

# **Advancing a Circular Economy for Solar Photovoltaics Exported for Reuse**

Analysing the Institutional Feasibility of International Extended  
Producer Responsibility for EU-West Africa Transboundary  
Movements

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## Abstract

Solar photovoltaic (PV) panels and other electrical and electronic equipment exported for reuse from the EU to West Africa can contribute to a circular economy (CE) extending products' use, but too often impact negatively on receiving countries. Extended producer responsibility (EPR) schemes in the EU operate domestically and do not capture exports, thus EPR fees do not flow to receiving countries. "International EPR" policy proposals emerged recently, however aspects of governance and feasibility are underexplored. This thesis aims to assess the institutional feasibility of international EPR for solar PV exported for reuse from the EU to West Africa, focusing on Nigeria and Ghana. First, an ex-ante intervention theory framework is used, and three expert interviews complemented by literature allow to outline intended impact mechanisms. The identified impact mechanisms for international EPR work through transboundary resource transfers, strengthened export checks, and increased traceability. Then, the intervention theory is complemented by institutional analysis to discuss critical institutional aspects (CIAs) affecting feasibility. Eleven stakeholder interviews and five events were the data sources for qualitative thematic analysis. After examining CIAs and other moderating factors along the intervention theory, institutional feasibility is assessed under criteria of administrative burden and policy space. It is concluded that the institutional feasibility of international EPR is currently restricted. However, policy implications and ways forward emerged from the analysis, translated into policy recommendations. Policymakers in the EU should revise EPR governance and increase traceability measures. Harmonisation and standardisation efforts on reuse products and waste should also be undertaken globally. Policymakers in Nigeria and Ghana should increase e-waste management efforts, engage in formal international cooperation, and enact supporting policies for the informal waste sector. Ultimately, policy efforts for a circular economy transition should be attentive to their impact outside the policymakers' jurisdiction, to avoid externalities and ensure environmental and social sustainability.

**Keywords:** *circular economy, transboundary movements, extended producer responsibility, electronics, solar photovoltaics, policy analysis.*

## Executive Summary

A global transition to renewable energy requires large amounts of materials to be extracted. As solar photovoltaics (PV) represents the fastest growing renewable energy technology, strategies in the field of circular economy (CE) are needed to avoid a waste and resource crisis. Whereas PV recycling has received increasing attention, incentivising reuse of solar PV proves difficult in the EU due to market and legislative barriers. Outside of the EU, developing countries represent potential markets for reuse of solar PV. West African countries, for instance, already import used electrical and electronic equipment (UEEE), including PV panels. While in principle this can contribute to a CE, it also exposes important risks and ambiguities.

Extended producer responsibility (EPR) policies in the EU target electronic waste, including solar PV, generated domestically, making producers financially responsible for waste management. However, EU EPR schemes do not cover exported products, not allowing EPR fees to flow to importing countries which are therefore left to deal with the burden of waste management with their own resources. Academics and practitioners developed concepts and proposals to solve this issue, notably “international EPR” policies extending producer responsibility beyond national borders. However, aspects of governance and institutional factors influencing the feasibility of such proposals have been so far underexplored.

### Aim and Research Questions

The research aim of this thesis is to assess the institutional feasibility of international EPR schemes for solar PV exported for reuse from EU to non-EU countries. On a practical level, it aims to inform policymaking by exploring the role of EPR in an international circular economy, and policy needs and implications related to international extensions of EPR. The following research questions are posed and sequentially answered:

- (RQ1) What are the intended impact mechanisms of proposed international EPR schemes?*
- (RQ2) How can an international EPR scheme be designed for solar PV?*
  - (RQ2a) How would stakeholders in policy and along the value chain set it up?*
  - (RQ2b) What institutional aspects and contextual factors enable or limit the current feasibility of international EPR for reuse solar PV?*
- (RQ3) What are the policy implications and needs in sending countries and receiving countries contexts?*

### Methods and Research Design

The research design is qualitative and follows an exploratory approach. Data needs revolved around literature on international EPR, expert and stakeholder views. Data collection methods thus included a literature search and interviews with experts and stakeholders for primary data. In total, three unstructured expert interviews and eleven semi-structured stakeholder interviews with actors along the value chain and in policy were conducted. Thematic analysis was employed to analyse data, providing in-depth descriptions suited for policy development.

### Analytical Framework

Insights from theory-driven policy evaluation and institutional analysis shaped this study’s analytical framework and in turn the research process. An ex-ante intervention theory is utilised to uncover the intended impact mechanisms of international EPR proposals (RQ1), refined by stakeholder views on governance aspects (RQ2a). Further, critical institutional aspects (CIAs) – various factors affecting feasibility – are analysed and discussed against stakeholder views, and additional factors influencing links in the intervention theory (moderators) are identified (RQ2b). Then, institutional feasibility is analysed under sub-criteria of administrative burden and policy space. Finally, policy needs and recommendations arise following the analysis (RQ3).

