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The Interface Between Waste and Non-waste: Legal Preconditions for Reutilization of Sewage Sludge

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Abstract

Circular economy poses new challenges for waste management. Within the European Union, the regulatory framework for waste has the purpose of environmental protection in a broad sense. It can, however, be argued that the regulatory framework poses a barrier for circular economy as it favors environmental protection in the short-term, as strict requirements typically constitute a regulatory burden. In this paper, the regulatory requirements for waste and non-waste are highlighted through legal analysis. Co-incineration of sewage sludge and straw fuels serves as an example to illustrate differences. As a substance or object is either regarded as a waste or a non-waste, and due to the lack of clear cessation of waste status prior to incineration, unnecessary barriers for otherwise environmentally beneficial operations are created. This can be argued to constitute a hindrance to proper utilization of resources.

Keywords: End-of-waste; By-products; Circular Economy; EU Law; Environmental Law

1. Introduction

Demand for virgin materials such as food, feed, fibre, and aggregate is estimated to increase by 70% by 2050.[1] Almost all virgin materials show similar trends of an increase in demand, and if the world reaches the estimated global population of 9.8 billion by 2050, it would require almost three planets worth of natural resources to sustain the population.[2] Yet it is becoming increasingly clear that both finite and renewable resources are becoming scarce due to unsustainable rates of extraction.[3] To alleviate these issues, circular economy (CE) has been proposed as a sustainable economic model for the future. Initially, CE was, in the European Union's (EU) seventh Environmental Action Programme, described as an economic system where natural resources are managed sustainably and waste is recovered as a resource.[4] Today, CE is identified as a priority objective for the EU in the latest Environmental Action Programme where it is considered imperative to achieve an economy where growth is regenerative.[5]

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[1] M Dri, P Canfora, I S Antonopoulos and P Gaudillat, *Best Environmental Management Practice for the Waste Management Sector* (JRC Science for Policy Report, EUR 29136 EN, Publications Office of the European Union 2018) 26, doi:10.2760/50247.

[2] United Nations, 'Sustainable Development Goals: Goal 12 – Ensure Sustainable Consumption and Production Patterns' (UN, no date) <https://www.un.org/sustainabledevelopment/sustainable-consumption-production/>, accessed 17 May 2026.

[3] Dri et al., *supra* note 1, 28.

[4] Decision 1386/2013/EU of the European Parliament and of the Council of 20 November 2013 on a General Union Environment Action Programme to 2020 'Living well, within the limits of our planet', [2013] OJ L 354/171.

[5] Decision (EU) 2022/591 of the European Parliament and of the Council of 6 April 2022 on a General Union Environment Action Programme to 2030 [2022] OJ L 114/22 article 2(c).

One integral part of a regenerative economy is that waste is valued and utilized as a resource. However, waste is routinely, and often correctly, associated with negative connotations such as hazards, odors, pests, mess, disgust, etc.[6] A consequence of this is that the concept of waste itself carries a notion of increased risk regardless of the physical and chemical properties of the waste, which affects the possibility to valorize it as a resource. This is particularly true for certain waste streams, such as sewage sludge. Sewage sludge is a residual product from waste water treatment that contains large amounts of biodegradable material and plant nutrients, such as phosphorus and nitrogen, as well as pollutants in the form of heavy metals and pathogens.[7] It has been shown that treated sewage sludge can be used as an effective fertilizer with positive impacts on crop-yields and little to no biomagnification of pollutants.[8] At the same time, research shows that use of treated sewage sludge for agricultural purposes is routinely associated with great risks, while other, arguably, equally harmful practices such as spraying crops with pesticides are more commonly accepted.[9] The presence of pollutants in untreated sludge does, nevertheless, serve as a legitimate concern when it is used in agriculture. An alternative venue for the recovery of valuable material from sewage sludge is thermal conversion, where the sewage sludge is incinerated, and valuables are recovered from the ash. Notably, incineration enables both the destruction of pollutants and the concentration of valuables in the ash. Moreover, incineration of sewage sludge produces ash that is rich in phosphorous. Yet, there are drawbacks associated with incineration, including expensive infrastructure, transport, and negative public opinion.[10] For the purposes of this study, one potential challenge connected to utilization of waste and, by extension, both agricultural use and incineration of sewage sludge, is the regulatory framework.[11] One frequently mentioned issue concerning the management of waste is the different requirements for utilization of waste and non-waste, or in other words, the coherency of the regulatory framework.[12]

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[6] A Liu, F-R Wenlin, Y, Lin and J-Y Wang, 'A review of municipal solid waste environmental standards with a focus on incinerator residues' (2015) 4(2) *International Journal of Sustainable Built Environment* 165, 167.

[7] K Fijalkowski, A Rorat, A Grobelak and MJ Kacprzak, 'The presence of contaminations in sewage sludge – The current situation' (2017) 203 *Journal of Environmental Management* 1126, 1129.

[8] Hushållningssällskapet, *Slamtillförsel på åkermark. Slamrapport 2015–2018* (2021) ISBN 978-91-519-6761-5. <Available at: https://hushallningssallskapet.se/wp-content/uploads/2020/10/slamrapport-2020-rev-2021.pdf>; J Pulkrabová et al., 'Is the long-term application of sewage sludge turning soil into a sink for organic pollutants?: evidence from field studies in the Czech Republic' (2019) 19(5) *Journal of Soils and Sediments* 2445, 2455–58.

[9] N Ekane, K Barquet and A Rosemarin, 'Resources and Risks: Perceptions on the Application of Sewage Sludge on Agricultural Land in Sweden, a Case Study' (2021) 5 *Frontiers in Sustainable Food Systems* 647780, 6.; L Ekman Burgman, 'What sewage sludge is and conflicts in Swedish circular economy policymaking' (2022) 8 *Environmental Sociology* 292, 297.

[10] M Bagheri, *Sewage Sludge Treatment Scenarios: Techno-Economic Analyses of Energy and Phosphorus Recovery Focusing on Implementation Challenges* (PhD dissertation, Luleå University of Technology 2024) 5.

[11] J Grafström and S Aasma, 'Breaking circular economy barriers' (2021) 292 *Journal of Cleaner Production* 126002, 10.

[12] European Commission, *Communication from the Commission: on the implementation of the circular economy package: options to address the interface between chemical, product and waste legislation* COM (2018) 32 final, 7; European Commission, *Communication from the Commission: A new Circular Economy Action Plan for a cleaner and more competitive Europe* COM (2020) 98 final, 4; IM de Waal, 'Coherence in law: A way to stimulate the transition towards a circular economy? A critical analysis of the European Commission's aspiration to achieve full coherence between chemicals legislation and waste legislation – and product legislation' (2021) 28 *Maastricht Journal of European and Comparative Law* 760, 764; J Alaranta and T Turunen, 'How to Reach a Safe Circular Economy?—Perspectives on Reconciling the Waste, Product and Chemicals Regulation' (2021) 33 *Journal of Environmental Law*

Coherence has by the European Commission been identified as critical for the transition to a circular economy.[13] From a broader perspective, a coherent legal system is a desideratum of any law; Neil MacCormick has argued that it is even the basic idea of a legal system.[14] Yet, there is no set explanation of what coherence in law is. Typically, coherence is considered closely interlinked with consistency.[15] It is also considered a 'looser' concept than consistency.[16] In short, consistency means that application of different rules will result in the same legal outcome given the same facts. In relation to the topic of this paper, it would mean that a substance or object with the same physical and chemical characteristics would be regulated in the same manner regardless of its legal classification. To be even more precise, waste-based products, such as sludge-based fertilizers, should be subjected to the same regulatory standard as their virgin counterparts. However, a set of legal norms may be coherent, while at the same time inconsistent. If differences can be explained by virtue of a rational principle, inconsistencies may be coherent.[17] Thus, different requirements for waste and non-waste must be justified by some explicit or underlying principle or value, such as environmental protection. Tromans (2001), for instance, explains that there is an economic incentive to use raw materials as efficiently as possible, whereas the economic incentive for waste often is to dispose of it as cheaply as possible.[18] Gillespie (2015) has similarly noted that if it is not possible to dispose of waste in a commons for free (e.g., as emissions into air, or dumping into oceans), it is likely to end up in communities that are less likely to object to its placement.[19] This fact, that waste is likely to be handled as cheaply as possible, serves as a strong argument for certain diverging (stricter) rules for waste compared to its virgin counter-part, such as restrictions of transboundary transportation of waste. However, if it is economically advantageous to utilize waste this argument weakens.

