Electricity production and emission standards

de Graaf, Kars J.; Braaksma, Lolke

Published in:
Energy Law, Climate Change and the Environment

IX.29 Electricity production and emission standards

Kars J de Graaf

Professor of Public Law and Sustainability, Groningen Centre of Energy Law and Sustainability (GCELS), Faculty of Law, University of Groningen, The Netherlands

Lolke S Braaksma

PhD candidate, Groningen Centre of Energy Law and Sustainability (GCELS), Faculty of Law, University of Groningen, The Netherlands

Abstract

Electricity generated from fossil fuels negatively impacts the environment to a significant degree. To prevent and control emissions from such electricity production, most jurisdictions have issued legal regimes setting specific emissions standards. The Best Available Techniques (BATs) concept provides a technology-based tool to set Emission Limit Values (ELVs) for large industrial installations, specifically power plants using fossil fuels. This chapter provides two relevant examples of this concept: the Clean Air Act in the United States of America and the Industrial Emission Directive in the European Union.

Keywords

Environmental protection, electricity production, emission standards, Emission Limit Values (ELVs), polluting substances, Best Available Techniques (BATs), Best Available Control Technology (BACT)

Contents

IX.29.1 Introduction: technology-based emission standards

Electricity production has long caused significant negative environmental impacts. Despite growing global efforts to decarbonise electricity production and increase the share of renewable energy, the use of non-renewable sources (like coal, oil, lignite, and natural gas) remains widespread. This has multiple drawbacks, one of which being the negative environmental impact of emissions, *i.e.* the direct or indirect release of substances, vibrations, heat, or noise from individual or diffuse sources into air, water,

or land. Of greatest concern is the link between using carbon-based energy sources and climate change, which is a result of the emission of greenhouse gases (GHGs), such as carbon dioxide. However, using fossil fuels for electricity production also results in the emission of sulphur dioxide, nitrous oxides, particulate matter (dust), heavy metals, acid gases, and many other pollutants.

To combat the associated environmental and human health challenges, policies and practices have been implemented across the globe to prevent and control emissions from electricity production. These policies and practises seek to ensure a high level of environmental protection by preventing – or if that is not possible, reducing – the emission of pollutants. In many of the regulatory frameworks worldwide the public authorities are provided with the competence to set binding Emission Limit Values or emission standards for designated pollutants (ELVs) from specific industrial sources.[1] These ELVs are stipulated in the conditions of a mandatory environmental permit, in regulations providing emission/performance standards for specific categories of sources, or in both. ELVs are calculated using an evidence-based, predominantly technology-based, multi-stakeholder process, which aims to determine which technologies can be considered Best Available Techniques (BATs) to prevent and reduce the emission of pollutants to air, water, and land. This approach is often referred to as the BAT-concept. BATs are state-of-the-art techniques, developed at scale, which may be implemented provided economical and technical conditions are met. In the European Union (EU) BATs are defined in Directive 2010/75/EU (the Industrial Emissions Directive – IED)[2] as:

> the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions designed to prevent and, where that is not practicable, to reduce emissions and the impact on the environment as a whole [. . .].[3]

The BAT-concept is implemented around the world – while the specific definition and acronym may vary, the goal is always similar.[4] As the BAT-concept aims to strike an appropriate balance between socio-economic and environmental interests, it can be considered a manifestation of the principle of sustainable development.[5] Although implementation around the world is not uniform, the BAT-concept has evolved as one of the key concepts when setting ELVs in order to prevent and control emissions into air, water, and soil from power plants using carbon-based sources.[6] The process of establishing what may be considered a BAT for a particular source requires not only technical information and knowledge, but in most cases also stakeholder participation.[7] In light of the high level of resources required for such processes, the exchange of information

---

1 Zhang and others (2019).
2 Directive 2010/75/EU of the European Parliament and of the Council [2010] OJ L 334/17.
3 ibid art 3(10).
4 OECD (2017).
5 Merkouris (2012); Giljam (2019).
6 The BAT-concept can be found in international treaties: OSPAR Convention art 3(b)(i); Helsinki Convention art 3(3); Minamata Convention on Mercury art 2(b); Stockholm Convention on persistent organic pollutions art 5.
7 OECD (2018).

between jurisdictions may be beneficial. Once a BAT has been determined, achieving the ELVs associated with applying these techniques becomes mandatory for the operator of the source. The BAT-concept therefore serves as crucial technical guidance, helping industrial operators to design, operate, maintain, and decommission their installations. Use of the BAT-concept furthermore implies that the term and its contents change over time due to, for example, new technological developments to protect the environment and reduce emissions; it allows for flexibility and adaptation.

