Manure Processing Activities in Europe - Project reference: ENV.B.1/ETU/2010/0007

INVENTORY OF MANURE PROCESSING ACTIVITIES IN EUROPE

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Technical Report No. I to the European Commission, Directorate-General Environment

AGRO BUSINESS PARK

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Inventory of manure processing activities in Europe

Title

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Front page photos

Upper left: Decanter centrifuge for after-digestion separation of digestate.

Upper right: Composting of separated solid fraction of slurry in roofed store.

Lower left: Dried and pelletized separation fraction from biogas plant.

Lower right: Reception facilities at biogas plant.

Disclaimer

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PREFACE

Manure processing is presently a subject that enjoys considerable attention in the EU due to the ongoing revision of the Reference Document on Best Available Techniques for Intensive Rearing of Poultry and Pigs (BREF), as well as due to current efforts to implement policies and legislation on EU and Member State level, for instance concerning renewable energy targets, targets for reducing the loss of plant nutrients to the environment, targets for reduction of greenhouse gases, and targets for manure handling in agriculture in relation to legislation about water protection and manure surpluses in livestock intensive areas.

This report suggests on the basis of compilation and analysis of data from EU Member States that manure processing currently has reached an average level of 7.8% of the livestock manure production, with a big variation from country to country.

The report is prepared for the European Commission, Directorate General Environment, as part of the implementation of the project "Manure Processing Activities in Europe", project reference: ENV.B.1/ETU/2010/0007. The Report includes deliveries related with Task 1 concerning "Inventory of the actual manure processing activities in the EU"; the inventory indicates the amount of manure processed per Member State (MS), differentiated per type of manure and the scale of operations (farm scale – medium scale- industrial scale).

We greatly respect our contacts in the different EU Member States, listed in Annex B, and appreciate their assistance with the difficult task to establish an overview of manure processing activities in the EU. We hope that the compiled and analysed data of this report will be of value for everybody involved in this process.

Tjele, 28 October 2011

Henning Lyngsø Foged

Project Manager

Agro Business Park

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EXECUTIVE SUMMARY

Manure processing has become a focal issue in relation to current EU and national policies on environmental, climate, waste handling and renewable energy matters. However, there exists so far no official statistics about manure processing activities in EU, and this report is attempting to fill this information gap.

Information and data about manure processing activities has mainly been provided by national or regional experts, and collected via a digitalised survey. For a few Member States with marginal manure processing activities, for instance Malta and Cyprus, we did not get any response from our contacts, and we believe that manure processing in these countries is marginal. There are also no data for Ireland, where our contact reports, that manure processing hardly exists, neither for Portugal, where we are in doubt about the interpretation of the information we received.

Simple estimate of the total livestock manure production

The entire manure production in the EU that potentially is available for manure processing, distributed on Member States, is estimated to 1.4 billion ton. Not unexpected, the largest production is in France, followed by Germany, and the smallest production is in Malta. The figures make it possible to assess the share of livestock manure processing for the individual Member State and for the EU as a whole.

Steps to ensure the production of more precise estimates should be taken.

Inventory of livestock manure processing

Within the context of this study, manure processing is defined as the group of controlled processes that change the physical and/or chemical properties of the livestock manure, as an objective itself, or in order to recover energy from the livestock manure, make the livestock manure more stable, or remove nutrients from the main stream. In the study, technologies which have not yet reached the marketing phase are also included, although full scale plants/installations are not in operation on a commercial basis.

Conventional technologies related to logistics handling of livestock manure, like pumping, propagation, storing, and spreading have not been considered unless they are performed, as an objective itself, in order to change the physical and/or chemical properties of the livestock manure as controlled processes. Long term storage has not been considered as a processing technology, although it affects manure composition and lead to emissions to the atmosphere.

45 livestock manure processing technologies have been considered, comprising six principally related purposes:

- Separation comprises 10 mechanical, chemical and other technologies for active separation of slurries. Separation happens on 11,130 installations treating 49 million tonnes of livestock manure and other, equal to 3.1% of the entire livestock manure production in EU. Measured by treated volume the most used technology is separation by drum filters. In terms of the volume of processed manure and other products, separation is most used in Italy, where there are 8,802 installations processing an amount equal to 24% of the livestock manure production in the country.
- Additives and other pre/1st treatments comprise four technologies. Using additives and other pre/1st treatments happens on 668 installations treating 7.5 million tonnes of livestock manure and other products, equal to 0.5% of the entire livestock manure production in EU. Measured by treated volume, the most used technology is applying other additives to manure. In terms of the volume of processed manure and other products, the use of additives and

other pre/1st treatments is most used in United Kingdom, where there are 500 installations processing an amount equal to 2.6% of the livestock manure production in the country.

- Anaerobic treatment comprises mesophile and thermophile processes. Anaerobic treatment happens on 5,256 installations treating 88 million tonnes of livestock manure and other products, equal to 6.4% of the entire livestock manure production in EU. Measured by treated volume, the most used technology is mesophile anaerobic digestion. In terms of the volume of processed manure and other products, anaerobic treatment is most used in Germany, where there are 3,800 installations, processing an amount equal to 29.0% of the livestock manure production in the country.
- Treatment of the solid fraction comprises nine technologies. There are 1,486 installations treating 10.4 million tonnes of livestock manure and other products, equal to 0.8% of the entire livestock manure production in EU. In terms of the volume of processed manure and other products, treatment of the solid fraction is most used in Spain, where there are 254 installations processing an amount equal to 3.0% of the livestock manure production in the country.
- Treatment of the liquid fraction comprises 17 technologies. It happens on 587 installations treating 9.4 million tonnes of livestock manure and other products, equal to 0.7% of the entire livestock manure production in EU. Measured by treated volume, the most used technology is nitrification-denitrification (conventional). In terms of the volume of processed manure and other products, treatment of the liquid fraction is most used in Spain, where there are 87 installations processing an amount equal to 3.9% of the livestock manure production in the country.
- Air cleaning (as part of manure processing plant) comprises three technologies. There are 69 installations treating 4 million tonnes of livestock manure and other products, equal to 0.3% of the entire livestock manure production in EU. Measured by treated volume, the most used technology is air biofiltration. In terms of the volume of processed manure and other products, air cleaning (as part of manure processing plant) is most used in Denmark, where there are 19 installations and where the technology is applied to an amount equal to 5.4% of the livestock manure production in the country.

In total there is being processed 7.8% of the livestock manure production in the EU, equal to 108 million ton, containing 556,000 ton nitrogen and 139,000 ton phosphorus. 168 million ton livestock manure and other products are processed, whereof around 60 million ton (168 minus 108 million ton) is end and by-products from other processes and non-livestock manure biomasses. The largest share of the livestock manure production is being processed in Italy, Greece and Germany, with 36.8, 34.6 and 14.8% of their manure production respectively.

11 of the considered technologies do not exist in commercial operation, for instance struvite (magnesium ammonium phosphate) precipitation and partial nitrification - autothrophic anammox denitrification.

There is, in general, a large variation in the use of manure processing among the different EU countries, and the most widespread use is generally found in the areas of EU with the highest livestock densities. However, this tendency is blurred by other factors, for instance grazing practices, economic incentives and framework conditions, and the national context.

Another clear tendency we see from the survey is that biogas production (anaerobic digestion) is the "door-opener" for introduction of other manure processing technologies. Several EU Member States have no other type of manure processing than anaerobic digestion, for instance Latvia and Poland. Many of the manure processing technologies are complementary to the anaerobic digestion, either as pre-treatment technologies that can enhance the biogas production, or as post-treatments, which can help to convert the digestate into products with envisaged properties.

End and by-products

End and by-products from livestock manure processing comprise 11 groups of compounds, whereof 5 seem to be most relevant in relation to marketing, while the rest are most suited to be disposed of locally, close to the livestock manure processing installation.

The chemical composition of the end and by-products as well as other details are presented in Technical report No. III: End and by-products from livestock manure processing - general types, chemical composition, fertilising quality and feasibility for marketing.

General remarks

It is noted that when preparing an inventory in a situation without official statistics, and based on experts' estimates, there is a logic error of missing some data, i.e. information about manure processing installations, that were not known by the experts involved in the estimation. However, the consultant believes, despite this standard error, that the present report gives a good description of current manure processing activities in EU Member States.

1: BACKGROUND

Manure processing has become a focal issue in relation to current EU and national policies on environmental, climatic, waste handling and renewable energy matters, because it typically has effect on one or more of these policy targets.

Biogas production is one of the important manure processing technologies in this respect, having considerable positive effects on the environment, the climate, the waste handling and the renewable energy production. The Danish Government launched the so-called Green-Growth plan in 2009, a policy paper, which sets the target of reaching 50% of all manures processed for energy purposes by 2020. Netherlands has a goal of establishing 400 more biogas plants in the coming years, and France, Poland and several other Member States have similar goals.

There are also being developed, proposed and implemented other manure processing technologies. The group of manure separation technologies are efficient for securing a balanced fertilisation of the crops in areas with high livestock density. However, although we think we have a good insight into the effects of many manure processing activities, there is a need for examination of the activities, their effects and trends. In some cases manure processing activities could have adverse affects, for instance evaporation of laughing gas (nitrous oxide, N_2O – a greenhouse gas with a climate impact that is around 300 times that of CO_2), or contribution to the spreading of harmful substances like polymers in the nature. It is important to explore these and other effects, and balance positive and negative effects against each other.

However, there exists so far no official statistics about manure processing activities in EU despite its proven effects on the environment, the climate, the waste handling and the renewable energy production. The aim of this report is to indicate the scope and type of manure processing that actually takes place in order to fill the knowledge gap.

The concrete objective of this report is to make an inventory of the actual manure processing activities in the EU; the inventory indicate the manure processing type, the amount of manure processed per MS and differentiated per type of manure, and the scale of operations (farm scale – medium scale-industrial scale).

2: METHODOLOGY

A digitalised survey was chosen as the main methodology to collect data about current manure processing activities, and as secondary methodology, to supplement with reviews of articles and other available information, especially for countries where the survey method failed.

2.1: Digitalised survey

A questionnaire was developed on basis of the "long list" of manure technologies, which is presented in Annex A.

The manure processing technologies on the "long-list" in Annex A were selected on basis of the following definition:

- The technologies cater for controlled processes that change the physical and/or chemical properties of the livestock manure, as an objective itself, or in order to recover energy from the livestock manure, make the livestock manure more stable, or remove nutrients from the main stream.
- Technologies which have not reached the marketing phase are also included, although full scale plants/installations are not in operation on a commercial basis.
- Conventional technologies related to logistics handling of livestock manure, like pumping, propagation, storing, and spreading have not been considered unless they are performed, as an objective itself, in order to change the physical and/or chemical properties of the livestock manure as controlled processes. Long term storage has not been considered as a processing technology, although it affects manure composition and lead to emissions to the atmosphere.

The purpose of the survey was for each of the listed technologies to collect information about

- overview of manure processed expressed in ton as well as kg N and P;
- breakdown of manure processing by size (farm size, small-medium size (< 50.000 tons / year) and large scale (> 50.000 tons / year);
- breakdown of processing types; and
- amount processed from each processing types and a short characterisation of type and description of end and by-products.

The digitalisation of the survey was made in order to make it as easy as possible for respondents to deliver information, ease our analysing of the information, and avoid mistakes that typically appear when response data is manually handled. Agro Business Park made its own programming of the digitalised survey.

The digitalised survey was to some extent tested on data from Spain and Denmark before involving of external respondents.

As there are no official statistics on the inventory of manure processing activities, the involved experts were informed, that we expected to have experts' estimates. The survey gives possibility to register the source of the data, where available. Annex B provides a list of persons/institutions, who took part in the survey.

Respondents were motivated to participate in the survey by arguing that the analysed information gathered via the survey would be useful for them as well. They were also informed about the possibility to participate in the seminar organised within the frames of the project on 12 October 2011 in Brussels.

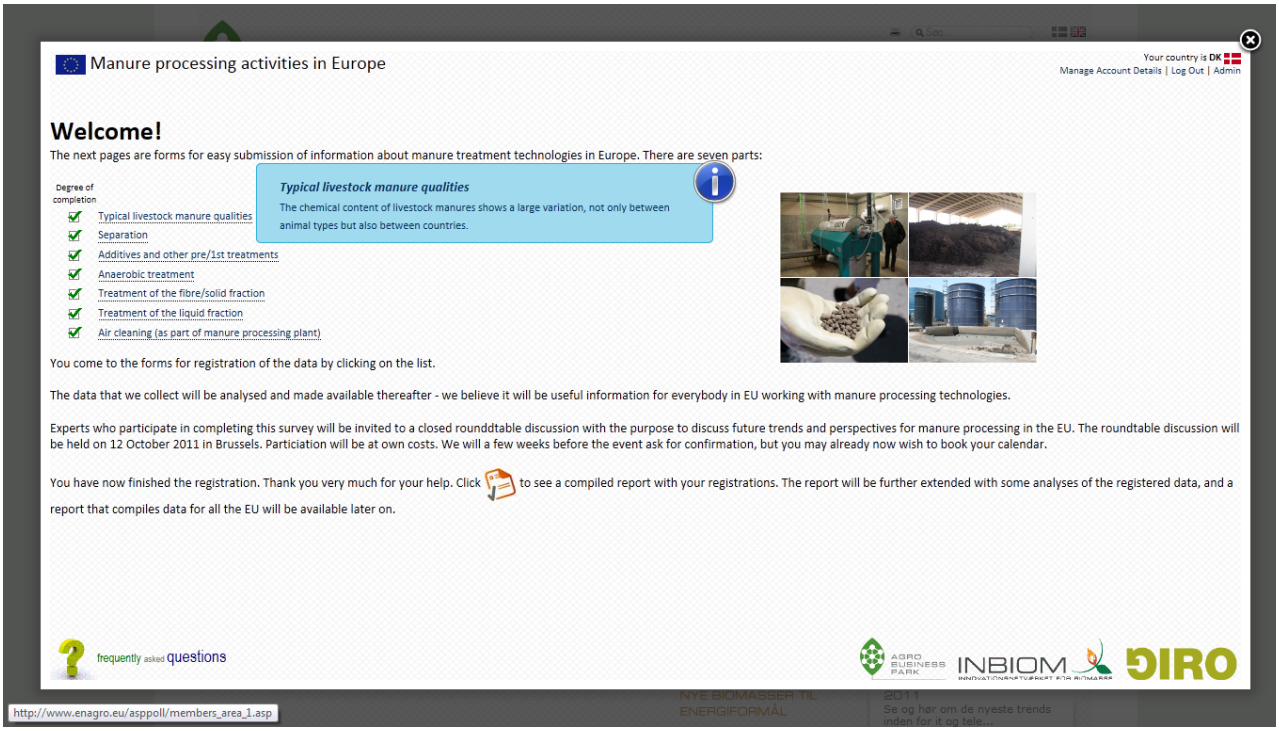

Figure 2.1.1: Screen dump of the digitalised survey, containing 7 parts; manure qualities and 6 groups of technologies. Tooltips were used for clarifying used terminologies, and a "Frequently Asked Questions" document available to explain further questions about working procedures for the survey. Icons were used to symbolise the degree of finalisation.

Annex C specifies in details which data/information we asked for in the survey. Annex C.1 concerns the livestock manure qualities, but as only a few countries registered their own values, the estimation of treated amounts of N and P has been based on the default values, that are inspired by Danish manure figures – see frequently asked questions in Annex D. Annex C.2 shows the data concerning each technology. The data collected about qualities of end and by-products is presented in Technical report No. III: End and by-products from livestock manure processing - general types, chemical composition, fertilising quality and feasibility for marketing.

The work with the survey was organised in the sub-activities that are listed in the following table:

Table 2.1.1: Sub-activities concerning task 1 about inventory of manure processing activities.

Activity #	Activity
1.1	Development of a "long-list" of technologies, and the products and by-products they make
1.2	Development of a draft questionnaire (also considering information needed to perform tasks 2-5)
1.3	Test the questionnaire
1.4	Revise and digitalise the questionnaire
1.5	Carry out the survey
1.6	Remind of answering (ABP and GIRO)
1.7	Analysing results (Mainly ABP)

Activity #	Activity
1.8	Delivery of Technical Report (ABP)

The consultant has in chapter 3 made a simplified estimate of the entire livestock manure production in EU Member States in order to be able to calculate the share of process livestock manure in the different MS as well as for different technologies. The decision to make own, simplified estimates of the livestock manure production followed an unsuccessful search for published, uniform and updated statistics or estimates covering all MS.

The methodology for the estimation were based on FAO statistics on livestock numbers, combined with a number of assumptions, for instance that pigs in all EU Member States produce the same amount and quality of livestock manure. A complete overview of assumptions used for the simplified estimate is seen from Table 3.4.1.

2.2: Used definition and terms

See section 2.1 concerning definition of manure processing.

Annex D lists frequently asked questions, here under definition of terms and assumptions. It is for instance assumed that pig, cattle and poultry manure make up the vast majority of the livestock manure that is interesting in relation to manure processing.

