

Chapter 13

Resource recovery from used water: The (European) regulator's point of view

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13.1 INTRODUCTION

As discussed in the previous chapters of this book, resource recovery from wastewater (often referred to as 'used water') covers a wide scope of activities including energy, nutrients, minerals, coagulants, cellulose, metals and many more substances. Each of these product areas is governed by specific legislation that need to be considered if resource recovery activities are undertaken. Specific legislations are effective if end of waste criteria are fulfilled. The present chapter therefore goes beyond the technical and economic aspects of resource recovery and aims to provide the reader with important insight into the importance of regulation and legislation in the context of resource recovery from water. This chapters focusses in particular on the specific legislation by setting the boundaries with respect to energy and nutrient recovery within the European Union. The boundaries for energy and nutrient recovery were selected because of these sectors being the largest, best developed and most widely covered by European policies and legislation. Policies and legislation essentially aim at a sustainable use of resources, abatement of greenhouse gas emissions, preservation of soil fertility, food security and safe food production 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 effluents 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 adaptations 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 energy and nutrient recovery activities looks overwhelming, readers will soon acknowledge that they follow a clear target and pursue a meaningful strategy. Indeed, it is expected that after reading this chapter readers will understand that this legal framework is providing a roadmap for business and revenue opportunities, albeit with some constraints inherent in every act of legislation.

Direct revenue opportunities provided by the European legal framework include feed-in tariffs, premiums and green certificates for renewable energy. Business opportunities created by the

restrictions of spreading unlimited amounts of nutrient rich residues to crop- and grassland require innovation and technologies to produce more concentrated and fit for purpose fertilising products that can be shipped to destinations where nutrients are needed. New ideas for facing the existing and upcoming challenges, may be supported by funding of one of the European and/or Member State based Research and Innovation programmes. As mentioned above, this chapter covers only European legislation with the rationale that it is more comprehensive than in many other parts of the world. Consequently, it cannot give a direct guidance to legal acts governing energy and nutrient recycling and recovery in other parts of the world. However, it still can guide the reader through areas which may be governed by regulation and where attention to existing or forthcoming policy intervention should be paid. The chapter can also be taken as a reference for policy makers if they feel that certain challenges may be effectively addressed by regulatory measures.

13.2 LEARNING OBJECTIVES

This chapter aims to identify and assess regulatory support schemes and constraints that investors and operators of water facilities face when considering energy and nutrient recovery from wastewater. It covers European legislation which is probably the most comprehensive regulatory package one may encounter by undertaking that kind of activity. It gives a good example of how regulatory bodies may address challenges related to water quality, human, animal and environmental protection, renewable energy, circular economy and placing new products on the market. By studying and discussing these topics, at the completion of this chapter you should be able to:

- Understand the motivation of regulators when selecting specific topics for regulation.
- Understand which legislative bodies need to be considered if undertaking activities of recovery and recycling of energy and nutrients.
- Identify areas and activities where energy and nutrient recovery could be successfully implemented.
- Realise how to conceive projects and design processes and products in compliance with legal requirements.
- Be familiar with how to design projects and processes to make best use of the legal framework.
- Explain the governing legal framework and its motivation to colleagues and third parties.

13.3 EUROPEAN POLICIES

Legislation of the European Union consists of policies, regulations and directives which govern municipal and private holdings, energy conversion from water, wastewater and sewage sludge such as heating and cooling systems, anaerobic digestion, as well as nutrient recycling and waste management activities. Hence, investors and operators planning an activity related to energy conversion and nutrient recovery from wastewater are advised to start with considering the European regulatory framework. When it fits in this framework, one should turn to the regulatory framework of the Member State where the resource recovery facility will be located and where the recovered materials are sold and used.

13.3.1 Overview of relevant policies in the context of resource recovery from wastewater

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. [Table 13.1](#) provides a summary of some of the key EU policies relevant for energy and nutrient recovery from wastewater. Each of the following policies is implemented by several of these acts. Acts that are relevant to the owners and operators of resource recovery and recycling systems are briefly explained in this chapter, even if their relevance is only marginal or indirect.

