EIP-AGRI Focus Group - Nutrient recycling

Mini-paper – Regulatory environment effecting nutrient recycling

Christian Kabbe, Vera Eory, Emilie Snauwaert, Edward Someus, Jean-Philippe Bernard

1. Introduction

On our way towards circular economy, traditional terms like waste, raw material and product deserve redefinition. Although nutrient recycling was well established and efficient without harm and low risk to human health and environment, industrialization, population growth and excessive mass production became a threat for those end points. In consequence and thanks to precautious thinking, waste criteria have been defined and implemented end of last century. The implementation of regulatory barriers intended to reduce the distribution and circulation of hazardous substances from all kinds and fields of anthropogenic activity contributed to reduced water, soil and air pollution since the end of the last century. Also the prohibition of production and application of known so called priority substances (chemicals considered threads to human health and environment) lead to improvements where implemented. Depending on member state, either very fragmented or cross-environmental media approaches can be observed in the regulatory framework. The latter represent already a rudimental harmonisation of requirements and restrictions for a certain set of environmental compartments (water, soil and air) – the integral approach.

Positive effects like the shrinking of the hole in the ozone layer of the Southern hemisphere can be attributed to the ban of CFC and Halons in previous decades.

Within the EU there are two main levels of regulation: the European level and the member state level. Depending on the member state, there might also be provinces, federal states and even municipalities mandated to regulate certain issues.

In general, one can state, that the European level sets the general frame and member states implement accordingly within certain flexibility, allowing stricter requirements, but not less strict requirements. Depending on type of EU level legislation, we distinguish between directives and regulations implementing the issues addressed in directives.

For example, the Water Framework Directive has to be transferred into national law by each member state. In Germany it is mirrored and covered by WHG (Wasserhaushaltsgesetz).

Regarding the nutrient recycling aspect, various EU level and member state level regulations have effect. Most of them are not up-to-date and therefore do discriminate recovered or recycled materials against primary source materials. Since the adaption of regulation can take long time, it is not surprisingly, that the regulation in most member states and at EU level are lacking behind the state of the art for nutrient recovery and recycling.

The initiative of the COM to revise the fertiliser regulation (EC 2003/2003) is one of the first concrete actions to create a level playing field for both, primary and secondary source materials. This will pave or better legalize the way for nutrient recovery and recycling. Some European countries have already implemented more or less strict requirements for nutrient recovery from wastewater or meat and bone meal. Here, the non EU country Switzerland appears to be the frontrunner by implementing in 2016 an

obligation to recover phosphorus from sewage sludge and animal meat and bone meal after a 10 y transition phase. Other countries are expected to follow.
Besides that, international green deals, like the North Sea Resources Roundabout, initiated by the Netherlands are good examples, how governments support and facilitate international (border crossing) cooperation and business to facilitate higher resource efficiency and the transformation of circular economy as buzz word just written on paper into real life.
This paper provides an overview of the regulatory framework in Europe and in the Member States with regards to nutrient recovery and recycling. The overview considers the current and proposed regulations from the perspective of increasing nutrient recycling in the European (circular) economy.

2. Overview of relevant directives on EU level and their national implementation in member states

Water Framework Directive (WFD) – 2000/60/EC

The WFD adopted in the year 2000 represents the core and framework for the European water policy. Many of the following directives in this mini-paper are related to implement aspects of the WFD.
http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1473254528990&uri=CELEX:32000L0060

Urban Waste Water Directive – 91/271/EEC

http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31998L0015
Council Directive 91/271/EEC concerning urban waste water treatment was adopted on 21 May 1991 to protect the water environment from the adverse effects of discharges of urban waste water and from certain industrial discharges. In February 1998 the Commission issued Directive 98/15/EC amending Directive 91/271/EEC to clarify the requirements of the Directive in relation to discharges from urban waste water treatment plants to sensitive areas which are subject to eutrophication. This had the effect of amending Table 2 of Annex I and finally facilitated the implementation of phosphorus removal in WWTPs, transferring more phosphorus from the wastewater into the sludge.

Sewage Sludge Directive – 86/278/EEC

http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31986L0278
as such regulates the agricultural application of sewage sludge.
It seeks to encourage the use of sewage sludge in agriculture and to regulate its use in such a way as to prevent harmful effects on soil, vegetation, animals and man. To this end, it prohibits the use of untreated sludge on agricultural land unless it is injected or incorporated into the soil. Treated sludge is defined as having undergone "biological, chemical or heat treatment, long-term storage or any other appropriate process so as significantly to reduce its fermentability and the health hazards resulting from its use". To provide protection against potential health risks from residual pathogens, sludge must not be applied to soil in which fruit and vegetable crops are growing or grown, or less than ten months before fruit and vegetable crops are to be harvested. Grazing animals must not be allowed access to grassland or forage land less than three weeks after the application of sludge. The Directive also requires that sludge should be used in such a way that account is taken of the nutrient requirements of plants and that the quality of the soil and of the surface and groundwater is not impaired.

The Directive specifies rules for the sampling and analysis of sludges and soils. It sets out requirements for the keeping of detailed records of the quantities of sludge produced, the quantities used in agriculture, the composition and properties of the sludge, the type of treatment and the sites where the sludge is used. Limit values for concentrations of heavy metals in sewage sludge intended for agricultural use and in sludge-treated soils are in Annexes I A, I B and I C of the Directive.