Several relevant aspects of the implementation of the BAT-concept for setting ELVs, specifically for electricity production from fossil fuels, can be identified. The first is the definition of the BAT-concept in a regulatory framework. In what way does the definition move away from a purely technology-based concept by allowing for economic considerations? Secondly, to which pollutants and sources is the BAT-concept applied? Thirdly, does implementation stipulate an integrated approach, for example covering emissions to air, water, and land; the generation of waste; the use of raw materials; energy efficiency; noise; prevention of accidents; and the restoration of the site upon closure? A fourth aspect concerns the approaches to establish what shall be considered BATs, whether these are standardised, and whether they allow for public consultation and an exchange of information between permitting authorities. Lastly, what is the nature of the legal link between the BAT-concept and the standards or objectives for the quality of (specific aspects of) the environment? Such standards are representative of another instrument seeking to protect against environmental degradation, and are used in many countries in combination with the BAT-concept. An Environmental Quality Standard (EQS), for example, is a requirement which must be fulfilled by public authorities at a given time, and pertain to a specific environment or particular part thereof. Such requirements might be based on objective criteria to protect the integrity of ecosystems, human health or the quality of environmental media such as air, water, and land. Obvious linkages exist between the objective to attain EQSs and ELVs for individual sources as ELVs contribute to attaining EQSs.

The BAT-concept has been implemented in a growing number of countries worldwide, including China, New Zealand, Korea, India, and Russia.[8] This chapter, however, focuses on the above-mentioned aspects of the implementation of the BAT-concept for power plants by analysing the regulatory frameworks for air pollution in the United States of America (USA) and industrial emissions in the EU, as each jurisdiction provides a relevant example of this key policy tool. The chapter concludes with a brief conclusion and outlook.

IX.29.2 The BAT-concept in the Clean Air Act in the USA

This section discusses the USA's implementation of the BAT-concept for air pollution, describing its relevance to emissions generated by fossil fuel power plants.

IX.29.2.1 Introduction

The federal Clean Air Act (CAA) is the main legislative act regulating air pollution caused by emissions from a diverse array of pollution sources, including power plants.

[8] OECD (2019).

The Act has been in force since 1963, and is designed to protect public health and welfare from different types of air pollution, and to protect air quality at national, state, and local levels. Amongst the many pollutants to which the Act applies are sulphur dioxide, nitrous oxides, dust, and GHGs.

IX.29.2.2 Quality standards and emission standards

Under the CAA, the Environmental Protection Agency (EPA) has established the National Ambient Air Quality Standards (NAAQS). These standards apply to outdoor air throughout the USA for 'criteria pollutants', such as particulate matter, sulphur dioxide, and nitrous dioxide. These standards are an example of an EQS, and are to be reviewed every five years; they are not technology-based.

In 1990, the CAA was amended to specify a list of Hazardous Air Pollutants (HAP) that are known or suspected to be hazardous for human health and the environment, and for which the EPA has adopted National Emission Standards (NESHAP). These standards are based on Maximum Achievable Control Technology (MACT), and apply to both new and existing major and area sources, as defined in the CAA.[9] 'Maximum Achievable' equates to the emissions of hazardous air pollutants by the best-performing industry sources, and thus becomes the new minimum industry standard to ensure compliance. 'Control Technology' refers not only to physical moving parts, but encompasses the processes, methods, systems, and techniques that are used in facilities to reduce emissions. The technology and work practices in facilities that produce the lowest emissions are used to set the standards for the remaining industrial sources. Under NESHAP, the EPA in 2012 introduced the Mercury and Air Toxics Standards (MATS), which took effect from 2016.[10] These standards require all coal and oil fired power plants over 25 MW to implement pollution control technologies to curb emissions of heavy metals (mercury, arsenic, chromium, and nickel) and acid gases. In 2020, the EPA reassessed whether regulating these emissions is 'appropriate and necessary', and opted to introduce less stringent standards.[11]

Besides the (MATS) NESHAP, the EPA has adopted national sector-specific emission standards for new, as well as modified and reconstructed sources: the New Source Performance Standards (NSPS). The EPA conducts extensive technology evaluations, including comment periods for stakeholders, which can include on-site inspections, emissions testing, reviews of existing processes and technologies (including facilities outside the USA), and questionnaires to industry members about their operations. The EPA then consults the public through an announced 'comment period'. Emission limits are based on the EPA's assessment of the degree to which emissions limitations are achievable through the application of the best system of emission reduction. This system must be determined to have been adequately demonstrated, with the EPA also considering the cost of such reduction and any non-air quality health and environmental

---

[9] Domike and Zacaroli (2017).

