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SYSTEMIC
Circular solutions for biowaste

2018

Report on regulations governing AD and NRR in EU member states



Ludwig Hermann and Ralf Hermann



Horizon 2020

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Public Report

Deliverable 2.1

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Preface

During the conception of SYSTEMIC, we were assigned the task of developing commercially viable business cases and business models for recovery and recycling of nutrients from agricultural waste flows. The critical question was, what drives the demonstration plants to implement nutrient recycling processes and – more fundamentally - what has driven agricultural entrepreneurs to invest in large digestion plants?

Well, it became clear very soon. Investment in digester plants was driven by supporting schemes for renewable energy supply in four of the five cases. The decision in favour of nutrient recycling was driven by legal restrictions to apply the digestate on nearby crop- or grassland. Again, in four out of our five demonstration cases. The exception is a very special case – descendants of a Nobel Prize winner who are driven by care for soil fertility and biodiversity. In our project eighty percent of entrepreneurs are driven by regulation. If considering how many Nobel Prize winner families are active in agriculture, our eighty percent rate may be underestimated.

Hence it became clear that regulations are the key to the business cases. It turned out that a close review of the regulative framework was needed before we could turn our efforts to analysing and evaluating the businesses. A few years ago, we successfully performed a similar study for the FP7 project P-REX, developing nutrient recycling from sewage sludge, so we knew what lied ahead of us.

The present report is the result and the first milestone towards the development of business cases and business models: review and evaluation of the policy and regulatory framework in EU Member States where our five demonstration plants and – already integrated – twelve outreach plants operate. Active promotion of SYSTEMIC had already during its first year attracted builders and operators of digesting plants in Europe who intend to follow the example of the demonstration plants in terms of sustainability and nutrient recycling and to which knowledge and technologies from the demonstration plants will be transferred. These plants are called outreach plants.

The report is one of the deliverables of the SYSTEMIC project, which is funded by the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no. 730400.

We want to take the opportunity to thank all partners who have contributed to this comprehensive report: the operators of demonstration and outreach plants, the scientific partners as well as EBA, VCM and the Rise Foundation have provided valuable information.

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Introduction

The Green Revolution, starting from the 1950s, has produced food and feed for over 7 billion humans now living on our planet. We can call this a success story, albeit it did not happen without consequences. Today we have ample evidence that the massive extraction, conversion and use of resources has reduced the resilience of life supporting systems which may sooner or later collapse with dramatic consequences for life on Earth.

By converting atmospheric nitrogen and fossil phosphorus to fertilisers, humankind has made the green revolution possible. Over time, we have used too much and without care about losing a substantial fraction of reactive nutrients to soil, air and water. Intensive livestock farming concentrated in specific regions and inadequate removal of nutrients from wastewater exacerbated the problem. Consequently, we have algae blooms feeding bacteria that consume the oxygen needed for a balanced aquatic life and leaving dead zones in large parts of our oceans, one of our essential life supporting systems. Rivers and lakes in Europe are equally overloaded with nutrients and frequently missing the state of good quality at which European policies aim.

This is a very brief introduction to the biosphere framework in which we operate. The Commission, the Council and the Parliament has initiated several European policies, regulations, directives and actions to cope with the problems. One of them is Horizon 2020 which has co-funded our project SYSTEMIC (Framework Programme Research and innovation, Grant Agreement no. 730400), showing how five demonstration plants convert agricultural waste and organic fractions from industrial and municipal waste to energy – electricity, heat and/or biomethane - and recover nutrients in a form that they can be returned to cropland where they are needed.

Hence, SYSTEMIC addresses two of the threatened ecosystems mentioned above: climate and aquatic bodies. It develops examples of applied Circular Economy bringing together multiple actors from agriculture, industry, science, services and policy. It will demonstrate that combining digestion for energy conversion and nutrient recycling for a balanced distribution on soils across Europe can be a profitable business and simultaneously reduce harmful nutrient emissions to the environment.

The present report is conceived as a guidance for investors, planners, owners and operators of large rural anaerobic digestion facilities who are intending to recover and recycle nutrients from the digestate of their operating or planned facilities.

It covers European and selected national policies and legislation that are relevant to digestion projects¹. Policies and legislation essentially aim at a sustainable agriculture, abatement of greenhouse gas emissions, preservation of soil fertility, food security and safe food for European citizens. The legal framework consists of a mix of financial support schemes for conversion of biomass to renewable energy and restrictions to the excessive use of nutrient rich digestates on crop- and grassland. It contains a large variety of legal acts which are binding for the whole territory of the European Union, albeit in part leaving room for adaptions and interpretations when European Directives are adopted in Member States' legislation. The European Court of Justice is the highest instance to decide if a national interpretation and/or adaption of a European Directive corresponds to the original intention and scope of the European legal act to which the national legislation refers.

Even if the density of legal acts addressing rural activities looks overwhelming, readers will soon acknowledge that they follow a clear target and pursue a meaningful strategy. Indeed, readers will

¹ For easier reading and understanding, the report does not include support schemes which are relevant for small agricultural digester plants that typically do not qualify for peripheral nutrient recovery techniques for commercial reasons.

understand that this legal framework is providing a roadmap for opportunities albeit with some constraints inherent in every act of legislation.

Looking over the opportunities provided by the European legal framework: sources for funding and constant revenues by the Common Agricultural Policy (CAP), the European Regional and Agricultural Development Funds and by feed-in tariffs, premiums and green certificates for renewable energy, to name just a few. Business opportunities created by the restrictions of spreading unlimited amounts of nutrient rich residues to crop- and grassland requiring innovation and technologies to produce more concentrated fertilising products you can ship to destinations where nutrients are needed. And if you have new ideas how to face the existing and upcoming challenges, you always can apply for funding to one of the European and/or Member State based Research and Innovation actions.

Summary and recommendations

The regulatory framework governing anaerobic digestion and biogas production in EU Member States is arranged in European Policies, Regulations and Directives and by national legislation, which is based on European Policies and Directives. Consequently, we have organised the Regulatory Framework Report following the same structure. Chapter 1 deals with European Policies which are followed by European Regulations that must be enforced by all Member States as they are in chapter 2. Chapter 3 refers to European Directives which must be adopted by Member States but not literally. Directives typically stipulate a target but leave room for selecting the strategy and pathway by the Member State. Chapter 4 briefly deviates from legislation and provides - extracted from the EBA Annual Reports² - statistical information on the regional development of electricity from biogas and biomethane production in Europe clearly showing Germany in the lead but higher recent dynamics regarding biomethane in France and Nordic countries. In chapter 5 the report returns to legislation in Member States, starting with comprehensive information on the countries with demonstration plants. Chapter 6 deals with legislation in countries with outreach plants and chapter 7, finally, gives an overview of all Member States.

A second structural string follows the purpose of legislation, distinguishing between supportive acts based on European renewable energy policies, regulations and directives on one hand and constraining legislation mainly derived from environmental regulations like the Nitrate Directive and the Water Framework Directive on the other hand. Feed-in tariffs, feed-in premiums and green certificates clearly have been the drivers behind the development of anaerobic digestion. However, operators are increasingly facing more stringent limits to nutrient application in terms of the application periods, application methods, the acceptable amounts of nitrogen and phosphorus and requirements to storage capacities that increase the cost of digestate handling and transport, but it offers opportunities for the innovative technologies demonstrated in SYSTEMIC.

Due to the frequent amendments of regulative acts, the report can only provide a conclusive picture as of late 2017 and early 2018. Trying to compensate for this unavoidable drawback we provide the links to relevant authority and service web-sites where readers can find updated information directly in the text and/or in the reference section. The report provides very comprehensive coverage of the countries that are relevant for SYSTEMIC partners and outreach plants, eleven, out of twenty-eight Member States. An overview of all Member States with basic information and links to information portals is provided in the last chapter.

If readers plan a project in a country that is only marginally covered, they can always take the Europe-wide applicable regulations and the regulations in demonstration or outreach countries as a guideline and look for corresponding regulation in their own jurisdiction.

The main findings of the legal framework review are:

- (1) Totally different supporting schemes in Member States, from zero subsidy in Spain to quite generous support schemes in Italy, at least if the plant does not digest sewage sludge.
- (2) A widespread discrepancy in national legislation regarding the regulation of acceptable substrates if the digester should benefit from support schemes in terms of energy crops, sewage sludge, agricultural and food waste etc. More harmonisation among Member States or general European regulation would be desirable.
- (3) Regarding restrictive regulation many Member States have implemented similar action programmes to improve water quality as required by the Nitrates Directive leading to similar regulation on nutrient application. However, compliance with similar regulation is much more challenging in countries with high livestock density as demonstrated by all demonstration plants

² EBA Annual Report 2017, Annex 1 to the report

in comparison to some outreach plants in countries where the pressure towards nutrient separation is lower.

Recommendations

- **Harmonisation:** Europe is sharing policies, regulations and objectives but how objectives are pursued is governed by each Member State with own definitions, strategies and regulations complicating the life of actors in the common market. If at least European definitions were shared by all member states, transactions between Member States would be facilitated. We hope that the new regulation of fertilising products is only a first step in a process extending to other European areas including supporting schemes.
- **Continued support to renewable energy supplies:** surprisingly, after Europe and Member States signed and ratified the Paris (COP21) agreement, subsidies for renewable energy were reduced, in some cases to zero (Spain) and in others to quite unattractive tenders (Germany) discouraging investment in biogas plants.
- **Saving greenhouse gas emissions must pay back:** emissions and other externalities must be subject to sensible taxes or other mechanisms causing a relevant penalty for the polluter.
- **Long-term legislative framework reliability:** Funding schemes must provide a reliable framework within a time-frame, corresponding to the pay-back time of investments. AD/NRR projects will only happen in a market environment where business cases will not be upset by unforeseeable legislative acts.
- **Gradual shift of taxation from labour to materials use:** nutrient recovery and recycling frequently involves higher workload - compared to producing fertilisers from fossil resources - creating (wanted) jobs in rural areas. However, renewable labour is highly charged with taxes and social expenses whereas fossil materials use is not or only marginally taxed adversely affecting recycling.
- **Level playing field for equal products, regardless of their origin:** Circular Economy is only possible if products are regulated without discriminating recycled raw materials. This approach is pursued by the new regulation of fertilising products but the trilogue tends to water down the Commission's draft. Several other European Regulations and Directives still need to be adapted.

1 European Policies

Legislation of the European Union legislation consists of policies, regulations and directives which govern anaerobic digestion, nutrient and waste management activities. Hence, farmers and entrepreneurs planning an activity related to energy conversion and nutrient recovery from energy crops, agricultural waste as well as organic fractions of municipal and industrial waste are advised to start with considering the European regulatory framework and then turn to the regulatory framework of the Member State where the facility will be located.

1.1 Overview

European Policies are disclosed and implemented by a variety of acts including opinions, communications, recommendations, decisions, directives and regulations, from non-binding to binding acts. Each of the following policies is implemented by several of these acts. Acts that are relevant to the owners and operators of systems as demonstrated by SYSTEMIC are briefly explained in this report, even if their relevance is only marginal or indirect.

| Policies | National regulation recommended |
|----------------------------------|---|
| Common Agricultural Policy (CAP) | Representing about 40% of the total EU annual budget, the CAP provides support for farmers' revenues, sets the rules for the common agricultural market including policies for international agricultural trade and aims at ensuring a sustainable rural development according to the specific needs in each EU country. The CAP is based on two pillars: for direct payments (I) and rural development (II), financed by two Agricultural Funds (EAGF and EAFRD), implemented through EU Regulations and managed by European (EU Commission) and national authorities appointed by the Member States' Ministries of Agriculture. |
| 2030 Energy Strategy | The EU's Renewable Energy policy aims at a low carbon economy. A binding target of 20% final energy consumption from renewable sources was set for 2020. EU countries have committed to reaching their own national renewables targets. All EU countries have adopted national renewable energy action plans (NREAP). The 2030 Energy Strategy includes a new renewable energy target of at least 27% of final energy consumption in the EU by 2030. On 30 November 2016, the Commission published a proposal for a revised Renewable Energy Directive to ensure that the 2030 target is met. |
| Clean Air Package | The clean air package aims to substantially reduce air pollution across the EU and prevent subsequent health and environmental impacts by abating acidification, eutrophication and ground-level ozone. This is pursued by limiting the emissions of SO ₂ , NO _x , NH ₃ and volatile organic compounds by 2030 as stipulated in the Gothenburg Protocol, and has been addressed in EU legislation by the National Emission Ceilings (NEC) Directive. |
| Bioeconomy Strategy | Europe's Bioeconomy Strategy addresses the production of renewable biological resources and their conversion into vital products and bio-energy. It aims at focusing Europe's common efforts in response to increasing populations, depletion of natural resources, impacts of increasing environmental pressures and climate change. |
| Circular Economy Package | The CE package contributes to "closing the loop" of product lifecycles through increased recycling and re-use. The plans aim at extracting the maximum value and use from all raw materials, products and waste, fostering energy savings and reducing greenhouse gas emissions. Its first deliverable in form of a legal act is the new Fertilising Products Regulation. |

1.2 Common Agricultural Policies (CAP) [1] [2]

The CAP aims at providing a policy framework and financial support for farmers enabling a decent standard of living and ensuring stable food supply in a sustainable way and at affordable prices for more than 500 million Europeans. The EU farm policy also covers requirements for animal health and welfare, environmental protection and food safety. Its overall objective is a sustainable rural development.

The CAP is targeted on 22 million farmers and 44 million employees in food processing, food retail and food services depending on agriculture. The EU exports food products for more than 130 billion Euro per year.

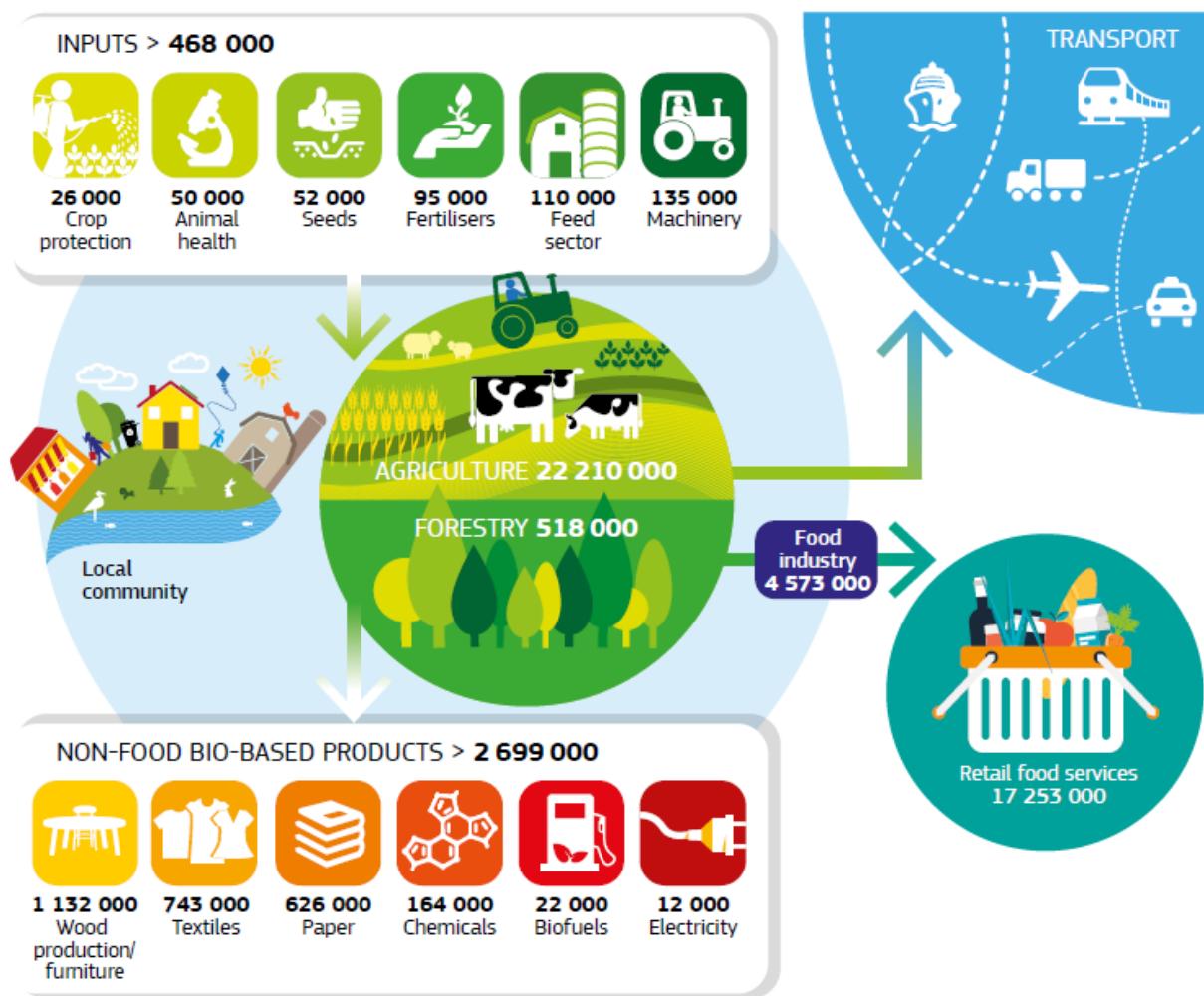


Fig. 1 Number of employees in the farming, forestry and related industry (source EU brochure Agriculture)

With an annual budget of roughly 59 billion Euro, the CAP supports i) farmers' revenues based on market orientation, sustainability, food safety and animal welfare, ii) market measures to balance impacts on volatile and vulnerable agricultural markets and iii) rural development programmes responding to the specific needs for rural developments of each of the 28 EU Member States.

Developments in global agricultural markets and new European Union (EU) commitments on **climate change and sustainable development** mean the common agricultural policy needs to evolve yet again, to meet these continuing challenges. Future Common Agricultural Policies will respond to the climate change and sustainability challenges and shift financial incentives to related activities.

On 29 November 2017, the European Commission presented the communication Future of Food and Farming (COM(2017) 713 final) [3]. The communication comes after a consultation on the future of the

Common Agricultural Policy to better understand where the current policy can be simplified and modernised.

Tackling climate change and preserving the environment is the number one challenge facing the EU, and the CAP must play an enhanced role in this battle – not only to protect farmers from the impact of climate change but also to ensure that farming does not contribute to making the problem worse. Stringent new goals will be set at European level to ensure farming contributes fully to helping meet the EU's international commitments on climate change and sustainability.

The CAP is based on two Pillars: Pillar I, comprising direct payments and market measures and Pillar II focusing on rural development policy. Both CAP Pillars allow for a large variety of environmental measures. The CAP financing support represents about 40% of the total EU budget and is financed by two funds managed by the European Commission which form part of the EU's general budget: i) The European Agricultural Guarantee Fund (EAGF) primarily finances direct payments to farmers and measures regulating or supporting agricultural markets and ii) The European Agricultural Fund for Rural Development (EAFRD) finances the EU's contribution to rural development programmes. According to the principle of shared management, the management and payment tasks are delegated to the Member States, who themselves work through national or regional paying agencies.

Each Pillar may include measures that have impacts on the activities of SYSTEMIC. 30% of the expenses of the rural development policy must be reserved for voluntary, targeted measures reducing greenhouse gas emissions and triggering other environmental benefits.

To promote innovation in Agriculture, the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI) has been launched. It links the different policies, works to facilitate a broader uptake of research and innovative solutions on the ground and to develop a research agenda which is more targeted to farmers' and foresters' needs.

Stakeholders interested in investing in nutrient recovery and recycling systems as demonstrated by SYSTEMIC are advised to review the agricultural financing facilities of the Member State where the technology is located. Under the 2014-2020 rural development policy, the EU will contribute over € 95 billion to investments in Member States which aim at: i) fostering the competitiveness of agriculture, ii) ensuring the sustainable management of natural resources, iii) combatting climate change and iv) achieving a balanced territorial development of rural economies and communities including the creation and maintenance of employment. Funds for rural development are disbursed through programmes run by national governments: the government appoints the Managing Authority whose task is to inform potential beneficiaries of the support that is available, the rules that apply and the level of the EU contribution. For information specific to Member States the Ministry of Agriculture in the Member State should be contacted.

1.3 The 2030 Energy Strategy [4]

EU countries have agreed on a new 2030 Framework for climate and energy, including EU-wide targets and policy objectives for the period between 2020 and 2030. These targets aim to help the EU achieve a more competitive, secure and sustainable energy system and to meet its long-term 2050 greenhouse gas reductions target.

The strategy sends a strong signal to the market, encouraging private investment in new pipelines, electricity networks, and low-carbon technology. The targets are based on a thorough economic analysis that measures how to cost-effectively achieve decarbonisation by 2050.

The cost of meeting the targets does not substantially differ from the price we will need to pay in any case to replace our ageing energy system. The main financial effect of decarbonisation will be to shift our spending away from fuel sources and towards low-carbon technologies.

1.3.1 Targets for 2030

- A 40% cut in greenhouse gas emissions compared to 1990 levels
- At least a 27% share of renewable energy consumption
- At least 27% energy savings compared with the business-as-usual scenario.

1.3.2 Policies for 2030

- A reformed EU emissions trading scheme (ETS)
- New indicators for the competitiveness and security of the energy system, such as price differences with major trading partners, diversification of supply, and interconnection capacity between EU countries
- First ideas for a new governance system based on national plans for competitive, secure, and sustainable energy. These plans will follow a common EU approach. They will ensure stronger investor certainty, greater transparency, enhanced policy coherence and improved coordination across the EU.

1.4 The Clean Air Package [5]

The clean air package aims to substantially reduce air pollution across the EU. The proposed strategy sets out objectives for reducing the health and environmental impacts of air pollution by 2030 and contains legislative proposals to implement stricter standards for emissions and air pollution.

The package was published by the Commission on 18 December 2013 and includes a communication (COM(2013) 918 final) on the "Clean Air Programme for Europe", plus three legislative proposals on emissions and air pollution. The main target of the Clean Air Programme is to improve health of European citizens and reduce health related expenses. In addition, the package aims at protection of ecosystems, innovation and enhancing EU competitiveness in the field of green technology.

Part of the Clean Air Package and relevant for SYSTEMIC stakeholders is the Gothenburg Protocol.

1.4.1 Gothenburg Protocol [5]

The Gothenburg Protocol aims at abating acidification, eutrophication and excessive ground-level ozone concentrations. The Protocol is part of the Convention on Long-Range Transboundary Air Pollution (LRTAP convention) which is the main international framework for cooperation and measures to limit and gradually reduce and prevent air pollution. 51 countries from the UN Economic Commission for Europe (UNECE) region are parties to the convention, including the EU Member States, Canada, the United States and several countries in Central Asia.

Since its signature in 1979, the LRTAP convention has been extended by 8 specific protocols, including the 1999 Protocol to stop acidification, eutrophication and ground-level ozone. To that effect, it sets national emission ceilings for each Party to be met by 2010 and thereafter for the following four air pollutants: sulphur (mainly sulphur dioxide, SO₂), nitrogen oxides (NO_x), ammonia (NH₃) and volatile organic compounds other than methane (VOC). This protocol, also known as 'the Gothenburg Protocol', was approved by the Council on behalf of the EU in June 2003. It was transposed into EU law mostly through the 2016 National Emission Ceilings Directive and the 2015 Directive on emissions from large combustion plants.

The focus on the abatement of acidification, eutrophication and ground-level ozone by limiting SO₂, NO_x, NH₃ and volatile organic compound emissions makes the Gothenburg Protocol relevant for SYSTEMIC, even if the emission ceilings are set for Member States.

1.5 The Bioeconomy Strategy [6]

Launched and adopted on 13 February 2012, Europe's Bioeconomy Strategy addresses the production of renewable biological resources and their conversion into vital products and bio-energy. Under the lead of Directorate General (DG) Research and Innovation, the Strategy was co-signed by several other Commission departments namely DG Agriculture and Rural Development, DG Environment, DG Maritime Affairs and DG Industry and Entrepreneurship.

The strategy aims to focus Europe's common efforts in response to increasing populations, depletion of natural resources, impacts of increasing environmental pressures and climate change. Its main purpose is to streamline existing policy approaches in this area.

It is structured around three pillars: i) investments in research, innovation and skills, ii) reinforced policy interaction and stakeholder engagement, iii) enhancement of markets and competitiveness.

The Strategy is also needed to ensure that fossil fuels are replaced with sustainable and renewable alternatives as part of the shift to a post-petroleum society. The Bioeconomy Strategy manifests itself in dedicated research and innovation strategies and topics, including the Integrated EU Maritime Strategy Blue Growth covering research programmes like BONUS for the Baltic Sea and BLUAMED for the Mediterranean Basin. The strategy is relevant for potential additional research projects which may come out of the nutrient recovery and recycling activities of SYSTEMIC and its demonstration and outreach plants.

1.6 Circular Economy Package [7]

The European Commission has adopted an ambitious Circular Economy Package in December 2015 to help European businesses and consumers to engage in a transition to a stronger and more circular economy where resources are used in a more sustainable way.

The European Commission has started the initiative, after the withdrawal of a legislative proposal on waste, by presenting a new package in 2015 which would cover the full economic cycle (not just waste reduction targets) and is drawing on the expertise of all the Commission's services.

The proposed actions contribute to "closing the loop" of product lifecycles through greater recycling and re-use and bring benefits for both the environment and the economy. The plans aim at extracting the maximum value and use from all raw materials, products and waste, fostering energy savings and reducing greenhouse gas emissions.

The proposals cover the full lifecycle of products: from production and consumption to waste management and the market for secondary raw materials. This transition is supported financially by the European Structural & Investment Funds (ESIF), which include € 5.5 billion for waste management. In addition, support is provided by € 650 million under Horizon 2020 and investments in the circular economy at national level.

The new Regulation of fertilising products replacing the Regulation (EC) 2003/2003 [8] has been conceived as the first deliverable of the Circular Economy Package. By its holistic approach including virgin and recycled materials from mineral and organic resources and by its "built-in" end-of-waste

status for compliant products it fully reflects the circular thinking. Other legislative proposals followed: the recast of the Waste Framework Directive including all other waste related acts, the recent EU Strategy for Plastics in the Circular Economy and the review of the list of Critical Raw Materials [9] are other examples of the highly integrated approach.

The Circular Economy Package with its new Fertilising Products Regulation is a cornerstone of the SYSTEMIC and many other research and innovation projects dealing with the globally acknowledged primary target of sustainable development: “**Decoupling**”, economic growth and full employment without growing use of resources. As such, it is embedded in the global framework of the Sustainable Development Goals [10] and the COP21 [11] agreements to confine the temperature increase by a maximum of 2°C, both adopted by virtually all United Nations by the end of 2015.



Fig. 2 The Sustainable Development Goals (Source UN Sustainable Development Knowledge Platform [10])

2 European Regulations [3]

2.1 Overview

An EU Regulation is a binding legislative act. It must be applied in its entirety across the EU and inherently does not allow divergent interpretations by Member States that nonetheless exist within the activity areas covered by the present report. Due to frequent amendment of legislation referred to in this report, interested parties are advised to consult <http://eur-lex.europa.eu/homepage.html> [3] and official comments which can be easily accessed by entering the regulation denomination as listed below to an internet search engine.

| Regulations | Binding in all Member States – Objective / Regulated subject |
|---|---|
| New Fertilising Products Regulation – recast of Regulation (EC) 2003/2003 | The current regulation defines and lists inorganic fertilisers (primary, secondary and micro-nutrients), liming materials and regulates their market placement. The draft version for the new regulation defines Component Material Categories (CMC) and Product Function Categories (PFC) for CE labelled fertilisers from organic and inorganic materials. Compliance with the new regulation acknowledged by the CE-label also determines Europe-wide end-of-waste status. |
| Animal By-products Regulation (EC) 1069/2009 | Laying down health rules regarding animal by-products (ABP) and derived products not intended for human consumption. Currently excludes ABP Cat 1 from use as raw materials for renewable fertiliser production, albeit with different approaches in certain Member States (UK, Portugal). |
| Plant Protection Product (PPP) Regulation (EC) 1107/2009 | Regulates placing of plant protection products on the market. The Regulation on fertilising products, when enforced, will include bio-stimulants. |
| REACH Regulation (EC) 1907/2006 | Concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC. |
| Classification, Labelling and Packaging (CLP) Regulation (EC) 1272/2008 | The CLP Regulation contributes to the UN Globally Harmonised System (GHS) aim that the same hazards will be described and labelled in the same way all around the world. |
| Waste Shipment regulation (EC) 1013/2006 | On supervising and controlling shipments of waste within EU borders and to/from EFTA, OECD and Basel Convention countries. |
| Common Provisions for EU Funds ³ Regulation (EU) No 1303/2013 | Laying down common provisions on the EU Funds |
| Rural Development Regulation (EU) 1305/2013 | Fosters the development of rural areas in terms of competitiveness, sustainable management of natural resources and job creation. |
| Horizontal CAP Issues Regulation (EU) 1306/2013 | Lays down the rules for CAP expenditure, the farm advisory system, control systems set up by EU countries and the cross-compliance system. |
| Direct Payments to Farmers Regulation (EU) 1307/2013 | Provides a set of common rules for direct payments for active farmers including a mandatory "greening" component and a focus on young farmers; all payments being subject to cross-compliance, i.e. respecting certain practices which are beneficial for the environment by farmers. |
| Common Market Organisation (CMO) Regulation (EU) 1308/2013 | Provides the basic elements for a common organisation of markets in agricultural products, such as private storage aid for certain products listed in the regulation. The CMO also addresses international agricultural trade issues. |

³ Regulations 1303/2013-1308/2013 are the binding legislative acts of the Common Agricultural Policy

2.2 Fertilising Products Regulation [3]

Regulation (EC) No 2003/2003 relating to fertilisers was adopted on 11.12.2003 and aims at providing EU-wide rules for the definition, nutrient content, nutrient solubility, packaging and labelling of **mineral** fertilisers. Organic fertilisers are exempt from the current regulation and governed by national legislation. In Annex I the regulation lists fertiliser types according to their specific characteristics. Once a fertiliser meets this type designation it may bear the letters 'EC'. The fertiliser may then be sold and used throughout the EU. This EC designation guarantees farmers that the fertilisers contain a minimum nutrient content and are safe to use. For a new type designation to be listed in the Annex I to the regulation, the manufacturer of a fertiliser corresponding to that type designation must lodge a request with a national competent authority. This request is forwarded to the European Commission, which consults the other EU countries and decides to accept or reject the application based on the advice of a committee set up by the regulation. To achieve the EC status, a fertiliser must provide nutrients effectively, not harm human, animal or plant health or the environment and demonstrate it has been subject to the relevant sampling, analysis and test methods.

As a first deliverable of the Circular Economy Package, the Commission presented a draft proposal for a new Fertilising Products Regulation (COM(2016) 157 final) [8] with substantial amendments: the new regulation includes amendments of Regulations (EC) No 1069/2009 and (EC) No 1107/2009 covers **organic** and inorganic fertilising products, next to liming materials, soil amendments, growing media, bio-stimulants and blends) organized in so-called Product Function Categories (PFC) determined in Annex I to the proposed Fertilising Products Regulation and so-called Component Material Categories (CMC) determined in Annex II of the draft regulation. EC labelled fertilising products may only be produced from designated CMC.

PFCs set out the requirements related to the Product Function Categories ('PFC') to which EU marked fertilising products shall belong. The requirements laid down in Annex I for a given PFC apply to EU marked fertilising products in all subcategories of that PFC.

2.2.1 Designation of Product Function Categories (PFC)

1. Fertiliser
 - A. Organic fertiliser
 - I. Solid organic fertiliser
 - II. Liquid organic fertiliser
 - B. Organo-mineral fertiliser
 - I. Solid organo-mineral fertiliser
 - II. Liquid organo-mineral fertiliser
 - C. Inorganic fertiliser
 - I. Inorganic macronutrient fertiliser including sub-categories
 - II. Inorganic micronutrient fertiliser including sub-categories
2. Liming material
3. Soil improver
 - A. Organic soil improver
 - B. Inorganic soil improver
4. Growing medium (substrate in which plants are grown)
5. Agronomic additive (note: subject to change during the trilogue)
 - A. Inhibitor
 - I. Nitrification inhibitor
 - II. Urease inhibitor
 - B. Chelating agent
 - C. Complexing agent
6. Plant bio-stimulant (note: subject to change during the trilogue)
 - B. Microbial plant bio-stimulant
 - C. Non-microbial plant bio-stimulant

- I. Organic non-microbial plant bio-stimulant
- II. Inorganic non-microbial plant bio-stimulant

7. Fertilising product blend

CMCs set out the requirements to components of which CE marked fertilisers may be produced. An CE marked fertilising product shall consist solely of component materials complying with the requirements of one or more of the Component Material Categories ('CMC') listed below. The component materials, or the input materials used to produce them, shall not contain one of the substances for which maximum limit values are indicated in Annex I of this Regulation in such quantities as to jeopardise the CE marked fertilising product's compliance with one of the applicable requirements of that Annex.

2.2.2 Designation of Component Material Categories (CMC)

- CMC 1: Virgin material substances and mixtures
- CMC 2: Non-processed or mechanically processed plants, plant parts or plant extracts
- CMC 3: Compost
- CMC 4: Energy crop digestate
- CMC 5: Other digestate than energy crop digestate
- CMC 6: Food industry by-products
- CMC 7: Micro-organisms
- CMC 8: Agronomic additives
- CMC 9: Nutrient polymers
- CMC 10: Other polymers than nutrient polymers
- CMC 11: Certain animal by-products (excluding Cat 1 animal by-products)
- CMC 12: Determined industrial by-products (recently added)
- CMC 13: Recovered P-salts (to be added after JRC study/policy decision)
- CMC 14: Ashes (to be added after JRC study/policy decision)
- CMC 15: Biochar/pyrolysis products (to be added after JRC study/policy decision)

The draft EU Fertilising Products Regulation is now in the Trilogue, i.e. the process by which Commission, Parliament and Council elaborate an unanimously acceptable final version of the new regulation that can be finally adopted.

The Fertilising Products Regulation is highly relevant for SYSTEMIC as it sets the rules for a common European market for the products which are developed and put to the market by the project. It aims at superseding the highly diversified national rules that are exhibited in this document, avoid notification between Member States if shipped across EU borders and create a common market for recycled fertilisers. However, CMC 11 criteria (including manure and digestate highly relevant for SYSTEMIC) have not yet been set by DG Santé.

The regulation is a form of facultative regulation. National regulation will remain in force and may be chosen by a producer not trading products cross borders. A CE marked fertilising product will qualify for free trade within the EU regardless of national regulations.

2.3 Animal By-product (ABP) Regulation [3]

Regulation (EC) No 1069/2009 adopted on 21.10.2009 is laying down health rules regarding animal by-products and derived products not intended for human consumption. The regulation deals with the movement, processing and disposal of ABPs.

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

- Animal feed - e.g. based on fishmeal and processed animal protein

- Organic fertilisers and soil improvers - e.g. manure, guano, processed organic fertilisers/soil improvers on the base of processed animal protein
- Technical products - e.g. pet food, hides and skins for leather, wool, blood for producing diagnostic tools

ABP of Cat 2 and Cat 3 may be placed on the market provided they are pressure sterilised (Art. 15), come from registered and approved plants and – in case of Cat 2 material – must be prevented from use as feed by adding an appropriate component that excludes this use. Equally, digestion residues from transformation of ABP Cat 2 and 3 into biogas or compost may be placed on the market and used as organic fertilisers or soil improvers.

