sustainability

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The Legal Transition towards a More Circular Electrical and Electronic Equipment Chain—A Case Study of The Netherlands

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Abstract: The transition towards a circular economy in the EU requires that the legal framework does not create (legal) barriers, but rather enables or stimulates this transition. At this moment, however, the existing literature argues that the current legal system that governs the life cycle of materials and products—EU chemicals, product and waste legislation—might hamper the transition. This article looks into the legal framework for the transition of the product stream of electrical and electronic equipment (EEE) and more specifically into the general and specific applicable EU chemicals, product and waste legislation, as well as its implementation in the Netherlands. By means of both doctrinal and empirical legal research, this article identifies legal barriers, gaps and incentives in the current legal framework that governs the life cycle of EEE in light of the transition towards a circular economy (CE). To enable or stimulate the CE transition in the EEE chain, it appears that it would be desirable to improve the interaction within this legal system and better align it with the objectives of the CE and life cycle thinking. Moreover, this research shows that a different approach within EU chemicals, product and waste legislation could be beneficial for the CE transition. With regard to EEE, a holistic approach could enable a more circular EEE chain, either within the current sector-approach, or with a more product-specific or material-specific approach within the EU chemicals, product and waste legislation governing EEE.

Keywords: circular economy (CE); electrical and electronic equipment (EEE); waste electrical and electronic equipment (WEEE); EU chemicals legislation; EU product legislation; EU waste legislation

Citation: de Waal, I.M. The Legal Transition towards a More Circular Electrical and Electronic Equipment Chain—A Case Study of The Netherlands. *Sustainability* **2023**, *15*, 935. https://doi.org/10.3390/su15020935

Academic Editor: Antonella Petrillo

Received: 17 October 2022
Revised: 22 November 2022
Accepted: 20 December 2022
Published: 4 January 2023

1. Introduction

The European Union (EU) is in the process of transitioning from a linear economy to a circular economy (CE), which is an economy 'where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste is minimized' [1]. As one of the main building blocks of the EU Green Deal, the transition towards a CE aims to contribute to creating a more sustainable economy for the EU [2]. One of the product groups on which there is a particular focus with regard to the transition towards a CE in the EU, is electrical and electronic equipment (EEE) [3]. EEE is a resource-intensive sector, as EEE consists of a complex and heterogenous mixture of materials and components [2,4–7]. It often contains hazardous substances, as well as critical raw materials (CRMs) [8–10], and other rare and valuable materials. Throughout its life cycle, from the mining of raw materials to the disposal of products, EEE causes negative environmental impacts [11–13], and the used resources and materials can also pose challenges for human health and the environment at the end of life (EoL) stage due to their hazardousness or toxicity [6,10,11,13–15]. Waste EEE (WEEE) is also one of the fastest growing waste streams in the EU [3,10]. Because of growing prosperity [5], rapid innovations and competition within the sector [12,16], and declining product lifetimes [12], the consumption of EEE is expected to keep increasing in the future, simultaneously leading to an increase of WEEE. However, only about 40% of all WEEE is being recycled [3,7], and

the reuse rate is estimated at only 1% of all collected WEEE [8,16]. Significant materials and value are thus being lost to the economy.

The transition towards a more circular EEE chain could not only lead to economic and environmental benefits for the EEE sector itself [17], but could also make a significant contribution to achieving a CE in the EU in general [11]. However, the transition towards a more circular EEE chain has been limited so far [1,7,10,15,18].

The transition towards a CE, including the transition towards a more circular (W)EEE chain, would ideally require, amongst other things, having a legal framework in place that does not hamper the transition, but is conducive to this transition instead. This specifically counts for the legislation that governs the lifecycle of products and materials: EU chemicals, product and waste legislation [19–21]. EEE is governed by sector-specific EU chemicals, product and waste legislation, such as the Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS Directive) [22] and the Directive on waste electrical and electronic equipment (WEEE Directive) [23], as well as more general legislation, such as the Directive establishing a framework for the setting of ecodesign requirements for energy-related products (Ecodesign Directive) [24], and the Waste Framework Directive (WFD) [25]. Extended producer responsibility (EPR) applies to EEE as well, meaning that all those who bring EEE on the European market are responsible for the management of the waste stage of these products [23,25].

Since the first CE Action Plan, the EU has taken several steps to align its legislation with the CE transition, as evidenced by the amendments of the WFD [26], or, specifically with regard to (W)EEE, the amendments of the WEEE Directive [27], and the RoHS Directive [28]. Additionally, following up on its 2020 CE Action Plan, the EC recently announced a proposal for a new Ecodesign for Sustainable Products Regulation [29], as well as reviews of several other legislation governing EEE. Nevertheless, there still seem to be situations in which the transition towards more circular material and product chains is hampered or where there are unexploited opportunities to stimulate the transition through legal measures. This also counts for the transition towards a circular EEE chain. For example, this article shows that EU chemicals legislation poses potential barriers for the recycling of WEEE plastics and the use of secondary plastics, and that the possibility to set circular product requirements is not fully utilized. More in general, the current legal framework that governs the life cycle of materials and products—EU chemicals, product and waste legislation—has been shown to not fully support the transition towards a CE, amongst other things, because of the presumption that there is a lack of coherence between these three areas of law [30]. The idea of having to improve the coherence within the legal framework governing the life cycle of materials and products aligns with the CE and is also in line with and indicated by life cycle thinking, which is key in a CE [19,20].

In light of the transition towards a more circular EEE chain, the aim of this article is to examine legal barriers and incentives with regard to the EU chemicals, product and waste legislation applicable to (W)EEE, in order to determine what can be done to take away these barriers and incentivize the transition. Next to legal doctrinal research, empirical legal research was used, comprising of 14 semi-structured interviews with 16 (W)EEE stakeholders in the Netherlands. The novelty of this article lies in the fact that it combines these two research methods and therewith provides thorough research into the legal transition towards a more circular EEE chain, from both a practical and theoretical perspective.

The article is structured as follows. Section 2 sets out the methodology of the literature and interview study and the choice for examining the Netherlands. Section 3 focuses on the EU chemicals, product and waste legislation governing EEE, both in general and in relation to the transition towards a CE. Section 4 contains the results of both studies and sets out the identified legal barriers and (lack of) incentives for a more circular EEE chain. Section 5 analyzes the identified legal barriers and (lack of) incentives, also in light of future developments. Finally, Section 6 contains the conclusion.

2. Materials and Methods

The aim of this research has been to broaden the discussion on legal barriers and incentives for the CE transition in the EEE chain beyond a theoretical point of view. Therefore, the choice was made to combine a literature study with conducting interviews with (W)EEE stakeholders along the EEE product chain in the Netherlands.

The literature study aimed to identify legal barriers and incentives for the CE transition in the (W)EEE chain, by examining both (legal) literature, policy documents and case law that make mention of (W)EEE and the CE transition, or related and preceding concepts such as life cycle thinking, lifetime extension or resource efficiency. This literature was found by searching online databases (Scopus, Worldcat, Google Scholar and Legal Intelligence), the online databases of the EC, the Council of the European Union and the European Parliament as well as the databases of the CJEU and the Dutch judiciary. In addition, the snowballing method was used to select further relevant literature.