[10] See *Michigan v. EPA*, 576 U.S. (2015); the Supreme Court ruled that the EPA interpreted the CAA improperly in crafting MATS because it did not consider the costs of emissions reductions.

[11] BK Collins, 'INSIGHT: What's at Stake in EPA's MATS Finding Reversal' (*Bloomberg Law*, 26 May 2020) <https://news.bloomberglaw.com/environment-and-energy/insight-whats-at-stake-in-epas-mats-finding-reversal> accessed 3 August 2020.

impact and energy requirements. While the limit is intended to force the adoption of a specific technology, it is also the intention that affected sources are capable of meeting it. The NSPS for fossil-fuel-fired electric utility steam generating units are outlined in the Code of Federal Regulations under 40 CFR Part 60 Subpart Da, and contain standards for nitrous oxides, sulphur dioxide, and particulate matter.

IX.29.2.3 New Source Review permitting: BACT

For any major new or major modification to an existing source of air pollution, for example a coal-fired power plant, a pre-construction New Source Review (NSR) permit is required under the CAA. When emissions are above a certain threshold, and when the source is located in an area where the NAAQS have not been met, it is determined that these sources must not further degrade air quality. ELVs must be established in each individual permit, based on the Lowest Achievable Emission Rate (LAER). That implies that air pollution prevention controls are at least as effective as the best performing source of that same category anywhere in the country. When such a new source is in an area where the NAAQS have been met, the Prevention of Significant Deterioration (PSD) permitting programme is applicable. Since 2011, this permit programme has also applied to GHG emissions.[12] This implies that ELVs are determined on a case-by-case basis by the permitting authority, based on the Best Available Control Technology (BACT). US federal legislation defines BACT as:

> [. . .] an emissions limitation (including a visible emission standard) based on the maximum degree of reduction for each pollutant subject to regulation under the Act which would be emitted from any proposed major stationary source or major modification which the Administrator, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes or available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of such pollutant [. . .].[13]

The interpretation of this regulatory definition of BACT has been the subject of significant dispute.[14] The BACT requirements focus on the facility proposed by the applicant, and are not intended to redefine the source. The permitting authority interprets terms such as 'available' (*e.g.* beyond the conceptual stage) and 'achievable' (*e.g.* can be met on a continual basis over each averaging period for the lifetime of the facility) on a case-by-case basis; the BACT and/or LAER cannot be less stringent than the NSPS. Although the permitting agency must also consider interactions among pollutants, the BACT analysis under the CAA is focused on emissions to air only. The BACT analysis therefore does not provide an example of an integrated approach, as it fails to take into account emissions to water and land.[15]

---

[12] *American Elec. Power Co. v. Connecticut*, 131 S. Ct. 2527 (2011); *Utility Air Regulatory Group v. EPA*, 134 S. Ct. 2427 (2014).

[13] 40 CFR § 52.21(b)(12).

[14] Driesen, Keck and Metroka (2018).

[15] The US Clean Water Act (CWA) provides for Water Quality Standards and Technology Based Effluent Standards, see *e.g.*, 'Steam Electric Power Generating Effluent Guidelines and Standards', 40 CFR Part 423.

Determining what is to be considered the BACT requires the permitting authority to assess available information about sources, emission control options (and their achievable limits), processes, and pollutants. Sources of information include existing permits and permit applications for similar facilities, though the latter are less reliable. For information-sharing purposes, the EPA established the *BACT Clearinghouse*, a central searchable database of air pollution technology information. Also, it provides permitting guidance documents, for example for GHGs from stationary sources, including power plants.[16] Procedures to establish such documents often allow the public to participate.[17]

IX.29.3 The BAT-concept in the EU Industrial Emissions Directive

This section discusses the EU's implementation of the BAT-concept and describes its relevance to emissions generated by fossil fuel power plants.