2.3: Reviews of articles and other

We reviewed various articles and reports to supplement the data and information we got via the survey.

2.4: Quality and availability of data from the Member States

Annex B lists the respondents, who have taken part in the collection of data. The list also score and comment the data information reliability.

It is emphasized, that the information and data in the survey to a large extent is made on basis of experts' assumptions /estimates, here under also the consultant's estimates.

3: SIMPLIFIED ESTIMATE OF LIVESTOCK MANURE AMOUNTS AND QUALITIES IN EU MEMBER STATES

3.1: Livestock number in EU

When analysing the current manure processing activities in EU Member States the consultant proposes to compare this to the entire manure production in EU Member States, in order to be able to calculate the relative amount of livestock manure being processed in the individual Member State.

The decision to make own, simplified estimates of the livestock manure production followed an unsuccessful search for published, uniform and updated statistics or estimates covering all MS.

The following table provides an overview of pigs, cattle and chickens in each EU Member State, assuming that those are the most relevant animal categories when estimating the livestock manure production. There are many other types of livestock manures, for instance horse manure, which sometimes are processed, while on the other hand we do not estimate the amount of the manure that is not available for processing, because it is directly deposited on the field during grazing; probably these two factors will outweigh each other. Bioteau et al. (2009) has clarified that dairy cattle in average spend around 40% of their time outdoors, while beef cattle spend averagely around 60% of their time outdoor.

Table 3.1: Number of pigs, cattle and chicken in EU Member States in 2009. Source: FAOSTAT.

EU Member States	Pigs	Cattle	Chickens (x 1000)
Austria	3,064,231	1,997,209	14,500
Belgium	6,227,900	2,535,400	29,048
Bulgaria	783,649	564,904	17,549
Czech Republic	1,909,232	1,349,286	24,042
Cyprus	464,932	55,589	2,904
Denmark	12,369,145	1,540,340	19,224
Estonia	364,900	237,900	1,757
Finland	1,381,207	918,268	4,918
France	14,810,000	18,591,000	176,000
Germany	26,886,500	12,944,903	118,000
Greece	942,000	620,000	31,800
Hungary	3,383,000	701,000	31,165
Ireland	1,468,200	6,716,100	No data
Italy	9,252,400	6,124,000	26,000
Latvia	383,700	380,200	4,000
Lithuania	897,100	770,900	8,841
Luxembourg	80,217	196,470	97,418
Malta	65,511	17,777	500
Netherlands	12,108,000	3,996,000	97,000
Poland	14,278,647	5,700,017	124,129
Portugal	2,339,700	1,438,700	39,000
Rumania	6,174,000	2,684,000	84,373
Slovakia	740,862	483,810	13,249
Slovenia	432,011	469,983	4,387
Spain	26,289,600	6,020,200	138,000
Sweden	1,528,740	1,538,281	7,159
United Kingdom	4,601,000	9,901,000	170,000
TOTAL	153,226,384	88,493,237	1,284,963

3.2: Amount of livestock manure produced in EU Member States

In order to estimate the livestock manure amount it is necessary to make some further assumptions concerning the relative share of different animal types – see the following table:

Table 3.2: Assumed relative number of animals of different types, and their livestock manure production on an annual basis (based on Hanne Damgaard Poulsen (2010)).

Animal type	Pigs		Cattle		Chickens	
	Relative number of animals	Tonnes livestock manure per animal per year	Relative number of animals	Tonnes livestock manure per animal per year	Relative number of animals	Tonnes livestock manure per animal per year
Mother animals	100	7.7	100	24	100	0.2820
Males for breeding			3	12		
Youngsters until weaning			55	1.9		
Young, females after weaning	500	0.5	55	5	100	0.0016
Young males after weaning	500	0.5	20	3	100	0.0016
Average amount per animal, tonnes		1.2		12.3		0.0951

There would in practice be differences in the relative number of animals per type, for instance due to

- Pig production: Different weaning age, different slaughter weight of fatteners, different culling rate.
- Cattle production: Different culling rate, different practices concerning age of male calves at slaughter, different calving age.
- Chickens: Export/import relations for chicken meat and eggs. Weight at slaughter for broilers.

There would also in practice be differences in the amount of livestock manure produced per animal, for instance due to

- Pig production: Different litter size, different feed intensity / daily gain potential of fatteners.
- Cattle production: Different milk yield, relative share of beef and dairy cattle, predominant breeds (weight of animals).
- Chickens: Feed intensity for broilers.

Another assumption, necessary for making an estimate of the livestock manure amounts are the distribution on different livestock manure types – see the following table:

Table 3.3: Assumed relative share of different types of manure production, all figures in percent (%). Figures are based on a survey made by Bioteau et al. (2009).

Livestock manure type	Pigs	Cattle	Chickens
Solid	8	27	
Liquid	5[1]	5[1]	
Slurry	84	41	3
Deep litter	3	27	97

[1] There should theoretically be higher amounts of liquid manure from stables with source separated manure, but here assumed smaller liquid fraction, as it is often not collected in especially eastern European Member States.

Based on the above assumptions, the following tables shows the amounts of livestock manure production from pigs, cattle and chickens in EU Member States.

Table 3.4: Estimated amount of livestock manure produced from pigs, cattle and chickens in the EU Member States, divided on major livestock manure types, based on assumptions that appear from the above tables. All figures in 1,000 tonnes per year.

EU Member State	Source separated pig manure		Pig slurry	Pig deep litter	Source separated cattle manure		Cattle slurry	Cattle deep litter	Poultry slurry	Poultry deep litter	Total
	Solid	Liquid			Solid	Liquid					
Austria	283	177	2972	106	6655	1232	10106	6655	41	1337	29564
Belgium	575	359	6039	216	8448	1564	12829	8448	83	2679	41241
Bulgaria	72	45	760	27	1882	349	2858	1882	50	1618	9545
Czech Republic	176	110	1851	66	4496	833	6827	4496	69	2217	21142
Cyprus	43	27	451	16	185	34	281	185	8	268	1499
Denmark	1142	714	11995	428	5133	950	7794	5133	55	1773	35117
Estonia	34	21	354	13	793	147	1204	793	5	162	3524
Finland	128	80	1339	48	3060	567	4646	3060	14	454	13395
France	1368	855	14362	513	61948	11472	94068	61948	502	16230	263264
Germany	2483	1552	26073	931	43134	7988	65500	43134	337	10881	202013
Greece	87	54	913	33	2066	383	3137	2066	91	2932	11762
Hungary	312	195	3281	117	2336	433	3547	2336	89	2874	15519
Ireland	136	85	1424	51	22379	4144	33983	22379			84580
Italy	855	534	8972	320	20406	3779	30987	20406	74	2398	88731
Latvia	35	22	372	13	1267	235	1924	1267	11	369	5515
Lithuania	83	52	870	31	2569	476	3901	2569	25	815	11390
Luxembourg	7	5	78	3	655	121	994	655	0	9	2527
Malta	6	4	64	2	59	11	90	59	1	46	343
Netherlands	1118	699	11742	419	13315	2466	20219	13315	277	8945	72515
Poland	1319	824	13847	495	18993	3517	28841	18993	354	11447	98630
Portugal	216	135	2269	81	4794	888	7280	4794	111	3596	24164
Romania	570	356	5987	214	8943	1656	13581	8943	241	7780	48272
Slovakia	68	43	718	26	1612	299	2448	1612	38	1222	8086
Slovenia	40	25	419	15	1566	290	2378	1566	13	405	6716
Spain	2428	1518	25494	911	20060	3715	30462	20060	394	12726	117766
Sweden	141	88	1482	53	5126	949	7784	5126	20	660	21430
United Kingdom	425	266	4462	159	32991	6110	50098	32991	485	15676	143663
TOTAL	**14151**	**8845**	**148590**	**5307**	**294870**	**54606**	**447766**	**294870**	**3387**	**109518**	**1381911**

3.4: Concluding remarks

As mentioned above, the simplified estimate was made on basis of several assumptions, and the following Table 3.5 gives an overview of these.

Table 3.5: Overview of assumptions made for the simplified estimate

#	Assumption	Comment
1	The estimates only include manure from cattle, pigs and chickens, disregarding sheep and horses.	The error on the estimate would probably be within ±10%, judged on basis of the number of sheep and horses and the amount of manure they produce, in relation to the same estimates for cattle, pigs and chicken. Livestock manures from other livestock types are seldom used for processing.
2	The estimate disregards that some livestock manure is directly deposited on the fields during grazing, therefore not available for processing.	The error on the estimate would probably be within ±15%; it should be kept in mind that, although grazing, many cattle have access to stables and that dairy cows are taken to stables twice per day for milking.
3	Used standard values for livestock manure were based on official Danish values, except for Netherlands and Belgium.	The error would probably be within ±10%, based on own qualified estimate, and would be due to some MS having other milk yield of dairy cows, lower feed intensity in the pig production (actually giving higher feed consumption / livestock manure production), different production systems, other relation between beef and dairy cattle, etc. However, productivities and production systems are becoming more and more similar in different EU MS' professional livestock production. The consultant did not have sufficient data about standard values for livestock manure from the different MS, and could therefore not base the estimates on this.
4	The share of animal types (for instance division on number of sows and produced fatteners) have been estimated from the total statistics (for instance size of pig herds)	As above (# 3)
5	All MS have the same distribution of livestock manure on different types, i.e. for instance the same share of slurry from cattle.	The error would probably be within ±10%, based on own qualified estimate, and be due to difference in stable systems, for instance that loose housing systems with slotted floors are more used for cattle in Denmark than in Poland.

The simplified estimate, based on the mentioned assumptions, shows, that there in EU annually are roughly 1.4 billion tonnes of livestock manure potentially available for manure processing. Not unexpected, the largest production in absolute figures is in France, followed by Germany, and the smallest production is in Malta.

The estimated amounts are generally similar to the estimates for the EU-15 countries, made by Holm-Nielsen and Al Seadi (2006), within ±10% of variation. Schultheiß et al. (2010) estimated that the total

livestock manure production in Germany is 169 million ton, which is about 16% less than estimated on basis of the methodology used to produce table 3.4 above. F.E. de Buisonjé, Wageningen UR Livestock Research, the Netherlands, has cited an estimate of Dutch livestock manure production to be of the same size as the abovementioned estimate. Stan Lalor of Teagasc has pointed out that more than 80% of cattle manure is in the form of slurry in Ireland.

We are aware of the uncertainties and standard errors in the estimates in table 3.4, and have mentioned these above. However, despite the uncertainties we believe that it is useful to have a possibility to compare the amounts of processed livestock manure with estimates for the entire amounts, based on a uniform methodology across EU Member States.

However, the EU Commission is recommended to take steps to ensure availability of more precise estimates than it was possible to do in this study.

4: INVENTORY OF MANURE PROCESSING ACTIVITIES

The following sections provide information on actual manure processing activities in the EU; the inventory indicates the amount of manure processed per EU Member State, differentiated per type of manure and the scale of operations (farm scale – medium scale- industrial scale), organised according the manure processing technology.

It is emphasized that the tables in this section as well as the tables in Annex E list technologies that are found to be in commercial operation in the EU Member States. There were 12 of the considered technologies that do not exist in commercial operation, for instance struvite (magnesium ammonium phosphate) precipitation and partial nitrification - autothrophic anammox denitrification.

Similarly, in the tables in this section as well as in Annex E, only Member States where we have found commercial use of the technologies in question are listed. For instance, there is only reported use of livestock manure separation in nine EU Member States (see Table 4.2).

It is likewise emphasized, that the tables in this section and in Annex E both provide information about treated amounts of "livestock manure and other" and "livestock manure". With "livestock manure" is here meant "raw", i.e. not previously processed/treated livestock manure, while "Other" means by or end products of livestock manure that is already processed, and / or substrates that are other organic wastes than livestock manure.

4.1: Separation

Definition: System with the objective of separating manure into two flows: a concentrate (solid fraction) and a diluted fraction (liquid fraction).

Table 4.1: Livestock manure processing, distributed on separation technologies, in EU 27.

#	Livestock manure processing technology	Number of plants			Average treated per installation, tons/year			Total treated amounts			
		Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Livestock manure and other[2], 1000 tonnes	Livestock manure[3], 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus, tonnes
1	Coagulation-	20		9	9800		187200	1881	162	700	156

[2] "Other" means by or end products of livestock manure that is already processed, and / or other organic wastes.

[3] "Livestock manure" means "raw", i.e. not previously processed/treated livestock manure.

#	Livestock manure processing technology	Number of plants			Average treated per installation, tons/year			Total treated amounts			
		Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Livestock manure and other[2], 1000 tonnes	Livestock manure[3], 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus, tonnes
	Flocculation										
3	Separation by grate	20		4	15000		120000	780	780	6845	2748
4	Separation by screw pressing	3617	38	13	2983	7876	77538	12096	11549	51365	13280
5	Separation by sieves	1989	1	5	3624	31171	112000	7799	7205	33845	8771
6	Separation by filter pressing	114		4	10711		72500	1511	1287	6444	1244
7	Separation by centrifuge	136	80	28	4037	15682	99220	4582	3388	21157	4893
8	Air Flotation			2			60000	120			
9	Separation by drum filters	4632		3	2611		115000	12441	12434	40933	14771
10	Natural settling separation	407	1	7	16162	31171	104000	7337	6578	34387	7060
Total		**10935**	**120**	**75**	**-**	**-**	**-**	**48547**	**43383**	**195676**	**52923**

Table 4.2: Separation of livestock manure, distributed on EU Member States.[4]

Livestock manure processing technology	Number of plants			Average treated per installation, tons/year			Total treated amounts			
	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes
Belgium	1	76	3	16500	14665	62720	1320	1294	11521	2304
Czech Republic	250			1000			250	250	913	203
Denmark	79	2	3	9854	50000	100000	1179	816	3633	774
Finland	31			1968			61	61	213	42
France	73			1507			110	110	851	315
Germany	106			14953			1585	1585	8046	1642
Greece	954			3191			3045	3045	15166	2757
Italy	8800	2		2465	31171		21758	21693	78546	26793
Netherlands		31	16		7258	68437	1320	1046	4619	1236
Romania	88			65244			5742	5742	30878	7482
Spain	120	9	53	11025	12703	120959	7849	3413	18549	5552
United Kingdom	433			10000			4330	4330	22746	3827

[4] Communication with L. Ferreira: "80 % (to be conservative) of pig livestock is covered by treatment systems which use screeners (rotating or static sieves). Very few examples of farms are using screw pressing separators (I would not count them due to the very inexpressive representativeness)". There are 10,830 pig farms in Portugal, which implies 8,664 installations, but this number seems excessive and is not inserted in the survey (J. Palatsi).

Livestock manure processing technology	Number of plants			Average treated per installation, tons/year			Total treated amounts			
	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes
Total	**10935**	**120**	**75**	**-**	**-**	**-**	**48549**	**43385**	**195681**	**52927**

Table 4.3: Separation of livestock manure, distributed on livestock manure types. All figures in %.

Source separated pig manure		Pig slurry	Pig deep litter	Source separated cattle manure		Cattle slurry	Cattle deep litter	Poultry slurry	Poultry deep litter	Other
Solid	Liquid			Solid	Liquid					
1		49				33		7		11

Conclusion: Separation comprises 10 mechanical, chemical and other technologies for active separation of slurries. Separation happens on 11,130 installations treating 49 million tonnes of livestock manure and other, equal to 3.1% of the entire livestock manure production in EU. Measured by treated volume, the most used technology is separation by drum filters. In terms of the volume of processed manure and other products, separation is most used in Italy, where there are 8,802 installations processing an amount equal to 24% of the livestock manure production in the country.

4.2: Additives and other pre/1st treatments

Definition: Set of processes which objective is the preparation of the material for a further purpose or treatment.

Table 4.4: Livestock manure processing, distributed on technologies concerning additives and other pre/1st treatments, in EU 27.

#	Livestock manure processing technology	Number of plants			Average treated per installation, tons/year			Total treated amounts			
		Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes
11	Acidification of liquid livestock	80	23	17	6750	47826	81294	3022	1476	6861	1377

#	Livestock manure processing technology	Number of plants			Average treated per installation, tons/year			Total treated amounts			
		Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes
	manures										
12	pH increasing (liming)	1	2	1	1000	16282	66530	100	100	796	209
13	Temperature and pressure treatment		17			29520		502	502	2173	665
14	Applying other additives to manure	525	2		7267	17000		3849	3799	19694	3355
Total		**606**	**44**	**18**	**-**	**-**	**-**	**7473**	**5877**	**29524**	**5606**

Table 4.5: Additives and other pre/1st treatments of livestock manure, distributed on EU Member States.