The main aim of the interview study was to, in light of the transition towards a circular (W)EEE chain, identify possible legal barriers, solutions and (lack of) incentives regarding EU chemicals, product and waste legislation applicable to (W)EEE as well as to validate identified legal barriers, gaps, solutions and incentives mentioned in literature and policy documents. Based on purposive and snowball sampling [31,32], 16 stakeholders were interviewed in 14 semi-structured interviews between March–May 2022 [33–35]: 6 with producer (organizations), 2 with refurbishers, 4 with treatment facilities, and 2 with governmental organizations. The interviews were semi-structured to allow interviewees to introduce new topics and to have the flexibility to discuss certain topics more in-depth. A set list of questions was used for each interview, while leaving room to deviate from this list or to elaborate on particular topics (see Appendix A for the questionnaire) [33]. The transcripts of the interviews were de-identified, coded using NVivo and analysed together with the results of the literature study using a theoretical thematic analysis [36]. As only stakeholders in the Netherlands were interviewed, it is noted that the interview study is not representative for all EU MSs. However, the outcome could be relevant to other MSs as well, as it gives insight into the relation between identified barriers and (lack of) incentives in literature and the experienced barriers and (lack of) incentives in practice as well as into the implementation of EU chemicals, product and waste legislation applicable to (W)EEE.

The decision was made to conduct interviews with stakeholders in the Netherlands. In general, from recycling statistics it appears that the Netherlands is among the best performing half of the MSs in Europe [37,38]. However, with regard to the collection and recycling of WEEE, based on the (most recent) statistics of 2018 and 2019, the Netherlands currently belongs to the worse performing half of the MSs, with a collection rate of 49%, and a recycling percentage of 41% [39–41]. While the Netherlands did achieve the minimum recovery and recycling targets for all main categories, it has failed to reach the overall collection target of 65% that has been in place since 2019 [41–43]. Figure 1 clearly shows an increase of the distance to the target of 65% and, compared to 2020, the amount of collected WEEE has decreased by 7% in 2021. It also becomes apparent that PV panels have an important impact on the collection rate, as their share of the three year average POM is almost one third while the collection of PV panels is next to nothing [43]. In short, Figure 1 shows that over half of all WEEE is currently not being recycled nor recovered. Unfortunately, the interviews were conducted before the results over 2021 were published, so the interviewees could not be asked what, in their opinion, caused the deteriorated results, therewith representing a gap for further research.

Next to the implementation of the EU chemicals, product and waste legislation governing EEE (see Appendix B), the Netherlands has also taken additional steps. With regard to the EPR for WEEE, a so-called 'generally binding agreement' (*algemeen verbindend verklaring* (AVV)) is applicable in the Netherlands. This AVV formalizes an EPR initiative from the sector, which means that all producers and importers of a product must contribute to the EPR scheme that is laid down in the AVV. In the case of EEE, the AVV requires all producers and importers to join the producer responsibility organization (PRO) 'Foundation OPEN'

Stichting OPEN), and to contribute a waste management fee to this PRO. Additionally, the voluntary CENELEC standards (previously WEEELABEX) are mandatory in the Netherlands, meaning that waste treatment facilities have to comply with those [44]. Nevertheless, as stated before, the collection and recycling results are disappointing and show a growing failure to reach the target of 65%.

On balance, the Netherlands poses as an interesting case to examine which existing approaches were or still are successful, but at the same time to look at ways in which the existing framework can or even should be modified in order to realize a more circular EEE chain.

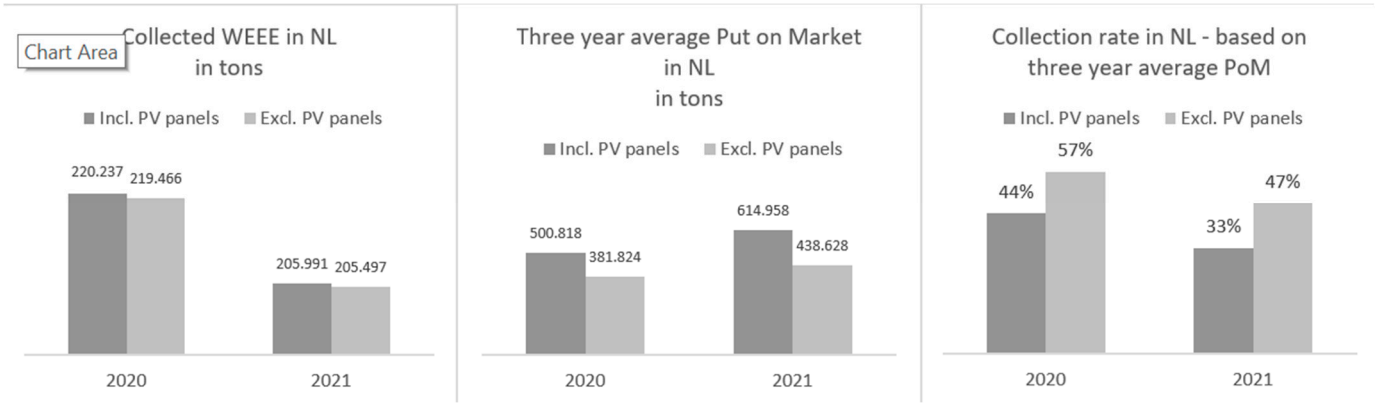

Figure 1. Achieved results in the Netherlands in 2021 and 2020 [42,43].

3. EU Chemicals, Product and Waste Legislation Governing WEEE in Light of the CE

Under EU law, (W)EEE is governed by both general and sector-specific EU chemicals, product and waste legislation, which together can be said to govern the whole life cycle of EEE [19–21,30]. The main legal acts within these three areas are the RoHS Directive, the REACH Regulation [45], and the Classification, Labelling and Packaging Regulation (CLP Regulation) [46]; the Ecodesign Directive and the Energy Labelling Framework Regulation [47]; and the WEEE Directive, the WFD and Waste Shipment Regulation (WSR) [48]. Where the RoHS Directive and the WEEE Directive are sector-specific legal acts, the other acts can be considered key legal acts in their respective areas of law and are, to varying degrees, considered to be comprehensive legal frameworks.

In a CE, life cycle thinking is considered key as it enables optimization of the life cycle of materials or products and further enables the assessment of their overall environmental impact [49–51]. Therefore, next to providing some additional insight into the key provisions of the legislation, the following overview shows whether both the CE and life cycle thinking are taken into account in the abovementioned legislation. It also includes the interaction between the legislation governing the life cycle, which is also relevant in light of both the CE and life cycle thinking [30].

Table 1 contains a concise overview of the main legal acts governing EEE, including their objectives and key provisions, as well as a brief description of the extent to which the CE or life cycle thinking are taken into account. Appendix B contains a brief overview of the implementation of these legal acts in the Netherlands.

Table 1. Overview of EU chemicals, product and waste legislation governing EEE in light of the CE transition.