The aim of this paper is to contribute to the ongoing discussion regarding the coherency of the legal framework for waste and to discuss if and how diverging legal requirements between waste and non-waste may affect recovery strategies. Co-conversion of sewage sludge with straw-fuel using existing infrastructure (district heating plants) will serve as an example to illustrate how different legislated limit values may affect the feasibility of innovative solutions. These two input materials (feedstock) are chosen due to their inevitable production and substantial quantity.[20] In addition, Hannl et al. (2024) have noted that mono-thermochemical conversion of both sewage sludge and agricultural residues such as straw may cause operational issues, such as slag-formation, deposit buildup or

113, 125; T de Römph and JM Cramer, 'How to improve the EU legal framework in view of the circular economy' (2020) 38 *Journal of Energy & Natural Resources Law* 245, 252.

[13] European Commission, *Communication from the Commission: Closing the loop—An EU action plan for the circular economy* COM (2015) 614 final, 3; European Commission, *supra* note 12, p. 3; Directive (EU) 2018/852 of the European Parliament and of the Council of 30 May 2018 amending Directive 94/62/EC on packaging and packaging waste OJ L 150/141, Recital 4.

[14] N MacCormick, *Legal Reasoning and Legal Theory* (2nd edn, Clarendon Press 1994) 106.

[15] de Waal, *supra* note 12, 763.

[16] MacCormick, *supra* note 14, 106.

[17] T Spaak, 'Consistency in Law' (Faculty of Law, Stockholm University Research Paper No 132, 13 April 2023) 4 SSRN <https://ssrn.com/abstract=4418149> 4; MacCormick, *supra* note 14, 106–107.

[18] S Tromans, 'EC Waste Law – A Complete Mess' (2021) 13 *Journal of Environmental Law* 133, 135.

[19] A Gillespie, Waste Policy: International Regulation, Comparative and Contextual Perspectives (Edward Elgar Publishing 2015) 3.

[20] TK Hannl et al., 'Bubbling fluidized bed co-combustion and co-gasification of sewage sludge with agricultural residues with a focus on the fate of phosphorus' (2024) 357 *Fuel* 129822, 2.

corrosion.[21] Moreover, they note that co-conversion of sewage sludge and agricultural residues alleviate these operational issues, such as by reducing agglomeration.[22] Co-conversion also provides other benefits, such as reducing the need for drying through mechanical dewatering or thermal treatment of the sewage sludge prior to incineration.[23] Additionally, co-conversion may produce a more favorable ash-composition that provides for a more plant available form of phosphorous.[24]

2. Setting the Scene: Waste or Non-Waste

To discuss diverging requirements between waste and non-waste, it must first be established what the concept of waste entails. Much like how it is justified to adopt different rules for apples and oranges, it can be justified to adopt different rules for waste and non-waste, provided that the rules relate to real differences between the substances, such as physical or chemical properties. This means that the definition of waste itself can serve as justification for diverging rules. However, for this reasoning to be adequate, the definition of waste can only be applicable to substances or objects that show a certain negative trait, such as toxicity, likelihood of abandonment, etc.

The current definition of waste within the EU reads: '"waste" means any substance or object which the holder discards or intends or is required to discard'.[25] According to de Römph (2018), the regulatory framework(s) for waste can be considered to be developed 'around' this definition.[26] Yet, the definition has not been substantially revised since its introduction in 1991 and has subsequently garnered much judicial review and attention in scholarly debate.[27] Both legal scholars and jurists have debated whether the current definition is the most appropriate.[28]

[21] *Ibid*.

[22] *Ibid.* See also H Liu et al., 'Influence of sewage sludge on ash fusion during combustion of maize straw' (2019) 33 *Energy Fuels* 10237-10246, 240; A Nordin et al., 'Co-Combustion of municipal sewage sludge and biomass in a grate fired boiler for phosphorus recovery in bottom ash' (2020) 13 *Energies* 1708, 2; L Li, Q Ren, S Li S and Q Lu, 'Effect of phosphorus on the behavior of potassium during the co-combustion of wheat straw with municipal sewage sludge' (2013) 27 *Energy Fuels* 5923, 5924; J Falk et al., 'Ash transformation during Fixed-Bed co-combustion of sewage sludge and agricultural residues with a focus on phosphorus' *ACS Omega* 13162, 13163.

[23] F Neuwahl et al., *Best Available Techniques (BAT) Reference Document for Waste Incineration* (European Commission Joint Research Centre, EUR 29971 EN, 2019) 33 <https://doi.org/10.2760/761437>.

[24] Bagheri, *supra* note 10, 6.

[25] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives, OJ L 312, 22.11.2008, art. 3(1).

[26] T de Römph, *The Legal Transition towards a Circular Economy: EU Environmental Law Examined* (PhD Dissertation, KU Leuven and Hasselt University 2018) 220.

[27] See e.g., I Cheyne and M Purdue, 'Fitting Definition to Purpose: the Search for a Satisfactory Definition of Waste' (1995) 7 *Journal of Environmental Law* 149; G van Calster, 'The EC Definition of Waste: the Euro Tombesi Bypass and Basel Relied Routes' (1997) 8 *European Business Law Review* 137; L Bontoux and F Leone, *The Legal Definition of Waste and Its Impact on Waste Management in Europe* (European Commission Joint Research Centre, Institute for Prospective Technological Studies (IPTS) 1997); M Purdue and A van Rossem, 'Distinction between Using Secondary Raw Materials and the Recovery of Waste: the Directive Definition of Waste' (1998) 10 *Journal of Environmental Law* 116; D Pocklington, 'UK Perspectives on the Definition of "Waste" in EU Legislation' (1999) 5 *European Environmental Law Review* 177; Tromans, *supra* note 18; I Cheyne, 'Definition of Waste in EC Law' (2002) 14 *Journal of Environmental Law* 61.

[28] Opinion of AG Jacobs in Joined Cases C-304/94, C-330/94, C-342/94 and C-224/95 *Euro Tombesi* [1996] ECLI:EU:C:1996:399; Opinion of AG Alber in Joined Cases C-418/97 and C-419/97, *Arco Chemie* [1999] ECLI:EU:C:1999:286; Opinion AG Jacobs in Case C-129/96, *Inter Environment* [1997] ECLI:EU:C:1997:216; E Pongrácz, *Re-defining the concepts of waste and waste management* (PhD thesis, University of Oulu 2002); E Pongrácz and VJ Pohjola, 'Re-defining waste, the concept of ownership and the role of waste management' (2004) 40 *Resources, Conservation and Recycling* 141; N de Sadeleer, 'EC Waste Law or How to Juggle with Legal Concepts: Drawing the Line between Waste, Residues, Secondary Materials, By-products, Disposal and Recovery Operations' (2005) 6 *Journal of European Environmental & Planning Law* 458.

