sustainability

Review

Ecodesign for Industrial Furnaces and Ovens: A Review of the Current Environmental Legislation

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Abstract: The increasing global demand for energy- and resource-efficient, environmentally friendly products has led the European Union (EU) to develop a sustainable product policy, incorporating ecodesign legislation and energy labeling as effective tools for promoting energy efficiency and sustainability. Recent European energy policies, such as the Energy Efficiency Directive (EED) and the Ecodesign Directive (EDD), have set new objectives for enhancing energy efficiency. This study focuses on the 2012 Lot 4: Industrial and Laboratory Furnaces and Ovens, Tasks 1–7 Final Report, which informed the European Commission's 2014 working document for the Ecodesign Consultation Forum on industrial and laboratory furnaces and ovens. The working document proposed initial draft measures and requirements for this product group, aiming to achieve specific energy savings and related greenhouse gas (GHG) emissions reductions. The findings of the investigations on energy consumption and GHG emissions are presented in this work, with draft calculations and projections serving as the foundation for discussions on future measures. The BAT (best available technologies) scenario would result in lower environmental impacts. The initial and indicative draft Lot 4 impact assessment predictions for energy savings demonstrate the positive influence of prospective ecodesign measures in reducing energy consumption. These deliberations will ultimately contribute to the formulation of an official mandatory regulation for industrial and laboratory furnaces and ovens, in line with the EU's sustainable product policy objectives.

Keywords: ecodesign; environmental legislation; European Commission; energy-related products (ErPs); directive; industrial furnaces/burners

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1. Introduction

To reduce energy and resource use, there is a global desire for more efficient and sustainable products [1,2]. There is a need for sustainable industrial production and processing for the recovery of materials by optimizing methods and taking into account appropriate design concepts for process intensification [3,4]. The EU's sustainable product policy, ecodesign regulation, and energy labeling are powerful tools for increasing product energy efficiency and sustainability [5,6]. Energy efficiency is one of the most cost-effective methods of mitigating climate change, improving energy security, and growing economies while providing environmental and social advantages [7,8]. Recent European energy directives, such as the Energy Efficiency Directive (EED) in 2012 [9] and the Ecodesign Directive (EDD) in 2009 [10], aim to increase energy efficiency and save energy. The 2012 directive, as updated in 2018, sets rules and responsibilities for the EU to meet in order to achieves its energy-saving goals for 2020 and 2030. It is beneficial to understand these goals in detail and explore their outcomes, especially those for 2020, to assess the success of the regulations and directives in promoting energy efficiency.

The Directive 2009/125/EC sets the framework of the ecodesign requirements for energy-related products with the regulation (EU) 2017/1369 of the European Parliament and of the Council of 2017 that sets the framework for energy labeling. The Ecodesign Directive 2009/125/EC established the foundation for decision-making in the 27 Member States on measures directly influencing energy-related products. An analysis of the impact of this directive on influencing the design of energy-related products in terms of their compliance with energy efficiency requirements and energy labeling, can shed light on the effectiveness of this policy tool. The requirements in these directives aim to produce energy savings on the one hand and a minimum level of performance for energy-related products on the other. Because of their broad scope, these directives intersect with several national energy efficiency measures [11].

The research on ecodesign for industrial furnaces/burners has reached the midway point. The first edition of the Ecodesign Directive for Energy-using Products (EuPs) was issued in 2005 [12]. An amendment directive to the Ecodesign Directive 2005/32/EC was enacted in 2008, while the recast of this Ecodesign Directive was developed in 2009, as mentioned above. The first working plan of the Ecodesign Directive, which was enacted in 2008, outlined the product groupings that were prioritized for implementing measures in 2009–2011 [13].

The Commission compared 57 product categories that are covered by the Ecodesign Directive to the principal environmental effect, which is primary energy consumption in the usage phase, in order to determine which product groups had the highest potential to reduce GHG emissions. These product categories were methodically determined based on the PRODCOM product list in order to establish the working plan. Lastly, the Commission prioritized ten product groups (air conditioning and ventilation systems; electric and fossil-fueled heating equipment; food-preparation equipment; industrial and laboratory furnaces and ovens; machine tools; network, data processing, and data storing equipment; refrigeration and freezing equipment; sound and imaging equipment; transformers; water-using equipment) with more than 200,000 units sold and traded within the community each year, as well as ten product categories (machines, tools, transformers, sound and imaging equipment, and industrial and laboratory furnace) [9,14].