IX.29.3.1 Legal basis and limits to application

Articles 191 to 193 of the Treaty on the Functioning of the European Union (TFEU)[18] provide a legal basis for environmental law and policy at EU level and state its goals and principles. The EU has the competence to act in all areas of environmental policy, such as air and water pollution, waste management, and climate change[19] – although its scope to act is limited by e.g. the principle of subsidiarity.

The BAT-concept was first introduced in the EU in 1984 to combat air pollution emissions from large industrial installations, and has only gained importance since then.[20] Its introduction signified a move away from a sectoral approach to more integrated environmental protection.[21] Today, this approach is reflected in the IED, which was adopted in 2010. The IED establishes rules on the integrated prevention and control of pollution arising from industrial activities, not only to achieve a high level of environmental protection (in compliance with the 'polluter pays' principle, the principle of pollution prevention, and the principle of rectifying environmental damage at the source), but also to achieve a level playing field for industries within the EU.[22]

The IED applies to specific industrial installations, listed in Annex I, among which there are installations for the combustion of fuels in installations with a total rated thermal input of 50 MW or more, and for the gasification or liquefaction of coal or other fuels in installations with a total rated thermal input of 20 MW or more.[23] The IED

---

[16] See EPA, 'PSD and Title V Permitting Guidance for GHGs' (2011), which does not reflect the U.S. Supreme Court decision in *Utility Air Regulatory Group v. EPA*, 134 S. Ct. 2427 (2014).

[17] OECD (2019).

[18] The Treaty on the Functioning of the European Union (consolidated version, 7 June 2016) 2016 OJ C 202/47 (TFEU).

[19] Until 2009, EU legislation for the electricity sector was based on its competence in the internal market and environment. See: Chapter 10 of this volume.

[20] The concept was first known as *BAT Not Entailing Excessive Costs*. See Council Directive 84/360/EEC [1984] OJ L 188/20, which was eventually superseded by the IED.

[21] Bohne (2006).

[22] TFEU art 192; IED recital 2.

[23] Installations for capturing GHGs were brought under the scope of the IED through Directive 2009/31/EC of the European Parliament and of the Council [2009] OJ L 140/114. See: de Graaf and Jans (2010).

applies to all emissions into air, water, and land of polluting substances listed in Annex II (*e.g.* sulphur dioxide, nitrous oxides, metals, arsenic, particulate matter) from these installations. The IED is not, however, the primary legal framework for regulating emissions of GHGs from power plants, and GHGs are not listed in Annex I. Recital 9 of the IED explains that the permit on the basis of the IED should not include an ELV for GHGs if the emissions from that installation falls within the scope of Directive 2003/86/EC (the EU Emission Trading System Directive),[24] except where it is necessary to ensure that no significant local pollution is caused, or where an installation is excluded from the EU ETS.[25] In order to avoid duplication of regulation, the emissions of GHGs from power plants are regulated under the aforementioned Directive.[26]

IX.29.3.2 Defining the concept

To achieve the objectives of the IED, EU member states must ensure that no Annex I installation is operated without a permit.[27] Such a permit must contain ELVs (or equivalent parameters or technical measures)[28] based on the emissions associated with the application of the 'best available techniques'.[29] The IED also allows setting emission standards in general binding rules, providing that they are based on BATs.[30] The BAT-concept is therefore of decisive significance, and has been strengthened in the IED compared to its predecessor.[31] The EU BAT-concept provides a balance between a high level protection, economic feasibility, and the availability of techniques. The definition of BAT in article 3 of the IED, as provided in the introduction of this chapter, is clarified through the definition of three relevant elements: 'techniques' (both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned), 'best' (most effective in achieving a high general level of protection of the environment as a whole), and 'available techniques':

> [. . .] those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator.

Although the BATs function as the reference point when determining the permit conditions,[32] additional measures are included where an EU EQS requires it.[33] In specific

---

[24] Directive 2003/87/EC of the European Parliament and of the Council [2003] OJ L 275/32. This directive is discussed in Chapter 30 of this volume.

[25] ibid art 2(2); IED art 9.

[26] ibid. Squintani, Holwerda and de Graaf (2012) 67–88.

[27] IED arts 4, 5.

[28] ibid art 14(2).

[29] ibid art 3(10); ibid Annex III.

[30] ibid recital 7; ibid arts 6, 17.

[31] Council Directive 96/61/EC [1996] OJ L 257/26.