Some have argued that the existence of waste should be derived from whether the substance or object has purpose or is functional,[29] others have argued that the altering current definition of waste is best avoided as it will create numerous 'knock-off' effects.[30] A common critique of the definition of waste is ambiguity, particularly in relation to (1) when a substance or object becomes waste and (2) when a waste ceases to be waste. As waste management within the EU generally requires a permit or prior notification, clarity in what is, and what is not, covered by the definition is important. In other words, it is important that those targeted by the definition can predict the legal consequences of their actions, such as whether a transboundary shipment requires a permit or prior notification.[31] This is particularly important as illegal waste management typically carries criminal liability,[32] which cannot least be highlighted by the numerous preliminary rulings of the Court of Justice of the European Union (CJEU) concerning criminal liability for illegal waste management.[33]

Notably, the meaning of the center of the definition of waste, the verb 'discard', is not clearly defined in the Waste Framework Directive (WFD), despite this being a highlighted issue prior to the enactment of the WFD in 2008.[34] This has been a long-standing issue within the waste sector, and it is often surmised as a regulatory or administrative burden that increases the cost of various operations due to uncertainty.[35] Here, it must also be noted that even if this can be seen as a shortcoming of the definition, it also serves as a safeguard that enables assessments to err on the side of caution. In many cases, the meaning of 'discard' is evident. An ice cream wrapper in a garbage bin is obviously 'discarded', whereas a brand-new item on a store shelf is obviously not 'discarded'. However, in other cases it is not immediately evident (or even logical). An illustrative example of this is biochar. Biochar is a solid material that is generated by heating biomass with limited oxygen to prevent combustion. It has been shown that biochar can be used for several purposes, such as feedstock for energy production or as a fertilizer.[36]

Regarding the waste status of biochar, Strubelj (2022) notes that it depends on the input biomass, not its content. He asserts that if waste-based biomass is used, the end product (biochar) will constitute waste, whereas if virgin biomass is used, the end product will be non-waste. This

[29] Pongrácz and Pohjola, *supra* note 28, 150–153; Opinion of AG Jacobs in Joined Cases C-304/94, C-330/94, C-342/94 and C-224/95, *supra* note 28.

[30] L Krämer, '*The Distinction between Product and Waste in Community Law*' (2003) 1 *Environmental Liability* 3, 9; D Pocklington, 'Opening Pandora's Box – the EU Review of the Definition of "Waste"' (2003) 12 *European Environmental Law Review* 204, 215. Krämer notes that thousands of laws are built upon the current definition, which means that altering it would require extensive revision of an entire corpus of law.

[31] E Paunio, 'Beyond Predictability – Reflections on Legal Certainty and the Discourse Theory of Law in the EU Legal Order' (2009) 10 *German Law Journal* 1469, 1472.

[32] Regarding the importance of predictability for criminal liability in general, see Paunio *supra* note 31, 1472; J Habermas, *Between Facts and Norms: Contributions to a Discourse Theory of Law* (MIT Press 1996) 220. Regarding the importance of predictability for the concept of waste see Opinion of AG Jacobs in Joined cases C-304/94, C-330/94, C-342/94 and C-224/95, *supra* note 28, para. 56.

[33] See e.g., Joined cases C-206/88 and C-207/88, *Vessoso and Zanetti* [1990] ECLI:EU:C:1990:145; Joined cases C-304/94, C-330/94, C-342/94 and C-224/95 *Euro Tombesi* [1997], ECLI:EU:C:1997:314; Case C-235/02, *Saetti and Frediani* [2004] ECLI:EU:C:2004:26; Case C-1/03, *Van de Walle* [2004] ECLI:EU:C:2004:490; Case C-457/02, *Niselli* [2004] ECLI:EU:C:2004:707; Joined Cases C-487/17 to C-489/17, *Verlazza* [2019] ECLI:EU:C:2019:270; or Case C-624/17, *Tronex* [2019] ECLI:EU:C:2019:564.

[34] European Commission, Proposal for a Directive of the European Parliament and of the Council on waste COM (2005) 667 final, 1–3.

[35] See e.g., Bontoux and Leone, *supra* note 27, 24; or more recently Judgment of the Swedish Environmental Court of Appeal of 20 May 2020, Case M 9646-19.

[36] L Štrubelj, 'Waste, Fertilising Product, or Something Else? EU Regulation of Biochar' (2022) 34 *Journal of Environmental Law* 529, 531.

means that regardless of content, if waste-based biomass (such as garden waste) is used as an input material, the resulting biochar will constitute waste, whereas if virgin (non-waste) feedstock is used, the biochar will constitute non-waste.[37] This is true no matter how miniscule amount of waste are used as an input material; the 'end product' will constitute waste even if only small amounts of waste-based biomass is used. In *Sappi Austria*, the CJEU concluded that mixing municipal sewage sludge (waste) with waste water from paper and pulp production (in that case, a by-product; a non-waste) to a ratio of 3% waste and 97% non-waste results in the mixture wholly constituting waste.[38] In essence, the CJEU argued that if waste is mixed with non-waste to a degree where they become inseparable, the mixture always constitutes waste, as it would otherwise be possible to circumvent waste requirements by dilution. This reasoning is, of course, generally applicable for all processes where waste is used as an input material, be it the production of organic fertilizer, glass bottles, or clothing. It is not possible to remove the waste status of a substance or object by mixing it with something else, unless it is expressly stated by law, as is the case for, e.g., animal by-products per the ABP-regulation.[39] Instead, the only way to remove waste status is to recover the substance or object in the legal sense.

To clarify when a recovery operation is complete and to indicate that waste ceases to be waste, an 'end-of-waste' procedure was introduced in the 2008 WFD. The aim of the provision was to decrease the uncertainty regarding when a waste that has been treated to the state equal of a product ceases to be waste. Today the provision is found in article 6(1) WFD and reads:

Member States shall take appropriate measures to ensure that waste which has undergone a recycling or other recovery operation is considered to have ceased to be waste if it complies with the following conditions:

(a) the substance or object is to be used for specific purposes;
(b) a market or demand exists for such a substance or object;
(c) the substance or object fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products; and
(d) the use of the substance or object will not lead to overall adverse environmental or human health impacts.

Most member states (MS) have, with few exceptions, transposed the provision *in verbatim*.[40] For the purposes of utilizing sewage sludge, application of the provision provides for an interesting example. For a waste to cease to be waste in accordance with article 6(1) WFD, it must (1) undergo a recovery operation and (2) conform with the cumulative criteria (a)-(d). First, a 'recovery operation' per article 6 WFD ranges from simple processes such as cleaning or inspecting functionality to more complicated treatment pro-

[37] *Ibid.*, 533.

[38] Case C-629/19, *Sappi Austria* [2020] EU:C:2020:824, paras. 58–59.

[39] Regulation (EC) No 1069/2009 of the European Parliament and of the Council of 21 October 2009 laying down health rules as regards animal by-products … OJ L 300, 14.11.2009. If animal by-products are mixed with waste the mixture will wholly be treated as an animal by-product unless it contains hazardous waste or merely trace amounts of animal by-product, see Case C-634/17, *ReFood* [2019] EU:C:2019:443, para. 62 in conjunction with Joined Cases C-21/19, C-22/19, C-23/19, *P.F. Kamstra Recycling BV* [2020] EU:C:2020:636, paras. 58–59 and 61.

[40] European Commission, Directorate-General for Environment, *Study to assess member states (MS) practices on by-product (BP) and end-of waste (EoW): final report* (Publications Office 2020), 15.

cesses such as regeneration of acid.[41] For sewage sludge, aerobic or anaerobic digestion, or incineration are common methods of treatment and recovery.[42] Recovery is defined in article 3(15) WFD as:

> any operation the principal result of which is waste *serving a useful purpose by replacing other materials* which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy. [emphasis added]

The first requirement of a recovery operation is that waste will substitute other materials that would have otherwise been used. For example, if waste is burned to obtain energy, the waste has replaced other materials that would otherwise have been burned to obtain energy. The substitution requirement should not be interpreted too strictly, as the CJEU has asserted that, for the purposes of reaching end-of-waste, a recovery operation may be as simple as checking whether the conditions of article 6(1) WFD are fulfilled.[43] Recovery alone is, however, per article 6(1) WFD, not enough for cessation of waste status to be attained. This remains a contentious issue for stakeholders in the waste sector in general and sewage sludge management in particular. Chiefly, it may be challenging to assess conformity with the cumulative conditions. For sewage sludge in particular, it may be difficult, if not impossible, to show conformity with article 6(1b) WFD as the provision typically requires that the substance or object show a positive market price. As classification as 'waste' in itself is considered to be detrimental to market value, the condition also creates a self-fulfilling prophecy: the waste cannot cease to be waste due to no market value, and there is no market value due to waste status.[44] The applicability of article 6(1) WFD is discussed further in section 4.