The ABP Regulation is of particular concern to the project regarding two relevant aspects: i) animal by-products include manure which is subject to use limitations in nitrate vulnerable zones designated by Member States in accordance with the Nitrate Directive and ii) we are currently confronted with different interpretations by DG Environment and the British and Portuguese governments, allowing the use of ash from ABP-Cat 1 incineration for use as fertilisers whereas DG Environment insists that Cat 1 ABP ash is excluded from all kind of agricultural use.

The draft version of the new Fertilising Products Regulation (COM(2016) 157 final) [8] includes provisions for use of ABP Cat 2 and 3 as CMC, provided they are free of salmonella (in a 25 g product sample) and do not contain Escherichia coli, or Enterococcaceae in a concentration of more than 1000 CFU/g fresh mass in the EU marked product. In addition, it must contain at least 7.5% organic carbon and more than 40% dry matter. ABP for use as CMC must have reached the endpoint in the manufacturing chain as determined in accordance with Regulation (EC) No 1069/2009. However, as of May 2018, DG Santé has not designated ABPs that can be used for fertiliser production.

2.4 Plant Protection Products (PPP) Regulation [3]

Regulation (EC) 1107/2009 of the European Parliament and of the Council concerning the placing of plant protection products (pesticides) on the market. The Regulation sets out rules governing the authorization of plant protection products in commercial form and their placing on the market, use and control within the European Community. It applies to products consisting of or containing active substances i) for protecting plants or plant products against harmful organisms, ii) influencing the life process of plants, iii) preserving plant products and iv) destroying undesired plants or their parts.

A plant protection product usually contains more than one component. The active component against pests/plant diseases is called “active substance”. The Commission evaluates every active substance for safety before it reaches the market in a product. Substances must be proven safe for people's health, including their residues in food and effects on animal health and the environment. They may include micro-organisms, pheromones and botanical extracts.

Before any PPP can be placed on the market or used, it must be authorised in the Member State(s) concerned. Regulation (EC) No 1107/2009 lays down the rules and procedures for authorisation of PPPs. Provisions regarding plant bio-stimulants will become subject to the Fertilising Products Regulation and to REACH registration and thus relieved from the stricter provisions of the PPP regulation including individual authorisation by Member States.

2.5 REACH Regulation [3]

REACH Regulation (EC) No 1907/2006 aims at ensuring a high level of protection of human health and the environment by a better identification of intrinsic properties of chemical substances. It includes the

promotion of alternative methods for assessment of hazards of substances, as well as the free circulation of substances on the internal market.

This Regulation lays down provisions on substances and mixtures that shall apply to the manufacture, placing on the market or use of such substances on their own, in mixtures or in articles.

REACH holds industry accountable to manage the risks from chemicals and to provide safety information on the substances. Manufacturers and importers are required to gather information on the properties of their chemical substances, which will allow their safe handling, and to register the information in a central database in the European Chemicals Agency (ECHA) in Helsinki. The Agency is the central point in the REACH system: it manages the databases necessary to operate the system, co-ordinates the in-depth evaluation of suspicious chemicals and is building up the public database in which consumers and professionals can find hazard information. The Regulation also calls for the progressive substitution of the most dangerous chemicals (referred to as "substances of very high concern") when suitable alternatives have been identified.

REACH requires increasing levels of information depending on the volume of substances manufactured and placed on the market. Requirements are stipulated in the annexes and aim at reflecting the level of potential impacts from (hazardous) substances and expenses needed for compliance.

Several substances are exempt from REACH: radio-active substances, substances used in food, pharmaceuticals and waste. Chemical products manufactured by one of the techniques demonstrated in SYSTEMIC are subject to registration, if the end-of-waste status is achieved. Compost is explicitly exempt from REACH registration. An extension of the derogation to other types of digestate is currently negotiated.

2.6 CLP Regulation [3]

Regulation (EC) 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures aims at identifying hazardous chemicals and informing users about their hazards through standard symbols and phrases. CLP is legally binding across the Member States and directly applicable to all industrial sectors. It requires manufacturers, importers or downstream users of substances or mixtures to classify, label and package their hazardous chemicals appropriately before placing them on the market.

Hazard identification is the process by which information about the intrinsic properties of a substance or mixture is assessed to determine its potential to cause harm. If the nature and severity of an identified hazard meets the classification criteria in Annex I to the CLP Regulation, a certain hazard class will be assigned to the substance or mixture. There are hazard classes for physical hazards, health hazards, and environmental hazards.

For most substances and mixtures, manufacturers, importers, downstream users and distributors must determine the hazard classification themselves. In certain cases, the classification of a chemical is harmonised at EU level. The list of harmonised classification and labelling is included in Annex VI to the CLP Regulation.

The United Nations' Globally Harmonised System of Classification and Labelling of Chemicals (GHS) provides a harmonised basis for globally uniform physical, environmental, and health and safety information on hazardous chemical substances and mixtures. It sets up criteria for the classification of chemicals for physical-chemical, health, and environmental hazards of chemical substances and mixtures and sets up standardised hazard information to facilitate global trade of chemicals. GHS was adopted by the United Nations in 2002 and is periodically updated. The implementation of the GHS in the EU in 2008 makes the EU a front-runner in its uptake.

In line with the GHS standard, CLP allows for the identification of hazardous chemicals and the communication of these hazards to users through labelling. It also provides the basis for safety data sheets (SDS) regulated under the REACH Regulation and sets requirements for the packaging of hazardous chemicals.

CLP sets general packaging standards to ensure the safe supply of hazardous substances and mixtures. In the case of certain hazards, substances and mixtures need to carry child-resistant fastenings and/or tactile warnings.

Further information on CLP is available in a specific ECHA web-site called "Understanding CLP"
<https://echa.europa.eu/regulations/clp/understanding-clp>

2.7 Waste Shipment Regulation [3]

Regulation (EC) 1013/2006 deals with supervising and controlling shipments of waste within EU borders and shipments to/from EFTA, OECD and Basel Convention countries. The regulation addresses the problem of uncontrolled transport of waste and lays down procedures for the transboundary shipments (i.e. transport) of waste. It implements into EU law the provisions of the "Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal" as well as the OECD Decision. The Regulation includes a ban on the export of hazardous wastes to non-OECD countries ("Basel ban") as well as a ban on the export of waste for disposal.

Different regimes apply to shipments of wastes for disposal and for recovery, as well as to hazardous and "green-listed" non-hazardous wastes. The shipment of hazardous wastes and of wastes destined for disposal is generally subject to notification procedures with the prior written consent of all relevant authorities of dispatch, transit and destination. However, as a rule, the shipment of "green-listed" wastes for recovery within the EU and OECD does not require the consent of the authorities.

Despite the Regulation, illegal shipments of waste are still a significant problem (some estimates suggest that the overall non-compliance rate with the Regulation could be around 25 %). To strengthen Member States' inspection systems, the Regulation was amended in 2014 through Regulation (EU) No 660/2014 of 15 May 2014 laying down minimum inspection requirements with a focus on problematic waste streams (such as hazardous waste and waste sent illegally for dumping or sub-standard treatment). EU countries will have to prepare inspection plans by 2017.

The Waste Shipment Regulation is relevant to the fertilising products from biogas plants if they have not yet achieved the end-of-waste status, requiring mutual notification between departing and receiving states. Even if the shipment is between Member States and if none of the states rejects the shipment it may cause considerable delays.

2.8 Horizontal Regulation on European Funds [3]

Regulation (EU) No 1303/2013 of the European Parliament and of the Council of 17 December 2013 laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund and laying down general provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund and repealing Council Regulation (EC) No 1083/2006

2.9 Rural Development Fund [3]

Regulation (EU) 1305/2013 provides the rules for rural areas of the EU to meet the wide range of economic, environmental and social challenges of the 21st century. Frequently called "the second pillar" of the Common Agricultural Policy (CAP), it complements the system of direct payments to farmers and measures to manage agricultural markets (the so-called "first pillar"). Rural Development policy shares several objectives with other European Structural and Investment Funds (ESIF).

2.9.1 EU framework for rural development programmes

Member States and regions draw up their rural development programmes based on the needs of their territories and addressing at least four of the following six common EU priorities:

- i) fostering knowledge transfer and innovation in agriculture, forestry and rural areas,
- ii) enhancing the viability and competitiveness of all types of agriculture, and promoting innovative farm technologies and sustainable forest management,
- iii) promoting food chain organisation, animal welfare and risk management in agriculture,
- iv) restoring, preserving and enhancing ecosystems related to agriculture and forestry,
- v) promoting resource efficiency and supporting the shift toward a low-carbon and climate-resilient economy in the agriculture, food and forestry sectors and
- vi) promoting social inclusion, poverty reduction and economic development in rural areas.

The rural development priorities (RDP) [1] are broken down into "focus areas". For example, the priority on resource efficiency includes focus areas "**reducing greenhouse gas and ammonia emissions from agriculture**" and "**fostering carbon conservation and sequestration in agriculture and forestry**".

Within their RDPs, Member States or regions set quantified targets against these focus areas. They then set out which measures they will use to achieve these targets and how much funding they will allocate to each measure.

At least 30% of funding for each RDP must be dedicated to measures relevant for the environment and climate change and at least 5% to LEADER ("Liaison Entre Actions de Développement de l'Économie Rurale"), an EU programme to support innovative actions in rural areas.

2.10 Horizontal CAP Issues Regulation [3]

Regulation (EU) 1306/2013, the so-called "Horizontal" Regulation provides the financial management rules for the two CAP funds, the European Agricultural Guarantee Fund (EAGF) which finances market measures and direct payments, and the European Agricultural Fund for Rural Development (EAFRD) which finances support to rural development. It brings together the rules on cross compliance, farm advisory systems and monitoring and evaluation of the CAP.

2.10.1 Cross-compliance rules

The Common Agriculture Policy (CAP) reform agreement of June 2013 carries forward the principle that there is a link through the cross-compliance (CC) system between receipt of CAP support by farmers and respect of a set of basic rules related to the main public expectations on environment, public and animal health, as well as, animal welfare.

Introduced in 2003, cross-compliance covers direct payments, certain rural development and wine sector payments.

The CAP has regularly been adapted to respond to new challenges. The 2013 reform was designed to achieve continued food security and safety in Europe, whilst also ensuring a sustainable use of land and maintaining natural resources, preventing climate change and addressing territorial challenges. In this framework, changes have also been introduced for cross-compliance by clarifying objectives, regrouping the legal base, simplification of the cross-compliance scope and the enlargement of the Farm Advisory System (FAS).

To receive payments, farmers shall respect a set of basic rules. Farmers not respecting EU law on environmental, public and animal health, animal welfare or land management will see the EU support they receive reduced. The reductions are proportional to the extent, permanence, severity and repetition of the infringement specified.

2.11 Direct Payments to Farmers Regulation [3]

Regulation (EU) 1307/2013 provides the rules for direct payments granted to farmers to ensure them a safety net. They are mainly granted in the form of a basic income support, decoupled from production, stabilising their income stemming from sales on the markets, which are subject to volatility. To maximise their profits, producers must respond to market signals, so that they produce goods that are demanded by consumers. Direct payments also contribute, through greening, and in combination with, to providing basic public goods.

2.11.1 Integrated Administration and Control System (IACS)

An important share of the taxpayer's money financing the Common Agricultural Policy (CAP) is administered by the Member States. This is the case of the direct aid channelled to farmers across the EU. To safeguard the financial interests of the EU ensuring that this direct aid is correctly allocated to the right farmers, Member States should operate since 1992 a system for the management and control of payments to farmers, the Integrated Administration and Control System (IACS).

2.11.2 Transparency rules in a nutshell

Under these rules, Member States shall ensure annual ex-post publication of the beneficiaries of CAP payments. The rules enhance transparency regarding the use of EU funds under the CAP and improve the sound financial management of these funds by reinforcing public control of the money used. At the same time, they strike a balance between these objectives and the beneficiaries' right to respect of their private life in general and to the protection of their personal data.

2.12 The Common Market Organisation (CMO) [3]

Regulation (EU) 1308/2013 is the legal basis for a set of rules which regulate agricultural markets in the European Union. It builds on the rules for the common market in goods and services with specific policy tools that help improve the functioning of agricultural markets.

The CMO sets out the parameters for intervening on agricultural markets and providing sector-specific support (e.g. for fruits and vegetables, wine, olive oil sectors, school schemes).

It also includes rules on marketing of agricultural products (e.g. marketing standards, geographical indications, labelling) and the functioning of producer- and interbranch organisations.

Finally, it covers issues related to international trade (e.g. licenses, tariff quota management, inward and outward processing) and competition rules.

3 European Directives [3]

3.1 Overview

An EU Directive is a legislative act that sets out a goal that all EU Member States must achieve. However, it remains up to the individual countries to devise their own laws on how to reach these goals. Readers are advised to consult <http://eur-lex.europa.eu/homepage.html> [3] for amendments, updates and official comments which can be easily accessed by entering the regulation denomination as listed below to an internet search engine. However, the planned facility needs to be compliant with national legislation of the Member State where it is located.

| Directives | Corresponding national regulation required – Objective / Regulated subject |
|--|---|
| Renewable Energy Directive 2009/28/EC under recast (COM(2016) 767) | Establishes an overall policy for the production and promotion of energy from renewable sources in the EU |
| Liability of defective products directive 85/374/EEC | Guarantees the liability of the producer in the event of damage caused by malfunctioning products |
| Biofuels and Indirect Land Use Change Directive (ILUC) Directive (EU) 2015/1513 | Encourages advanced biofuels that do not displace food crops or cause indirect land use change (ILUC), relevant for the feedstock of anaerobic digesters |
| Nitrates Directive 91/676/EEC | Sets the limit of 170 kg N/ha/year from livestock manure in nitrate vulnerable zones. Member States declare designated regions as nitrate vulnerable zones (NVZ) for which National Action Programmes (NAP) are developed. Directive allows Member States to get derogations to go beyond the 170kg limit, under strict conditions. |
| Water framework Directive (WFD) 2000/60/EC | Establishes a comprehensive, cross-border approach to water protection organised around river basin districts (RBDs), aiming at good water quality status for European water bodies. |
| Groundwater Directive 2006/118/EC | Complements the WFD, sets groundwater quality standards, including 50 mg/l of nitrates and introduces measures to prevent or limit pollutant inputs to groundwater. |
| Drinking Water Directive 98/83/EC | Lays down the essential quality standards of water intended for human consumption at EU level, requiring monitoring of 48 parameters including nitrates (limit 50 mg/l). |
| Bathing Water Directive 76/160/EEC amended by 2006/7/EC | It requires Members States to monitor and assess the bathing water for at least two parameters of (faecal) bacteria and inform the public about water quality. |
| Marine Strategy Framework Directive 2008/56/EC | The Marine Directive aims to achieve Good Environmental Status (GES) of the EU's marine waters by 2020 and to protect the resource base upon which marine-related economic and social activities depend. |
| Urban Waste Water Directive 91/271/EEC amended by 98/15/EC | Requires collection and at least two stage treatment of waste water for agglomerations >2,000 person-equivalents (PE) and nutrient removal for plants covering >10,000 PE. |
| Sewage Sludge Directive 86/278/ EEC | 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. |
| Waste Framework Directive 2008/98/EC | Sets the basic concepts and definitions related to waste management, such as definitions of waste categories (including provisions for end-of-waste status), recycling and recovery. |
| Landfill Directive 1999/31/EC | Defines different categories of waste and aims to prevent negative effects on the environment, on surface water, groundwater, soil, air, and on human health by introducing stringent technical requirements for waste and landfills. |
| Hazardous Waste Directive 91/689/EEC, amended by Directive 94/31/EC | Provides additional labelling, record keeping, monitoring and control obligations from "cradle to the grave", i.e., from the waste producer to the final disposal or recovery. |

| | |
|--|--|
| Air Quality Directive 2008/50/EC | Merges four Directives and one Council Decision into a single Directive on air quality, setting standards and target dates for reducing concentrations of fine particles (PM2.5). |
| Industrial Emissions Directive (IED) 2010/75/EU - replaces IPPC Directive 96/61/EC | The IED is the main EU instrument regulating pollutant emissions from industrial installations. SYSTEMIC demo-plants are subject to the IED because of exceeding the threshold of 75 t/d processing capacity. |
| EU National Emissions Ceilings Directive 2016/81/EC (under revision) | Sets national emissions ceilings for five important air pollutants: nitrogen oxide (NOx), non-methane volatile organic compounds (NMVOCs), sulphur dioxide (SO2), ammonia (NH3) and fine particulate matter (PM2.5). |

3.2 Renewable Energy Directive (RED) [3]

Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources. It establishes an overall policy for the production and promotion of energy from renewable sources in the EU. It requires the EU to fulfil at least 20% of its total energy needs with renewables by 2020 – to be achieved through the attainment of individual national targets. All EU countries must also ensure that at least 10% of their transport fuels come from renewable sources by 2020.

The Directive specifies national renewable energy targets for each country, taking into account its starting point and overall potential for renewables. These targets range from a low of 10% in Malta to a high of 49% in Sweden. EU countries set out how they plan to meet these targets and the general course of their renewable energy policy in national renewable energy action plans (NREAP). Progress towards national targets is measured every two years when EU countries publish national renewable energy progress reports.

Biofuels and bioliquids are instrumental in helping EU countries meet their 10% renewables target in transport. The Renewable Energy Directive sets out biofuels sustainability criteria for all biofuels produced or consumed in the EU to ensure that they are produced in a sustainable and environmentally friendly manner.

3.2.1 Recast of the Renewable Energy Directive (RED-recast) [3]

On 30.11.2016, the Commission published a proposal for a revised Renewable Energy Directive to make the EU a global leader in renewable energy and ensure that the target of at least 27% renewables in the final energy consumption in the EU by 2030 is met. The recast of the Renewable Energy Directive (RED-recast) (COM(2016) 767), in Art. 26(7) [3], specifies the minimum greenhouse gas (GHG) emissions saving thresholds that bioenergy must comply with to count towards the renewables targets and to be eligible for public support. Annex V (liquid biofuels) and Annex VI (solid and gaseous biomass) of the RED-Recast describe the methodology for GHG savings calculations needed to comply with the GHG criteria. They also provide a list of default GHG emission values, aggregated and disaggregated, that operators can use to demonstrate compliance of their product with the GHG criteria.

A corresponding JRC report [12] describes the input data, assumptions and methodological approach applied by the JRC when compiling the updated dataset used to calculate GHG emissions for the different biomass pathways. The GHG emissions resulting from the application of the methodology from COM(2016) 767, and presented in Annex VI of the document, are also shown. The report aims to provide operators, stakeholders, and the scientific community all the necessary information to explain the assumptions chosen as well as to guarantee reproducibility of the results. Additional analysis to test the sensitivity of the results to various assumptions is presented in the final section of the report.

3.2.2 Support Schemes

The Renewable Energy Directive governs grid access and national support schemes of high relevance for the revenues and the viability of business cases addressed by SYSTEMIC. Apart from the incentives represented by feed-in tariffs, feed-in premiums and green certificates provided by most Member States to biogas-based energy carriers, policy measures such as incentivising compressed or liquified biogas as vehicle fuel as promoted by most northern countries may become effective tools for promoting integrated energy conversion and nutrient recycling systems as demonstrated by SYSTEMIC.

The EU adopted guidance for EU countries (SWD(2013) 439) [3] final when designing and reforming renewable energy support schemes. This guidance suggests that:

- Financial support for renewables should be limited to what is necessary and should aim to make renewables competitive in the market
- Support schemes should be flexible and respond to falling production costs. As technologies mature, schemes should be gradually removed. For instance, feed in tariffs should be replaced by feed in premiums and other support instruments that incentivise producers to respond to market developments
- Unannounced or retroactive changes to support schemes should be avoided as they undermine investor confidence and prevent future investment
- EU countries should take advantage of the renewable energy potential in other countries via cooperation mechanisms. This would keep costs low for consumers and boost investor confidence.

Support schemes are also governed by the "Guidelines on State aid for environmental protection and energy 2014-2020" (2014/C 200/01) [3] published as Commission Communication in 2014. It aims at preventing State Aid from distorting competition in the internal market and affecting trade between Member States in a way which is contrary to the common interest, Article 107(1) of the Treaty on the Functioning of the European Union. The Treaty lays down the principle that State aid is prohibited. In certain cases, however, State aid may be compatible with the internal market under Articles 107(2) and (3) of the Treaty. The document provides guidelines on how environmental protection and renewable energy support schemes should be designed to be compatible with the Treaty.

3.3 Liability of Defective Products Directive [3]

Directive 85/374/EEC, modified by Directive 1999/34/EC, guarantees the liability of the producer in the event of damage caused by malfunctioning products. The Directive lays down a common rule for strict liability (i.e. "liability without fault") of producers at EU level and offers a real possibility to consumers to claim financial compensation for death or personal injuries or for damage caused to an item of property intended for private use with a threshold of 500 EUR. The Directive provides the injured person with an extracontractual regime of liability. The "strict liability" approach extends the liability of producers to injured consumers who suffer loss through defective products without the need to prove a contractual link, a duty of care or failure to take reasonable care to comply with relevant legislation.

Directive 85/374/EEC applies to all movable products, even when incorporated into other movable or immovable property, including primary agricultural products and also electricity. It establishes that a product is defective when it does not provide the safety which a person is entitled to expect, taking all circumstances into account, including the presentation of the product or the time when the product was put into circulation.

3.4 Biofuels and Indirect Land Use Change Directive (ILUC) [3]

Directive (EU) 2015/1513 adopted on 9.9.2015 and amending the Fuel Quality Directive 98/70/EC and the above mentioned Renewable Energy Directive 2009/28/EC on the promotion of the use of energy from renewable sources.

The European Union has been considering proposals to amend the Renewable Energy Directive (RED) and the Fuel Quality Directive (FQD), to encourage advanced biofuels that do not displace food crops or cause indirect land use change (ILUC).

ILUC issues have a considerable impact on SYSTEMIC regarding the acceptance of energy crops as feedstock, not allowed in some of the countries subject to this report and with much lower (50% and further decreasing) allowance in Germany, where until 2017 biogas production could be largely based on energy crops.

3.5 Nitrates Directive [13]

Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources. The Nitrates Directive aims to protect water quality across Europe by preventing nitrates from agricultural sources polluting ground and surface waters and by promoting the use of good farming practices.

The Nitrates Directive is one of the European policy instruments that plays a crucial role to the national legislations regarding the digestates' management. Under the directive Member States must analyse the nitrate concentration in their waters and have installed close to 60.000 groundwater and surface water monitoring stations. Member States have designated territories draining into waters that are or could be affected by high nitrate levels or eutrophication as vulnerable zones. Austria, Denmark, Finland, Germany, Ireland, Lithuania, Luxembourg, Malta, the Netherlands and Slovenia have adopted a whole territory approach, meaning they have designated their whole territory as vulnerable zone.

All Member States had to establish codes of good practice for farmers, to be implemented on a voluntary basis throughout their territory and develop specific action programmes for compulsory implementation by farmers located in nitrate-vulnerable zones. Action programmes include periods when fertilisation is prohibited, minimum storage capacity for livestock manure, and rules to control the spreading of nutrients near water or on slopes, to reduce the risk of contamination. All of them include the limit of 170kg nitrogen per hectare per year from livestock manure that is set out in the Directive. The Directive allows Member States to get derogations to go beyond the 170kg limit, under strict conditions. Six Member States (BE, NL, DK, IE, DE, UK) had been granted derogation from the maximum allowable nitrogen application rate of 170 kg of nitrogen per hectare with animal manure, typically 250 kg N/ha (DK 230 kg N/ha). DE has no more derogation since 2014, Italy has one since 2009.

The Nitrates Directive's impact goes beyond its scope of protecting the water bodies. Inter alia it could support climate change abatement by improving livestock management and fertilising practices reducing nitrous oxide (N_2O) and methane emissions (CH_4) with a global warming potential of 265 times (N_2O) and 28 times (CH_4) of CO_2 [14]. However, a holistic approach to farmyard manure and fertiliser management is necessary to protect water bodies and climate.

Fertiliser use has been and still is a major source of water pollution in Europe. Regardless of mineral fertiliser consumption having stagnated since the early 1990s, overall nitrogen consumption has increased by 6%. Farming remains responsible for over 50% of the total nitrogen discharge into surface waters.

Due to the increasing pressure from European and national regulations, including the WFD and the Nitrates Directive, farmers are exploring new techniques such as manure processing. SYSTEMIC with its large-scale demonstration of targeted technologies is a milestone towards widespread implementation of more sustainable management of organic waste with a focus on digested farmyard manure. Particularly article 2 of the Nitrates Directive deserves being reconsidered regarding new products produced by SYSTEMIC technologies and fully exchangeable with mineral fertilisers:

3.5.1 Article 2 of the Nitrates Directive

Lit. g) 'livestock manure': means waste products excreted by livestock: or a mixture of litter and waste products excreted by livestock, **even in processed form**.

When the Nitrates Directive was enforced in 1991, technologies for processing manure did not encompass producing products with distinctively different characteristics in terms of chemical composition, physical state and crop nutrition performance.

SYSTEMIC demonstrates precisely that such products can be produced, including, among others, mineral fertilisers which fully correspond to specifications of mineral fertilisers from fossil resources:

- i) Ammonium Sulphate (AS) or Ammonium Nitrate (AN) after N-stripping and ammonia absorption into sulphuric or nitric acid. Yara fully replaces AN produced from natural gas borne ammonia in Porsgrunn (Norway) by AN produced from N-stripping at the Oslo wastewater treatment plant. Since both products are produced from gaseous ammonia, transfer of organic compounds can be excluded.
- ii) Ammonium Sulphate (AS), solid lime and (optional) ammonia-free fibres for fibreboard production after (acid-free) N-stripping and ammonia absorption into gypsum coming as a by-product from desulphurization processes at the BENAS plant.
- iii) Struvite (magnesium-ammonium-phosphate) is produced by different processes. Compared to mineral NP fertilisers, pure struvite has the advantage that the compound is only scarcely water soluble leading to a fertiliser that releases nutrients in response to the exudates of crop roots, in a way "on demand" of crops. This property may be seen as an advantage to conventional mineral NP fertilisers in terms of water protection but if this is indeed beneficial still needs to be confirmed by ongoing research, including in SYSTEMIC. There is robust evidence of the P fertilising efficiency of struvite - among others listed in the STRUBIAS draft report. However, effective separation of struvite crystals from manure depends on the production process, sometimes leading to relevant mass fractions of digestate present in struvite. Hence, only struvite in compliance with Product Function Category (PFC) I Fertiliser, Lit. C Inorganic Fertiliser according to ANNEX I, Part I of the Proposal for an EU regulation laying down rules on the making available on the market of EU marked fertilising products and amending Regulations (EC) No 1069/2009 and (EC) No 1107/2009 qualifies as mineral fertiliser.
- iv) Mineral concentrates produced by means of application of reverse osmosis on the liquid fraction of manure or digestate and which consists of nitrogen (>90% inorganic nitrogen), potassium and sulphur.

In addition, the Common Agricultural Policy (CAP) may be a viable instrument of backing the Nitrates Directive by supporting rural development measures as presented by SYSTEMIC. Notwithstanding the fact that some member states have enforced nutrient management schemes and wider buffer strips along rivers which may be financially supported by payments, many more measures need to be implemented across Europe. Cross compliance of rural support mechanisms with European regulation including the Nitrates Directive must be ensured across the European territory.

3.6 Water Framework Directive (WFD) [3]

Directive 2000/60/EC of the European Parliament and of the Council established on 23.10.2000 provides a framework for the Community action in the field of water policy" which establishes a comprehensive, cross-border approach to water protection organised around river basin districts (RBDs), with the aim of achieving good status for European bodies of water by 2015. The WFD defines environmental objectives for surface water, groundwater and protected areas. The criteria for achieving good groundwater chemical status are defined in Annex V and require that concentrations of pollutants (in groundwater) do not exceed any quality standards applicable under other relevant Community legislation according to Article 17. Further, there is a requirement to identify and reverse any significant and sustained upward trends in the concentration of pollutants.

The WFD was the result of a multiannual stakeholder process showing that the previous European water policies were too fragmented and not effective. Essentially, they included the Urban Wastewater Treatment Directive and the Nitrates Directive. In the second half of the nineties, the Drinking Water Directive and the Directive for Integrated Pollution Prevention and Control (IPPC) were adopted.

Expanding the scope to all waters, setting the targets for achieving good status, a combined approach of quality standards and emission limit values as well as the transboundary river basin approach were the cornerstones of the new WFD.

The WFD is currently reviewed, *inter alia* due to the poor results regarding the improvements of the ecological status of water bodies in the EU – the quality status is still deplorable. Frequent and non-transparent use of exemptions, lack of control and particularly **agricultural practices** are considered as the main challenges.

Member States' legal acts on water are typically based on the WFD. They include regulations regarding the discharge of digester effluents, included purified liquid effluents, into water bodies and are consequently relevant to SYSTEMIC.

3.7 Groundwater Directive [3]

Directive 2006/118/EC adopted on 12.12.2006 aims at the protection of groundwater against pollution and deterioration. It sets groundwater quality standards and introduces measures to prevent or limit inputs of pollutants into groundwater. The directive establishes quality criteria that takes account of local characteristics and allows for further improvements to be made based on monitoring data and new scientific knowledge. The directive thus represents a proportionate and scientifically sound response to the requirements of the Water Framework Directive (WFD) as it relates to assessments of chemical status of groundwater and the identification and reversal of significant and sustained upward trends in pollutant concentrations. Member States should establish standards at the most appropriate level and take into account local or regional conditions.

The Groundwater Directive complements the Water Framework Directive (WFD). It requires Member States to set groundwater quality standards, perform pollution trend studies referred to a baseline level based on data 2007-2008, reverse negative trends and prevent or limit inputs of pollutants to assure achievement of environmental objectives by 2015 (targets not achieved).

Relevant to SYSTEMIC is compliance with good chemical status criteria (based on EU standards of nitrates (50 mg/l) and pesticides and on threshold values established by Member States. Limit values set by Member States may include lower nitrate limits in groundwater.

3.8 Drinking Water Directive [3]

Directive 98/83/EEC lays down the essential quality standards of water intended for human consumption at EU level. Its objective is to protect human health from adverse effects of any contamination of water intended for human consumption by ensuring that it is wholesome and clean.

A total of 48 microbiological, chemical and indicator parameters must be monitored and tested regularly. In general, World Health Organization's guidelines for drinking water and the opinion of the Commission's Scientific Advisory Committee are used as the scientific basis for the quality standards in the drinking water.

When adopting the Drinking Water Directive to their own national legislation, Member States of the European Union can include additional requirements but are not allowed to set lower standards as the level of protection of human health should be the same within the whole European Union.

Member States may, for a limited time depart from chemical quality standards specified in the Directive by applying for a derogation. Derogations can be granted, provided it does not constitute a potential danger to human health and provided that the supply of water intended for human consumption in the area concerned cannot be maintained by any other reasonable means. The Directive also requires providing regular information to consumers. In addition, drinking water quality must be reported to the European Commission every three years.

Of particular relevance to SYSTEMIC is the limit concentration of nitrates in drinking water of 50 mg/l. Member States must ensure that the sum of $\text{NO}_3/50$ (nitrates) + $\text{NO}_2/3$ (nitrites) does not exceed the value 1 and that the value of 0,10 mg/l for nitrites is not exceeded in the effluents of water treatment works.

On 1 February 2018 the European Commission has adopted the proposal for a revised Drinking Water Directive to improve the quality of drinking water and provide better access to information for citizens. The proposal updates existing safety standards in line with latest recommendations of the World Health Organisation (WHO) and ensure our drinking water is safe to use for the decades to come.

3.9 Bathing Water Directive [3]

Directive 76/160/EEC amended by 2006/7/EC provides the targets and rules to safeguard public health and clean bathing waters. The revised Bathing Water Directive (BWD) of 2006 updated and simplified these rules. It requires Members States to monitor and assess the bathing water for at least two parameters of (faecal) bacteria. In addition, they must inform the public about bathing water quality and beach management, through the so-called bathing water profiles. These profiles contain for instance information on the kind of pollution and sources that affect the quality of the bathing water and are a risk to bathers' health, such as wastewater discharges.

The major sources of pollution are sewage and water draining from farms and farmland. Such pollution increases during heavy rains and floods due to sewage overflow and polluted drainage water being washed into rivers and seas. All EU Member States, plus Albania and Switzerland, monitor their bathing sites according to the provisions of the EU's revised Bathing Water Directive. The legislation specifies if the bathing water quality can be classified as 'excellent', 'good', 'sufficient' or 'poor', depending on the levels faecal bacteria detected. Where water is classified as 'poor', Member States must take measures, like banning bathing or posting a notice advising against it, providing information to the public, and suitable corrective measures. Bathing water in the EU has achieved good levels in 2016 with only a few sites reporting poor conditions.

3.10 Marine Strategy Framework Directive [3]

Directive 2008/56/EC aims to achieve Good Environmental Status (GES) of the EU's marine waters by 2020 and to protect the resource base upon which marine-related economic and social activities depend. It is the first EU legislative instrument related to the protection of marine biodiversity, as it contains the explicit regulatory objective that "biodiversity is maintained by 2020", as the cornerstone for achieving GES.

The directive provides a legislative framework to the management of human activities having an impact on the marine environment, integrating the concepts of environmental protection and sustainable use. It establishes European marine regions and sub-regions based on geographical and environmental criteria. Environmental criteria include eleven indicators comprising biodiversity and eutrophication, which may be affected by SYSTEMIC activities.

The Directive covers four European marine regions – the Baltic Sea, the North-east Atlantic Ocean, the Mediterranean Sea and the Black Sea – located within the geographical boundaries of the existing Regional Sea Convention. To achieve GES by 2020, each Member State is required to develop a strategy for its marine waters (or Marine Strategy). In addition, because the Directive follows an adaptive management approach, the Marine Strategies must be kept up-to-date and reviewed every 6 years. A compliant Marine Strategy must include an initial assessment of the status and the relevant human activities, a definition of GES and targets to be achieved by 2020 and a measuring and monitoring programme.

3.11 Urban Wastewater Directive [3]

Directive 91/271/EEC amended by Directive 98/15/EC aims at the protection of the environment from the adverse effects of urban and certain industrial waste water discharges.

It requires Member States to designate sensitive areas, identify catchment areas of the sensitive areas and ensure that agglomerations with more than 10,000 PE (person equivalents) within the catchment areas comply with more stringent discharge requirements than secondary treatment and establish a technical and financial programme for the implementation of the Directive for the construction of sewage treatment systems within the deadlines set up by the Directive. Furthermore, Member States must implement regulations and provisions for discharge of municipal and industrial wastewater depending on the sensitivity of catchment areas and the volume of wastewater treated. Member States must ensure that the environmentally and technically sound reuse or disposal of sewage sludge is subject to general rules, registration or authorisation and that the requirement of specific inter-linked Directives for agricultural re-use (86/278/EEC), incineration (89/429/EEC and 89/369/EEC), and landfill (99/31/EC) are respected. The disposal of sewage sludge in surface waters is banned.

The Urban Wastewater Directive is indirectly relevant for the SYSTEMIC activities as far as liquid effluents should be discharged. The industrial sectors covered by the Urban Wastewater Directive include a variety of food processing industries including dairies, fruit, vegetable, meat and fish processing facilities which are frequently cooperating with anaerobic digestion plants or even operating them.

3.12 Sewage Sludge Directive [3]

Directive 86/278/EEC 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. Many EU Member States have adopted stricter regulations including certification schemes for sewage sludge use.

Sewage sludge is used as a feedstock by some of the SYSTEMIC plants and thus they may be concerned by the Sewage Sludge Directive. In addition, if used in agriculture, sewage sludge is competing with digestates and/or products produced from digestates within the project which is partly reflected by national regulations, for instance by setting very low heavy metal limit values for agricultural use of sewage sludge in the Netherlands and, more recently, by the ban of using sewage sludge from large wastewater treatment plants (>50,000 PE) in agriculture in Germany.