The European Commission is currently assessing whether the current Directive should be reviewed – and if so, the extent of this review. For example, Directive 86/278/EEC sets limit values for seven heavy metals. Since its adoption, several Member States have enacted and implemented stricter limit values for heavy metals and set requirements for other contaminants.

funded by European Commission

For its assessment, the European Commission has launched a study to gather existing information on the environmental, economic, and social as well as health impacts of present practices of sewage sludge use on land. This study will also assess the risks and opportunities that can be foreseen in coming years. The study identified possible options for European policy and estimated their costs and benefits. The Commission has chosen the consultancy team of Milieu Ltd, WRc PLC and RPA Ltd to undertake this *Study on the environmental, economic and social impacts of the use of sewage sludge on land* (DG ENV.G.4/ETU/2008/0076r)

Reports can be found here: **http://ec.europa.eu/environment/waste/sludge/**

Waste Framework Directive – 2008/98/EC

http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0098
It sets the basic concepts and definitions related to waste management, such as definitions of waste, recycling, recovery. It explains when waste ceases to be waste and becomes a secondary raw material (so called end-of-waste criteria), and how to distinguish between waste and by-products. The Directive lays down some basic waste management principles: it requires that waste be managed without endangering human health and harming the environment, and in particular without risk to water, air, soil, plants or animals, without causing a nuisance through noise or odours, and without adversely affecting the countryside or places of special interest. Waste legislation and policy of the EU Member States shall apply as a priority order the following waste management hierarchy:

Fig. 2: Waste hierarchy according to the waste framework directive

The Directive introduces the "polluter pays principle" and the "extended producer responsibility". It incorporates provisions on hazardous waste and waste oils (old Directives on hazardous waste and waste oils being repealed with the effect from 12 December 2010), and includes two new recycling and recovery targets to be achieved by 2020: 50% preparing for re-use and recycling of certain waste materials from households and other origins similar to households, and 70% preparing for re-use, recycling and other recovery of construction and demolition waste. The Directive requires that Member States adopt waste management plans and **waste prevention programmes.**

Nitrates directive – 91/676/EEC

http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31991L0676

http://ec.europa.eu/environment/pubs/pdf/factsheets/nitrates.pdf

The objective of the Nitrates Directive is to *reduce water pollution caused or induced by nitrates from agricultural sources and to prevent further such pollution*. The Nitrates Directive forms an integral part

of the **Water Framework Directive** and is one of the key instruments in the protection of waters against agricultural pressures.
It has to be reached through a close monitoring of water quality, the designation of **Nitrates Vulnerable Zones (NVZ)** and the implementation of codes of good agricultural practices (voluntary) and action programmes (mandatory in NVZ) in Member States. These instruments set out a number of requirements, whose general lines are defined by the Directive, but whose details are to be elaborated by Member States based on scientific evidence and local conditions.

The Directive **targets a very specific source of pollution (nitrates from agricultural sources**), which is the largest diffused pollution in the EU[1]. Other sources of nitrate pollution are also targeted by EU legislation, such as the Urban Wastewater Treatment Directive (wastewater from urban and certain industrial sources) and the Water Framework Directive (targeting all sources of pollution and pollutants in view of the achievement of good status of water bodies).

The Directive requires mandatory measures to the farming sector **only in case of pollution problems**. The Action Programmes apply only in the Nitrate Vulnerable Zones (NVZ), i.e. in those areas where a pollution problem is recognized by Member States on the basis of their monitoring programmes. Member States have also the choice to apply mandatory measures in the whole territory (either because it is recognized fully vulnerable or in order to apply equal obligations to all farmers). This remains fully a choice of the Member States.

The Directive **targets a very specific source of pollution (nitrates from agricultural sources**), which is the largest diffused pollution in the EU[2]. Other sources of nitrate pollution are also targeted by EU legislation, such as the Urban Wastewater Treatment Directive (wastewater from urban and certain industrial sources) and the Water Framework Directive (targeting all sources of pollution and pollutants in view of the achievement of good status of water bodies).

[1] According to the last Water Framework Directive implementation report, Diffuse pollution significantly affects 90% of river basin districts.

[2] According to the last Water Framework Directive implementation report, Diffuse pollution significantly affects 90% of river basin districts.

funded by European Commission

Fig. 3: Screenshot of JRC mapping of current status of NVZ in EU
http://fate-gis.jrc.ec.europa.eu/geohub/MapViewer.aspx?id=2

The Directive requires mandatory measures to the farming sector **only in case of pollution problems**. The Action Programmes apply only in the Nitrate Vulnerable Zones (NVZ), i.e. in those areas where a pollution problem is recognized by Member States on the basis of their monitoring programmes. Member States have also the choice to apply mandatory measures in the whole territory (either because it is recognized fully vulnerable or in order to apply equal obligations to all farmers). This remains fully a choice of the Member States.

Implementation and action programmes (update by DG ENVIRONMENT planned for 2017)

The overall principle guiding the measures of the directive is the **balanced fertilization**, i.e. nutrients must be applied in the amount, at the time and in the conditions whereby they are functional to crop growth and they are not lost to waters. This principle applies to all nutrients (animal manure and other fertilizers).

- The Directive is **continuously informed by scientific evidence**, which is embedded in one of its articles (Article 5.3[3]). It is to the Member States to define the measures applying to farmers in the Action Programmes, based on the most recent scientific evidence. Combined with the fact that at least every four years the Nitrates Action Programmes have to be updated, the implementation of the Directive automatically takes into account the progress in science, technologies and practices.

- The Directive sets out **only a specific limit** that is a maximum application standard of 170 kg/ha/year of Nitrogen from livestock manure that only applies in NVZ. However, this limit is flexible

[3] *Action programmes shall take into account: (a) available scientific and technical data, mainly with reference to respective nitrogen contributions originating from agricultural and other sources; (b) environmental conditions in the relevant regions of the Member State concerned .*

funded by European Commission

insofar different limits are proposed and scientifically justified by Member States. In these cases, the Commission can adopt implementing decisions (derogations), if it is demonstrated that these different limits do not undermine the objectives of the directive.

- The **other requirements** (e.g. prohibition of fertilizer application in periods of absence of crop uptake, facilities to store the manure during those periods, establishment of buffer zones along water courses, application of fertilizers only in the amount needed by the crops, etc.) are listed in the directive, but their details are established by Member States in the Action Programmes, guided by scientific evidence.