Member State	Number of plants			Average treated per installation, tons/year			Total treated amounts			
	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes
Belgium		3	1		21888	66530	132	132	915	215
Denmark	80	18		6750	50000		1440	1296	6085	1204
Finland	6			2667			16	16	60	13

Member State	Number of plants			Average treated per installation, tons/year			Total treated amounts			
	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes
France	20			2500			50			
Netherlands		16			31240		500	500	2149	650
Spain		7	17		28986	81294	1585	183	811	195
United Kingdom	500			7500			3750	3750	19504	3330
Total	**606**	**44**	**18**	**-**	**-**	**-**	**7473**	**5877**	**29524**	**5607**

Table 4.6: Additives and other pre/1st treatments of livestock manure, distributed on livestock manure types. All figures in %.

Source separated pig manure		Pig slurry	Pig deep litter	Source separated cattle manure		Cattle slurry	Cattle deep litter	Poultry slurry	Poultry deep litter	Other
Solid	Liquid			Solid	Liquid					
		25				52		1		21

Conclusion: Additives and other pre/1st treatments comprise four technologies. Using additives and other pre/1st treatments happens on 668 installations treating 7.5 million tonnes of livestock manure and other products, equal to 0.5% of the entire livestock manure production in EU. Measured by treated volume the most used technology is applying other additives to manure. Use of additives and other pre/1st treatments is in terms of the volume of processed manure and other products most used in United Kingdom, where there are 500 installations processing an amount equal to 2.6% of the livestock manure production in the country.

4.3: Anaerobic treatment

Definition: Series of biological processes in which microorganisms break down organic molecules in absence of oxygen, resulting in the production of a mixture of gases, named biogas, mainly composed of methane and carbon dioxide.

Table 4.7: Livestock manure processing, distributed on anaerobic treatment technologies, in EU 27.

#	Livestock manure processing technology	Number of plants			Average treated per installation, tons/year			Total treated amounts			
		Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes
15	Mesophilic anaerobic digestion	4377	457	101	13861	29232	75014	81605	45887	216885	52564
16	Thermophilic anaerobic digestion	315	2	4	19783	2500	49375	6434	3147	16078	3653
Total		**4692**	**459**	**105**	**-**	**-**	**-**	**88039**	**49034**	**232963**	**56217**

Table 4.8: Anaerobic treatment of livestock manure, distributed on EU Member States.

Member State	Number of plants			Average treated per installation, tons/year			Total treated amounts			
	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes
Austria	307	31	3	1564	1929		540	500	2459	463

Member State	Number of plants			Average treated per installation, tons/year			Total treated amounts			
	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes
Belgium	4	19	8	16500	7979	25812	424	417	2949	652
Austria	307	31	3	1564	1929		540	500	2459	463
Belgium	4	19	8	16500	7979	25812	424	417	2949	652
Bulgaria	2			15000			30	23	104	21
Czech Republic	180			20000			3600	1800	6570	1462
Denmark	57		19	26000		100000	3382	2537	13539	2657
Estonia		1			40000		40	30	86	12
Finland	9		1	4889		120000	164	164	521	93
France	30			5500			165	125	596	72
Germany	3800			15395			58500	27495	141512	32538
Greece	2			32850			66	66	283	63
Hungary	1	1	1	19000	35000	90000	144	86	483	96
Italy	208	289	24	6700	39429	75343	14597	10948	41601	12772
Latvia	8	8		20000	10000		240	240	1493	341
Lithuania			1			54000	54	54	166	11

Member State	Number of plants			Average treated per installation, tons/year			Total treated amounts			
	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes
Luxembourg	25		5	1000		30000	175	116	484	63
Netherlands		100	30		13750	75000	3625	2712	12149	3117
Poland	3	2	2	27500	45000	82000	337	252	1088	242
Romania	1			730			1			
Slovakia	5			4000			20	16	73	15
Slovenia	5	3	2	40706	6610	88600	401	337	1676	434
Spain	7	3	9	22286	36667	94889	1120	807	3728	844
Total	**4692**	**459**	**105**	**-**	**-**	**-**	**88041**	**49034**	**232963**	**56218**

Table 4.9: Anaerobic treatment of livestock manure, distributed on livestock manure types. All figures in %.

Source separated pig manure		Pig slurry	Pig deep litter	Source separated cattle manure		Cattle slurry	Cattle deep litter	Poultry slurry	Poultry deep litter	Other
Solid	Liquid			Solid	Liquid					
		30				21	4			44

Conclusion: Anaerobic treatment comprises mesophile and thermophile processes. Anaerobic treatment happens on 5,256 installations treating 88 million tonnes of livestock manure and other, equal to 6.4% of the entire livestock manure production in EU. Measured by treated volume the most used technology is mesophile anaerobic digestion. In terms of the volume of processed manure and other products, anaerobic treatment is most used in Germany, where there are 3,800 installations, processing an amount equal to 29.0% of the livestock manure production in the country.

4.4: Treatment of the solid fraction

Definition: Processing methods especially suitable for solid manures or solid fractions obtained after separation.

Table 4.10: Livestock manure processing, distributed on technologies for treatment of the solid fraction, in EU 27.

#	Livestock manure processing technology	Number of plants			Average treated per installation, tons/year			Total treated amounts			
		Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes
17	Composting of solid livestock manure or fibre fractions of liquid livestock manure	1180	101	7	2730	15776	63837	5262	3459	43663	10341
18	Vermicomposting	5	3		4000	2043		26	21	173	36
19	Biodrying	62	8	7	5806	13300	107300	1218	1145	9078	1843
20	Thermal drying	1	45	35	3300	11199	52547	2346	1395	22208	7344
21	Pelletizing	5	6	10	8200	10000	35600	457	280	1570	355
22	Combustion	1	6	4	6500	7375	268750	1126	1122	13639	3128
Total		**1254**	**169**	**63**	**-**	**-**	**-**	**10435**	**7422**	**90331**	**23047**

Table 4.11: Treatment of the solid fraction of livestock manure, distributed on EU Member States.

Member State	Number of plants			Average treated per installation, tons/year			Total treated amounts			
	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes
Belgium	2	37	11	2150	12171	89691	1441	1087	6553	1585
Denmark	5	2		2420	25000		63	55	398	89
Estonia		2			17500		35	35	344	88
Finland	20			2000			40	40	289	98
France	110			3182			350	350	6558	861
Germany			5			200000	1000	750	18750	6600
Greece	496			2002			993	904	17946	4111
Netherlands		38	1		16316	400000	1020	1020	9224	2585
Romania	84			4429			372	374	2155	537
Spain	128	83	43	7977	13608	32709	3556	1247	6807	1777
Sweden		7			4179		29	25	163	45
United Kingdom	409		3	2103		225000	1535	1535	21144	4671
Total	**1254**	**169**	**63**	**-**	**-**	**-**	**10434**	**7422**	**90331**	**23047**

Table 4.12: Treatment of the solid fraction of livestock manure, distributed on livestock manure types. All figures in %.

Source separated pig manure		Pig slurry	Pig deep litter	Source separated cattle manure		Cattle slurry	Cattle deep litter	Poultry slurry	Poultry deep litter	Other
Solid	Liquid			Solid	Liquid					
1	1	7		14		1	4	3	25	27

Conclusion: Treatment of the solid fraction comprises nine technologies. There are 1,486 installations treating 10.4 million tonnes of livestock manure and other products, equal to 0.8% of the entire livestock manure production in EU. In terms of the volume of processed manure and other products, treatment of the solid fraction is most used in Spain, where there are 254 installations processing an amount equal to 3.0% of the livestock manure production in the country.

4.5: Treatment of the liquid fraction

Definition: Processing methods especially suitable for diluted manures or liquid fractions obtained after separation.

Table 4.13: Livestock manure processing, distributed on technologies for treatment of the liquid fraction, in EU 27.

#	Livestock manure processing technology	Number of plants			Average treated per installation, tons/year			Total treated amounts			
		Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes
27	Ultra filtration			1			55000	55			
28	Reverse osmosis		23			10870		250			
29	Concentration by vacuum evaporation		5	18		40000	81222	1662	180	776	173
30	Concentration by atmospheric evaporation		2	7		8800	80857	584			
31	Ammonia stripping and		1			31856		32			

#	Livestock manure processing technology	Number of plants			Average treated per installation, tons/year			Total treated amounts			
		Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes
	absorption										
33	Electro-oxidation		1			1000		1	1	4	
34	Ozonizing		4	9		40000	75333	838			
35	Aerobic digestion (aeration)	123	4	1	7858	40000	80000	1207	850	3594	792
37	Nitrification-denitrification (conventional)	229	76	23	6441	13130	78952	4289	1118	3641	364
42	Constructed wetlands	55	5		7273	17000		485			
Total		**407**	**121**	**59**	**-**	**-**	**-**	**9403**	**2149**	**8015**	**1329**

Table 4.14: Treatment of the liquid fraction of livestock manure, distributed on EU Member States.

Member State	Number of plants			Average treated per installation, tons/year			Total treated amounts			
	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes
Belgium		84	4		13113	54975	1322	45	125	9

Member State	Number of plants			Average treated per installation, tons/year			Total treated amounts			
	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes
Finland	20			3000			60	60	190	34
France	215			5233			1125	1000	3080	210
Greece	1			59130			59	59	255	57
Italy		1			31856		32			
Netherlands		23	12		10870	71250	1105			
Spain	31	13	43	17653	40000	83302	4649	310	1456	371
United Kingdom	140			7500			1050	675	2909	648
Total	**407**	**121**	**59**	**-**	**-**	**-**	**9402**	**2149**	**8015**	**1329**

Table 4.15: Treatment of the liquid fraction of livestock manure, distributed on livestock manure types. All figures in %.

Source separated pig manure		Pig slurry	Pig deep litter	Source separated cattle manure		Cattle slurry	Cattle deep litter	Poultry slurry	Poultry deep litter	Other
Solid	Liquid			Solid	Liquid					
	11	11				1				77

Conclusion: Treatment of the liquid fraction comprises 17 technologies. It happens on 587 installations treating 9.4 million tonnes of livestock manure and other products, equal to 0.7% of the entire livestock manure production in EU. Measured by treated volume, the most used technology is nitrification-denitrification (conventional). In terms of the volume of processed manure and other products, treatment of the liquid fraction is most used in Spain, where there are 87 installations processing an amount equal to 3.9% of the livestock manure production in the country.

4.6: Air cleaning (as part of manure processing plant)

Definition: Methods applied to clean process air used during some manure treatment (i.e. exhaust air from composting, or from venting of storage systems).

Table 4.16: Livestock manure processing, distributed on technologies for air cleaning (as part of manure processing plant) , in EU 27.

#	Livestock manure processing technology	Number of plants			Average treated per installation, tons/year			Total treated amounts			
		Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes
43	Air scrubbing		13	8		15215	97770	980			
44	Air biofiltration		8	25		15858	101987	2677			
45	Bioscrubing (Aerobic biofilter)		9	6		19222	32242	366			
Total			**30**	**39**	**-**	**-**	**-**	**4023**			

Table 4.17: Air cleaning (as part of manure processing plant), distributed on EU Member States.

Member State	Number of plants			Average treated per installation, tons/year			Total treated amounts			
	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes
Belgium		23	15		14426	103353	1882			

Member State	Number of plants			Average treated per installation, tons/year			Total treated amounts			
	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes
Denmark			19			100000	1900			
Netherlands		5	5		25000	15000	200			
Spain		2			20433		41			
Total		**30**	**39**	**-**	**-**	**-**	**4023**			

Table 4.18: Air cleaning (as part of manure processing plant), distributed on livestock manure types. All figures in %.

Source separated pig manure		Pig slurry	Pig deep litter	Source separated cattle manure		Cattle slurry	Cattle deep litter	Poultry slurry	Poultry deep litter	Other
Solid	Liquid			Solid	Liquid					
										100

Conclusion: Air cleaning (as part of manure processing plant) comprises three technologies. There are 69 installations treating 4 million tonnes of livestock manure and other products, equal to 0.3% of the entire livestock manure production in EU. Measured by treated volume, the most used technology is air biofiltration. In terms of the volume of processed manure and other products, air cleaning (as part of manure processing plant) is most used in Denmark, where there are 19 installations and where the technology is applied to an amount equal to 5.4% of the livestock manure production in the country.

4.7: Overall analyses

The following tables show the relative share of the livestock manure production that is being processed per livestock manure processing technology group and per Member State.

Table 4.19: Overview of total manure processing in EU, divided on processing technology.

Livestock manure processing technology group	Number of plants			Total treated amounts					
				Livestock manure and other		Livestock manure			
	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	1000 tonnes	% of all livestock manure production in observed Member States	1000 tonnes	% of all livestock manure production in observed Member States	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes
Separation	10935	120	75	48546	3,5	43383	3,1	195676	52923
Additives and other pre/1st treatments	606	44	18	7473	0,5	5877	0,4	29524	5606
Anaerobic treatment	4692	459	105	88039	6,4	49033	3,5	232963	56217
Treatment of the solid fraction	1254	169	63	10435	0,8	7422	0,5	90331	23047
Treatment of the liquid fraction	407	121	59	9402	0,7	2149	0,2	8015	1329
Air cleaning (as part of manure processing plant)	0	30	39	4023	0,3	0	0,0		
Total	**17894**	**943**	**359**	**167918**	**12.2**	**107864**	**7,8**	**556509**	**139122**

Table 4.20: Overview of total manure processing in EU, divided on Member States.

EU Member State	Number of plants			Total treated amounts					
				Livestock manure and other		Livestock manure			
	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	1000 tonnes	% of all livestock manure production in observed Member States	1000 tonnes	% of all livestock manure production in observed Member States	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes
Austria	307	31	3	540	1,8	500	1,7	2459	463
Belgium	7	242	42	6521	15,8	2975	7,2	22063	4765
Bulgaria	2	0	0	30	0,3	23	0,2	104	21
Czech Republic	430	0	0	3850	18,2	2050	9,7	7483	1665
Denmark	221	22	41	7964	22,7	4704	13,4	23655	4724
Estonia	0	3	0	75	2,1	65	1,8	430	100
Finland	86	0	1	341	2,5	341	2,5	1273	280
France	448	0	0	1800	0,7	1585	0,6	11085	1458
Germany	3906	0	5	61085	30,2	29830	14,8	168308	40780
Greece	1453	0	0	4163	35,4	4074	34,6	33650	6988
Hungary	1	1	1	144	0,9	86	0,6	483	96
Italy	9008	292	24	36387	41,0	32641	36,8	120147	39565
Latvia	8	8	0	240	4,4	240	4,4	1493	341

EU Member State	Number of plants			Total treated amounts					
				Livestock manure and other		Livestock manure			
	Farm size installations	Small/medium size installations, treating < 50,000 tons/year	Large-scale installations, treating > 50,000 tons/year	1000 tonnes	% of all livestock manure production in observed Member States	1000 tonnes	% of all livestock manure production in observed Member States	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes
Lithuania	0	0	1	54	0,5	54	0,5	166	11
Luxembourg	25	0	5	175	6,9	116	4,6	484	63
Netherlands	0	213	64	7770	10,7	5278	7,3	28141	7588
Poland	3	2	2	337	0,3	252	0,3	1088	242
Romania	173	0	0	6115	12,7	6116	12,7	33033	8019
Slovakia	5	0	0	20	0,2	16	0,2	73	15
Slovenia	5	3	2	401	6,0	337	5,0	1676	434
Spain	286	117	165	18800	16,0	5960	5,1	31351	8739
Sweden	7	9	0	135	0,6	86	0,4	374	67
United Kingdom	1513	0	3	10975	7,6	10538	7,3	67495	12704
Total	**17894**	**943**	**359**	**167922**	**12,2**	**107867**	**7,8**	**556514**	**139128**

In total there is being processed 7.8% of the livestock manure production in the EU, equal to 108 million ton, containing 556,000 ton nitrogen and 139,000 ton phosphorus. 168 million ton livestock manure and other products are processed, whereof around 60 million ton (168 minus 108 million ton) is end and by-products from other processes and non-livestock manure biomasses. The largest share of the livestock manure production is being processed in Italy, Greece and Germany, with 36.8, 34.6 and 14.8% respectively.

11 of the considered technologies do not exist in commercial operation, for instance struvite (magnesium ammonium phosphate) precipitation and partial nitrification - autothrophic anammox denitrification.

5: COMMENTS TO THE SURVEY

Generally there are large variations in the use of manure processing among the different EU countries, and the most widespread use is generally found in the areas of EU with the highest livestock densities – see the figure below. However, this tendency is blurred by other factors, for instance grazing practices, economic incentives and framework conditions and the national context:

- Grazing practices: Ireland is under-represented with respect to manure processing in relation to the number of livestock in the country. The very widespread practice of grazing is undoubtedly an important reason for this situation.
- Economic incentives: Higher economic incentives for processing manure in biogas plants are probably the reason why for instance Austria seems over-represented with respect to manure processing.
- Framework conditions and the national context: Differences in regulatory mechanisms, the way that the EU legislation has been implemented in national legislation and the national context, are probably the reasons why the chosen technologies shows a large variation, and that for instance France (Bretagne) has chosen nitrification-denitrification as a common way to process livestock manure, while in Denmark slurry acidification dominates. Another example is that in Flanders the bigger livestock entities are obliged to process part of their manure by law. This explains as well the relatively high share of manure processing activities in Flanders.