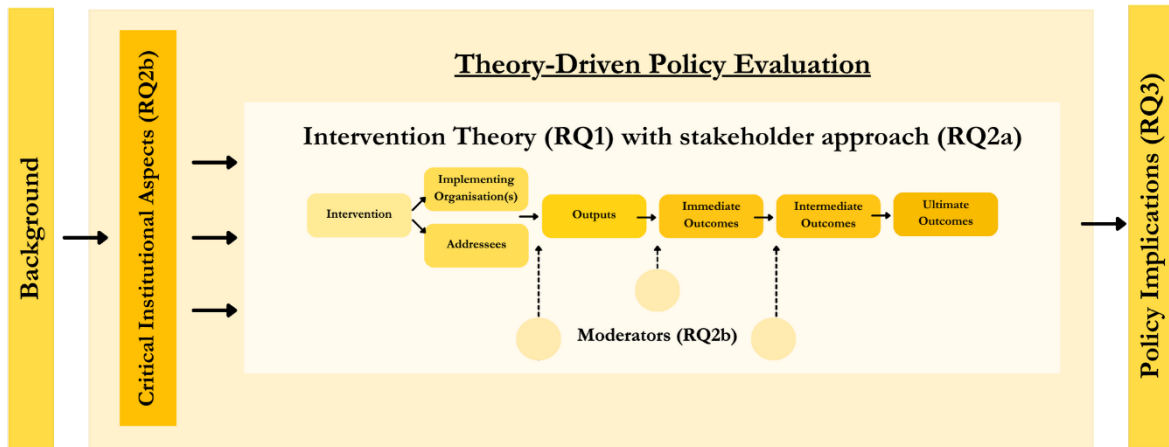


Figure ES-1: Representation of the analytical framework. Source: own illustration.

## Findings

Analysis conducted to answer **RQ1** found that proposals of international EPR schemes primarily target PROs and national authorities, envisioning as main output a resource/fee transfer system or a joint EPR fund coordinated at EU or international level. Other necessary outputs include harmonised standards and definitions of used products and waste, increased checks at export borders, and involvement of other actors in EPR governance. Outcomes of increased data generation on transboundary movements and resource transfers to receiving countries would be achieved. A decrease in illegal exports and investments in recycling infrastructure in importing countries are consequently envisioned, ultimately reducing the waste burden nowadays shifted to receiving countries.

**RQ2a** found that stakeholder views on international EPR governance were varied. Overall, a regional approach with EU-West Africa cooperation was preferred. This could take form in a resource transfer between EPR systems (for Nigeria), or in a joint EPR fund (for Ghana). These options both entail agreeing on harmonised definitions and standards for products and producer responsibility, as well as increased efforts in transboundary movements traceability and transparency of funds transferred.

**RQ2b** uncovered several factors affecting the institutional feasibility of international EPR measures. These were positioned either before the intervention theory (critical institutional factors) or within it (moderators). Critical institutional factors broadly encompassed cost factors, political factors, and policies in place. Cost factors included information asymmetries, dispersion of responsibilities, and administrative and private costs. Political factors included administrative inertia, corruption, political continuity, and policy mix frictions. Current EPR policies showed ambiguous responsibilities, policy gaps, risks of opportunism, heterogeneous interests as well as bargaining and decision-making power imbalances and endowment effects. Moderators were mainly related to traceability and illegal exports, incentives to ship for reuse, and supporting policies in EU and West Africa. Traceability issues e.g. lacks of data, insufficient checks of exports and fraud were recurring factors potentially affecting international EPR mechanisms such as allocation of responsibilities. Incentives to ship were linked to demand and supply of reuse PV, as well as incentives to reuse in the EU and policy loopholes. Supporting policies included ecodesign and traceability measures as well as reuse incentives under EPR in the EU, and measures to integrate informal actors in receiving countries.

Overall, it could be concluded that the institutional feasibility of international EPR measures for reuse solar PV is currently limited. Necessary outputs would entail high administrative

burdens, and the current policy space in the EU restricts possibilities for concrete developments. However, **RQ3** identified policy needs and implications to enhance institutional feasibility. Recurring themes were harmonisation of criteria and standards to distinguish reuse products from waste, governance of current EPR schemes in the EU, traceability of exported products, and policies supporting the informal sector in receiving countries. Together, these form the basis for this thesis' practical recommendations. Agreeing on common terms and definitions on WEEE in the EU and globally was seen as crucial to enable international action, allocating responsibilities, and generate data, thus reducing ambiguities, risks of opportunism, policy mix frictions and gaps and information asymmetries. A standard for reuse solar PV is also needed, to incentivise reuse in the EU and reduce risks of waste exports. More fundamentally, orienting EPR towards reuse and including more actors in decision-making, including via a revision of the WEEE Directive, can enlarge the policy space by tackling aspects of power imbalances, endowment effects, and reducing ambiguities related to exports. Traceability improvements, including via tools like digital product passports (DPPs), are needed to reduce administrative burden for monitoring, reduce ambiguities and risks of fraud, and to aid data generation and transfers. Finally, supporting policies in receiving countries are needed, to make sure the informal sector can benefit from and contribute to EPR systems.

### **Conclusions and Recommendations**

This thesis concluded that the institutional feasibility of international EPR proposals is currently restricted by prospects of high administrative burden and a limited policy space. Views of stakeholders on policy needs often expanded to include aspects related to EPR systems governance in the EU and CE policies more widely. This study found that EU CE policies at present do not sufficiently account for their impact on third countries. Careful design and implementation to avoid social and environmental externalities is needed, and thorough consideration of effects outside the policies' jurisdiction is crucial. This is closely related to this study's policy recommendations, as international EPR proposals represent a way forward to this aim, but measures are necessary to enable effective and inclusive developments.