Legal Act	Focuses on: Use of Chemicals (C), and/or Product Stage (P) and/or Waste Stage (W)	Objective of the Legislation	Description, including any Key Provisions	The Taking into Account of the CE or Life Cycle Thinking
RoHS Directive	C (W)	Regulates the use of hazardous substances in EEE to contribute to the protection of human health and the environment, including environmentally sound recovery and disposal of WEEE (art. 1).	• Restricts the use of ten hazardous substances, including flame retardants, heavy metals and plasticizers (art. 4 (1) jo. Annex II). • Contributes to improving flow of information on substances in EEE.	• Life cycle thinking is reflected in the objective, and is explicitly mentioned to apply when assessing the impacts of exemptions (art. 5, Annex V). • The interaction with the waste stage is to be taken into account in the review and amendments of restricted substances (art. 6).
REACH Regulation	C	Aims to ensure a high level of protection of human health and the environment from adverse effects of chemical substances, as well as to support the functioning of the internal market and stimulate competitiveness and innovation (art. 1 (1)).	Sets up a system for registration, evaluation, authorization and restriction of chemical substances.	Underlines the importance of taking into consideration the whole life cycle of substances, which becomes apparent with respect to the preparation of chemical safety reports and assessments (art. 3.37, art. 18(4)(a), Annex I, Annex II, Annex XII).
CLP Regulation	C	Aims to ensure a high level of protection of human health and the environment, and the free movement of substances (art. 1(1)).	Establishes the system of classification, labelling and packaging of chemical substances and mixtures in the EU.	Does not mention nor reflect the CE or life cycle thinking.
Ecodesign Directive	P (C) (W)	Aims to ensure the free movement of energy-related products within the internal market (art. 1(1)).	• Establishes a framework for setting ecodesign requirements for energy-related products in the EU (art. 1 (1) and (2)). • Ecodesign requirements are implemented through product-specific implementing regulations.	• Ecodesign means that the environmental aspects are integrated into the product design to 'improve the environmental performance of the product throughout its whole life cycle' (art. 2 (23)). • Ecodesign requirements can include aspects that contribute to the CE, such as resource efficiency [52,53]. Implementing regulations that also take CE aspects into account, albeit to a limited extent, are in force since 2019 [54].
Energy Labelling Framework Regulation	P	Aims to ensure the functioning of the internal market and high level of environmental and consumer protection, as well as to reduce negative environmental impacts of products [55].	• Sets the framework for the labelling of energy-related products, regarding energy efficiency, consumption of energy and other resources during use (art. 1 (1). • Complements ecodesign requirements.	Current product-specific energy labelling regulations for EEE do not provide information on circularity aspects, instead the predominant focus is on energy efficiency.

Table 1. *Cont.*

Legal Act	Focuses on: Use of Chemicals (C), and/or Product Stage (P) and/or Waste Stage (W)	Objective of the Legislation	Description, including any Key Provisions	The Taking into Account of the CE or Life Cycle Thinking
WEEE Directive	W (P)	Aims to protect human health and the environment and contribute to sustainable development by preventing and improving the waste management of WEEE, by reducing the impacts of resource use, and by improving the efficiency of resource use (art. 1).	• Requires MSs to take appropriate measures for ensuring that ecodesign requirements facilitating reuse and treatment of WEEE are applied (art. 4). • Requires separate collection as well as proper treatment of WEEE (art. 5, art. 8). • Sets minimum collection target to be achieved annually in each MS of 65% of the average weight of EEE placed on the market (PoM) in the three preceding years in the Member State concerned or 85% of WEEE generated on the territory of that Member State (art. 7). • Contains specific recovery and recycling targets for each EEE category (Annex V). • Contains provisions on the setting and development of standards for the treatment of WEEE, which has resulted in the CENELEC standards (art. 8 (5)) [56,57].	• Life cycle thinking is reflected in its objective, in which the interaction with and supplementation of EU waste management legislation, such as the WFD, is also mentioned (art. 1). • Multiple provisions reflect CE and life cycle aspects, e.g., the establishment of EPR [50]; the fact that MSs are to encourage the cooperation between producers and recyclers with a view to improve product design for the end-of-life treatment (art. 4) [58]; MSs are to ensure that collecting and transporting WEEE provide for optimal conditions for the preparation of reuse and recycling (art. 6); and there are requirements on proper treatment for certain materials and components (art. 8 jo. Annex VII and VIII).
WFD	W (C) (P)	Aims to protect human health and the environment by preventing or reducing the (adverse impacts of the) generation of waste; by reducing the overall impacts of resource use; and by improving the efficiency of resource use (art. 1).	Provides the general framework for the waste management in the EU, including the waste hierarchy (art. 4); by-products and end-of-waste criteria (art. 5, art. 6); EPR (art. 8, art. 8a); and targets for the preparation for reuse and recycling of waste (art. 11).	• Explicitly mentions that its objective is 'crucial for the transition to a circular economy' (art. 1). • Multiple provisions underline the importance of looking at the life cycle of materials and products as a whole, or are based on life cycle thinking, such as the waste hierarchy or EPR (e.g., art. 4, art. 6, art. 8, art. 9). • Regularly mentions the interaction between the WFD and EU chemicals and product legislation (art. 6, art. 9).
WSR	W	Aims to reduce risks for human health and protect the environment [59].	Establishes procedures and control regimes for shipments of waste between MSs, imported from or exported to third countries (art. 1).	Neither the CE nor life cycle aspects are explicitly mentioned in this legal act.

Table 1 shows that some of the legal acts take into account the CE or life cycle thinking, or refer to the interaction between the different areas of law or legal acts. For example, the objective of the WFD explicitly refers to the transition to a CE and the WEEE Directive requires that MSs take appropriate measures to ensure that ecodesign requirements are applied that facilitate reuse and treatment of WEEE. In addition, the CE, life cycle thinking or the interaction between the legal acts are often referred to in the recitals in the preamble of the legal acts. Recitals are not legally binding, but provide the reasons on which the legal acts are based and serve as an interpretative tool [60]. For example, recital 2 of the 2017 revision of the RoHS Directive shows that the Directive focuses on the secondary market operations of EEE, such as the availability of spare parts, repair and reuse and therewith to contribute to the CE transition [28,61]. Recital 36 of the Energy Labelling Framework Regulation states, for example, that the analysis for further product groups for which an energy label could be established, should also look at supplementary information to be included, such as durability or environmental performance, in coherence with the objective to promote a CE [47]. Recitals 6 and 11 of the 2012 recast of the WEEE Directive already underlined that the first priority in contributing to sustainable production and consumption is to prevent WEEE, and that the Directive seeks to improve 'the environmental performance of all operators involved in the life cycle of EEE' [23], whereas recital 1 of the 2018 amendment of the WEEE Directive states that waste management should be improved with a view to, amongst other things, 'promoting the principles of the circular economy' [27]. With regard to the interaction, several of the recitals of the RoHS Directive mention that it supplements the general EU waste management legislation, interacts with the Ecodesign Directive, and also refers several times to the interaction within EU chemicals legislation, especially referring to the REACH Regulation [22]. In addition, the recitals of the WEEE Directive mention several times its interaction with the Ecodesign Directive [23], and the recitals of the Ecodesign Directive and WFD explicitly mention the synergies and interaction between the abovementioned legal acts and areas of law [24,26].