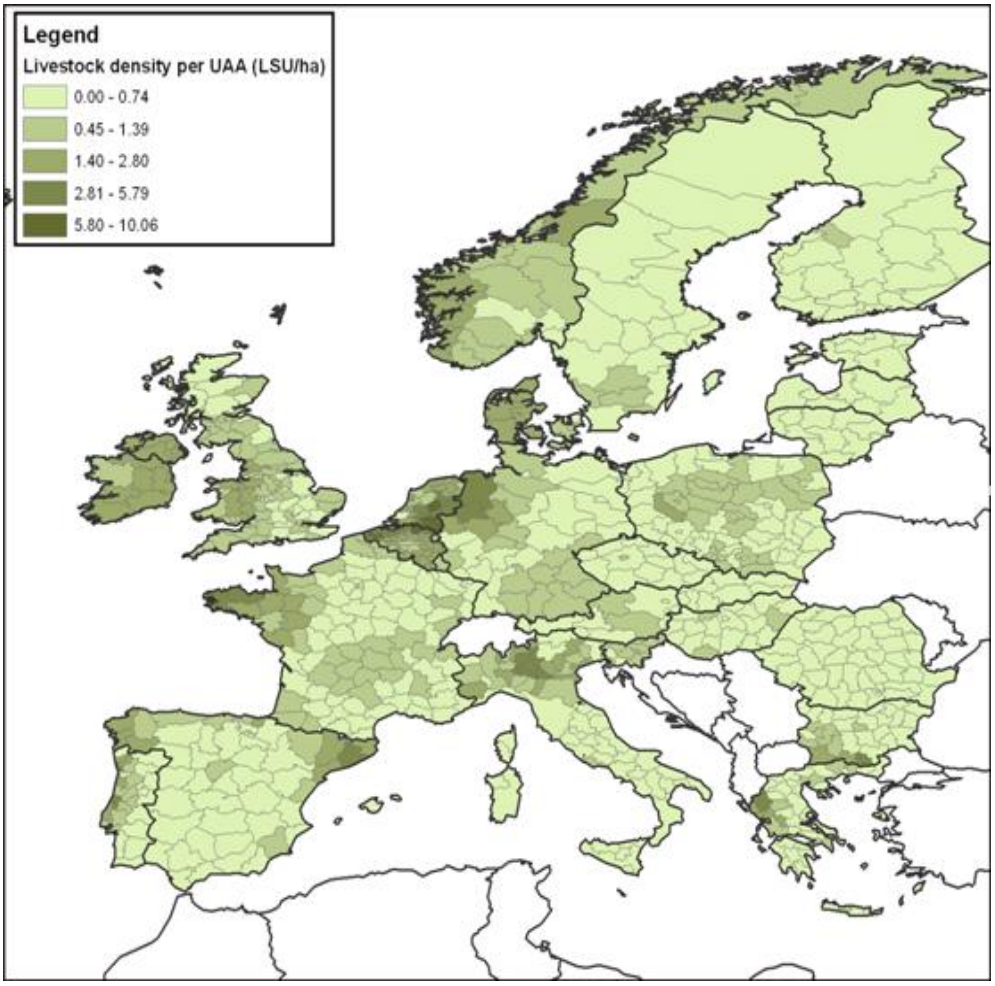

Figure 5.1: Livestock density at regional level in 2007 (Source: EuroStat).

Another clear tendency we see from the survey is that biogas production (anaerobic digestion) often is the door-opener for introduction of other manure processing technologies. The reason for this is simply that many of the manure processing technologies are complementary to the anaerobic digestion, either as pre-treatment technologies that can enhance the biogas production, or as post-treatments, which as part of the business concept for the livestock manure treatment plant can help to convert the digestate into products with envisaged properties. Several EU Member States have no other type of manure processing than anaerobic digestion, for instance Latvia and Poland.

6: BRIEF CHARACTERISATION OF END AND BY PRODUCTS

The main groups of end and by-products from livestock manure processing comprise:

- Separation products:
  - Livestock manure solids typically with a dry matter content of around 25% and rich in phosphorus and nitrogen.
  - Liquid fraction, typically with dry matter content around 2% and with a relatively high content of nitrogen and potassium.
- Additives and other pre/1st treatments:
  - Products that mainly have different pH or bacteriological characteristics, while the dry matter content and the content of plant nutrients remain unchanged, and the use of sulphuric acid will lead to an increased content of sulphur. These treatments include also pasteurizing slurry, which is needed in order to comply with EU regulations for export of manure to other Member States.
- Anaerobic treatment:
  - Digestate with a lower dry matter content and a higher share of mineralised nitrogen than the undigested raw livestock manure.
- Treatment of the solid fraction:
  - Products with high dry matter content but without or with very low organic matter concentration, such as ashes from combustion or charcoal from pyrolysis. These kinds of products have very low or null concentration of nitrogen.
  - Products with a relatively high content of dry matter, organic matter and nutrients, but with a significant moisture content (i.e. typically >40%, from 15%), such as the products of composting.
  - Products with low amount of moisture (< 10%) and high concentrations of dry matter, organics and nutrients, such as the products of thermal drying or pelletizing. Relative concentration values of nutrients and organic matter depend of the processes previous to drying.
- Treatment of the liquid fraction produces, in some case after several processes,
  - Filter water with minimal amount of organic matter. Typically a result of filtration techniques;
  - Effluent fraction with a small amount of organic matter that can be used for fertigation. Typically a result of nitrification-denitrification;
  - Ammonia water and other concentrates with a low amount of organic matter, with a high level of nitrogen or other plant nutrients with fertilising value;
- Air cleaning (as part of manure processing plant) produces a sludge, in which ammonia, dust and nuisances are dissolved.

Apart from the above, also biogas is an end-product from livestock manure processing.

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8: ABBREVIATIONS AND ACRONYMS

ABP	Agro Business Park A/S
AU	Animal Unit. Danish coefficient that expresses the nutrient load of livestock. 1 AU = 100 kg N in livestock manure ex. storage = app. 36 produced slaughter pigs from 32 to 107 kg.
BAT	Best Available Technique, as defined in Directive 2008/1/EEC
BREF	Reference Document on Best Available Techniques for Intensive Rearing of Poultry and Pigs
Ca	Calcium - the conversion factor from CaO to Ca is 0.7146.
CO_2	Carbon Dioxide
CPH	Combined Heat and Power
DG ENV	European Commission, Directorate-General Environment
DM	Dry matter
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations.
GIRO	GIRO Centre Tecnològic
IED	Industrial Emissions Directive 2010/75/EEC
IPPC	Integrated Pollution Prevention and Control, as defined in Directive 2008/1/EEC, now replaced by the Industrial Emissions Directive 2010/75/EEC
IRPP	Intensive Rearing Pigs and Poultry
IRR	Internal Rate of Return
K	Potassium - the conversion factor from K_2O to K is 0.8301.
KC	Mr. Kurt Christensen, chief manager at Morsø BioEnergy.
Laughing gas	Nitrous oxide, N_2O – a greenhouse gas with a climate impact that is around 300 times that of CO_2
LSU	The livestock unit, abbreviated as LSU (or sometimes as LU), is a reference unit which facilitates the aggregation of livestock from various species and age as per convention, via the use of specific coefficients established initially on the basis of the nutritional or feed requirement of each type of animal (see table below for an overview of the most commonly used coefficients). The reference unit used for the calculation of livestock units (=1 LSU) is the grazing equivalent of one adult dairy cow producing 3 000 kg of milk annually, without additional concentrated foodstuffs. See also http://epp.Eurostat.ec.Europa.eu/statistics_explained/index.php/Glossary:Livestock_unit_(LSU).
MBE	Morsø BioEnergy
MSJ	Mr Mogens Skov Jensen, owner of slurry acidification plant near Randers, Denmark.
Mg	Magnesium - the conversion factor from MgO to Mg is 0.6031.
MS	Member State of the European Union
N	Nitrogen
Na	Sodium - the conversion factor from Na_2O to Na is 0.741839763.

NVZ	Nitrate Vulnerable Zone, as defined in Directive 676/91/EEC
OU	Odour Units.
P	Phosphorus – the conversion factor from P_2O_5 to P is 0.436681223.
VS	Volatile solids

ANNEX A: "LONG-LIST" OF CONSIDERED MANURE PROCESSING TECHNOLOGIES

Index	No.: Livestock Manure Treatment Technology	Stand alone	Combined
	10: Separation		
1	10A Coagulation-Flocculation		✓
2	10B Electrocoagulation		✓
3	11 Separation by grid		✓
4	12 Separation by screw pressing	✓	✓
5	13 Separation by sieves	✓	✓
6	14 Separation by filter pressing	✓	✓
7	15 Separation by centrifuge	✓	✓
8	16 Air Flotation		✓
9	17 Separation by drum filters	✓	✓
10	18 Natural settling separation		✓
	20: Additives and other pre/1st treatments		
11	21 Acidification of liquid livestock manures	✓	✓
12	22 pH increasing (liming)	✓	✓
13	23 Temperature and pressure treatment	✓	✓
14	24 Applying other additives to manure	✓	✓
	30: Anaerobic treatment		
15	31A Mesophilic anaerobic digestion	✓	✓
16	31B Thermophilic anaerobic digestion	✓	✓
	40: Treatment of the solid fraction		
17	41 Composting of solid livestock manure or fibre fractions of liquid livestock manure	✓	✓
18	41A Vermicomposting	✓	✓
19	42 Biodrying	✓	✓

Index	No.: Livestock Manure Treatment Technology	Stand alone	Combined
20	43 Thermal drying		✓
21	44 Pelletizing		✓
22	45 Combustion		✓
23	46 Thermal gasification		✓
24	47 Pyrolysis		✓
25	48 Wet oxidation		✓
	50: Treatment of the liquid fraction		
26	51 Microfiltration		✓
27	52 Ultra filtration		✓
28	53 Reverse osmosis		✓
29	54A Concentration by vacuum evaporation		✓
30	54B Concentration by atmospheric evaporation		✓
31	55 Ammonia stripping and absorption		✓
32	56 Carbon dioxide stripping		✓
33	57 Electro-oxidation		✓
34	58 Ozonizing		✓
35	59A Aerobic digestion (aeration)	✓	✓
36	59B Autothermal aerobic digestion (ATAD)	✓	✓
37	60 Nitrification-denitrification (conventional)		✓
38	61 Partial nitrification - autothrophic anammox denitrification		✓
39	62A Struvite (magnesium ammonium phosphate) precipitation		✓
40	62B Calcium phosphate precipitation		✓
41	63 Algae production on liquid manure substrates		✓
42	64 Constructed wetlands		✓
	100: Air cleaning (as part of manure processing plant)		

Index	No.: Livestock Manure Treatment Technology	Stand alone	Combined
43	101 Air scrubbing		✓
44	102 Air biofiltration		✓
45	103 Bioscrubing (Aerobic biofilter)		✓

ANNEX B: LIST OF EXPERTS THAT ASSISTED IN ESTABLISHING OF THE INVENTORY

EU Member State	Person 1		Person 2		Comments	ID User Number in the survey	Information reliability[5]
	Name	eMail	Name	e-Mail			
Austria	Barbara Amon	barbara.amon@boku.ac.at			Only AD information Data from a report she sent authored by herself	**86**-Austria August	3
Belgium	Frederik Accoe	frederik.accoe@vcm-mestverwerking.be	Ester Goidts	esther.goidts@spw.wallonie.be	We gathered information separately from Flandern and Wallonie.	67 – Flandern 92 - Wallonie	1
Bulgaria					Work in progress	--	3
Czech Republic	Jan Klir	klir@vurv.cz	Jiri Vegrich	jiri.vegricht@vuzt.cz			1
Cyprus	Dalias Panagiotis				After initial acceptance to cooperate finally refused and provided an alternative address: Agriculture Ministry from where I did not get any answer yet	**79**-Cyprus Panagiotis	2
Denmark	Henning L. Foged	hlf@agropark.dk				18	1
Estonia	Arvo Iital	arvo.iital@ttu.ee				30	1
Finland	Maarit Hellstedt	maarit.hellstedt@mtt.fi				57	1
France	Colin Burton	Colin.burton@cemagref.fr			He will send information during April	**83**-France	3
Germany	Hans-Jörg Brauchmann	hbrauckm@uni-osnabrueck.de	Sebastian	s.wulf@ktbl.de	Anaerobic digestion is the big issue an	46 and 51	2

[5] The scoring of the information reliability means:
1: Complete information (only little estimations used)
2: Incomplete information but NO further information is expected
3: Incomplete information but further information is expected

EU Member State	Person 1 Name	Person 1 eMail	Person 2 Name	Person 2 e-Mail	Comments	ID User Number in the survey	Information reliability[5]
			Wulff		Germany, but large assumptions had to be made because there are no statistics about the share of biogas plants the use livestock manure. Similarly the use of separation in Germany is roughly estimated.		
Greece	Dimitris Georgakakis	digeo@aua.gr			We received the following message from Prof. Georgakakis: *"I have read your very interesting report but surprisingly I realized that all information sent from me on psychrophylic anaerobic digestion of mechanically separated pig and dairy slurries in open earthen storage lagoons is missing.* *Mechanical separation of such slurries followed by longterm storage (for 3-6 'winter' months) and psychrophilic anaerobic digestion in open earthen lagoons is obligatory by law to all greek pig farms and now is being extended to dairy farms too with the auger pressing separators becoming dominant. Improvement steps expected in the coming future are the lining of these lagoons by plastic sheets and the covering of their surface to collect and use biogas and ammonia gases emitted and also protect atmospheric air from pollution.* *The stored effluents are then applied either to arable land based on nitrogen content to fertilize plants, mainly corn plants, or in non-arable*	**72**-Greece	2-3

EU Member State	Person 1 Name	Person 1 eMail	Person 2 Name	Person 2 e-Mail	Comments	ID User Number in the survey	Information reliability[5]
					land for self - grown vegetation enrichment. *I would greatly appreciated it, if the aforementioned could be included 9reflected) somehow in the report, since they represent a legal practice applied in Greece for more than 30 years."* However, we are uncertain to which extent the mentioned psycrophilic anaerobic digestion differ from "normal" livestock manure storage requirements in other EU countries, for instance for 9 months in Denmark. We are also uncertain how we shall understand the mentioned "mechanical separation" and did unfortunately not get any detailed information about number and type of installations, neither processed amounts.		
Hungary					Work in progress		
Ireland	Stan Lalor	Stan.Lalor@teagasc.ie			Our contact from Teagasc has commented, that: ▪ Separation by screw pressing: Very few commercial units exist. ▪ Thermophilic anaerobic digestion: Very few commercial operations in existence. ▪ Aerobic digestion (aeration): Small number of units in	71	2