For innovative solutions, the waste status becomes important as it determines what regulatory framework will be applicable, and consequently what is required for the permissibility of the intended action. The consequences of waste classification can be extensive, especially if the operation involves transboundary shipment or transfer of ownership. For instance, prior to a commercial transaction of waste, it must, as a main rule, be ascertained whether the buyer needs or has a permit to either treat, store, or transport waste.[45] While it is possible for a waste to cease to be waste prior to a transaction, the waste must in such a case show conformity with the requirements of article 6(1) WFD. This means that actors are faced with two options: either deal with the substance or object as a waste or recover the waste prior to the transaction. Here it should be noted that there is no set standard to illustrate that the requirements of article 6(1) WFD are fulfilled. The European Commission published a guidance document in 2012, but it offers scant explanation regarding the specific conditions of article 6(1a–d) WFD.[46] Equally important, most

[41] See Annex II of the WFD for a non-exhaustive list of recovery operations.

[42] See e.g. T Bauer, Sustainable Sewage Sludge Management: Addressing Multidisciplinary Challenges (PhD thesis, Luleå University of Technology 2023) or Bagheri, *supra* note 10.

[43] Case C-238/21, *Porr Bau* [2022] ECLI:EU:C:2022:885, para. 66.

[44] G van Calster, *EU Waste Law* (Oxford University Press 2015) 47.

[45] In Sweden, this was most recently the case in *Harrys Bilskrot* where the Swedish Land and Environmental Court of Appeal (MÖD) disallowed a 'self-picking' service at a scrapyard. As the scrapyard had not ascertained that the customers had the necessary permits to manage waste, they were not allowed to sell the scrap parts. See Judgement of the Environmental Court of Appeal of 31 May 2023, Case M 3735-20.

[46] European Commission, *Guidance on the interpretation of key provisions of Directive 2008/98/EC on waste* (2012) 22 *et seq.* N.B. for iron, copper and aluminum scrap, and

MS do not provide for the possibility to ascertain whether 'end-of-waste'-status has been achieved by a government authority. In fact, the CJEU has in *Tallina Vesi* asserted that article 6(1) WFD does not obligate MS to recognize that 'end-of-waste'-status has been achieved.[47] This means that the 'end-of-waste' assessment made by an operator may be challenged by administrative authorities after the fact. Consequently, as mismanaging waste often carries criminal liability, this has been considered a 'risky approach'.[48] To safeguard their decisions, stakeholders in MS, such as Sweden, have requested that an 'end-of-waste' procedure that involves a government decision should be established. As of yet, this, however, has not been established in Sweden and is uncommon in other MS.[49] Interestingly, the Swedish transposition of article 6(1) WFD has resulted in a situation where the authorities, in many cases, cannot provide a decision regarding 'end-of-waste', even if they wanted to. In *Econova Recycling*, the Swedish Environmental Court of Appeal determined that the supervisory authorities are only empowered to make the necessary decisions to ensure that the Swedish Environmental Code is not infringed. As demonstrating 'end-of-waste'-status does not in itself imply that the Code is infringed, supervisory authorities are only empowered to make decisions concerning 'end-of-waste' when it is decisive in determining potential infringement, such as whether a transport concerns a shipment of waste or non-waste.[50]

3. Sewage Sludge

Waste is within the EU regulated through the WFD and its daughter acts. The WFD contains provisions for the management of waste in general and provides for a minimum level of environmental protection that must be observed by all waste management activities within the EU. The WFD is applicable to various waste fractions, ranging from relatively homogenous waste streams, such as agricultural residues, to heterogenous waste streams, such as mixed municipal waste. The wide range of waste fractions covered implies that it is hard to provide for detailed provisions in one framework directive. Instead, detailed provisions for various waste management operations, such as shipping or incineration, and waste fractions, such as sewage sludge or electronic waste, are provided by daughter acts to the WFD. For sewage sludge, detailed provisions are found in the Sewage Sludge Directive (SSD).[51]

Regarding waste classification of sewage sludge, the CJEU has proclaimed in *Sappi Austria* that '[i]t is common knowledge that residential or municipal waste water is to be regarded as a substance which its holder discards.'[52] Consequently, the residual from its treatment – sewage sludge – was due to its origin and unavoidable nature considered as a waste in a legal sense by the CJEU.[53] However, by virtue of article 2 WFD, some waste fractions are wholly or partially excluded from the scope of the Directive, including

certain waste-based fertilizers, explicit end-of-waste regulations containing explicit indicators, such as content of foreign material etc., exist.

47 Case C-60/18, *Tallinna Vesi* [2019] ECLI:EU:C:2019:264, para. 30; N.B this verdict was made under the original wording of article 6(1) WFD, which means that it is not certain that the CJEU would reach the same conclusion today.

48 AM Ragossnig and DR Schneider, 'Circular economy, recycling and end-of-waste' (2019) 37 *Waste Manag Res* 109, 110.

49 European Commission, *supra* note 40, 16–28.

50 Judgement of the Environmental Court of Appeal of 31 May 2023, Case M 3735-20 (available in Swedish).

51 Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture OJ L 181, 4.7.1986.

52 Case C-629/19, *supra* note 38, para. 59.

53 Case C-629/19, *supra* note 38, paras. 46, 47 and 62.

the definition of waste. Wastewater is a fraction that may be partially excluded from the WFD in accordance with article 2(2a):

> The following shall be excluded from the scope of this Directive to the extent that they are covered by other Community legislation:
> (a) waste waters; […]

The partial exclusion implies that waste water is omitted from the scope of the WFD to the extent that it is covered by other Community legislation.[54] Prior to the enactment of the 2008 WFD, the CJEU noted in *Thames Water* and *Avesta Polarit* that not only legislation on EU-level but also national legislation could exclude the applicability of the WFD.[55] This is no longer the case, as since the enactment of the 2008 WFD, article 2(2) explicitly refers to Community legislation. Regardless, article 2(2) WFD, which still only allows for partial exclusions, must be interpreted restrictively, and requires that application of other legislation achieve the same level of environmental protection as application of the WFD would.[56] Nevertheless, due to the partial exclusion of waste water, there has been some confusion regarding the exclusion of the residual of its treatment: sewage sludge.

In the above-mentioned case *Sappi Austria*, a case which concerned the waste status of sewage sludge prior to co-incineration, the CJEU was faced with the question and determined that the SSD only regulates a specific recovery operation, agricultural use of sewage sludge on arable land. Sewage sludge is in large not excluded from the scope of the WFD and must therefore be handled as a waste in accordance with the framework present in the WFD.[57] The CJEU highlights that the potentially applicable legislation, the Urban Waste Water Treatment Directive (UWWD),[58] does not provide for the same level of environmental protection as the WFD in relation to sewage sludge, and consequently, sewage sludge cannot be excluded from the scope of the WFD by virtue of being covered by the UWWD.[59] However, the CJEU did not deliberate upon whether the environmental protection provided by the SSD would be enough for exclusion. Instead, the CJEU asserts that the SSD is irrelevant for the purposes of classifying sewage sludge prior to incineration (as the SSD only regulates agricultural use).[60] It is likely that the SSD does not reach the standard of protection mandated by the WFD as it is largely based on scientific knowledge from the mid 1980's and has, therefore, been considered outdated by the wastewater treatment sector and the European Commission alike.[61] Considering that the CJEU

[54] The treatment of wastewater was at the time covered by Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment, OJ L 135/40, 30.5.1991 (UWWD). Sewage sludge was to an extent also covered by the UWWD. Article 14(1) of the UWWD prescribed that sewage sludge should be re-used whenever appropriate, and that disposal of sludge is subject to general rules or registration or authorization. The UWWD does, however, not contain any detailed provisions relating to how sludge should be treated or used. The Directive has since been amended, and the corresponding provision is today found in article 20 of Directive (EU) 2024/3019 of the European Parliament and of the Council of 27 November 2024 concerning urban wastewater treatment, OJ L, 2024/3019, 12.12.2024.