Table 13.1 European policies relevant to energy and nutrient recovery from wastewater.

Policies	National Regulation Recommended	Relevance to Resource Recovery from Water
2030 Energy Strategy (see section 13.3.2)	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 renewable 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	Relevant to heating or cooling using waste- or drinking water, anaerobic digestion and combustion of sewage sludge and other organic residues from municipal and industrial wastewater treatment plants
Clean Air Package (see section 13.3.3)	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	Relevant to storing, handling and use of nutrient containing residues from wastewater facilities
Bioeconomy Strategy (see section 13.3.4)	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	Encourages nutrient recovery, recycling and reuse
Circular Economy Package (see section 13.3.5)	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. The new Fertilising Products Regulation is the first legal act coming out of the CE package	Encourages closing the material loops, particularly the nutrient loops

13.3.2 The 2030 Energy Strategy (European Commission, 2018a)

In 2018, all EU countries 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, as committed to in the Paris Agreement in 2015. 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 renewable, low-carbon and even carbon capture and storage (CCS) and carbon capture and utilizing (CCU) technologies. The (ambitious) targets set forward for 2030 are as follows:

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

In order to achieving these goals, the following policies will be implemented by the year 2030:

- (1) A reformed EU emissions trading scheme (ETS);

- (2) 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;
- (3) First ideas for a new governance system based on national plans for competitive, secure, and sustainable (renewable) energy. These plans will follow a common EU approach aiming to ensure stronger investor certainty, greater transparency, enhanced policy coherence and improved coordination across the EU.

13.3.3 The Clean Air Package (European Council, 2013)

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 the health of European citizens and reduce health related expenses. In addition, the package aims at the protection of ecosystems, innovation and enhancing EU competitiveness in the field of green technology. Part of the Clean Air Package and relevant for stakeholders in nutrient recovery activities is the Gothenburg Protocol.

13.3.4 Gothenburg Protocol (UNECE, 1999)

Launched and adopted by the United Nations Economic Commission for Europe (UNECE) on 30 November 1999, 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. Fifty-one 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 eight 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 nutrient recovery activities, even if the emission ceilings are set for Member States.

13.3.5 The Bioeconomy Strategy (European Commission, 2012)

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; and (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 BLUEMED for the Mediterranean Basin. The strategy is relevant for potential additional research projects which may come out of nutrient recovery and recycling activities.

13.3.6 Circular Economy Package (European Commission, 2018b, 2018d)

The European Commission 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 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 increased 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 life-cycle 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 Regulation (EC) 2003/2003 (European Commission, 2016), 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 (European Commission, 2018d) are other examples of the highly integrated approach.

The Circular Economy Package with its new Fertilising Products Regulation is a cornerstone of 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 (United Nations, 2013) and the Paris 2015 United Nations Climate Change Conference (UNFCCC, 2015) agreements to confine the temperature increase to a maximum of 2°C, both adopted by virtually all countries in the United Nations by the end of 2015.

13.4 EUROPEAN REGULATIONS (EUROPA, 2018)

13.4.1 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 chapter. Due to frequent amendments of legislation referred to in this chapter, interested parties are advised to consult <http://eur-lex.europa.eu/homepage.html> (Europa, 2018) and official comments which can be easily accessed by entering the regulation denomination, as listed in Table 13.2, to an internet search engine.

13.4.2 Fertilising Products Regulation (Europa 2018)

Regulation (EC) No 2003/2003 relating to fertilisers was adopted on the 11th of December 2003 and aims at providing EU-wide rules for the type definition, nutrient content, nutrient solubility, packaging and labelling of mineral fertilisers. Important to note is that organic fertilisers are exempt from the

Table 13.2 European regulations in the context of resource recovery from wastewater.