3.13 Waste Framework Directive [3]

Directive 2008/98/EC on waste sets the basic concepts and definitions related to waste management, such as definitions of waste, recycling and recovery. It explains when waste ceases to be waste and becomes a secondary raw material (so called end-of-waste criteria), which waste related properties render waste hazardous and how to distinguish between waste and by-products. The Directive lays down some basic waste management principles: it requires that waste being managed without endangering human health and harming the environment, and 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. In addition, the Directive lays down the targets for recycling of certain waste streams. Waste legislation and policy of the EU Member States shall apply as a priority order the following waste management hierarchy:



Fig. 3 Waste hierarchy as stipulated in the Waste Framework Directive (Source [7])

The directive is currently recast in the context of the Circular Economy Package. EU Communication COM(2015) 595 [3] final suggests an amendment of the Waste Framework Directive, stipulating, among

others, to increase the recycling target for municipal waste to 65% by 2030 and new measures for preventing food waste.

3.14 Landfill Directive [3]

Directive 1999/31/EC aims at preventing or reducing negative effects of landfilling of waste on the environment, particularly on surface water, groundwater, soil, air and on human health. It introduces stringent technical requirements for waste and landfills. The Landfill Directive defines the different categories of waste (municipal waste, hazardous waste, non-hazardous waste and inert waste) and applies to all landfills, defined as waste disposal sites for the landfilling of waste onto or into land.

Among others, the Landfill Directive does not allow landfilling of untreated waste and liquid waste. It stipulates that 15 years after its implementation (i.e. 2014) biodegradable waste must not exceed 35% of the total amount (by weight) of biodegradable municipal waste produced in 1995. In addition, most national regulations implementing the Landfill Directive do not allow landfilling waste with more than 5% biodegradable carbon content. However, several Member States' waste management practices are not in compliance with the Directive.

Landfilling any organic residues from the SYSTEMIC plants is not intended and is not a legal option either.

3.15 Hazardous Waste Directive [3]

Directive 91/689/EEC amended by Directive 94/31/EC lays down the rules for the management of hazardous waste in the Member States. Member States must ensure that hazardous waste is recorded and identified. They must also ensure that different categories of hazardous waste are not mixed, and that hazardous waste is not mixed with non-hazardous waste.

Hazardous wastes pose a greater risk to the environment and human health than non-hazardous wastes and thus require a stricter control regime. This is laid down in Articles 17 to 20 of Directive 2008/98/EC. It provides additional labelling, record keeping, monitoring and control obligations from "cradle to the grave", i.e., from the waste producer to the final disposal or recovery. In addition, mixing of hazardous substances is banned to prevent risks for the environment and human health. Moreover, the permit exemptions that may be granted to installations dealing with hazardous wastes are more restrictive than for installations dealing with other wastes.

The classification into hazardous and non-hazardous waste is based on the system for the classification and labelling of dangerous substances and preparations, which ensures the application of similar principles over their whole life cycle. The properties which render waste hazardous are laid down in Annex III of Directive 2008/98/EC and are further specified by the Decision 2000/532/EC establishing a List of Wastes as last amended by Decision 2001/573/EC. The List of Wastes is currently being reviewed (see information on the Waste Framework Directive pages).

The Hazardous Waste Directive may be relevant to the project if recovery and recycling activities produce a waste or by-product stream which due to elevated concentration of pollutants may be considered as hazardous.

3.16 Air Quality Directive [3]

Directive 2008/50/EC merges four directives and one Council decision into a single Directive on air quality. It sets standards and target dates for reducing concentrations of fine particles, which together with coarser particles known as PM₁₀ already subject to legislation, are among the most dangerous pollutants for human health.

Under the directive Member States are required to reduce exposure to PM_{2.5} in urban areas by an average of 20% by 2020 based on 2010 levels. It obliges them to bring exposure levels below 20 micrograms/m³ by 2015 in these areas. Throughout their territory Member States will need to respect the PM_{2.5} limit value set at 25 micrograms/m³. This value must be achieved by 2015 or, where possible, already by 2010.

The Directive introduces objectives for fine particles PM_{2.5} but does not change existing air quality standards. It does, however, give Member States greater flexibility in meeting some of these standards in areas where they have difficulty complying. Meeting PM₁₀ limit values is proving challenging for 25 of the 27 EU Member States which are exceeding these limits in at least one part of their territory (see IP/07/1537).

The deadlines for complying with the PM₁₀ standards can be postponed for three years after the directive's entry into force (mid-2011) or by a maximum period of five years for nitrogen dioxide and benzene (2010-2015) provided that the relevant EU legislation such as industrial pollution prevention and control (IPPC, see MEMO/07/441) is fully implemented, and that all appropriate abatement measures are being taken. The directive provides a list of measures that need to be considered.

The Directive on air quality (see IP/07/1895 and MEMO/07/571) is one of the key measures outlined in the 2005 Thematic Strategy on air pollution adopted by the Commission in September 2005 (IP/05/1170). It establishes ambitious, cost-effective targets for improving human health and environmental quality up to 2020.

The Air Quality Directive may not have a direct impact on SYSTEMIC systems but may have an impact on permits for installations by limitations of small particle emissions.

3.17 Industrial Emissions Directive (IED) [3]

Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) is based on a Commission proposal recasting 7 previously existing directives (including the IPPC Directive) following an extensive review of the policy. The IED entered into force on 6 January 2011 and had to be incorporated to national legislation by Member States by 7 January 2013.

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 five pillars, i) an integrated approach, ii) use of best available techniques, iii) flexibility, iv) inspections and v) public participation.

- i) The integrated approach means that the permits must consider 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.
- ii) The permit conditions including emission limit values must be based on the Best Available Techniques (BAT). 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.
- iii) 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.
- iv) 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.
- v) 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.

Regarding SYSTEMIC, in Annex I of the Directive

5.3. b) Biological treatment of waste is listed as subject to the IED Directive if the capacity of the plant exceeds 75 t/day. If the only waste treatment activity is anaerobic digestion, the plant is subject to the IED if exceeding a capacity of 100 t/day.

6.2. Determines that intensive rearing of poultry or pigs is subject to the Directive, if places for poultry exceed 40,000, for pigs over 30 kg exceeds 2,000 places and for sows 750 places.

All SYSTEMIC demonstration plants are consequently subject to the IED and the corresponding permits according to the legislation in the countries of location.

3.18 National Emissions Ceilings (NEC) Directive [3]

Directive 2016/2284/EU about National Emission Ceilings entered into force on 31 December 2016. Replacing earlier legislation (Directive 2001/81/EC), the new NEC Directive sets 2020 and 2030 emission reduction commitments for five main air pollutants. It also ensures that the emission ceilings for 2010 set in the earlier directive remain applicable for Member States until the end of 2019. The new directive introduces several new reporting requirements for Member States.

Reporting requirements are defined in Annex I of the directive and include annual information on emissions of several pollutants: i) the five main air pollutants NO_x, NMVOCs, SO₂, NH₃ and PM_{2.5} as well as carbon monoxide (CO); ii) in addition to PM_{2.5}, also PM₁₀, particulate matter and, if available, black carbon (BC) and total suspended particulate matter (TSP); iii) heavy metals cadmium (Cd), lead (Pb) and mercury (Hg) and, if available, the additional heavy metals arsenic, chromium, copper, nickel, selenium and zinc) and v) persistent organic pollutants (POPs) including selected polycyclic aromatic hydrocarbons (PAHs), dioxins and furans (PCDDs and PCDFs), polychlorinated biphenyls (PCBs) and hexachlorobenzene (HCB).

To help ensure that information on emissions reported by Member States is consistent and harmonised with international requirements, the NEC Directive requires Member States to follow the methodologies agreed upon by the UNECE LRTAP Convention (described in the policies chapter). It also requires that Member States use the EMEP/EEA air pollutant emission inventory guidebook in preparing their inventories.

Emission reporting at the national level is expected to have an impact on national legislation about industrial emissions that may affect SYSTEMIC activities.

4 Statistics on Member States [15] [16]

Regarding legislation in Member States, the report is based on information from owners and operators of demonstration plants, on reports from the European Biogas Association (EBA) [16] [17] and previous EU research and innovation projects including BIOGAS ACTION (2016-2019) [17] and the Arbor – Biomass for Energy Project (2011-2015) [18]. In addition, national legislation as far as accessible in the Internet and understandable by the authoring team has been assessed, particularly for updating the information on renewable energy incentives to provide relevant information for new plants. Demonstration plants usually operate on incentive schemes adopted at the time of their commissioning which were frequently more favourable than current incentive schemes in the concerned Member States.

Member States' legislation is usually governed by i) incentives for renewable energy: feed-in tariffs (FIT) as fixed prices per kWh, feed-in premiums (FIP) as fixed premiums on top of the market price and green certificates (GC) as indirect support schemes and ii) by restrictions to the use of nutrient rich digestate on crop- and grassland. Restrictive legislative acts are largely based on incorporation of corresponding European Directives to legislation in Member States and regulations regarding the construction and operation of biogas plants, again largely based on the incorporation of European Directives to Member States' legislation.

The assessment of national regulations clearly shows that regulation is the dominant driver for operating biogas plants and – more recently – for installing peripheral techniques for producing higher concentrated fertilisers as demonstrated by SYSTEMIC. According to the BIOGAS ACTION report of 31 August 2017 [17] over 70% of the European biogas plants have been motivated by renewable energy incentives. The same report exhibits a large increase of biogas production in Europe during the decade from 2005 to 2015: the production went from 4.0 to 15.6 Mtoe (+390%) and from 94.1 to 355.8 kWh per capita (a yearly average increment of 26.2 kWh per inhabitant). Germany, in particular, increased from 558 ktoe in 2000 (start of the EEG) to 7,854 ktoe in 2015 (+1,406%) and became the largest biogas producer in Europe and one of the largest in the world [17]. The number of biogas plants per country in December 2015 is shown in figure 4.

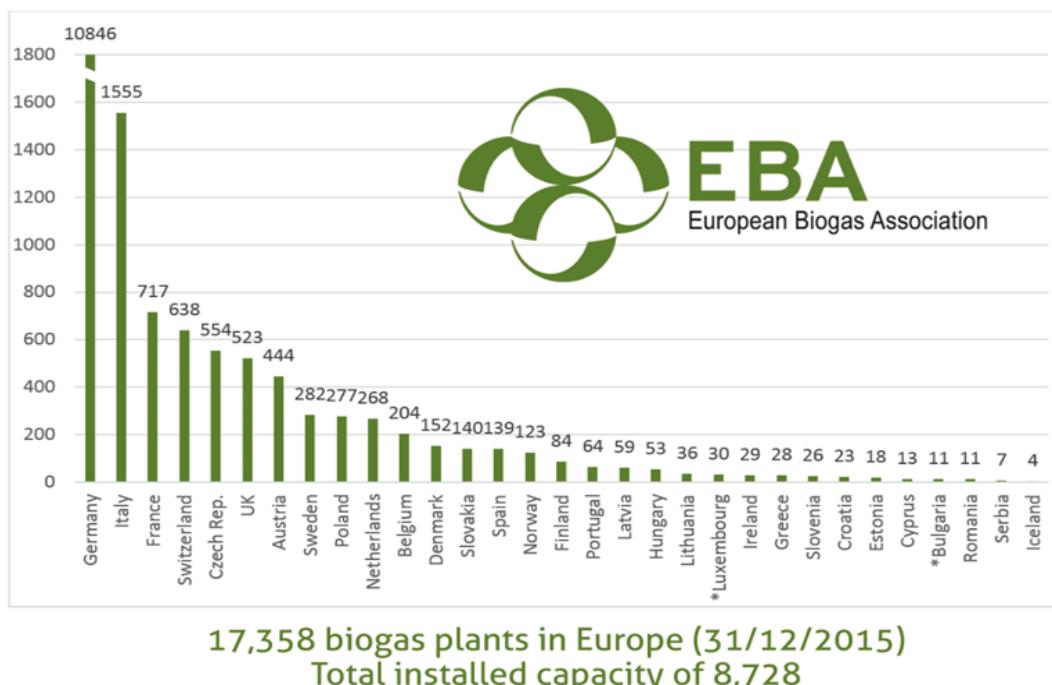


Fig. 4 Number of biogas plants in European countries and total installed capacity 8,728 MWel (source EBA Statistical Report 2016) [17]

According to the latest available statistics of the European Biogas Association, published in January 2017 (one year after the graph in Fig. 4), we count 17,662 biogas plants in Europe (as of 31.12.2016) of which 10,849 (62%) located in Germany. After Germany comes Italy (1,555 plants, 9%), France (873 plants, 5%, Switzerland (624 plants, 4%), Czech Republic (567 plants, 4%), UK (564 plants, 4%) and Austria (423 plants, 3%). On the other side of the spectrum are Iceland, Serbia, Romania, Bulgaria, Cyprus, Estonia and Croatia with less than 25 plants in each country. The increase was most dynamic in France with additional 93 plants in comparison to the previous year, but the overall number was almost stagnating with a year-to-year growth rate of only 1%. This was largely due to less favourable legislation in several countries which hampered the investment into new biogas plants.

In contrast, the number of biomethane plants is strongly increasing with a total of 503 plants by end of December 2016 and again lead by Germany with 196 plants. Germany is followed by UK (93 plants), Sweden (71 plants), Switzerland (36 plants), France (26 plants), The Netherlands (21 plants) and Austria (14 plants). The biomethane production increased by 40% in 2016 and is shown in figure 5 per country.

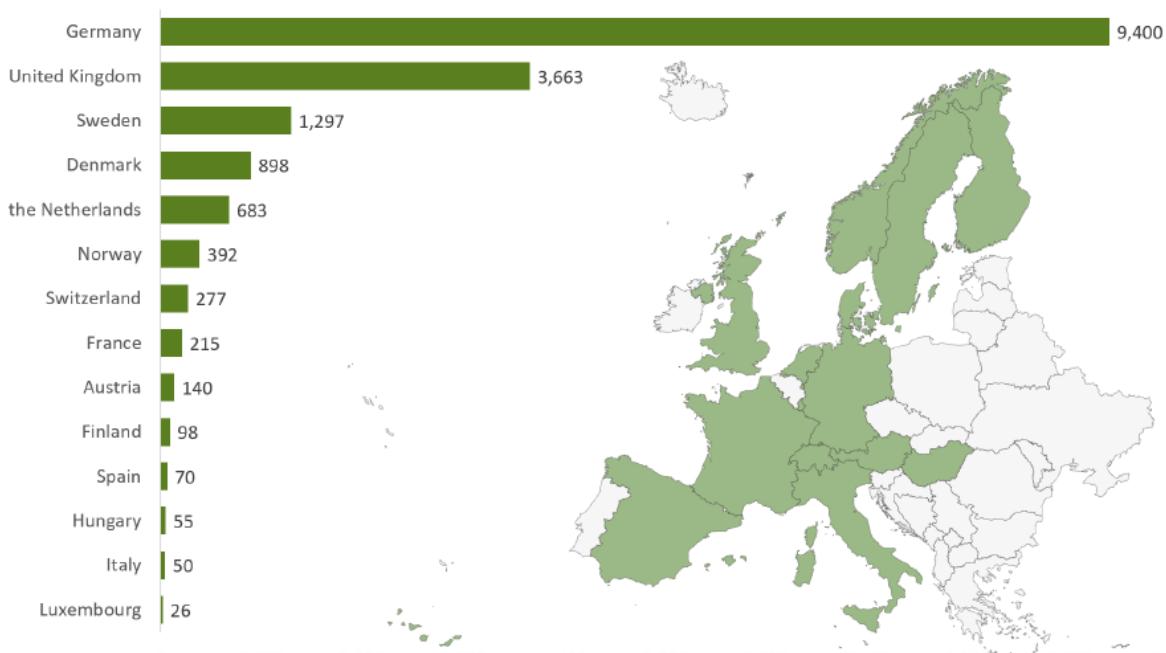


Fig. 5 Biomethane production in European countries in GWh 2016 [16]

Countering the overall decline in biofuels production in Europe in 2016, biomethane continued to gain share of the transport fuels mix, particularly in Sweden, which achieved record shares (88%) of biomethane in its supply of compressed natural gas (CNG) for transport. Europe is home to four of the world's five largest producers of biogas for vehicle fuel: Germany, Sweden, Switzerland and the United Kingdom [19]. All Nordic countries focus on biomethane as heavy-duty vehicle fuel. Italy may join with its new biomethane strategy.

Nonetheless, legislative proposals by the European Commission during the year, known collectively as the "Clean Energy for All Europeans Package" [20], caused some concern for the renewables sector (including manufacturers, project developers, investors and financing institutions). Concerns stemmed from proposals to remove priority access and dispatch for renewable energy, from the level of 2030 targets for renewable energy and energy efficiency, from the absence of binding national targets or indicative benchmarks, and from the planned mandatory replacement of FITs by tendering [19]. This is

confirmed by recent trends in Germany, where only a fraction of the planned new biogas capacity under the new Renewable Energy Act (EEG 2017) [21] was assigned under the new support scheme.

For more information please see the EBA Statistical Report 2017 [16], Annex I to the report.

5 Legislation in Member States with Demonstration Plants

5.1 Belgium – Flanders



Demonstration plant: AM Power

5.1.1 Supporting legislation on renewable energy supply [22] [23]

"Energiedecreet van 8 mei 2009", Decree Establishing General Conditions for Energy Policy – Energy Law of 8 May 2009, enforced 01.01.2011, last recast 10.03.2017.

"Het Energiebesluit van 19 november 2010", Regulation of the Flemish Government on General Conditions for Energy Policy – Energy Regulation of 19 November 2010, enforced 01.01.2011, last recast 08.09.2017.

5.1.2 Type of supporting scheme, characteristics [23]

Operational support for the production of green electricity and heat:

Biogas plants with a CHP are eligible for both green electricity and combined heat and power certificates ("Groene stroom certificaten": GSC & CHP)*. Certificates are awarded per quantity of energy produced. One green electricity certificate corresponds to 1 MWh produced electricity, multiplied by the *banding factor*. For installations with a start date from 1 January 2013, the minimum price of the certificates is multiplied by the banding factor. Each year the Flemish Energy Agency calculates the banding factor for each biogas technology. Until 2018 the banding factor was always set at 1 for biogas from manure and organic biological waste streams, meaning that each certificate One combined heat and power certificate corresponds to 1 MWh CHP savings, multiplied by the *banding factor*¹ corresponded to 1 MWh green

electricity or 1 MWh CHP savings. As from April 1, 2018 the banding factor for green electricity is set at 0,8, meaning that biogas plants need to produce $1\text{MWh}/0,8 = 1,25$ MWh green electricity to receive one green electricity certificate. As for CHP certificates, the banding factor stays 1.

The minimum support per certificate depends on the start date of the installation. For a particular biogas installation, the minimum price per certificate is clicked on at the start of the installation. This price remains valid for the entire support period. Biogas plants with a start date before April 1, 2018 can benefit from this support mechanism for at least 10 years. Biogas plants with a start date after April 1, 2018 can benefit from this support mechanism for 15 years. The support period for CHP certificates is 10 years for all installations.

The table below provides an overview of the minimum support per green electricity certificate depending on the start date for biogas plants for the fermentation of mainly manure and/or agricultural flows.

| Technology | Minimum support per certificate (euros/GSC)* <i>banding factor¹</i> | | | | |
|---|--|----------------------|---|----------------------|---------------------------------|
| | Support for at least 10 years | | | | Support for 15 years |
| | Start date before 2010 | Start date from 2010 | Start date from 2012 | Start date from 2013 | Start date from April 1st, 2018 |
| Biogas from fermentation of mainly manure and/or agricultural flows | € 100 | € 100 | € 100 or € 110 depending whether the installation received an ecology premium | € 93 * 1 = € 93 | € 93 * 0,8 = € 74,4 |

The minimum price for CHP certificates is € 27 for biogas plant with a start date before 2012 and € 31 for biogas plant with a start date starting from 2012, multiplied by the banding factor.

The support period may be extended if the installations have not used up all production hours that were provided for in the initial support calculation. This is called the extension based on full load hours. If after the expiry of the support period and possibly an extension based on full load hours, part of the original investment or any additional investments has not been amortized yet, the support period can be extended by 5 years. The support height depends on a specific banding factor, calculated based on the non-amortized part of the investment(s) of a specific installation. The maximum banding factor is 1. This period can be extended once by another five years, as long as not all investments have been amortized.

*Biogas plants with a CHP of less than 10 kWe and a start date after 1 January 2018 are no longer eligible for support through certificates. These installations are supported through an investment support.

*Biogas plants that do not valorise the biogas in a CHP are not eligible for certificates. If the biogas is upgraded to biomethane, the installation is eligible for investment support via the *call green heat*.

5.1.3 Application

An operator of a renewable energy plant who would like to receive green certificates for the electricity he produced shall file an application with the Flemish Electricity and Gas Regulator (VREG) (Article 6.1.2 §1 Energy Regulation).

5.1.4 Additional Support

Investment support for small-scale anaerobic digestion

Biogas plants with a CHP of less than 10 kWe and a start date after 1 January 2018 are supported through an investment support. The investment support amounts up to € 4.700/kWe.

Investment support for the production of biomethane

The reprocessing of biogas to biomethane is supported in Flanders by the call green heat. This investment subsidy is opened annually via a call system. Only projects that do not qualify for green power or combined heat and power certificates, strategic ecology support or the ecology premium plus can claim this subsidy. However, a fermentation plant that converts the biogas into biomethane and then valorises this biomethane a CHP can claim both the investment support and the operational support via the certificates. This is because a reprocessing plant for the purification of biogas to biomethane is not seen as a part of a biogas plant under the regulation of green electricity or combined heat and power certificates.

New or renewed biogas plants that produce biomethane and inject the biomethane into the natural gas grid or use it directly as biofuel (bio-CNG/LNG) can apply. Biomethane installations are only eligible for the support mechanism if the internal rate of return (IRR) is greater than or equal to 15%. Moreover, the biomethane cannot be produced based on food crops if it is used as transport fuel. This last condition follows from the European regulations concerning group exemptions (EU Regulation No. 651/2014 of the European Commission, article 63).

The maximum amount of support amounts to € 1,000,000 per project. The percentage of investment costs that are eligible is related to the size of the company. The maximum support rate for small enterprises is 65%, for medium-sized companies 55% and 45% for large companies.

5.1.5 Nutrient framework / regulations [24] [25]

Ordinance on fertiliser application (or Fertilizing regulations)⁴ [25]

The Flemish Manure Decree is the transposition of the European Nitrates Directive in Flemish legislation. It defines fertilisation restrictions for nutrients (N and P) that can be applied on Flemish soils for different types of fertilisers: animal manure, mineral fertilisers and other fertilisers. In June 2015, a new Flemish Manure Decree came into force, the fifth Manure Action Plan came into force (2015-2018). Its principle is a more region-specific approach with special attention for 'focus farms'. Next, a farm level approach is applied to fix the amount of fertilization per farm; before this was stated per field. On top of that, all Flemish fields were categorized in 4 groups, depending on the amount of phosphorus in the soil. The category determines the fertilization limit for P.

N-limits

The standards, based on 'effective N', differ for each (group of) crop(s) and per type of soil (sand/other) (Table 5.1.2). The effective N is the amount of total N applied from animal manure and animal-based products that is expected to be available for crop uptake in the season of application. It is calculated based on legally imposed N working coefficients (Table 5.1.1).

Table 5.1.1: N working coefficients used to calculate Effective N (% of total N) (VLM, 2017b)

| Animal based products | N working coefficient (%) |
|--|---------------------------|
| Synthetic N fertiliser, air scrubber water and effluent from biological treatment (nitrification-denitrification) | 100 |
| Liquid animal manure and other animal-based products (except drainwater from horticulture and floriculture and effluent from biological treatment (nitrification-denitrification)) | 60 |
| Solid animal manure, slow release fertiliser (except certified VFG and green compost) and farm compost | 30 |
| Nitrogen from direct excretion in grazing | 20 |
| Certified VFG and green compost | 15 |

⁴ Vlaamse Codex, Mestdecreet, <https://codex.vlaanderen.be/>

Table 5.1.2: General N-limits for fertilization for 2017 (VLM, 2017b)

| Crop | Effective N (kg/ha/y) | | Total N (kg/ha/y) from animal manure |
|---|-----------------------|------------------|--------------------------------------|
| | Sandy soil | Non-sandy soil | |
| Grassland | Mowing | 300 | 310 |
| | Mowing + grazing | 235 | 245 |
| Winter wheat | | 160 | 175 |
| Winter barley or other cereals | | 110 | 125 |
| Sugar beets | | 135 | 150 |
| Fodder beets | | 235 | 260 |
| Potatoes | | 190 | 210 |
| Maize | | 135 ⁵ | 150 |
| Vegetables group I | | 225 | 250 |
| Vegetables group II | | 160 | 180 |
| Vegetables group III | | 115 | 125 |
| Horticulture and arboriculture | | 160 | 180 |
| Strawberries | | 160 | 160 |
| Brussels sprouts | | 225 | 250 |
| Crops with low N-need | | 115 | 125 |
| Other legumes other than pies and beans | | 70 | 75 |
| Other crops incl. fodder kale and fodder radish | | 130 | 145 |

*S: sandy soil, NS: non-sandy soil

Attention: for crop combinations, fields where derogation is applicable, fields under management contract, etc. different fertilization limits are in force.

P₂O₅-limits

Agricultural soils are categorized into 4 groups, depending on the plant available P in the soil, expressed in mg P/100 g soil (Table 5.1.3).

Table 5.1.3: Soil categories based on plant available P

| Class | Plant available P in arable land (mg P/100 g air-dried soil) | Plant available P in grass land (mg P/100 g air-dried soil) |
|-------|---|--|
| I | ≤12 | ≤19 |
| II | 12 < X ≤ 18 | 19 < X ≤ 25 |
| III | 18 < X ≤ 40 | 25 < X ≤ 50 |
| IV | >40 | >50 |

The amount of plant available P needs to be analysed by an accredited laboratory.

Per P-soil class, different P-limits for fertilization apply (table 5.1.4).

Table 5.1.4: P₂O₅-limits per soil category per crop for 2017 (VLM, 2017b)

| Crop | Class I | Class II | Class III | Class IV |
|--|---------|----------|-----------|----------|
| All grassland | 115 | 95 | 90 | 70 |
| 1 st cut grassland/cut rye + maize | 115 | 95 | 90 | 70 |
| Maize | 100 | 80 | 70 | 55 |
| Grain crops | 95 | 75 | 70 | 55 |
| Potatoes | 95 | 75 | 70 | 55 |
| Beets, vegetables, horticulture & forestry, strawberries, collards, crops with low N-need, legumes and other crops | 85 | 65 | 55 | 45 |

If manure is co-digested, the digestate is considered as 100% manure and must be applied according to the fertilisation restrictions for "animal manure". If no manure is digested, the digestate can be applied according to the fertilisation restrictions for "other fertilisers".

5.1.6 Substrate related regulations

Ordinance on marketing and transport of manure KB 28/01/2013 [26]

On Belgian level, the Royal Decree 28/01/2013 regulates the trade in fertilisers, soil improvers and cultivation substrates.

If a product is traded in Belgium, this product needs to be described on the list in Annex I. This list contains a description of norms of which the product needs to answer.

If the product is not mentioned on the list, a derogation needs to be applied. A derogation is needed for compost and digestate.

This Ordinance is not applicable to products in transit or during preparation, and to raw slurry/manure.

Animal by-products Regulation- REGULATION (EC) No 1069/2009 [3]

When animal by-products are processed, the requirements in EU REGULATION (EC) No 1069/2009 concerning the installations must be met. Installations must be recognised by the Flemish Manure Bank (if manure as input) or OVAM, the Flemish Public Waste Agency (if other animal by-products than manure as input).

Flemish Decree on Animal wastes (1995) is only applicable to installations processing waste from slaughterhouses and meat-processing industry.

Circular spatial planning (RO/2006/01)

This Circular sets specific conditions for the location of new installations for processing or AD of manure located in agricultural areas:

- Maximum capacity of 60.000 tons input/year
- Minimum 60% of input streams must originate directly from agriculture/horticulture: Animal manure and products (plant origin) direct from the agriculture/horticulture farm and which are not considered as waste
- Some Flemish provinces with high manure pressure require a minimum manure input (e.g. 30% in Western Flanders/Antwerp)

Waste legislation (VLAREMA) (only if applies to manure) [27]

In the Flemish Region, animal manure is not regarded as a waste. Consequently, the waste legislation only applies if other waste streams are used as input, e.g. in co-digestion plants. In the case where other waste streams are used as input material (e.g. co-digestion) the end products (digestate and derivates) are considered to be waste. Nevertheless, it may become eligible for use as a fertiliser or soil conditioner (secondary raw material). For these products the Flemish regulation on sustainable management of material cycles and waste materials, called 'VLAREMA' applies.

If the end products are considered as waste, they can only be used as a resource if they are listed in annex 2.2 of the VLAREMA. This list describes the materials which are eligible for the use as resource.

VLAREMA ANNEX 2.2

| Raw material | Origin and description | Conditions regarding composition |
|--------------|------------------------|----------------------------------|
| | | |

| | | |
|---|---|---|
| Vegetable fruit and garden waste- and green compost | licensed establishment for the composting or digestion of vegetable, fruit and garden waste with a maximum of 25% organic-biological industrial waste or organic waste released in gardens, public gardens, parks and along roadside verges | article 2.3.1.1 and 2.3.1.3 |
| Filter cake from fermentation | Fermentation industry Anaerobic digestion | article 2.3.1.1 resource certificate |

<https://navigator.emis.vito.be/mijn-navigator?woId=44701>

Next to this, these products need to meet the requirements for composition and use as fertilisers or as soil improvers. If they are not listed, a '**resource certificate**' can be applied for.

The application form consists of different parts:

- overview of the production process, with description of the used input and the different steps where the product is produced;
- a copy of the environmental permit for the process;
- analysis report with the different VLAREMA parameters (see table 5.1.5);
- description of the specific application or the specific use of the material, and reports in support of this.

Table 5.1.5: Parameters VLAREMA for use as fertiliser/soil improver

| Parameters heavy metals | mg/kg DM |
|---|----------|
| As | 150 |
| Cd | 6 |
| Cr | 250 |
| Cu | 375 |
| Hg | 5 |
| Ni | 50 |
| Pb | 300 |
| Zn | 900 |
| Parameters monocyclic aromatic hydrocarbons | mg/kg DM |
| Benzene | 1,1 |
| Ethylbenzene | 1,1 |
| Styrene | 1,1 |
| Toluene | 1,1 |
| Xylene | 1,1 |
| Benzo(a)anthracene | 0,68 |
| Benzo(a)pyrene | 1,1 |
| Benzo(ghi)perylene | 1,1 |
| Benzo(b)fluoranthene | 2,3 |
| Benzo(k)fluoranthene | 2,3 |
| Chrysene | 1,7 |
| Phenanthrene | 0,9 |
| Fluoranthene | 2,3 |
| Indenol(1,2,3cd)pyrene | 1,1 |
| Naphthalene | 2,3 |

| Parameters monocyclic aromatic hydrocarbons | mg/kg DM |
|--|-----------------|
| Monochlorobenzene | 0,23 |
| Dichlorobenzene | 0,23 |
| Trichlorobenzene | 0,23 |
| Tetrachlorobenzene | 0,23 |
| Pentachlorobenzene | 0,23 |
| Hexachlorobenzene | 0,23 |
| 1,2-dichlorethane | 0,23 |
| Dichloromethane | 0,23 |
| Trichloromethane | 0,23 |
| Trichloroethene | 0,23 |
| Tetrachloromethane | 0,23 |
| Tetrachloroethene | 0,23 |
| Vinyl chloride | 0,23 |
| 1,1,1-trichlorethane | 0,23 |
| 1,1,2-trichlorethane | 0,23 |
| 1,1-dichlorethane | 0,23 |
| Cis+trans-1,2-dichlorethane | 0,23 |
| Hexane | 5,5 |
| Heptane | 5,5 |
| Octane | 5,5 |
| Mineral oil C10-C20 | 560 |
| Mineral oil C20-C40 | 5600 |
| Polychlorinated biphenyl | 0,8 |

In the context of VLAREMA, 'Vlaco npo' is appointed by the Flemish Wasted Authority 'OVAM' to implement quality control for the biological treatment of organic-biological waste. By means of sampling and company audits, the operational management, the input streams, the treatment process as well as the end-product are monitored. The intended use of the final product is also considered. To perform this, Vlaco developed a quality assurance system through independent certification.

Consequently, if organic biological waste streams are used in a biological treatment for production of fertilisers (= compost, digestate), an '**inspection certificate**' is needed for the end products, instead of a 'resource certificate'. The product must meet the criteria according to the 'Vlaco' quality manual (stricter than VLAREMA parameters) (table 5.1.6):

Table 5.1.6: Parameters quality manual of 'Vlaco' for digestate

| Parameters heavy metals | mg/kg DM |
|-------------------------|----------|
| As | 20 |
| Cd | 2 |
| Cr | 100 |
| Cu | 300 |
| Hg | 1 |
| Ni | 50 |
| Pb | 150 |
| Zn | 600 |

5.1.7 Waste water treatment

Basic environmental quality norms for surface water (Annex 2.3.1 of VLAREM II).

see: <https://navigator.emis.vito.be/mijn-navigator?woId=10071> (different categories for different types of water bodies).

Specific discharge conditions: these are included in the environmental permit and are depending on the advice of the governmental agencies regarding to the individual environmental permit application. So, for every manure processing installations the conditions can differ.

Sectoral discharge conditions: these are included in Annex 5.3.2. of VLAREM II, point 24 bis (<http://www.lne.be/themas/vergunningen/bestand/regelgeving/VLAREM-II-bijlagen-versie-VITO-pdf.zip>):

"24bis. Manure processing installations (with processing of external manure – category 28.3)":

| Large-scale installations (> 60.000 ton/year) for pig manure: | | Installations for cattle slurry (all sizes): | |
|---|--------------------------|--|--------------------------|
| CZV | 125 mg O ₂ /l | CZV | 125 mg O ₂ /l |
| BZV | 25 mg O ₂ /l | BZV | 25 mg O ₂ /l |
| Total N | 15 mg/l | Total N | 15 mg/l |
| Total P | 2 mg/l | Total P | 2 mg/l |
| Chlorides | 1000 mg/l | Chlorides | 2800 mg/l |
| Suspended solids | 35 mg/l | Suspended solids | 35 mg/l |

Other installations: unless differently described in the environmental permit, for small and medium scale installations for pig manure and for all other installations which do not fall under a) or b), the same norms as in a), by exception of the norms of chlorides.

General discharge conditions: „discharge of industrial waste water which do not contain any dangerous substances in regular surface water“ See Art. 4.2.2.1.1
(<http://www.lne.be/themas/vergunningen/bestand/regelgeving/VLAREM-II-versie-VITO.pdf>).

Some relevant points:

1. The dischargeable industrial waste water, that contains germs in such a quantity that the receiving water could be dangerously infected, needs to be disinfected;
2. The pH of the discharged industrial waste water cannot be higher than 9 or lower than 6,5;
3. The biochemical oxygen use in five days at 20°C in the discharged industrial waste water cannot be higher than 25 mg oxygen use per litre;
4. The temperature of the discharged industrial waste water cannot exceed 30°C
5. In the discharged industrial waste water, the following contents may not be exceeded:
 - a) 0,5 ml/l for sedimentary substances (during a static sedimentation of 2h);
 - b) 60 mg/l for suspended solids;
 - c) 5 mg/l for perchloroethylene-extractable non-polar substances
 - d) 3 mg/l for the sum of anionic, non-ionic and cationic surfactants;

5.1.8 Other relevant regulatory framework conditions [25]

Application periods and methods

The application of livestock manure, other fertilisers and chemical fertilisers on arable lands not permanently covered is banned from 1 September to 15 February. In addition, application is also banned at night and on Sundays and public holidays and, in coastal areas, on Saturdays, except for chemical fertilisers. Derogations are possible for manures and composts (prohibited only from 15 November to 15 January), or even for nitrogen-fixing intermediate crops, which may benefit from a time lag.