However, these goods offer tremendous room for development, including a high potential for energy savings and other environmental advantages. “Industrial and laboratory furnaces and ovens” were included in this list. Preparatory research was initiated in 2010 for this purpose, and the final report was published in September 2012 [15]. Finally, in 2014, the European Commission’s working document published the first indicative, draft, ecodesign requirements/measures for discussion in the consultation forum, which is comprised of stakeholders, expert groups, and so on [16].

The following goods are grouped alongside industrial furnaces/burners under “Industrial and laboratory furnaces and ovens,” in addition to those with considerable environmental effects in addition to having huge sales volumes: high running duration (up to 24 h a day or high: roughly 8 h a day), high energy consumption (>1000 PJ/year), waste creation, related emissions, and other environmental effects of the materials utilized. There is, nevertheless, a considerable opportunity for energy savings (estimated average >20%) and other environmental enhancements (e.g., enhanced heat transfer systems or bulk reduction, etc.) [17,18]. This prioritization was necessary to meet the requirements of Article 15 of the original Ecodesign Directive regarding the volume of sales and trade of energy-using products within the community, the severity of those impacts during those products’ lifecycles within the community, and the possibility of ameliorating those impacts.

The goal of the Ecodesign Directive is to provide the framework for the required minimum standards for each product group, which will lead to particular implementing actions for each product group after a given procedure [19,20]. There is a wealth of study information available on the European Commission’s Ecodesign Directives and the prioritized product groups under investigation, particularly those relating to the residential sector. However, while there is a comprehensive analysis based on the Ecodesign Directive for the "industrial and laboratory furnaces and ovens" product group, there is no description of the industrial furnaces explicitly. We have sought to fill this "gap in knowledge" in this study.

The novelty of this study lies in its comprehensive exploration of the energy consumption and greenhouse gas emissions of industrial and laboratory furnaces and ovens in relation to the EU's ecodesign legislation, particularly within the framework of the 2012 Lot 4 report. It is pioneering in its use of the BAT scenario to demonstrate the environmental potential of using the best available technologies. This work is unique in its approach, as it not only scrutinizes the projections of energy savings resulting from prospective ecodesign measures but also contributes to the initial drafting and impact assessments for a future mandatory regulation specifically tailored for this product group. This study thus forms an essential foundation for ongoing EU sustainability discussions, thereby aligning industrial and laboratory equipment standards with broader energy efficiency objectives.

The primary goal of this article is to briefly demonstrate the diachronic evolution of European Ecodesign regulations in terms of industrial furnaces and associated equipment, such as burners, in terms of environmental issues. Simultaneously, the potential mandatory future requirements and policy options assessed by the European Union's authorities will be depicted, launching the first discussions for the final official measures.

2. Base Cases and Environmental Impacts

The environmental legislation process so far, regarding the industrial furnaces and ovens product group, is presented in Figure 1. According to the EC's working document [10] and the associated preliminary study, the current final energy consumption of all industrial and laboratory furnaces and ovens is 1650 TWh/year, which is about half of the total energy consumption of EU industrial sectors. The ENTR Lot 4 preliminary study categorizes furnaces based on their size as laboratory (<120 liters), small and medium (120 < capacity < 10 tones for batch and 120 < per day < 20 tones for continuous), and large and very large (>10 tones capacity for batch and > 20 tones/day for continuous).

This paper adopts a rigorous approach in analyzing the environmental impact of industrial furnaces and ovens as informed by the European Commission's working document [13] and the ENTR Lot 4 preliminary study. The furnaces and ovens were categorized based on their size and energy consumed, which allowed us to focus on medium- and large-sized furnaces and oven items that account for a significant portion of the total energy consumption.

Seven major base cases (BCs) were constructed for a more granular understanding of the environmental impact based on the type of fuel utilized for their operation. The base cases were organized as follows:

- BC2a: Medium-size batch oven (electric);
- BC2b: Medium-size batch oven (gas);
- BC3a: Batch chamber furnace (electric);
- BC3b: Batch chamber furnace (gas);
- BC4a: Continuous oven (electric);
- BC4b: Continuous oven (gas);
- BC5a: Continuous belt furnace (electric);
- BC5b: Continuous belt furnace (gas);
- BC6: Large furnace (gas);
- BC7: Very large oven (gas).