In short, in addition to the legal acts themselves that take into account CE objectives, life cycle thinking, or the interaction among the legal acts, the recitals of several legal acts also mention these aspects. In general, however, the legislation is still to a large extent 'linear' as it predates the CE transition, but this may change in the near future as multiple reviews of existing legislation as well as proposals for new legislation have been introduced (see further Section 5.1).

4. Results

The literature study and interview study identified a wide variety of barriers and incentives for the transition towards a more circular EEE chain, including many legal barriers and (lack of) incentives that relate to the EU chemicals, product and waste legislation governing EEE. These barriers and incentives were identified at three levels: within EU legislation, at the interface between EU legislation and national legislation and at the national (Dutch) level.

Although the article is limited to discussing these legal barriers and (lack of) incentives related to EU chemicals, product and waste legislation governing EEE, multiple other issues and incentives were identified, each representing an area requiring further research, for example with regard to:

- different legislation, for example consumer legislation and green public procurement [18,62–64];
- the behavior, attitude and awareness of consumers and producers, such as the lack of awareness and attitude of consumers with regard to recycling WEEE and their willingness to buy refurbished products [6,15,52,62,63,65–68];
- the collection of WEEE [6,66,69];
- the cooperation, transparency and flow of information within the supply chain [6,12,62,70];
- data safety and IP [12,71];
- financial and economic aspects, such as deposit refund schemes [6,8,63,69,72,73];

- information and knowledge on circular (W)EEE management [5,65,66,72,74];

The identified legal barriers and (lack of) incentives regarding EU chemicals, product and waste legislation often relate to existing legislation, and include barriers with regard to existing provisions or (lack of) incentives related to these acts. These will be set out below. For the sake of completeness, it should be noted, however, that the following overview does not claim to be a comprehensive overview of all existing legal barriers and (absent) legal incentives.

4.1. EU Chemicals Legislation

It is important that WEEE is disposed of and treated properly, as (W)EEE can contain various hazardous substances, such as flame retardants, PCBs and PBDEs, that could pose a threat to human health and the environment [11]. However, from a CE perspective WEEE is not only considered waste, but also a resource [69]. Therefore, the presence of hazardous substances as well as the legislation governing them can form a barrier for the refurbishment and recycling of WEEE. Two interviewees remarked that refurbished products that are placed on the market must comply with the most recent EU chemicals legislation, i.e., the RoHS Directive [75]. According to an interviewed producer, this hampers the refurbishment of EEE, as they do not have the information that is required to check if these refurbished products and components comply with this new legislation [18]. The legacy substances problem was also mentioned [21,76–78], meaning that despite the regulation of the use of hazardous substances, they continue to be present in waste streams as it not only takes a long time to phase out these hazardous substances [69], but products containing hazardous substances can still enter the EU market due to online shopping [11]. In the literature, it has furthermore been noted that, despite the fact that the REACH Regulation requires that the whole life cycle of substances should be taken into account with regard to chemical safety reports and assessments, the use and end-of-life stages are not considered detailed enough [64].

Issues with regard to hazardous substances present in WEEE streams often concern the presence of hazardous substances in plastics. In the literature, chemicals legislation, more specifically the REACH Regulation and RoHS Regulation but also the POPs Regulation, were named as a common barrier for recovering and recycling plastics in EEE, as well as for using recycled plastics in new EEE [12]. This aligns with interview statements by waste treatment facilities and producers, who stated that the legislation on flame retardants hampers the recycling of WEEE plastics and the use of secondary plastics. Not only because of the legacy substances problem, but also because they will not be able to measure the refined concentrations of flame retardants that are being proposed as new thresholds for EEE plastics [79]. Furthermore, the reuse, refurbishment and recycling of WEEE, as well as the use of secondary materials in EEE have been said, in both literature and interview, to be hampered, as the rules in EU chemicals legislation, more specifically the REACH regulation and ROHS Directive, cause uncertainties and administrative burdens [18].

4.2. EU Product Legislation

The Ecodesign Directive is often mentioned when it comes to legislation that could stimulate the transition towards a circular economy as well as limit the environmental impact of products [64]. It provides the possibility to set ecodesign requirements that could contribute to the creation of products that already take into account the subsequent life cycle stages [24,68], as well as contribute to the lifetime extension [80,81], durability [82], and resource efficiency of products [64,82,83]. Ecodesign requirements can, moreover, serve as a 'push' instrument for producers and can create a level playing field in the EU [64,84].

Only a few of all possible ecodesign requirements to contribute to these objectives include requirements on easy disassembly (e.g., time thresholds for disassembly [84–87], standardization of fastenings [52], mandatory dismantlability of key components [88]), on material efficiency [88], on recycled content [12,52,64,72,89], on promoting repairability (e.g., availability of spare parts or software for a specified number of years) [72,80], or on

material use (e.g., ban of (hazardous) materials that negatively affect recycling or reuse, concentrated use of priority materials, use of mono-materials) [52,64]. [52,67] Interviewees added, inter alia, the possibilities of setting requirements on the number of allowed plastic types to facilitate the waste treatment process [52], or requirements that accommodate color separation in the waste treatment process. They also remarked that a requirement on recycled content could boost demand for recycled materials, especially for plastics.

Ecodesign requirements could, moreover, contribute to improve the flow of information within the supply chain [72], for example, by setting information requirements on resource efficiency [64], the presence of hazardous substances or CRMs [52,71,89], or on disassembly, disposal or recycling [52]. This could inform consumers on resource aspects, help end-users to correctly dispose their products, and help improve the efficiency and safety of recycling and recovery processes. However, such information has to be easily accessible for the relevant actors. According to some interviewees, an attached QR code could be a possibility for consumers and repairers, but all but one of the waste treatment operators stated that this would not work, as scanning and looking up information per product does not fit in the current waste treatment process. As an alternative, it was suggested to embed information on the product itself, for example, by means of color marking or logos [52].

Some of the abovementioned suggestions are already implemented in ecodesign implementing measures for a few product groups, such as requirements on the reusability of components and on compulsory available software [54,72,90,91]. In general, however, limited use has been made of the possibility to include CE aspects in ecodesign requirements [30]. A shift to improve the focus of ecodesign requirements from energy efficiency to resource efficiency and lifetime extension would be desirable to stimulate the CE transition [52,88]; also according to six interviewees. This does require, however, that the methodology for ecodesign of energy-related products - the assessment for ecodesign requirements on a specific product group [92] - is adjusted to ensure that resource efficiency and durability aspects can actually be implemented in ecodesign requirements [52,64,88,93]. In addition, it is important that there are adequate standards and methods in order to prove compliance, to monitor and to enforce these ecodesign requirements [52,54,67,83,88,89,94]. Nevertheless, it has been pointed out in literature and by an interviewee that it is difficult to check if products meet product requirements, especially as products are mostly manufactured outside of Europe [16,52,93]. Lastly, it has been argued that too many and too detailed ecodesign requirements might actually hamper innovation, which is undesirable for the CE transition [95,96]. This aligns with the comment of an interviewed producer of circular products, who is against more stringent product requirements for this reason.