Policymakers in the EU are encouraged to assess the impact of CE policies beyond the EU and study measures to minimise externalities. Resource transfers like those envisioned in international EPR are advised, but supporting measures are needed. Traceability of products must be improved, e.g. via DPPs, including for energy-related products. Definitions and protocols to distinguish between used products and waste should be improved and harmonised. Standards for reuse products like solar PV should be developed, and industry initiatives encouraged. On a more fundamental level, the aim and priorities of EPR systems need to be revisited to improve reuse in the EU and account for international resource loops currently not captured. To this aim, revising EPR governance is crucial. Policymakers in receiving countries like Nigeria and Ghana should increasingly engage in formal discussions, for instance through international fora, with their EU counterparts. If international EPR is to be pursued, it needs to be advocated for not only by NGOs and academia but also from importing countries. Policymakers and practitioners should also increase efforts in WEEE management, including but not exclusively through effective EPR schemes. Supporting policies are also crucial to ensure that ultimately informal workers can benefit from EPR instead of being isolated.

This thesis took a few first steps forward in the exploration of potential international dimensions of EPR. Feasibility aspects were explored and discussed, and avenues for further research emerged in turn. In particular, the policy space for international EPR and the discourses and power dynamics shaping it were shown to deserve further investigation, along with further research on governance configurations and on the impact that exported products and waste have on receiving countries, their EPR systems and their community, to strengthen academically and practically concrete efforts towards international action.

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## Abbreviations

CE	Circular economy
CEAP	Circular Economy Action Plan
DPP	Digital product passport
E	Event (1-5)
EEE	Electrical and electronic equipment
EoL	End-of-life
EPR	Extended producer responsibility
EPRON	E-waste Producer Responsibility Organisation Nigeria
ESPR	Ecodesign for Sustainable Products Regulation
EU	European Union
GACERE	Global Alliance on Circular Economy and Resource Efficiency
GHG	Greenhouse gas(es)
GW	Gigawatt
HS	Harmonised Commodity Description and Coding System
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
M	Moderator (1-7)
NESREA	National Environmental Standards and Regulations Enforcement Agency
NGO	Non-governmental organisation
OECD	Organisation for Economic Co-operation and Development
PICA	Procedure for Institutional Compatibility Assessment
PRO	Producer responsibility organisation
PV	Photovoltaic(s)
R	Respondent (1-14)
UEEE	Used electrical and electronic equipment
UN	United Nations
UNEP	United Nations Environment Programme
UPR	Ultimate Producer Responsibility
WEEE	Waste electrical and electronic equipment

# 1 Introduction

The energy sector is responsible for over two thirds of global greenhouse gas (GHG) emissions (Intergovernmental Panel on Climate Change [IPCC], 2020). Scientific evidence tells us that an energy transition away from fossil-based energy sources to renewables is urgently needed, and in recent years renewable energy generation has considerably increased (International Energy Agency [IEA], 2023; IPCC, 2021). Among renewable energy sources and technologies, solar photovoltaics (PV) has experienced considerable growth and is set to play a leading role in the achievement of international renewable and climate targets, currently being the third largest renewable electricity technology worldwide (Franco & Groesser, 2021; IEA, 2023; Strupeit & Tojo, 2023) and the only one on track with the IEA's net zero emissions by 2050 scenario (IEA, 2023). In the European Union (EU), initiatives such as the EU Solar Strategy as part of the REPowerEU plan show commitment to rapid deployment of solar PV (European Commission, 2022a). Looking ahead, the growth of solar PV is expected to continue, with projections showing that by 2030 the global cumulative installed PV capacity is estimated to reach 2840 gigawatt (GW) globally, while by 2050 it may reach 8500 GW (International Renewable Energy Agency [IRENA], 2019).

While the deployment of renewable energy, such as solar PV, is crucial to curb GHG emissions from energy generation, the rapid growth of the sector brings about a significant resource and waste challenge. Having an average lifespan of 20-30 years, the older EU PV fleets are just now approaching their technical end-of-life (EoL) and being decommissioned or substituted with newer more efficient models, therefore overall solar PV waste volumes have so far been low (Godinho et al., 2023). As a result, specialised recycling infrastructure is still lacking (Franco & Groesser, 2021; Mehta, 2017). As solar PV panels reach their EoL, the waste stream from solar PV is expected to grow, with estimates of up to 78 million tons of PV waste being generated by 2050, 11 of which in the EU (IRENA & IEA-PVPS, 2016). The composition of solar panels further complicates the issue, as solar PV contains hazardous materials such as cadmium and lead as well as rare substances like indium, gallium and silver (Maani et al., 2020). In light of this emerging waste and resource crisis, it is important to develop and investigate strategies to avoid a situation where the enhancement of climate actions leads to the depletion of resources and environmental degradation (Strupeit & Tojo, 2023).

Circular economy (CE) emerges as a framework to provide strategies to cope with these issues through smarter design and manufacturing, extended products lifetime and EoL management (Bocken et al., 2016; Kirchherr et al., 2017). The EU adopted its new circular economy action plan (CEAP) in 2020 encompassing several current and upcoming policies, many of which include considerations for solar PV panels as well (European Commission, 2020b; Strupeit & Tojo, 2023). The WEEE Directive 2012/19/EU, for example, regulates the EoL management of waste electrical and electronic equipment (WEEE), and includes solar PV in category 4 "large equipment" (Annex IV) (European Commission, 2012). After the latest amendments in 2024, it is now set to be evaluated and revised by 2026 (European Parliament & Council of the European Union, 2024). Another important downstream measure is the Waste Shipment Regulation 1013/2006, implementing the United Nations (UN) Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal in EU legislation (European Commission, 2006; Secretariat of the Basel Convention, 2020). More upstream, the EU has been working on Ecodesign requirements for solar PV to enhance circular design under the Ecodesign Working Plan 2022-2024 (European Commission, 2022b), within the framework of the Ecodesign Directive 2009/125/EU (European Commission, 2009).