Application requires mandatory incorporation within two hours for slurry and 24 hours for manure. The regulations support the prevention of atmospheric emissions as follows:

Other fertilisers and livestock manure

- Injection or drop pipes in grassland and cultivated land,

- Injection or incorporation within two hours (immediately on Saturday for livestock manure) on non-cultivated arable land, but the time is increased to 24 hours for manure, compost and other fertilisers with low ammoniacal nitrogen and incorporation is not mandatory for manure or mushroom compost on grassland or land cultivated with winter cereals, green compost, etc.
- Treated or processed livestock manure: no incorporation in the soil if ammoniacal N content < 1 kg/1,000 kg (1,000 l)

Storage

Minimum required storage capacities

- 9 months for animals still in the housing unit,
- 6 months for free-range animals,
- 3 months for housing unit manure.
- No obligation for poultry: manure removed from the building after each cycle.

The government sets the minimum capacities in m³ based on the type of animal and housing unit. The farmer has the option of demonstrating that lower capacities, including removal, are not harmful to the environment.

Processing

In the Flemish Manure Decree, 'manure processing' is defined as:

- Export of non-processed manure (only poultry/horse)*;
- Export of processed manure (1069-recognition needed)
- Disposition of processed manure on non-farming land (private gardens, parks, etc.);
- Conversion into a mineral fertiliser;
- Conversion to N2;
- Export of other types of manure than poultry or horse, after specific approval by the receiving member state.*

* Since 2010 this is also the case for export of unprocessed manure to certain regions in the Netherlands near the border.

Who has to process manure?

Anaerobic digestion as such is not considered as a manure processing technique if the digestate returns to Flemish farmland since it still contains all the nutrients originally present in the manure. Only if the digestate is treated so that it is converted into a mineral fertiliser or the stipulated conditions for export are met, it can be considered as processed.

Calculation of manure processing obligation

The manure processing obligation of a business unit in a certain year equals 0.6% for each 1000 kg net N-surplus of that year. This number is augmented by a certain percentage depending on the regional manure production pressure (kg N/ha):

- < 170 kg N/ha: 10%
- 170 - 340 kg N/ha: 20%
- > 340 kg N/ha: 30%

The net-N-surplus is the amount of N from animal manure, reduced with the amount of N from animal manure that can be applied on the agricultural surface of the farm.

The manure processing obligation is limited to maximum 60% of the surplus. If the processing obligation is less than 5,000 kg net N, the business unit is exempt from its obligation

A business unit can meet its processing obligation by:

- Receiving manure processing certificates (MVC's);

- not producing the amount of manure;
- cancelling permanently the livestock rights.

If the obligation is not met in time, the 'Mestbank' gives an administrative fine of 2€/kg N. If the obligation is not met a second time (in five years after the first violation), the fine increases to 4€/kg N.

Manure processing certificates

The objective of manure processing is to decrease the addition of nitrogen from animal manure and other fertilisers on Flemish arable land.

The 'Mestbank' hands out manure processing certificates (MVC's) for the amount of processed N from animal manure. For every kg N processed, one receives 1 MVC. There are two types of MVC: poultry or non-poultry MVC.

The MVC's prove that a business unit has met its manure processing obligation. The MVC's are transferable and can be traded which creates more opportunities for farmers to meet their processing obligation.

If a farmer wants to enlarge his livestock, he receives an extra manure processing obligation (125% of the increase). If he wants to adopt livestock rights* from another farmer, he is obliged to process 25% of the increase or to cancel 25% of the rights.

* To be able to keep livestock, farmers must obtain a certain number of livestock rights (=nutrient emission rights – see following part). These rights are tradeable.

Rules for expansion (of animals)

To reduce the surplus of manure, the increase of number of animals should be prevented, of course without undermining the growth possibilities of farms. This objective has been translated into 'nutrient emission rights'. These are individual and tradable rights that determine how many animals can be kept on a farm. Each farmer has the responsibility to check if he doesn't produce more animal manure than allowed according to his nutrient emission rights. The nutrient emission rights are expressed in NER-D (D stands for animals) and is calculated by replicating the animals (with a certain nutrient content) with the numbers specified in a table. There are four different NER-D: NER-D for cattle, for pigs, for poultry and for other animals.

According to the Manure Decree there are different possibilities for expansion:

- Expansion by taking over the nutrient emission rights (NER), with cancellation of 25% of these NER;
- The takeover of NER without cancellation, only if on top of the manure processing obligation an extra of 25% NER is processed by processing of manure produced at the farm; expansion after proved manure processing.
- Expansion after proved manure processing is possible since 2008, if the following condition is fulfilled: the nutrient balance in the Flemish Region needs to be in balance, as it needs to appear from a significant improvement of the results of the measurements of relevant parameters. Here it needs to be checked if the results of the measurements of the nitrate concentrations in the surface and ground water have been improved significantly. If in the same year more than 13 million kg N is processed in the Flemish Region, an application for expansion after proved manure processing can still be submitted for the next year.

Declaration for processing of manure:

every operator of a processing plant for animal manure or other fertilisers, with a capacity higher than 300 kg P₂O₅ per year needs to do a declaration to the 'VLM-Mestbank' (Flemish Land Agency) every year. The operator also needs to register all input and output of animal manure and other fertilisers.

Derogation

For 2015-2018 Flanders has obtained a derogation, that is a deviation to the fertilisation standard of 170 kg N/ha from animal manure. In addition, effluents (end-product of biological treatment) and liquid fraction of pig manure can be used as derogation manure under certain conditions (required composition).

Transport of manure

Transport to and from the manure processing installation needs to be done by a recognised manure transporter. For the transport of hygienised end products there is an exception, that is, the operator can be recognised as a transporter and does not have to comply to the requirement of AGR-GPS.

Application of animal manure products with low N-content

Effluent from the processing of manure (e.g. biological processing) with a low concentration of ammonium-N does not need to be applied in an emission-low way. A permit for this exception is needed. Next to that, processed animal manure or other fertilisers with a low N-content can be applied during the prohibition period under very strict conditions. A permit for this exception is needed.

Manure analysis

From 2018, the legislation for determination of the nutrient composition of the produced manure at the farm will change. From then, every livestock farmer can choose between a legal fixed manure composition or a manure composition based on regular analyses. The chosen system is applicable for the whole year. Every year this choice can be reconsidered.

Specific to pig manure, a 'farm level manure composition' can be chosen for. This means that based on at least 4 analyses of the manure (in the transport truck, not in the stable), the pig farmer can show that his manure has a stable composition, so he can use these numbers for the whole year. The obligation to analyse the manure every three months is then not applicable anymore. This system is also new, because a recent Flemish study showed that the composition of pig manure on the farm can be stable.

The determination of the nutrient composition of the produced manure needs to be done for transport of the manure (e.g. to manure processing), for specifying the available storage at the farm, for the fertilisation registers and to determine how much animal manure can be used on own land. Samples need to be taken by an accredited person (from the lab or qualified manure transporter) and needs to be analysed by an accredited laboratory.

5.1.9 Support scheme used by the Flemish demonstration plant "AmPower"

AmPower was commissioned in 2011 and has an installed capacity of 7,5 MW_{el}. It converts 180.000 tonnes of mixed feedstock, close to 90% mixed bio-waste, to 30 Mm³ biogas with 56% CH₄ concentration, corresponding to 170 m³ biogas/t of feedstock.

AmPower uses the green certificate scheme described above, albeit with a higher GC level which was at € 100/MWh with banding factor 1 at the time of commissioning.

5.1.10 Remarks

The Flemish green certificate (GC) renewable energy support scheme is an understandable system with degressive certificate prices. Among the European schemes it is not very attractive, but it may be good enough to help Belgium achieve its National Renewable Energy Action Plan (NREAP) targets by 2020. In 2015, the Belgium per capita production of biogas was 234,6 kWh compared to 103,3 kWh in 2005, an increase of 127% [16].

5.2 Germany – Lower Saxony



Demonstration plant: BENAS Biogas plant, Ottersberg

5.2.1 Supporting legislation on renewable energy supply [21] [28]

„Erneuerbare Energien Gesetz“ (EEG2017) [21] Renewable Energy Sources Act, enforced 21.07.2014, last recast 17.07.2017 and Verordnung über die Erzeugung von Strom aus Biomasse (BiomasseV) Ordinance about the generation of electricity from biomass, enforced 29.03.2000, last recast 31.07.2004, together determine the support scheme and the supported feedstock. CHP is required as are continuous records of the substrates used for biogas conversion.

5.2.2 Type of supporting scheme, characteristics

EEG2017 supports electricity from renewable sources by a market premium scheme. It replaces feed-in tariffs valid until 2017. Up to 50% energy crops are allowed in 2018, 47% in 2019 and 44% in 2020. Eligible biomass is defined as plants and parts of plants, energy carriers produced from plants, waste and by-products of plant or animal origin from agriculture, forestry and aquaculture, **separately collected** organic fraction from municipal solid waste and biogas from anaerobic digestion if not produced sewage sludge (max. sewage sludge content in feedstock 10%).

Non-eligible biomass are fossil fuels, peat, paper, sewage sludge, textiles and animal by-products according to Regulation (EC) 1069/2009.

New biogas plants are entitled to the degressive feed-in premium for 20 years.

Guaranteed feed-in premiums (FIP) 2017 of € 100,90-101,90/MWh depending on the quarter of the year of commissioning, but only half of the installed capacity qualifies for the feed-in premium. The remaining amount needs to be sold on the market. In addition, plants receive € 40,00/kWh installed per year as a flexibility premium. The feed-in premium is reduced by 0,5% each half year.

5.2.3 Application

One public tender per year (September) for a pre-determined amount of some 150 MW electricity (last September 122,45 MW), interested parties with a valid operational permit may apply informally. In September 2017, only 33 parties applied for 41 MW and only 24 were accepted with 28 MW. 20 cases were old plants applying for extended support, only 4 new plants were supported.

5.2.4 Additional Support

KfW (Kreditanstalt für Wiederaufbau) loans with low, fixed interest rates are available for plants up to an investment amount of 50 M€.

5.2.5 Nutrient framework/regulations [29]

Fertiliser Act and Fertiliser Ordinance (last changed 05/2017): e.g. requirement for calculation and control of material and nutrient (N, P) flow balances (concerning all input materials), the nitrogen application is limited to 170 kg N / ha of all organic substrates (previously only fertiliser products of animal origin), specifications and restrictions for uniform fertiliser demands, regulations for "no-use" periods (after last harvesting to end of January), specifications for application and more storage capacity for digestate and manure (9 months)...

All details on regulations regarding agricultural use are available under:

<https://www.landwirtschaftskammer.de/landwirtschaft/ackerbau/duengung/duengeverordnung/duenv-kompakt.htm#p68>

Closed (no-application) period for fertilisers with significant N-content (§ 6(8))

- 1 November - 31 January for grassland, perennial field food
- After harvest - January 31 for farmland

By contrast, fertilization on arable land is possible up to the level of the N fertiliser requirement, up to a maximum of 60 kg/ha total N or 30 kg/NH₄-N

- Until 1 October to winter rapeseed, intermediary crops, field feed (when sowing until 15 September) or to winter barley after grain (when sowing until 1 October),
- Until 1 December to vegetables.
- No compensatory fertiliser allowed to grassland!
- 15 December - 15 January for mucking hoofed or cloven-hoofed animals and compost
- Closed period shift for up to 4 weeks possible
- Fertiliser demand calculation according to (§ 3 (2)) is required

Before applying significant amounts of N (= 50 kg/ha N) or P (= 30 kg/ha P₂O₅), farmers must determine the fertiliser requirement of the crop for each plot or farming unit.

This also applies to fertiliser use in autumn. If additional nutrient requirements for catch crops, winter rape or winter barley after grain or field crops are applied with organic fertilisers, 10% of the total N content must be taken into account in the following N requirement calculation for the main crop.

The final details are regulated by regional enforcement instructions of the German federal states.

Requirements for nitrogen demand calculation (§ 4 (1))

The following influences must be taken into account when determining nitrogen requirements for arable crops:

- N-demand
- Average yield over the past 3 years
- Minimum N content of the soil (reference values, analyses)

- Humus content of the soil (from >4%)
- Subsequent delivery of organic fertiliser from the previous year (10% of the total N quantity applied)
- Subsequent delivery from pre- and intermediate crop

Example of an N demand calculation for A / B winter wheat

N-Demand for A- or B-wheat in kg N/ha at 80 dt/ha

(referring to 0-90 cm soil)

Corrections depending on:

| | | |
|--|---|------|
| Harvest (average last 3 years) | 90 dt/ha | + 10 |
| Nmin-Content | measured | - 35 |
| Location/Humus content | < 4,0 % | - 0 |
| Organic fertilization previous year(=calendar year) | 100 kg Total-N /ha as digestate 10% of which must be added | - 10 |
| Previous fruit | Winter rapeseed | - 10 |
| Intermediate crop | None | - 0 |
| N-Demand in kg N/ha | | 185 |

Standards for Nitrogen demand calculation (§ 4 (2))

The following influences must be taken into account when determining nitrogen fertiliser demand for grassland

- N-demand
- Average yield over the last 3 years
- Crude protein content averaged over the last 3 years
- Humus content of the soil
- N replenishment of legume N fixation
- Subsequent delivery from organic fertilisation of the previous year (10% of the total N quantity applied)
- N fertiliser quantity applied after the last use in the previous year
- Standards for phosphorus demand calculation (§ 4 (3))

The following influences must be taken into account when determining phosphorus fertiliser demand:

- Expected yield, quality
- Site conditions
- Growing conditions
- Phosphate contents of the soil
- Crop rotation is permitted

From soil contents >20 mg/100 g soil P₂O₅ (CAL) fertilisation is allowed to a maximum of the amount of P-uptake of the crop.

N-limits for organic fertilisers (§ 6 (4))

- The use of all organic and organo-mineral fertilisers, including manure, is limited to max. 170 kg/ha total weight and year
- Compost excepted
- Within 3 years max. 510 kg total N/ha.
- In the case of compost use, subdivision of the N subsequent delivery (10% of the total N content) to 3 years.
- Currently, Germany does not use a derogation allowing higher N applications for organic fertilisers

Nutrient comparison (§ 8)

- New balancing method: Plausibilisierte Feld-Stall-Bilanz = Plausible field-animal house balance stipulating that ruminant farms must calculate the nutrient removal via the basic feed by the number of animals and their nutrient uptake
- Balance sheet accounting is possible
- An additional ordinance is expected to regulate the details of material flow balancing from 2018 onwards

Permitted N and P balances (§ 9 (2,3))

- N balance: from 2018 max. 50 kg/ha N-surplus (3-year average)
- P balance: from 2018 max. 10 kg/ha P₂O₅-surplus (6-year average)
- If the permitted balance values are exceeded: arrangement for participation in fertiliser-use counselling. In the following year submission of the fertiliser needs calculations and nutrient comparisons.

Absorbing capacity of the soil (§ 5 (1))

- No N / P fertilization if the soil is flooded, water saturated, frozen or snow covered.
- On frozen ground, max. 60 kg total N/ha to be applied if
 - the absorption capacity is given due to thawing during the day
 - there is no risk of flooding into waters or neighbouring areas
 - there is a plant cover (= catch crop, grassland)
 - otherwise compression / structural damage would occur

Distance restrictions to waterbodies (§ 5 (2,3))

Application prohibition for N- / P-containing substances near waterbodies

- 4 m between the application surface and the edge of the slope,
- 1 m if the spread width equals the working width or border spreading device is present,
- 5 m on slopes starting at 10% slope gradient.

Further restrictions on slopes from 10% gradient in the range 5-20 m:

Application only at

- Immediate incorporation into not cultivated field
- developed under sowing or immediate incorporation in row crops (= 45 cm distance)
- adequate stock development or mulching, direct sowing with non-row crops

Prohibited application techniques (§ 11)

- Solid manure spreader without controlled manure feed to the distributor
- Liquid manure / slurry tankers with free outlet on the distributor
- Central upwardly radiating impact distributor
- Liquid manure cart with vertically arranged centrifugal disc
- Rotary jet sprinkler for sprinkling manure

Ground level application on cultivated field (§ 6 (3))

- From 1.2.2020, liquid organic and liquid organic-mineral fertilisers must be placed in strips on the soil or injected directly into the soil (grassland / field grass as of 01.02.2025)
- On request, exceptions for natural bodies, agri-structural features or for security reasons are possible

Obligation for incorporation into not cultivated fields (§ 6 (1))

- Organic and organic mineral fertilisers with a significant content of nitrogen must be incorporated on not cultivated farmland at least 4 hours after application.

- Exceptions: Solid manure (hoofed and cloven-hoofed animals), compost, fertilisers with <2% DM content, urea with urease inhibitors
- Urea must be mixed with urease inhibitors from 01.02.2020 or must be incorporated within 4 hours after application

Storage capacity (§ 12)

- 6 months for liquid manure, manure, silage slurry, fermentation residues
- 2 months for solid manure of hoofed or cloven-hoofed animals, compost from 01.01.2020
- 9 months for farms with more than 3 LSU (livestock units) / ha and for farms without own crop- or grassland from 01.01.2020

Obligatory documentation

- N, P fertiliser demand per field or management unit including calculation
- In the event of a later increase in fertiliser demand, renewed fertiliser demand calculation including justification
- N-content of applied nutrient carriers, including total N, available N or ammonium N, total phosphate
- Minimum N contents of the soil (except grassland, multi-crop forage) determined using minimum N guidelines / own analyses
- Phosphate contents of the soil for fields >1 ha every 6 years
- Output data and results of the nutrient comparison as a plausibility field-animal house balance up to 31.03. of the calendar year following the expired fertilization year

5.2.6 Substrate related regulations [30]

German Biomass Ordinance (last changed 10/2016): definition of approved biomass.

Renewable Energy Sources Act (last changed 07/2017): e.g. bonus for renewable raw materials only if maximum 50 % grain or corn (max. 47% for commissioning 2020/21 and max. 44% for commissioning 2022/23) as input substrate for new biogas plants (not for existing ones like Benas)

Regulation (EC) No 1069/2009 on animal by-products in its German adoption: no general hygienisation for animal liquid and solid manure (no hygienisation demand to Benas) required.

5.2.7 Waste water treatment

Digestate from liquid and solid manure and approved biomass (like the one used at Benas) are not subject to waste legislation if they are used in agriculture.

Germans Ordinance on facilities for the handling of substances hazardous to water (04/2017): new requirements for biogas plants with fermentation substrates from agricultural origin regarding earth basin, leakage detection and walling. BENAS has built a new storage tank according to this demand.

5.2.8 Other relevant regulatory framework conditions

N/A

5.2.9 Support scheme used by the German demonstration plant "Benas"

Benas was commissioned in 2006 and has an installed capacity of 5,25 MW_{el}. It converts 103.000 tonnes of mixed feedstock, about 56% corn silage, to 20 Mm³ biogas with 53% CH₄ concentration, corresponding to 194 m³ biogas/t of feedstock.

Benas, due to the much better conditions of the German Renewable Sources Energy Act in force at the time of the plant commissioning, uses a fixed feed-in tariff with several elements as follows:

| | | |
|---------|--------------|--|
| FIT | € 116,70/MWh | Feed-in tariff |
| Bonus | € 40,00/MWh | Renewable raw materials use (<500 kW = 60/MWh, >500 kW = 40/MWh) |
| Bonus | € 20,00/MWh | Innovative technology including biomethane |
| Bonus | € 20,00/MWh | CHP heat utilisation |
| Bonus | € 10,00/MWh | Air protection (only up to 500 KW) |
| Premium | € 8,95/MWh | Flexibility |
| Premium | € 1,44/MWh | Direct marketing |

Benas' average revenues for 2017 were € 180/MWh.

5.2.10 Remarks

The German market premium (FIP) renewable energy support scheme is an understandable system with degressive (in 0,5% steps twice a year) premium. Compared to the previous German schemes it is unattractive demonstrated by the modest interest in the last auction. However, Germany has already achieved its National Renewable Energy Action Plan (NREAP) targets of 2020. In 2015, the German per capita production of biogas was 1.125 kWh compared to 142 kWh in 2005, an increase of 693% [16].

5.3 Italy – Lombardy region



Demonstration plant: Aqua & Sole S.r.l.

5.3.1 Supporting legislation on renewable energy supply [22] [31] [32]

Decreto Ministeriale 23 giugno 2016, "Incentivazione della produzione di energia elettrica da impianti a fonti rinnovabili diversi dai fotovoltaici", Incentive for production of electric energy from facilities using renewable feedstock different from PV [32].

5.3.2 Type of supporting scheme, characteristics

Electricity: 45-50€/MWh

For biogas plants of 1-5 MW installed capacity, Italy has a feed-in premium determined in the a.m. legislation. The regulation discerns between different types of technology and feedstock from different origin.

Eligible biomass in general is defined as "agricultural products" listed in tabella 1b and distinguished from industrial bio-waste (sottoprodotti acc. to tabella 1a) and the organic fraction from municipal solid waste (tabella 1c). Sewage sludge must not be used as a feedstock to receive the feed-in premium. Biogas from sewage sludge is considered under the own category "Gas residuati dai processi di depurazione".

Guaranteed feed-in premiums 2017 of € 115-140/MWh for biomass digesters depending on type of feedstock: the lower value is for agricultural products, the higher for biological waste products which are not separately collected.

5.3.3 Application

First step for an applicant is being registered in a register serviced by Gestore Servizi Energetici (GSE) [32]. Registration is subject to tenders (one or two times per year) opening registration up to a cap. The 2017 cap was 90 MW.

The feed-in premium is guaranteed for 20 years, without degression.

5.3.4 Additional Support

No additional support is offered in Italy.

5.3.5 Nutrient framework/regulations

National framework

D. Lgs. n. 152 of the 3rd of April 2006 and the subsequent D. Lgs. n. 128 of the 29th of June 2010 are the reference in the Italian environmental regulations. There are two articles closely related to the nitrate problem: 92 and 112.

Article 92 establishes the criteria for:

- the identification of the Nitrates Vulnerable Zones;
- the guidelines of the Action Programs to be drafted and approved by the Regions;
- the information and the training for farmers on the programs themselves and on the Good Agricultural Practices, to be done by the Regions.

Article 112 regulates the general criteria for the agronomic use of livestock manure (detailed in D.M. of the 7th of April 2006). This one was updated by the current D.M. of the 25th of February 2016.

The D.M. of the 25th of February 2016 disciplines the entire agronomic use cycle of livestock effluents and all others organic fertilisers: production, storage, treatment, transport and distribution, both in Vulnerable and Non-Vulnerable Zones. It provides for specific rules on the use of nitrogen, which concern in particular distribution methods (period, doses) and relative territorial restrictions (e.g. distance from ditches, rivers, lakes, etc.).

Regional framework

Lombardy Region approved the Action Program (period 2016-2019) for:

- Nitrate Vulnerable Zones (DGR X/5171 of the 16th of May 2016);
- Nitrate Non-Vulnerable Zones (DGR X/5418 of the 18th of July 2016).

Both Action Programs regulate:

- Use of fertilisers (Good Agricultural Practices);
- Periods and areas of distributions;
- Criteria for the editing of fertilization plans (Maximum Nitrogen per Crop, nitrogen efficiency, ...).

Furthermore, the DGR VIII/3297/2006 defines the Nitrates Vulnerable Zones in Lombardy.

At last, the Lombardy Region issued the Guidelines defining administrative sanctions related to the Nitrates Directive and its methods of application by Provinces and Municipalities by DGR X/3745 of the 11th of July 2012.

5.3.6 Substrate related regulations

The plant must follow:

- The directive 2001/77/CE about the stimulation of green energy production (and relative Italian transpositions D. Lgs. 387/2003);

- The directive 2010/75/UE about Integrated Pollution Prevention and Control (and relative Italian transpositions D. Lgs. 128/2010 and D. Lgs. 152/2006);
- The directive 2008/98/CE about waste treatment (and relative Italian transpositions D. Lgs. 152/2006 art. 208).

Acqua e Sole obtained the authorization by local authority (the plant is in Vellezzo Bellini, district of Pavia) on the 12th of February 2016. The authorization (n° 03/16 p.e.) rules:

- Plant construction and management;
- Plant atmospheric, sound and waste-water emissions;
- Feeding biowaste (type, analyses, ...);
- Digestate (areas of distribution, maximum dose/ha);
- Ammonium sulphate (nitrogen content).

Regional framework

Lombardy Region rules treatment and use of sewage sludges in agriculture by regulation DGR X/2031/2014 and its subsequent rules DGR X/5269/2016 and X/7076/2017.

Those 3 procedures rule about the entire process of sewage sludges agronomical use:

- Treatment plants (construction, type of treatment, ...);
- Analyses for feeding biowaste.

5.3.7 Waste management

Outcoming flows from the plant are:

- Digestate for agricultural use (considered as a waste, CER 190699);
- Ammonium sulphate, an end of waste fertiliser;
- Wastes produced by plant maintenance.

National framework

The digestate produced by the plant falls within the scope of the regulations about use of sewage sludges in agriculture.

D. Lgs. 99/92 aims to regulate the use of sewage sludge in agriculture to avoid harmful effects to soil, vegetation, animals and humans, and to encourage, at the same time, its correct use.

D. Lgs. 99/92 rules:

- Type of sewage sludges treatment (e.g.: thermal, biological, etc.);
- Conditions of sewage sludges agronomic use (e.g.: maximum dose/ha criteria, sewage sludges analyses, soil analyses, etc.);
- Prohibitions of sewage sludges agronomic use;
- Administrative procedure to be applied to use sewage sludges in agriculture.

The plant also produces an end of waste fertiliser, the ammonium sulphate, regulated by plant authorization and D. Lgs. 75/2010 (Italian law about fertilisers).

This product is recorded in the register of Italian fertilisers.

Acqua e Sole manages the waste produced by plant maintenance in compliance with D. Lgs. 152/2006.

Regional framework

Lombardy Region rules use of sewage sludges in agriculture by regulation DGR X/2031/2014 and its subsequent DGR X/5269/2016 and X/7076/2017.

Those 3 procedures rule about the entire process of sewage sludges agronomical use:

- Procedures for sewage sludges treatments;
- Use of sewage sludges in agriculture (soil analyses, sewage sludges analyses, areas of distribution, criteria of maximum application/ha, etc.).

Local framework

Competent Local authorities must grant a clearance for every field where the digestate will be used, in accordance with D. Lgs. 99/92 and DGR X/2031/2014.

The evaluation is based on:

- Soil and digestate analyses;
- Approval of the landowner.

Waste Water Treatment:

European and national framework

The management of wastewater deriving from the plant falls within the scope of directive 2000/60/CE (and relative Italian transpositions D. Lgs.152/2006).

The authorisation of the plant also covers the clearance for wastewater.

Regional framework

Lombardy Region rules the wastewater management by two regulations:

- R.R. n. 3/2006 about urban and similar wastewater;
- R.R. n. 4/2006 about all waste water (rainfall and/or washing) fallen upon impermeable areas.

The plant produces two types of wastewaters deriving from:

- 1) The toilets for operators: it runs to public sewer;
- 2) Rainfall waters (first 5 mm) are considered wastewater and are collected to the public sewer, whereas the excess rainfall water is directly discharged to a superficial water body.

All wastewaters collected and discharged to the public sewer must comply with quality required by D. Lgs. 152/2006.

Local framework

The discharge of wastewater is also approved by the local water authority. Its clearance is included in the permit of the plant.

5.3.8 Other relevant regulatory framework conditions

N/A

5.3.9 Support scheme used by the Italian demonstration plant "Aqua e Sole"

Acqua e Sole was commissioned in 2016 and has an installed capacity of 1,6 MW_{el}. It converts 72.000 tonnes of mixed feedstock, about 85% sewage sludge, to about 4 Mm³ biogas with 56-60% CH₄ concentration. Figures are preliminary estimations due to the short production period since the plant commissioning.

Due to using sewage sludge as the main feedstock, Acqua e Sole does not receive the feed-in premiums as mentioned above. In turn, electricity is sold against market prices for € 45-50/MWh.

5.3.10 Remarks

The Italian market premium (FIP) renewable energy support scheme is an understandable system with a fixed feed-in premium for 20 years. It looks like the most attractive support scheme among all countries hosting a demonstration plant. In addition, Italy has already achieved its National Renewable Energy Action Plan (NREAP) targets of 2020. In 2014, the Italian per capita production of biogas was 375 kWh compared to 81 kWh in 2008, an increase of 362 % in only 6 years [16].

5.4 The Netherlands



Demonstration plant: Groet Zevert Vergisting B.V., Beltrum

5.4.1 Supporting legislation on renewable energy supply [33] [22]

"Besluit Stimulering Duurzame Energieproductie (SDE)", Renewable Energy Production Incentive Scheme 2007, enforced 16.10.2007, last recast 01.04.2017.

5.4.2 Type of supporting scheme, characteristics

SDE+ Variable Premium Feed-in Scheme (FIP) for electricity, renewable gas and heat on top of sales for market prices via APX (electronic exchange for next day electricity supplies) and TTF (Gasunie virtual trading point for natural gas).

An SDE+ grant is awarded for 12 years.

Electricity and biomethane must be sold at market prices, hence basic revenues are determined by market prices.

Average market prices 2017: electricity via APX € 33-47/MWh_{el} and CH₄ via TTF € 16-21/MWh.
The SDE+ conceived as a feed-in premium aims at compensating the difference between the energy conversion cost and the market price. The FIP is set in phases with correction factors reflecting the variations in power/gas market prices.

Net FIP for 2018 € 47-48/MWh including the preliminary correction factor (€ 17/MWh). FIP is determined every year by the Minister of Economic Affairs and Climate Policy.

5.4.3 Application for Supporting Schemes

Applicant must apply online to the Dutch energy agency through the Netherlands Enterprise Agency, Rijksdienst voor Ondernemend Nederland. Application in 2 stages per year with 3 phases (different FIP for each phase). Capped budget provided by Dutch government.

5.4.4 Additional Support

- "Garantie van Oorsprong" GvO, certificate of origin of renewable energy, market price € >0,85/MWh, expected around € 2,00/MWh. The system is managed by WISE.
- "Regeling Groenprojecten" Regulation Green Projects 2016, enforced 01.04.2016, beneficial interest rate for qualified projects.
- "Regeling aanwijzing categorieën duurzame energieproductie 2014" Regulation designating sustainable energy production categories 2014, enforced 01.10.2014, definition of technologies and regulation for subsidies. Innovation subsidies are available for qualified projects.
- "Wet inkomstenbelasting 2001", Act on the income tax 2001, enforced 01.01.2001, last recast 01.07.2017 Tax regulation mechanisms II (Energy Investment Allowance, EIA scheme), tax credit during the year of eligible investment up to € 120,000,000.

5.4.5 Nutrient framework / regulations

The Fertiliser Act (IRFA, in Dutch: *Meststoffenwet*) regulates manure surplus and free trade of fertilising products. Manure and digestate are designated fertilising products. Both quality (see substrate related regulations) and use are thus regulated. Regulations do have many details. An overview of factual implications for farmers, producers, traders and intermediates is given by RVO.nl [34]⁶ (Dutch only). Regulations have each year an update. Given information is based on regulations in force in January 2018.

The following regulations on nutrients from fertilising products apply (links in the footnotes refer to the Dutch law text):

- Fertiliser act⁷
- Fertiliser Decree⁸
- Implementation regulation Fertiliser Act⁹
- Act environmental management (framework)¹⁰
- Soil protection act¹¹
- Decree Use Fertiliser¹²

The use of manure or digestate as a secondary raw material is part of regulations for free trade. The use as a fertiliser product in the context of application rate, application method and application period meet the following regulatory requirements.

Nutrient use regulation summary

Nitrogen and phosphorus application standards

- Nitrogen application standards are depending on the crop grown (details under 5.4.5.1). The Nitrates Directive allows to use only 170 kg N/ha from animal manure or digestate. The Netherlands have a derogation to use more nitrogen from animal manure and digestate (co-

⁶ <https://www.rvo.nl/onderwerpen/agrarisch-ondernemen/mest/mest/tabellen-en-publicaties/tabellen-en-normen>

⁷ <http://wetten.overheid.nl/BWBR0004054/2018-01-01>

⁸ <http://wetten.overheid.nl/BWBR0019031/2018-01-01>

⁹ <http://wetten.overheid.nl/BWBR0018989/2018-01-01>

¹⁰ <http://wetten.overheid.nl/BWBR0003245/2017-08-30>

¹¹ <http://wetten.overheid.nl/BWBR0003994/2017-01-01>

¹² <http://wetten.overheid.nl/BWBR0009066/2017-03-28>

digested manure) on grasslands on sandy soils and löss in the provinces Overijssel, Gelderland, Utrecht, Noord-Brabant or Limburg 230 kg N/ha, on other soils or sandy soils in other provinces 250 kg N/ha. Grassland is defined as 80% of land use being grassland.

- Nitrogen fertiliser replacement values for organic fertilisers and organic soil amendments. These apply on the application standards for nitrogen but not on the total use of nitrogen (details under 5.4.5.2). Total use of animal manure and digestate is regulated by the policy instruments of the Nitrates Directive which are implemented in the Fertiliser Act.
- Phosphorus application standards are based on soil phosphorus status (details under 5.4.5.3)

Method of application. Manure and digestate can be applied by an NH₃-emission preventing method. It is obligatory to place the fertilising product in the soil. Most common is a form of injection (e.g. narrow band, shallow injection).

Time of application. There are designated time slots or situations when it is forbidden to apply fertilising products (details under 5.4.5.4)

Sampling, analyses and transport of animal manure (including digestate). Each load of manure must be sampled and analysed. Implementation regulation¹³ [35] Fertiliser Act (IRFA) gives the obligatory standard and requirements for:

- Performance characteristics sampling equipment (in Dutch: Prestatiekenmerken bemonsteringsapparatuur (IRFA, annex E);
- Accreditation program solid manures AP06 (in Dutch: Accreditatie programma vaste dierlijke meststoffen, AP06 (IRFA, annex Ea))
- Transport certificate (in Dutch: Vervoersbewijs dierlijke meststoffen (IRFA, annex F))
- Transport certificate sewage sludge and compost (in Dutch: Vervoersbewijs zuiveringsslib en compost (IRFA, annex G))
- Accreditation program animal manure AP05 (in Dutch: Accreditatieprogramma dierlijke meststoffen (AP05 (IRFA, annex H)))

Storage capacity needed to overcome periods during which soil application of fertilising products is forbidden.

Specific regulations are in force

- For areas with sloping landscapes, obligatory cultivation of catch crops (see RVO.nl).
- For intensive livestock farms without enough land for manure application. The surplus of nitrogen and phosphorus caused by the production of manure is regulated (see RVO.nl).

5.4.5.1 Nitrogen application standards

Scope

The quantity of nitrogen a farmer can apply on his or her land is depending of the total area, soil type, region and crop rotation for crops or group of crops. The total quantity is called total nitrogen utilization capacity (In Dutch: stikstofgebruiksruimte)

The nitrogen application standards are used to calculate the total nitrogen utilization capacity for a farm. The nitrogen application standards (kilos of nitrogen per hectare per year) are determined per crop or crop group.