Next to the possibilities of the Ecodesign Directive, additional options were mentioned in the literature to increase, amongst other things, the durability and repairability of products. Some options concerned the potential of the EU energy label or the voluntary Ecolabel. Similar to how these product policy instruments currently address energy efficiency, both labels could also address CE criteria and therewith serve as 'pull' instruments for both consumers and producers [63,64,81,84]. The EU Energy label could, for example, provide information on durability aspects, such as an average expected product lifetime, and repairability [62,85], whereas the Ecolabel could address resource efficiency [63,84]. Another mentioned option for the EU to promote durability is to enter into voluntary agreements on durability with the (W)EEE industry [62].

4.3. EU Waste Legislation

The WEEE Directive has as its objective to prevent the generation and disposal of WEEE and to retrieve materials contained in EEE. From previous research, it appeared that the WEEE Directive, including its requirements, targets and standards, is considered an enabler for implementing circular business models in the EEE chain [12]. At the same time, however, the WEEE Directive is criticized for encouraging recycling at the expense of higher options in the waste hierarchy, such as reuse and repair [6], and for hampering the transition to a more circular EEE chain [12]. It is argued that the objectives of the

WEEE Directive are not reflected in its provisions, as targets are not consistent with these objectives [69]. The Directive does not contain specific incentives for (preparation for) reuse or for specific materials, only for collection and recycling [73], despite the fact that the Directive provides a possibility for setting a target for the preparation of reuse in Article 11(6) and that targets for specific materials were to be considered according to recital 7 of the 2018 amendment [23,27]. The current structure of the WEEE Directive is also said to lead to actors putting all their effort into meeting the collection and recycling targets instead of focusing on higher waste hierarchy steps [73], which is supported by four interviewees criticizing the Dutch PRO Stichting OPEN for only fixating on achieving the 65% target and using its position in such a way that reuse, repair and refurbishment are hampered in favor of material recycling by shredding; all in order for them to reach that target.

Looking at the specific instruments, in five interviews, the current structure of the target itself was perceived as an obstacle to a more circular EEE chain, as aiming for higher levels of the waste hierarchy negatively influences the amount of waste that can be collected and therefore influences the achievement of the 65% target. However, another interviewee mentioned that reuse actually can be included in the recycling and recovery target, but that the registration—which takes place in the waste stage—is the problem [74]. Two interviewees remarked that the criticism of the target also seems to be used as an excuse for not achieving the target itself. As stated before, the Netherlands did not achieve the collection target of the WEEE Directive (see Section 2).

The literature also criticized the references of the existing targets: in general for being mass-based, therewith neglecting the (ecological) value and scarcity of materials in EEE [69,97], and specifically the 65% collection target because its 'Put on Market' reference does not properly reflect the amount of WEEE that is generated or available for collection [74]. One waste treatment operator acknowledged that the recycling of CRMs makes no difference if targets remain weight-related, given their low weight share. Furthermore, three interviewees were critical of the collection target references, in particular, as the target wrongly assumes that EEE PoM is discarded after 3 years.

Moreover, the WEEE Directive is argued to fail to incentivize producers to focus more on ecodesign, as Article 4 does not guarantee that the design of EEE is indeed facilitating reuse, dismantling and recovery of WEEE [16], and because producers cannot get their product or material back at its end-of-life [89]. In addition, the information obligation in Article 15 is not considered effective [21,85,94]. A lack of legislation for access to discarded products for preparation for reuse [16], and for preventing leakage flows as well as a lack of enforcement in preventing leakage flows were also mentioned [18]. The fact that the implementation of the WEEE Directive leads to different rules and requirements among MSs was also perceived as a barrier [12,18].

To solve the issues regarding the targets in the WEEE Directive, it has been suggested to set more stringent targets [98], introduce new targets, such as for reuse and preparation for reuse [6,99], or introduce qualitative targets, focusing on certain materials or the quality of collected products [97,100,101]. According to two interviewees, such targets are possible, but do require that the need for achieving such targets is already taken into account at the product stage. Specifically with regard to the 65% collection target, it was suggested to change the reference from WEEE placed on the market to WEEE that is actually generated or available for collection [74]. An adjustment of this target was also considered by two interviewees, while the registration of reuse and export for reuse were also believed to be important for contributing to the achievement of the 65% collection target.

Other incentives that were reported with regard to the WEEE Directive range from the revision of the Directive to more directly address the period before EEE is discarded [6], to introduce mandatory testing for repairability or reuse [16], to revise article 6(2) to ensure that the reusability of EEE is safeguarded during its collection [99], and to introduce a landfill ban [98], and a mandatory certification scheme for recyclers [102]. To improve the actual collection in the Netherlands, another incentive that already has been proposed is the so-called legal handover obligation (*wettelijke afgifteplicht*), requiring all parties who receive

WEEE from consumers to hand it over to CENELEC certified treatment facilities [103], since WEEE still ends up in non-compliant schemes despite the fact that CENELEC standards are mandatory in the Netherlands [74].

As EPR applies to EEE, it plays an important role in achieving the objectives and targets from the WEEE Directive. Despite the fact that EPR is said to have had a positive effect on the collection and recycling of WEEE [89,101,104], as stated before the current collection targets were in 2019 only met by three MSs, not including the Netherlands [105]. In the Netherlands, for example, approximately half of all generated WEEE is not disposed of properly, is exported for reuse or non-compliantly recycled [74]. More in general, the instrument of EPR is criticized in the literature for not achieving the desired results. EPR is intended to positively influence the design and production of EEE as well as to take into account the whole life cycle and thereby strengthen the reuse of EEE as well as the prevention, recycling and other recovery of WEEE [52,53,89]. However, the quality of the recycling is disputed and the effect of EPR on the design of products is minimal. EPR is therefore said to be not sufficient for guaranteeing sustainable waste management [89,101,104,106].

Nine interviewees were critical of the instrument of EPR, with some of them criticizing the EPR governance in the Netherlands in particular. According to three interviewees, EPR has potential, but it is very complex to achieve its objectives. The limited insight and influence of producers on other actors in the still linear market was mentioned as an explanation [107]. While this made one producer wonder if the responsibility within EPR is properly distributed, another interviewee was critical of the role of producers because of their conflicting interests, as they still benefit from a linear economic model. Other interviewees, including one producer of circular products, stated that the current EPR system hinders producers to act more circularly as EPR also applies to producers who take back their own products or take other circular measures such as preparation for reuse. Moreover, barriers can be related to the way in which the MSs have set up their national EPR schemes [12]. In the Netherlands, it becomes apparent that in 2021, the collection of WEEE has substantially decreased and that the distance to the 65% target has increased (Section 2), despite the establishment of PRO Stichting OPEN. In addition, interviewees were critical of the Dutch set up as a pay-as-you-go system (*omslagstelsel*) for not taking provisions for future challenges, and of the way Stichting OPEN uses their position in the market, for example, with regard to contracts.