The WEEE Directive implements the concept of extended producer responsibility (EPR), defined by the EU as "a set of measures to ensure that producers of products bear financial

and/or organisational responsibility for the management of the waste stage of a product's life cycle" (European Parliament, 2008). This is adapted from Lindhqvist's (2000) definition of EPR, "a policy principle to promote total life cycle environmental improvements of product systems by extending the responsibility of the manufacturer of the product to various parts of the entire life cycle of the product, and especially to take back, recycling and final disposal of the product". Producers can fulfil their responsibility individually or collectively, by setting up a producer responsibility organisation (PRO) to which fees are paid. In both cases, EPR aims to operationalise the polluter-pays-principle by shifting the responsibility of EoL management from municipalities onto the producers, thereby internalising environmental costs (Röling & Darut, 2023). What sets apart EPR from a simple tax is that fees paid by producers are directly used by PROs to fund waste management and are closely linked to the products placed on the market by the individual producers (Röling & Darut, 2023).

The mechanisms of EPR appear straightforward in a linear economy where products are used and disposed. However, a CE should prioritise strategies such as reuse, repair and refurbishment (inner loops) before recycling, recovery and disposal (outer loops) (Potting et al., 2017). This is reflected in the EU Waste Hierarchy set out in the Waste Framework Directive 2008/98/EC and in several conceptualisations of CE (European Commission, 2008; Kirchherr et al., 2017). In a growing sector like solar PV in the EU, where efficiency is improving and prices of new panels keep dropping, it is difficult to develop a market for PV inner loops as used panels cannot compete with cheap new models (Franco & Groesser, 2021; Rajagopalan et al., 2021).

Demand exists in developing countries where reuse solar PV could play an important role in boosting energy security and independence, as well as support small-scale agriculture for sustenance and income (Franco & Groesser, 2021; Godinho, 2021; Strupeit & Tojo, 2023; Tsanakas et al., 2020). Western African countries such as Nigeria and Ghana have already been receiving large amounts of used electrical and electronic equipment (UEEE) (Baldé et al., 2020; Godinho et al., 2023; Thapa, Vermeulen, Deutz, et al., 2022). When used products get exported and enter multiple use cycles, however, responsibilities under EPR in the EU become ambiguous, as products become waste under another jurisdiction. This complicates the path to a CE encompassing more actors (Vermeulen et al., 2022). Moreover, the absence of sound EoL management in receiving countries and an unclear regulatory framework surrounding UEEE exposes risks of waste exports and raises concerns of sustainability, equity, and justice.

As policy interest and action towards a CE keeps growing, especially at the EU level, it is important to investigate how a rapidly growing sector like solar PV and related EPR provisions interact in an increasingly international CE.

## **1.1 Problem Definition**

Exports of UEEE such as solar PV for reuse from the EU to West Africa can in principle bring significant benefits to both regions, promoting reuse, efficient use of resources and access to EEE and renewable energy technologies (Arbinolo, 2023; Brown et al., 2023; Franco & Groesser, 2021). However, they also raise several concerns. Firstly, the lack of a clear regulatory distinction between UEEE and WEEE poses the risk of exporting products for reuse that are only fit for disposal (Strupeit & Tojo, 2023; Thapa et al., 2023). Testing and recertification services for reuse solar PV are far from being standardised (Tsanakas et al., 2020). If combined with frauds, corruption and poor controls at exporting and importing ports, this signals high risks of illegal exports of WEEE mixed with or disguised as UEEE (European Environment Agency, 2012). Several studies expose this issue and it is widely recognised that e-waste shipments, solar PV included, risk to not contribute to circularity nor sustainability but just to add to a global waste crisis (Cotta, 2020; Faculty of Geosciences Utrecht University, 2021; Thapa

et al., 2023). This not only hinders a just transition but contributes to global spatial inequality and unequal ecological exchange causing harm elsewhere (Thapa et al., 2023).

Secondly, EPR schemes do not account for the multiple “circles” of reuse of products that take place outside domestic borders. The WEEE Directive includes reuse as an option but does not currently differentiate between reuse and recycling targets (European Commission, 2012; Nyffenegger et al., 2023). Moreover, it currently excludes exports from estimates of waste volumes generated in the EU, according to which EPR fees are paid. As a result, EPR schemes are said to incentivise exports allowing PROs to retain EPR fees of exported products or to claim that exports are recycled and meet their targets (Arya & Bhutani, 2023; Yamaguchi, 2021). Since current EPR schemes in EU countries do not foresee fee transfers along with exported products and EPR policies in several importing countries only cover goods produced domestically, receiving countries are left with the ultimate burden of waste management without having access to the fees paid by producers in sending countries (Arya & Bhutani, 2023). Instead of being placed on the original producers, the financial burden is shifted onto the receiving country (Nyffenegger et al., 2023; Röling, 2023; Röling & Darut, 2023; Talbott et al., 2022).