Fig. 4: Official information about the current implementation status in each member state can be found at websites of competent member state authorities. DG Environment provides a map, where web-links to these specific authorities are provided:
http://ec.europa.eu/environment/water/water-nitrates/ms.html
This Directive defines a chemical fertilizer as a fertilizer manufactured by an industrial process and livestock manure as waste products excreted by livestock, even in processed form (art. 2(g) Nitrates Directive). Consistency between the Nitrates Directive and the EC Regulation 2003/2003 (see further) would be necessary to create a level playing field between chemical fertilizers and the manure based alternative.

A summary note on biogas status and trends in EU based on a survey done in 2012 by DG ENVI provides an overview on implementation in the different member states and how they cope with the max. 170 kg N/ha/year requirement. Different approaches are currently being taken across the EU:

1. Total N in digestate is accounted for in calculation for the respect of the 170 kg N/ha/year limit, regardless of the composition of the input material. This approach is applied in Belgium (Wallonia) and Estonia.

2. Total N in digestate is accounted for in calculation for the respect of the 170 kg N/ha/year limit:
- if any percentage of livestock manure is part of the input material
- in some cases, even if livestock manure is not part of the input material.
This approach is being taken in Belgium (Flanders).

funded by European Commission

3. Total N in digestate is accounted for in calculation for the respect of the 170 kg N/ha/year limit, if any percentage of livestock manure is part of the input material. Ireland and Northern Ireland follow this approach.

4. The Netherlands account for total N in digestate if at least 50% of the input material is livestock manure and the co-material is part of a specific list.

5. Denmark accounts for the total N in digestate if more than 75% of the input material is livestock manure.

6. Only N from livestock manure is accounted for in calculation for the respect of the 170 kg N/ha/year limit. This approach is applied in Austria, Germany, France, Italy, Latvia and Portugal.

7. In Slovenia, N from digestate is not accounted in current legislation, although legislation will be revised so as to account for N from livestock manure.

8. In Sweden, N from digestate is not accounted for in calculations for the respect of the 170 kg N/ha/year, unless the whole input material is livestock manure.

9. In Bulgaria, N from digestate is not accounted for in calculations for the respect of the 170 kg N/ha/year.

The following countries did not provide a reply to the question: Cyprus, Czech Republic, Hungary, Norway, Poland, Spain, UK-England and Wales, Greece, Luxembourg and Malta, while replies from others did not provide a straightforward answer, sometimes outlining some lack of clarity or gaps in legislation.

The Nitrates Directive has proven to be effective since its entry into force in the nineties, with decreased average nitrate concentrations in Europe and improved fertilizer use efficiency. The Directive has also induced a reduction of the nutrient surplus and an increased adoption of good agricultural practices and innovative technologies. Management of livestock manure has become more and more a central element in farm management and manure has started to be considered not only a waste but a resource.

- **Water quality**: According to the last monitoring results carried out by Member States (referring to the period 2008-2011), an average slight improvement of water quality is being observed, with a decrease of the overall share of polluted monitoring stations for both groundwaters and surface waters[4]. This is also due to a general improvement of the quality of the action programmes over the last years, with tightened measures, improved fertilization methodologies, additional storage capacity and enhanced enforceability.

  There remain 'hotspots' where improvements are not yet forthcoming and which need greater attention in future, especially with respect to action programme measures. This is especially true in areas of very intensive livestock production.
  Here, following the good example of the manure tracking and monitoring implemented in the Netherlands should be copied by the others member states. It is evident, that a lack of monitoring and tracking and reporting of the manure shipped across countries opens the door for non-

[4] In 2008–2011, in EU-27, 14.4% of groundwater stations exceeded 50 mg nitrate per litre and 5.9% were between 40 and 50 mg/1. This is a slight improvement compared to the previous reporting period, in which 15% stations exceeded 50 mg and 6% were between 40 and 50 mg.
In surface waters, 2.4% showed concentrations between 40 and 50 mg per litre and 2.4% exceeded 50 mg per litre23. This is also an improvement compared to the previous reporting period, in which 3% stations exceeded 50 mg per litre and 2.9% were between 40 and 50 mg per litre.
Source: Report from the Commission on the implementation of the Nitrates Directive in the reporting period 2008-2011, published in 2013.

sustainable manure management and is likely to fail the target of this directive. It is evident, that regional hotspots failing the targets of this directive are a result of lacking monitoring, tracking and reporting of manure in areas with high livestock density. Since tracking and reporting requires official survey and data processing in a concerted way, responsible authorities need the capacities and mandates to do so. In many member states like in Germany, authorities are rather regional and in worst case have competing competences. Sustainable nutrient management on the other hand requires national and even transnational data compilation and aggregation. Interpol might be an good example for a European "manure watch" or similar.

- **Fertilizer use and nitrogen surplus**. The directive is largely recognized as one of the drivers of the trend of decreased fertilizer use since the nineties, which has induced a general decrease of the nitrogen discharge into the environment. The nitrogen surplus has also fallen significantly since the establishment of the directive, thanks to the efficiency of use of nutrients.

- **Phosphorus**. Even if not targeting directly phosphorus, the Nitrates Directive entails a better management of livestock manure, thus affecting both nitrates and phosphates. Some Member States where eutrophication remains a big challenge have also set up specific phosphorus measures in their Action Programmes, such as phosphate application standards.

Industrial Emissions Directive (IED) – 2010/75/EU

http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0075

The IED aims to achieve a high level of protection of human health and the environment taken as a whole by reducing harmful industrial emissions across the EU, in particular through better application of Best Available Techniques (BAT). Around 50,000 installations undertaking the industrial activities listed in Annex I of the IED are required to operate in accordance with a permit (granted by the authorities in the Member States). This permit should contain conditions set in accordance with the principles and provisions of the IED.

The IED is based on several pillars, in particular (1) an integrated approach, (2) use of best available techniques, (3) flexibility, (4) inspections and (5) public participation.

1. The **integrated approach** means that the permits must take into account the whole environmental performance of the plant, covering e.g. emissions to air, water and land, generation of waste, use of raw materials, energy efficiency, noise, prevention of accidents, and restoration of the site upon closure.