How to use?

The nitrogen utilization capacity is calculated from the area of a crop and the designated nitrogen application standard by multiplication of the area in hectares with the application standard. This is done for all crops. Then the outcomes are summed up.

¹³ <http://wetten.overheid.nl/BWBR0018989/2018-01-01#BijlageM>

Nitrogen application standards are given per crop, the cultivar (high, low standard), soil type, region and crops grown on farms with or without derogation (maize).

Source

<https://www.rvo.nl/onderwerpen/agrarisch-ondernemen/mestbeleid/mest/tabellen-en-publicaties/tabellen-en-normen> [34]

Table 5.4.5.1 Nitrogen application standards

| Crop | Clay 2017 | Northern, western and central sand 2017 | Southern sand 2017 | Löss 2017 | Peat 2017 |
|---|-----------|---|--------------------|-----------|-----------|
| Arable crops (kg N per ha per cultivation) | | | | | |
| Ware potato, high standard | 275 | 260 | 208 | 204 | 270 |
| Ware potato, other | 250 | 235 | 188 | 184 | 245 |
| Ware potato, low standard | 225 | 210 | 168 | 164 | 220 |
| Seed potato, high standard | 140 | 140 | 140 | 140 | 140 |
| Seed potato other | 120 | 120 | 120 | 120 | 120 |
| Seed potato, low standard | 100 | 100 | 100 | 100 | 100 |
| Starch potato | 240 | 230 | 184 | 184 | 230 |
| Sugar beet | 150 | 145 | 116 | 116 | 145 |
| Chicory | 70 | 70 | 70 | 70 | 70 |
| Winter wheat | 245 | 160 | 160 | 190 | 160 |
| Spring wheat | 150 | 140 | 140 | 140 | 140 |
| Winter barley | 140 | 140 | 140 | 140 | 140 |
| Spring barley | 80 | 80 | 80 | 80 | 80 |
| Triticale | 160 | 150 | 120 | 120 | 150 |
| Maize, farms with derogation | 160 | 140 | 112 | 112 | 150 |
| Maize, farms without derogation | 185 | 140 | 112 | 112 | 150 |
| Grassland (kg N per ha per year) | | | | | |
| Grassland with grazing | 345 | 250 | 250 | 250 | 265 |
| Grassland only mowing | 385 | 320 | 320 | 320 | 300 |

5.4.5.2 Fertiliser replacement value (Fertiliser equivalent) [34]

Scope

The fertiliser replacement value or fertiliser equivalent (In Dutch: *stikstofwerkingscoëfficiënt*) for animal and other organic fertilisers is used to calculate the effective amount of nitrogen.

With the nitrogen application standard for fertilisers the total amount of fertiliser which can be used is calculated.

Different percentages have been set for animal manure and other organic fertilisers. The percentages depend on the type of fertiliser, origin, type of farm (with or without grazing) and time of use. For mineral nitrogen fertiliser the fertiliser equivalent is 100%.

Please note that the fertiliser use capacity is calculated from total nitrogen contents.

How to use?

To calculate the crop available nitrogen in the manure to be used, multiply the amount of used manure by the relevant percentage (fertiliser replacement value/fertiliser equivalent) for all used fertilising products (animal manure, compost, sewage sludge and other organic fertilisers on the farm).

Source

<https://www.rvo.nl/onderwerpen/aqrarisch-ondernemen/mest/mest/tabellen-en-publicaties/tabellen-en-normen> [36]

Table 5.4.5.2 Fertiliser replacement value

| Type and origin | Use | Fertiliser replacement value, % |
|--|--|---------------------------------|
| Animal slurry and thin fraction of separation | | |
| Slurry of grazing animals, own farm | With grazing | 45 |
| | Without grazing | 60 |
| Pig slurry | Clay, peat | 60 |
| | Sandy soil and löss | 80 |
| Animal slurry other animals | | 60 |
| Solid animal manure | | |
| Solid animal manure of grazing animals, own farm | Arable land on clay and peat from 1 September till 31 January | 30 |
| Solid manure pigs, poultry, mink | | 55 |
| Other | | |
| Compost | | 10 |
| Mushroom compost | | 25 |
| Sewage sludge | | 40 |
| Other organic fertilising product | | 50 |
| Mixtures | For mixture the fertiliser replacement value is equal to the highest value of its constituents | |

5.4.5.3 Phosphate application standards [34]

Scope

The quantity of phosphate (P_2O_5) a farmer can apply on his or her land is depending of the total area, phosphate status and land use. The total quantity is called total phosphate utilization capacity (In Dutch: *fosfaatgebruiksruimte*).

The phosphate application standards are used to calculate the total phosphate utilization capacity for a farm.

The phosphate application standards (kilos of phosphate (P_2O_5) per hectare per year) are determined per phosphate status and per culture: grassland and arable land.

How to use?

The phosphate utilization capacity is calculated from the area of a crop and the designated phosphate application standard by multiplication of the area in hectares with the application standard. This is done for all crops. Then the outcomes are summed up.

Phosphate application standards are given for four classes of phosphate status of the soil per land use (grassland, arable land). The phosphate status of grassland is determined with the P-Al-method; on arable land with the Pw-method. Over four years a combined phosphate indicator based on P-CaCl₂ and P-Al will replace current methods. This combined indicator will be used for all crops.

Table 5.4.5.3 Phosphate application standards

| Grassland, P-Al value, mg P ₂ O ₅ /100 g | Rating | 2017 | 2018-2022 |
|--|---|------|------------------|
| < 16 | Phosphate poor and phosphate fixing soils | 120 | Work in progress |
| < 27 | Low | 100 | |
| 27-50 | Neutral | 90 | |
| > 50 | High | 80 | |
| Arable land, Pw-value, mg P₂O₅/L | | | |
| < 25 | Phosphate poor and phosphate fixing soils | 120 | Work in progress |
| < 36 | Low | 75 | |
| 36-55 | Neutral | 60 | |
| > 55 | High | 50 | |

Source

<https://www.rvo.nl/onderwerpen/agrarisch-ondernemen/mest/mest/tabellen-en-publicaties/tabellen-en-normen>

<https://www.rvo.nl/onderwerpen/agrarisch-ondernemen/mest-en-grond/mestbeleid/fosfaatarme-en-fosfaatfixerende-gronden>

5.4.5.4 Specified periods for application for animal manure and sewage sludge [34]

Scope

There are specified periods for applications of animal manure and sewage sludge. These periods depend on type of animal manure, soil type and land use (grassland or arable land). Table 5.4.5.4 gives an overview.

It is also forbidden to apply fertilising products if the soil is frozen, saturated with water or covered with snow. Also, it is forbidden to apply fertilising products when the soil is irrigated (all forms) or irrigated.

If sewage sludge may not contain more than 70 g nitrogen per kg dry matter, then there are no restrictions on the period of application.

Source

<https://www.rvo.nl/onderwerpen/agrarisch-ondernemen/mest/mest/tabellen-en-publicaties/tabellen-en-normen>

<https://www.rvo.nl/sites/default/files/2015/04/Tabel%202012%20Uitrijdperiodes%202014-2017.pdf>

<https://www.rvo.nl/onderwerpen/agrarisch-ondernemen/mest/mest/uitrijden-en-gebruiken/compost-en-kalkmeststof>

<https://www.rvo.nl/onderwerpen/agrarisch-ondernemen/mest/mest/uitrijden-en-gebruiken/stikstofkunstmest-gebruiken>

Table 5.4.5.4 Periods for application of fertilising products

| Month | Grassland | | | | Arable land | | | |
|-----------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| | Slurry | | Solid | | Slurry | | Solid | |
| | Sand and löss | Clay and peat |
| January | | | | | | | * | |
| February | | | | | | | | |
| March | | | | | | | | |
| April | | | | | | | | |
| May | | | | | | | | |
| June | | | | | | | | |
| July | | | | | | | | |
| August | | | | | ** | ** | | |
| September | | | | | | | * | |
| October | | | | | | | * | |
| November | | | | | | | * | |
| December | | | | | | | * | |
| Application forbidden | | | | | | | | |
| Application allowed | | | | | | | | |

* Solid manure and sewage sludge can be applied on sand and löss year-round;

** Slurries of animal manure and sewage sludge can be applied until September 1st if ultimately on 31st

August of the same year a green manure is cultivated or flower bulbs in the adjacent autumn are planted.

Compost and liming materials can be used year-round.

Nitrogen fertilisers, other inorganic (nitrogen) fertilisers and compost cannot be applied if:

- The upper soil layer is water saturated;
- The soil simultaneously is irrigated (all methods) or is infiltrated during the period 1st September – 31st January;
- The soil a sloping percentage has of 7% or more and suffers from gully erosion;
- Bare soil has a slope gradient of 7% or more;
- Arable land a slope gradient of 18% or more.

5.4.6 Substrate related regulations

The Fertiliser Act regulates free trade by criterions for the quality of fertilising products and the (secondary) raw materials used for their production. The Fertiliser Act distinguishes:

- Mineral fertilisers regulated by EC Regulation on fertiliser 2003/2003;
- Other mineral fertilising products not meeting the requirements of the EC Regulation fertilisers 2003/2003
- Animal manure and products of animal manure
- Sewage sludge
- Compost
- Other organic fertilising products (including recovered phosphates¹⁴).

The Fertiliser Act distinguishes two types of digestates:

¹⁴ Struvite, dicalcium phosphate, magnesium phosphate

1. Digestates from animal manure. At least 50% of animal manure has to be present. These digestates are defined as animal manure and thus have to meet the requirements for use of animal manure.
2. Digestates without animal manure (0% animal manure). These digestates have to meet requirements of other organic fertilising products and have to meet application standards for nitrogen and phosphorus for fertilising products other than animal manure.

'Other mineral fertilising products, sewage sludge, compost and ,other organic fertilising products have to meet environmental criterions (Annex II of the Fertiliser Decree [37], details under 5.5.6.1)

5.4.6.1 Environmental criteria for fertilising products (no EU fertilisers) according annex II of the Fertiliser Decree of the Fertiliser Act of the Netherlands and Decree Use Fertilisers.

Environmental criteria for fertilising products are based on a maximal accepted load of a contaminant. This load is calculated on the value giving component (i.e. phosphate (P_2O_5), nitrogen, potassium (K_2O), acid neutralising value (CaO , liming materials) of organic matter. For each of these values giving components an application rate standard is used.

Table 5.4.6.1 Maximum values for heavy metals in fertilising products per kg of value giving component.

| Heavy metals | Maximum value in mg per kg value giving component | | | | |
|---------------------|--|-----------------|------------------|------------------------------------|-----------------------|
| | Phosphate (P_2O_5) | Nitrogen | Potassium | Acid neutralising value | Organic matter |
| Cd (Cadmium) | 31.3 | 25 | 16.7 | 6.3 | 0.8 |
| Cr (Chromium) | 1875 | 1500 | 1000 | 375 | 50 |
| Cu (Copper) | 1875 | 1500 | 1000 | 375 | 50 |
| Hg (Mercury) | 18.8 | 15 | 10 | 3.8 | 0.5 |
| Ni (Nickel) | 750 | 600 | 400 | 150 | 20 |
| Pb (Lead) | 2500 | 2000 | 1333 | 500 | 67 |
| Zn (Zinc) | 7500 | 6000 | 4000 | 1500 | 200 |
| As (Arsenic) | 375 | 300 | 200 | 75 | 10 |

For the application of table 5.4.6.1 first the application rate of the fertilising product is calculated when applying 80 kilograms of phosphate (P_2O_5), 100 kg of nitrogen (N), 150 kilograms of potash (K_2O), 400 kilograms of neutralizing value (CaO) or 3000 kilograms of organic matter. The lowest application rate determines the value giving component. Next the heavy metals are calculated on this value giving component (e.g. mg Cd/kg P_2O_5). Calculated contamination grade may not exceed maximum values of Table 5.4.6.1.

For sewage sludge the maximum values for heavy metals are given in Table 5.4.6.2. These criterions are based on mg per kg dry matter (DM). Next application rates are limited to 2 tons DM/ha/year of grassland and 3 tons of DM/ha/year on arable land. Once every 10 year a farmer must sample the soil. Standards for heavy metals and metalloids in soil may not be exceeded.

Table 5.4.6.2 Maximum values for heavy metals in sewage sludge per kg DM.

| Heavy metals | Maximum value in mg per kg DM |
|---------------|-------------------------------|
| Cd (Cadmium) | 1.25 |
| Cr (Chromium) | 75 |
| Cu (Copper) | 75 |
| Hg (Mercury) | 0.75 |
| Ni (Nickel) | 30 |
| Pb (Lead) | 100 |
| Zn (Zinc) | 300 |
| As (Arsenic) | 15 |

For compost the maximum values for heavy metals are given in Table 5.4.6.3. These criterions are based on mg per kg dry matter (DM). Next use of compost follows application standards for phosphate. If the phosphate content is lower than 3.5 g P₂O₅/ kg DM, an exemption is given: 50% of the phosphate is let off (needs not to be taken into account).

Table 5.4.6.3 Maximum values for heavy metals in compost per kg DM.

| Heavy metals | Maximum value in mg per kg DM |
|---------------|-------------------------------|
| Cd (Cadmium) | 1 |
| Cr (Chromium) | 50 |
| Cu (Copper) | 90 |
| Hg (Mercury) | 0.3 |
| Ni (Nickel) | 20 |
| Pb (Lead) | 100 |
| Zn (Zinc) | 290 |
| As (Arsenic) | 15 |

For organic fertilising products with the exemption of animal manure, sewage sludge and compost table 5.4.6.4 gives the maximum allowable contents of designated organic contaminant in mg/kg DM. The risk assessment follows the same procedure as given at Table 5.4.6.1.

Table 5.4.6.4 Maximum values for organic fertilising products other than animal manure, sewage sludge and compost.

| Organic contaminants | Maximum values for organic contaminants in mg per kg value giving component. | | | | |
|----------------------|--|----------|------------------------------|----------------------------|-------------------|
| | Phosphate (P ₂ O ₅) | Nitrogen | Potash (K ₂ O) | Acid neutralising value | Organic matter |
| Σ PCDD/PCDF | 0.019 | 0.015 | 0.010 | 0.0038 | 0.00051 |
| α-HCH | 310 | 248 | 165 | 62 | 8.3 |

| Organic contaminants | Maximum values for organic contaminants in mg per kg value giving component. | | | | |
|-------------------------|--|----------|------------------------------|----------------------------|-------------------|
| | Phosphate (P ₂ O ₅) | Nitrogen | Potash (K ₂ O) | Acid neutralising value | Organic matter |
| β-HCH | 12 | 9.6 | 6.4 | 2.4 | 0.32 |
| γ-HCH (lindane) | 1.2 | 0.96 | 0.64 | 0.24 | 0.032 |
| HCB | 31 | 31.2 | 20.8 | 7.8 | 1.0 |
| Aldrin | 7 | 5.6 | 3.7 | 1.4 | 0.2 |
| Dieldrin | 7 | 5.6 | 3.7 | 1.4 | 0.2 |
| Σ Aldrin/Dieldrin | 7 | 5.6 | 3.7 | 1.4 | 0.2 |
| Endrin | 7 | 5.6 | 3.7 | 1.4 | 0.2 |
| Isodrin | 7 | 5.6 | 3.7 | 1.4 | 0.2 |
| Σ Endrin/Isodrin | 7 | 5.6 | 3.7 | 1.4 | 0.2 |
| Σ DDT + DDD + DDE | 23 | 18.4 | 12.3 | 4.6 | 0.6 |
| PCB-28 | 18.5 | 14.8 | 9.9 | 3.7 | 0.48 |
| PCB-52 | 18.5 | 14.8 | 9.9 | 3.7 | 0.48 |
| PCB-101 | 75 | 60 | 40 | 15 | 2 |
| PCB-118 | 75 | 60 | 40 | 15 | 2 |
| PCB-138 | 75 | 60 | 40 | 15 | 2 |
| PCB-153 | 75 | 60 | 40 | 15 | 2 |
| PCB-180 | 75 | 60 | 40 | 15 | 2 |
| Σ 6-PCB (excl. PCB-118) | 375 | 300 | 200 | 75 | 10 |
| Naphthalene | 600 | 480 | 320 | 120 | 16 |
| Phenanthrene | 750 | 600 | 400 | 150 | 20 |
| Anthracene | 600 | 480 | 320 | 120 | 16 |
| Fluoranthene | 185 | 148 | 98 | 37 | 4.9 |
| Benzo(a)anthracene | 230 | 184 | 123 | 46 | 6.1 |
| Chrysene | 230 | 184 | 123 | 46 | 6.1 |
| Benzo(k)fluoranthene | 270 | 216 | 144 | 54 | 7.2 |
| Benzo(a)pyrene | ne 290 | 232 | 155 | 58 | 7.7 |
| Benzo(g.h.i)peryleen | 210 | 168 | 112 | 42 | 5.6 |
| Indeno(1.2.3-c.d)pyrene | 235 | 188 | 125 | 47 | 6.3 |
| Σ 10-PAH | 11500 | 9200 | 6133 | 2300 | 307 |
| Mineral oil | 935000 | 748000 | 498668 | 187000 | 24933 |

Digestates result mostly from digestion of animal manure and other substrates called co-products. These co-products are by-products and wastes. The resulting digestate is a co-digested manure. Only co-digested manures from designated co-materials (thus designated wastes and by-products) are allowed for use as a fertilising product. Allowed co-materials are given in Annex Aa of the Implementation Regulation [37] of the Fertiliser Act (details under 5.4.6.2).

Co-materials that are animal by-products (including manure) according EU Regulations 1069/2009 and 142/2011 can only be digested if registered by the Dutch Authority '*Nederlandse Voedsel en Waren Autoriteit (NVWA)*'. A registration is not needed for biogas plants that use vegetative co-materials only.

Co-materials that are not listed in Annex Aa of the Implementation Regulation of the Fertiliser Act can be used. The resulting digestate is however a waste and cannot be used as a fertilising product.

5.4.6.2 Annex Aa of the Implementation Regulation Fertiliser Act (article 4).

Scope

Only designated wastes and by-products can be used as a fertilising product, a secondary raw material for the production of a fertiliser or as a co-material for biogas product. The co-material is a specific type of a secondary raw material for fertiliser production. Digestate is a fertilising product if animal manure and/or designated co-materials are used. The use of non-designated co-material gives the resulting digestate the status of waste and therefore cannot be used as a fertilising product. The decision to include a waste or a by-product in Annex Aa is taken by the Minister of Agriculture, Nature and Food Safety (In Dutch: *Ministerie van Landbouw, Natuur en Voedselkwaliteit*). The decision is based on amongst others a risk assessment. This risk assessment follows a protocol of the Scientific Committee on the Nutrient Management Policy (2016) [38].

Source

<http://wetten.overheid.nl/BWBR0018989/2018-01-01#BijlageAa>

Outline

The source gives entrance to the full list of designated fertilising products, secondary raw materials and co-materials.

Categories are:

- I. Materials which can be traded as fertiliser (single products)**
- II. Materials which can be traded as fertiliser (groups of products, e.g. Drain water from air scrubbers)**
- III. Materials which can be used for the production of fertilisers)**
- IV. End-products of production processes which can be used as fertiliser**

- **Category 1.** Product from fermentation of at least 50% animal manure with one or more designated co-materials given in the Table of Annex Aa [39] regarding co-digested manure. There is a specific subcategory G with specific requirements.
 - A. Materials of vegetative origin on a farm
 - B. Materials of vegetative origin from nature as defined in article 1.1.e of the Decree Use Fertilisers
 - C. Materials from food industries
 - D. Materials from feed industries
 - E. Materials from other industries
 - F. Aids and additives
 - G. Materials on which specific requirements rests [39]
- **Category 2.** Digestate of fermentation of co-materials of vegetative origin only
- **Category 3.** Liquid fraction of digestate of fermentation of co-materials of vegetative origin only.

- **Category 4.** Solid fraction of digestate of fermentation of co-materials of vegetative origin only.

5.4.7 Waste Management

Waste management of manure processing technologies and biogas plants starts at the establishment of a new plant. In short, the following regulatory instruments apply on a new plant:

Fertiliser Act: scope: regulation of manure surpluses and free trade of fertilising products.

Regulation on animal by-products (EC regulations 1069/2009 and 142/2011): scope: prevention of spreading animal diseases.

Spatial planning Act (in Dutch: *Wet ruimtelijke ordening*): scope: spatial planning and role of planning organisations (provinces, cities).

Act environmental management (in Dutch: *Wet milieubeheer*): scope protection of the environment and prevention and limiting environmental hindrances (noise, stench, light ...). This framework act implements the European Waste Framework Directive. The Act gives a framework of acts, decrees and regulations. For new digestion plants are important:

- Act general provisions environmental law (in Dutch: *Wet Algemene Bepalingen Omgevingsrecht (Wabo)*): scope general provisions on organisation of a digestion plant.
- Decree and regulation of collecting wastes (in Dutch: *Besluit en Regeling inzamelen van afvalstoffen*);
- Decree Collecting Wastes (in Dutch: *Besluit inzameling afvalstoffen*); scope: regulation of how to collect and how to transport waste and permits therefore.
- Regulating gatherers, transporters, traders and intermediates of wastes (In Dutch: *Regeling inzamelaars, vervoerders, handelaars en bemiddelaars van afvalstoffen*); scope: registration of legal entities that are involved in collecting, transporting and trading wastes).
- Decree Reporting Industrial waste and hazardous materials (In Dutch: *Besluit melden bedrijfsafvalstoffen en gevaarlijke stoffen*)

A permit to build a new plant is based on

- An environmental permit (In Dutch: *Omgevingsvergunning*)
- An (obligatory) environmental impact report (In Dutch: *M.e.r.-beoordelingsplicht*)
- Legal requirements for processing manure (in Dutch: *Mestverwerking* (article 5.4. of the Decree of Environmental Law (In Dutch: *besluit omgevingsrecht*))
- Chapter 10 of the Act Environmental management (article 22.1. sub-articles 2 and 8)
- Permit of NVWA according EU regulation 1069/2009
- Decree Environmental Law on manure processing and designated authority (In Dutch: *Mestverwerking en bevoegd gezag volgens het Besluit omgevingsrecht*)

5.4.8 Waste Water Treatment

Waste water treatment is regulated by the Act environmental management (Chapter 10). In the context of this document waste water from manure and digestate processing to fertilising products has the focus.

Criterions for waste water treatment of these processes are identical to those for the waste water treatment plant processing municipal or industrial waste waters.

The criterions are given in the Decree Discharges outside processing plants (In Dutch: *Besluit Lozingen buiten inrichtingen*) i.e. there is no discharge in a sewer.

For a discharge a permit must be obtained from the regional Waterboard¹⁵.

Implications for permeate from mineral concentrate plants

¹⁵ <https://www.uvw.nl/wp-content/uploads/2015/08/Afvalwater-uit-een-mestverwerkingsinstallatie-lozen.pdf>

Some mineral concentrate producing plants discharge permeate on surface water. Others discharge on sewers which leads to costs depending on the rate of pollution of the permeate.

Implications for sewage sludge

In the Netherlands, sewage sludge from communal WWTP is treated in mono-incinerators, co-incinerators or dried and used as a fuel. This practice is the result of the introduction of stricter standards on heavy metals in 1993. Standards for Cu and Zinc are so strict that practically no WWTP can fulfil the requirements. Moreover, there is no demand for P-rich sewage sludge because of the excess and sewage sludge and products thereof have a negative image.

It is not allowed to mix sewage sludge with other fertilisers such as manure or composts. Consequently, there are no AD plants in the Netherlands treating sludge and manure.

Sewage sludge has a waste status when exported or when not fulfilling requirement of Annex II of the Decree Fertiliser Act. Consequently, export of sewage sludge or sludge products such as compost is legally and administratively very complex though not completely impossible as GMB BioEnergy (outreach plant) managed to get permission to export bio-granulate to France where it is to be used as a fertiliser.

There are some WWTP that recover phosphorus in the form of struvite. Though it is allowed to use struvite, calcium phosphate and/or magnesium phosphates (In Dutch: *herwonnen fosfaten*) from waste water as a fertiliser, there is no demand for this product in the Netherlands because of the excess amount of manure.

5.4.9 Other relevant regulatory framework conditions

Biogas plants are subjected to regulation to prevent emission of NO_x, Sulphur content biogas and SO₂. Decree criterions emission middle large combustion plants (in Dutch: *Besluit emissie-eisen middelgrote stookinstallaties*).

Farmer confronted with a surplus of manure (phosphate) have to process the manure. This is an obligatory regulatory instrument of the Fertiliser Act. Methods of manure processing are designated:

- Export of manure
- Incineration or gasification resulting in a material with less than 10% organic matter.

Co-digesting, separation, sanitation, drying, pelletising or other methods of treatment are not designated manure processing methods.

5.4.10 Support scheme used by the Dutch demonstration plant "Groot Zevert"

Groot Zevert was commissioned in 2004 and has an installed capacity of 6,5 MWel. It converts 102.000 tonnes (135.000 t from 2018) of mixed feedstock, 70% farmyard manure, to 10 Mm³ biogas with 58% CH₄ concentration, corresponding to 75 m³ biogas/t of feedstock.

Groot Zevert operates within the scheme as outlined above by selling electricity and biogas at market prices whereas supplying biogas as produced to a nearby facility of Friesland Campina.

Category extended lifespan for co-digestion of manure with co-materials [39] is not subsidized from 2018 onwards. Mono-digestion of manure (minimal 95% manure) and new initiatives for co-digestion of manure (minimal 50% manure) qualifies for subsidies. Mono-digestion of manure is limited to 400 kW (farm scale digesters). Subsidies awarded to co-digestion initiatives of previous years of extended lifespan for co-digestion continues over the appointed time periods (10 years).

Additional national support schemes are addressed by small CAPEX related subsidies of the newly installed technologies, regarding the full-scale implementation of the nutrient recovery and recycling

system GENIAAL turning the digestate into separated phosphate, nitrogen and potassium fertilisers and clean water.

5.4.11 Remarks

The Dutch SDE+ renewable energy stimulation scheme (FIP) is a rather understandable system with variable, very market-oriented feed-in premiums. Among the European schemes it is not very attractive and probably not good enough to achieve the biogas related Dutch National Renewable Energy Action Plan (NREAP) targets by 2020. In 2015, the Dutch per capita production of biogas was 225,1 kWh compared to 86,7 kWh in 2005, an increase of 160% [16].

5.5 United Kingdom



Demonstration Plant: Fridays

5.5.1 Supporting legislation on renewable energy supply [22] [40] [41]

The British renewable energy support scheme is based on the Energy Act 2008 [41], enforced 28.11.2008, last recast (specifications) by The Renewable Heat Incentive Scheme (Amendment) Regulations 2016 [41].

The regulative body is managed by OFGEM, the Office of Gas and Electricity Markets, a non-ministerial government department and an independent National Regulatory Authority. OFGEM publishes guidance documents and the annually adapted conditions for supplying renewable energy [40].

5.5.2 Type of supporting scheme, characteristics

The Renewable Heat Incentive Scheme (RHI) for heat, power and biomethane is based on a combination of feed-in tariff (renewable electricity up to 5 MW_{th}), feed-in premium, quota and tax regulation mechanism. It includes the production of power, biomethane and heat.

Biomass is defined as 'material, other than fossil fuel or peat, which is, or is derived directly or indirectly from, plant matter, animal matter, fungi or algae' and includes sewage sludge.

Biomethane is defined in the Energy Act 2008 as 'biogas which is **suitable for conveyance** through pipes to premises in accordance with a license under section 7 of the Gas Act 1986 (gas transport license)'.

Payments according to the RHI scheme will be made for 20 years in the form of quarterly periodic support payments. Once an installation is accredited, a tariff level is assigned to the plant depending on

its type and size. A table of RHI tariffs is updated and published on the RHI website annually, with the adjusted rates beginning on 1 April and ending on 31 March of the following year.

A degression mechanism is in place entitling OFGEM [40] to reduce the tariffs in case the fixed annual budget is exceeded.

Electricity feed-in tariff for plants up to 5 MW installed capacity. Tariffs are variable and fixed quarterly. For electricity from anaerobic digestion of biomass with an installed capacity of 250-500 KW, the tariff for plants accredited in Qu4/2017 was GBP 47/MWh (€ 53/MWh). In Qu1/2018 it is only GBP 42/MWh.

The feed-in tariff for anaerobic digestion plants >500 KW is much less, only GBP 15,70/MWh.

After a review of the recent degression of the biomethane feed-in tariffs, the new FIT was eventually set at the level of early 2016. Consequently, the FIT for biomethane injection to the gas grid for the UK Demo-plant Friday is GBP 53/MWh (€ 60/MWh). The biomethane tariff is divided into 3 tiers, for the first 40.000 MWh, the second 40.000 MWh and additional biomethane supplied to the gas grid.

In addition, in accordance with the RHI scheme for renewable heat, Friday receives GBP 35/MWh (€ 40/MWh) for biogas CHP thermal energy for 284kw of renewable heat used in the ammonia recovery stage.

5.5.3 Application

To receive support under the RHI, an eligible installation will have to be accredited. Accreditation (which is defined in the Regulations) is the term used to denote admission of an applicant to the RHI once OFGEM determines that the installation meets the eligibility criteria of the scheme and that the application for accreditation is properly made. Applicants may apply for preliminary accreditation allowing to forecast the eligibility for accreditation. Biomethane plants apply under a different scheme called registration.

Requirements:

Three-stage application for the tariff-guarantee, available for plants commissioned before the 31.01.2020 (subject to parliamentary approval in April 2018). Fuel Measurement Sampling (FMS) questionnaire to determine the type and characteristics of feedstock for its eligibility and sustainability.

Regular self-reporting on feedstock sustainability including greenhouse gas (GHG) lifecycle emissions and land use criteria are mandatory for biogas plants >1 MW_{th} and biomethane producers. Waste biomass is deemed to meet the sustainability criteria. Installation of permissible meters for measuring the volumes of heat, power and gas. Independent report on metering arrangements (IRMA) for installations >1 MW_{th}. Air quality compliance by an RHI emission certificate or by an environmental permit. Health and Safety Executive requirements on gas safety. Detailed description of the process by which biogas is upgraded to biomethane suitable for conveyance.

5.5.4 Additional Support

Applicants may receive a grant which is subject to repayment by the RHI payments.

5.5.5 Nutrient framework/regulations [42]

Overview of the British Nitrates Action Programme [43]

Nitrate Vulnerable Zones (NVZs) include about 58% of land in England. The Department for Environment, Food and Rural Affairs (Defra) reviews NVZs every 4 years to account for changes in water pollution.

NVZs for 2017 to 2020 started on 1 January 2017. They include new areas of NVZs and exclude areas that have been de-designated. Farmers with land in new NVZs were informed by DEFRA early 2017. They need not to comply with several of the restrictions applicable to NVZs until 31.09.2019. The current NVZs are shown in figure 6.

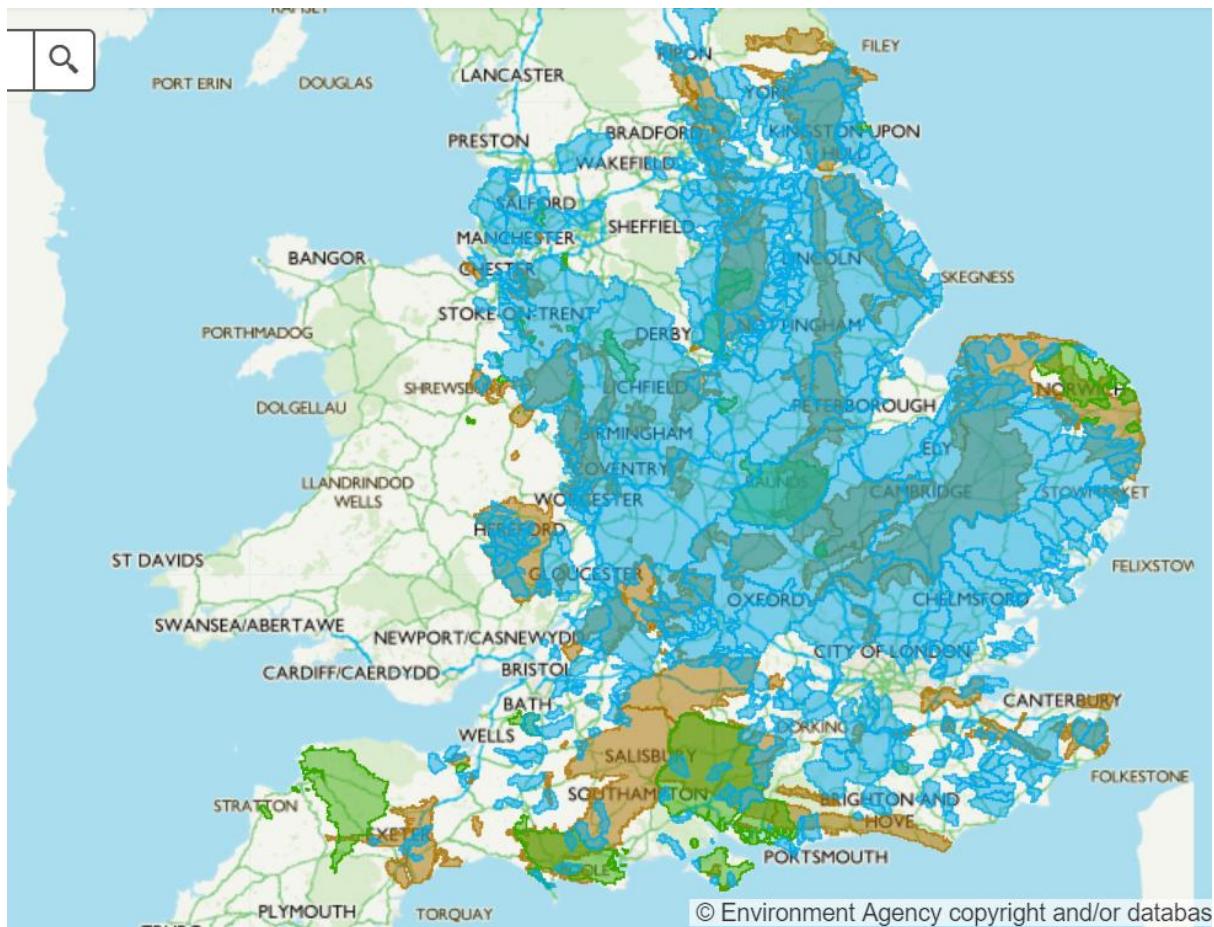


Fig. 6 Nitrate Vulnerable Zones in the UK applicable from 2017 (Source: UK Environment Agency)

In previously designated NVZs and in newly designated NVZs from 1.10.2019 the maximum rate of 170 kg/ha applies for N from livestock manure as an average loading limit across one holding. It includes manure deposited directly by grazing livestock. There is a separate field limit for all organic manures (including livestock manure) of 250 kg/ha N spread in any 12 months period. Up to 500 kg/ha of certified green compost may be used every two years if worked into the ground.

All farmers must use standard values to work out how much nitrogen is produced by the livestock on a farm or bought on to a farm. Farmers must plan N-fertiliser use so that they don't exceed the limit. Planning includes calculating the amount of crop-available N and total N in manure, using the fertiliser manual or the information provided by the supplier.

Derogations

A farmer can apply for a grassland derogation to increase this amount to 250 kg/ha if the nitrogen comes from grazing livestock manure. A current derogation finishes at the end of December 2018. Farmers must reapply for a 2019 derogation.

Cross-compliance requirements

The NVZ rules are part of the requirements for cross compliance, known as Statutory Management Requirement 1. Farmers must meet all NVZ cross-compliance requirements to qualify for full payment under the Basic Payment Scheme and other direct payments governed by the CAP.