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 EC labelled fertilisers from organic and inorganic materials. Compliance with the new regulation acknowledged by the EC-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
Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Regulation (EC) 1907/2006	Concerning the establishment of 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

current regulation and governed by national legislation. In its 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 technical 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 the first deliverable of the Circular Economy Package, the Commission presented a draft proposal for a new Fertilising Products Regulation (COM (2016) 157 final) (European Commission, 2016) with substantial amendments: the new regulation includes amendments of Regulations (EC) 1069/2009 and (EC) 1107/2009 and covers organic and inorganic fertilising products, next to liming materials, soil amendments, growing media, bio-stimulants and blends thereof 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 (Table 13.3). EC labelled fertilising products may only be produced from designated CMC. PFCs set out the requirements related to the PFCs to which EU marked fertilising products shall belong. The requirements described in Annex I for a given PFC apply to EU marked fertilising products in all subcategories of that PFC.

CMCs set out the requirements to components of which EC marked fertilisers may be produced. An EC marked fertilising product shall consist solely of component materials complying with the

Table 13.3 Designation of product function categories (PFC).

Main Category	Sub-category 1	Sub-category 2
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		
5. Agronomic additive	A. Inhibitor	I. Nitrification inhibitor II. Urease inhibitor
	B. Chelating agent	
	C. Complexing agent	
6. Plant bio-stimulant	A. Microbial plant bio-stimulant	
	B. Non-microbial plant bio-stimulant	I. Organic non-microbial plant bio-stimulant II. Inorganic non-microbial plant bio-stimulant
7. Fertilising product blend		

requirements of one or more of the CMCs listed in [Table 13.4](#). 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 EC marked fertilising product's compliance with one of the applicable requirements of that Annex.

Table 13.4 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	Microorganisms
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
CMC 13	Precipitated phosphate salts and derivates (to be added after JRC study/policy decision)
CMC 14	Thermal oxidation materials and derivates (ashes) (to be added after JRC study/policy decision)
CMC 15	Pyrolysis and gasification materials and derivates (biochar) (to be added after JRC study/policy decision)

The draft EU Fertilising Products Regulation is now in the Trilogue, that is the process by which Commission, Parliament and Council elaborate an unanimously accepted final version of the new regulation that can be finally adopted. The Fertilising Products Regulation is highly relevant for nutrient recovery and recycling as it sets the rules for a common European market for the products which are developed and put to the market. It aims at superseding the highly diversified national rules including the criteria determining the end of waste status of a material and thus avoid notification between Member States (necessary if waste materials are shipped across EU borders) and create a common market for recycled fertilisers. 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. An EC marked fertilising product will qualify for free trade within the EU regardless of national regulations.

13.4.3 Animal By-product (ABP) Regulation (Europa, 2018)

Regulation (EC) No 1069/2009, adopted on 21st October 2009, lays 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, for example based on fishmeal and processed animal protein;
- organic fertilisers and soil improvers, for example manure, guano, processed organic fertilisers/soil improvers on the base of processed animal protein; and
- technical products, for example pet food, hides and skins for leather, wool, blood for producing diagnostic tools.

ABP of Category 2 (high risk) and Category 3 (low risk) may be placed on the market provided they are pressure sterilised (Art. 15), come from registered and approved plants and – in case of Category 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 Category 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 concern to energy and nutrient recycling from wastewater 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) Category 1 (very high risk) animal by-products must be incinerated and may be used as fuel and for nutrient enrichment in sludge incinerators. Since ash from Category 1 ABP is excluded from use under CMC 14 (thermal oxidation materials), this practice is not in compliance with the draft Fertilising Product Regulation. The critical question arises whether incineration ash marks the endpoint of ABP and the corresponding regulation or not. DG Environment and the British and Portuguese governments have different answers to this question. National governments consider it as an endpoint, allowing the use of ash from ABP-Category 1 incineration for use as fertilisers whereas DG Environment insists that Cat 1 ABP ash is excluded from use as a fertiliser if the use of crops or grass as animal feed cannot be ruled out.