2. The permit conditions including emission limit values must be based on the **Best Available Techniques (BAT)**. In order to define BAT and the BAT-associated environmental performance at EU level, the Commission organises an exchange of information with experts from Member States, industry and environmental organisations. This work is co-ordinated by the **European IPPC Bureau** of the Institute for Prospective Technology Studies at the EU Joint Research Centre in Seville (Spain). This process results in **BAT Reference Documents** (BREFs); the BAT conclusions contained are adopted by the Commission as Implementing Decisions. The IED requires that these BAT conclusions are the reference for setting permit conditions.

For certain activities, i.e. **large combustion plants**, waste incineration and co-incineration plants, solvent using activities and titanium dioxide production, the IED also sets EU wide emission limit values for selected pollutants.

3. The IED allows competent authorities some **flexibility** to set less strict emission limit values. This is possible only in specific cases where an assessment shows that achieving the emission levels associated with BAT described in the BAT conclusions would lead to disproportionately higher costs compared to the environmental benefits due to the geographical location or the local environmental

conditions or the technical characteristics of the installation. The competent authority shall always document its justification for granting such derogations.

Furthermore, Chapter III of the IED on large combustion plants includes certain flexibility instruments (Transitional National Plan, limited lifetime derogation, etc.).

4. The IED contains mandatory requirements on **environmental inspections**. Member States shall set up a system of environmental inspections and draw up inspection plans accordingly. The IED requires a site visit to take place at least every 1 to 3 years, using risk-based criteria.
5. The IED ensures that the **public has a right to participate** in the decision-making process, and to be informed of its consequences, by having access to permit applications, permits and the results of the monitoring of releases.

In addition, through the **European Pollutant Release and Transfer Register (E-PRTR)**. emission data reported by Member States are made accessible in a public register, which is intended to provide environmental information on major industrial activities.

Related to nutrient recycling, the major impact can be seen for incinerators, but also leaching processes and of course, ammonia emissions where ever applicable.

3. Overview of relevant regulations on EU level and their national implementation in member states

Fertiliser Regulation – 2003/2003/EC

http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=URISERV:l21278

This regulation was adopted in order to gather all rules applying to fertilisers into a single piece of legislation and to ensure the uniform application of a package of very technical provisions. Today it only applies to mineral fertilisers made up of one or more plant nutrients (or fertilising elements).

General provisions

All types of fertiliser which appear in Annex I and comply with the provisions of the regulation may bear the words EC fertiliser. The list of the various types of fertilisers authorised on the European market may be extended. In order to be listed, the manufacturer must apply to the competent authority in their country and constitute a technical file on the characteristics of the fertiliser. Applications are then sent to the Commission which accepts or rejects the manufacturer's application.

All 'EC fertilisers' may circulate freely on the European market. Member States may not prohibit or limit their placing on the market unless they consider that the fertiliser in question represents a danger for health or a risk to the environment. In such cases, the product is temporarily withdrawn from the market until a study is carried out at European level to ascertain whether the risk is well founded.

Minimum requirements

A type of fertiliser shall only bear the words EC Fertiliser if:

- it has no adverse effect on the health of humans, animals, plants or the environment under normal conditions of use;
- it is effective;
- relevant sampling and analysis methods are being provided.

Annex I of the Regulation, amended in 2013, also establishes minimum nutrient content required for each type of fertiliser (nitrogen content, phosphorus content, etc.).

Rules regarding packaging and labelling of fertilisers

The Regulation lays down a certain number of compulsory statements which must appear on the packaging and labels of fertilisers. In particular, these include the marking EC Fertiliser, details relating to the description of nutrients or micro-nutrients, information about the manufacturer and, if applicable, details of blends. Some optional information is also recommended, such as specific directions for the use, storage and handling of the fertiliser.

The Regulation harmonises the rules on labelling and packaging in the EU. These rules concern, inter alia, the marking of nutrient content. Quantities of substances may be indicated in several ways. For example, phosphate content may be indicated in elemental form or in oxide form.

Specific provisions

The Regulation sets out detailed technical provisions regarding the scope, declaration, identification and packaging of four types of fertiliser:

- main inorganic nutrient fertilisers: these are the main fertilising elements supplied in substantial quantities for plant growth, i.e. nitrogen, phosphorus and potassium;
- secondary inorganic nutrient fertilisers: these are calcium, magnesium, sodium and sulphur;
- inorganic micro-nutrient fertilisers: these contain elements required in small quantities such as boron, cobalt, copper, iron, manganese, etc.;
- ammonium nitrate fertilisers of high nitrogen content: given the dangerous nature of this type of fertiliser, the Regulation lays down additional measures such as a detonability test described in Annex III to the Regulation.

Controls

Member States may carry out official controls to verify compliance of fertilisers bearing the words EC fertiliser with the provisions of the Regulation. These control measures are to be carried out by designated laboratories in each Member State in accordance with a uniform procedure set out in the Annexes to the Regulation.
For inspection purposes, manufacturers must keep records of the origin of EC fertilisers for as long as they are being supplied to the market.
Member States determine the rules on penalties applicable to infringements of the provisions of the Regulation.
The Commission shall be assisted in implementing the Regulation and making adaptations to the Annexes by a committee composed of representatives of the Member States.
This body is represented in the Fertiliser Working Group chaired by DG Growth unit D2 – GROW.
The current revision of the fertilizer regulation as one concrete pillar of the Commission's circular economy package:
http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015DC0614

A first draft of a revised fertilizer regulation has been published for comments in March 2016. The revision intends to create a level playing field for primary source and secondary source materials, be it as ready to use fertilizer or raw material to be used in fertilisers. Whereas the 2003 version focused on mineral fertilisers, the new regulation is supposed to cover also bio-based materials in organo and organo-mineral fertilisers, bio-stimulants, etc. . Another goal is to foster harmonization of requirements between several regulations (reduce administrative burden and legal uncertainties), which may cause in today's state confusion or raise unintended barriers.