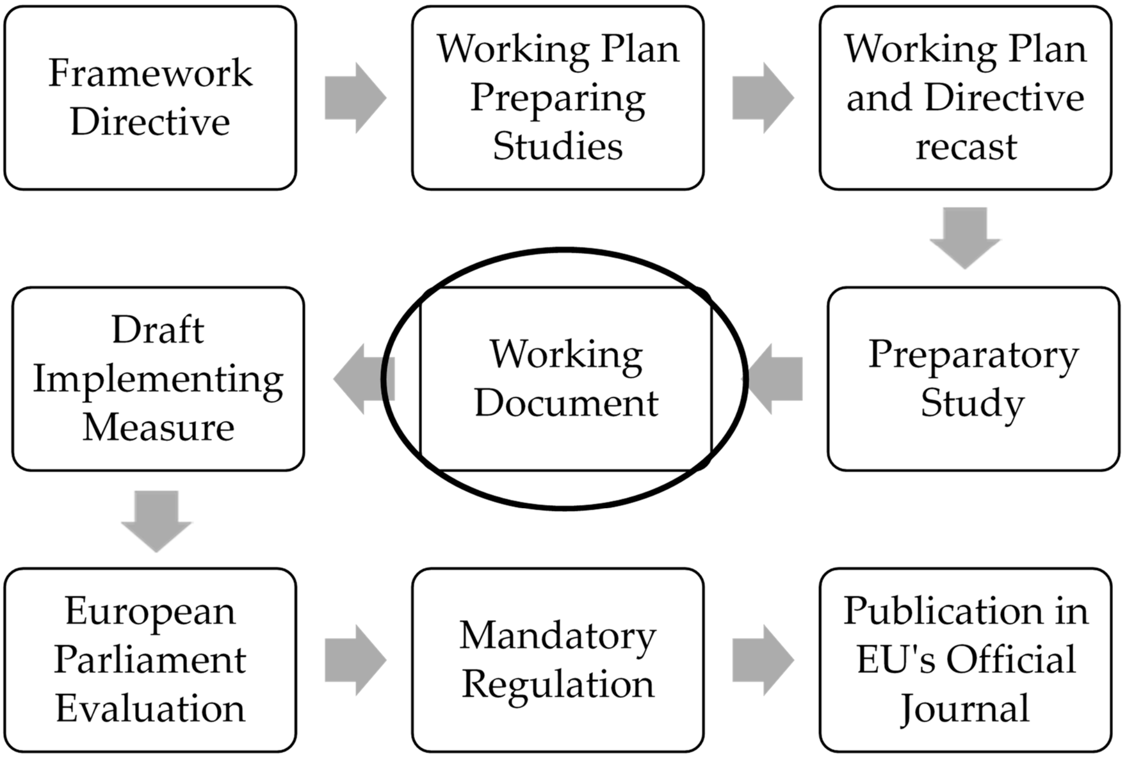

Figure 1. Environmental legislation process so far, regarding industrial furnaces and ovens product group.

For each base case, an impact evaluation was conducted using the MEEuP (EcoReport Unit Indicators) approach, which analyzes the environmental implications across each life-cycle stage [9]:

1. Raw materials use and manufacturing (production phase);
2. Distribution phase;
3. Use phase;
4. End-of-life phase.

The results were extrapolated to represent the combined effects across all 27 Member States of the European Union by calculating the environmental implications of each base case relative to the current quantity of each furnace/oven type in stock within the Union. This approach allowed us to focus specifically on energy consumption and greenhouse gas emissions, two pressing environmental concerns. When interpreting the results, it is important to consider that different energy sources have differing efficiencies and emission profiles. For example, coal combustion emits more CO_2 than oil or gas combustion, and the electricity generation efficiency ranges between 30 and 40% for coal or gas power generation. These factors have been considered in our analysis. Table 1 shows the energy consumption and GHG emissions by furnaces/ovens in the EU for each base scenario as well as for the whole year.

While BC6 and BC7 both use fossil fuels (gas), it is important to note that they are distinct in terms of their specific applications: BC6 is a large furnace, while BC7 is a very large oven. Furnaces and ovens, while similar, have different operating principles and uses, which can contribute to the variance in energy consumption and GHG emissions. Furnaces, for instance, are often used for high-temperature applications such as forging, smelting, or heat treatment. These processes can be more energy-intensive than those typically carried out in ovens, which are generally used for baking, drying, or curing at relatively lower temperatures. Therefore, despite BC6 being smaller in size compared to BC7, it may have higher energy consumption and GHG emissions due to the nature of its applications.