[55] C-252/05, *Thames Water* [2007] ECLI:EU:C:2007:276, para. 33; Case C-114/01, *AvestaPolarit* [2003] ECLI:EU:C:2003:448, para. 49.

[56] Case C-252/05, *supra* note 55, para. 34; Case C-114/01, *supra* note 55, para. 60; Case C-629/19, *supra* note 38, para. 36.

[57] Case C-629/19, *supra* note 38, paras. 38–39.

[58] Directive 91/271/EEC, *supra* note 54.

[59] Case C-629/19, *supra* note 38, paras. 37–39.

[60] Case C-629/19, *supra* note 38, para. 38.

[61] Cf. L Ekman-Burgman and B Wallsten, 'Should the Sludge Hit the Farm?: – How Chemo-Social Relations Affect Policy Efforts to Circulate Phosphorus in Sweden' (2021) 27 *Sustainable Production and Consumption* 1488, 1489; A Nilsson, 'Avloppsslam som gödselmedel? Om normhierarkier, normkonflikter och principer förlag-

in *KVZ Retec* determined that the exclusions should be interpreted restrictively, it is likely that sewage sludge under no circumstances is excluded from the WFD.[62]

4. Incineration of Sewage Sludge

Like all waste incineration, incineration of sewage sludge is regulated by the Industrial Emissions Directive (IED).[63] The IED provides for an exhaustive framework for industrial emissions in general.[64] This includes emission limits for combustion, incineration, industrial tanning, or livestock rearing.[65] Notably, the IED only applies to 'industrial activities',[66] but does not clarify what 'industrial activities' are, other than that research activities are not included. Jans and Vedder (2012) have noted that it follows from Annex I of the IED that the Commission shall establish guidance regarding certain activities of the Annex.[67] Annex I, however, cannot be seen as an exhaustive list of the activities covered by the Directive. It should also be mentioned that research activities on an industrial scale are not excluded, such as trials of emerging technologies. Notably, since the adoption of the 'IED 2.0' in 2024, the possibility for derogations for trials of emerging technology has been extended. It now follows from article 27b that temporary derogations may be granted for a period up to 30 months (as opposed to the prior 9 months) to evaluate emerging technologies on an industrial scale.

All activities covered by the IED are considered environmentally hazardous and require that MS establish a permit or notification procedure for such activities in accordance with article 4 IED.[68] This includes incineration of sewage sludge. Both new and 'substantially changed' operations must acquire a permit per article 4–5 IED. A substantial change is a change that carries a change in the nature or functioning, or an extension of the operation that may have significant negative effects on human health or the environment.[69] The permit shall contain conditions, or reference to generally binding rules, that will ensure that the operation fulfills the requirements of the IED.[70] The CJEU has noted in *Ilva and Others* that it is not enough to limit the permit conditions to substances that may foreseeably be present without accounting for the emissions generated in practice.[71] Additionally, operators must show that best available technology (BAT) is used in accordance with article 11 IED. In general, the requirements of the IED vary between different operations. For incineration of waste, the requirements of the IED are largely a codification of the old Waste Incineration

tolkning' In L. Gipperth, & C. Zetterberg (eds), *Miljörättsliga perspektiv och tankevändor* (Iustus förlag 2013) 371, 371; European Commission, Communication from the Commission: Consultative Communication on the Sustainable Use of Phosphorus COM (2013) 0517 final, 18.

[62] C-176/05 *KVZ Retec* [2007] ECLI:EU:C:2007:123, para. 46.

[63] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) OJ L 334, 17.12.2010. N.B. In 2024, the EU has adopted the Industrial and Livestock Rearing Emissions Directive (IED 2.0), which amends the IED. Notably, through the IED 2.0 circular economy is included as an explicit goal of the IED. The provisions for waste-incineration remain largely unchanged. See Directive (EU) 2024/1785 … OJ L, 2024/1785, 15.7.2024 art. 1.

[64] JH Jans and HHB Vedder, *European Environmental Law: After Lisbon* (Europa Law Publishing 2012) 365. N.B A fifth edition of the book has been published in 2024, however, in the fifth edition, chapter 8, which concerns secondary law, is omitted. This means that the fourth edition still contains the up-to-date reference. This distinction follows from Article 3(12) WFD.

[65] See Articles 2, 10 and Annex I IED.

[66] Article 2 IED.

[67] Jans and Vedder, *supra* note 64, 364.

[68] Article 4(1) IED.

[69] Case C-43/21, *FCC Česká* [2022] ECLI:EU:C:2022:425, paras. 33–4.

[70] Articles 4–6 IED.

[71] Case C-626/22, *Ilva and Others* [2024] ECLI:EU:C:2024:542, para. 117.

Directive,[72] whereas the provisions for incineration of non-waste are largely a codification of the old Integrated Pollution Prevention and Control Directive (IPPC).[73]

For waste incineration or waste co-incineration plants, there are stricter rules pertaining to emission control, operation conditions, and delivery and reception of feedstock. These stricter rules stem from the typically heterogenous (and unknown) composition of waste. Consequently, waste incineration or waste co-incineration plants usually have more advanced flue-gas cleaning systems that can handle the wide range of chemical variations in the waste and feature a more controlled storage of feedstock. For example, during delivery and reception of feedstock, the operator of a waste incineration plant, including co-incineration plants, must take all necessary measures to prevent or minimize pollution of the air, soil, surface water, and groundwater (article 52 IED). Additionally, they should mitigate other negative environmental impacts that may occur during reception and delivery, such as odors and noise. There are no corresponding explicit requirements for delivery or reception of non-waste feedstock. However, precautions during delivery and reception may be necessary due to article 11 IED, which requires MS to ensure that plants take all the appropriate preventive measures to mitigate pollution, and that no significant pollution is caused. As article 11 IED already requires that the necessary precautions are made to mitigate pollution, the requirements of article 52 IED may, to an extent, be superfluous.[74] At the same time, the existence of a more rigorous provision for waste incineration and co-incineration plants provides for clarity and suggests that the Directive is enacted under the presumption that waste is more hazardous than their virgin counterparts.

A similar observation can be made in relation to the operating conditions for waste incineration and waste co-incineration plants. It follows from article 50(2) IED that a temperature of at least 850 °C for non-hazardous waste and 1 100 °C for some hazardous waste must be maintained for at least two seconds during incineration.[75] The latter only applies to hazardous waste that contains halogenated organic substances, expressed as chlorine.[76] Principally, however, hazardous and non-hazardous waste is subjected to largely the same requirements.[77] Nevertheless, the tempera-

[72] Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste OJ L 332/91, 28/12/2000.

[73] Directive 2008/1/EC of the European Parliament and of the Council of 15 January 2008 concerning integrated pollution prevention and control, OJ L 24/8, 29/01/2008.

[74] Interestingly, one shortcoming of the legal framework prior to the adoption of the IED in 2010 was, according to the Commission, lack of coherence. See European Commission, Proposal for a Directive of the European Parliament and of the Council on industrial emissions (integrated pollution prevention and control) COM (2007) 843 final 5. To some degree, the IED still demonstrates incoherence between its different chapters. For example, for waste incineration and waste co-incineration there are explicit emission limits stated in Annex VI IED, whereas for incineration of non-waste the emission limits largely follow from an individual permit (however, cf. Annex V IED).

[75] In individual cases, higher temperatures than what the law mandates may, however, be required to remove certain contaminants. For example, a temperature of 1000 °C is required for removal of heavy metals from sewage sludge, see G Hui et al., 'An overview of removing heavy metals from sewage sludge: Achievements and perspectives' (2020) 266 *Environmental Pollution* 115375, 7.