Maximum N application rates (total amount of manure and manufactures fertilisers)

There's a limit on the average amount of manufactured fertiliser and crop-available nitrogen from organic manure that farmers can apply to most crops each year - this is known as the N-max limit.

Table 5.1 N-max limits per crop and expected crop yield

| Crop | N-max limit (kilograms of nitrogen per hectare) | Standard crop yield (tonnes per hectare) |
|---|---|--|
| Autumn or early winter-sown wheat | 220 | 8 |
| Spring-sown wheat | 180 | 7 |
| Winter barley | 180 | 6.5 |
| Spring barley | 150 | 5.5 |
| Winter oilseed rape | 250 | 3.5 |
| Sugar beet | 120 | - |
| Potatoes | 270 | - |
| Forage maize | 150 | - |
| Field beans | 0 | - |
| Peas | 0 | - |
| Grass | 300 | - |
| Asparagus, carrots, radishes, swedes, individually or in any combination | 180 | - |
| Celery, courgettes, dwarf beans, lettuce, onions, parsnips, runner beans, sweetcorn, turnips individually or in any combination | 280 | - |
| Beetroot, brussels sprouts, cabbage, calabrese, cauliflower, leeks individually or in any combination | 370 | - |

There are a number of exceptions to these rules for designated crops and in case of expecting higher crop yields. On grassland for dehydration or chlorophyll production, up to 700 kg/ha N (irrigated, non-irrigated up to 500 kg N/ha) can be applied.

Assess the risk of run-off before spreading

It's an offence to allow fertiliser or organic manure to enter surface water (such as rivers or ponds). Farmers

must inspect the field to assess the risk of nitrogen getting into surface water (for example, through runoff) before spreading any fertilisers or organic manures.

When assessing the risk of runoff, farmers need to take account of:

- Land that's sloping, especially if the slope is over 12 degrees

- Ground cover provided by vegetation
- The distance to surface water
- Weather conditions
- The soil type and condition
- The presence of land drains

Areas where farmers can't spread manufactured fertilisers or organic manures

Farmers must not spread any manufactured fertilisers or organic manures if a field is either:

- Waterlogged, flooded or covered in snow
- Frozen for more than 12 hours in the previous 24 hours

Farmers must not spread:

- Manufactured nitrogen fertiliser within 2 metres of surface water
- Manufactured nitrogen fertilisers within a 2-metre zone from the centre of an established hedge (this only applies if farmers need to meet cross compliance requirements)
- Organic manure within 50 metres of a spring, well or borehole or 10 metres of surface water

Farmers must only spread manufactured nitrogen fertilisers and manures on agricultural land that they are using to grow crops (including grass). Farmers must spread manufactured nitrogen fertilisers and organic manures as accurately as possible.

Exceptions for precision spreading equipment for organic manures

Farmers can spread slurry, sewage sludge and anaerobic digestate no less than 6 metres from surface water if they use precision manure spreading equipment like:

- Band spreaders (trailing hose or trailing shoe)
- Shallow injectors (that inject no more than 10cm below the surface)
- Dribble-bar applicators

Exceptions for straw-based solid manure

Farmers can spread straw-based solid manure (such as farmyard manure) within 10 metres of surface water on land that's notified as a site of special scientific interest or managed under an agri-environment scheme if meeting one of the following conditions:

- Managing the land for breeding wader birds
- The land is designated as a 'species-rich semi-natural grassland'

Farmers must only spread between 1 June and 31 October and not:

- Directly into surface water
- More than 12.5 tonnes per hectare each year

Using manures with high readily available nitrogen

Some organic fertilisers have more than 30% of their total nitrogen content immediately available to crops. These are called 'high readily available nitrogen manures' and include:

- Poultry manure (layer manure and litter)
- Liquid organic manures (such as sludge, cattle and pig slurries and anaerobic digestate)

If using sewage sludge or slurry on the holding, farmers need to follow the rules in this guidance and separate rules on managing sewage sludge, slurry and silage.

Farmers must not spread high readily available nitrogen manures on or between the dates shown in this table.

| | On grassland | On tillage land |
|------------------------|------------------|-----------------|
| Sandy or shallow soils | 1 Sep to 31 Dec | 1 Aug to 31 Dec |
| All other soils | 15 Oct to 31 Jan | 1 Oct to 31 Jan |

On sandy soils or if it lies over sandstone or it has all the characteristics shown in this table:

| Layer of soil | Up to 40cm | From 40cm to 80cm |
|----------------------|---|---|
| Content of the soil | more than 50% by weight of particles from 0.06mm to 2mm in diameter | more than 70% by weight of particles from 0.06mm to 2mm in diameter |
| | less than 18% by weight of particles less than 0.02mm in diameter | less than 15% by weight of particles less than 0.02mm in diameter |
| | less than 5% by weight of organic carbon | less than 5% by weight of organic carbon |

Soil is shallow if it's less than 40cm deep

Exceptions for crops on sandy or shallow soils

If farmers sow a crop on sandy or shallow tillage land on or before 15 September, they can apply manures with high readily available nitrogen between 1 August and 15 September inclusive.

Exceptions for organic farms

An organic farmer, or one formally converting to organic status, can spread manures with high readily available nitrogen in the periods shown in the table but never more than 150 kg N/ha.

| Crop | When farmers can spread nitrogen | Additional limits on spreading |
|--|--|---|
| Asparagus, overwintered salad onions, parsley, bulb onions | from the start of the closed period to the end of February | |
| Brassica | from the start of the closed period until harvest | no more than 50kg of nitrogen per hectare every 4 weeks |
| Winter oilseed rape | from the start of the closed period to the end of October | |
| Grass | from the start of the closed period to the end of October | no more than 40kg at any one time |

Farmers must not spread more than 30 m³/ha of slurry or 8 tonnes/ha of poultry manure in a single application from the end of the closed period until the end of February. Farmers must allow at least 3 weeks between each individual application. The poultry manure limit remains the same, but the slurry limit has been reduced from 50 m³ to 30 m³.

Equipment for spreading slurry

Farmers must only spread slurry using precision spreading equipment or equipment that either:

- Has a low spreading trajectory (below 4 metres from the ground)
- Spreads slurry at a maximum rate of no more than 1 millimetre per hour when operating continuously

Work organic manures into the soil after spreading

When farmers spread manure on bare soil or stubble (except if it's been sown with seed), they must:

- Work poultry manure, slurry and liquid-digested sludge into the soil (for example, by ploughing) as soon as it's practically possible to do so and within 24 hours at the latest

- Work any organic manure into the soil (unless it's been spread as mulch on sandy soil) as soon as possible and within 24 hours at the latest if the land is sloping and within 50 metres of surface water that could receive run-off from it

Farmers don't have to work in slurry and liquid-digested sludge if having applied it using a trailing hose, shoe band spreader, dribble bar applicator or an injector.

Closed periods when farmers can't spread manufactured nitrogen fertilisers

Farmers must not spread manufactured nitrogen fertiliser on or between the following dates (closed periods):

- from 15 September to 15 January on grassland
- from 1 September to 15 January on tillage land

Nonetheless farmers can spread manufactured nitrogen fertiliser during the closed period if growing the crops listed in the table and keeping to the limits and times shown.

| Crop | Maximum amount of nitrogen you can spread within the closed period on each hectare |
|----------------------------|---|
| Winter oilseed rape | 30kg (you must not spread nitrogen after 31 October) |
| Asparagus | 50kg |
| Brassica | 100kg (no more than 50kg can be applied every 4 weeks, up to the date on which you harvest the crop) |
| Grass | 80kg (you can apply a maximum of 40kg at any one time, and you must not spread nitrogen after 31 October) |
| Over-wintered salad onions | 40kg |
| Parsley | 40kg |
| Bulb onions | 40kg |

Exemptions for greenhouses and low-intensity farms

Greenhouses

Farmers don't need to keep to limits on fertiliser use on land inside greenhouses, glasshouses and polytunnels where the land is enclosed for the whole calendar year. If land is exposed to the open air at any time (for example, if farmers uncover a polytunnel) the limits apply for the whole of that year. Farmers don't need to keep records of your use of nitrogen fertilisers or the yield of arable crops in a greenhouse.

Low-intensity farms

Farmers are low-intensity farmers if all of the following apply:

- At least 80% of your land is grassland
- Farmers apply no more than 100kg of nitrogen per hectare per year as organic manure (including any nitrogen in manure deposited on the field by livestock)
- Farmers spread no more than 90kg of nitrogen per hectare per year as manufactured fertiliser
- Farmers don't bring any organic manure onto your holding

Low-intensity farmers don't have to keep a record of actual applications of manufactured fertiliser and organic manure in each field. Farmers must have recorded information to show that you meet the criteria for low-intensity farms. They must still plan your nitrogen use by keeping a fertilisation plan.

When calculating your fertiliser applications, farmers must not include any area of their holding where they don't spread any fertiliser or work the soil (for example, on rough grazing areas).

Keeping records

Farmers must keep all records of fertiliser use for at least 5 years. Records must include the fertilising plant encompassing crops, anticipated yields, calculated fertiliser need, months of manure application, crop N-requirement, etc. All recording requirements are shown in the guidelines.

Further requirements for claimants of direct payments

Farmers must follow the Code of Good Agricultural Practice for nitrates if claiming direct payments other than those under the basic payment scheme (for example, agri-environment payments).

Code of Good Agricultural Practice [44]

Protecting our Water, Soil and Air: A Code of Good Agricultural Practice for farmers, growers and land managers (the 'CoGAP') offers practical interpretation of legislation and provides good advice on best practice. Good agricultural practice means a practice that minimises the risk of causing pollution while protecting natural resources and allowing economic agriculture to continue. It has been written by technical specialists from Defra and Natural England.

All farm staff and contractors on the farm who handle, store, use, spread or dispose of any substances that could pollute water, soil or air should be aware of their responsibilities and know about the causes and results of pollution. They should know how and when to operate and maintain the equipment they use and know what to do in an emergency.

The CoGAP provides an important point of reference, based around the main operations that farmers, growers and land managers might undertake; the advice covers activities carried out in the field, but also management plans, farm infrastructure and waste management.

Use of organic manures and manufactured fertilisers on farmland (outside NVZs) [42]

The Code of Good Agricultural Practice and the requirement to fertiliser planning, accounts for nutrients available in soil, record keeping, limits for organic manure (250 kg N/ha), closed period (1 September to 15 January for cropland, 15 September to 15 January for grassland), application and spreading rules also apply to crop- and grassland outside NVZs, albeit less strict.

Sewage sludge on farmland: code of practice [45]

The sewage sludge code of practice is for anyone in England, Wales and Northern Ireland who produces, supplies or uses sewage sludge. Owners or managers of farmland where it is used should also read this guidance. It helps to make sure that when farmers produce, supply or use sewage sludge they:

- Follow good agricultural practice
- Maintain the long-term viability of the soil
- Avoid public nuisance and water pollution
- Protect human, animal and plant health

Thermophilic or mesophilic digestion is one of the recommended treatments of sewage sludge for reducing pathogens. It allows sludge spreading (untreated sludge must be injected or worked into the soil).

Inspections and enforcement

The Rural Payments Agency inspects a proportion of farmers who claim Basic Payment under the cross-compliance rules.

5.5.6 The Waste and Resources Action Programme (which operates as WRAP) [46]

BSI PAS 110 - Producing quality anaerobic digestate

Anaerobic digestion (AD) systems can produce valuable renewable energy and fertiliser resources. The publicly-available specification (PAS) BSI PAS 110 aims to remove the major barrier to the development of AD and its markets for digestion process outputs by creating an industry specification against which producers can verify that they are of consistent quality and fit for purpose.

BSI PAS 110 covers all anaerobic digestion (AD) systems that accept source-segregated biowastes. It specifies:

- Controls on input materials and the management system for the process of anaerobic digestion and associated technologies;
- Minimum quality of whole digestate, separated fibre and separated liquor; and
- Information that is required to be supplied to the digestate recipient.

Fridays will apply for end of waste criteria on digestate under the UKs PAS110 regulations which will mean digestate can be spread to land without any Environmental permit.

5.5.7 Substrate related regulations

Under RHI Fridays need to report on the feedstock source through an FMS questionnaire once a year.

5.5.8 Waste Management

Environment Agency Permit (Bespoke) is required to operate the facility processing waste. Administered by UK Environment Agency.

<https://www.gov.uk/topic/environmental-management/environmental-permits>

5.5.9 Other relevant regulatory framework conditions

Health and Safety Executive (HSE):

Construction: CDM Regulations

<http://www.hse.gov.uk/construction/cdm/2015/index.htm>

Operations: Various Directives from the HSE need to be complied with when operating a waste facility. Here are some examples:

Waste guidance <http://www.hse.gov.uk/waste/wish-guidance.htm>

Working time directive <http://www.hse.gov.uk/contact/faqs/workingtimedirective.htm>

Working at height <http://www.hse.gov.uk/toolbox/height.htm>

5.5.10 Support scheme used by the British demonstration plant "Fridays"

Friday plant is planned to be commissioned in 2018 and will have an installed capacity of 1,8 MW_{el}. It will convert 40.000 tonnes of poultry manure to about 4,6 Mm³ biogas with 55% CH₄ concentration, corresponding to 114 m³ biogas per ton of feedstock.

As Friday has been accredited in Qu4/2017, it uses the British RHI scheme as described above.

5.5.11 Remarks

The British renewable energy support schemes (RHI) are fragmented and apparently require a smart combination of power and biomethane production including heat use to make a project commercially feasible.

Since UK is the only European country with a decreasing National Renewable Energy Action Plan (NREAP) target, the country has already achieved its target for 2020. In 2015, the British per capita production of biogas was 404 kWh compared to 284 kWh in 2005, an increase of 42% [16].

6 Legislation in Member States with Outreach plants

6.1 Croatia

6.1.1 Supporting legislation on renewable energy supply [22] [47]

In Croatia, electricity from renewable sources is promoted through a premium tariff and a guaranteed feed-in tariff, but legislation adopted is only for installations of less than 30 kW, allocated through tenders. So far, no tenders have been organised due to the delays in adopting the necessary secondary legislation. Preferential loans and subsidies for renewable energy projects are also provided. Renewable energy sources for heating purposes only are not promoted at national level.

The access of electricity from RES to the grid is regulated by the general legislation on energy and RES installations are given priority. Electricity from RES is subject to special provisions only in case of wind power plants.

A training programme for RES installers aims at promoting the development, installation and usage of RES plant in the electricity and heating sector.

For plants of more than 30 kW installed capacity, there are provisions for several support schemes, at least theoretically available:

- HBOR-Loans: The loans granted for the implementation of RES-E projects are part of the "environmental protection" loan scheme by the Croatian Bank for Reconstruction and Development (HBOR) in cooperation with commercial banks.
- FZOEU-Incentives: The Environmental Protection and Energy Efficiency Fund (FZOEU) offers financial incentives (interest-free loans, subsidies, financial assistance, donations) for the use of renewable energy sources.
- Premium tariff: RES-E plant operators, who have obtained the status of privileged producer and have won a public tender carried out by the Croatian Energy Market Operator, can receive a premium tariff in addition to the selling price, which was obtained on the electricity market

6.1.2 Restrictive legislation on use of digestate

Croatia, as well as EU members, have and are preparing their legislation in accordance with the valid EC Regulation 1069/2009, implementing Regulation 142/2007, and other regulations relevant to the specific product (Špicnagel, 2016).

The topic of soil fertilizer and soil improvers is determined and regulated by several regulations and strategies in the Croatian legislation, among which the most important are the Law on Agriculture (NN 148/2013) and the Law on Manure and Soil Improvers (NN 14/2014).

Term digestate is defined in Article 3. of the Regulation on by-products and the end-of-waste status (NN 117/2014), where the following is: "Anaerobic digestate is an organic fertilizer and/or soil improver, produced by anaerobic digestion of waste and which satisfies the requirements of Annex V., Part 2. of this Regulation."

Croatia does not have a separate legislative framework that would determine the issue of certification or placing on market organic fertilizers and soil improvers, and therefore uses the Regulation on the protection of agricultural land from pollution. As for the digestate, there is Regulation on by-products

and the abolition of waste status (NN 117/2014), designed by The Ministry of Environment and Nature. The new Regulation is currently being designed.

Detailed description of regulations

The Ministry of Environment and Nature enforced the Regulation on by-products and the end-of-waste status (NN 117/2014)

The general provisions in Article 1 regulate the content of the request for registration in the Register for the end-of-waste status and the Register of by-products, specific criteria for the end-of-waste status, including limit values of pollutants and harmful effects of substances or articles on the environment, specific criteria for by-products, the contents of a certificate for registration in the Register for end-of-waste status and Register of by-products, content and way of operating the Register for the end-of-waste status and Register of by-products, and the manner and conditions for implementing the European Union regulations setting out the criteria for end-of-waste status of each type of waste.

Article 3 The term "anaerobic digestate" defines an organic fertilizer and/or soil improver, produced by anaerobic digestion of waste which satisfies the requirements of Annex V, Part 2 of this Regulation. Specific criteria for the determination of by-products are defined in Articles 4 and 5 of the Regulation.

Special criteria for the end-of-waste status are also foreseen in Articles 6, 7 and 8. in Annex I - IX of the Regulation. Annex V specifies specific criteria for the end-of-waste status for anaerobic digestate.

- A) Criteria for waste being subject to a process of recycling stipulating that a person performing a waste recycling is obliged to ensure that wastes entering the recycling process comply with the specified type of waste (key number) and with heavy metal limits in accordance with Table 6.1, types of waste and additional waste conditions entering the recycling process for the production of anaerobic digestate; and that it is derived from separate collection of waste not including waste generated by the fractionation of mixed municipal waste.
- B) Criteria for the recycling process requiring the person performing the recycling must have a waste management license for the recycling activity. In the case of waste to which a special regulation governing the treatment of animal by-products applies, the person performing the recycling must possess an act or document allowing the performance of activities in accordance with special regulations governing the handling of animal by-products.
 - In all types of waste entering the recycling process, minor amounts of pollutants (eg. plastics) are allowed in the intake waste if they are separated in the recycling process.
 - The recycling process must be carried out in a way to prevent contact and contamination of the waste that has undergone a waste recycling process with the waste that has not undergone a recycling process, and that the shortest hydraulic residence time for anaerobic treatment in the biogas plant is 30 days at 35°C or 20 days at 55°C.
- C) Criteria for end-of-waste status if making sure that the anaerobic digestate contains heavy metals and certain organic substances in quantities less than the values defined in Table 6.1. The allowed content of heavy metals and certain organic substances in the anaerobic digestate, containing at least 15% by weight of organic matter in dry substance, contains no more than 2 glutamine vegetable seeds in a volume sample of 1 liter, does not contain *Salmonella* sp. in a sample of 25g of dry matter, contains a maximum of 1000 live bacteria (CFU) of *Escherichia coli* in a sample of 25g of dry matter, containing macroscopic primers of plastic, metal or glass in an amount of less than 2% by weight of the dry matter in the sample, mineral particles larger than 5 mm in an amount of less than 5% by weight of the dry matter of the sample.
 - That the person performing the recycling is obliged by a certified laboratory to ensure verification tests meeting the requirements in accordance with Table 6.2 Frequency of test of compliance.

Table 6.1. Maximum heavy metal concentrations allowed in waste feedstock

| Parameter | Maximum content (mg/kg in dry matter) |
|---------------|---------------------------------------|
| Cadmium (Cd) | 3 |
| Chromium (Cr) | 250 |
| Mercury (Hg) | 3 |
| Nickel (Ni) | 100 |
| Lead (Pb) | 200 |
| Copper (Cu) | 500 |
| Zinc (Zn) | 1800 |
| PAU | 6 |
| PCB | 1 |

Table 6.2 Frequency of compliance tests

| The amount of anaerobic digestate that is produced annually in tons | Number of tests |
|---|-----------------|
| to 1000 | 1 |
| from 1001 to 5000 | 2 |
| from 5001 to 10 000 | 3 |
| from 10 001 to 50 000 | 5 |
| more than 50 000 | 10 |

- D) Permitted uses of recyclable waste: anaerobic digestate intended for use in agriculture on soil not used for food production and in a manner defined by a special regulation that regulates fertilizer and soil improvers for use on forest or parkland, and for the purpose of landscaping or land reclamation, as well as for the production of final recultivation landfill layer and ensuring of being in compliance with the principles of good agricultural practice.

Regulation implementing the Nitrates Directive

On the basis of Article 88 of the Constitution of the Republic of Croatia, the Croatian Parliament passes the Decision on declaring the Law on Waters (NN 153/2009)

The Croatian Parliament passed the Decision on declaring the Law on Waters, where in Article 50 Nitrate Vulnerable Zones (NVZ) are determined where it is necessary to implement increased measures for the protection of waters against pollution by nitrates of agricultural origin. The Act on the Determination of Nitrate Vulnerable Zones referred to in Paragraph 1. of this article are adopted by the Government of the Republic of Croatia in accordance with the criteria of the regulations referred to in Article 41, paragraph 1 of this Law, and on the basis of continuous monitoring. The Act also defines the obligation to monitor the concentration of nitrates of agricultural origin in surface and groundwater in NVZ. In order to achieve a general level of protection against nitrate pollution from all layers of surface, including coastal and groundwater, the principles of good agricultural practice are applied, for which application of appropriate incentive measures may be adopted.

For areas determined by the regulation referred in Paragraph 2 of this Article as vulnerable, the Minister of Agriculture is responsible to implement Action Programmes with mandatory measures for a period of four years. The detailed content of the Action Programme that envisages the taking of compulsory measures is defined by the Minister of Agriculture. The act referred to Paragraph 2 of this article shall be reviewed at least every 4 years and, if necessary, amended and / or supplemented. The Code of Good Agricultural Practices shall be according to the regulations on agriculture.

The Nitrates Directive (Directive 91/676/EEC) of 1991 is a regulation of the European Union that protects water bodies against pollution with nitrates from agricultural sources. The Directive requires EU Member States to define areas that are vulnerable to pollution of nitrates from agriculture and to design and implement operational programs for the prevention of such pollution. In Croatia, in this respect, the most important is a Regulation of Good Agricultural Practice regarding the Use of Fertilizers (NN 56/08), which came into force on the date of entry of the Republic of Croatia to the European Union (1.7.2013).

The Regulation of Good Agricultural Practice regarding the Use of Fertilizers indirectly determines the density of livestock in agricultural areas, i.e. defines the largest quantity of nitrogen from organic manure that can be used to fertilize the agricultural area annually. In the initial four-year period, the maximum allowable amount of nitrogen input through organic fertilizers is 210 kg N/ha per year. After the initial four-year period, a permanent limit on the maximum allowable amount of nitrogen input by an organic fertilizer is 170 kg N/ha per year.

Good Agricultural Practice and Use of Fertilisers

The Ministry of Agriculture, Fisheries and Rural Development, based on the Article 11 Paragraph 2 of the Law on Fertilizers and Soil Improvers (NN 163/2003, 40/2007), the Minister of Agriculture, Fisheries and Rural Development implements the Regulation on Good Agricultural Practice in the use of fertilizers (NN 56/2008)

Article 1 of this Regulation lays down the general principles of good agricultural practice in the use of fertilizers, the period during which the application of fertilizers on agricultural soils is prohibited, the method of application of fertilizers on slopes, water-saturated soil, flooded, frozen or snow-covered soil, fertilizer application near watercourses, mineral and organic fertilizer application methods, size and properties of manure tanks.

Conditions of use and treatment of manure defined by this Regulation in areas which are declared vulnerable under the Decision on Areas Affected to Eutrophication and areas vulnerable to nitrates defined in the Law on Waters (NN 107/1995, 150/2005) are binding and in other areas that are not declared vulnerable are considered as recommendation.

Articles 5 – 11 determines methods for the use of nitrogen fertilizers.

Article 5 states that nitrogen fertilizers are applied to the soil when suitable for agricultural operations, and defines conditions where fertiliser application is prohibited, e.g. flooded, frozen or snow-covered soils. Machines for fertilizer application must fulfill all technical requirements to ensure controlled and proper application of fertilizers with minimal losses. In protected zones and close to water reservoirs, which are used or intended for public water supply, the fertilization of agricultural land underlies specific restrictions.

Article 6 states that the amount of manure and the method and time of application must comply with the provisions of this regulation; during one calendar year, the farm can fertilize the agricultural area with manure to the following limit values of application of nitrogen: 210 kg/ha nitrogen N in the initial four-year period and 170 kg/ha nitrogen N, after the first four-year period; manure must be applied in such a way that nitrogen losses are minimized; in order to reduce the losses of nitrogen by application of manure, the following practices are recommended:

- Fertilization with manure is carried out in such a way as to prevent ammonia evaporation and it is necessary to take into account the stage of vegetation, time intervals as well as temperature and humidity of air
- On unsown areas it is necessary to work the manure into the soil as soon as possible
- Manure should be evenly distributed over the surface of the soil
- Mix the slurry before fertilization.

The amount of nitrogen contained in manure from the annual production of domestic animals converted into LSU (per animal) is defined in Table 2 of the Appendix to this Regulation.

Article 7 states that for the purpose of reducing the losses of nitrogen by elution and evaporation it is prohibited:

- Fertilization with manure and slurry on all agricultural areas, regardless of the coverage from December 1 to March 1
- Fertilization with slurry and manure spread on the surface without injecting or working it into the soil on all agricultural areas from May 1. to September 1
- Fertilization of raw manure on all agricultural areas from May 1 to September 1
- Fertilization of mineral fertilizers with nitric nitrogen on all agricultural areas from November 1 to February 1; it is exceptionally permitted to use urea ammonium nitrate (UAN) on harvest residues.

From the harvest until the beginning of the fertiliser free period referred to in Paragraph 1 of this article, by applying mineral fertilizers, the amount of nitrogen on light (sandy) soils shall not exceed 40 kg/ha and on heavy (clay) soils 80 kg/ha.

Article 8 states that the use of manure is prohibited:

- In the neighbouring zone of sanitary protection of sources, unless otherwise specified by regulations governing water management
- On water-saturated grounds
- On snow-covered grounds
- On frozen soils and land
- In the production of vegetables, berry fruits and medical herbs, within 30 days before the maturation and harvest
- Mixed with waste sludge or compost from waste sludge
- Manure from farms where diseases caused by pathogens

The use of sludge and slurry is prohibited:

- In the neighbouring zone of sanitary protection of sources, unless otherwise specified by regulations governing water management
- Within 25 m from wells
- Within 20 m from lakes
- Within 5 m from other water courses,
- On slopes towards watercourses, with a gradient of more than 10% at distances of less than 10 m from watercourses.

Article 9 states that the maximum amount for application of manure and slurry on agricultural surface is laid down in Table 3. The content of nitrogen, phosphorus and potassium in manure and the maximum amount for the application of fertilizers, the Annex to this Regulation, and outside the vegetation period (October - April), it is allowed to apply a maximum of 50% of the annual quantity.

Article 10 stipulates the conditions for manure storage:

Storage tanks are built to prevent groundwater and surface water pollution and to preserve the fertilising value of manure. Tanks must be impermeable, prevent spills, flushing or leaking of manure into the environment.

- Manure storage must be provided for a minimum of six months
- Farms growing animals in boxes on a bed or some other surface (rubber mats, sand, sawdust) must build structures for storing manure. Holdings with excessive number of animals in relation to land application areas without sufficient storage capacities can contractually transfer manure storage to holdings with excess storage capacity

- Using manure for the production of renewable energy, significant savings in capacities needed for the storage of manure and energy for heating rooms, technological waters, gas, electricity, etc. are possible.

Article 11 states that if manure fertilization with livestock manure cannot be carried out in accordance with Article 6 of this Regulation due to insufficient agricultural areas for application, the holding must dispose of excess manure by:

- Fertilization of agricultural land of another holding on the basis of a contract
- Processing of manure to bio-gas, compost, substrates and other suitable products
- Disposal of manure in other lawful ways.

The Croatian Parliament, pursuant to Article 88 of the Constitution of the Republic of Croatia, enforces a decision on the Law on Manure and Soil Improvers (NN 163/2008).

In the general provisions of Article 1 this legal act regulates the quality, quality control, marking, trading, handling and monitoring of fertilisers (mineral and organic) and soil improvers, and the production and monitoring of organic fertilisers and soil improvers.

In Croatia there are currently no regulations regarding phosphorous (P) use and catch crops. Farmers in Croatia typically use crop rotation.

Relevant links:

https://narodne-novine.nn.hr/clanci/sluzbeni/2014_10_117_2217.html
http://www.savjetodavna.hr/adminmax/File/vijesti/kodovi%20za%20tisak_web.pdf
https://narodne-novine.nn.hr/clanci/sluzbeni/2009_12_153_3744.html
https://narodne-novine.nn.hr/clanci/sluzbeni/2008_05_56_1937.html
https://narodne-novine.nn.hr/clanci/sluzbeni/2003_10_163_2346.html
https://narodne-novine.nn.hr/clanci/sluzbeni/2007_04_40_1344.html

6.1.3 Remarks

For further information on supportive regulation for renewable energy supplies:

Hrvatski operator tržišta energije (HROTE) – Croatian Energy Market Operator

<http://www.hrote.hr/>

Phone: +385 1 63 06 700

Mail: hrote@hrote.hr

6.2 Denmark

6.2.1 Supporting legislation on renewable energy supply [28] [48]

In Denmark, electricity from renewable sources is mainly promoted through a premium tariff and net-metering. The premium tariff for offshore wind parks is awarded through tenders. Renewable energy sources for heating purposes are exempt from the tax obligations on the production, supply and use of energy sources. The use of biogas for heating purposes is supported through a direct tariff. The main incentive for renewable energy use in transport is a quota system. Selling of biogas for transport purposes is supported through a direct tariff.

Access of electricity from renewable energy sources to the grid shall be granted according to the principle of non-discrimination. Regarding the use of the grid, renewable energy shall be given priority. The connection of a heat generation plant to a district heating network in Denmark always involves grid development, since the construction of a plant must occur simultaneously with the development of the district heating grid.

Plants using pure biogas or gas from gasification – the maximum subsidy plus Bonus is: DKK 793/MWh (EUR 110/MWh) net price indexed and calculated every year on 1 January.

The Bonus is DKK 260/MWh (EUR 35/MWh), variable and depending on the gas price of the previous year plus DKK 100/MWh (EUR 50/MWh) until the end of 2019.

The plant operator may opt for a maximum subsidy of EUR 110/MWh plus a fixed Bonus of EUR 60/MWh up to a total aid for the project of equivalent to EUR 15 million.

Similar feed-in premiums apply to co-firing plants.

6.2.2 Restrictive legislation on use of digestate [49]

The use of manure and digestate in Denmark and the implementation of the Nitrates Directive are jointly governed by the Ministry of Agriculture and the Ministry of Environment (Danish EPA) by several orders and acts. In the following current acts and orders (1-8), the Danish implementation, which applies to the whole territory, of both the code of good agricultural practice and the measures to be included in the action programme can be found:

1. Act on Environmental protection no.1189 (27/09/16) as amended (until August 2017)
2. Consolidated Act on environmental approval etc. of commercial livestock/ Act on commercial livestock and use of fertiliser etc. no. 442 (13/05/2016) and no. 256 (21/03/2017) as amended
3. Order on commercial livestock, livestock manure, silage, etc. no. 1324 (15/11/16) as amended
4. Consolidated Act on agricultural use of fertiliser and plant cover no. 388 (27/04/16) and no. 433 (03/05/2017) as amended
5. Order on agricultural use of fertiliser in the planning period 2016/2017 no. 1055 (01/07/16) as amended
6. Order on plant cover and cultivation-related measures no. 1056 (01/07/16) and subsequent changes as amended
7. Consolidated Act on Water extraction no 125 (26/01/2017)
8. Order on monitoring the status of surface water, ground water and no. 1001 (29/06/2016) The consolidated Act on charge of nitrogen contents in fertilisers has a supplementary effect to the legislation 1 -8:
9. Consolidated Act on charge of nitrogen contents in fertilisers no 1357 of 18. November 2016

Overview of the Danish Nitrates Action Programme

The whole country is considered as a nitrate vulnerable zone and measures to improve water quality have been in place since 1985. The crop season extends from 01/08 to 31/07.

The Action Programme is laid down in orders on livestock, livestock manure, silage, digestate and other organic fractions as well as orders on plant cover and cultivation, use of fertilisers and water extraction. Designated nitrate classes are applied to very vulnerable and vulnerable Natura 2000 areas according to the map in figure 7. The map is used for identification of areas, where there the number of LU/ha (The harmony rules) is reduced when a livestock is approved. 85% of the Danish area drain-off to Natura 2000 areas.

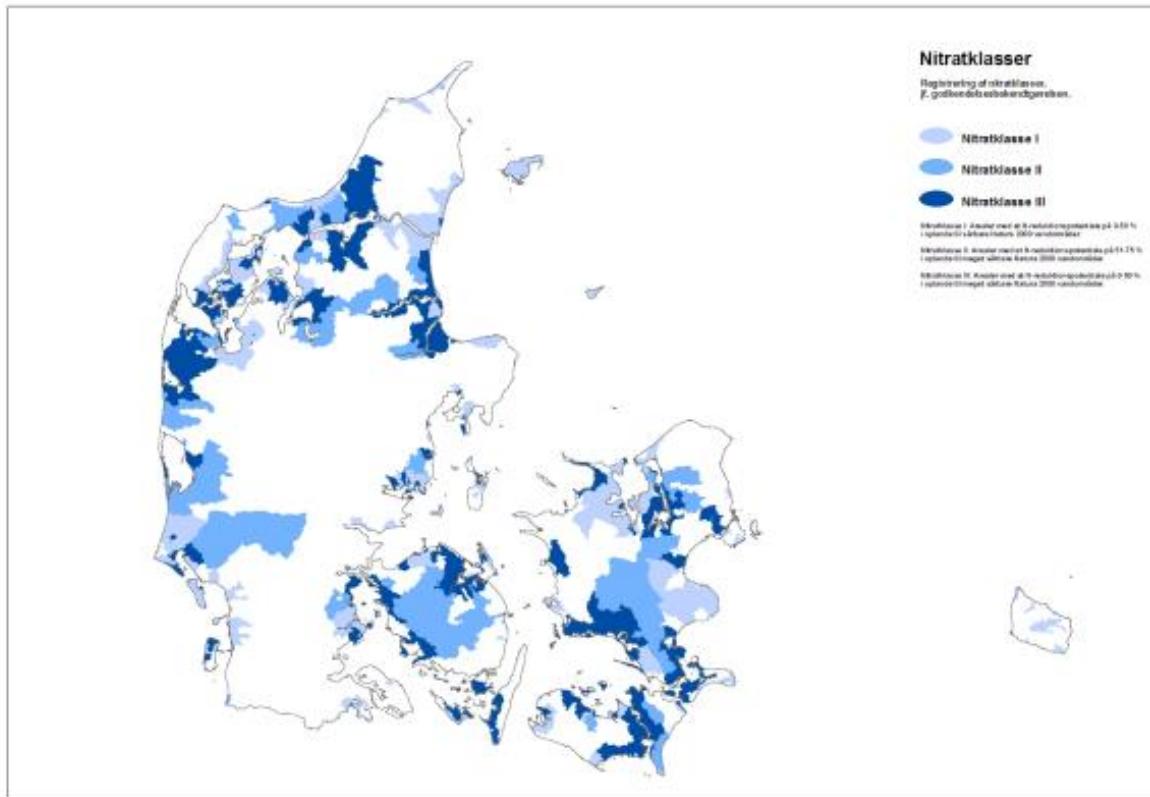


Fig. 7 Danish nitrate classes

The ordinances

- i) Restrict periods of application,
- ii) Regulates distance to surface waters
- iii) Application under determined soil conditions (frozen, water saturated, etc.)
- iv) Application under risk of surface loss;
- v) Requirements related to animal housing preventing the risk of water pollution,
- vi) Requirements to slurry and fertiliser storage facilities in terms of loss prevention,
- vii) Requirements to methods of application - only trailing hoses or shoes or direct injection;
- viii) Land use management through the mandatory fertiliser accounting system including limiting fertiliser application to the quota stipulated by the ministry;
- ix) A general requirement to use catch crops for approx. 240,000 ha used by holdings applying manure
- x) Farmers needing permission for water intake for irrigation
- xi) Requirements for slurry and solid manure storage in terms of capacity, covering at least 6 months – available storage capacity covers at least 9 months
- xii) Restriction to application only to crops with a nitrogen, phosphorus and potassium standard
- xiii) Restriction to maximum application of 170 kg N/ha except for use of derogations under determined conditions (up to 230 kg N/ha)
- xiv) Restriction of application in vicinity of lakes and coastal waters
- xv) Restriction to maximum slurry/manure/digestate application corresponding to 1.7 livestock units (LU) per hectare

Overview of the Danish Nitrates Action Programme

One central objective of the Danish agricultural regulation is to optimize the Nitrogen cycle within the agricultural production system by increasing efficiency of (re)using nutrients from organic sources, as e.g. animal slurry, within the system and by limiting the introduction of chemical fertilisers to the system to a maintainable amount, while reducing losses from the system to an environmentally compatible level.