The draft version of the new Fertilising Products Regulation (COM 2016) 157 final) ([European Commission, 2016](#)) 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 CE marked product. ABP for use as CMC must have reached the endpoint in the manufacturing chain as determined in accordance with Regulation (EC) No 1069/2009.

13.4.4 Plant Protection Products (PPP) Regulation (Europa, 2018)

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 for: (i) 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 microorganisms, pheromones and botanical extracts.

Before any PPP can be placed on the market and/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. Currently, the PPP regulation also covers plant bio-stimulants that may be produced from sewage sludge. Albeit, provisions regarding plant bio-stimulants will become subject to the new Fertilising Products Regulation and to REACH registration and thus relieved from the stricter provisions of the PPP regulation including individual authorisation by Member States. As soon as the new Fertilising Products Regulation will be enforced, the PPP Regulation will cease to be relevant to the wastewater sector.

13.4.5 REACH Regulation (Europa, 2018)

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. This makes it very relevant for materials recovered from (waste-)water with the goal to bring it into the market.

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 potentially risky 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 when larger volumes of a given substance are 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: (i) radio-active substances; (ii) substances used in food; (iii) pharmaceuticals; and (iv) waste. Chemical products manufactured by resource recovery and recycling techniques are subject to registration if the end-of-waste status is achieved. Compost is explicitly exempt from REACH registration. An extension of the derogation for compost to other types of digestate is currently negotiated.

13.4.6 CLP Regulation (Europa, 2018)

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 and makes it therefore relevant for recovered substances from (waste-)water.

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, end 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 the 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>).

13.4.7 Waste Shipment Regulation (Europa, 2018)

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 15th 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 were tasked with preparing inspection plans by 2017.

The Waste Shipment Regulation is relevant to the fertilising products from wastewater derived residues and 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.

13.5 EUROPEAN DIRECTIVES (EUROPA, 2018)

13.5.1 Overview

An EU directive is a legislative act that sets out a goal that all EU Member States must achieve (Table 13.5). 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> (Europa, 2018) for amendments, updates and official comments, which can be easily accessed by entering the regulation denomination as listed below to an internet search engine. Any planned energy or nutrient recovery facility needs to be compliant with national legislation of the Member State where it is located.

13.5.2 Renewable Energy Directive (RED) (Europa, 2018; European Commission, 2018c)

Directive 2009/28/EC of the European Parliament and of the Council of 23rd 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.

Recast of the Renewable Energy Directive (RED-recast) (Europa, 2018). On the 30th November 2016, the Commission published a proposal for a revised Renewable Energy Directive to make the EU a global leader in renewable energy as well as to ensure that the target of at least 27% renewables in the 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) (European Commission, 2017), 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 (JRC Science for Policy Report, 2017) 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 with 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.

Renewable Energy Support Schemes. The Renewable Energy Directive governs grid access and national support schemes of high relevance for the revenues and the viability of energy and nutrient recovery and recycling business cases connected to biogas plants. Apart from the incentives represented by feed-in tariffs, feed-in premiums and green certificates provided by most Member States

Table 13.5 European directives.

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 170 kg 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 bathing water for at least two parameters of (fecal) bacteria and inform the public about water quality
Marine Strategy Framework 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
Urban Wastewater Directive 91/271/EEC amended by 98/15/EC	Requires collection and at least two stage treatment of wastewater for agglomerations >2000 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', that is 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 (PM _{2.5})
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. Sewage sludge treatment plants are subject to the IED if 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 (NO _x), non-methane volatile organic compounds (NMVOCs), sulphur dioxide (SO ₂), ammonia (NH ₃) and fine particulate matter (PM _{2.5})

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.

The EU adopted guidance for EU countries (SWD (2013) 439) (Europa, 2018) when designing and reforming renewable energy support schemes. This guidance suggests that:

- (1) Financial support for renewables should be limited to what is necessary and should aim to make renewables competitive in the market;
- (2) 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;
- (3) Unannounced or retroactive changes to support schemes should be avoided as they undermine investor confidence and prevent future investment;
- (4) 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) (Europa, 2018) published as a 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) of the Treaty (Europa, 2018). The document provides guidelines on how environmental protection and renewable energy support schemes should be designed to be compatible with the Treaty.