[76] The higher temperature requirements for halogenated organic substances was a contentious issue when the initial waste incineration directive was to be adopted. The Parliament initially wanted specific strict standards for incineration of Polyvinyl Chloride (PVC or Vinyl). Ultimately, this was not accepted, and the Parliament had to settle for the current solution. See van Calster *supra* note 44, 191.

[77] In the amended proposal for a waste incineration directive, the European Commission noted that the distinction between hazardous and non-hazardous waste follows from the properties of the waste but that this matters less if the same level of emissions is maintained

ture requirements reflect the basic aim of waste incineration: heat generation, destruction or immobilization of contaminants, and reduction of volume.[78] The presumption is, that incineration of waste is more hazardous than incineration of a virgin fuel. As mentioned in the introduction, Tromans (2001) and Gillespie (2015) have noted that a plausible rationale for diverging requirements are economic considerations. Typically, waste will be disposed of as cheaply as possible. Often it is cheap to incinerate it. However, if it is economically advantageous to utilize waste this argument weakens. For example, end-of-waste criteria for precious metals have been considered redundant, as precious metals very rarely get discarded due to their value.[79] A more persuasive argument is that the requirements are based on the precautionary principle, especially for incineration of heterogenous waste where the unknown composition warrants a higher degree of caution. The composition may be unknown both due to the waste being mixed (such as municipal solid waste or sewage sludge) or the origin being unknown (such as a barrel of unknown content). Thus, control of additional substances, like lead or mercury, is warranted as these can before the fact be excluded when using a homogenous virgin fuel. If, however, mercury, lead, or any similarly hazardous emission is caused by a virgin fuel, they must be covered by emission limits in a permit.[80]

In connection to this, in the amended proposal for a waste incineration directive, the European Commission noted that the distinction between hazardous and non-hazardous waste follows from the properties of the waste, but that this matters less if the same level of emissions are maintained, at least from the perspective of environmental protection.[81] This is an important argument, and the same can be applied to the incineration of waste and non-waste. The input material matters less if the output, emissions, ash, etc., is the same. Yet, in addition to monitoring additional substances, the average daily emission limit for, for example, sulfur dioxide (SO_2) is up towards eight times lower for waste than for non-waste.[82] Conversely, it has been noted by Alaranta and Turunen (2020) that higher levels of Cadmium (Cd) are allowed for in recycled plastic (0.1%) than virgin plastic (0.01%).[83] Their observation reflect the reality of the variance in quality of waste. At the same time, it in practice enables products manufactured from waste to be of lower quality, which in turn *inter alia* provides for reduced legitimacy.[84] It also illustrates that diverging requirements may be necessary to make operations practically feasible.

5. Waste Status Prior to Incineration

It follows from the above that it is pivotal to determine what will be incinerated at a plant, as this will determine the applicable rules, and thus which precautions are necessary. From a prac-

(European Commission, Amended proposal for a European Parliament and Council Directive on the incineration of waste (2000/C 150 E/01), COM (1999) 330 final, 3 Art. 6(b). Cf. Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste OJ L 332/91, 28.12.2000, recital 16).

78 Neuwahl et al., *supra* note 23, p. 1.

79 A Villanueva et al., Study on the selection of waste streams for end-of-waste assessment (European Commission Joint Research Centre, EUR 24362 EN, 2010) 5–6.

80 Case C-626/22, *supra* note 71, paras. 113–14.

81 European Commission, *supra* note 77 and Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste OJ L 332/91, 28.12.2000, recital 16.

82 For non-waste, Annex V Part 1(2) allow daily emissions up towards 400 mg/Nm^3 depending on feedstock and thermal input (ranging from 200–400 mg/Nm^3). For waste, however, the same emission limit is a fixed 50 mg/Nm^3 per Annex VI Part 3(1.1) and Annex VI Part 4(2.3).

83 Alaranta and Turunen, *supra* note 12, 12.

84 Alaranta and Turunen, *supra* note 12, 18.

tical perspective, Hannl et al. (2024) note that classifying sewage sludge as a usable fuel is an arduous task due to the waste streams' heterogeneity.[85] From a legal perspective, sewage sludge is either a 'waste' or a 'non-waste', although classification may be arduous from a legal perspective as well. While the CJEU in *Sappi Austria*, as noted above, concluded that untreated sewage sludge is a waste in the legal sense, the waste status of sewage sludge may become uncertain depending on how the sludge is treated. The CJEU proclaims in the same case that it is possible for sewage sludge to cease to be waste – attain end-of-waste status – prior to incineration, granted that conformity with article 6(1) WFD is demonstrated.[86]

For the purposes of co-incinerating straw fuel with treated sewage sludge, it is first worth noting that converting sewage sludge into a suitable fuel, such as through briquetting, dewatering, or drying, can itself be regarded as a recovery operation. Recovery and recycling include not only processes where a waste material directly replaces another material, but also processes in which waste is prepared so that it can be used as a raw material in other operations. A common example is the production of pellets from waste wood chips for use as fuel in pellet boilers. In the 2012 guidance, the European Commission noted that a recovery operation may be as simple as ascertaining the working condition of a substance or object.[87] In such cases, the CJEU clarified in *Mastrodonato* that the recovery operation must result in a product that is suitable for its intended purpose, taking into account the most recent state of scientific and technical knowledge.[88] Following this reasoning, the creation of a briquette for the purpose of use as fuel in a district heating plant can be regarded as a recovery operation given that the briquette is a suitable fuel. Recovery alone is, however, not enough to demonstrate compliance with article 6(1) WFD. It must also be demonstrated that (a) there is an intended use; (b) there is a market or demand; (c) the intended use is lawful and complies with technical standards; and (d) the intended use carries at least neutral environmental impacts.

As for (a), creating a usable fuel in the form of a briquette shows that there is a specific use for the sludge in question. The CJEU has, however, noted in *Prato Nevoso* that 'end-of-waste' must be assessed on a case-by-case basis, which means that it is not possible to grant 'end-of-waste' before the fact.[89] This means that criterion (a) must be read in conjunction with criterions (b)-(d). In other words, it must be determined if there is a market or demand for this particular use of the substance or object; if this particular use is legal and complies with technical standards; and, finally, if this particular use of the substance or object carries with it at least neutral environmental impacts.[90]

It is harder to show general compliance with (b), the existence of a market or a demand for such briquettes, than with (a). While previous research has shown that there are potential benefits associated with using sludge briquettes as an additive, there is currently no demonstrable market for this product.[91] While specific buy-orders may be enough to demonstrate compliance with the criterion in individual cases, the marketability of the substance or object as the waste-

[85] Hannl et al., *supra* note 20, 2.
[86] Case C-629/19, *supra* note 38, para. 69.
[87] European Commission, *supra* note 46, 30.
[88] Case C-147/15, *Mastrodonato* [2016] ECLI:EU:C:2016:606, para. 45.
[89] Case C-212/18, *Prato Nevoso* [2019] ECLI:EU:C:2019:898 para. 50.
[90] *Id.* para. 55.
[91] This is, of course, not surprising as the operation is not deployed on commercial scale yet.

status still becomes uncertain as each individual consignment would have to pass this criterion.

As for (c), incinerating the briquette for energy must comply with the rules applicable to non-waste, i.e. Chapter III of the IED. Ironically, these requirements are less strict than those for waste, meaning that compliance must instead be shown with potentially more lenient standards. From a systematic perspective, this can be seen as a shortcoming of the regulatory framework. One purpose of waste law is to control how waste is managed and to maintain a certain level of environmental protection.[92] This purpose is undermined if a substance or object can cease to be waste simply by meeting lower environmental requirements.

This issue becomes more pronounced given that corresponding rules for waste incineration impose stricter obligations. At the same time, it may be argued that the provision works as intended, as it excludes material that is of equal quality to a virgin counterpart. The substantive IED rules for waste incineration, however, concern not only emission limits but also operating conditions such as purification requirements and tighter control during shipping and receiving. These requirements relate less to the properties of the waste itself and more to the operation of the plant.