Harmony Rules

Harmony rules set requirements for the minimum size of the area a livestock holding must have available for spreading livestock manure from the respective livestock production. The requirement is defined as a limitation in livestock units per hectare (LU/ha), based on the content of nitrogen in the respective livestock manure (ex. storage), where 1 LU is equal to 100 kg N in livestock manure in the best modern production system with the lowest ammonia emission. Thereby the harmony rules implement the Nitrates Directive's requirement to limit the amount of manure per hectare to max. 170 kg N, corresponding to 1.7 LU/ha in the best production system. The new harmony rules (effective from August 2017) replace the more restrictive harmony rules (1.4 LU/ha for pig farms) effective between 2002 and 2017.

The standard nitrogen quota at farm level

The yearly amount of nitrogen that is permitted at farm basis is calculated taking into account the characteristics of the area and is based on a balance between the foreseeable nitrogen requirement of the crops and the nitrogen supply to the crops from the soil and from fertilization. The optimal relationship between the nitrogen requirements of the crops and nitrogen supply is set every year on basis of trials. This is done for four different soil types, covering the range of typical soil types in Denmark and for irrigated sandy soil. In addition, the relationship between prices for nitrogen and crops is taken into account, and the economically optimal fertilization rate for the respective crop is calculated. Based on the composition and distribution of crops and soil types at farm level as well as the crop-specific nitrogen standards (in total more than 250 different standards), the nitrogen demand for economic optimal production is automatically calculated for each farm. The nitrogen supply to the crops from the soil is taken into account in several ways. As different amounts of nitrogen residues remain after the harvest of a crop, this is taken into account, when the standard of the following crop is set.

Consequently, the individual standards are differentiated with regard to the residual effect of the previous crop, which has to be withdrawn from the crop's standard the following year. Under the principle of having a balance between the uptake of nitrogen in the plants and the nitrogen supply to the crops, the farm nitrogen quota is adjusted every year, according the actual amount of plant available nitrogen in the soil, called "the nitrogen prognosis". SEGES, The Knowledge Centre for Agriculture and the Danish Pig Research Centre in cooperation with Aarhus University provide the result on whether the adjustment is negative or positive in specific geographical areas in the respective year, due to yearly variations in temperature and extent of rainfalls in the wintertime. Hence, the overall nitrogen standard quota predominantly depends on the specific crop, but also on the type of soil, the pre-crop, climatic conditions, precipitation and irrigation.

The total use of livestock manure, chemical fertilisers and other fertilisers must not exceed the standard nitrogen quota on farm level. Any surplus application of nitrogen fertilisers compared to the quota is regarded as a violation to the rules. Controls are performed at farm level, where all parameters of the production are checked.

The revised phosphorus regulation: phosphorus ceilings at farm level

Introduction of direct P ceilings, at different levels throughout the country, depending on geographical location (and livestock manure type):

- General P ceilings, which cover at least 76 % of the area.
- Stricter ceilings, which cover up to 24 % of the area, covering catchments of P-vulnerable aquatic environment.

The revised phosphorus regulation addresses all types of fertilisers, i.e. all types of organic fertilisers (manure, biogas digestate, degassed plant biomass, sludge from sewage water treatment, etc.) and industrial/mineral fertiliser. Applied phosphorus from the various types of fertilisers will be registered through the fertiliser accounting system like nitrogen has already been registered from the different types of livestock manure in the previous years. The direct P ceilings in the period 2017-2022 are shown in the following table 6.1:

Table 6.1 Previous, current and future P limitations in Denmark

| kg P/ha ¹ | Harmony -rules (2015) | 2017-2020 (strict ceilings from 2018) | | 2020-2022 | |
|-----------------------|-----------------------|---------------------------------------|----------------------|-----------------|--------------|
| | | General (76% of area) | Strict (24% of area) | General (76%) | Strict (24%) |
| Poultry | Up to 55 | 43 | 30 | 35 ² | 30 |
| Mink | 43 | 43 | 30 | 35 ² | 30 |
| Slaughter pigs | 34 | 39 | 30 | 35 | 30 |
| Sows and piglets | Up to 37 | 35 | 30 | 35 | 30 |
| Cattle | 27 | 30 | 30 | 30 | 30 |
| Derogation farms | 36 | 35 | 35 | 35 | 35 |
| Organic waste | 30 | 30 | 30 | 30 | 30 |
| Industrial fertiliser | No limit | 30 | 30 | 30 | 30 |

¹ Dispensation opportunity for some special production systems, e.g. closed systems like greenhouses.

² The ceilings for mink and poultry will already apply from 2019 (until 2022).

Depending on phosphorus concentrations in soils and after regular testing, the P-ceiling can be raised by up to 14 kg/ha, but only up to a maximum limit of 45 kg P/ha. P in soils is determined by the Olsen test. The recommended level of P is 2-4 mg P/100 grams of soil. For soils with this concentration of P, the amount of P applied by manure should be equal to the amount taken up by crops.

Phosphorus field balances are monitored as part of the national monitoring programme NOVANA that includes the Agricultural Catchment Monitoring Programme (LOOP). In this programme, the field balances for phosphorus including all types of fertilisers are monitored.

An additional "indicator system" is introduced that will allow for an approximation of the expected actual phosphorus application already during the respective planning period, using data from the Danish agricultural monitoring programme (LOOP), the national husbandry register (CHR) data from "Statistics Denmark" (concerning sales of phosphorus containing industrial fertiliser). Should either the indicator system or the new monitoring system show that the actual annual average phosphorus fertilization rate on agricultural soils in Denmark might exceed or has actually exceeded the levels given in Table 6.1, the ceilings, including the general ceilings for maximum phosphorus application will be reduced accordingly.

The fertiliser accounting system

Danish farmers, using livestock manure on their holding, may sign up with the Danish Register of Fertiliser Accounts. Signing up is mandatory for a large proportion of holdings, while it is voluntary for other farmers, depending on their annual monetary turnover and amount of livestock manure at farm level. The Danish AgriFish Agency ensures the mandatory signing-up of farmers to the Fertiliser Accounting System's register through an automatic IT-check based on the Danish Central Business Register (CVR) data of all farms.

Every year, the Danish AgriFish Agency publishes guidelines to the farmers, which include Nitrogen fertilization standards for all individual crops, the standard nitrogen and phosphorus contents in different livestock manure types and the required minimum nitrogen efficiency rate. Based on this compiled

information, the maximum allowed total amount of nitrogen and phosphorus that may be used on the farm within the respective cropping season is automatically calculated.

By the end of March each year, farmers are obliged to submit their annual fertilization account containing the following information on the previous cropping season (August-July) to the Danish AgriFish Agency for registration and control: i) Total area and harmony area of the holding, ii) The automatically calculated nitrogen quota (max. total amount of N to be used for fertilization, see also details below), iii) The automatically calculated phosphorus ceiling (max. total amount of P to be used for fertilization, see also details below), iv) Use of nitrogen and phosphorus for fertiliser: livestock manure, mineral/inorganic fertilisers as well as other organic fertilisers (e.g. sewage sludge); v) The compulsory utilisation efficiency of nitrogen in livestock manure and other organic fertilisers; vi) Storage of livestock manure, mineral fertiliser and other organic fertilisers from one year to the next; vii) Information on livestock manure contracts (i.e. written agreements on import/export of manure from/to holding); viii) Information on livestock density ix) Area with catch crops x) Information about using the derogation from the Nitrates Directive.

Accounting for livestock manure in the fertiliser accounting system

The content of nitrogen and phosphorus in livestock manure must be calculated using nationally defined standards. Standards are set for different types of livestock, taking the housing system into account. The residual nitrogen supply from manure application in previous years is also included in the manures efficiency, which has to be accounted for.

Table 6.2 Accounted efficiency rate of manure for N-fertilisation

| Type of manure | Efficiency |
|---|------------|
| Pig slurry | 75% |
| Cattle slurry | 70% |
| Mink slurry | 70% |
| Poultry slurry | 70% |
| Liquid fraction after slurry separation | 85% |
| Deep litter | 45% |
| Solid manure | 65% |

Efficiency requirements can only be realized, if losses of nitrogen, primarily in form of ammonia are avoided to a large extend during spreading. In this way, these provisions promote the investment in and use of advanced slurry application techniques (no use of nozzles). Livestock manure from grazing animals must be regarded as applied with an N efficiency of 45-65%. Furthermore, livestock manure can only be applied in areas where it may and can be applied with machinery.

The use of chemical fertilisers and other fertilisers (e.g. sewage sludge) must also be accounted for in the Fertiliser Accounting System. Retailing companies, delivering nitrogen and/or phosphorus fertilisers to farms in the register, are obliged to report yearly to the Danish AgriFish Agency about the deliveries (information about farm (VAT numbers), quantity as well as content of N and P, respectively) and this information will automatically be transferred to the respective fertiliser accounts.

Revised regulation of livestock holdings and the use of manure

All establishments, expansions or modifications of livestock holdings must give notice or receive a permit complying with the Environmental Approval Act of Livestock Holdings. The act sets minimum thresholds to ensure environmental protection in terms of odour and ammonia emissions from livestock animal housing systems.

The local authorities assess the environmental impact on a local and national scale together with the minimum requirements. If the approval is given, it will be on a set of conditions that ensures no significant deteriorating effect on the surrounding environment. The Danish parliament has adopted a

new and more emission-based regulation of livestock holdings when granting permits to installations for animal husbandry to be implemented in 2017. The regulation ensures a simpler and more flexible regulation designed as a permit based on an environmental assessment of the production area of livestock in the stable. Besides being simpler and easier to enforce and control, this method targets the emissions of ammonia from livestock holdings in a more precise way.

As a prerequisite for this emission-based regulation of permits for installations for animal husbandry the Danish Parliament has adopted a separate regulation of the actual installations for the animal production sites (stables, storage vessels i.e.) and the regulation of the spreading of the livestock manure on arable land. Thus, this revision of regulation implies that the permit for the holding from 2017 does not contain any limitations regarding the spreading of livestock manure, which are regulated through comprehensive, general environmental rules instead.

Since the leaching of nitrate from livestock manure is more pronounced than the nitrate leaching from commercial fertilisers, the revised regulation of the spreading of livestock manure will also include additional requirements to ensure a reduction of nitrate leaching. This regulation consists of individual requirements for establishing catch crops designed for each holding based on information from the fertiliser accounting system instead of individual assessments by the local municipalities like previously.

The individual requirement to establish catch crops for holdings using organic manure such as livestock manure is aimed at ensuring the sufficient protection towards nitrogen leaching to sensitive Natura 2000-areas in catchment areas, where the amount of applied organic manure has increased since 2007 and at contributing to the reduction of nitrogen leaching to coastal water bodies, where a reduction of nitrate leaching is necessary in order to obtain the environmental objective according to the RBMP's. It is the aim of this catch crop scheme to ensure a level of environmental protection that corresponds to the level of protection ensured by the present system for livestock permits at a national level.

This catch crop scheme has been introduced from August 2017. It is expected that the area covered by the catch crop scheme for holdings using livestock manure will cover approximately 34.000 hectares by the time the scheme is fully implemented. These catch crops are mandatory and are not compensated. The requirement may be fulfilled by using alternative measures such as establishing energy crops, early establishment of winter crops etc., cf. the Order on plant cover and cultivation-related measures. This catch crop scheme is included in the Nitrates Action Programme and described in this section.

Controls of farms

Approximately 90% of all Danish farmers must submit data to the Fertiliser Accounting system each year, which is administrated by the Danish AgriFish Agency. All submitted fertiliser accounts are automatically checked at submission by the IT-system, according to a set of previously defined risk criteria. Besides this fully automatic administrative control, holdings are controlled administratively, assuring that 2.5% of all farms are controlled every year.

The holdings registered in the fertilizing accounting had an average farm area of 62.9 ha per holding, covering 96.1 % of the agricultural area. The non-registered farms are obliged to pay a tax on purchase of mineral and processed organic fertilisers of DKK 5.00 (= approx. 0.67 €) per kg N. This puts a significant restriction on their use of fertiliser.

The councils of the Danish municipalities are the supervisory authority for environmental inspections on all agricultural farms. The municipalities must inspect all livestock farms of more than 3 LU regularly (every 3-6 years. Danish farmers must ensure inspection of their slurry tanks ($>100\text{ m}^3$) at least every 10 years.

River basin management plans

Additional measures in the context of the Water Framework Directive are gradually implemented, among others: establishment of wetlands, afforestation, improved wastewater management, acquisition of fish farms aiming at an additional reduction of N-losses of about 7000 tons of N per year.

6.2.3 Remarks

Until 2017, Denmark had Nitrate Action Programme limiting fertiliser use to quantities of 10-15% below the economic optimum (since 1998) and came down to 18% less than the optimum (estimated economic losses of €150 to 200M a year for the country). Significant reductions of protein contents in bread wheat created serious problems which were countered by a derogation for bread wheat. This system was finally abandoned allowing more flexibility and fertiliser use to the economic optimum with the new Action Programme enforced from 2017.

However, strict regulation and rigorous control of nutrient flows and farm performances is still enforced. In Denmark, 20 % of all slurry is acidified prior to land application. The technology is fully implemented in the Danish environmental legislation and is also admitted as a BAT technology for reducing ammonia emissions in the final draft of the BREF for the Intensive Rearing of Poultry and Pigs.

Further information on energy subsidies: <https://en.energinet.dk/>
Energinet.dk – Transmission System Operator
Phone +45 701 022 44, Mail: info@energinet.dk

Further information on digestate use: <http://eng.mst.dk/trade/agriculture/nitrates-directive/>
The Danish Environmental Protection Agency
Phone +45 72 54 40 00, Mail: mst@mst.dk

6.3 Finland

6.3.1 Supporting legislation on renewable energy supply [22]

Electricity price without tariff is ~40 €/MWh and with tariff 83,50 €/MWh (133,50 €/MWh if the total energy efficiency is 75 %, heat bonus 50 €/MWh)

- This support system will be ended in the end of 2018, meaning that the application must be before)
- The new system, currently under preparation will be based on competitive tenders: bidders who produce certain amount of renewable electricity with the lowest costs will be awarded with subsidies.
- Producers of renewable electricity will be granted access to the grid following non-discrimination principles.

Currently investment aid (~30%) is available for "new technology", meaning production of traffic fuel. Producers need to choose tariff or investment aid, and investment aid available for electricity production is lower than for traffic fuel production if granted.

The Investment aid under the new support scheme (max. 30%) for fuelling stations is also based on competitive bids against tenders. The bids will be scored according to economic efficiency and other criteria and support will be capped by the budget allocated to the tenders. The final conditions are still under elaboration, but the first tender is expected for autumn 2018.

Taxation

Biogas is exempt from excise tax.

National agricultural environmental aid system:

Rural Development Programme for Mainland Finland 2014–2020 [50]

National legislation of environmental compensation for agriculture

Over 95 % of farmers are committed to this compensation system; it gives rules for nitrogen and phosphorous spreading amounts/hectare depending on the plant and the characteristics of soil etc.

Nutrient surplus and deficiency areas in Finland

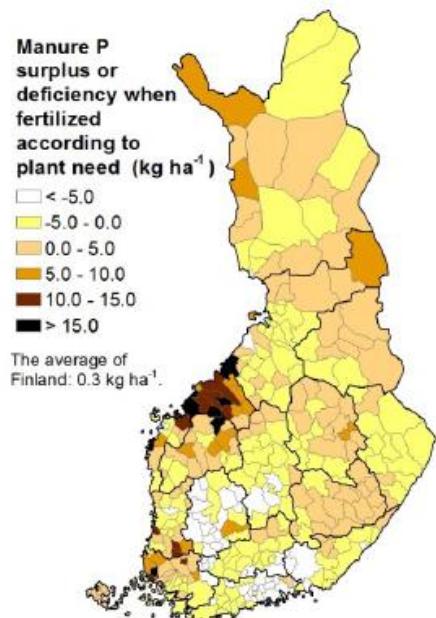


Fig 6.1 Nutrient surplus and deficiency areas in Finland (Source: Natural resources and bio-economy studies 26/2018)

6.3.2 Restrictive legislation on use of digestate

Building and operations of anaerobic digester are subject to the national environmental legislation. Among other regulations, environmental permits must be obtained before a plant can be built.

Nutrient framework/regulations

In Finland, fertilisation is determined by crop needs, phosphorus and nitrogen are administered as indicated by crop growth responses, taking the legacy nutrients in the soil into account. Maximum phosphate fertilization is 32 kg/ha.

Nitrate directive based national legislation

- Whole Finland is designated as nitrate vulnerable zone, no derogations,
- Manure and manure-based fertilisers: 170 kg N/ha
- Classification as manure if organic fertiliser contains >10% of manure
- Covered (solid or floating) storage capacities needed for 12 months
- Periodic field storage of manure is possible, albeit with several restrictions: field storage is possible only for material with >30% dry matter, not between 1 November and 31 March and not in groundwater sensible areas.
- No spreading of manure on cropland is possible between 1 November and 31 March
- No spreading on snow covered, frozen and/or water saturated soils.

National fertiliser legislation

- General requirements
- Group requirements

Groups

- Mineral fertilisers: Organic content <1%, nutrient concentration >3%
- Organic fertilisers: Animal and plant based, nutrient concentration >1%
- Soil conditioners: All materials, incl. all sewage sludge based organic fertilisers, e.g. digestate as such, different kind of composts, no requirements for nutrient concentration
 - Soil conditioners containing sewage sludge can only be used for cereals and grassland when planted with protection cereal crops. Vegetables cannot be grown on cropland during 5 years after sewage sludge containing fertilisers/soil conditioners have been applied
- Heavy metal limits for fertilisers/soil conditioners:
 - As 25 mg/kg DM (dry matter)
 - Hg 1 mg/kg DM
 - Cd 1.5 mg/kg DM
 - Cr 300 mg/kg DM
 - Cu 600 mg/kg DM
 - Pb 100 mg/kg DM
 - Ni 100 mg/kg DM
 - Zn 1500 mg/kg DM

6.3.3 Remarks

Gas network is only available in the southern part of Finland but biomethane (CNG/LNG) is a target product for heavy-duty transportation fuel.

6.4 France

6.4.1 Supporting legislation on renewable energy supply [22] [51] [52]

In France, electricity from renewable sources is promoted through a feed-in tariff, a premium tariff as well as through tenders for the definition of the premium tariff level. Additionally, tax benefits are also available. The generation of heat through renewable energy plants is promoted through several energy subsidies, tax regulation mechanisms as well as through a zero percent-interest loan. The main support scheme for renewable energy sources used in transport is a quota system. Furthermore, biofuels are supported through fiscal regulation.

The use of the grid for the transmission of electricity from renewable sources is subject to the general legislation on energy. There are no special provisions for electricity from renewable sources. As far as heating and cooling is concerned, public distribution of heat in France is a competence of the local or regional authorities. The procedure of grid connection is at the same time also the procedure for grid development, since the construction of a plant must occur simultaneously with the construction (development) of the district heating grid.

There are various policies aiming at promoting the development, installation and use of renewable energy installations in France, including training programmes, certification schemes or research programmes.

Electricity from anaerobic digestion

The amount of the feed-in tariff s is set as follows (Annex 1, Arrêté du 13 décembre 2016 biogaz):

- Biogas plants with a capacity of >80 kW: EUR 175/MWh
- Biogas plants with a capacity of >500 kW: EUR 150/MWh
- The values for biogas plants between 80 kW and 500 kW are calculated by linear interpolation.

Moreover, a bonus of EUR 50 per MWh can be granted for biogas plants using a share of at least 60% of livestock manure (Annex 1, Arrêté du 13 décembre 2016 biogaz).

Please note: from 1 January 2018 onwards, the amount of the feed-in tariff shall be decreased by 0,5 % on a quarterly basis (Annex 1, Arrêté du 13 décembre 2016 biogaz).

Energy crops must not exceed 15% in the feedstock mix calculated as average value during three years of operations.

Biomethane from anaerobic digestion

Contracts for 15 years with a reference tariff plus premiums.

- EUR 45-95/MWh for landfill facilities (lower values for plants >350 kWh installed)
- EUR 64-95/MWh for the other installations (lower values for plants >350 kWh installed)
- Premium for municipal waste and household waste: EUR 5/MWh.
- Premium for waste from agriculture and agri-food EUR 20-30/MWh, depending on flows
- Premium for sewage sludge EUR 1-39/MWh.
- Financial assistance may be granted on a case-by-case basis by the public authorities (ADEME, regional and departmental councils, the European Fund, etc.).

6.4.2 Restrictive legislation on use of digestate [53]

In France, Nitrate regulation has been jointly drawn up by the Ministry in charge of Environment and by the Ministry in charge of Agriculture to implement Directive 91/676/EEC.

National legislation is laid down in Decree of 10.10.2011 (new architecture), Decree dated 07.05.2012 (regional AP, reinforcements), Interministerial order dated 20.12.2011 (Regional Expert Group on Nitrates – GREN – role, composition, etc.), Interministerial order on national AP dated 23.10.2013 amending order dated 19.12.2011 as well as Regional Prefectoral orders.

A relatively large percentage of the utilized agricultural area of France (57%) has been designated as nitrate vulnerable zone as shown in figure 8.

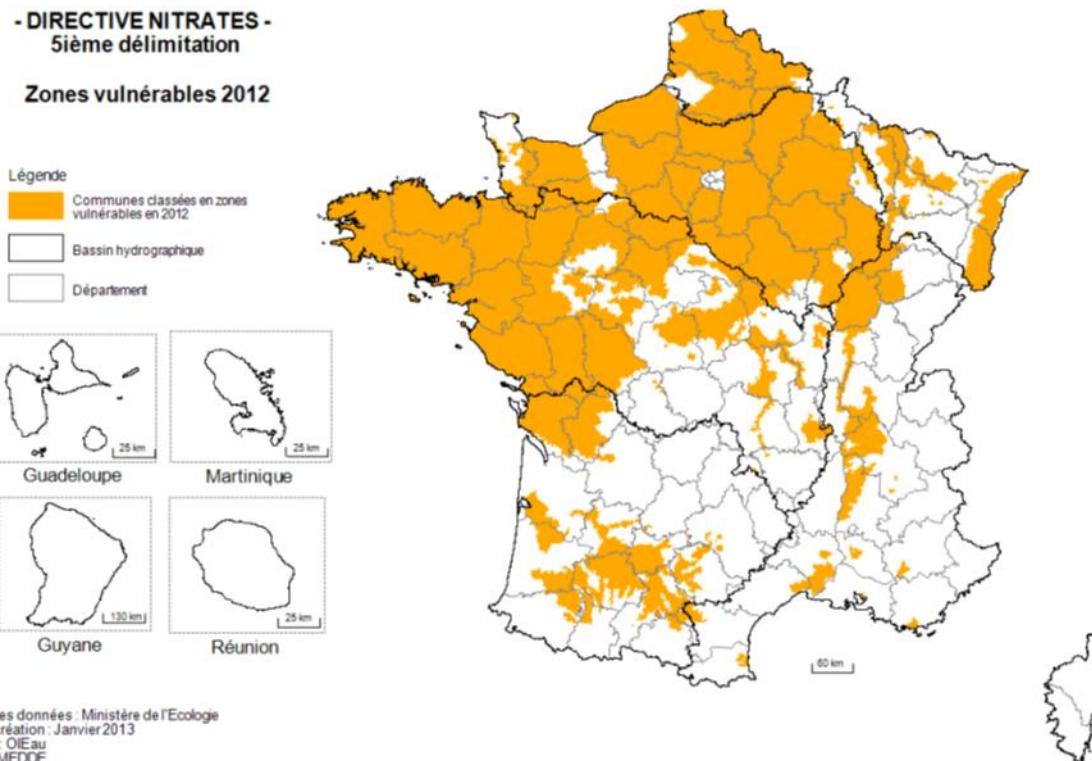


Fig. 8 Nitrate vulnerable zones (NVZ) in France

National Nitrate Action Programme (AP)

The AP focuses on 8 measures:

- i) Prohibited periods for applying fertilisers
- ii) Minimum storage capacity for livestock manure
- iii) Limitation of fertiliser application based on nutrient (fertilization) balance
- iv) Provisional fertiliser plan (estimation) and logbook by the farmer
- v) Limitation of 170 kg N/ha of utilized agricultural area per year for application of livestock manure
- vi) Specific limitations for application of fertiliser regarding the location and soil conditions (near watercourses, on sloping land, waterlogged, flooded, frozen or snow-covered land)
- vii) Soil covering to absorb soil nitrogen
- viii) Planted strips along watercourses

At the regional level, national measures may be reinforced taking into account agro-pedo-climatic characteristics and nitrates pollution in specific areas, in detail:

- i) Tougher restrictions with regard to measures i), iii), vii) and viii) of the national AP
- ii) Measures targeted on specific zones (water catchments where nitrate concentration exceeds 50 mg/l, watershed with green algae blooms, high density livestock zones)
- iii) Enhancing the role of technical and scientific support in the regions ("GREN" regional expert groups on nitrates under the authority of the "préfet de la région")

Regulations to N-fertiliser application in detail

Three different types of fertilisers are defined:

Type I = high C/N ratio and low proportion of mineral nitrogen (farmyard manure of any livestock except poultry, some standardised composts);

Type II = low C/N ratio with organic nitrogen (slurry, poultry manure, unprocessed digestate);

Type III = mineral fertiliser.

In essence, application of manure and digestate is forbidden between 1 July and 15 January with exceptions if catch crops are planted which allow additional periods of application from 15 days before seeding to 20 days before harvesting the catch crops.

The national AP determines a storage capacity expressed in months of manure production, depending on the type of livestock farming – cattle and sheep, dairy or not, pigs or poultry - and on the location – zone A = almost all of Brittany, Pays-de-la-Loire, Basse-Normandie; zone B = Alsace, Dordogne, Aquitaine, Haute-Normandie, Ile de-France, Picardie, Poitou-Charentes; zone C= Bourgogne, Rhone-Alpes; zone D = Auvergne. The required storage capacities range from 4 months for manure of dairy cattle (goats and sheep) spending more than 3 months outside buildings in Brittany to 7 months for slurry of dairy cattle (goats and sheep) in the Auvergne spending less than 3 months outside buildings. For pig and poultry manure the minimum storage capacity is 7 months and for pig and poultry slurry 7.5 months in all zones.

Compact manure (with a lot of litter) stored at least 2 months under the animals or on a storage platform and not likely to cause liquid leaks as well as dried poultry manure without litter (at least 65 % dry matter) can be stored on agricultural plots under the following conditions:

- Where manure application is allowed and in areas unlikely to be flooded and out of high infiltration zones (karst);
- Storage duration limited to 10 months;
- The quantity of manure stored must correspond to the amount of fertilisers applicable on the plot
- No storage on the same location for the next 3 years;
- For poultry manure, the heap has to be covered by a waterproof gas-permeable tarpaulin.

Land application of fertilisers must be based on a balance between (i) the foreseeable nitrogen requirements of the crops, and (ii) the nitrogen supply to the crops from the soil and from fertilisation (organic and mineral)

Farmers must calculate the nitrogen balance before application according to a method defined in the AP respecting several national rules like target yields, soil nitrogen content and more detailed regional guidelines requiring fertiliser application with respect to nutrient uptake of each culture set by regional expert groups (GREN) and adopted by regional order. A detailed brochure (in French, Calcul de la fertilisation azotée) is available under <http://www.comifer.asso.fr/index.php/bilan-azote.html> [53]

For each agricultural plot (fertilised or not), the farmer must:

- Have a provisional fertilisation plan summarizing the main elements of the calculation of the nitrogen dose to be applied in accordance with national and regional operational guidelines (measure 3°)
- Have and keep up to date a logbook with information on implemented cover, fertiliser application, type of management of the period between main crops and catch crops implantation and destruction.

The logbook must also contain information on livestock and on manure exchange with other farmers (transfer slips recording information on the type of product, the quantity of N exchanged).

Limitation of the quantity of nitrogen from livestock manure spread on the farm each year:

170 kg N/ ha of Utilised Agricultural Area, without prejudice to respect of the fertilisation balance (measure 3°), and of fertilisation bans (e.g.: N fixing crops, unfertilised strip along water courses, etc.).

The calculation of nitrogen from livestock manure on the farm is based on the formula

- number of animals x amount of available N produced per animal
- plus, import of nitrogen from livestock manure coming from other farms
- minus export of nitrogen from livestock manure leaving the farm
- minus nitrogen from livestock manure eliminated through processing (e.g. denitrification or methanisation plant)

The amount of N produced by animal is set in the national AP's table for each type of animal following the calculation:

- N = excreted nitrogen
- minus gaseous losses of nitrogen in livestock building and during storage.

So far, France has not applied for any derogations.

Specific restrictions apply to manure/digestate application

- Forbidden near water courses (min. distance 35 m or – in case of a 10 m wide, unfertilised grass strip, 10 m)
- Forbidden on slopes steeper than 15% or steeper than 20% with a 10 m wide, unfertilised grass strip downhill with exceptions for perennial crops and permanent grassland
- Forbidden on waterlogged or flooded land
- Forbidden on snow-covered or frozen land, except for compact manure, compost or livestock manure and other organic products applied to prevent soil erosion.

The national AP includes rules for soil covering to prevent nitrogen leaching in rainy seasons requiring

- Soil cover prior to seeding spring crops
- After oilseed rape and prior to seeding crops in autumn and winter; oilseed rape regrowth is allowed
- Chemical destruction of cover is not allowed (with some exceptions)

Along water courses, lakes or ponds covering at least 10 ha

- permanent grass and/or wooded strips must be set up and maintained along
- the strip must not be fertilised or treated with pesticides (more regulations apply)

6.4.3 Remarks

No limitations regarding application of phosphorus have been identified.

Updated information on energy related support schemes:

Ministère de la Transition Écologique et Solidaire

Phone: +33 14 081 212 2

<https://www.ecologique-solaire.gouv.fr/>

<http://www.injectionbiomethane.fr/>

RENEWABLE GAS FRENCH PANORAMA 2016

Ministry of Agriculture, Agrifood and Forestry, Conseil général de l'alimentation, de l'agriculture et des espaces ruraux (CGAAER): <http://agriculture.gouv.fr/>

Comifer Comité Français d'Etude et de Développement de la Fertilisation

Immeuble Le Diamant A

14 rue de la République

92800 PUTEAUX - France

<http://www.comifer.asso.fr/fr/>

6.5 Ireland

6.5.1 Supporting legislation on renewable energy supply [22] [54]

Ireland has a target of 16% of gross final energy consumption to come from renewable sources in 2020, with sub-targets for the electricity (40%), transport (10%) and heat (12%) sectors. In 2016, we have already reached a level of 6.8% (with a target of 12%) in the heat sector. The Government has introduced a range of measures across the electricity and transport sectors to help meet our targets, and a support scheme for renewable heat will expand this suite of support measures into the heating sector.

The scheme will support projects through one of the following support mechanisms:

- i) An on-going operational support (paid for a period up to 15 years) based on useable heat output in renewable heating systems in new installations or installations that currently use a fossil fuel heating system and convert to using the following technologies:
 - Biomass heating systems
 - Anaerobic digestion heating systems
- ii) Other technologies and methods of support continue to be under consideration (including biomethane grid injection) for subsequent phases of the scheme.

The scheme will support projects through one of the following support mechanisms:

This support consists of a multi-annual payment (for a period of up to 15 years) based on defined tariffs. The maximum tariffs paid will be:

- EUR 56.60/MWh of energy produced from biomass heating systems and
- EUR 29.50/MWh of energy produced from anaerobic digestion heating systems

The tariffs paid will reduce with increasing output reflecting the economy of scale associated with larger systems.

Each tariff will set the amount of support that the Scheme participant will receive in respect of each unit of heat energy used for an eligible purpose. The tariff level for a particular project will generally be fixed for the period of support. Tariff levels will not be linked to indexation. However, adjustments may be applied to prevent windfall gains.

It will be mid 2018 before the scheme is open for applications. No further information is available currently.

6.5.2 Restrictive legislation on use of digestate [55] [56]

The Ministry of Agriculture (Agriculture, Food and Marine Department) is responsible for implementing the Nitrates Directive. The Ministry of Environment relies on the Environmental Protection Agency and regional communities to implement the water policy. Public agricultural research and advice are entrusted to TEAGASC (Irish Agriculture and Food Development Authority). There is a large private farm advisory sector.

Regulations governing nutrient management and fertiliser application in Ireland:

- Ireland's third Nitrates Action Programme, Strategic Environmental Assessment Environment, Community and Local Government, January 2014
- Statutory Instruments n° 31 of 2014 Good Agricultural practice for Protection of Waters regulation 2014
- Commission Implementing Decision of 27 February 2014_ 2014/112/EU
- Explanatory handbook for good agricultural practices for the protection of waters regulations 2014 Status 2013 and trends in N & P of groundwaters, rivers, lakes and estuarine and coastal waters, EPA 2014.

Nitrates Action Programme

In Ireland, surface and groundwater quality is better than in most comparable countries. Nitrates are only a problem in very few places; phosphates have more impact on the aquatic environments, with a particular risk of marine eutrophication.

The entire country was classified as a vulnerable zone from the start.

The decree defines three categories of fertiliser:

- Farmyard manure (mix of excrement and litter for all types of animal except poultry),
- Other organic fertilisers (any type of liquid manure from livestock activities apart from farmyard manure),
- Chemical fertilisers

Ireland is divided in three pedoclimatic zones: A = South-East, B = West, C = North

Mandatory no-application periods

- Farmyard manure: 1 November to 12 (A), 15 (B) and 31 (C) January
- Other organic fertilisers: 15 October to 12 (A), 15 (B) and 31 (C) January
- Chemical fertilisers: 15 September to 12 (A), 15 (B) and 31 (C) January

Minimum storage capacities:

The storage capacity must be sufficient for a minimum number of weeks of liquid manure production, with the forecast volume estimated by a flat rate stipulated in the texts. The number of weeks is based on the usual grazing time of the animals.

- Normally sixteen weeks (A), eighteen weeks (B), twenty or 22 weeks (C or north of zone C). These rules include exceptions: livestock farms with less than 100 pigs or 2,000 poultry spaces: 26 weeks; stags, goats or sheep: six weeks.