It is against this background that scholars and practitioners show growing awareness that EU policy should look at these issues from a global perspective (Arya & Bhutani, 2023; Cotta, 2020; Faculty of Geosciences Utrecht University, 2021; Strupeit & Tojo, 2023; Thapa et al., 2023), looking at the impact of its policies in third countries (Reichstadt et al., 2023). On one hand, academics have theorised and proposed ways to cope with the issue, including through innovative EPR schemes that extend internationally following exported products (Calisto Friant et al., 2022; Thapa, Vermeulen, Olayide, et al., 2022; Vermeulen et al., 2022). On the other hand, practitioners from diverse backgrounds, sectors and geographies started to demand justice and to propose modifications to current EPR schemes to make them globally accountable (Arya & Bhutani, 2023; Campbell-Johnston et al., 2022; European Environmental Bureau et al., 2023; Major Groups and Stakeholders, 2024; The OR Foundation, 2023). Other proposals include globally administered fees or funds (Ghana, 2023; Raubenheimer & Urho, 2020), voluntary schemes (Forrest et al., 2019; Strupeit & Tojo, 2023), bilateral cooperation programmes and public-private partnerships (Godinho et al., 2023; Ndzibah et al., 2022; Trinomics et al., 2021). However, such concepts and proposals of “international EPR” have not been analysed or assessed so far, nor entered debates in industry and policy arenas and have not been implemented. In particular, aspects of governance and institutional arrangements that could constrain and influence policy design and related decisions (Gupta et al., 2007) were found to be so far underexplored. The focus of this work arises therefore from the possibility to contribute academically to an urgent practical research problem.

## 1.2 Aim and Research Questions

The research aim of this master thesis is to assess the institutional feasibility of international EPR schemes for solar PV exported for reuse from EU to non-EU countries. This research topic has not been investigated from the point of view of feasibility or governance, which unveils a need for further research.

The following RQs were formulated:

- *(RQ1) What are the intended impact mechanisms of proposed international EPR schemes?*
- *(RQ2) How can an international EPR scheme be designed for solar PV?*
  - *(RQ2a) How would stakeholders in policy and along the value chain set it up?*
  - *(RQ2b) What institutional aspects and contextual factors enable or limit the current feasibility of international EPR for reuse solar PV?*
- *(RQ3) What are the policy implications and needs in sending countries and receiving countries contexts?*

The RQs are linked sequentially. Whereas RQ1 mostly relies on literature analysis and expert views and sets the scene for the analysis by outlining the theory behind proposed schemes, RQ2 represents the heart of the study. To answer it, views of different stakeholders were analysed to test and refine the intended impact mechanisms and identify critical institutional aspects before evaluating institutional feasibility. The results of the analysis, taking into account different stakeholder views, allow to answer RQ3 and for policy recommendations to emerge.

### **1.3 Scope and Delimitations**

This empirical study focuses on the value chain of solar PV and UEEE from manufacturing in/import into the EU until EoL in receiving countries. It does not cover the stages following disposal, for example secondary materials markets after recycling of WEEE, nor does it focus on critical raw materials considerations in the EU, except to the extent that these are influenced by exports and a reduction thereof. This is due to the scope of the study specifically on EPR and its current and potential role in transboundary movements of reuse solar PV as an EEE category. As such, the subjects of the empirical analysis (respondents) were purposefully selected among actors along the value chain, in policymaking, experts and civil society. In total, 14 respondents were included.

The geographical scope of the study is limited to the EU and the two West African countries of Nigeria and Ghana. This scope was chosen seeing the significant volumes of UEEE flowing from Europe to West Africa, the policies in place in Nigeria and Ghana to tackle e-waste, the involvement of both Nigerian academics and Ghanaian practitioners in different efforts related to international EPR, the space and time constraints of this thesis and the availability of respondents. (Arya & Bhutani, 2023; Baldé et al., 2016; Thapa et al., 2023; Trinomics et al., 2021).

The scope chosen also has methodological implications. Nigeria already has an EPR scheme in place for electronic products, including solar PV, while Ghana has a different system where producers pay an eco-levy to a public e-waste fund (Arya & Bhutani, 2023). Therefore, the chosen scope allows for comparisons between the two countries as well. Arguably, treating the EU as a single entity can be seen as a generalisation, as implementation of EPR can vary from country to country. However, this allowed for more considerations on EU policy to emerge when interacting with respondents. As such, whereas the chosen scope and methods may limit the external validity of results outside of EU-Nigeria/Ghana, it allowed for meaningful discussions on EU policy and the local contexts of Nigeria and Ghana to emerge.