Moreover, there are no definitive prohibitions on fuels that may be used for energy production; permissibility is assessed case by case. This reflects the underlying idea that the input matters less than the output. From a sustainability perspective, however, the input does matter. Promoting renewable energy over fossil fuels is a core objective of EU energy policy, whereas in waste policy, incineration (energy recovery) represents the least preferred form of recovery in the waste hierarchy.[93] Accordingly, granted that mono or co-incineration of a sludge briquette complies with the requirements of the IED, the use can be considered lawful.

The fourth requirement, condition (d), is likely the most difficult to assess, as there are no objective indicators to reference. Whether there is a use, a market, and whether the use is legal and complies with technical standards can be clearly demonstrated, e.g., through buy-orders and specifications. But as article 6(1d) requires that the use cannot lead to overall adverse environmental or human health impacts, it requires more extensive assessment. The European Commission (2012) notes that compliance can be indicated by a comparison between the use of the substance or object under relevant product legislation with the same use under waste legislation.[94] In relation to this, in *Inter Environment*, AG Jacobs has previously expressed that special attention must be given to what provisions apply if waste legislation ceases to apply and subsequently, if the application of those provisions are disadvantageous for the environment.[95] This has since been confirmed in *Prato Nevoso*, where the CJEU concluded that the use of the waste as a product should not imply any greater (negative) effects on the environment than it would under the waste regime.[96]

Interestingly, Van Calster (2015) has noted that stricter emission limits for dioxins and furans was one key objective of the first harmo-

[92] Cf. Article 1 WFD.

[93] See e.g., Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources, OJ L 328/82, 21.12.2018, recital 2.

[94] European Commission, *supra* note 46, 24.

[95] Opinion of Mr AG Jacobs in Case C-129/96, *supra* note 28, paras. 43–48.

[96] Case C-212/18, *supra* note 89, para. 55. The CJEU reached a similar conclusion in *Mayer Parry*, see Case C-444/00, *Mayer Perry* [2003] ECLI:EU:C:2003:356 paras. 73–74.

nized waste incineration directive.[97] As of writing, strict limit values for the presence of dioxins and furans during waste incineration and co-incineration follow from chapter IV and Annex IV IED. For example, over a sampling period of a minimum of 6 hours and a maximum of 8 hours, tetrachlorodibenzodioxin (TCDD) cannot exceed 0,1 ng/Nm^3 and octachlorodibenzodioxin (OCDD) cannot exceed 0,0001 ng/Nm^3. However, there are no corresponding provisions for incineration of non-waste.[98] This means that applying product legislation to waste that may emit dioxins or furan during incineration will always imply a lower level of environmental protection. At the same time, it can be argued that since waste legislation in general provides for a high level of environmental protection, the standard protection will always be lower if product legislation is applied. In connection with this, Turunen (2018) notes that negative effects from continued waste classification should also be accounted for. He mentions, for example, emissions associated with shipping virgin materials as opposed to utilizing local waste.[99]

All in all, the procedure aims to ensure that the waste-based risks are eliminated. To thereafter determine if the creation of a sludge briquette for the purposes of co-incineration complies with this standard of review is an arduous task. The fact that the chemical composition of the sludge is not altered suggests that the risks are not eliminated, although it is allowed to use the same sludge as fertilizer in agriculture. Moreover, it is arguably 'safer' from an environmental protection perspective to immobilize contaminants through incineration than to spread them on agricultural land.

6. Waste Status After Incineration

As noted earlier, the waste status of a material is decisive for determining which regulatory framework applies to its incineration. It is equally relevant for the subsequent use and marketability of the resulting residual, namely, the ash. When sewage sludge is applied to arable land as fertilizer, it normally falls under the SSD rather than the WFD.[100] By contrast, fertilizer derived from ash generated during the incineration of sewage sludge is governed by the general waste rules in the WFD, since ash is typically regarded as a substance discarded by its holder and is not excluded from the scope of the WFD. Following its generation, the holder of the ash may therefore either manage it in accordance with the provisions applicable to waste or seek to have the ash recognized as a product.

Classification as a product may occur either under the Fertilizer Regulation (FR),[101] if CE-marking is intended, or pursuant to the general exclusions under the WFD, namely, as a by-product (article 5(1)) or through the attainment of end-of-waste status (article 6(1)). Here, it should be noted that CE-marking is not mandatory, and ash-derived fertilizer may be marketed and utilized without CE-classification per the regulation, granted that the utilization is done in accordance with national rules.[102] For non-CE

[97] van Calster, *supra* note 44, 190. See also European Commission, Proposal for a Council Directive on the incineration of waste COM (1998) 0558 final, 11.

[98] Emission limits for both dioxins and furans may, however, follow from a permit condition. See article 14(1a) and Annex II IED.

[99] T Turunen, *The Concepts of Waste and Non-Waste in the Circular Economy* (PhD thesis, University of Eastern Finland 2018) 99.

[100] This follows from the partial exclusion found in article 2 WFD.

[101] Regulation (EU) 2019/1009 of the European Parliament and of the Council of 5 June 2019 laying down rules on the making available on the market of EU fertilising products … OJ L 170/1, 25/06/2019.

[102] Recital 5 FR. Whether the conformity with the new regulation should be optional was discussed at length during the legislative process. Ultimately, the Commission decided that fertilizers should only be subjected to

fertilizers, however, national legislation becomes decisive. MS retain discretion to impose stricter rules or even prohibitions on the use of materials derived from sewage sludge in agriculture, including setting lower contaminant limits, requiring permits, or adopting precautionary bans. These domestic frameworks are therefore directly relevant for determining 'lawfulness of use' under Articles 5(1d) and 6(1c) WFD, since the permissibility of placing ash-derived products on the national market cannot be assumed from EU-level rules alone.

Regarding the CE-marking per the FR, it follows from article 1(2a) when sewage sludge is used in agriculture, it is excluded from the scope of application of the FR. The same does, however, not apply when ash derived from incineration of sewage sludge is used as fertilizer. Here follows from component material category 13 (CMC) that ash derived from incineration (oxidation) of sewage sludge may be accepted as an input material for fertilizer production.[103] Concerning waste status and the cessation thereof, the FR establishes indicators distinct from those under Article 6(1) WFD. Pursuant to Article 19 FR, a waste ceases to be waste once it forms part of a compliant EU fertilizing product. Thus, where a waste material is used as an approved input under the FR, the conditions of Article 6(1) WFD are deemed to be satisfied without the need for an independent assessment. Although the conceptual approach differs, the underlying criteria largely overlap. Inclusion in a compliant fertilizer demonstrates both a use (condition a) and the existence of a market (condition b), while lawfulness of use (condition c) is inherent in compliance with the FR. The principal difference concerns (condition d), as the FR does not require a separate assessment of environmental benefits; compliance with the Regulation is sufficient to establish that the intended use does not entail adverse effects.

Alternatively, the holder may seek recognition of the ash as a by-product under article 5(1) WFD. According to article 5(1) WFD, substances or objects that are a secondary result of a production process, for example, ash from incineration, may be considered non-waste, granted that the residue meets the conditions of article 5(1) WFD. A strict interpretation of 'production process' may appear to exclude recovery operations; however, CJEU case law provides a more nuanced picture. In *Palin Granit* the CJEU stated that residuals from a 'manufacturing or extraction process' may be regarded as a by-product.[104] This wording has since been reused by the CJEU.[105] In relation to the re-utilization of sewage sludge, the CJEU has determined that article 5(1) WFD may be applicable to sewage sludge but that its management also requires special precautions, which indicates that it is a waste.[106] The CJEU has neither explicitly applied article 5(1) to residues from recovery operations, nor precluded such an application. In *Sappi Austria* the CJEU, however, noted that it was not necessary in that instance to examine whether the sewage sludge in question was a 'by-product'; waste-status was already demonstrated.[107] Regardless, it is reasonable to assume that the provision would be applicable to residues from recovery processes, granted that the subsequen-

the regulation if the holder of the fertilizer wishes to CE-mark the fertilizer, see European Commission, Commission Staff Working Document: *Impact Assessment* SWD (2016) 64 final, 17 March 2016, accompanying COM (2016) 157 final, ch. 5, 27–34.