Table 1. Major environmental impacts of the product group [15].

Annual Energy Consumption and GHG Emissions by Furnaces/Ovens in the EU											
Base Cases	**BC2a**	**BC2b**	**BC3a**	**BC3b**	**BC4a**	**BC4b**	**BC5a**	**BC5b**	**BC6**	**BC7**	**Total**
Total Energy (PJ)	347.00	48.67	39.17	5.49	252.91	35.37	28.30	3.97	4952.74	212.45	5926.00
Electricity Consumption (PJ)	347.00	0.01	39.03	0.00	251.35	0.04	28.25	0.00	8.87	0.43	675.00
GHG in GWP100 (million tons of CO_2 eq.)	15.00	2.69	1.72	0.30	11.11	1.96	1.24	0.22	274.79	11.81	321.00

Moreover, the efficiency of energy use could be different between the two. The furnace in BC6 might be less energy-efficient compared to the oven in BC7, leading to higher energy use and greater emissions. The age and condition of the equipment, as well as how well it is maintained, can also affect its energy efficiency and emission rates. Lastly, the frequency and duration of usage can play a crucial role. If BC6 furnaces are used more frequently or for longer durations compared to BC7 ovens, this would result in higher total energy consumption and GHG emissions for BC6. In sum, the discrepancy between BC6 and BC7's energy consumption and GHG emissions is likely due to a combination of the different applications and operational characteristics of furnaces versus ovens, efficiency levels, and usage patterns.

The overall primary energy consumption for base cases 2–5 (medium-size furnaces and ovens) is 760.88 PJ/year, approximately 211 TWh/year. There is also a 34 million tons CO_2-equivalent per year Global Warming Potential (GWP). The electrical-powered furnaces/ovens have the greatest environmental impact during their use phase (due to electricity consumption), according to the Lot 4 study. Gas-powered furnaces/ovens, on the other hand, have five major effects during the use phase and five important impacts during the material production phase. This variation is most likely due to the varied materials utilized in calculations during the manufacturing process of furnaces and ovens.

There is roughly 5165 PJ/year, or 1435 TWh/year, for base cases 6 and 7 (large size furnaces and ovens) (of a total of 1650 TWh/year or 5935.07 PJ/year). These two base cases have a GWP impact of around 287 million tons of CO_2-equivalent per year. According to the Lot 4 study, the principal environmental impact of these large-sized furnaces/ovens is energy consumption during usage, identifying the specific items as the sector's biggest energy consumer.

In conclusion, the energy consumption of the European Union's industrial furnaces and ovens industry is roughly 5935 PJ/year or 1650 TWh/year. This figure, however, includes not only the energy consumed during the usage phase, but also the energy consumed during the manufacture and disposal phases of the products. The Global Warming Potential is equal to 321 million tons of CO_2-equivalent per year.

It should be noted at this point that the link between energy usage and greenhouse gas emissions is not always evident. Coal combustion, for example, emits more CO_2 than oil or gas combustion. Many furnaces use coal, while others use gas or electricity. Gas furnaces can be far more efficient than electric furnaces, which are often powered by fossil fuels.

In additional detail, electricity generation efficiency ranges between 30 and 40% for either coal or gas power generation. There are also transmission losses (2%) and the so-called "primary energy factor" of electric heating (1 kWhe generation equates to 2.5 kWhf). However, as long as the vented hot combustion gases are interpreted as a heat loss, (direct) fossil fuel-fired furnaces appear to be less efficient. Nonetheless, heat losses are typical in both scenarios; they merely happen at different times (production for electricity and use for fossil fuels) [9].

3. Implementation of Eco-Scenarios

3.1. Energy Consumption and GHG Emissions

The Lot 4 study encountered the following scenarios for implementing ecodesign measures:

- The no action scenario (referred also as BaU—Business as Usual);
- The policy recommendation scenario: implementation of minimum energy performance standards in three tiers (2014, 2018, and 2024);
- The LLCC (Least Life Cycle Cost scenario): implemented from 2014;
- The BAT (best available technologies scenario): implemented from 2014, expressing the maximum energy-saving potential achievable.