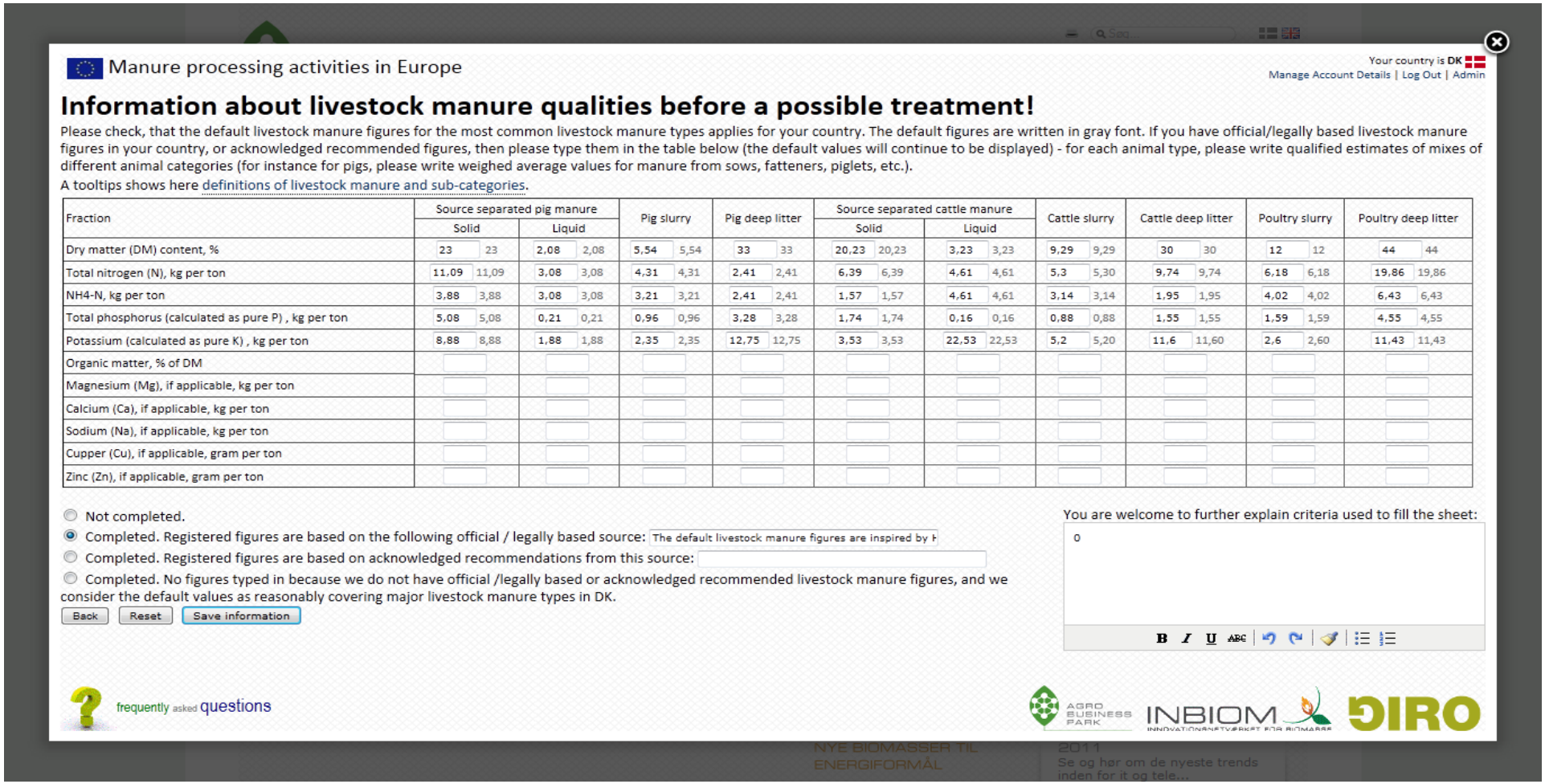
EU Member State	Person 1 Name	Person 1 eMail	Person 2 Name	Person 2 e-Mail	Comments	ID User Number in the survey	Information reliability[5]
					operation, but no data available. The message from Teagasc seem to be backed by the recent report from Houses of the Oireachtais (2011), who largely mention the biogas potentials in Ireland in connection to energy crops, realising the widespread practice of using grazing 365 days per year for the large cattle population.		
Italy	Sergio Piccinini	s.piccinini@crpa.it			Only AD information. Data from some paper he sent authored by himself.	**87** – Italy August	3
Latvia	Zanda Kruklite	zanda@agito.lv				58	1
Lithuania	Dalius Aksenavicius	dalius.aksenavicius@lzukt.lt				54	1
Luxembourg	Philippe Delfosse	delfosse@lippmann.lu			We had to do some large assumptions on the data we had.	34	2
Malta	Anthony Gruppetta				No data provided	--	2
Netherlands	Fridtjof de Buisonje	fridtjof.debuisonje@wur.nl	Henri Boss	h.bos@minlnv.nl	Information more or less completed Data from a report authored by himself and Roland Melse	**82**-The Netherlands August	3
Poland	Kamila Mazur	k.mazur@itep.edu.pl				63	1
Portugal	Luis Ferreira	lferreira@isa.utl.pt	Claudia Cordovil	cms@isa.utl.pt	Estimations of manure/slurry productions from ENAPAI (2007) report, completed with general comments from mentioned experts (L.Ferreira).	**53**-Portugal Jordi	2
Romania	Cristin Borda	cborda@usamvcluj.ro			Estimations of manure/slurry productions and applied treatments	**90**-Rumania Jordi P	2

EU Member State	Person 1		Person 2		Comments	ID User Number in the survey	Information reliability[5]
	Name	eMail	Name	e-Mail			
					from ICPA (2009) report and assistance of experts (C.Borda).		
Slovakia					We have had contact with many, for instance Ministry of Agriculture and Rural Development and Agricultural Technical and Testing Institute, but none of them could help us or referred to others, and we ended up with using a recent article, clarifying that there are 5 small biogas plants in Slovakia.	**73**	3
Slovenia					Only manure qualities and AD information Data from some paper (Babnik et al.) and biogas regions report	**89** – Slovenia Albert Magrí	2
Spain	Arturo Dauden	adauden@sodemasa.com				**68**. Spain Community of Aragon	1
Spain	Gloria Batllo	gbatllo@gencat.cat				**69**.Spain Community of Catalonia	1
Spain	Lidia Caro	lmcaromartin@jccm.es				**77**.Spain Community of Castilla la Mancha	1
Spain	Jose Luis Rico	ricoj@unican.es				**65**.Spain Community of Cantabria	1
Spain	Isidoro Romero	Luisisisdoro.romero@uca.es				**88**. Spain	3

EU Member State	Person 1		Person 2		Comments	ID User Number in the survey	Information reliability[5]
	Name	eMail	Name	e-Mail			
						Community of Andalucia	
Spain	Miriam Pinto	Mpinto@neiker.net				**59**. Spain Community of Euskadi	3
Spain	Pedro Esteban	EstTurPe@jcyl.es				**28**. Spain Community of Castilla Leon	1
Sweden	Eva Salomon	Eva.Salomon@jti.se				60	1
United Kingdom	Brian Chambers	Brian.Chambers@adas.co.uk	Ken Smith	Ken.Smith@adas.co.uk		91	1

ANNEX C: DIGITALISED SURVEY QUESTIONNAIRE

Annex C.1: Chemical composition of typical/major start products / livestock manure types



Manure processing activities in Europe

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Information about livestock manure qualities before a possible treatment!

Please check, that the default livestock manure figures for the most common livestock manure types applies for your country. The default figures are written in gray font. If you have official/legally based livestock manure figures in your country, or acknowledged recommended figures, then please type them in the table below (the default values will continue to be displayed) - for each animal type, please write qualified estimates of mixes of different animal categories (for instance for pigs, please write weighed average values for manure from sows, fatteners, piglets, etc.).

A tooltips shows here definitions of livestock manure and sub-categories.

Fraction	Source separated pig manure		Pig slurry	Pig deep litter	Source separated cattle manure		Cattle slurry	Cattle deep litter	Poultry slurry	Poultry deep litter
	Solid	Liquid			Solid	Liquid				
Dry matter (DM) content, %	23 23	2,08 2,08	5,54 5,54	33 33	20,23 20,23	3,23 3,23	9,29 9,29	30 30	12 12	44 44
Total nitrogen (N), kg per ton	11,09 11,09	3,08 3,08	4,31 4,31	2,41 2,41	6,39 6,39	4,61 4,61	5,3 5,30	9,74 9,74	6,18 6,18	19,86 19,86
NH4-N, kg per ton	3,88 3,88	3,08 3,08	3,21 3,21	2,41 2,41	1,57 1,57	4,61 4,61	3,14 3,14	1,95 1,95	4,02 4,02	6,43 6,43
Total phosphorus (calculated as pure P) , kg per ton	5,08 5,08	0,21 0,21	0,96 0,96	3,28 3,28	1,74 1,74	0,16 0,16	0,88 0,88	1,55 1,55	1,59 1,59	4,55 4,55
Potassium (calculated as pure K) , kg per ton	8,88 8,88	1,88 1,88	2,35 2,35	12,75 12,75	3,53 3,53	22,53 22,53	5,2 5,20	11,6 11,60	2,6 2,60	11,43 11,43
Organic matter, % of DM										
Magnesium (Mg), if applicable, kg per ton										
Calcium (Ca), if applicable, kg per ton										
Sodium (Na), if applicable, kg per ton										
Cupper (Cu), if applicable, gram per ton										
Zinc (Zn), if applicable, gram per ton										

- Not completed.
- Completed. Registered figures are based on the following official / legally based source: The default livestock manure figures are inspired by
- Completed. Registered figures are based on acknowledged recommendations from this source:
- Completed. No figures typed in because we do not have official /legally based or acknowledged recommended livestock manure figures, and we consider the default values as reasonably covering major livestock manure types in DK.

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You are welcome to further explain criteria used to fill the sheet:

0

frequently asked questions

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Annex C.2: Questions to each technology (exemplified for technology # 52: Ultra filtration)

Number of installations		INPUT AMOUNT		INPUT TYPE		OUTPUT QUALITY			
Number of installations		INPUT AMOUNT: Average amount of treated livestock manure and other substrates per year per size-type installation, tonnes		INPUT TYPE: Treated amount of livestock manure and other substrates, broken down on types, relative and volume-based (summing up to 100%)			OUTPUT I QUALITY: Please describe the typical second/secondary/end or by product (typical value or value range)		OUTPUT II QUALITY: Please describe the typical second/secondary/end or by product (typical value or value range)
							Average or minimum	Maximum	Average or minimum	Maximum
Number of farm size installations		Average amount (tons) of treated livestock manure and other substrates per year per farm-size plant		Solid pig manure, %		Name/description				
Number of small/medium size installations, treating < 50,000 tons/year		Average amount (tons) of treated livestock manure and other substrates per year per small/medium size plant		Liquid pig manure,%;		Dry matter (DM) content, %				
Number of large-scale installations, treating > 50,000 tons/year		Average amount (tons) of treated livestock manure and other substrates per year per large-scale plant		Pig slurry, %		Total nitrogen (N), kg per ton				
				Pig deep litter, %		NH4-N, kg per ton				
				Solid Cattle manure, %		Total phosphorus (calculated as pure P) , kg per ton				
				Liquid Cattle manure,%;		Potassium (calculated as pure K) , kg per ton				
				Cattle slurry, %		For solid fractions: Organic carbon (C), kg per ton				
				Cattle deep litter, %		For solid fractions: Volatile solids (VS), kg per ton				
				Solid Poultry manure, %		For liquid fractions: Suspended matter, kg per ton				
				Liquid Poultry						

Number of installations	INPUT AMOUNT	INPUT TYPE		OUTPUT QUALITY				
		manure, %		For liquid fractions: Biological oxygen demand, BOD				
		Poultry slurry, %		For liquid fractions: Chemical oxygen demand, COD				
		Poultry deep litter, %		Magnesium (Mg), kg per ton				
		Other, here under end/by products of other processes, i.e. not raw livestock manure, %		Calcium (Ca), kg per ton				
		TOTAL, %	100	Sodium (Na), kg per ton				
				Cadmium (Cd), gram per ton				
				Cupper (Cu), gram per ton				
				Zinc (Zn), gram per ton				
				Mercury (Hg), gram per ton				
				Lead (Pb), gram per ton				
				Cromium (Cr), gram per ton				
				Nickel (Ni), gram per ton				

ANNEX D: FREQUENTLY ASKED QUESTIONS

Issue	Answer
How to work with the survey – start up	
Registration as use	On the opening screen at http://www.enagro.eu/asppoll/21010.asp you have to start with registration of yourself as user; click on "Need to create an account?", select your country and enter information about preferred password etc. An email is sent to you and you have to confirm your email address before you are able to login.
Login	Go to at http://www.enagro.eu/asppoll/21010.asp and login with your email-address and your password. The checkbox "Keep me logged-in on this computer" is pre-ticked, meaning that a cookie will be left on your computer and you don't have to login in the next 30 days. If you wish to login by every visit, then un-check the checkbox "Keep me logged-in on this computer" before login.
How to work with the survey – qualities of raw livestock manure	
What is the origin of the default livestock manure figures?	Default livestock manure figures are displayed in gray, small font beside the input fields in the manure part. In case there are no other official or recommended livestock manure figures in your country, then we will use these as basis for assessing the baseline before the treatment processes. The default livestock manure figures are inspired by Hanne Damgaard Poulsen (ed.): Normtal for husdyrgødning – 2010, 33 pages, http://www.agrsci.dk/ny_navigation/institutter/institut_for_husdyrbiologi_og_sundhed/husdyrernaering_og_miljoe/normtal . Different assumptions are used for assessing average figures for different production systems.
Why only asking for typical qualities of pig, cattle and poultry manure?	Principally the survey encompasses processing of manures from all types of livestock, but we expect that the vast majority of livestock manure processing happens with pig, cattle and poultry manure.
How to work with the survey – information about manure treatment technologies	
How to register input amounts and types	All input amounts should be registered for installations where livestock manure is treated, also in case a part of the input is "Other, here under end/by products of other processes, i.e. not raw livestock manure". However, it is important that treatment of raw livestock manure only happen in case where it actually is raw/fresh livestock manure – otherwise it would look as if much more manure is treated than what is actually the fact. In order to avoid double registration of treatment of raw livestock manure at manure

Issue	Answer
	processing plants using a combination of several manure treatment technologies, it is important to register, how much of the treated material, that is that is "Other, here under end/by products of other processes, i.e. not raw livestock manure". The following examples will show how this is done: **Example 1:** In case the treatment technology is for raw livestock manure alone (could for instance be composting): A. Number of installations: 10 B. Treated amount, average per installation per year: 10,000 tonnes (meaning 100,000 tonnes per year in total for all 10 installations C. Types of livestock manure treated: 50% source separated solid pig manure and 50% pig deep litter, summing up to 100%. 0% is calculated as "Other, here under end/by products of other processes, i.e. not raw livestock manure, %" **Example 2:** In case the treatment technology in some cases is used for raw livestock manure and in other cases used for treatment of intermediate streams and end products of other livestock manure treatments (could for instance be centrifuge separation): A. Number of installations: 10, whereof 5 for treatment of raw manure, and 5 for separation after anaerobic digestion. B. Treated amount, average per installation per year: 10,000 tonnes (meaning 100,000 tonnes per year in total for all 10 installations C. Types of livestock manure treated: 50% pig slurry and 50% digestate, summing up to 100%. 50% is calculated as "Other, here under end/by products of other processes, i.e. not raw livestock manure, %" **Example 3:** In case the treatment technology is used alone for treatment of intermediate streams and end products of other livestock manure treatments (could for instance be reverse osmosis): A. Number of installations: 10. B. Treated amount, average per installation per year: 10,000 tonnes (meaning 100,000 tonnes per year in total for all 10 installations C. Types of livestock manure treated: 100% permeate from ultra filtration. 100% is calculated as "Other, here under end/by products of other processes, i.e. not raw livestock manure, %"
What if the manure input type is not originating from cattle, pigs or poultry?	In case any processing happen of livestock manures from for instance horses, sheep, goats, rabbits or other, i.e. not originating from pigs, cattle or poultry, then please indicate the input type as one of the cattle manure types.
Definition of terms	

Issue	Answer
Livestock manure	Organic material consisting primarily of a more or less homogenous mix of faeces and urine from livestock, including bedding material, and secondarily of other material that would be discarded as waste from a livestock production such as fodder residues, silage effluents, and process water. Livestock manure might also be more or less diluted with rain water during storage.
Source separated livestock manure	Sub-group of livestock manure. The stables are designed with drains in the solid floors, enabling to collect liquid fractions such as urine, silage effluents, process water and alike, in separate stores, and vice versa with the solid fractions.
Solid livestock manure	Sub-group of source separated livestock manure. Normally having a dry matter content of 20-30 %, and removed from the livestock stables on a daily basis, and placed in a manure pad with drains to collect effluents and rain water.
Liquid livestock manure	Sub-group of source separated livestock manure. Normally having a dry matter content of 2-10 %, and flowing out of the livestock stables via piping systems by gravity or pumping, and placed in a liquid manure tank, which is closed/with cover in order to reduce ammonia emissions.
Slurry	Sub-group of livestock manure. Usually a mix of faeces and urine from livestock, bedding material with small structure like sawdust or chopped straw, washing water, water spill, etc. and originating from stables with whole or partly slotted floors. Normally having a dry matter content of 2-10 %, and flowing out of the livestock stables via piping systems by gravity or pumping, and placed in a liquid manure tank, in some cases with cover in order to reduce ammonia emissions.
Deep litter	Sub-group of livestock manure. Also called deep bedding. Originates from livestock stables where livestock are kept on a bed of long straw or similar material, up to 1 metre thick. The bed is only removed with intervals of up to one year, when the livestock is removed from the stable for slaughter or grazing. The bed will during use undergo a natural composting process, whereby the temperature often raise to 50°C or more. The dry matter content is therefore kept on a high level, typically over 30%, and the deep bedding can after removal from the stable be stored on the bare ground in field heaps without risks for leakage.
Further contact/support	
Contact	If you come from any of the countries ES, PT, NL, FR, IT, MT, CY, RO, BG, EL, HU, AT or SI then please contact ▪ Xavier Flotats - Xavier.Flotats@giroct.irta.cat, August Bonmati Blasi -

Issue	Answer
	august.bonmati@giroct.irta.cat, Albert Magri - Albert.Magri@giroct.irta.cat or Jordi Palatsi - Jordi.Palatsi@giroct.irta.cat **GIRO Centre Tecnològic. Centre IRTA-UPC.** Rambla Pompeu Fabra, 1 08100 Mollet del Vallès (Spain) Tel +34 93 579 67 80 For other countries contact ▪ Henning Foged - hlf@agropark.dk **Agro Business Park** Niels Pedersens Allé 2 DK-8830 Tjele +45 8999 2500

ANNEX E: SURVEY RESULTS SPECIFIED ON TECHNOLOGIES

Separation

Definition: System with the objective of separating manure into two flows: a concentrate (solid fraction) and a diluted fraction (liquid fraction).