[103] CMC 13(1e) and CMC 14 FR.

[104] Case C-9/00, *Palin Granit* [2002] ECLI:EU:C:2002:232, para. 34.

[105] Case C-235/02, *supra* note 33, para. 35; Case C-457/02, *supra* note 33, para. 44; Case C-629/19, *supra* note 38, para. 51.

[106] Case C-629/19, *supra* note 38, paras. 45–47.

[107] Case C-629/19, *supra* note 38, paras. 51–52.

tial use is both certain and environmentally as well as economically beneficial.

Granted that article 5(1) WFD is applicable, ash stemming from co-incineration of sewage sludge and straw fuel may be excluded from the scope of application of the WFD. This, however, requires that the cumulative conditions of article 5(1) WFD are met. The conditions are similar to those of article 6(1) WFD mentioned above. First, the holder of the residue must show that further use of the object is certain. There is no standard to follow to demonstrate certainty of further use, but economic benefits or the existence of an established market may be guiding.[108] Second, the residue cannot be subjected to any further processing that is not normal industrial practice. Here, the intention is to exclude residues that require treatment akin to the treatment of waste. This requirement has, nevertheless, been highlighted as potentially excluding innovative practices as they typically cannot be considered normal due to their novelty. Application of this condition requires the holder to determine whether (a) any treatment is necessary and (b) whether that treatment is normal industrial practice. Examples of normal industrial practice include washing, cleaning, or modification of size or shape.[109] Third, the residue must be produced as an integral part of a production process. To an extent, this requirement is self-explanatory; the residue must be a result of the production process in question. The European Commission (2012) notes that flue gas desulphurisation (FGD) gypsum, a residue from flue gas cleaning during incineration of fossil fuels, fulfills this condition. Similarly, it is reasonable to assume that ash stemming from incineration also fulfills this condition. Fourth, future use must be both lawful and carry with it at minimum a net benefit for the environment. Similarly, to end-of-waste, this condition requires that it be demonstrated that the residue complies with the legal requirements for their virgin counterpart. Here, it can be noted that if there are no corresponding requirements for virgin materials, the use is, of course, lawful, granted that its use is not specifically forbidden.[110]

In connection to the lawfulness of use, the FR does not allow for by-products that are a direct result of either incineration or pyrolysis of waste to be used as an input material for fertilizer.[111] In practice, this means that the by-product status as well as end-of-waste-status of ash derived from mono- or co-incineration of sewage sludge is largely redundant if the holder intends to market it as CE-fertilizer per the FR. This is because the ash must comply with the substantive requirements of the FR irrespective of whether it is classified as waste or non-waste under the WFD to be CE-marked.[112]

Finally, it is important to situate this analysis within the broader EU sustainability framework. Phosphorus is recognized as a critical raw material,[113] and the revised Urban Wastewater Directive encourages the development of nutrient-recovery pathways from sewage sludge.[114] At the same time, the waste hierarchy places energy recovery among the least preferred options, while agricultural land application of sewage sludge raises increasing environmental concern. Ash-based phosphorus recovery is therefore

[108] Turunen, *supra* note 99, p. 84.
[109] European Commission, *supra* note 46, pp. 17–18; Turunen, *supra* note 99, p. 85.
[110] European Commission, *supra* note 46, p. 20.
[111] CMC 11(1f–g) FR.
[112] See Annex IV, Part II, Module D1 FR.
[113] Regulation (EU) 2024/1252 of the European Parliament and of the Council of 11 April 2024 establishing a framework for ensuring a secure and sustainable supply of critical raw materials … OJ L, 2024/1252, 3.5.2024, Annex II Section 1(z).
[114] Directive (EU) 2024/3019, *supra* note 54, Recital 42 and Art. 20.

viewed as a potential compromise strategy, yet the regulatory framework remains fragmented between waste law, fertilizer law, and national discretion. These systemic tensions underscore the importance of clarifying the legal status of sewage-sludge ash to support coherent policy implementation.

7. Conclusion

Waste status is decisive for incineration of sewage sludge or sewage sludge-derived products as it determines the applicable regulatory framework and, consequently, the legal requirements. Additionally, the legal requirements vary depending on whether the substance or object is incinerated as a waste or non-waste. This in turn affects the necessary precautions and makes certainty of waste-status paramount. At the same time, the European Commission has noted that the relevant factors for incineration are, in principle, not the input, but the output.

Whether a substance or object constitutes a waste relies upon the definition of waste found in article 3(1) WFD, a definition that is neutral in the sense that it does not rely on physical or chemical characteristics of a substance or object. Instead, the definition relies upon whether the substance or object has been discarded. Regarding sewage sludge, the CJEU has noted that sewage sludge is typically something that is discarded by its holder. This means that when sewage sludge is used as a fuel, the rules pertaining to incineration of waste are applicable if waste-status is maintained. Consequently, sewage sludge cannot be co-incinerated with virgin fuels unless (a) relevant waste or co-incineration rules are adhered to or (b) the sewage sludge loses waste-status prior to incineration.

For sewage sludge to lose its waste-status it must be recovered. Additionally, it must conform with the corresponding national rule that codifies the conditions of article 6(1) WFD. For most MS, these conditions are codified *in verbatim*. Interestingly, for the purposes of incineration, article 6(1c) requires that the contended waste conforms with laxer requirements than those that would apply if waste status were maintained. As noted above, the CJEU has in *Prato Nevoso* determined that article 6(1d) WFD requires that the environmental impacts are at least neutral for the condition to be fulfilled. Likely, this means that even if the intended use is lawful, the waste cannot cease to be waste if the environmental impacts would be greater if non-waste legislation is applied. To an extent, this is rational as it means that waste cannot cease to be waste by virtue of complying with a lower standard. At the same time, it means that it is, in principle, permitted to incinerate non-waste that result in higher environmental impacts than it would if the non-waste were incinerated according to the requirements for waste incineration.

Regarding utilization of the ash and consistency of the regulatory framework, it can be noted that if sewage sludge is used directly as a fertilizer in accordance with the rules of the SSD, the allowed concentration of certain pollutants, such as cadmium or mercury, is up towards 20 times higher than when ash derived from sewage sludge is used as an input material for CE-marked fertilizer.[115] This discrepancy highlights a regulatory tension: the shift from the SSD to the FR not only changes the applicable legal framework but also results in substantially stricter contaminant thresholds for materials stemming from the same original source. The stricter contaminant limits under the FR reflect its harmonized and market-oriented scope, aimed at ensuring a high level of environmental and human-health protection in cross-border fertilizer trade. At the same time, the comparatively lenient limits under the SSD underscore

[115] Cf. Annex I PFC1 FR and Annex 1B SSD.

its function as a minimum harmonization instrument primarily focused on safe land application within national boundaries. Consequently, the regulatory pathway chosen for the material, direct land application versus conversion into a fertilizer product, significantly influences both the legal status and the permissible environmental risk profile of the substance.

In conclusion, the waste status of sewage sludge plays a critical role in determining the regulatory framework for its incineration, impacting the legal requirements and necessary precautions. The process for sewage sludge to lose its waste status involves recovery and compliance with national rules transposing article 6(1) WFD. The environmental impact considerations, as highlighted by the CJEU, ensure that waste cannot be reclassified to non-waste if it results in greater environmental harm. Additionally, the utilization of ash from incinerated sewage sludge as an input material under CMC 13 demonstrates a different regulatory approach compared to the direct use of sewage sludge as fertilizer, emphasizing the importance of consistent regulatory standards to manage pollutant concentrations effectively.