Suggestions for improving the EPR framework were also identified. Among other things, stronger enforcement [12], introducing modulated fees - adjusted to and therewith stimulating the circular design of products and favoring circular producers [12,63,76,106]-, and extending EPR by including take-back requirements [98] were mentioned in the literature. Interviewees further suggested to renew the governance structure of EPR by including people who monitor and supervise the contribution of the EPR systems to the CE or to think about an EPR design that includes more than just buying out producers' responsibility for the end-of-life stage [106]. With regard to the functioning and position of the PRO Stichting OPEN, interviewees mentioned the idea to only use Stichting OPEN's structure for critical waste streams instead of all WEEE and leave other waste streams to the market itself, or to split up the current AVV for all WEEE, because of the differences between all WEEE products. Moreover, it was suggested in both literature and the interviews that it should be clarified that in case of (preparation for) reuse, repair, or refurbishment, one should not be considered to be a producer within the meaning of EU legislation, including EPR [62]. Modulated fees were, in contrast to the literature, only considered positive by one interviewee, while three other interviewees were critical about its potential.

The observation that the sector-specific waste legislation, i.e., the WEEE Directive, focuses too little on higher R-strategies, such as reuse, also applies to the waste legislation in general, including the WFD. In the literature, it is stated that there is too little focus and guidance on higher steps in the waste hierarchy [6,108], and that, in general, the focus on recycling within waste law forms a barrier for longer lifetime and repairability

of products [63]. This was also recognized by one interviewee, who remarked that the precedence of reuse over recycling is not well anchored in legislation. Another issue relating to the WFD, that came up several times in the interviews, was the influence of the waste status on reuse of EEE. Five interviewees indicated that it is difficult to transition something that has been classified as waste to a product, and that this hampers the reuse or refurbishing of products. One interviewee also pointed out that the waste status advantages virgin raw materials and resources over secondary ones, as the former do not fall under the as stringent perceived waste legislation and WSR (see below). In contrast, however, two of the interviewees indicated that the waste status is not a problem for the reuse of components, with one giving the treatment according to the CENELEC standards as an explanation. Two other interviewees, both working for a government organization, were more critical of the issues regarding the waste status and wondered whether it is truly the waste status itself or whether it is something else, such as the image of waste, that hampers the CE transition.

Incentives often focused on the waste status as well. For example, in the literature, it has been suggested to clearly differentiate between 'reuse to prevent waste' and 'reuse that follows material recovery processes' [11]. One of the interviewees stated that the focus should not be on the definition of waste itself, but rather on solving actual issues in legislation that hamper CE activities when something is being classified as waste, such as an exemption for the permit requirements for recovery or waste disposal for circular repair centers. Further, creating more end-of-waste criteria was mentioned as a priority incentive by the same interviewee.

In the literature and the interviews, multiple barriers were also identified regarding the WSR and the export of (W)EEE. In the literature, cross-border shipments of used EEE to refurbishment or recycling sites are said to be hampered by unclear and overlapping legislation [18]. This corresponds to the experiences of an interviewed producer, who experiences limitations when shipping products for refurbishment, as they are constantly dealing with questions on whether it is possible to ship products that are suitable for refurbishment or repair to designated refurbishment sites abroad. Another barrier for optimal recycling of WEEE that is identified in the literature is that the WSR is complex and leads to lengthy administrative processes and high administrative costs, therewith making transactions of WEEE for repair or recycling more difficult [18,89]. This has been endorsed by three interviewed waste treatment facilities. Especially, the notification procedure of the WSR and the Euralcodes are, respectively, considered burdensome and not working properly. Another barrier that is regularly mentioned in the literature relates to a lack of enforcement and monitoring to restrict, inter alia, informal or illegal export of 'sham reuse' to developing countries [14,15,18,66,70], despite the fact that the Euralcodes and CENELEC standards should contribute to preventing this. While interviewees also mentioned a lack of enforcement, one government organization official stressed, however, that it is difficult for authorities to check if exports contain functioning EEE instead of WEEE. In addition, one interviewee argued that there is a lack of proper regulation for the trade in second-hand EEE.

5. Discussion

The previous section has shown that identified legal barriers and incentives in the literature largely correspond to the legal barriers and incentives that were identified by stakeholders in the Netherlands. Although the opinions of interviewees differed with regard to the implementation of information requirements and the possibility of modulated fees in EPR, in almost all other cases the barriers and incentives identified in the literature were endorsed and often supplemented by interviewees based on their experiences in practice. On top of that, interviewees also regularly emphasized the importance of general aspects of legislation, i.e., the necessity of legislation being enforceable, in line with practice and not too complex. Looking at the overview of the legal barriers and (lack of) incentives above, three main themes could be observed.

First, several of the identified barriers and incentives seem to be related to aspects linked to the implementation of the examined legislation, including challenges related to measurement methods and standards, its enforcement and more general aspects, such as its complexity. In both the literature and the interviews, it was stated that current measurement methods should be adjusted, that appropriate methods and standards should be developed and that the measurability of CE aspects should be improved. In addition, calls for the usefulness and necessity of a level playing field in the EU were made regularly [89], in particular, to reduce or prevent regulatory disparities between MSs. The lack of enforcement of legislation is also clearly a problem that affects a large part of the examined legislation. The interviews revealed that this can be due to the legislation itself, for example, the difficulty in checking if products comply with certain product requirements. However, according to interviewees in the Netherlands, it seems to be particularly due to more practical and non-legal aspects, such as a lack of manpower, money or knowledge, either on the part of the competent authority, or on the part of other market actors, such as a lack of awareness among consumers. More in general, across all legal acts, the legislation seems to be leading to uncertainties and administrative burdens or is considered to be too complex, which hampers the reuse, refurbishment and recycling WEEE.

Second, the identified barriers and incentives reveal that the interaction between the three legal areas can lead to (potential) issues and therefore could or should be improved. This becomes apparent in the aforementioned barriers and incentives, for example, the identified lack of influence between EU waste legislation and the ecodesign of products. In addition, the (proposed) thresholds in EU chemicals legislation and the difficulty to measure such refined concentrations of hazardous substances may affect the recycling of WEEE, more specifically, WEEE plastics. As compliance with these thresholds cannot be proven, interviewees argued that this will eventually lead to an impossibility to recycle WEEE plastics altogether. In turn, this will have negative consequences for meeting the recycling targets set by the WEEE Directive, as EEE increasingly consists of plastic components. In addition, the interaction between EU chemicals legislation and some of the proposed product requirements—i.e., the requirements on the use of hazardous substances or the use of recycled content, more specifically plastics—risks overlap between the Ecodesign Directive and the RoHS Directive and the REACH Regulation [52,82], respectively, leads to concerns about the compatibility with requirements in EU chemicals legislation, according to interviewees [89]. At the same time, the interaction between the three areas of legislation also provides opportunities, in the sense that it could lead to synergies. Ecodesign requirements could contribute to improving the link with the end-of-life stage and EU waste legislation: requirements on disassembly could be used to support and complement the requirements on disassembly in the WEEE Directive, and product requirements could be used to anticipate the achievement of potential new targets in the WEEE Directive or to ban materials that negatively influence reuse and recycling. More generally, synergies could be used to strengthen compliance and enforcement of existing legislation [6,52,89,109].