### **1.4 Ethical Considerations**

This thesis project was not funded or directly supported – and as such, was not influenced – by any external organisation. As mentioned, it departed from the normative standpoint that a CE approach to solar PV is desirable. Possible biases arising from this were mitigated through explicit reflexive efforts, peer debriefing and external auditing at different stages (Creswell & Creswell, 2018). Ownership of ideas was always clearly attributed when not originating from the researcher. In navigating a topic inherently linked with global north-south issues, it was of paramount importance to avoid inadvertently perpetuating colonial thought practices and reinforcing historical power imbalances. A reflexive stance was thus taken towards Eurocentric perspectives and a decolonised approach was pursued by actively seeking diverse viewpoints and valuing all stakeholders' expertise and experiences equally. Purposive sampling was employed across stakeholder groups and 14 interviews were conducted to diversify perspectives and obtain a holistic account of expert and stakeholder views. In the literature review and during interviews, measures to avoid selectivity and to minimise biases were taken, by including potential contrasting views in the literature review and by avoiding leading questions or

arguments during interviews. Interviews were entirely voluntary and based on the principle of informed consent, and the possibility of anonymising data was always offered to interviewees. All empirical data gathered throughout the master thesis was stored on the hard drive of a password protected computer and uploaded to a private Lund University Box drive. Attention was paid for the results of this thesis project not to generate asymmetric expectations from actors involved, making it clear that the contribution this thesis aims to make, to academia and practitioners, is to shed light on the feasibility of international EPR for solar PV, that is what can be done, if it can, how and under what conditions. Emerging policy recommendations do not represent an exhaustive guide for policymakers but rather uncover policy needs to be addressed and possible ways forward – including avenues for further research. Data was made available in the form of the completed master thesis to all research participants involved. Finally, research design was reviewed against the criteria for research requiring an ethics board review at Lund University and was found to not require a statement from the ethics committee.

## 1.5 Audience

The findings and implications of this research project contribute to an emerging literature on international implications and potential extensions of EPR, discussing how producer responsibility in a global CE can “circulate” accordingly. The literature reviewed for this study showed a need for analysis – and frameworks thereof – to assess proposals that have been put forward in recent years. This academic contribution is therefore coupled with a framework that can be used in other contexts as well by academics and policy evaluators. On a more practical side, stakeholders’ perspectives played a central role in the analysis, adding to the value of this contribution and giving relevant stakeholders equal space and voice. As a result, policy implications, needs and recommendations arising from the findings constitute the thesis’ more practical contribution. These can be particularly relevant for practitioners in the solar PV and EEE value chain, EPR actors and regulatory bodies, policymakers in sending and receiving countries and at the EU level, non-governmental organisations (NGOs) and EoL actors in receiving countries, including formal recyclers and informal actors. Given the policy perspective of this study, particular emphasis in the targeted audience is placed on governmental agencies and decision-makers in Nigeria and Ghana and in the EU.

## 1.6 Disposition

This thesis consists of six chapters. **Chapter 1** provided an introduction and the definition of the research problem. **Chapter 2** delves into the literature on circular economy and solar PV, EPR and transboundary movements of EEE and solar PV between EU and West Africa and various proposals of international EPR. It also discusses concepts and perspectives as useful lenses to build a framework to guide the analysis. **Chapter 3** outlines the methodology for data collection and analysis. **Chapter 4** reports the findings from data analysis referring to and answering the three RQs. **Chapter 5** discusses the findings and their importance by placing them in the broader context of the reviewed literature. Finally, **Chapter 6** concludes with practical and methodological implications of the study, before some final remarks.

## 2 Literature Review

### 2.1 Circularity of Solar PV and EEE from EU to West Africa

Current knowledge of circular approaches to solar PV in the EU, of transboundary movements between EU and West-African countries, and of WEEE management challenges in Nigeria and Ghana was captured through a literature review of academic and non-academic sources. Insights from existing literature are presented here following the various value chain steps: starting from manufacturing/importing of solar PV in the EU and discussing reuse and EoL in Europe (2.1.1), moving to reuse markets in developing countries, focusing on West Africa (2.1.2), and discussing related transboundary movements (2.1.3) before presenting EoL challenges related to e-waste management in Nigeria and Ghana (2.1.4). Policy considerations from the literature, especially concerning the role EPR plays in reuse solar PV and UEEE value chains, are included in each section.

#### 2.1.1 Manufacturing/Importing to End-of-Life in the EU

The solar PV sector has experienced considerable growth in the EU and globally, ever since early EU adopters like Germany, Italy and Spain started deploying solar energy through feed-in-tariff schemes (Godinho et al., 2023; IEA, 2023). Considerations regarding material use and EoL management in solar PV, however, are relatively recent. Research shows that the solar PV value chain has mostly been studied from a linear perspective and a technological point of view (Franco & Groesser, 2021). As such, the PV industry has been paying much attention to efficiency in panels' first life rather than circular design and reuse business models (Godinho, 2021; Tsanakas et al., 2020).

Today, the large deployment of solar PV has led to a reduction of prices by over 50% since 2017 (IRENA, 2023; Sharma et al., 2019). However, the European PV market as of now is highly dependent on imports, notably from China (Abnett & Chestney, 2024; Rabe et al., 2017). Solar PV manufacturers and EU policymakers have thus placed significant emphasis on securing raw materials and reducing dependencies on third countries (SolarPower Europe, 2024). As a result, in recent years considerations on solar PV recycling have largely increased (Tsanakas et al., 2020). Solar PV recycling is set to be crucial not only for securing secondary materials, but also to deal with the large amounts of PV waste projected for the years to come. This is especially true considering that, because of efficiency improvements and decreasing prices, a number of PV panels in the EU are decommissioned before their EoL and substituted with newer models (Franco & Groesser, 2021; Tsanakas et al., 2020). This “repowering” trend has been observed in most developed economies like the EU and is likely to cause future volumes of PV waste to be higher than projections show (Franco & Groesser, 2021; Strupeit & Tojo, 2023).