Fertiliser regulation for the organic farming sector

A dedicated fertilizer regulation **2008/889/EC** is in place and under the responsibility of DG AGRI. A revision is under discussion and materials like struvite or calcined phosphates from ashes should be seriously considered to be approved as alternative mineral phosphorus source. Expert Group for Technical Advice on Organic Production (EGTOP) "**Final Report on Organic Fertilizers And Soil Conditioners (II)**", final version 2 February 2016.
http://www.sinab.it/sites/default/files/share/Final%20Report%20on%20Organic%20Fertilizers%20And%20Soil%20Conditioners%20%28II%29%20%20%28February%202016%29.pdf

Animal by-products regulation – 2009/1069/EC

http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009R1069

Animal by-products (ABPs) are materials of animal origin that people do not consume. ABPs include among others:

- Animal feed - e.g. based on fishmeal and processed animal protein
- Organic fertilisers and soil improvers - e.g. manure, guano, processed OF/SI on the base of processed animal protein

- Technical products - e.g. pet food, hides and skins for leather, wool, blood for producing diagnostic tools

According to the EFPRA (Europe's leading authority on the use, value and bio-security of edible animal fats and meat industry by-products) in the EU28 in 2015 about 51,099.28 kt absolute weight of animals slaughtered, that has been producing 16,760 kt edible and inedible ABPs. Carcass weight is approx. 34,339 kt/year in EU28, from which the average raw bone is 16.6 %. MBM cannot be used as a feed material, but it is valued as a source of green energy and a raw material in a variety of industrial applications. While PAP (nitrogen-containing substances that are formed by amino acids, containing up to 14% fat and 60% protein) and MBM are both derived by means of the rendering process, the regulations governing the production of PAP ensures it is never produced in the same processing facility as MBM in the EU. Soft PAP does not contain soil and plant fertilizer elements with economical importance. The impact of mammal origin sterilized PAP in vivo agricultural environment (that is often abundant with human and animal dormant pathogens, Salmonella, Foot and Mouth disease and many others) and possible contact with mammal animals and humans is highly risky, due to the trans and recontamination.

An excellent infographic ("Rendering in numbers") is provided by EFPRA here:
http://www.efpra.eu/Objects/3/Files/EUInfographic.pdf

From the 5,700 kt/y as received raw bone approx. 3400 kt/y is industrially available, that is after high temperature processing approx. 2,000 kt/y bone meal/grist produced. The bone industrial products are the food grade gelatin, China Bone for porcelain industry, pet food and bone grist for high temperature >600°C 20min carbonization to recover calcium phosphate ABC Animal Bone bioChar organic fertilizer and adsorbents. The EU28 substtitution potential of the mineral Phosphate import, substituted with industrially available and economically viable animal bone based bio-phosphate is calculated to approx. 20-27% before 2030.

In the EU, over 20 million tons of ABPs emerge annually from slaughterhouses, plants producing food for human consumption, dairies and as fallen stock from farms.

ABPs can spread animal diseases (e.g. BSE) or chemical contaminants (e.g. dioxins) and can be dangerous to animal and human health if not properly disposed of. EU rules regulate their movement, processing and disposal.

ABPs are categorised according to their risk using the basic principles in this regulation. Most relevant for the nutrient recycling aspect is, the original category sticks to the down-stream materials derived from it after processing. It does not provide the option to define new categories for material, extracted or transformed by processing of i.e. manure. All materials derived from manure remain manure, no matter of their physical, chemical properties. Here, the definition of end-of-waste criteria for promising recyclates may provide a quite bureaucratic solution.

Currently, DG SANTE is working on defining an 'end point' for ABP materials/processing chains beyond which the material can be used as input for 'EC fertilisers' (see 2003/2003/EC).

REACH – 2006/1907/EC

http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32006R1907

aims to improve the protection of human health and the environment through the better and earlier identification of the intrinsic properties of chemical substances. This is done by the four processes of REACH, namely the **registration, evaluation, authorisation and restriction of chemicals**.

For the nutrient recycling aspect, REACH and it's exemptions are important. Particularly in the case of struvite recovered from waste or waste water article 2.7(d) provided an option to avoid bureaucratic

burden. Unfortunately, this article and particularly the definition of the term "recovered" is matter of national interpretation. Here, clarification on EU level has to be considered essential.

4. What measures or regulative adaptions have been proposed or implemented in EU and member states to foster nutrient recycling?

European Commission:

2013 - Public consultation on sustainable phosphorus management

2014 – Phosphate rock included in EU Critical Raw Materials List

2015 – Public consultation on circular economy

2016 – 1st official draft of revised fertiliser regulation

2016 – Implementation of an European working group to define quality and end-of-waste criteria for **STRU**vite, **BI**ochar and **AS**hes intended to be used as fertiliser or raw material for fertiliser production by 2018. The group was mandated by EC DG GROW and is coordinated by IPTS at JRC in Seville.

Switzerland: (not an EU member state)
Adaption of waste regulation entered into force 1st January 2016 making phosphorus recovery obligatory for sewage sludge and meat and bone meal with 10 years transition phase.
«Verordnung über die Vermeidung und die Entsorgung von Abfällen» (VVEA)
https://www.news.admin.ch/message/index.html?lang=de&msg-id=59785
Belgium, Flanders:
In 2014 an action plan has been published: "**sustainable management of biomass (side)streams' (2015-2020)**' to guarantee a sustainable management for the coming 5 years. With this action plan a guiding and inspiring framework is offered to contribute to a sustainable and efficient use of biomass streams and residues. Different action programs have been elaborated, f.e. nutrient recovery, biobased products, valorisation of biomass residues into agriculture/feed, prevention of food waste, etc.