Third, not only could the interaction between and within the EU chemicals, product and waste legislation governing EEE be improved, but the legislation could also be better aligned with CE objectives [12]. It appeared from the literature, and it was also stated by several interviewees, that the current legal framework does not match CE ambitions or even hampers them. For example, the transition in the EEE chain is, according to interviewees, hampered by the issues related to the waste status of products and EU chemicals legislation, particularly with regard to the use of (secondary) plastics. Moreover, a disconnection between the current legislation and the CE objectives can be found in the waste legislation governing EEE. The obligations of the WEEE Directive and WFD may be in line with the CE and life cycle thinking, but there is a lack of focus on higher steps of the waste hierarchy in its actual provisions. For instance, reuse does not form a major part of the legal framework [6], the targets of the WEEE Directive are said to be stimulating recycling over reuse, and EPR is said to disadvantage circular companies. This shows that it is not only

important that the objectives of legislation are in line with the CE, but also that its contents are to actually fulfil or realize those objectives.

The same counts for existing instruments and possibilities in legislation. The 65% collection target as well as the instrument of EPR are, moreover, criticized for only working moderately. In the Netherlands, there has been an increasing failure to achieve the 65% target in 2021 (see Section 2). Although this raises the question whether that is due to the functioning of the target itself or due to the implementation by the Netherlands, the fact that only three MSs did achieve the collection target seems to indicate an underlying issue [105]. In other words, it appears that just setting the target is pointless and that more is required to achieve the desired results. In addition, EPR is criticized for not meeting its objectives: it only has minimal effect on the design of products and is not sufficient for guaranteeing sustainable waste management. Lastly, the numerous examples regarding the potential of ecodesign requirements show that the current possibility to set these requirements under the Ecodesign Directive has been insufficiently utilized to date. All in all, the current legislation could be better aligned with the CE objectives and the current instruments and possibilities within the legislation could be better utilized to contribute to the CE transition in the EEE chain.

In summary, the results from the literature and empirical study seem to indicate that, next to the more practical matters, the legal barriers and incentives are mostly related to either the interaction within or between the three legal fields and respective legal acts, or a disconnection between the legislation and CE objectives. This is not entirely unexpected, as the current legislation to a large extent predates the start of the CE transition in the EU. The current legislation, therefore, has been designed on the basis of linear thinking, instead of circular and life cycle thinking (see also Section 3). In order to enable or stimulate the CE transition in the EEE chain, it might be desirable to adjust the EU chemicals, product and waste legislation governing EEE based on circular and life cycle thinking, while also taking into account the abovementioned practical aspects, such as the clarity and enforceability of legislation.

The results of the literature and interview study give reason to reflect on the approach within the EU chemicals, product and waste legislation governing EEE. In the literature, it has been suggested to adopt a holistic approach for (W)EEE management to account for the whole life cycle [6,69] and also to take into account economic, technical, sustainability and social aspects, as well as the cooperation between actors within the EEE supply chain. This could address the finding that there is a need to improve the interaction between the three legal fields as well as the alignment of the legislation with CE objectives. Adopting such a holistic approach in EU chemicals, product and waste legislation governing EEE would mean that life cycle thinking, including CE objectives, would underpin the legislation and that the legal framework would be shaped accordingly [69]. This would build on the already existing attention that is, in some cases, present in the (recitals of the) legal acts (see Section 3).

A holistic approach within EU chemicals, product and waste legislation governing EEE could, in line with the current approach of the legislation, focus on the sector of EEE. However, in the interviews it was discussed whether the differences within the EEE sector could or should lead to a specific focus on (a number of) separate products, as is already the case with the ecodesign requirements and, to a more limited extent, with the product categories in the WEEE Directive [8,73]. Some interviewees mentioned that products within the EEE chain are all very different from each other and that therefore attention should be paid to the degree in which identified barriers and incentives apply to, respectively, have a positive CE impact on all EEE. In addition, these differences make it difficult to set generic requirements or targets for all EEE. On top of that, as multiple of the identified issues and incentives seem to be related to specific materials in (W)EEE, the question arose if instead of a (more) product-specific approach, a (more) material-specific approach might be beneficial to the CE transition in the EEE chain. As appears from literature, but also according to several interviewees, it often are the (hazardous substances in) (W)EEE plastics that lead

to barriers or require incentives regarding their recycling and reuse. The same counts for hazardous substances in general or CRMs [110]. This creates the impression that several barriers and incentives do not relate to specific products, but to specific materials.

Alongside the reflections on the approach within the EU chemicals, product and waste legislation governing EEE, in particular the finding that there is a need for improving the interaction and alignment with CE objectives, underlines the importance and difficulty of finding a balance between interests that appear difficult to reconcile. For example, between stimulating the CE transition by promoting reuse or recycling on the one hand, and ensuring the safety of human health and the environment on the other hand [63]. Especially the identified barriers and incentives that relate to EU chemicals legislation and (W)EEE plastics show that safeguarding human health and the environment could have consequences for more circularity, and vice versa [111]. Similar considerations play a role in choices regarding life time extension versus energy efficiency [52,112], modularity versus higher environmental impact or [113], according to interviewees, repairability and consumer-safety. The difficulty and the necessity of finding a balance between such interests not only plays a role in the EU chemicals, product and waste legislation governing EEE, but also in relation to the concept of the CE in general [110]. Furthermore, in both the literature and interviews, it was noted that too much and too detailed legislation, particularly product requirements, could impede innovation [6,95], which would be undesirable in view of the transition towards CE. On the other hand, many interviewees were positive about more legislation. As the interviews revealed that actors regularly point at and wait for each other when it comes to taking steps towards a CE, legislation could be used to get the sector moving and to 'push' actors, especially producers, in the right direction.

5.1. Current and Future Developments

The overview of barriers and incentives has shown that there are still many legal barriers that could be taken away and many incentives that could be implemented in order to facilitate the transition towards a CE in the EEE chain. These identified barriers and (lack of) incentives are related to both the EU chemicals, product and waste legislation itself and to the implementation or approach by the MSs, in this case, the Netherlands. This means that with regard to the EU chemicals, product and waste legislation governing EEE barriers could be taken away and incentives could be provided at both the EU level and the Dutch level. In some cases, there might already be possibilities for MSs to take away barriers or provide incentives, i.e., to pick the low-hanging fruit. An example is the possibility in Article 8a WFD to introduce modulated fees to therewith promote circular businesses and products, despite the divided opinions of the interviewees. There are also examples where a MS, in this case the Netherlands, takes or has taken action itself, such as with regard to the afgifteplicht or the AVV. Many barriers and incentives, however, would require action at the EU level, such as reviewing target references in the WEEE Directive or to introduce more circular ecodesign requirements. As already stated in the introduction, amendments of EU chemicals, product and waste legislation have already taken place since the official start of the transition towards a CE, such as the amendments of the WEEE Directive and WFD in 2018. Further amendments and reviews are planned for the near future.