The EU Waste Framework Directive envisions higher value retention options such as reuse to be pursued before recycling, to extend products' life cycles (European Commission, 2008). Given the lifespan of solar PV panels (20-30 years), however, volumes of decommissioned PV have so far been low, meaning reuse options are limited and even reaching recycling targets set out for EPR schemes under the WEEE Directive has proven challenging (WEEE Forum, 2022). Additional barriers to reuse and recycling are waste crimes such as illegal exports, which cause significant volumes of WEEE to “disappear” from formal systems, as reported by Huisman et al. (2015) and Baldé et al. (2020). Moreover, solar PV shows characteristics of an increasingly low-margin sector, where reuse sales compete with cheap new products (Chase, 2023; Dalhammar et al., 2021). As a result, economic viability and customer acceptance of reuse solar PV in the EU is challenging and limited to a few specific cases mainly linked to social enterprises, (circular) public procurement and isolated virtuous initiatives (Clyncke, 2022; Soren, 2023; Strupeit & Bocken, 2019). In light of this, it does not come as a surprise how much



attention in research and practice has been given to recycling than reuse, repair, refurbishment and ecodesign (Tsanakas et al., 2020).

Legislative barriers to PV reuse in the EU exist alongside economic ones. The lack of a recognised standard for reuse solar PV testing and warranties of performance, functionality, safety and reliability cause reuse solar PV to be perceived as complex and risky (Van Opstal & Smeets, 2023). Moreover, although reuse is included as an option in the WEEE Directive covering EoL of solar PV, no specific targets or rewards for reuse are set, making incentives for reuse relatively weak (European Commission, 2012; Godinho et al., 2023). Researchers and practitioners argue that policy has a role to play in reducing uncertainties and developing a market for solar PV reuse in the EU, by supporting ecodesign measures, the development of warranties and testing protocols, harmonised standards and recertification schemes, and eco-modulation of EPR fees to incentivise reuse (Christiansen, 2021; Franco & Groesser, 2021; Van Opstal & Smeets, 2023). While the European Commission has been developing ecodesign criteria for solar PV under the Ecodesign Directive (European Commission, 2022b), efforts towards reuse have so far been limited to projects such as CIRCUSOL, that in 2021 delivered recommendations for international standards for reuse PV (Strupeit & Tojo, 2023).

In short, literature shows how CE approaches to solar PV in the EU are still relatively in their infancy, despite concerning projections of future PV waste flows. High value retention options such as reuse face market and regulatory barriers due to repowering trends, decreasing prices, low incentives, and a lack of distinction between reuse and recycling targets for EPR in the WEEE Directive. Overall, researchers agree that incentivising reuse in the EU can contribute to a CE through waste reduction and higher value retention as geographically close as possible, reducing the risks of leakages to developing countries (Calisto Friant et al., 2022).

### **2.1.2 Reuse in non-EU Countries**

Research shows how non-EU countries represent a potential market for solar PV reuse, as opposed to the EU currently (IRENA & IEA-PVPS, 2016; Strupeit & Tojo, 2023). Demand already exists in developing countries where panels can give access to affordable off-grid energy, support local livelihoods, and increase economic opportunities locally, and where low costs can compensate lower performance (Franco & Groesser, 2021; Meza, 2021). Uses for solar PV include home energy, battery charging, irrigation and refrigeration for agriculture (Franco & Groesser, 2021). Evidence shows almost all reuse solar PV sales appear to be in developing countries in the Middle East and Africa (Christiansen, 2021; Godinho et al., 2023; Meza, 2021). The driving forces of this demand are mainly related to energy needs, affordability, and favourable solar irradiation (Godinho et al., 2023; Ndzibah et al., 2022). Overall, the volume of the global reuse market is estimated to be still relatively limited compared to new installations (van der Heide et al., 2022). However, it is expected to grow as volumes of decommissioned PV panels from the EU increase substantially, with repowering trends and early failures leading the supply of reuse panels (IRENA & IEA-PVPS, 2016).

Drivers behind reuse possibilities for solar PV apply more broadly to all electrical and electronic equipment (EEE). Research on exports of electronics shows that EEE trade between the EU and Africa can bring new technology, close the digital divide and boost economic opportunities in receiving countries (Arya & Bhutani, 2023; Baldé et al., 2024; Cotta, 2020). However, if on one hand reuse trade can be considered positive for importing countries and for CE in general, it also exposes several ambiguities and risks.

One important ambiguity concerns EPR, meaning producer financial and/or operational liability for exported products. According to EU legislation, exported UEEE falls out of scope of current EPR schemes, meaning exported volumes are deducted from estimates of WEEE

generated in the EU (European Commission, 2012). Several researchers argue that this allows producers to “get a free pass” on their EPR fees when products get exported (Röling & Darut, 2023; Yamaguchi, 2021), as fees do not get transferred along with the products (Arya & Bhutani, 2023). As such, EPR schemes in the EU have been criticised for incentivising exports for reuse (Trinomics et al., 2021; Yamaguchi, 2021). According to several authors, the role of EPR in addressing EoL international value chains is unclear due to these leakages (Brown et al., 2023; Vermeulen et al., 2021; Yamaguchi, 2021), while at the same time reinforcing exports to third countries where ultimately governments and informal workers bear the costs of EoL management (Talbot et al., 2022). Many argue that the very purpose of EPR is undermined due to the fact that fees do not support the actual EoL management of those products originally placed on the EU market (Arya & Bhutani, 2023; Yamaguchi, 2021), while perpetuating unethical practices of burden shifting towards the global south (Cotta, 2020; Nyffenegger et al., 2023; Röling & Darut, 2023).