Two significant policy alternatives are presented at the end of the European Commission's working document from 2014 for additional consideration through impact assessment studies:

5. Draft recommendations for base case-specific ecodesign implementing measures that are applicable to Lot 4 furnaces and ovens;
6. Regulating Lot 4 furnaces and ovens by the Industrial Emissions Directive (IED) sectoral BAT conclusions (greater likelihood of being more effective through sectoral customization) or the Horizontal Energy Efficiency BAT conclusions, via the same "ecodesign-style" requirements. Clearer energy consumption objectives would be provided by this approach, which would improve IED but not interfere with ETS's "benchmarking" method.

The first alternative for policy examines the necessary energy-saving objectives and strategies that may be formed by a daughter regulation from the Ecodesign Directive and stand alone, with no connection to the existing regulations that only partially address the product category (IED and ETS). The second policy option, which tackles the same challenges as the first but makes use of present law [16,21–23], is based on the sectoral best available technologies results from the IED. Table 2 provides a summary of the ecodesign strategies that have been presented and are mentioned in the EC's working document.

Table 2. Proposed ecodesign measures according to European Commission's working document [16].

Heat Recovery				
Size of the Process	**Temperature of the Process**	**Minimum Amount of Heat Recovery per Specific Time Period**		
		2016 and Onwards % Recovered and Reused	**2019 and Onwards % Recovered and Reused**	**2025 and Onwards % Recovered and Reused**
Medium	<1000 °C	-	≥25% (flue gas ≤ 500 °C)	≥35% (Flue gas ≤ 350 °C)
Large	<1000 °C	Flue gas ≤ 600 °C	≥35% (flue gas ≤ 500 °C)	≥50% (flue gas ≤ 350 °C)
Medium	≥1000 °C	-	≥30% (flue gas ≤ 550 °C)	≥40% (flue gas ≤ 400 °C)
Large	≥1000 °C	A minimum of 40% heat recovery	≥40% (flue gas ≤ 500 °C)	≥55% (flue gas ≤ 300 °C)

Insulation (heat losses)							
Base Case	2	3	4	5	6 (>1000 °C o.t. *)	6 (450 °C to 1000 °C o.t.)	7 (< 450 °C o.t.)
Mandatory Requirements (W/m^2 away from "hot-spots")	<300	<300	<500	<400	<500	<400	<200

* o.t.: operating temperature

Table 2. *Cont.*

Heat Recovery				
Size of the Process	Temperature of the Process	Minimum Amount of Heat Recovery per Specific Time Period		
		2016 and Onwards % Recovered and Reused	2019 and Onwards % Recovered and Reused	2025 and Onwards % Recovered and Reused
Maximum λ value				
Time Period	2016 and onwards		2019 and onwards	
NG	1.25		1.15	
LPG	1.25		1.15	
Fuel oil	Not yet determined		Not yet determined	

Heat recovery option is applicable to direct gas-fired base cases; the improved insulation is applicable to electricity and direct gas-fired base cases; and the optimized control of the fuel/air ratio "λ" is applicable to indirect gas-fired base cases. The preceding ecodesign measures apply to a wide variety of furnaces. Due to the heterogeneity and complexity of the processes, applications, user requirements, and product group contents, generally, there are a number of limitations and exceptions for furnaces and related equipment (such as burners) in terms of the proposed mandatory requirements and measures, even on a case-by-case basis. Restrictions, exclusions, and detailed implementation directions are specifically avoided in this document since they fall outside of its scope.

Table 3 shows some illustrative instances of conventional furnaces and ovens, as well as the relevant characteristics and performance metrics using the current BAT. According to the ENTR Lot 4 European study, these figures are based on data submitted by stakeholders. The ecodesign choice recommendations were based on the analysis of similar data, following thorough analyses and computations that combined various indicators and characteristics.

Table 3. Types of EU furnaces and their operational characteristics according to the ENTR Lot 4 European study [15].

Type of Furnace/Oven	Average Power Rate (MW)	Energy Consumption (GWh/Year)	Working Hours, Capacity Utilization
Cement rotary kiln	130	1000	8000 h/year, 60%
Flat glass melting gas	60	156–477	Continuous for 15 years
Rotary ferrous melting furnace gas	1–4	0.2 to 27	3650 h/day
Rotary non-ferrous melting gas	1–4	0.3–43 (copper)	3650 h/day
Steel wire heat treatment (various, gas)	1.1–1.5	11	8000 h/year, 90%
Steel wire galvanizing (various, gas)	0.3–1	7.2	8000 h/year, 90%
Heat treatment aluminum gas	1–20	6.4–128	8000 h/year, 80%
	<1	4	6500 h/year, 60%
Wall tile kiln	6	14 (estimate)	8040 days/year

The next charts, based on Annex E of the European Commission's working document [24], represent the energy savings that will occur if the proposed policies' requirements are implemented (Figures 2 and 3).