In March 2022, the EC presented the proposal for the Ecodesign for Sustainable Products Regulation, which has as its objective 'to reduce the negative life cycle environmental impacts of products and improve the functioning of the internal market', and will apply to almost all physical products on the EU market. It proposes a framework for setting product requirements in product specific legislation on energy efficiency as well as on sustainability and circularity aspects, such as durability, resource efficiency or recycled content [29]. In addition, the Regulation proposes new information requirements, including digital product passports. These passports should not only help consumers to make informed choices, but also provide access to relevant information to recyclers and repairers, and contribute to improving the enforcement of legal requirements. Labelling requirements, including the incorporation of circularity aspects in energy labels, as well as the introduction of a new

Ecodesign for Sustainable Products label, have also been proposed [29]. Until the proposal of the Ecodesign Regulation is adopted, there will be an increased emphasis on integrating circular economy aspects in implementing regulations based on the current Ecodesign Directive [114].

In several aspects, the proposal for the Ecodesign Regulation corresponds to the identified incentives, particularly with regard to the introduction of circular ecodesign requirements and the use of labels, but also with regard to strengthening the level playing field in the EU. Regarding the digital product passport, it is remarkable that multiple interviewees, among whom waste treatment operators, a refurbisher, and producer (organizations), were very critical. While some interviewees admitted that the information stored in such passports could be useful as an overall information tool for within the EEE supply chain, waste treatment operators and refurbishers specifically stated that passports with repair or treatment information do not fit their current processes and that they themselves would therefore not consult such passports.

The CEAP 2020 also announced a Circular Electronics Initiative, which inter alia includes a focus on decreasing the environmental impact of mobile phones and tablets [115], the right to repair and regulatory measures on chargers for mobile phones and similar devices [3]. In addition, the RoHS Directive is being revised to address several practical and systemic issues, such as high complexity and administrative burden, difficulties regarding enforcement, insufficient provisions to support the CE and consistency with the REACH Regulation and Ecodesign Directive [116]. The proposal for the revised Directive is expected in the last quarter of 2022 [117]. Following the CEAP and EU Green Deal, the WSR has also been revised, which has resulted in a proposal for a new Regulation. The objectives of the revision were to facilitate waste shipments in the EU, to align the WSR with CE objectives, to tackle illegal waste shipments and to ensure that waste exports to third countries are managed in an environmentally sound way. Amongst other things, changes have been proposed to the procedure for waste shipments in order to reduce administrative burdens, waste exports to third countries shall require evidence of environmentally sound treatment, and measures are proposed to improve the enforcement of the WSR [118]. This seems to be largely in line with the identified barriers and incentives relating to the WSR (see Section 4.3). Furthermore, the REACH Regulation and CLP Regulation are being revised [119,120], the EC is currently working on a revision of the WFD [121], and an evaluation of the WEEE Directive has recently been announced [122].

6. Conclusions

In light of the transition towards a more circular EEE chain, this article discusses legal barriers and incentives with regard to the EU chemicals, product and waste legislation governing EEE as well as the implementation of this legislation in the Netherlands. These legal barriers and incentives were identified in literature and in interviews with practitioners in the Netherlands, in which the results of the literature study were largely confirmed. The results show that changes to the EU chemicals, product and waste legislation governing EEE are necessary to take away barriers and incentivize the transition towards a more circular EEE chain. It would be desirable to improve the interaction within the legal framework governing the life cycle of EEE, as this interaction leads to (potential) issues, but also because this interaction would provide opportunities in creating synergies. It would also be beneficial to better align the legislation with the objectives of the CE and life cycle thinking, including shifting the focus of the WEEE Directive and WFD to higher levels of the waste hierarchy, as well as making better use of existing instruments and possibilities in legislation, such as improving EPR and setting more circular ecodesign requirements. This, without losing sight of practical aspects, such as the enforceability and complexity of the legislation. The numerous future developments at the EU level, especially the proposal for the Ecodesign for Sustainable Products Regulation, seem promising in this regard. However, attention should also be paid to the already existing possibilities for MSs to take action with regard to the legal barriers and incentives at the national level.

Overall, the identified legal barriers and incentives give reason to argue that a holistic approach within the EU chemicals, product and waste legislation governing EEE, reflecting the whole life cycle of EEE, would benefit the transition towards a more circular EEE chain. While such a holistic approach could be applied within the current sector-specific approach of EU chemicals, product and waste legislation governing EEE, this research additionally shows that a more product-specific or even material-specific approach could be more beneficial. Further research on this is needed. The same counts for the question on how to deal with the legal solutions and incentives that seem irreconcilable or require balancing contradictory interests, such as increasing reuse and recycling on the one hand and protecting human health and the environment on the other.

In short, the identified legal barriers and incentives that are related to the EU chemicals, product and waste legislation governing EEE indicate that changes to the legal framework are necessary for the transition towards a more circular EEE chain. This article has given an overview of possibilities and suggestions to do so from a theoretical and empirical perspective, and therewith contributes to creating a legal framework that is conducive to the CE transition, both with regard to the EEE chain and in general.

The research in this article will be continued by similar research into two other product streams, in order to examine whether and to what extent the findings also apply to these, and in order to draw conclusions on the legal barriers and incentives for the CE transition in EU chemicals, product and waste legislation in general. Next to legal barriers and incentives, the literature and interview study identified multiple barriers and incentives that fell outside the scope of this research (see Section 3). Directions for further research, therefore, include looking into additional (non-legal) steps that might need to be taken to facilitate and stimulate the transition towards a more circular EEE chain [6], as well as the interaction of such additional steps with the EU chemicals, product and waste legislation governing EEE.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Review Committee of the Faculty of Law, Economics and Governance of Utrecht University.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Restrictions apply to the availability of these data. Data was obtained from the interview participants and are only available from the author with the permission of the interview participants.

Conflicts of Interest: The author declares no conflict of interest.

Appendix A. Questionnaire for the Semi-Structured Interviews

1. What is your experience with or opinion on the current chemicals, product and waste legislation in light of the transition towards a circular EEE chain?
2. Do you identify issues or barriers to the transition towards a more circular EEE chain?
3. What solutions do you think would be desirable to remove identified obstacles?
4. Are there incentives that, in your opinion, could stimulate the transition towards a circular EEE chain?
5. Looking at the goal of realizing a 50% circular economy by 2030 and a 100% circular economy by 2050, what do you consider as big challenges for the EEE chain and what should really be focused on?

Appendix B

Table A1. Implementation of the EU chemicals, product and waste legislation governing EEE in the Netherlands.

EU Legislation	Implementation in The Netherlands
RoHS Directive	Regulation of hazardous susbtances in electrical and electronical equipment (*Regeling gevaarlijke stoffen in elektrische en elektronische apparatuur*)
REACH Regulation	Chapter 9-Environmental Protection Act (*Wet milieubeheer*)
CLP Regulation	Chapter 9-Environmental Protection Act
Ecodesign Directive	Chapter 9-Environmental Protection Act
Energy-labelling Regulation	Decree on energy-labelling energyrelated products (*Besluit energie-etikettering energiegerelateerde producten*)
WEEE Directive	Regulation of waste electrical and electronic equipment (*Regeling afgedankte elektrische en elektronische apparatuur*)
WFD	Chapter 10-Environmental Protection Act

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