*Full-scale proof of principle for a **pro rato system** for digestate from anaerobic co-digestion*

Currently, according to Flemish legislation, the total amount of nitrogen in digestate from co-digestion is considered as nitrogen from animal nitrogen. Whether the amount of animal nitrogen at the input side is 1% or 99%, in both cases the nitrogen in the digestate has the status of 100% animal nitrogen (administrative 'manure-multiplication effect'). In practice this means that it is very difficult to spread digestate on agricultural land within the Flemish region due to the competition with animal manure, since there is already a surplus of animal manure. Therefore, a 'pro rato system' is been researched in practice, where only the share of animal-N at the input side is considered as animal-N at the output side and nutrients from vegetable origin can be applied as 'other fertilizer' replacing the need for mineral fertilizers. 'Other' fertilizers (different from animal and mineral fertilizers) can be applied on the field on top of the limit of animal manure (170 kg N/ha), but within limits imposed on the level of effective nitrogen per hectare. For this research liquid fraction of digestate is applied within this system, where the availability of the nutrients to the crop /nutrient efficiency and the risk of nutrient leaching is been tested.
In 2015, 6 hectares of maize has been fertilised with LIF DIG and DIG according to the 'pro rato' system.
In 2016, 7 farmers will use the LIF DIG as fertilizer according to the 'pro rato' system on 57.8 hectares in total.
The goal of this full-scale proof of principle is to demonstrate that the use of digestate following a pro rato scheme does not compromise the objectives of the Nitrates Directive, that is the protection of waters against pollution of nitrates from agricultural sources.

Sweden:

In 2010 included 60% P recycling target from sewage sludge to arable land by 2015 in it's "waste plan", but did not frame how. So, direct land application of sludge on land, which is the traditional recycling route is included as option to achieve the goal. Good quality assurance measures have been demonstrated on regional level (i.e. REVAQ) to ensure only safe sludge is recycled.

Denmark:

In it's Resource Strategy of 2013, Denmark's government announced the target of 80% P from sewage to be recycled by 2018, be it as sewage sludge applied on agricultural soil or P recovered from incineration ash.

France:
The French Environment and Energy Management Agency – Ademe – worked a lot to improve the organic wastes recycling during the 90's, particularly urban wastes compost and sewages sludges. In parallel, the livestock effluents were considered like pollutant materials by water agencies. So the roadmaps from the different public agencies contained quite contradictory guidelines. But the agronomical way of organic recycling increased from 1990 until 2010. Nowadays one part of organic wastes is managed with spreading plans and the other part by producing standardized composts. Ademe motivates local authorities to implement territorial plans of organic waste management. The most recent prompting to recycling nutrient is professed in the government report "Agriculture and innovation 2025": the purpose is to increase the carbon content of soil to improve soil fertility and to prevent from climate change.

Germany:
Newly elected government stated in it's coalition contract of 2013 to reduce or even ban direct sludge application on arable land and to enforce technical P recovery from sewage sludge instead.
After more than 10 years of revision, the new draft of the German sewage sludge ordinance has been sent by the Federal Ministry of Environment (BMUB) to the European Commission for notification at September 26th 2016. The notification to EC is a typical procedure for new member state regulations according to directive 2015/1535/EU. Once approved by EC, the content cannot be changed afterwards except for minor adaptions. During notification, there is a three months stand-still agreement.
The next steps after positive notification will be cabinet resolution within the different DGs of Federal government in January 2017 before it is presented for enactment to the Federal Council of Germany and the Parliament in spring 2017.
It may enter into force with a date 1st January 2018 making phosphorus recovery from sewage sludge obligatory for all German WWTP larger than 50,000 person equivalents (~500 WWTP out of ~9300 WWTP). They will have to recover the phosphorus if the sludge contains more than 2% phosphorus /DS (dry solids) or have to incinerate the sludge in mono-incinerators. Land application of sludge will only be allowed for WWTP < 50,000 p.e.. The ~500 WWTP represent roughly 66% of the total phosphorus removed from German wastewater and transferred into the sludge.
The currently 29% of sludge spread on arable land are expected to half as consequence of the new fertilizing ordinance (DüV) and sewage sludge ordinance (AbfKlärV) entering into force. The fertilizing ordinance is the German implementation of the nitrates directive and will dramatically affect the sludge disposal or valorization in Germany already next year.

Since WWTP operators need security in terms of sludge disposal, most will turn towards mono-incineration. Still there are no substantial capacities available to recover the P from the resulting ashes, so they will have to be put into interim storage. But stockpiling can neither be considered recovery nor recycling.
So, the intention of this kind of recovery obligation can be considered good, but the way it is implemented leaves a lot of question marks. Innovation always starts with the lowest hanging fruit, not with the highest hanging out of reach.
Besides that, the German wastewater ordinance should be adapted to allow WWTP to switch from chemical P removal towards biological P removal. This would allow implementation of more struvite recovery facilities on site. But the strict discharge monitoring applying the 4 out of 5 rule provides no flexibility.

Download: **http://www.bmub.bund.de/themen/wasser-abfall-boden/abfallwirtschaft/wasser-abfallwirtschaft-download/artikel/abfklaerv-klaerschlammverordnung/**

The Netherlands:
In contrary to Germany, the Netherlands do not enforce the WWTP sector to recover P but strongly support the waterboards to establish biological P removal, enabling already feasible P recovery and recycling in form of struvite. The Dutch discharge limit monitoring requires to annual average match and therefore allows some flexibility needed for the waterboards to switch from chem-P to bio-P removal.
Also the Dutch government's initiative to start an international green deal named "North Sea Resource Roundabout" demonstrates the commitment of all stakeholders within the Netherlands to enable not only recovery, but also the recycling. No value chains, no recycling! The struvite case is one part within this intl. green deal. **http://www.greendeals.nl/north-sea-resources-roundabout/**

UK/Scotland:
1. New sewage sludge recommendations from the Scottish Government (Safe Sludge Matrix for land application, tighter monitoring, etc.)
2. Consultation on creating a more circular economy in Scotland (2015) and links to the ongoing Better Environmental Regulation programme "we will consider what improvements can be made to the regulatory and licencing framework to provide greater clarity on where activities are subject to regulation, and to support and promote greater levels of reuse."
3. Waste (Scotland) Regulations 2012: separate collection of key materials, including food waste (prohibiting these going to incineration or landfill).