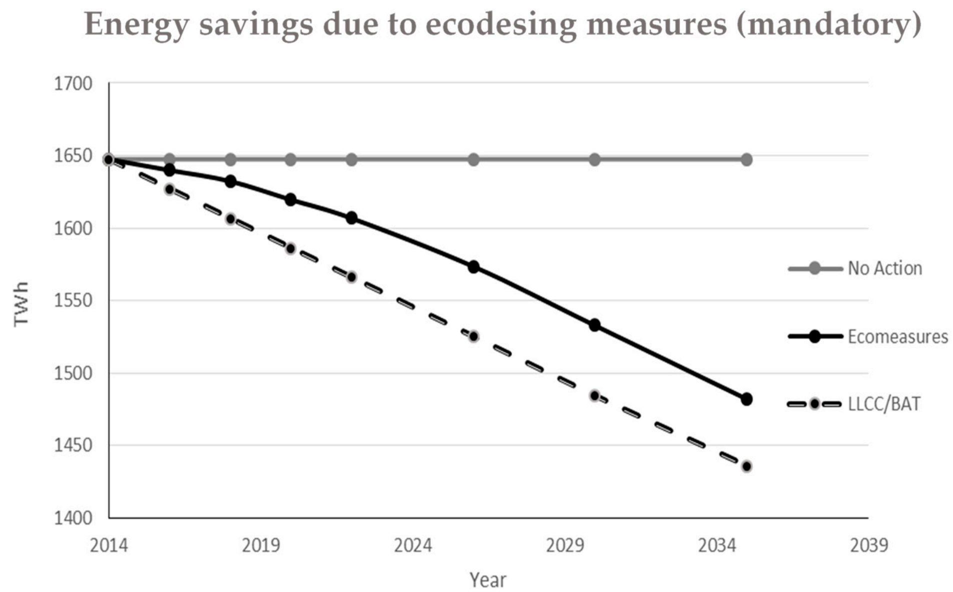

Figure 2. EU studies predictions on final energy consumption by applying ecodesign measures for the 2014–2035 period. Based on data obtained from EC's working document, Annex E [24].

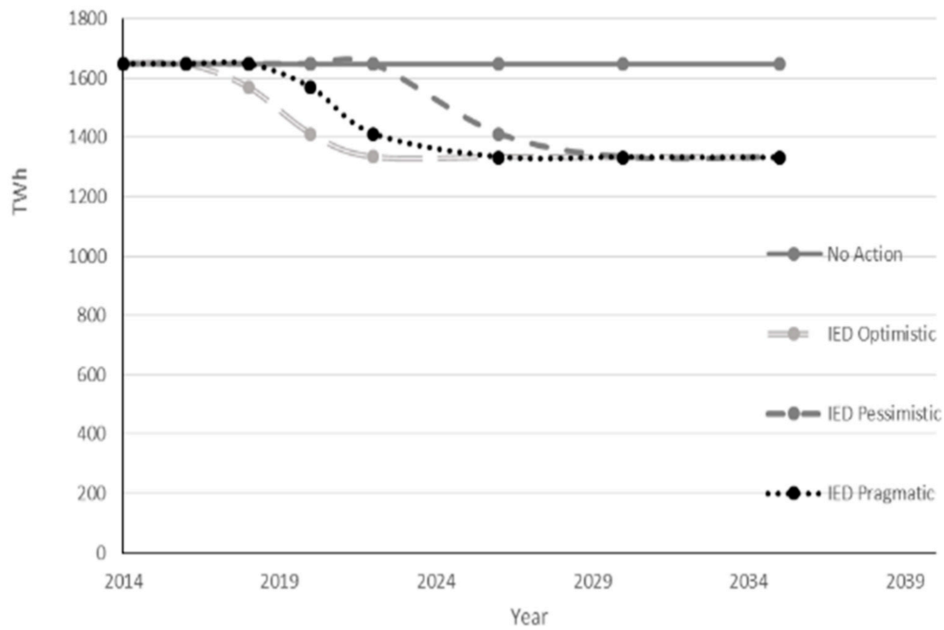

Figure 3. EU studies' predictions on final energy consumption by applying IED BAT measures for the 2014–2035 period. Based on data obtained from EC's working document, Annex E [24].