13.5.3 Liability of Defective Products Directive (Europa, 2018)

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. 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 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.

13.5.4 Biofuels and Indirect Land Use Change Directive (ILUC) (Europa, 2018)

Directive (EU) 2015/1513, adopted on 9th September 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 nutrient recovery and recycling if energy crops are used as feedstock for biogas production, not allowed in some European countries and with much lower (50% and further decreasing) allowance in Germany, where until 2017 biogas production could be largely based on energy crops. Consequently, waste and residues from wastewater purification become more important as a resource for renewable energy conversion.

13.5.5 Nitrates Directive (Europa, 2018; European Commission, 2018e)

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 170 kg 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 170 kg 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 had no more derogation since 2014, Italy has had 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 (IPPC Intergovernmental Panel on Climate Change 2014). 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.

The Nitrates Directive is only indirectly relevant to nutrient recovery from wastewater due to sewage sludge and sewage sludge ash not being constrained by the related national regulations. However, if a facility mixes manure and sewage sludge in an anaerobic digester, digestion residues become manure in many Member States, even if manure represents only 10% of the input flows. This needs to be considered when conceiving a project.

13.5.6 Water Framework Directive (WFD) (Europa, 2018)

Directive 2000/60/EC of the European Parliament and of the Council, established on 23rd October 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 water bodies 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 1990s, the Drinking Water Directive and the Directive for Integrated Pollution Prevention and Control (IPPC) were adopted.

Expanding the scope to all water bodies, 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 wastewater and digester effluents, including purified liquid effluents, into water bodies and are consequently relevant to energy and nutrient recovery and recycling.

13.5.7 Groundwater Directive (Europa, 2018)

Directive 2006/118/EC, adopted on 12th December 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 2007–2008 data, reverse negative trends and prevent or limit inputs of pollutants to assure achievement of environmental objectives by 2015 (targets not achieved). Relevant to nutrient recovery 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.

13.5.8 Drinking Water Directive (Europa, 2018)

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, the 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 nutrient recovery and recycling activities 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 of 1 and that the value of 0.10 mg/L for nitrites is not exceeded in the effluents of water treatment works. In February 2018 the European Commission 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 the latest recommendations of the World Health Organisation (WHO) and ensure our drinking water is safe to use for the decades to come.

13.5.9 Bathing Water Directive (Europa, 2018)

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 Member States to monitor and assess the bathing water for at least two parameters of (fecal) bacteria. In addition, they must inform the public about bathing water quality and beach management, through 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, lakes 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 of fecal 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.

13.5.10 Marine Strategy Framework Directive (Europa, 2018)

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 nutrient recovery and recycling activities.

The Directive covers four European marine regions – the Baltic Sea, North-east Atlantic Ocean, Mediterranean Sea and 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 six 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.

13.5.11 Urban Wastewater Directive (Europa, 2018)

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 wastewater 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 nutrient recycling and biogas 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.

13.5.12 Sewage Sludge Directive (Europa, 2018)

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 3 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 several nutrient recycling plants and thus they are concerned by the Sewage Sludge Directive. In addition, if used in agriculture, sewage sludge is competing with agricultural digestates and/or products produced from those digestates 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. Such bans frequently induce the development of technical resource recovery processes to overcome the constraints. Consequently, barriers may act as stimulants and promote innovation and technology development.

13.5.13 Waste Framework Directive (Europa, 2018)

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 is 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 waste management hierarchy as shown in [Figure 13.1](#).

The Directive is currently recast in the context of the Circular Economy Package. EU Communication COM (2015) 595 ([Europa, 2018](#)) 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.

13.5.14 Landfill Directive (Europa, 2018)

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 resource recovery activities is not a legal option in Europe.



Figure 13.1 Waste hierarchy as stipulated in the waste framework directive (source: [European Commission, 2008](#)).