5. Proposed measures/options to foster nutrient recycling

Besides the above mention measures or options, various other are already under discussion or have been proposed:

Taxation of fossil based nutrients used and reduced taxation for renewable nutrients use. Also reduction of VAT for renewables is discussed.

Quantification and charging of the real cost including environmental impacts not yet included in any environmental taxation.

CAP – subsidies should only be paid to farmers implementing or working on measures to produce more sustainable, which would need a clear definition and if possible standardisation of sustainability criteria.

Labelling on i.e. fertilisers including share of recovered nutrients or carbon food print per kg or similar.

Phasing out the use of non-renewable biological materials (e.g. peat) (Scottish Government 2016)

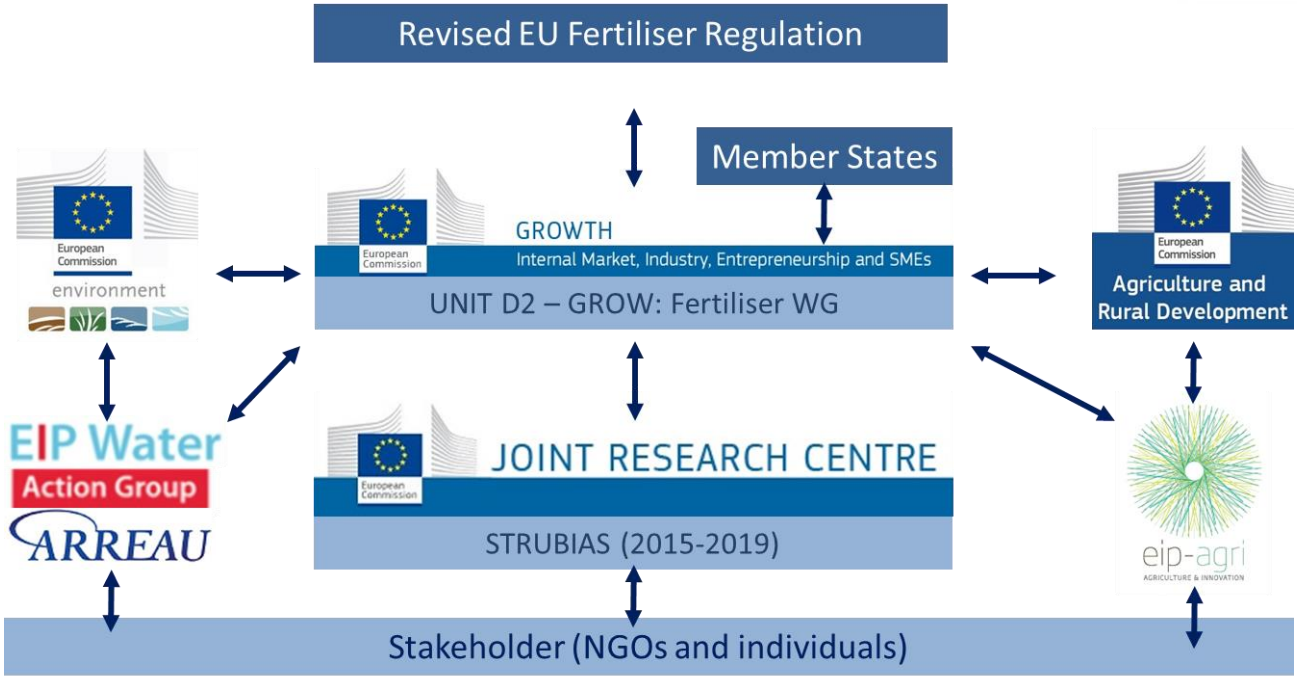

Fig. 5: STRUBIAS as example, how policy can be adapted and who is involved

An excellent compilation of networks, initiatives and project dealing with sustainable nutrient management is compiled by the European Sustainable Phosphorus Platform under the following link:

http://www.phosphorusplatform.eu/platform/links-and-networks/r-d-and-projects

6. Proposal for potential operational groups

1. For regulatory affairs, an intergovernmental OP covering interested member states could be one option to define and facilitate replication of best practices. For example, the Dutch initiative of the intl. green deal called "North Sea Resources Roundabout" works pretty well bringing together governmental officials and value chain stakeholders to bring forward the recycling of various materials in the North Sea region. For nutrients, struvite is already part of this green deal allowing close interaction of Dutch and French officials and value chain stakeholders. This initiative should be expanded to other member states or regions.
   The Brunswick area looks suitable to become another nutrient recovery and recycling cluster, where wastewater utilities, industry and farmers can closely cooperate to close local, regional or even trans- national nutrient cycles.

2. As also identified by DG ENV, there is still a lack on the real fertiliser or agronomic value of the various recyclates. Here, a pan European network of farm based tests sites and a links, well coordinates monitoring programme would be of great value. The information derived would be necessary to define and agree on agronomic material properties and the further development of so-called "next generation fertilisers" delivering the nutrients on crop demand and therefore providing higher fertilising efficiencies and reduction of nutrient losses to soil and water bodies.

3. It still has to be observed, that the exchange of information and practical experience with innovative solutions is still lacking or very isolated. This calls, similar for point 1 for a pan-EU exchange network, bringing together practicioners and regulators.

7. Proposals for (research and innovation) needs from practice

Due to the obvious lack of reliable data on nutrient flows in Europe, a sound monitoring project should be implemented. Sound strategies for better nutrient management can only be developed based on reliable data, not on vague assumptions and national statistics.

Implementation of TRL9 nutrient recycling industrial replication projects, that are the only and ultimate true value demonstration points for applicability of any lower matured TRL research results in practice.

We need reality based nutrient budgets for soils and farms (not assumptions based on paper calculation).