The scenarios under examination in terms of (the ongoing) impact assessment evaluation were changed (compared to Lot 4) in the 2014 working document's Annex E to the following:

- No action scenario;
- Policy options-related scenarios (Table 4).

Table 4. The 2 main policy ecodesign options according to the EC's 2014 working document, Annex E [24].

Policy Option 1			**Policy Option 2**		
Ecodesign measures (only for sales of new products) Three scenarios			BAT applied through the already existing legislation (IED, etc.)—implemented on existing stock and new sales Three scenarios		
Mandatory Ecodesign Requirements (MERs) scenario	Least Life Cycle Cost (LLCC) scenario—only for reference	BAT	Optimistic	Realistic	Pessimistic
Three tiers—starting from 2016 (2020 and 2026)	Hypothetically implemented from 2016		Starts in 2016	Starts in 2018	Starts in 2022

It should be noted that, in general, the BAT and LLCC scenarios match in terms of energy consumption (and GHG emissions where data are available), both in the Lot 4 research and the working document draft predictions (Annex E) [6,24].

According to the ENTR Lot 4 analysis, the product category would consume around 1648 TWh of primary energy in the "no action" scenario in 2035. Similarly, over the 25-year study period (2011–2035), a total of 41,188 TWh of primary energy would be utilized, with an impact of 8025 million tons of a CO_2-equivalent. Of them, base case 6 (large fossil fuel furnaces) accounts for 86% of the total emissions and 83% of the total energy use.

On the other hand, the lowest planned energy performance measures described in the same study would result in 1482 TWh of the primary energy required in 2035, while a total of 39,664 TWh would be consumed during the entire 25-year timeframe. For the same time period, the equal amount of GHG emissions would be 7725 million tons of a CO_2-equivalent. Of them, base case 6 accounts for 85% of the total GHG emissions and 83% of the total energy consumption.

Finally, as projected, the BAT scenario would result in lower environmental impacts: 1436 TWh of the primary energy would be required in 2035, with a total primary energy consumption of 38,835 TWh from 2011 to 2035. The overall emissions of greenhouse gases will be 7561 million tons of a CO_2-equivalent (base case 6, which accounts for 85% of the total emissions and 83% of the total energy use) [9].

3.2. Case Study: Waste to Energy (WtE) Industry—BAT Conclusions of the European Union

To reduce waste and boost recovery, the European Union has launched a waste-to-energy initiative [25,26]. There are more than 500 WtE facilities in the European Union that process 30% of the continent's municipal waste that use furnaces and ovens. The development and integration of WtE facilities as the primary waste treatment method can be a viable alternative energy option, resulting in lower CO_2 and CH_4 emissions while conserving limited fossil fuel and natural resource resources [27]. Numerous plants co-process hazardous wastes and sewage sediment, among others. Following a lengthy debate, the European Commission implemented decision (EU) 2019/2010, establishing the BAT findings for waste combustion (document C (2019) 7987) in December 2019 [28]. The BAT conclusions are a result of the Industrial Emissions Directive (IED 2010/75/EU) of the European Parliament and of the Council—a framework for regulating about 50,000 industrial installations across the EU—which in practice, requires that the permits of plants comply with the BAT conclusions [21]. While the primary objective of these BAT conclusions is to reduce emissions from waste incineration, including noise and odor, other environmental concerns that contribute to the circular economy are also addressed, such as the recovery of useful materials, energy efficiency, and resource efficiency (water and reagent consumption). Within four years of the publication of a decision on the BAT conclusions, all the relevant environmental permits must be adapted to the new requirements and, if necessary, remediation work must be performed to ensure that the BATs are implemented. The BAT

Reference Document (BREF) for waste incineration [29] offers national authorities a solid technical foundation for establishing permit criteria.