13.5.15 Hazardous Waste Directive (Europa, 2018)

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 17–20 of Directive 2008/98/EC. It provides additional labelling, record keeping, monitoring and control obligations from ‘cradle to the grave’, that is 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 recovery and recycling activities that produce a waste or by-product stream which due to elevated concentration of pollutants may be considered as hazardous. Occasionally, even sewage sludge ash may be characterised as hazardous due to, for instance, elevated mercury concentrations. Many Member States have legal mechanisms by which hazardous wastes may be turned into non-hazardous wastes, frequently used to de-classify sludge ash. The draft Fertilising Product Regulation allows the use of hazardous waste as input material provided the relevant pollutants are removed. Dilution of pollutants is not legal within the Hazardous Waste Directive.

13.5.16 Air Quality Directive (Europa, 2018)

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 PM2.5 in urban areas by an average of 20% by 2020 based on 2010 levels. It obliges them to bring exposure levels below 20 µg/m³ by 2015 in these areas. Throughout their territory Member States will need to respect the PM2.5 limit value set at 25 µg/m³. This value must have been achieved by 2015 if 2010 levels were not already below the limit.

The Directive introduces objectives for fine particles PM2.5 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 have an impact on permits for installations aiming at resource recovery by limitations of small particle emissions.

13.5.17 Industrial Emissions Directive (IED) (Europa, 2018)

Directive 2010/75/EU of the European Parliament and of the Council of 24th November 2010 on industrial emissions (integrated pollution prevention and control) is based on a Commission proposal recasting seven previously existing directives (including the IPPC Directive) following an extensive review of the policy. The IED entered into force on 6th January 2011 and had to be incorporated to national legislation by Member States by 7th January 2013. The IED applies to treatment of sewage sludge, particularly biological or thermal energy conversion and resource recovery, for instance nutrient recovery.

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 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: (1) an integrated approach; (2) use of best available techniques; (3) flexibility; (4) inspections; and (5) public participation:

- (1) The integrated approach means that the permits must consider the whole environmental performance of the plant covering, for example, emissions to air, water and land, generation of waste, use of raw materials, energy efficiency, noise, prevention of accidents, and restoration of the site upon closure.
- (2) The permit conditions including emission limit values must be based on the Best Available Techniques (BAT). 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.
- (3) The IED allows competent authorities some flexibility to set less strict emission limit values. This is possible only in specific cases where an assessment shows that achieving the emission levels associated with BAT described in the BAT conclusions would lead to disproportionately higher costs compared to the environmental benefits due to the geographical location or the local environmental conditions or the technical characteristics of the installation. The competent authority shall always document its justification for granting such derogations.
- (4) The IED contains mandatory requirements on environmental inspections. Member States shall set up a system of environmental inspections and draw up inspection plans accordingly. The IED requires a site visit to take place at least every 1–3 years, using risk-based criteria.
- (5) The IED ensures that the public has a right to participate in the decision-making process, and to be informed of its consequences, by having access to permit applications, permits and the results of the monitoring of releases.

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

Biological treatment of sewage sludge is subject to the IED Directive if the capacity of the plant exceeds 75 t/day. If the only treatment activity is anaerobic digestion, the plant is subject to the IED if exceeding a capacity of 100 t/day.

13.5.18 National Emissions Ceilings (NEC) Directive (Europa, 2018)

Directive 2016/2284/EU about National Emission Ceilings entered into force on 31st 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:

- (1) the five main air pollutants NO_x, NMVOCs, SO₂, NH₃ and PM_{2.5} as well as carbon monoxide (CO);
- (2) in addition to PM_{2.5}, also PM₁₀, particulate matter and, if available, black carbon (BC) and total suspended particulate matter (TSP);
- (3) heavy metals cadmium (Cd), lead (Pb) and mercury (Hg) and, if available, the additional heavy metals arsenic, chromium, copper, nickel, selenium and zinc; and
- (4) 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 resource recovery and recycling activities.