E.1: Coagulation-Flocculation:

Definition: Physical-chemical system where separation is enhanced by the help of a chemical agent (coagulant or flocculant), which improves the aggregation of colloids. Usual inorganic flocculants are multivalent cations such as aluminium, iron, calcium or magnesium, added as salt or hydroxide, and the organic substances are polyelectrolyte polymers such as polyacrylamide.

ID User Number in the survey[6]	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
18	Denmark	19			9000			171	162	700	156	Birkmose.T. (2010): 'Status over anvendelsen af gylleseparering i Danmark. maj 2010'. Danish Agricultural Advisory Service. Aarhus. Denmark.	The number of installations and treated amounts include various types of mechanical separation (such as centrifuge. screw pressing. and band filer separation) following the flocculation, and we[7] have not been able to divide these

[6] Reference is made to Annex B.

[7] It is emphasized, as clarified in section 2, that the data is collected via a digitalised survey by assistance from livestock manure experts in the EU Member States, listed and numbered in Annex B. The data, as well as references and comments are provided by the experts in Annex B, and when comments includes wording like "we", "own data", "own studies" or alike, it refer to the institution, that the expert number in the first/left column refer to.

ID User Number in the survey[6]	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
													technologies.
68	Spain	1		9	25000		187200	1710				own data	One industrial plant data and the farms size unit comes from an own study The other belong to treatment plants of our own promotion and project management. In all of them. 2 coagulation and/or flocculation systems are installed: one at the head
	TOTAL	**20**		**9**				**1881**	**162**	**700**	**156**		

E.2: Electrocoagulation:

Definition: An electro coagulation reactor is made up of an electrolytic cell with one anode and one cathode. During electro coagulation, the positive charged ions (Fe3+, Al3+) required for coagulation are obtained from a consumable metal electrodes (anode), released by electrical current, producing also electrolysis. Aggregates are separated by sedimentation and by flotation, induced by the hydrogen gas produced during water electrolysis at the cathode.

Not found.

E.3: Separation by grate:

Definition: Separation of particles by sizes using a grate, a frame composed of parallel or cross-bars.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
51	Germany	20			15000			300	300	1523	311	Brauckmann University of Osnabrueck	Estimates on the basis of a total estimation of separation of 5 million ton livestock manure
68	Spain			4			120000	480	480	5323	2438	own data	Data correspond to treatment plants which we promote and carry out the project management.
	TOTAL	**20**		**4**				**780**	**780**	**6846**	**2749**		

E.4: Separation by screw pressing:

Definition: The screw press is composed of a screw-type conveyor that forces the slurry through a tube with a cylindrical screen. The screw conveys the solids retained on the screen to the end where the solids are discharged.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
18	Denmark	25			10000			250	81	376	76		Birkmose.T. (2010)
51	Germany	25			15000			375	375	1903	388	Brauckmann University of Osnabrueck	Data from test in July 2011. For details see www.bioenergie-suedoldenburg.de. Average and max. In practice of screw presses are mainly used with cattle slurry. There are no data available.
57	Finland	20			2000			40	40	139	27		Estimation, no statistics available.
65	Spain	3	3		4500	4500		27	27	104	30	non published data	So far, there are only three manure separators in Cantabria. Two are installed in two dairy farms. The other one is located in a pilot plant for I+D+i purposes. The quantities of manure generated are calculated in function of the livestock.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
68	Spain			1			108000	108				own data	The data corresponds to a device installed in a plant of our promotion and project management.
69	Spain	33			10000			330	330	1422	317	Agencia de Residus de catalunya	Input amount estimated, not really know (by Xavier Flotats)
72	Greece	274			7937			2175	2175	11418	1922	personal estimation	Information updated after comments exchange between X. Flotats and D. Georgakakis: Up to 10% of pig farms and 25-30% (27% considered here) adopt a screw pressing system (FAN). The estimated efficiencies are: 3-5% of the inflow
77	Spain	2			44321			89	73	313	70	Medio Ambiente de Castilla-la Mancha. Dirección general de Calidad y Sostenibilidad Ambiental. Servicio de Residuos	
78	Czech	150			1000			150	150	548	122		Estimated 25% pig and

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
	Republic												75% cattle slurry
82	Netherlands		31	11		7258	72727	1025	871	3888	1015	Report authored by F. E. de Buisonjé and R.W. Melse Wageningen UR Livestock Research	Input type: Co-digested cattle slurry. Pig slurry and Cattle slurry.
83	France	50			1000			50	50	185	10	Reports and publications	Data above refer only to piggery slurry. Separated material often composted and exported from farm to remove local P surplus.
87	Italy	3000			2340			7020	7020	29203	8986		Assumptions based on the extract from the "Request from Italy for a derogation under paragraph 2(b) of Annex III to Directive 91/676/EEC from the limit of 170 kilograms of Nitrogen per hectare per year from livestock manure", presented at the Nitrate Committee in January 2010"
91	United	25			10000			250	250	1300	222		Total annual estimates

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
	Kingdom												based on all separator types: 7% of dairy slurry (around 1.4 m tonnes). 6% of beef (around 0.2 m tonnes) and 6%
93	Spain	4			5000			20	20	101	18	internet information for Canary Islands and Asturias. checked by GIRO	
97	Spain			1			100000	100				CORENWEB PAGE	0
98	Spain	6	4		4500	15200		88	88	465	77	Asking separator suppliers and farmers. Some own measurements	What I consider small/medium size installations are 4 separators that are portable and stay in different farms. Those are data from Gipuzkoa area. Basque Country.
	TOTAL	**3617**	**38**	**13**				**12096**	**11549**	**51366**	**13279**		

E.5: Separation by sieves:

Definition: Named also screen separators, including stationary inclined, vibrating, rotating, and channel vibrating screens. All separators of this type involve a screen of a specified pore size that allows only solid particles smaller in size than the openings to pass through.

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
18	Denmark	10			8900			89	89	401	84	Birkmose.T. (2010): 'Status over anvendelsen af gylleseparering i Danmark. maj 2010'. Danish Agricultural Advisory Service. Aarhus. Denmark.	
51	Germany	20			15000			300	300	1523	311		Estimates on basis of a total estimation of separation of 5 million ton livestock manure
57	Finland	10			2000			20	20	70	14		Estimation. no statistics available
68	Spain			5			112000	560				own data	The data correspond to 4 plants of own promotion and project management. Data of 1 other plant corresponds to a carried out study. The previous treatment of pig manure consists only of a

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
													separation grate.
72	Greece	680			1279			870	870	3748	835	personal estimation	Information updated after comments exchange between X. Flotats and D. Georgakakis: The usual system consists on double sieve separation. It is estimated that is applied to 80% of pig farms. Up to 10% of pig farms use a screw press.
87	Italy	1200	1		2340	31171		2839	2805	11365	3565		Assumptions based on the extract from the "Request from Italy for a derogation under paragraph 2(b) of Annex III to Directive 91/676/EEC from the limit of 170 kilograms of Nitrogen per hectare per year from livestock manure", presented at the Nitrate Committee in January 2010"
91	United Kingdom	25			10000			250	250	1300	222		Total annual estimates based on all separator types : 7% of
94	Romania	44			65244			2871	2871	15439	3741	ICPA (2009) and C.Borda comments	From information of Romanian Water Branches environmental information (ICPA. 2009) is estimated that in Romania are produced 14.000.000/4.000.000 and 600.000 Tm/year of poultry/piggery and cattle slurries/manures and

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
													3.000.000/2.250.000/185.00
	TOTAL	**1989**	**1**	**5**				**7799**	**7205**	**33846**	**8772**		

E.6: Separation by filter pressing:

Definition: The filter material is a belt, and the system consists of a flat, woven, fabric belt that runs horizontally between rollers. The liquid is forced through the belt by the rollers and the solids are carried along on the belt and dropped into a solids collection chamber.

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
18	Denmark	19			9000			171	17	74	16	Birkmose 2010	17 of the installations are second step in AL-2 separation
51	Germany	20			15000			300	300	1523	311	Brauckmann University of Osnabrueck	Some tests from Big Dutchman in Vechta but no data available Estimates on basis of a total estimation of separation of 5 million ton livestock manure
82	Netherlands			2			60000	120	120	516	156		
91	United Kingdom	75			10000			750	750	3901	666		Total annual estimates based on all separator types : 7% of dairy slurry
93	Spain			1			100000	100	100	431	96	ADAP and GIRO estimation	
98	Spain			1			70000	70				Estimated by	

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
												GIRO from information of biogas plant at Ultzama	
	TOTAL	**114**		**4**				**1511**	**1287**	**6444**	**1245**		

E.7: Separation by centrifuge:

Definition: Centrifugation involves solid-liquid separation using centrifugal forces to increase the settling velocity of suspended particles using either centrifuges or hydrocyclones. Typically centrifuges consist of a horizontal or vertical cylinder which is continuously turned at high velocities.

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
18	Denmark	3	2	3	30000	50000	100000	490	466	2079	441		Some of these centrifuge installations use coagulation/flocculation as pre-treatment - however we do not know how many.
28	Spain			5			100000	500	500	2155	480	Pedro Esteban. ADAP and GIRO estimation	information concerned to community of Castilla Leon
51	Germany	1			10000			10	10	51	10	Brauckmann University of Osnabrueck	Data from test in july 2011 GEA and Spallek. Further informations on www.bioenergie-suedoldenburg.de In practice the Spallek centrifuge is used.
65	Spain	1	1		30	30		0	0	0	0	Unpublished data	There is only a decanter centrifuge for the separation of manure in Cantabria. It is a Pieralisi Baby2. installed in the pilot plant for I+D+i purposes. The centrifuge receives the liquid fraction of dairy manure separated by screw

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
67	Belgium		76	3		14665	62720	1303	1294	11521	2304	vcm inquiry (2010). VITO BBT study manure processing (2007)	Only the nitrification-denitrification facilities that separate pig or cattle manure as a first step are counted here; in addition: 6 anaerobic digestors use separation by centrifuge for post-treatment of their digestate.
68	Spain	1	1	4	25000	40000	120000	545	74	816	374	own data	The 4 plants of app. 50000 size are of our own project management. The other data (2 plants) are from own studies. The farm size plant has a centrifuge of its own technology. Derived from the olive mill sector.
69	Spain			6			109167	655					Considered that the 6 large scale facilities have centrifuges (Xavier Flotats)
77	Spain	1		2	19567		100000	220	202	871	194	Consejería de Agricultura y Medio Ambiente de Castilla-la Mancha. Dirección general de Calidad y Sostenibilidad	

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
												Ambiental. Servicio de Residuos	
82	Netherlands			1			55000	55	55	215	65		
83	France	20			2500			50	50	555	254		Similar use to screw presses but centrifuges restricted to piggery slurry. No data found on analysis of solid stream used for composting or export.
87	Italy	100			2580			258	258	826	310		Assumptions based on the extract from the "Request from Italy for a derogation under paragraph 2(b) of Annex III to Directive 91/676/EEC from the limit of 170 kilograms of Nitrogen per hectare per year from livestock manure", presented at the Nitrate Committee in January 2010"
91	United Kingdom	8			10000			80	80	345	77		Total annual estimates based on all separator types : 7% of
92	Belgium	1			16500			17					It is assumed that post-separation at one biogas plant happen with centrifuge.

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
93	Spain			4			100000	400	400	1724	384	ADAP and GIRO estimation	Information elaborated based on information of Mr. Pedro Esteban Turzo. of the government of the community of Castilla Leon
	TOTAL	**136**	**80**	**28**				**4582**	**3388**	**21157**	**4892**		

E.8: Air Flotation:

Definition: Dissolved air flotation (DAF) method of separation consists of dissolving air under pressure and then releasing the air at atmospheric pressure in a flotation tank or basin. The released air forms tiny bubbles which adhere to the suspended matter causing the suspended matter to float to the surface, from where it is removed by a skimming device.

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
82	Netherlands			2			60000	120				Input type: Pig slurry liquid fraction coming from a belt press. Included in reverse osmosis plants.	
	TOTAL			**2**				**120**					

E.9: Separation by drum filters:

Definition: Separation is done by inclined rotary drums made by a sieve material, which punctured pore size allows the filtration or screening.

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
18	Denmark	3			2500			8	1	3	1	Birkmose.T. (2010): 'Status over anvendelsen af gylleseparering i Danmark. maj 2010'. Danish Agricultural Advisory Service. Aarhus. Denmark.	
51	Germany	20			15000			300	300	1523	311		Estimates on the basis of a total estimation of separation of 5 million ton livestock manure
69	Spain			3			115000	345	345	1487	331		
77	Spain	6			11344			68	68	293	65	Consejería de Agricultura y Medio Ambiente de Castilla-la Mancha. Dirección general de Calidad y Sostenibilidad Ambiental. Servicio de Residuos	

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
78	Czech Republic	100			1000			100	100	365	81		Estimated 25% pig and 75% cattle slurry.
83	France	3			3333			10	10	111	51		Just a handful of examples - centrifuges and screw presses much more common.
87	Italy	4500			2580			11610	11610	37152	13932		Assumptions based on the extract from the "Request from Italy for a derogation under paragraph 2(b) of Annex III to Directive 91/676/EEC from the limit of 170 kilograms of Nitrogen per hectare per year from livestock manure", presented at the Nitrate Committee in January 2010"
	TOTAL	**4632**		**3**				**12441**	**12434**	**40934**	**14772**		

E.10: Natural settling separation:

Definition: Separation of particles by gravity in a settler.

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
57	Finland	1			1000			1	1	4	1		Estimation. No statistics available
68	Spain			7			104000	728				own data	One source of data comes from an own study. The other source relates to treatment plants of our own promotion and project management. In two of them. 2 settlement systems are installed: one at the head of the plant after sieves. the other as the last treatment pr
77	Spain	62			11391			706	706	3044	678	Consejería de Agricultura y Medio Ambiente de Castilla-la Mancha. Dirección general de Calidad y Sostenibilidad Ambiental. Servicio de Residuos	
87	Italy		1			31171		31					Assumptions based on the extract from the "Request from Italy for a derogation under paragraph 2(b) of

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
													Annex III to Directive 91/676/EEC from the limit of 170 kilograms of Nitrogen per hectare per year from livestock manure", presented at the Nitrate Committee in January 2010"
91	United Kingdom	300			10000			3000	3000	15900	2640		Assuming all is dairy farms / cattle slurry and that the average treated amount per year is 10.000 ton.
94	Romania	44			65244			2871	2871	15439	3741	IPCA (2009) and C.Borda comments	From information of Romanian Water Branches environmental information (ICPA. 2009) is estimated that in Romania are produced 14.000.000/4.000.000 and 600.000 Tm/year of poultry/piggery and cattle slurries/manures and 3.000.000/2.250.000/185.000 are treated.
	TOTAL	**407**	**1**	**7**				**7337**	**6578**	**34387**	**7060**		

Additives and other pre/1st treatments

Definition: Set of processes which objective is the preparation of the material for a further purpose or treatment.

E.11: Acidification of liquid livestock manures:

Definition: Application of an acidic reagent resulting in a decreased pH, which may be desired for the inactivation of pathogens and/or reduction of especially ammonia emissions.

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
18	Denmark	80	18		6750	50000		1440	1296	6085	1204	Information from the companies BioCover and InFarm	The technology is reducing the pH of the slurry by adding sulphuric acid to the slurry. while the slurry still is in the stable system. Reducing the pH from app. 7.5 down to 5.0 prevents the main part of the ammonia to volatilize.
28	Spain		5	3		40000	80000	440				ADAP and GIRO estimation	
68	Spain			3			66000	198				ADAP and GIRO estimation	
69	Spain			3			88000	264				SENER and ABANTIA information	
77	Spain			2			100000	200	180	776	173	Consejería de Agricultura y Medio Ambiente de Castilla-la	

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
												Mancha. Dirección general de Calidad y Sostenibilidad Ambiental. Servicio de Residuos	
93	Spain			5			80000	400				ADAP and GIRO estimation	
97	Spain			1			80000	80				ADAP information and GIRO estimation	
	TOTAL	**80**	**23**	**17**				**3022**	**1476**	**6861**	**1377**		

E.12: pH increasing (liming):

Definition: Application of lime resulting in a raised pH, which may be desired for the inactivation of pathogens and/or the precipitation of phosphates.

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
57	Finland	1			1000			1	1	3	1		Only one installation. used for research purposes
67	Belgium		1	1		31665	66530	98	98	782	202	VCM enquiry	These two installations actually use liming as a treatment, not as a pre-treatment. The end-product is a calcium-rich fertiliser.
97	Spain		1			899		1	1	11	7	AGROAMB PRODALT SL	
	TOTAL	**1**	**2**	**1**				**100**	**100**	**796**	**209**		

E.13: Temperature and pressure treatment:

Definition: Conditioning treatment under high pressure and/or temperature, which favours the hydrolysis of long chain molecules of organic materials to smaller fragments. Also applicable for sanitation purposes.