[32] IED art 14(3). See specifically IED art 3(5), which defines ELVs as: 'the mass, expressed in terms of certain specific parameters, concentration and/or level of an emission, which may not be exceeded during one or more periods of time'.

[33] ibid art 18. National Emission Ceilings (NEC) in the NEC Directive (2016/2284/EU) cannot be seen as such an environmental quality standard, see: Joined Cases C-165/09 to C-167/09

cases, permitting authorities also have some flexibility to set stricter[34] (or less strict)[35] ELVs.

IX.29.3.3 The role of BAT Reference Documents

With a view to reaching a level playing field, providing clarity regarding BATs is important. Based on an exchange of information between member states, the industries concerned, non-governmental organisations (NGOs) promoting environmental protection and the European Commission (the *Seville process*),[36] BAT Reference Documents (BREFs) are drafted, reviewed and updated. BREFs provide information on which techniques can be considered BATs,[37] and may focus on a particular industrial sector ('vertical' BREFs) or deal with cross-sectoral issues, such as monitoring or energy efficiency ('horizontal' BREFs). The BREFs also stipulate the BAT-conclusions,[38] which are adopted by the European Commission and published in the Official Journal of the EU. These are particularly relevant as the BAT-conclusions act as the reference when setting ELVs.[39] If permit conditions are based on a BAT not described in any of the relevant BAT-conclusions, the competent authority shall ensure that special consideration is given to the criteria listed in Annex III and Article 15 of the IED is complied with. ELVs for all listed substances must be included in the permit, though the technique itself is not prescribed.[40] The IED provides not only that BAT-conclusions shall generally be reconsidered every eight years, but also that the public authorities must reconsider and, if necessary, update the permit conditions for the specific installation within four years after the new conclusion is published.[41]

Prior to the IED's introduction, emissions from large (more than 50 MW) power plants were subject to general binding rules stipulating emission standards for nitrous oxides, sulphur dioxide and dust (static approach). Since 2016, these plants have fallen under the scope of the IED.[42] This provides for a more dynamic approach to setting emission standards, as new BAT-conclusions in BREFs will most likely introduce new BATs as a reference for setting ELVs, which will lead to the permit conditions being updated within four years of adoption.

Based on the *Seville process*, BATs for large power plants have been identified in the BREF Large Combustion Plants (BREF LCP) and the BAT-conclusion, published in

---

Stichting Natuur en Milieu and Others v College van Gedeputeerde Staten van Groningen and College van Gedeputeerde Staten van Zuid-Holland [2011] ECLI:EU:C:2011:348.

34 IED arts 14(4), 18.

35 ibid art 15(4).

36 ibid recital 13; ibid art 13(1). See Commission Implementing Decision 2012/119/EU [2012] OJ L 63/1. The Seville process is steered by the Institute for Prospective Technological Studies of the European Commissions' Joint Research Centre.

37 IED recital 14; IED art 13(2).

38 ibid art 2(12).

39 ibid art 14(3).

40 ELVs can be supplemented or replaced by equivalent parameters or technical measures. See: ibid arts 14, 15(2).

41 ibid art 21(3), 21(3)(b).

42 ibid ch III; ibid art 30(2)–(3); ibid Annex V.

August 2017.[43] The BREF LCP, which provides information on the best available techniques for large fossil-fuel-power plants in the EU, addresses *inter alia* the combustion of fuels in installations with a total rated thermal input of 50 MW or more, the gasification of coal, and the disposal and recovery of waste. Operations in large power plants must be in accordance with the new requirements, and their environmental permits must be updated by August 2021.[44] The introduction of the BREF LCP can have far-reaching consequences for (older) coal-fired power plants, as efficiency levels for existing coal-fired power plants (of 31.5 per cent to 44 per cent) are associated with the BATs regarding these installations. Power plants with an efficiency level below that will face existential problems in 2021.[45] On the other hand, all coal-fired power plants that are able to meet the requirements can remain or become operational in accordance with the IED.