13.6 OUTLOOK AND RECOMMENDATIONS

- (1) 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. It is expected that the new regulation of fertilising products is only a first step in a process extending to other European areas including supporting schemes for renewable energy conversion.
- (2) Level playing field for comparable 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. Industrial lobbying frequently prevents strict regulation of conventional products and leads to much stricter requirements for recycled products.
- (3) Long-term legislative framework reliability: Harmonised (between Member States) funding schemes must provide a reliable framework within a timeframe, corresponding to the pay-back time of investments. Renewable energy and nutrient recovery projects will only happen in a market environment where business cases will not be upset by unforeseeable legislative acts.
- (4) 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, discouraging investment in biogas plants that have proven to serve as a preferred hub for nutrient recovery. In general, renewable energy from wastewater residues is much less supported than agricultural residues or biowaste.
- (5) 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.

- (6) Gradual shift of taxation from labour to materials use: Nutrient recovery and recycling frequently involves a 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.

13.7 CHAPTER SUMMARY

In this chapter we have provided an overview of some of the key regulations that are important in relation to resource recovery from wastewater. The regulatory framework governing nutrient recovery and recycling activities in EU Member States is arranged in European policies, regulations and directives and by national legislation, which is frequently based on European policies and directives. Consequently, this chapter followed the same structure. Part 1 deals with European policies that are followed by the European regulations that must be enforced by all Member States in part 2. Part 3 refers to European directives which must be adopted by Member States but not literally. Directives typically stipulate a target but leave room to the Member State for selecting the strategy and pathway to achieve the target.

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 in Europe. However, operators of biogas plants are increasingly facing more stringent limits to nutrient application on cropland 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 offer opportunities for innovative nutrient recycling technologies.

Due to the frequent amendments of regulative acts, this chapter can only provide a conclusive picture as of 2013. Trying to compensate for this unavoidable drawback the authors 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 chapter provides comprehensive coverage of the European Union, albeit it cannot cover the individual legislation of the Member States, which is largely governed by the European policies, regulations and directives but going sometimes beyond the European acts. However, if readers plan a project in a Member State or even in a third country, they can always take the European regulations as a guideline and look for corresponding regulation in their own jurisdiction. The main findings of the review regarding the legal framework for energy and nutrient recovery and recycling from wastewater are:

- (1) Supporting schemes for renewable energy conversion (from organic and agricultural residues) in Member States are not governed by European legislation and vary from zero subsidy in Spain and – for conversion of sewage sludge – Italy to quite generous support schemes in other Member States. However, energy conversion of municipal sewage sludge is frequently exempt from support schemes that are typically addressing agricultural residues and other biowaste.
- (2) Regarding restrictive regulations mainly related to the use of nutrients on grass- and cropland, many Member States have implemented similar action programmes to improve water quality as required by the Water Framework and the Nitrates Directives leading to similar regulations. However, compliance with similar regulation is much more challenging in countries with intensive and concentrated livestock rearing compared to countries with more extensive livestock farming. Countries with high livestock density tend to limit the use of sewage sludge and require processed, higher concentrated nutrients in more elaborate products.

The chapter covered only two currently most developed recovery and recycling pathways from water, namely, energy and nutrient recovery from wastewater. Recycling of water is not specifically addressed but largely covered by the same regulatory framework. After reading this chapter, the reader should understand that legislation in general aims at implementation of policies:

- Transitions towards certain global and common targets like preventing the rise of the global average temperature (UNFCCC, 2015) and the sustainable development goals (United Nations, 2013), both agreed by more than 190 United Nations in 2015;
- Protecting human health and the environment at large;
- Protecting specific natural goods like air, soil and water.

Both UN agreements aiming at a transition provide a global framework for European and national policies. Typically, these objectives and policies are closely interlinked. It is all about securing the survival of mankind and about creating basic minimum standards for all humans sharing our planet. In Europe, standards are typically higher than in the rest of the world and consequently regulations are stricter and usually better observed. Due to having chosen energy and nutrient recycling, regulations are focusing on air, soil and water protection. Nutrients are mainly used in agriculture, hence regulations regarding soil fertility, crop nutrition as well as safe feed and food are preponderant in the chapter. If we had chosen minerals for use as construction materials, the same would apply to regulations of construction works and buildings.