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
82	Netherlands		16			31240		500	500	2149	650	Report authored by F. E. de Buisonjé and R.W. Melse Wageningen UR Livestock Research	Pasteurization (70ºC. 1 hour) Input type: Co-digested pig and cattle slurry No information about size was provided.
97	Spain		1			2000		2	2	24	15	AVIPORTO SL	
	TOTAL		**17**					**502**	**502**	**2173**	**665**		

E.14: Applying other additives to manure:

Definition: Addition of chemical/biological products aiming at the modification of the manure properties in view of enhancing its management, subsequent treatments, or the animal welfare.

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
57	Finland	5			3000			15	15	57	12		A new method, partly under development.No statistics available.
67	Belgium		2			17000		34	34	133	13	VCM enquiry	
83	France	20			2500			50				General opinion	Some use of additives carried out especially in response to odour problems. No real quantification of the benefits or application. Some doubts over benefits.
91	United Kingdom	500			7500			3750	3750	19504	3330		Additives in the form of bacteria and enzymes. Assuming it is applied to 10% pig slurry and 90% cattle slurry (same distribution as for separation) and that the average treated amount per year is 7.500 ton.
	TOTAL	**525**	**2**					**3849**	**3799**	**19693**	**3355**		

Anaerobic treatment

Definition: Series of biological processes in which microorganisms break down organic molecules in absence of oxygen, resulting in the production of a mixture of gases, named biogas, mainly composed of methane and carbon dioxide.

E.15: Mesophilic anaerobic digestion:

Definition: Biological anaerobic decomposition of organic matter for biogas production, at a temperature range around 35°C.

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
18	Denmark	57		19	26000		100000	3382	2537	13539	2657	Jørgensen. P.J. (2009): 'Biogas – green energy'; PlanEnergi and Researcher for a Day. Faculty of Agricultural Sciences. Aarhus University. Research Centre Foulum. Denmark. / Bioenergimagasinet	Our references do not divide the number of plants in mesophilic and thermophilic installations. In this case we have placed them all at mesophilic installations, because most plants are mesophilic! Input amounts and types are pure estimates - a m
2	Spain			1			10000	100	100	431	96	Pedro Esten Turzo	Information provided by Mr. Pedro Esteban

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
8							0					Turzo. government of the community of Castilla Leon	
30	Estonia		1			40000		40	30	86	12	http://www.nefco.org/documents/tgf/projects/TGF_Project_Profile_Saaremaa_Biogas.pdf	
34	Luxembourg	25		5	1000		30000	175	116	484	63		It is assumed that 1/3 of substrate fresh weight is pig slurry. 1/3 is cattle slurry and 1/3 is maize silage and other, wherefore the estimated amount of treated manure is about 35.000 ton in total. or
51	Germany	3500			15000			52500	24675	126998	29201	Brauckmann University of Osnabrueck	Data from KTBL see mail. 20 000000 to 25 000000 t of manure are treated in Biogas plants. 5 000000 t are treated by separation mostly screw presses.

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
													1000000 t solids are dried.
54	Lithuania			1			54000	54	54	166	11	Lithuanian Biogas Association	
57	Finland	5			4000			20	20	60	10		According to the information given in the biogas association yearbook The treatment residue analysis from one installation used for research purposes (cattle slurry + silage)
58	Latvia	8	8		20000	10000		240	240	1493	341	Information collected from Latvia Biogas Association. Farmers Parliament. Plant operators. Ministry of agriculture. Rural Support Service	Analysis results for digestate: Total Nitrogen in dray matter - 3.02%; K in dry matter - 3.79%; P in dray matter - 1.05%; Butryc acid - 0.11%; lactic acid - 0.14%. Ph - 7.67 LLU farms Vecauce -

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
													the only and first one who has made analysis for di
60	Sweden	7	2		14000	4000		106	61	211	22	Personal communication Mats Edström JTI	
63	Poland	3	2	2	27500	45000	82000	337	252	1088	242	Foged. Henning Lyngsoe & Louise Krogh Johnson. 2010. Market description - the environmental technology and bioenergy sector in Poland. Published at http://www.inbiom.net	It is assumed that 25% external organic material is used and all biogas plant mesophile
67	Belgium		18	5		8200	25800	277	277	1937	445	VCM inquiry (2010)	In our inquiry we mainly ask for manure input into digestors. Therefore we lack data for many installations on "other" inputs like energy crops and organic waste streams. For this reason we only supplied the input of

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
													raw manure streams.
68	Spain		2	2		32500	87500	240	21	233	107		
69	Spain	6		3	17180		103000	412	371	1602	346	Agencia Residus de Catalunya	
72	Greece	2			32850			66	66	283	63	personal information	Information updated after comments exchange between X. Flotats and D. Georgakakis: Influent rate for these two anaerobic digestion systems are estimated based on 8-10 tons/day for 100 sows farm. depending of water use
73	Slovakia	5			4000			20	16	73	15	Marko. J. (ed.). 2009. Slovak Society of Chemical Engineering Institute of Chemical and Environmental Engineering Slovak University of Technology in Bratislava. PROCEEDINGS - 36th International	registered by ABP

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
												Conference of Slovak Society of Chemical Engineering	
77	Spain	1		2	52925		100000	253	210	905	202	Consejería de Agricultura y Medio Ambiente de Castilla-la Mancha. Dirección general de Calidad y Sostenibilidad Ambiental. Servicio de Residuos	
78	Czech Republic	170			20000			3400	1700	6205	1381		Estimated 25% pig and 75% cattle slurry - other is mainly maize silage
82	Netherlands		100	30		13750	75000	3625	2712	12149	3117	Input type: Liquid manures (70% Pig Slurry / 30% Cattle Slurry) and co-substrates (20-25%) Plants size: between 0.4 MW (corresponding approximately to 10.000 t/y waste). and 4.5 MW (corresponding approximately to 100.000 t/y) Total amount treated: 2000000-3000000 t/y Nº of plants: 130 Table is constructed considering the above information and some assumptions Assumption | Assumption | Assumption | Calculation | Assumption | Calculation Our classification | Average Power | Nº Plants | Plant size t/y | % manure (52.5% Pig slurry / 22.5 Cattle Slurry) | Total manure treated t/y Farm-size plant | 150 | | 3750 | 75% | 0	Report autohred by F. E. de Buisonjé and R.W. Melse Wageningen UR Livestock Research

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
												Small/Medium plant 550 100 13750 75% 1031250 Larg-scale plant 3000 **20** 75000 75% 1125000 **120** **2.156.250.00**	
83	France	30			5500			165	125	596	72	Publications	Some use of energy crops but most from animal wastes or sewage sludge. Couldnt find analysis data of digestate.
86	Austria	307	31	3	1564	1929		540	500	2459	463	Considerations about plants size -Nº of biogas plants < 500 kWe (it has been considered at farm-size plant): 307 plants (90%) -Nº of biogas plants > 1 MWe (it has been considered large-scale plants) : 3 pants -Nº of Small/Medium-size plants: 341-301 (90%)- 3: 31 plants Table is constructed taking into account the data provide. and some assumptions: 1) standard plant of 15000 t/y has a CHP of 350 kW. b) others assumptions indicated in the table.	Information provided by Barbara Amon. and the report

<table>
<tr><th rowspan="2">#</th><th rowspan="2">EU Member State</th><th colspan="3">Number of installations</th><th colspan="3">Average treated amount per installation, tonnes per year</th><th colspan="4">Total treated amounts</th><th rowspan="2">Source</th><th rowspan="2">Comment</th></tr>
<tr><th>Farm scale</th><th>Medium scale</th><th>Industrial scale</th><th>Farm scale</th><th>Medium scale</th><th>Industrial scale</th><th>Livestock manure and other, 1000 tonnes</th><th>Livestock manure, 1000 tonnes</th><th>Nitrogen in livestock manure, tonnes</th><th>Phosphorus in livestock manure, tonnes</th></tr>
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<table>
<tr><td colspan="2">Data provided</td><td>Assumption</td><td>Assumption</td><td>Calculation</td><td>Assumption</td><td>Calculation</td><td>Calculation</td></tr>
<tr><td>Power engine</td><td>N° Plants</td><td>Our classification</td><td>Average Power</td><td>Plant size t/y</td><td>% manure</td><td>Manure treated t/y</td><td>Total manure treated t/y</td></tr>
<tr><td>< 500 KW</td><td>307</td><td>Farm-size plant</td><td>146</td><td>6257</td><td>25%</td><td>1.564</td><td>480.236</td></tr>
<tr><td>500-1000 kW</td><td>31</td><td>Small/Medium plant</td><td>450</td><td>19286</td><td>10%</td><td>1.929</td><td>59.786</td></tr>
<tr><td>>1000 kW</td><td>3</td><td>Larg-scale plant</td><td>1200</td><td>51429</td><td>0%</td><td></td><td>0</td></tr>
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<tr><td>87</td><td>Italy</td><td>208</td><td>289</td><td>24</td><td>6700</td><td>39429</td><td>75343</td><td>14597</td><td>10948</td><td>41601</td><td>12772</td><td>Considerations about plants size
-Número of plants <100 kW (considered farm-size): 49 / Average power engine 28 kW
-Número of plants 101-500 kW (considered farm-size): 61 / Average power engine 283 kW
-Número of plants 501-1000 kW (considered small/medium-size): 100 / Average power engine 920 kW
-Número of plants > 1 MW (considerend large-scale plants) : 19 / Average power engine 1758 kW
-Número of plants with boiler (considerend farm-size): 10 / Average power engine 28 kW
-Número of plants without data (considered farm-size): 34 / Average power engine 28 kW
Considering that a standard plant of 15.000 t/y + 20% co-substrate has a power engine of 350 kW. the average size of each grup is:
-Plants <100 kW (considered farm-size): 1200 t/y</td><td>Information provided by Sergio Piccinini and diferent papers autohred by Sergio Piccinini et al.</td></tr>
</table>

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
												-Plants 101-500 kW (considered farm-size): 12 129 t/y -Plants 501-1000 kW (considered small/medium-size): 39 429 t/y -Plants > 1 MW (considerend large-scale plants) : 75 343 t/y -Plants with boiler (considerend farm-size): 1 200 t/y -Plants without data (considered farm-size): 1 200 t/y Average amount per size-type -Farm-size plant: 5529 t/y -Small/medium-size plant: 39429 t/y -Large-scale plant: 75343 t/y	
89	Slovenia	4	2	2	49007	9415	88600	392	336	1674	434	Shining examples of biogas plants – Biogas Regions	
91	United Kingdom	31			10000			310	248	1192	228	http://biogas-info.co.uk/maps/index2.htm#	Number of plants according http://biogas-info.co.uk/maps/index2.htm# -size of the plants and the distribution on cattle and pig slurry etc. are own assumptions.
92	Belgium	4			16500			66	59	276	55		It is assumed all 4 have the same size as the one we have data for. and that the digested matter is

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
													90% manure. whereof 2/3 pig slurry and 1/3 cattle slurry
93	Spain		1			45000		45	35	186	31	PROBIOGAS project	
94	Romania	1			730			1				BIG EAST Project	Is a pilot "manure facility" constructed in 1980 and owned by ISPCAIA. producing 800NM3 biogas/day.
95	Hungary	1	1	1	19000	35000	90000	144	86	483	96		
96	Bulgaria	2			15000			30	23	104	21		BIG-East (2008) Input types and amounts are pure guesses.
98	Spain			1			70000	70	70	371	62	http://www.diariodenavarra.es/20101215/otrascomarcas/ultzama-acoge-planta-biogas-base-purines-eficiente-europa.html?not=2010121502035958&idnot=2010121502035958&dia=20101215&seccion=otr	

#	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
												ascomarcas&seccion2=politica&chnl=10	
	TOTAL	**4377**	**457**	**101**				**81605**	**45887**	**216884**	**52566**		

E.16: Thermophilic anaerobic digestion:

Definition: Biological anaerobic decomposition of organic matter for biogas production, at a temperature range around 55°C.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
51	Germany	300			20000			6000	2820	14514	3337	KTBL (2010) and BMU (2010)	We estimate the thermophle plants are a little larger than the mesophile plants.
57	Finland	4		1	6000		120000	144	144	461	83		Information from the yearbook of the biogas association. the large installation 1/2 manure from agriculture 1/2 municipal wastes
67	Belgium		1	3		4000	25833	81	81	736	152	VCM inquiry (2010)	In our inquiry we mainly ask for manure input into digesters, therefore we lack data for many installations on "other" inputs like energy crops and organic waste streams. For this reason we only supplied the input of raw manure streams.
78	Czech Republic	10			20000			200	100	365	81		Estimated 25% pig and 75% cattle slurry - other is mainly maize silage

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
89	Slovenia	1	1		7500	1000		9	1	2	0	Shining examples of biogas plants – Biogas Regions	
	TOTAL	**315**	**2**	**4**				**6434**	**3147**	**16077**	**3653**		

Treatment of the solid fraction

Definition: Processing methods particularly suitable for solid manures or solid fractions obtained after separation.

E.17: Composting of solid livestock manure or solid fractions of liquid livestock manure:

Definition: Aerobic biological decomposition and stabilization under conditions which allow development of thermophilic temperatures as a result of biological heat, with a final product sufficiently stable for storage and beneficial soil application.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
18	Denmark	4	1		1400	20000		26	22	256	57	Birkmose. T.S.: Status over anvendelsen af gylleseparering i Danmark. maj 2010; Komtek A/S 2011. personal information.	Output quality is difficult to describe for composting. There are used various technologies. and we do not have proper

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
													information to make an average level.
28	Spain			1			23460	23				ADAP and GIRO estimation	
30	Estonia		2			17500		35	35	344	88	http://www.ippc.envir.ee/docs/Juhised/Energy%20and%20rearing/Tallegg%20Biogas%20Feasibility%20Study_JeM.pdf	Especially poultry manure is used for compost. usually not by the poultry farms.
57	Finland	20			2000			40	40	289	98		Estimation. No statistics available

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
60	Sweden		2			7500		15	11	72	20	Håkan Eriksson Wiggeby gård Färingsö and Mats Tuvesson Enköping	Composted horse manure is here documented as solid cattle manure. One of the installations compost horse manure on a drained concrete pad with collection of leached water. The compost

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
													is turned once during the 6 month period of treatment.
68	Spain		10	2		14332	75000	293	129	412	112	own studies. own data	
69	Spain	127	21		8000	25219		1546	757	4839	1318	Agencia Residus catalunya	Input type is in reference of medium size installations, with 51% of substrate different

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
													of manures. such as sewage sludge and other organic waste
72	Greece	496			2002			993	904	17946	4111	personal estimation	Information updated after comments exchange between X. Flotats and D. Georgakakis: Data are based

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
													on the an estimation:
77	Spain		49	3		9192	84466	704				Consejería de Agricultura y Medio Ambiente de Castilla-la Mancha. Dirección general de Calidad y Sostenibilidad Ambiental. Servicio de Residuos	
82	Netherlands		16			25000		400	400	9224	2585	Report autohred by F. E. de Buisonjé and R.W. Melse Wageningen UR Livestock Research	Input type: Pre-dried poultry manure and solid manures / solid fractions. with non-manure additives (straw. gypsum. etc.)