The authorities are required to establish Emission Limit Values (ELVs) to ensure that emissions do not exceed the values defined in the IED and reported as BAT-AELs (see IED Article 3 (13). BAT-AELs are derived from the data provided by operators of WtE facilities in response to a survey and were determined by selecting the lowest of the reported emissions and evaluating each substance separately. The BAT-AEPLs (BAT-Associated Environmental Performance Levels) and BAT-AEELs (BAT-Associated Energy Efficiency Levels) were introduced by the European Integrated Pollution Prevention and Control Bureau (EIPPCB), which coordinated the exchange of information between experts and also developed BREF documents, but they are not included in the IED.

The Confederation of European Waste to Energy Plants (CEWeEP), the European Suppliers of Waste to Energy Technology (ESWET), FEAD, and Euroheat and Power, which comprised the Technical Working Group for the review of the waste incineration BREF, have published an explanatory and guidance document [30]. The purpose of this document is to provide the background information gathered during the lengthy BREF review process that will be required for the implementation portion of the BAT conclusions. In addition, the European Environmental Bureau (EEB) released a summary of the recently released waste incineration BAT conclusions [31]. The briefing discusses the primary issues identified by the EEB and urges "incineration watchdogs" to closely monitor the permitting processes and bring the document's contents to the attention of the appropriate authorities.

The main challenges for the implementation of the BAT conclusions are as follows:

- Energy efficiency improving techniques are not novel and may not be suitable for a few facilities/markets;
- Different nature of BAT conclusions and BAT-AELs between 2006 BREF and new BREF (AEL: associated emission levels);
- Different reference for compliance between rules of the IED and BREF (NOC: Normal Operating Conditions; EOT: Effective Operating Time);
- No guidance on how to interpret the BAT-AEL ranges to set new ELVs (Emission Limit Values);
- New potentially complex requirements for waste acceptance procedures;
- Potential challenge to comply with uncertainty requirements when new ELVs are set around the lower end of the BAT-AEL ranges. This is associated with a likely increase in the relative measurement uncertainty (i.e., the uncertainty expressed as a percentage of the measured value) with decreasing emission levels;
- Ambitious requirements for water emissions;
- New rules for bottom ash handling and metal recovery—dry discharge from the bottom ash is suggested.

4. Discussion

The initial and indicative draft Lot 4 impact assessment predictions for energy savings demonstrate the positive influence of prospective ecodesign measures on reducing energy consumption. More specifically, the MER scenario is expected to provide 10% energy savings in 2035 compared to the "no action scenario" for all base cases, and the respective LLCC/BAT hypothetical scenario is expected to provide about 12.9% energy savings for all base cases (Policy 1, including base case 1—approximately the same energy consumption values in the Lot 4 study). In comparison to the no action scenario (Policy 2), the BAT under the IED is predicted to provide 19.2% energy savings in 2035 for each of its time-related versions (~1332 TWh final energy consumption in 2035). If the BATs are used, it appears that 90 TWh/year of energy savings (from all base cases) are possible. These preliminary impact assessment results do not include any forecasted greenhouse gas emissions [21–24].

It should also be noted that the working document's Annex E draft results refer to the final energy consumption/savings for fossil-fueled furnaces and ovens and the primary energy consumption/savings for electricity-powered products (the conversion assumption that 2.5 primary energy results in the final energy use is made: so, 1 electricity kWh (kWhe) corresponds to 2.5 kWh (KWhf) of coal, NG, etc., required, with an electricity generation conversion efficiency of 40%) [21–24].

In the BAT conclusions for the Waste to Energy (WtE) industry, BAT-AELs are expressed as (wide) ranges, while very little information is provided on how to interpret these ranges and how to obtain BAT-AELs, which are important issues considering that BAT-AELs are the future ELVs. However, it is known that BAT-AELs are based on a statistical assessment of the actual emission values reported in a survey, and the margin or uncertainty of the reported values is not accounted for.

5. Conclusions

This paper is a good opportunity to gain a direct understanding of the process of reviewing European directives and the issues that must be resolved. The environmental legislation process and the related technical studies regarding ecodesign in industrial furnaces/ovens (and, by extension, the equipment encompassed within the product group definition, such as burners) have considerable progress to make. Currently, a preliminary framework consisting of draft measures and associated proposals is in place. These suggestions will be scrutinized and re-evaluated, but they represent an initial step toward the eventual transition to official, binding, and conclusive regulations. We eagerly anticipate the final findings of the impact assessment, which are expected to offer more comprehensive data and analysis. Nevertheless, the studies conducted thus far demonstrate significant potential for substantial energy savings and greenhouse gas emission reductions.

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