The chapter did not include Safety, Health and Environmental (SHE) and social/contractual regulations related to operations itself, for instance in a water treatment or recycling plant. This is a separate body of legislation that must always be considered and it is mainly governed by national regulations. The authors hope to have shown that, regardless of which material is recovered and recycled, the basic principles of protecting air, soil, water and human livelihood remains the same. Operators should always think of the goods that may be affected by his activities and check if these goods are protected by global, multilateral or national regulations. Once the basic principles are understood, identifying and respecting the specific regulatory framework should be a not too difficult task.

13.8 DISCUSSION QUESTIONS

Question 13.1: What are the predominant concerns and targets of regulators? (leadership, utility management). After having read the comprehensive body of regulations governing the use of recovered resources from water and wastewater, think of the concerns and intentions of policy makers and interpret them in your own words. Which goods are protected by regulations and which behaviour is favoured by legal incentives? As a critical citizen, do you think the regulative body is complete or do feel that important human or natural goods are not sufficiently covered? How are the regulations linked to the global agreements like the Sustainable Development Goals or the Climate Agreement?

Question 13.2: How would you explain the legislative framework to colleagues or third parties with limited specific knowledge? (operators, utility management). In your role as an operator or manager of a utility, think of having to explain the legislative framework to third parties in your own words in 15 minutes, for instance in a presentation. Think of the structural approach in Europe with policies, directives and regulations and think of the restrictions and incentives. How is the Circular Economy addressed by regulations, if at all?

Question 13.3: What is the difference between EU regulations and regulations of your country (operators, utility management). Once you have read and understood the body of legislation in the European Union, check if you have equivalent regulations in the jurisdiction where you operate. The check should include regulations that have similar intentions and cover similar subjects, even if the explicit targets and wording are quite different from what EU regulators have adopted. Find out the differences, explain them with your own words. What is your opinion about the differences – do you think that the European regulations can serve as a model for other countries?

Question 13.4: Which regulations could support resource recovery initiatives? (leadership, utility management). Imagine you want to improve the environmental performance of your water activity, you have limited financial resources and your activity should generate additional revenues or reduce the cost of operating your facility. Reviewing the regulations, which type of regulations could contribute to your financial targets? For instance, about 100 struvite plants operate globally in wastewater treatment plants, saving maintenance costs because of preventing scaling and incrustations in pipes and tanks of EHBP plants. In many cases, recycling struvite pays back even if the product is given away for free.

Question 13.5: Which areas of the water and wastewater treatment sector are preferred targets for resource recovery? (leadership, utility management). Current legislation for water and wastewater treatment focuses on removal (not re-use) of contaminants, nutrients, organic matter, and so on. If you think of recovery and recycling, how would you select and which area would you chose? To what extent would you consider legislation and to what extent would you consider other drivers, for example operating costs? Which other arguments could influence your decision?

Question 13.6: Can anaerobic digestion contribute to reduce greenhouse gas emissions and abate global warming? (leadership, utility management). You have learned that policies aim at achieving renewable energy targets and prevent emissions to air and water bodies. Renewable energy can be recovered by anaerobic digestion of sewage sludge. Do you think that anaerobic digestion can make a relevant contribution to the renewable energy targets? How could anaerobic digestions concurrently contribute to pollution prevention?

Question 13.7: Which legislative bodies need to be considered if undertaking activities of recovery and recycling of energy and nutrients? (leadership, utility management). If you conceive a resource recovery and recycling activity, you need to plan compliance with the legislative framework outlined in this chapter. However, not all regulations are relevant for your planned activity. Please specify regulations you need to comply with for: (a) an energy recovery activity; or (b) a nutrient recovery activity. Find out which regulations need to be considered for every activity, regardless of the resource to be recovered, and which regulations are only relevant for specific recycling activities?

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