The storage capacity is calculated in m³ of manure per week:

- Dairy cow 0.33
- Pig slurry 0.024 to 0.053
- Hen (1,000 hens) 0.81

Storage in the field is prohibited outside application periods and for 11 months maximum. Storage sites must be at least 20 m away from water bodies and 50-200 m from drinking water supply sites and karsts.

Application restrictions

- Fertilisers must not be applied to floodplains or waterlogged land when rain is forecast within the next 48 hours.
- Before land application the ground temperature must be measured.
- Application of mineral fertilisers is not allowed within 2 m from water courses, of organic nitrogen within 5 m from water courses and of farm manure 20 m from water courses. Minimum distance of manure from karst is 50 m and from lakes is 20 m.
- On slopes steeper than 15% land application is not allowed except on grassland, on slopes steeper than 20% no application is allowed.

Balancing crop needs

The farmer is required to respect the fertilisation balance on his farm. The total nitrogen inputs on a farm (ground inputs, applications and chemical fertilisers) must not exceed the maximum needs of crops.

The balance is calculated using the method of balances on the farm with the following elements:

Determined on the farm:

- The "phosphorous index" indicates the nitrogen and phosphorous content of the soil from a soil analysis that is repeated every five years for each plot (at least one sample every 4 ha). The annual analyses deemed essential for accurate, effective running of all N + P fertilization are among the actions promoted strongly by the farm advisory system. They are mandatory when the farmer benefits from a derogation from the application ceiling of 170 kg organic N per ha.

Determined by the regulations for

- The production of nitrogen by the farm animals

| Type of animal | P2O5 kg/animal/space/year | N kg/animal/space/year |
|----------------|---------------------------|------------------------|
| Dairy cow | 85 | 13 |
| Pig | 9.2 | 1.2 |
| Laying hen | 0.56 | 0.12 |

- The "nitrogen index" defined for fourteen previous crops or according to date when last ploughed, for pastures;
- Inputs are estimated at a flat rate, according to 39 types of organic fertilisers with coefficients of availability depending on the phosphorous index or as per the C/N ratio of composts for five groups of fertilisers
- For pastures the maximum N and P requirements by taking into account the input from animal excrement at pasture according to the number of animals grazing and the mowing rate
- The maximum permitted N and P inputs, with details for eighteen ploughed crops, 25 vegetables and twelve fruit, as per the nitrogen and phosphorous indices
- Nitrogen input ceiling based on the nitrate content of the soil (nitrate index rated from 1 to 4 e.g. 4 very high content)

Table 6.3: maximum nitrogen inputs (N/ha)

| Main crop | 1 | 2 | 3 | 4 |
|--------------|-----|-----|-----|----|
| Winter wheat | 190 | 140 | 100 | 60 |
| Corn | 180 | 140 | 110 | 75 |

The farmer records the characteristic elements of their practices and keeps them at the disposal of the authorities for at least five years.

The derogation has been granted since 2007 and has involved 5,093 farms, 11.4% of livestock units on 5.19% of the utilized agricultural areas (of 45,000, subject to the programme). These farms are monitored and undergo reinforced control; they must draw up and send to the authorities a provisional application timetable and carry out soil analyses. This derogation allows farms that request the derogation, and which have a utilized agricultural area that includes over 80% grassland to apply up to 250 kg organic N/ha. The 70% grassland rate adopted in 2007 enabling a farm to benefit from the derogation was raised to 80% in 2014. The argument for obtaining successive derogations is that grass yields are high (high net precipitations, long growing season) causing a significant export of nitrogen.

The derogation is a major issue for Ireland, where the policy is to maintain a very strong grass-fed production system and thus allow the most dynamic farmers to expand their activity. The estimated extra annual expenditure per farmer to meet the conditions to benefit from the derogation is €1,000. Monitoring and control are reinforced for benefiting farms. The additional soil analyses bring knowledge and encourage these farms to benefit from these derogations by thinking more about their fertilisation. Concurrently the administration is developing farm management computerisation and remote declaration to cope with the reinforced controls without increasing the staff.

Targeted phosphorus measures

The phosphorous fertilisation balance is calculated every year. It takes into account the phosphorous index of the soil estimated every five years (see above).

Any farm with a structural surplus must provide proof of nutrient exports.

Advisory system

Ireland has developed a very strong advisory system consisting of about 300 private consultants and 300 officers from the applied research institute TEAGASC. In return for an incentive of EUR 1,000/farmer/year, co-financed by the EAFRD, the farmers are encouraged to work in groups of about fifteen, run by these consultants, to train, exchange regulatory, technical or economic information, recipes for success and make progress in implementing this directive. There are about 6,000 "milk" groups in Ireland and 4,900 "meat" groups. "Smart farmers" is an entirely voluntary programme launched by the profession which works on all environmental impacts of farms and attempts to convert the new environmental regulations into economic opportunities.

Farmers who benefit from the derogation must remotely declare their CAP information and fertilisation practices. A compliance check is then computed using the various declarations from the farm when it benefits from the derogation or during controls on site. Computer tools for entering, controlling and analysing the practices of all the farms are under development.

Economic incentives

Public credit of EUR 8M (EUR 2M per year) has supported the farmers during the first programme, EUR 5M for the second (EUR 1.5M per year), of which the farmers have paid half. An assessment research programme - the Agricultural Catchments Programme – was carried out over four years (phase 1 of EUR 8M) and is currently running for a further four years (phase 2 of EUR 6M). It involves six fairly large catchment areas that are representative of situations existing in the country. It has been used to experiment with certain agronomic actions by measuring their environmental impacts, but also by analysing their socio-economic requirements, which is both a source of scientific results and a remarkable tool for steering public policy.

6.5.3 Remarks

Updated information on supporting regulation regarding renewable energy production is available under: <https://www.seai.ie/>

SEAI
Wilton Park House
Wilton Place, Dublin 2
Email: aie@seai.ie

Updated information on manure and digestate use regulation is available under: <https://www.teagasc.ie/>
TEAGASC
Oak Park, Carlow R93 XE12
Email: info@teagasc.ie

Irish Farmers Association
Irish Farm Centre, Bluebell, Dublin 12
Email: info@ifa.ie
"Improve Farm return with better resource management" (<http://smartfarming.ie>)

6.6 Spain

Spain has some 965,000 agricultural holdings, a utilised agricultural area of 26,578,000 ha. Some parts of the country are areas of intensive livestock activity, in total counting 6.25 M cattle, 29.23 M pigs and 19 M sheep and goats. Spain cultivates frequently-irrigated crops, either perennial (olive and fruit trees and vines) or mainly sown in the Autumn (cereals, forage crops).

The development of pig farming has been supported in Spain by the so-called integration policy that concerns 47% of production Spain. This policy is based on an original breakdown of roles formalised by contract - between the farmer who provides the buildings and labour only and the integration company that owns the animals, supplies the animal feed and markets the products. The importance of integration companies (the largest one in Spain has 4.2 million pigs) facilitates compliance with environmental requirements as these large companies run serious commercial risks, at national scale, if they are found to have failed to comply with an environmental regulation, even locally. The authorities are planning to develop livestock farming in the future, but outside vulnerable or dense zones (e.g., development will be more in Aragon than in Catalonia).

6.6.1 Supporting legislation on renewable energy supply [22] [57]

In Spain, the generation of electricity from renewable sources was mainly promoted through a price regulation system. Plant operators could choose between two options: a guaranteed feed-in tariff and a guaranteed bonus (premium) paid on top of the electricity price achieved on the wholesale market. **The price regulation system was phased out through Real Decreto-ley 9/2013.**

The Real Decreto RD 413/2014 was approved to regulate the specific compensation regime or premium tariff ("Régimen Retributivo Específico"), aiming at supporting renewable energy plants. Only PV plants and wind energy are eligible under this system.

However, plant operators have priority access and connection of the plant to the grid with certain restrictive provisions to maintain grid stability. Grid access is regulated by Real Decreto 1/2012.

6.6.2 Restrictive legislation on use of digestate [58] [59]

Nitrate Action Programme

The use of manure and digestate is governed by Real Decreto 324/2000 de 3 de marzo normas de ordenacion de explotaciones and Real decreto 1514/2009 de 2 de octubre (proteccion de las aguas subterraneas);

Spain has designated several nitrate vulnerable zones (NVZ) where the limit of 170 kg N/ha and year applies without derogations. The vulnerable zones only relate to 17% of the entire Spanish utilised agricultural area, despite discussions with the European Commission on potentially extending them to up to 30%. The nitrate vulnerable zones are exhibited in Figure 9.

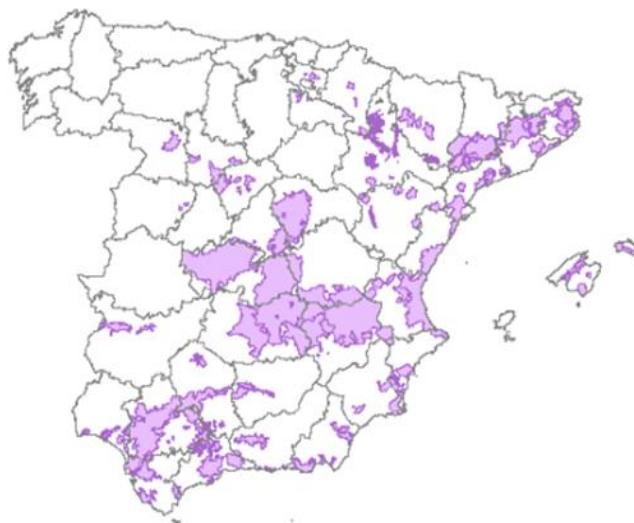


Fig. 9 Nitrate vulnerable zones in Spain (zones on the Canary Islands not shown)

National regulations referring to nitrogen containing fertilisers that are classified into two organic fertiliser types and two mineral fertiliser types according to their N-mobility:

Type 1 = organic fertiliser with slow mineralisation N and C/N >10 (cow, rabbit, sheep, goat or horse manure, compost, pig manure, solid part of pig liquid manure, poultry droppings with rice bran, straw, etc.).

Type 2 = organic fertilisers with easy-to-mineralise N and C/N < 10 (pig slurry, poultry droppings, cattle slurry, digestates, treatment sludge, untreated residual waters - type 2a corresponds to solid poultry droppings, type 2b to all others).

Type 3 = industrial nitrogen fertiliser.

Type 4 = slow-release industrial nitrogen fertiliser (low solubility, with retardant, etc.). They include mineral fertilisers covered by a semi-permeable membrane.

The restrictions of the Nitrogen Directive fully apply, including detailed regional and crop specific periods during which fertiliser application is prohibited.

Minimum storage capacity requirements (4-7 months according to animal, zone and irrigation). Field storage is allowed for up to 45 days if dry matter content is >20% or up to four months if certain conditions are fulfilled.

Maximum organic nitrogen application limits are enforced depending on the crop (170 kg N/ha and year) and sometimes lower in N-vulnerable zones, 250 kg N/ha and year in non-nitrogen vulnerable zones. In vulnerable zones, regionally maximum application rates are set which include mineral nitrogen fertilisers. Application of manure is not allowed from January through August for winter cereals, from March through September for spring cereals and from May through September for citrus fruits. Application of slurry is not allowed from April through August for winter cereals, from May through September for spring cereals and from June through January for citrus fruits. Similar but more diversified restrictions apply to grassland.

The quantities of nitrogen included in manure are defined on a flat-rate basis for 52 types of animal and livestock farm as shown in the table 6.4 below

Table 6.4 N in manure flat rates in Spain

| Type of animal | N kg / animal / year |
|---------------------------|----------------------|
| Dairy cow | 80.22 |
| Fattening pig (20-100 kg) | 7.25 |
| Laying hen | 0.50 |

These flat-rate quantities can be reduced if the farmer can prove that production is lower or disposed of without risk for the environment, for instance by separation technologies and if they obtain authorisation from the competent agriculture and livestock services.

It is mandatory to apply slurry with equipment fitted with distribution or dispersion devices; the 2015 action programme provides for fitting slurry tanks with a conductivity meter. In spray or drip irrigation systems, it is prohibited to mix water with animal fertilisers.

Lower evaporation is one objective of the Action Programme. This has already made itself felt through a reduction in the flat-rate quantity of nitrogen produced per fattening pig, subject to the metering of water and feed and built-in watering and cleaning conditions on the farm.

An animal dung management register is kept up-to-date i) for livestock farms inside and outside vulnerable zones and ii) for the crops located in vulnerable zones. It gives the quantities of nitrogen produced by the animals, the quantities extracted from pits, the quantities (kg N or volumes) applied with dates and types of crop benefiting from this and the quantities imported to or exported from the farm with records of dispatchers and recipients. This logbook must be updated within seven days of any operation and kept at the disposal of the authorities for five years. The 2015 action programme provides for a mandatory remote declaration system for all farms over two or three ha, both inside and outside vulnerable zones, and formalized agreements in advance between livestock farmers and other farmers providing for fertiliser trading.

Phosphorus related programmes

Regarding phosphorus, fertilisation is limited to a maximum of 150 mg P per kg of dry ground.

Advice and control

The animal dung management centres authorised by the competent division have the necessary skills. Publication of a technical file, information days and seminars, information handed over when livestock farmers request permits. Specific advice is issued to farmers who take out the "global farm contract", which assumes a significant change in nitrogen management with certain agri-environmental measures. 4.8% of farms are controlled.

The 2015 action programme provides for introduction of a mandatory remote declaration system that will replace the registers and be usable online to define control plans.

6.6.3 Remarks

For updated information on renewable energy related support schemes interested parties should refer to the Ministry of Energy, Tourism and Digital agenda that has some information in English.

<http://www.minetad.gob.es/en-US/Paginas/index.aspx>

For updated information on digestate application legislation interested parties should refer to the Ministerio de Agricultura y Pesca, Alimentacion y Medio Ambiente

<http://www.mapama.gob.es/es/>

National Pig Federation: ANPROGAPOR

http://www.anprogapor.es/anprogapor/anprogapor/inicio_2_1_ap.html

7 Overview EU-28

The Regulatory Framework Report covers all relevant European regulations and Member States' regulations of countries where demonstration or outreach plants are located. Regulations in these countries are typical for national regulations and can be taken as a guidance for regulations in other Member States.

The final section of the report provides nonetheless an overview of regulations and competent authorities in the remaining Member States.



| Country | Supportive legislation | Restrictive legislation | More Information |
|----------------|---|--|--|
| Austria | Feed-in tariff: > 1MW 133-101/MWh, Biogas from waste of OF only 47/MWh Registration only 1 week in the beginning of the year 2018/2019; subsidies limited with 1 M€/year for all new plants Contracting period 13 years | Whole country nitrate vulnerable zone (NVZ) plus risk areas with additional restrictions. Similar Action Programme (AP) as in Denmark (see country report) | OeMAG https://www.oem-ag.at/de/home/ Chamber of Agriculture https://www.lko.at/ |
| Belgium | See country report. | Nitrate surplus >50 kg N/ha. Whole country NVZ. | See country report. |
| Bulgaria | Feed-in tariff: 500 kW-1.5 MW ~204-229/MWh depending on feedstock Tariffs may be modified every year Contracting period 20 years | Issues with nitrate levels in some regions and with eutrophication in all coastal waters. Nitrate Directive infringement case in place on nitrate Action Programmes. Relevant P deficit. | Ministry of Energy https://www.me.government.bg/bg Ministry of Agriculture and Food http://www.mzh.govment.bg/bg/mzh/en/Home.aspx/ |
| Croatia | See country report. | 95% of freshwater bodies are eutrophic/hypertrophic. 9% of territory designated NVZ. | See country report. |
| Cyprus | Transitional feed-in tariff (1 year) 67-69/MWh not clear if available now and for which plant size Contracting period 1 year | 8% of utilized agricultural area designated as nitrate vulnerable zone; usual restrictions apply. Nitrate surplus >50 kg N/ha. Compliance varies. | Cyprus Energy Regulatory Authority https://www.cera.org.cy/engb Ministry of Agriculture, Rural Development and Environment http://www.moa.gov.cy/moa/agriculture.nsf/index_en/ |
| Czech Rep. | Market prices, no support for biogas | Ministry of Environment governs Nitrates Action Programme, adopted by 60% of farmers. Vulnerable areas designated. Nitrate surplus >50 kg N/ha. >50% utilised agricultural area is NVZ. | Energy Regulatory Office http://www.eru.cz/cs/ Ministry of Agriculture http://eagri.cz/public/web/en/mze/ |
| Denmark | See country report. | Nitrate surplus >50 kg N/ha. Whole country NVZ. | See country report. |
| Estonia | Feed-in premium 53.7/MWh regardless of technology and size paid by grid operator 32/MWh feed-in tariff for plants <10MW using waste, peat or oil-shale retorting gas | Nitrate Action Programme enforced; 8.5% of utilized agricultural areas are nitrate vulnerable zone. Compliant agricultural practices are supported, 65% of farmers adopted AP. Relevant P deficit. | Environmental Investment Centre https://www.kik.ee/en Ministry of Environment http://www.envir.ee/en/news-goals-activities/water/water-quality-and-agriculture |
| Finland | See country report. | Whole country NVZ | See country report. |
| France | See country report. | 68% of utilised agricultural area designated NVZ. Coastal waters around Brittany are eutrophic. High but decreasing cross national N surplus. | See country report. |
| Germany | See country report. | Whole country NVZ. Eutrophication of surface waters mainly attributed to excessive P applications. | See country report. |

| Country | Supportive legislation | Restrictive legislation | More Information |
|----------------|--|--|--|
| Greece | Feed-in premium 1-5 MW 162-204 (225)/MWh Subject to winning in a tender from 2017 on. | Nitrate Directive infringement case in place on nitrate vulnerable zone and Action Programmes. Monitoring and reporting is uncertain. | ADMIE http://www.admie.gr/nc/en/home/ Ministry of Rural Development and Food http://www.minagric.gr/index.php/en/ |
| Hungary | Feed-in premium >1 MW max. 103/MWh subject to win a tender making a winning bid Contractual period up to 25 years | 70% of the Hungarian territory is designated NVZ. Hungary still has a negative nutrient balance – mining soil-based nutrients. | Hungarian Energy Regulatory Authority http://www.mekh.hu/ Ministry of Agriculture http://www.kormany.hu/en/ministry-of-agriculture |
| Ireland | See country report. | Whole country NVZ. Similar AP as in Denmark (see country report). Grass is the dominant crop in Ireland. | See country report. |
| Italy | See country report. | About 13% of the territory is designated NVZ. | See country report. |
| Latvia | Support scheme suspended until the end of 2019 | About 13% of the territory is designated NVZ. Not all livestock farms are registered and controlled. 100% of coastal waters are eutrophic. | Ministry of Economics https://www.em.gov.lv/ Ministry of Agriculture http://www.zm.gov.lv/en/ |
| Lithuania | Feed-in premium <10 MW up to 134/MWh for 50% of the produced electricity currently suspended due to having reached the CAP; | Whole country designated as nitrate vulnerable zone. 100% of coastal waters and 50% of fresh waters are eutrophic. Compliance may be improved. | National Commission for Energy Control and Prices https://www.regula.lt/Puslapis/default.aspx Ministry of Agriculture https://zum.lrv.lt/en/ |
| Luxembourg | Feed-in tariff >500 kW-2.5 MW, 152/MWh Contractual period 15 years Grants available for new plants | Nitrate surplus >50 kg N/ha. Whole country NVZ. Similar Action Programme (AP) as in Denmark (see country report). Almost 90% of freshwater bodies are eutrophic. | ENOVS Luxembourg SA http://www.enovos.eu/ Landwirtschaftsportal https://agriculture.public.lu/de.html |
| Malta | Market price, no support for biogas | Second highest livestock density in the EU. Whole country NVZ. 44% of freshwater and 61% of coastal water is eutrophic. | M.E.E.R.A. http://www.meerea.org/ Agriculture https://agriculture.gov.mt/en/Pages/Index.aspx |
| Netherlands | See country report. | Nitrate surplus >50 kg N/ha. Highest livestock density in the EU. Whole country NVZ. All water bodies are eutrophic or hypertrophic. | See country report. |
| Poland | Feed-in tariff or feed-in premium Lowest bid against public tender Contractual period 15 years until 2035 latest | 15% if territory designated as NVZ. Nitrate Directive infringement case in place on nitrate vulnerable zone and Action Programmes. 90% of coastal waters are eutrophic and hypertrophic. Compliance leaves room for improvement. | Energy Regulatory Office http://www.ure.gov.pl/ Ministry of Agriculture and Rural Development https://www.minrol.gov.pl/eng/Start |

| Country | Supportive legislation | Restrictive legislation | More Information |
|----------------|--|---|---|
| Portugal | Market price, no support for commercial biogas plants | 4% of the territory designated NVZ. Frequent lack of soil and water analysis. | Directorate General for Energy and Geology http://www.dgeg.gov.pt/ Ministry of Agriculture, Forestry and Rural Development https://www.portugal.gov.pt/en/gc21/ministries/agriculture-forestry-and-rural-development/secretaries-of-state |
| Romania | Certificate (quota) scheme 2 certificates per MWh of electricity plus 1 additional certificate for high efficiency CHP plants; 1 certificate has a value of EUR 29.4-35 | Whole country designated as nitrate vulnerable zone. 54% of coastal waters eutrophic and hypertrophic. Compliance between 75% and 99%. | Romanian Energy Regulatory Authority http://www.anre.ro/ Ministry of Agriculture and Rural Development http://www.madr.ro/en/ |
| Slovak Rep. | Feed-in tariff >750 kWh 90.02/MWh (78.42/MWh if waste OF is used as substrate) Contractual period 15 years | 55% of agricultural area designated NVZ. Reported compliance quite good but since 2017 Nitrate Directive infringement case in place on nitrate vulnerable zone, Action Programmes and monitoring. | RONI Regulatory Office for Network Industries http://www.уро.gov.sk/ Ministry of Agriculture and Rural Development http://www.mpsr.sk/en/ |
| Slovenia | Feed-in tariff of feed-in premium Lowest bid against public tender Contractual period | Whole country NVZ. Similar Action Programme (AP) as in Denmark (see country report). | Borzen Centre for RES/CHP Support https://www.borzen.si/en Ministry of Agriculture, Forestry and Food http://www.mkgp.gov.si/en/ |
| Spain | See country report. | Freshwater eutrophication increased to 33% of waters. 35% of agricultural area is designated NVZ. | See country report. |
| Sweden | Certificate (quota) scheme Current price EUR 27/MWh Tax exemption system (energy tax) EUR 34/MWh energy tax | 70% of agricultural land is in NVZ. NVZ have been expanded over time. Use of manure is 20% higher in NVZ than outside. | Swedish Energy Agency http://www.energimyndigheten.se/en/ Swedish Board of Agriculture http://www.government.se/government-agencies/swedish-board-of-agriculture/ |
| UK | See country report. | Nitrate surplus >50 kg N/ha. 62% of agricultural land is in NVZ in England, only 17% in Scotland and 2.5% in Wales. In Northern Ireland, 25% of coastal waters are eutrophic and the whole territory is NVZ. | See country report. |

8 References

- [1] European Commission, "AGRICULTURE AND RURAL DEVELOPMENT," 04 2018. [Online]. Available: https://ec.europa.eu/agriculture/index_en.
- [2] A. Buckwell and E. Nadeu, "Nutrient Recovery and Reuse (NRR) in European Agriculture. A review of the issues, opportunities and actions," The RISE Foundation, Brussels, 2016.
- [3] Europa, "EUR-Lex Access to European Union Law," 04 2018. [Online]. Available: <https://eur-lex.europa.eu/homepage.html?locale=en>. [Accessed 04 2018].
- [4] European Commission, "2030 Energy Strategy," 22 05 2018. [Online]. Available: <https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/2030-energy-strategy>. [Accessed 22 05 2018].
- [5] European Council, "The Clean Air Package," 03 14 2018. [Online]. Available: <http://www.consilium.europa.eu/en/policies/clean-air/>. [Accessed 04 2018].
- [6] European Commission, "Bioeconomy," 13 02 2012. [Online]. Available: <https://ec.europa.eu/research/bioeconomy/index.cfm?pg=policy&lib=strategy>. [Accessed 04 2018].
- [7] European Commission, "Circular Economy," 07 03 2018. [Online]. Available: http://ec.europa.eu/environment/circular-economy/index_en.htm. [Accessed 04 2018].
- [8] European Commission, "Proposal for a Regulation on the making available on the market of CE marked fertilising products and amending Regulations (EC) No 1069/2009 and (EC) No 1107/2009," 17 03 2016. [Online]. Available: <http://ec.europa.eu/DocsRoom/documents/15949>. [Accessed 04 2018].
- [9] European Commission, "Report on Critical Raw Materials and the Circular Economy," 17 01 2018. [Online]. Available: <https://ec.europa.eu/docsroom/documents/27327>. [Accessed 04 2018].
- [10] United Nations, "Sustainable Development Goals," United Nations Department of Public Information, 2018. [Online]. Available: <https://sustainabledevelopment.un.org/sdgs>. [Accessed 12 03 2018].
- [11] UNFCCC, "Paris Agreement," Paris, 2015.
- [12] JRC Science for Policy Report, "Solid and gaseous bioenergy pathways: input values and GHG emissions - Calculated according to the methodology set in COM(2016) 767," European Union, Luxembourg, 2017.
- [13] European Commission, "The Nitrates Directive," 2018. [Online]. Available: http://ec.europa.eu/environment/water/water-nitrates/index_en.html. [Accessed January - May 2018].
- [14] IPPC Intergovernmental Panel on Climate Change, "IPPC Fifth Assessment Report (AR5)," 2014. [Online]. Available: <http://www.ipcc.ch/report/ar5/>. [Accessed 22 05 2018].
- [15] J. Stambasky, S. Pflüger, B. Deremince, S. Scheidl, N. de la Vega and M. Conton, "Statistical Report 2016," EBA European Biogas Association, Brussels, 2016.
- [16] B. Deremince and S. Königsberger, "Statistical Report of the European Biogas Association 2017," EBA European Biogas Association, Brussels, December 2017.
- [17] B. Deremince, S. Scheidl, J. Stambasky and A. Wellinger, "BIOGAS ACTION - Data bank with existing incentives and subsequent development of biogas plants compared to national targets," EC Network / BIOGAS ACTION, Copenhagen, 2017.
- [18] European Commission, "ARBOR: Securing North-West Europe's biomass energy supply," 31 01 2014. [Online]. Available: http://ec.europa.eu/regional_policy/en/projects/germany/arbor-securing-north-west-europe-s-biomass-energy-supply. [Accessed 04 2018].
- [19] Renewable Energy Policy Network REN21, "Renewables 2017 - Global Status Report," Ren21 Secretariat, Paris, 2017.
- [20] European Commission, "Energy - Clean Energy for All Europeans," 04 2018. [Online]. Available: <https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans>. [Accessed 04 2018].
- [21] Bundesministerium für Wirtschaft und Energie, "Informationsportal Erneuerbare Energien," 2018. [Online]. Available: <https://www.erneuerbare-energien.de/EE/Redaktion/DE/Standardartikel/EEG/eeg-2017.html>. [Accessed 04 2018].

- [22] RES Legal, "Legal Sources on Renewable Energy," 11 2017. [Online]. Available: <http://www.res-legal.eu/home/>. [Accessed 03 2018].
- [23] Vlaamse Regulator van de Elektriciteits- en Gasmarkt, "VREG uw gids op de energiemarkt," 2018. [Online]. Available: <http://www.vreg.be/nl>. [Accessed 04 2018].
- [24] Vlaanderen, "Vlaamse Land Maatschappij," 2018. [Online]. Available: <https://www.vlm.be/nl/>. [Accessed 04 2018].
- [25] Vlaamse Codex, "Ministerieel besluit tot aanduiding van de focusgebieden voor het jaar 2018 ter uitvoering van artikel 3.1.1 van de VLAREME van 28 oktober 2016," 18 01 2018. [Online]. Available: <https://codex.vlaanderen.be/Zoeken/Document.aspx?DID=1028932¶m=inhou&ref=search&AVIDS=1329257>. [Accessed 25 05 2018].
- [26] Belgielex.be, "J U S T E L - Geconsolideerde wetgeving," 28 01 2013. [Online]. Available: <http://www.ejustice.just.fgov.be/eli/besluit/2013/01/28/2013024068/justel>. [Accessed 25 05 2018].
- [27] Vlaanderen - Natuur en milieu, "Materialendecreet en VLAREMA," 2018. [Online]. Available: <https://www.vlaanderen.be/nl/natuur-en-milieu/afval/materialendecreet-en-vlarema>. [Accessed 04 2018].
- [28] Renewable Energy Database and Support, "RES LEGAL Europe," eclareon GmbH, , 2012. [Online]. Available: <http://www.res-legal.eu/home/>. [Accessed January - May 2018].
- [29] Landwirtschaftskammer Nordrhein-Westfalen, "Die neue Düngeverordnung - kompakt zusammengefasst," 27 09 2017. [Online]. Available: <https://www.landwirtschaftskammer.de/landwirtschaft/ackerbau/duengung/duengeverordnung/duenv-kompakt.htm#p68>. [Accessed 04 2018].
- [30] Bundesministerium für Justiz und Verbraucherschutz, "Biomasseverordnung," 2018. [Online]. Available: <http://www.gesetze-im-internet.de/biomassev/>. [Accessed 04 2018].
- [31] ARERA, "Autorità di Regolazione per Energia Reti e Ambiente," 2018. [Online]. Available: <https://www.arera.it/it/index.htm>. [Accessed 04 2018].
- [32] GSE, "Gestore Servizi Energetici," 2018. [Online]. Available: <https://www.gse.it/servizi-per-te/fonti-rinnovabili/fer-elettriche/>. [Accessed 04 2018].
- [33] Overheid NL, "Besluit stimulering duurzame energieproductie," 21 10 2017. [Online]. Available: <http://wetten.overheid.nl/BWBR0022735/2017-10-21>. [Accessed 04 2018].
- [34] RVO, "Rijksdienst voor Ondernemend Nederland," 01 01 2018. [Online]. Available: <https://www.rvo.nl/>. [Accessed 20 05 2018].
- [35] Overheid NL, "Uitvoeringsregeling Meststoffenwet," 01 01 2018. [Online]. Available: <http://wetten.overheid.nl/BWBR0018989/2018-01-01#BijlageM>. [Accessed 04 2018].
- [36] Rijksdienst voor Ondernemend Nederland, "Mest - tabellen en normen," 01 01 2018. [Online]. Available: <https://www.rvo.nl/onderwerpen/agrarisch-ondernemen/mestbeleid/mest/tabellen-en-publicaties/tabellen-en-normen>. [Accessed 04 2018].
- [37] Overheid NL, "Uitvoeringsbesluit Meststoffenwet," 01 01 2018. [Online]. Available: <http://wetten.overheid.nl/BWBR0019031/2018-01-01#BijlageII>. [Accessed 04 2018].
- [38] Wageningen University & Research, "Protocol beoordeling stoffen Meststoffenwet," WUR, Wageningen, 2018.
- [39] Overheid NL, "Uitvoeringsregeling Meststoffenwet," 01 01 2018. [Online]. Available: <http://wetten.overheid.nl/BWBR0018989/2018-01-01#BijlageAa>. [Accessed 04 2018].
- [40] ofgem, "Making a positive difference for energy consumers," 2018. [Online]. Available: <https://www.ofgem.gov.uk/>. [Accessed 04 2018].
- [41] The National Archives, "Legislation.gov.uk," 2008. [Online]. Available: <http://www.legislation.gov.uk/ukpga/2008/32/introduction>. [Accessed 04 2018].
- [42] GOV. UK Department of Environment, Food and Rural Affairs, "Use organic manures and manufactured fertilisers on farmland," 2018. [Online]. Available: <https://www.gov.uk/government/publications/nitrates-and-phosphates-plan-organic-fertiliser-and-manufactured-fertiliser-use/use-organic-manures-and-manufactured-fertilisers-on-farmland#nitrogen-limits-from-organic-manure>. [Accessed 22 05 2018].

- [43] GOV. UK, Department of Environment, Food and Rural Affairs and Environment Agency, "Using nitrogen fertilisers in nitrate vulnerable zones," 2018. [Online]. Available: <https://www.gov.uk/guidance/using-nitrogen-fertilisers-in-nitrate-vulnerable-zones#contents>. [Accessed 22 05 2018].
- [44] DEFRA Department for Environment, Food and Rural Affairs, Protecting our Water, Soil and Air - A Code of Good Agricultural Practice for farmers, growers and land managers, Norwich: TSO The Stationery Office, 2009.
- [45] GOV. UK Department of Environment, Food and Rural Affairs, "Sewage sludge on farmland: code of practice for England, Wales and Northern Ireland," 08 06 2017. [Online]. Available: <https://www.gov.uk/government/publications/sewage-sludge-on-farmland-code-of-practice/sewage-sludge-on-farmland-code-of-practice>. [Accessed 22 05 2018].
- [46] WRAP The Waste and Resources Action Programme, "BSI PAS 110 - Specification for Digestate," 2018. [Online]. Available: <http://www.wrap.org.uk/content/bsi-pas-110-specification-digestate>. [Accessed 22 05 2018].
- [47] HROTE, "HRVATSKI OPERATOR TRŽIŠTA ENERGIJE," 2018. [Online]. Available: <http://www.hrote.hr/>. [Accessed 04 2018].
- [48] ENERGINET, "ENERGINET," 2018. [Online]. Available: <https://en.energinet.dk/>. [Accessed 04 2018].
- [49] Ministry of Environment and Food of Denmark, "Environmental Protection Agency - Nitrates Directive," 2018. [Online]. Available: <http://eng.mst.dk/trade/agriculture/nitrates-directive/>. [Accessed 04 2018].
- [50] MAA - JA METSÄTALOUSMINISTERIÖ, "Rural Development Programme for Mainland Finland 2014–2020," 2018. [Online]. [Accessed 05 2018].
- [51] CRE, "Commission de Régulation de l'Énergie," 2018. [Online]. Available: <http://www.cre.fr/>. [Accessed 05 2018].
- [52] GRDF, "Injection Biométhane," 2018. [Online]. Available: <http://www.injectionbiomethane.fr/>. [Accessed 05 2018].
- [53] Comifer Comité Français d'Étude et de Développement de la Fertilisation Raisonnée, "Le bilan azote," 2018. [Online]. Available: <http://www.comifer.asso.fr/fr/bilan-azote.html>. [Accessed 04 2018].
- [54] Sustainable Energy Authority Ireland, "seia," 2018. [Online]. Available: <https://www.seai.ie/>. [Accessed 04 2018].
- [55] Irish Farming Association, "Smart Farming," 2018. [Online]. Available: <http://smartfarming.ie/>. [Accessed 04 2018].
- [56] Agriculture and Food Development Authority, "teagasc," 2018. [Online]. Available: <https://www.teagasc.ie/>. [Accessed 04 2018].
- [57] Ministerio de Energía, Turismo y Agenda Digital, "Secretaría de Estado de Energía," 2018. [Online]. Available: <http://www.minetad.gob.es/en-US/Paginas/index.aspx>. [Accessed 04 2018].
- [58] Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente, "Mercados agrícolas y ganaderos," 2018. [Online]. Available: http://www.mapama.gob.es/es/ganaderia/estadisticas/mercados_agrasicolas_ganaderos.aspx. [Accessed 04 2018].
- [59] National Pig Federation, "ANPROGAPOR," 2018. [Online]. Available: http://www.anprogapor.es/anprogapor/anprogapor/inicio_2_1_ap.html. [Accessed 04 2018].



Systemic large-scale eco-innovation to advance circular economy and mineral recovery from organic waste in Europe

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