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
													No information about size was provided. Compost produced: 60% of the input
83	France	100			2500			250	250	2858	406	Various	Sources are either separated liquid manure and/or FYM from cattle or dry poultry litter.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
													Rarely. other organic sources added. No real commercial use but more a means to remove nutrient excess with arable farming-
91	United Kingdom	400			2000			800	800	6775	1383		Rough estimates.
94	Romania	32			3500			112	111	648	163	ICPA (2009) and C.Borda comments	A maximum of

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
													110.000 Tm/year of "compost" or "partially stabilized" solid manures are produced in Romania. mainly from poultry manure or S/L separated slurries
98	Spain	1		1	5000		20000	25				Estimated by GIRO from information of the biogas plant at Ultzama. and amount estimated for a small composting plant at Bakio	

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
	TOTAL	**1180**	**101**	**7**				**5262**	**3459**	**43663**	**10342**		

E.18: Vermicomposting:

Definition: Production of compost utilizing various species of worms, usually red wigglers, white worms and earthworms. The end-product is also known as vermicast, worm casting, worm humus or worm manure.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
77	Spain		2			2565		5				Consejería de Agricultura y Medio Ambiente de Castilla-la Mancha. Dirección general de Calidad y Sostenibilidad Ambiental. Servicio de Residuos	
91	United Kingdom	5			4000			20	20	169	35		Assuming it happen on some of the largest organic farms
98	Spain		1			1000		1	1	4	1	A visit to the place	Is a manure and sludge manager that makes vermicompost for commercial purposes
	TOTAL	**5**	**3**					**26**	**21**	**173**	**36**		

E.19: Biodrying:

Definition: Partial drying of manure using the biological heat released during aerobic biological decomposition of organic matter.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
67	Belgium		8	7		13300	107300	858	782	3871	1014	0	there are 12 biothermal drying installations and 3 mushroom substrate composting facilities
83	France	10			10000			100	100	3700	455	0	Limited use in poultry industry to dry droppings before storage and export. Number of facilities estimated by Xavier Flotats. based on total amount of manure treated provided by CEMAGREF.
94	Romania	52			5000			260	263	1507	374	ICPA (2009) and C. Borda comments	A maximum of 110.00 Tm/year of manure or S/L separated slurries. are dried in concrete platforms before land application, mainly poultry manure/slurries. with more than 75%
	TOTAL	**62**	**8**	**7**				**1218**	**1145**	**9078**	**1843**		

E.20: Thermal drying:

Definition: Drying of manure using external heat. For liquid manures, drying follows concentration by evaporation.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
28	Spain			10			17437	174				ADAP and GIRO and Pedro Esteban Turzo estimations	Average tons treated by this technology are less than 50000. but is belonging to facilities treating averages amounts of 110000 tons/year of pig manure Information elaborated based on information provided by Perdo Esteban. government of Castilla.
51	Germany			5			200000	1000	750	18750	6600	Brauckmann University of Osnabrueck	Data from KTBL see mail. 1 000000 t/a solids from separated digestates are dried. At the other hand high rates of hen manure is dried - but there are no data available. There is a rapid decrease of drying hen manure because the amount of battery
67	Belgium		29	2		11860	57750	459	305	2682	571	VCM enquiry "2009-	

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
												2010"	
68	Spain			4			15700	63				ADAP and GIRO estimation	Amounts estimated by GIRO.
69	Spain			6			25000	150					These facilities are treating app. 100000 tons pig manure/year. The dried treatment is applied to solid fraction and concentrate from the evaporator with an average of 25000 tons/year treatment per drying unit
77	Spain			2			100000	200	180	776	173	Consejería de Agricultura y Medio Ambiente de Castilla-la Mancha. Dirección general de Calidad y Sostenibilidad Ambiental. Servicio de Residuos	
82	Netherlands		16			10000		160	160			Report authored by F. E. de Buisonjé and R.W. Melse Wageningen UR Livestock Research	

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
92	Belgium	1			3300			3					Assuming 20% solid fraction from the post-separation of digestate
93	Spain			5			23000	115				ADAP and GIRO estimation	
97	Spain			1			21470	21				ADAP and GIRO estimation	
	TOTAL	**1**	**45**	**35**				**2346**	**1395**	**22208**	**7344**		

E.21: Pelletizing:

Definition: Pelletizing is the process of compressing or moulding a material into the shape of a pellet. Usually following a previous drying process.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
67	Belgium			2			60000	120				VCM enquiry	
69	Spain			6			6000	36					There are: 3 installations with the diagram:anaerobic digestion+separation by centrifugue+thermal drying+pelletizing and 3 installations with the diagram: separation by drums filters+NDN+thermal drying+pelletizing. Comment
77	Spain			2			100000	200	180	776	173	Consejería de Agricultura y Medio Ambiente de Castilla-la Mancha. Dirección general de Calidad y Sostenibilidad Ambiental. Servicio de Residuos	

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
82	Netherlands		6			10000		60	60			Report autohred by F. E. de Buisonjé and R.W. Melse Wageningen UR Livestock Research	No information about size was provided.
91	United Kingdom	4			10000			40	40	794	182		
92	Belgium	1			1000			1					assuming 30% dry matter in the solid fraction
	TOTAL	**5**	**6**	**10**				**457**	**280**	**1570**	**355**		

E.22: Combustion:

Definition: Complete thermo-chemical oxidation of organic matter in order to obtain recoverable heat, and producing ashes and gasses.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
18	Denmark	1	1		6500	30000		37	33	142	32	Birkmose. T.S.: Status over anvendelsen af gylleseparering i Danmark. maj 2010	The input amount is treated livestock manure by separation, which means the solid output (for combustion) is app. 10% of the input weight, assuming the separation efficiency is 10% solid and 90% liquid.
60	Sweden		5			2850		14	14	91	25	Mikael Jansson. AB SWEBO Flis & Energi www.swebo.com	Horse manure is here documented as solid cattle manure. The combustion plant is adapted to horse manure where different types of litter have been used in the bed such as straw, wood chips. peat and pellets. The proportion of as
82	Netherlands			1			400000	400	400			Report autohred by F. E. de Buisonjé and R.W. Melse Wageningen UR	Input type: Dry Poultry manure (> 60% dry matter) No information about

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
												Livestock Research	size was provided. Ash produced: 7% of the input
91	United Kingdom			3			225000	675	675	13406	3071		Common for poultry litter. 2 in England and 1 in Scotland.
	TOTAL	**1**	**6**	**4**				**1126**	**1122**	**13638**	**3128**		

E.23: Thermal gasification:

Definition: Partial thermo-chemical oxidation with controlled amounts of oxygen and/or steam in order to obtain a mixture of carbon monoxide and hydrogen. The resulting gas, called syngas or synthetic gas can be further combusted in order to obtain heat or electricity.

No found.

E.24: Pyrolysis:

Definition: Thermo-chemical decomposition of organic material at elevated temperatures in the absence of oxygen. Pyrolysis is a special variant of thermolysis. The process produces gas and liquid products and leaves a solid, carbon rich residue (biochar, charcoal).

Not fond.

E.25: Wet oxidation:

Definition: Oxidation of dissolved or suspended components using oxygen as the oxidizer. The oxidation reactions occur at high pressure in superheated water at a temperature above 100° C, but below a critical point of 374° C.

Not fond.

Treatment of the liquid fraction

Definition: Processing methods particularly suitable for very diluted manures or liquid fractions obtained after separation.

E.26: Microfiltration:

Definition: Membrane filtration targeting removal of solid particles from liquid fractions in the range of about 0.1-10 µm.

Not fond.

E.27: Ultra filtration:

Definition: Membrane filtration targeting removal of solid particles from liquid fractions in the range of about 5 to 200 nm.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
82	Netherlands			1			55000	55				Input type: Liquid fraction coming from a centrifuge of a mixture of Pig slurry: 50000 t/y (91%) + Poultry litter: 5000 t/y (9%) + 15000 Maize-Co-products Total plant capacity (including co-products): 70.000 t/y Included in reverse osmosis plants	
	TOTAL			**1**				**55**					

E.28: Reverse osmosis:

Definition: Separation of dissolved components in permeates produced by ultrafiltration or other treatments separating small particles. Use pressure to force a solvent through a semipermeable membrane that retains the solute on one side and allows the pure solvent to pass to the other side.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
82	Netherlands		23			10870		250				Input type: Pig slurry liquid fraction coming from different pre-treatments (mechanical separator. ultrafiltration.…) No information about size was provided.	Report authored by F. E. de Buisonjé and R.W. Melse Wageningen UR Livestock Research
	TOTAL		**23**					**250**					

E.29: Concentration by vacuum evaporation:

Definition: Heating to boiling point, at temperatures below 100°C (required temperature depends on the vacuum applied), in order to evaporate water and volatile compounds.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
28	Spain		5	4		40000	80000	520				ADAP and GIRO and Pedro Esteban Turzo estimations	Elaborated based on information provided by Pedro Esteban. government of Castilla Leon
68	Spain			3			66000	198				ADAP and GIRO estimation	
69	Spain			3			88000	264					
77	Spain			2			100000	200	180	776	173	Consejería de Agricultura y Medio Ambiente de Castilla-la Mancha. Dirección general de Calidad y Sostenibilidad Ambiental. Servicio de Residuos	
93	Spain			5			80000	400				ADAP and GIRO estimation	
97	Spain			1			80000	80				COREN WEB PAGE and GIRO estimation	

	TOTAL		**5**	**18**				**1662**	**180**	**776**	**173**		

E.30: Concentration by atmospheric evaporation:

Definition: Heating to boiling point, a little over 100°C at atmospheric pressure, in order to evaporate water and volatile compounds.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
28	Spain			2			88000	176				ADAP and GIRO estimation	
67	Belgium		2	1		8800	60000	78				VCM enquiry	
68	Spain			1			66000	66					All vaporised liquid is previously treated pig manure. Amounts estimated by GIRO
69	Spain			3			88000	264					
	TOTAL		**2**	**7**				**584**					

E.31: Ammonia stripping and absorption:

Definition: Volatilization of ammonia from liquid phases in a packed column through a counter current gaseous flow (air or steam) and subsequent recovery in an acid solution as ammonium.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
87	Italy		1			31856		32				Sommariva. F.. Boccasile. G. Sandionigi. M.L.. Adani. F.. Provoli. G. (2011) Strippaggio dell'azoto. buoni risultati se abbinato all'implianto di biogas. L'informatore Agrario. 29. pp. 14-17.	
	TOTAL		**1**					**32**					

E.32: Carbon dioxide stripping:

Definition: Volatilization of carbon dioxide from liquid phases in order to reduce the buffer capacity.

Not found.

E.33: Electro-oxidation:

Definition: Advanced oxidation technology based on the in situ formation of hydroxyl radicals for the mineralization of organic compounds.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
67	Belgium		1			1000		1	1	4			VCM enquiry
	TOTAL		**1**					**1**	**1**	**4**			

E.34: Ozonizing:

Definition: Oxidizing post-treatment using ozone as reagent and targeting degradation of recalcitrant organic compounds and pathogens inactivation.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
28	Spain		4	1		40000	80000	240				ADAP, GIRO and government of Castilla Leon	This treatment belongs to a large facility treating 65000 tons/year pig slurry. Ozonizing is applied after aerobic biological treatment for hygineization Based on information provided by government of Castilla Leon
68	Spain			3			66000	198				ADAP and GIRO estimation	
93	Spain			4			80000	320				ADAP and GIRO estimation	
97	Spain			1			80000	80				ADAP and GIRO estimation	
	TOTAL		**4**	**9**				**838**					

E.35: Aerobic digestion (aeration):

Definition: Biodegradation of organic matter under aerobic conditions.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
28	Spain		4	1		40000	80000	240				ADAP and GIRO and Pedro Esteban estimations	Tecnology belonging to large facilities treating average 55000-65000 tons pig slurry /year
57	Finland	20			3000			60	60	190	34		No statistics available. The technology is used on organic farms.
72	Greece	1			59130			59	59	255	57	personal information	Influent rate for these two anaerobic digestion systems are estimated based on 8-10 tons/day for 100 sows farm, depending of water use in the farm.
77	Spain	2			36187			72	56	240	53	Consejería de Agricultura y Medio Ambiente de Castilla-la Mancha. Dirección general de Calidad y Sostenibilidad	

												Ambiental. Servicio de Residuos	
83	France	10			10000			100					Most aeration systems relate to nitrification systems (see separate heading).
91	United Kingdom	90			7500			675	675	2909	648		
	TOTAL	**123**	**4**	**1**				**1207**	**850**	**3594**	**792**		

E.36: Autothermal aerobic digestion (ATAD)

Definition: Self-heating thermophilic aerobic biodegradation especially suitable to avoid the dissemination of pathogens.

No found

E.37: Nitrification-denitrification (conventional):

Definition: Biological conversion of ammonium to innocuous nitrogen gas using classical nitrogen removal treatment, combining autotrophic nitrification and heterotrophic denitrification processes.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
28	Spain			1			88000	88				ADAP, GIRO and Government of Castilla Leon estimation.	Information elaborated based on information provided by Government of Castilla Leon.
67	Belgium		76	3		13130	53300	1158	44	121	9	VCM inquiry (2010); Mestwegwijzer BDB (2009)	
68	Spain	3		5	14167		100800	547	18	200	92	Own data	4 of the large scale plants are promoted by our institution. The other data are based on own studies. Reliability of performance data is low. so we prefer not indicating data at all. The 96.7% other is all previously treated pig manure

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
													(tr
69	Spain	24		3	15000		88000	624					
77	Spain	2			36187			72	56	240	53	Medio Ambiente de Castilla-la Mancha. Dirección general de Calidad y Sostenibilidad Ambiental. Servicio de Residuos	
82	Netherlands			11			72727	800				Report autohred by F. E. de Buisonjé and R.W. Melse Wageningen UR Livestock Research	Input type: Veal calf slurry and LF pig slurry No information about size was provided.
83	France	200			5000			1000	1000	3080	210	Various publications and reports	Removal of surplus nitrogen in Brittany : many examples, some with pre-screening of slurry.
	TOTAL	**229**	**76**	**23**				**4289**	**1118**	**3641**	**364**		

E.38: Partial nitrification - autothrophic anammox denitrification:

Definition: Biological conversion of ammonium to innocuous nitrogen gas using advanced nitrogen removal treatment, combining partial autotrophic nitrification and autotrophic anaerobic ammonia oxidation processes.

Not found.

E.39: Struvite (magnesium ammonium phosphate) precipitation:

Definition: Chemical reaction between magnesium, ammonium and phosphate in equal stoichiometric proportions resulting in a crystalline substance (struvite) precipitation.

Not found.

E.40: Calcium phosphate precipitation:

Definition: Chemical reaction between calcium and phosphate resulting in a precipitated (most likely amorphous or hydroxylapatite).

Not found.

E.41: Algae production on liquid manure substrates:

Definition: Nutrient uptake into phyto-biomass such as aquatic plants or microalgae and subsequent biomass harvesting.

Not found.

E.42: Constructed wetlands:

Definition: Treatment systems that use natural processes involving wetland vegetation, soils, and their associated microbial assemblages to improve water quality.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
67	Belgium		5			17000		85				VCM enquiry	
83	France	5			5000			25					Limited use, aiming to dilute livestock wastewater. Wider use for municipal wastewater in remote areas.
91	United Kingdom	50			7500			375					Assuming it is used for process / reject water, i.e. not for raw manure.
	TOTAL	**55**	**5**					**485**					

Air cleaning (as part of manure processing plant)

Definition: Methods applied to clean process air used during some manure treatment (i.e. exhaust air from composting, or from venting of storage systems).

E.43: Air scrubbing:

Definition: Air washing of unwanted pollutants using water or reagent solutions that specifically target certain compounds.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
67	Belgium		12	8		13150	97770	940				Not every installation provided the information on the air treatment (question was not mandatory). Some installations use a combination of different air treatment techniques. In total 26 installations told us they have an air treatment system.8 installations use air scrubbing as the only technique (1 big and 7 small installations).	VCM enquiry
68	Spain		1			40000		40				Own study.	own data
	TOTAL		**13**	**8**				**980**					

E.44: Air biofiltration:

Definition: Biodegradation of pollutants while the air is flowing through a packed bed colonized by bacteria and/or fungi.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
18	Denmark			19			100000	1900					We assume all Danish large-scale / regional biogas plans are equipped with air biofiltration technology.
67	Belgium		7	6		18000	108280	776				VCM enquiry	Not every installation provided the information on the air treatment (question was not mandatory).
97	Spain		1			865		1				COMPOST GALICIA SA	
	TOTAL		**8**	**25**				**2677**					

E.45: Bioscrubing (Aerobic biofilter):

Definition: Air washing through scrubbing and subsequent biodegradation of pollutants in a liquid-phase reactor.

ID User Number in the survey	EU Member State	Number of installations			Average treated amount per installation, tonnes per year			Total treated amounts				Source	Comment
		Farm scale	Medium scale	Industrial scale	Farm scale	Medium scale	Industrial scale	Livestock manure and other, 1000 tonnes	Livestock manure, 1000 tonnes	Nitrogen in livestock manure, tonnes	Phosphorus in livestock manure, tonnes		
67	Belgium		4	1		12000	118450	166				Not every installation provided us with the information on the air treatment (question was not mandatory). Some installations use a combination of different air treatment techniques. in total 26 installations told us they have an air treatment system. 2 small installations use bio-scrubbing as the only technique.	VCM enquiry
82	Netherlands		5	5		25000	15000	200	200	884	240		
	TOTAL		**9**	**6**				**366**	**200**	**884**	**240**		

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Manure processing is presently a subject that enjoys considerable attention in the EU due to the ongoing revision of the Reference Document on Best Available Techniques for Intensive Rearing of Poultry and Pigs (BREF), as well as due to current efforts to implement policies and legislation on EU and Member State level, for instance concerning renewable energy targets, targets for reducing the loss of plant nutrients to the environment, targets for reduction of greenhouse gases, and targets for manure handling in agriculture in relation to legislation about water protection and manure surpluses in livestock intensive areas.

This report is prepared for the European Commission, Directorate General Environment, as part of the implementation of the project "Manure Processing Activities in Europe", project reference: ENV.B.1/ETU/2010/0007. The Report includes deliveries related with Task 1 concerning "Inventory of the actual manure processing activities in the EU"; the inventory indicates the amount of manure processed per Member State (MS), differentiated per type of manure and the scale of operations (farm scale – medium scale- industrial scale).