IX.29.4 Conclusions and outlook

According to the OECD, a growing number of countries around the world implement policies to prevent and control emissions from stationary sources based on the BAT-concept.[46] These policies often choose this predominantly technology-based approach to serve as a reference for setting ELVs or emission performance standards, whether or not combined with an approach based on EQS. Both examples of regulatory frameworks implementing the BAT-concept provided in this chapter reflect such a combination and provide that both instruments are applicable in a sequential manner. Regulations stipulate either that the technological basis for setting ELVs differs in areas where an EQS is not attained (as in the USA), or it prescribes that stricter measures shall be included in the permit conditions when achieving an EQS requires it (as in the EU). Both examples also provide a definition of what is considered BAT, and clearly outline to which sources and which substances the concept applies, although GHG emissions have a specific role in both the US and the EU. The EU, for example, clearly favours an integrated approach, taking into account emissions into air, water, and soil, while the US example concentrates on air pollution. The BAT definitions refer to economic considerations and purposely use vague terms that inherently need continuously updated interpretation, allowing the BAT-concept to provide a dynamic, flexible, and adaptable reference for setting ELVs.

Implementing a technology-based BAT-concept requires significant resources information and knowledge-based resources. Countries implementing such a concept must introduce (standardised or *ad hoc*) procedures, approaches, and governance structures to determine what is considered a BAT. As in the two examples provided in this chapter, many countries engage stakeholders besides experts and research institutes in this process. When official reference documents for BATs or similar concepts are drafted, adopted, and updated, they result from a series of exchanges of information between a variety of stakeholders, including governmental experts, industry representatives and members of NGOs. In this respect, the standardised procedure for drafting, adopting and updating

---

43 Commission Implementing Decision (EU) 2017/1442 [2017] OJ L 212/1.
44 IED art 21(3).
45 Sokołowski (2018). Derogation is possible, pursuant to IED arts 32–35.
46 OECD (2019).

BREFs in the EU, including the obligation to update existing permit conditions within four years after a new BAT-conclusion's publication, provides a significant regulatory benchmark.[47] It creates a transparent and collaborative process that provides the basis for setting emission standards.[48]

Although the BAT-concept can be considered moderately successful, standing as a highly effective legal instrument, several observations can be made about future developments.[49] The strong focus of the BAT-concept on pollution might not cover all relevant environmental aspects, such as health, safety, land use planning, or local effects to nature and biodiversity.[50] In the perspective of the principle of sustainable development, a relevant argument against the current implementation of the BAT-concept for power plants is that it only relates to emissions from core industrial processes, and with broader life-cycle or value-chain considerations not considered; the extent to which raw materials can be regulated is unclear. Beyond that, it must be determined whether the BAT-concept can be extended to cover the whole chain of production.[51] The examples provided in this chapter showcase that permitting procedures are not fully integrated. The US Clean Air Act lists permit requirements for air pollution, while water pollution is predominantly covered by another legislative act. Meanwhile, the EU's IED requires coordination between different permitting systems under its scope. However, it does not require a 'one-stop-shop' for integrated permitting – multiple permits could still be required.[52]

From a regulatory perspective, the BAT-concept allows for a participatory objective assessment of the available technology to best prevent or reduce emissions from industrial installations. New political desires and emerging societal needs, for instance to transition towards electricity production that is carbon neutral by 2050,[53] are usually represented to a far lesser extent in the BAT-concept. Other environmental policy instruments are required to achieve such ambitious environmental objectives.

Bibliography

Bohne E, *The Quest for Environmental Regulatory Integration in the European Union: Integrated Pollution Prevention and Control, Environmental Impact Assessment and Major Accident Prevention* (1st edn, Kluwer Law International 2006).

Bohne E, 'The Implementation of the IPPC Directive from a Comparative Perspective and Lessons for its Recast (Part 1)' (2008) 5(1) Journal for European Environmental & Planning Law 1.

Braaksma LS and Tolsma HD, 'Integrated Pollution Prevention and Control – A Critical Legal Perspective on All-Inclusive Integration' in Peeters M and Eliantonio M (eds), *Research Handbook on EU Environmental Law* (1st edn, Edward Elgar 2020).

Domike JR and Zacaroli AC (eds), *The Clean Air Act Handbook* (4th edn, ABA 2017).

---

47 The IED was evaluated in 2019 (results expected second quarter of 2020; not yet available).

48 Industry and NGOs however want improvements, see: OECD (2019) 49.

49 European Commission, 'Publications: Industrial Emissions Rules in Action' (*European Commission*) <https://ec.europa.eu/environment/industry/stationary/publications.htm> accessed 3 August 2020.