We need clear information on nutrient use efficiencies to enable demand based nutrient application. Here, a systematic compilation and gap filling campaign on the agronomic value of the various recyclates still needs to be done. The information publicly available are very fragmented, to high extend outdated or not representative and only in some cases really comparable.

We need risk based requirements for materials intended for use on soils, no matter if the come from waste or primary sources. (level playing field) This also includes clear definitions of end-of-waste criteria.

We need impact based flexibility for pilot or demonstrative installations to bridge the gap between R&D (lab) and Innovation (Market).

We need "sustainable funding", meaning enabling R&D followed by Innovation (market deployment) covering first movers risks.

8. Conclusions

Looking at the current state of play, the legislative framework appears to be quite counter circular in the means of recycling of renewable resource. Given the fact, that most environmental laws have been implemented to enforce the protection of a healthy environment or to re-improve the environmental status of the biosphere, certain materials and their flows have been defined as waste. For some, really harmful materials this will and has to remain. But many resources, especially nutrients cannot be considered harmful or waste. They just need to be managed in a better way than we do today. According to the common saying, every substance is a poison depending on the dose applied, we can conclude, that the nutrient surplus is a threat to environment and human health, not the nutrient as such!
Therefore, the legal framework affecting nutrient recycling has to be redefined. Following very strict the precautionary approach, sustainable nutrient recycling is rather prevented than facilitated. Lot of precautionary measures have been concluded based on uncertainties and "emotional" aspects rather than facts. More clarity on nutrient balances, nutrient effectiveness and real demands are needed to bridge the gap between supply and demand of nutrients.
Besides these nutrient balance effects, quality aspects have to be considered fact based as well. Looking at the definitions of waste, we see, that in many member states waste always remains waste.
Even if waste is processed and some incredients have been transformed into high-quality materials, they remain waste and are restricted from proper use.
Looking at the current fertiliser regulation, recyclates are often excluded be it for fertiliser use or just as raw material for fertiliser production. A regulation requiring the same quality for both, the final product to be applied on soil and the raw material to produce this product, waste derived materials are excluded and circular economy will remain nothing more than just a fancy buzzword. If we really want circular economy to happen, recycling of any material has to be considered, evaluated, made safe and enabled.
This in general! Besides circular economy also innovation is a commonly used buzzword. But finally, even with a huge funding budget, innovation often fails, since regulators are not flexible enough to allow exemptions for small-scale temporarily installations (pilots) to bridge the gap between invention (development) and innovation (market deployment). What good are millions of public money spent for developing new technologies, if they cannot be tested or implemented? Knowledge is not enough, it

has to be demonstrated and applied! A good example to tackle this issue is the North Sea Resource Roundabout (NSRR) representing a green deal on various recyclable materials incl. struvite. Here stakeholders from practice and policy cooperate to enable recycling value chains between various member states. http://www.greendeals.nl/north-sea-resources-roundabout/

Quality criteria like heavy metal contents or organic pollutants are often derived from suspicion and not really based on facts. Here, proper monitoring would help increase the fact-based knowledge to enable or improve to evaluate the risks and finally to conclude proper risk reduction measures.
http://phosphorusplatform.eu/images/download/Kraus-Kabbe-Seis-Risk-Assessment-Recycled-Fertilisers-P-REX-2016.pdf
The challenge in nutrient recycling is the variety of environmental media involved. There are water bodies to be protected from eutrophication, soil (incl. groundwater) to be protected from depletion and contamination as well as air to be kept clean and breathable. This multimedia (horizontal) interaction has to be reflected in regulatory framework. There is no point in setting different requirements for i.e. the medium soil, be it from the fertilising, soil conservation or waterbody protection point of view. It would make sense, that all nutrients put on arable land are regulated in one single regulation, that also reflects on the collateral impacts to the other media.

9. References / links

- **European Commission**

Regulation and directive texts:
http://eur-lex.europa.eu/

DG ENV provides nitrates directive related links to competent member state authorities
http://ec.europa.eu/environment/water/water-nitrates/ms.html

- **Denmark**

https://www.retsinformation.dk/Forms/R0710.aspx?id=175399

- **France**

French guidelines for organic wastes recycling
http://www.ademe.fr/expertises/dechets/passer-a-laction/valorisation-organique

http://www.ademe.fr/en/waste-collection-sorting-recycling-and-recovery-strategic-roadmap

http://agriculture.gouv.fr/agriculture-innovation-2025-des-orientations-pour-une-agriculture-innovante-et-durable

- **Germany**

Draft Fertilising Ordinance
http://www.bmel.de/SharedDocs/Downloads/Service/Rechtsgrundlagen/Entwuerfe/EntwurfDuengeverordnung.pdf;jsessionid=FA112C739916E87B41D3969D572F4ADD.2_cid358?__blob=publicationFile

Draft sewage sludge ordinance
http://www.bmub.bund.de/fileadmin/Daten_BMU/Download_PDF/Abfallwirtschaft/abfklaerv_novelle_entwurf_2016_bf.pdf

funded by European Commission

- **The Netherlands**

https://www.rijksoverheid.nl/documenten/rapporten/2014/12/02/5e-nederlandse-ap-betreffende-de-nitraatrichtlijn-2014-2017

- **United Kingdom**

Nitrate related
http://www.legislation.gov.uk/all?title=Nitrate%20Pollution%20Prevention%20

http://www.gov.scot/Topics/farmingrural/Agriculture/Environment/NVZintro

Scottish Government (2016) Making things last - Consultation on creating a more circular economy in Scotland. http://www.gov.scot/Publications/2015/08/2820/downloads
http://www.gov.scot/Topics/Environment/waste-and-pollution/BER

Sewage sludge recommendations
http://www.uknutrientplatform.org/2016/04/21/scottish-government-announces-sewage-sludge-recommendations/

- **Spain**

Nitrate related
http://servicios2.marm.es/sia/visualizacion/lda/protegidas/nitratos.jsp