50 Sanden (2012) 232; Bohne (2008) 12–13.

51 Oosterhuis and Peeters (2014) 108–109. Giljam (2019) argues that the use of the BAT-concept should be extended and used in other areas of environmental law.

52 Sanden (2012). For more on coordination, see: IEEP (2010); IEEP (2011); IEEP (2013).

53 Commission, 'European Green Deal' (Communication) COM(2019) 640 final.

Driesen DM, Keck TM and Metroka BT, 'Half a Century of Supreme Court Clean Air Act Interpretation: Purposivism, Textualism, Dynamism, and Activism' (2018) 75 Wash & Lee L Rev 1781.

Giljam R, *Towards Ecological Governance in EU Energy Law: With a Focus on Biomass Regulation and the Use of 'Best Available Techniques'* (1st edn, Ridderprint 2019).

Graaf KJ de and Jans JH, 'Environmental Law and CCS in the EU and the Impact on the Netherlands' in Roggenkamp MM and Woerdman E (eds), *Legal Design of Carbon Capture and Storage: Developments in the Netherlands from an International and EU Perspective* (1st edn, Intersentia 2010).

IEEP, 'Linking the Water Framework Directive and IPPC Directive: Final Report' (IMPEL 2010) <https://www.impel.eu/wp-content/uploads/2016/09/Report-Linking-the-Water-Framework-and-the-IPPC-Directives.pdf> accessed 3 August 2020.

IEEP, 'Linking the Water Framework Directive and IPPC Directive: Report of Phase 2 of the Project' (IMPEL 2011) <https://www.impel.eu/wp-content/uploads/2016/09/impel-report-WFD-IPPC-final-report-07-December-2011.pdf> accessed 3 August 2020.

IEEP, 'Linking the Water Framework Directive and IED Directive; Report of Phase 3 of the Project' (IMPEL 2013) <https://www.impel.eu/wp-content/uploads/2016/09/FR-2013_11-Impel-report-WFD-IPPC-final.pdf> accessed 3 August 2020.

John D and Paddock L, 'Clean Air and the Politics of Coal' (2004) 20(2) Issues in Science and Technology 63.

Merkouris P, 'Sustainable Development and Best Available Techniques in International and European Law', in Makuch KE and Pereira R (eds), *Environmental and Energy Law* (1st edn, Wiley-Blackwell 2012).

OECD, 'Best Available Techniques (BAT) for Preventing and Controlling Industrial Pollution – Activity 1: Policies on BAT or Similar Concepts Across the World' (OECD 2017) <http://www.oecd.org/chemicalsafety/risk-management/policies-on-best-available-techniques-or-similar-concepts-around-the-world.pdf> accessed 3 August 2020.

OECD, Best Available Techniques (BAT) for Preventing and Controlling Industrial Pollution – Activity 2: Approaches to Establishing BAT Around the World (OECD 2018) <http://www.oecd.org/chemicalsafety/risk-management/approaches-to-establishing-best-available-techniques-around-the-world.pdf> accessed 3 August 2020.

OECD, Best Available Techniques (BAT) for Preventing and Controlling Industrial Pollution – Activity 3: Measuring the Effectiveness of BAT Policies' (OECD 2019) <https://www.oecd.org/chemicalsafety/risk-management/measuring-the-effectiveness-of-best-available-techniques-policies.pdf> accessed 3 August 2020.

Oosterhuis F and Peeters M, 'Limits to Integration in Pollution Prevention and Control' in Peeters M and Uylenburg R (eds), *EU Environmental Legislation: Legal Perspectives on Regulatory Strategies* (1st edn, Edward Elgar 2014).

Sanden J, 'Coherence in European Environmental Law with Particular Regard to the Industrial Emissions Directive' (2012) 21(5) European Energy and Environmental Law Review 220.

Sokołowski MM, 'Burning out Coal Power Plants with the Industrial Emissions Directive' (2018) 11(3) Journal of World Energy Law and Business 260.

Squintani L, Holwerda M and de Graaf KJ, 'Regulating Greenhouse Gas Emissions from EU ETS Installations: What Room is Left for the Member States?' in Peeters M, Stallworthy M and de Cendra de Larragán J (eds), *Climate Law in EU Member States. Towards National Legislation for Climate Protection* (1st edn, Edward Elgar 2012).

Zhang Y and others (eds), *Advances in Ultra-Low Emission Control Technologies for Coal-Fired Power Plants* (1st edn, Elsevier 2019).