Further risks exist related to exports of non-functional EEE disguised as UEEE. The absence of standards for functionality and reliability of UEEE, and the lack of clear distinction between UEEE and WEEE in the Harmonised Commodity Description and Coding System (HS codes) used at the World Trade Organisation makes it difficult to discern exports of UEEE – which are allowed under the EU Waste Shipment Regulation and the Basel Convention – from illegal exports of WEEE (Arya & Bhutani, 2023; Yamaguchi, 2021). The WEEE Directive does articulate responsibilities for inspections and outlines requirements to distinguish between UEEE and WEEE, however enforcement was found to be largely insufficient (Strupeit & Tojo, 2023). Moreover, van der Heide et al. (2022) argue that existing guidelines to distinguish between WEEE and UEEE – for instance in the WEEE Directive – have been designed with only energy consuming devices in mind, hindering their application to solar PV. Basel Action Network (2019) even argues that Annex VI of the WEEE Directive contains exceptions that potentially represent a loophole for waste exports. The risk of exporting non-functional products is further magnified by poor inspections at exporting ports and fraud leading to illegal shipments (Abderrahmane & Okai, 2024; Trinomics et al., 2021). Given this blurred line between UEEE and WEEE trade, exports for reuse can have negative environmental and social consequences, and data on transboundary movements remains scarce and unharmonised (Baldé et al., 2024; Thapa, Vermeulen, Deutz, et al., 2022).

Summing up, previous research on reuse markets for solar PV and UEEE in non-EU developing countries shows how opportunities as well as risks exist. If the non-EU reuse market is to be tapped into to extend products’ lifetime, it becomes crucial to distinguish between UEEE and WEEE, establish protocols and standards for used products and reduce ambiguities in producers’ responsibility and the role of EPR in addressing international EoL value chains.

### **2.1.3 Transboundary Movements from the EU to West Africa**

Data on transboundary movements of UEEE and WEEE, solar PV included, between the EU and West Africa remains scarce. This is due primarily to illicit activities not reported or registered by customs, as well as the difficulties in separating existing data streams between WEEE and UEEE according to HS codes (Yamaguchi, 2021). Studies have recently started to emerge, mainly in the form of on-field investigations in receiving ports (Basel Action Network, 2019; Odeyingbo et al., 2017) or through estimations based on trade data and guesstimates (Arya & Bhutani, 2023; Thapa et al., 2023). Reviewed literature has found evidence of UEEE exports between Europe and West Africa (Arya & Bhutani, 2023; European Environment Agency, 2012; Trinomics et al., 2021), including solar PV (Tsanakas et al., 2020; van der Heide et al., 2022).

Overall, around 4.3 megatons of EEE were estimated to be exported from the EU to Africa annually according to Arya and Bhutani (2023). Large equipment such as solar PV were

estimated to amount to 21% of these UEEE exports (Habib et al., 2022). Germany, Spain, France, Italy and the Netherlands were responsible for three quarters of EU-Africa UEEE trade between 2015 and 2020, however most shipments were found to occur from ports in the Netherlands, Belgium and Germany, showing evidence of intra-EU UEEE trade as well (Arya & Bhutani, 2023). These intra-EU movements were found to be poorly monitored under WEEE Directive provisions, causing flows to be underreported until they reach major EU ports, further hindering tracking and data generation (Arya & Bhutani, 2023). The “Person in the Port” project carried out between 2015 and 2017 found large amounts of UEEE imported into Nigeria (Odeyingbo et al., 2017). Of the 60 kilotons of UEEE imported annually – to be taken as a minimum due to under-declaration according to the authors – 77% originated from the EU (Odeyingbo et al., 2017). Similar findings were shown by studies focused on solar PV (Clyncke, 2022; van der Heide et al., 2022).

Similarly to what researchers found in exporting ports, insufficient checks by importing customs due to high costs and low resources were found to allow imports of defective products from the EU to Africa (Baldé et al., 2016; Trinomics et al., 2021). Corruption was also an enabling factor, as waste crimes especially in EEE are a highly lucrative business that often involves mafia groups, corporations and government officials (Abderrahmane & Okai, 2024; Baldé et al., 2016). Insufficient regulation, lack of transparency, awareness and monitoring were all identified as barriers to countering illegal trade by Thapa et al. (2023) in their study focused on Nigeria. As a result, important “twilight routes” are often followed by products and waste flowing from the EU to West Africa (Thapa et al., 2023), further hindering traceability (Arya & Bhutani, 2023).

From a policy perspective, literature shows how waste-related legislation in the EU and internationally appears largely ineffective to counter illegal transboundary movements from the EU to West Africa (Baldé et al., 2016; Basel Action Network, 2019; Strupeit & Tojo, 2023). Most waste-related legislation at the EU level does not cover used products, making reporting and monitoring difficult (Arya & Bhutani, 2023; Campbell-Johnston et al., 2021; European Environment Agency, 2012). The same is valid for international agreements such as the Basel Convention and the Bamako Convention (Secretariat of the Basel Convention, 2020; United Nations Environment Programme [UNEP], 1998), respectively focused on global transboundary movements and bans on imports of hazardous waste into Africa. At the same time, both Nigeria and Ghana – as many other developing countries – allow imports of UEEE but lack proper checks at import sites (Arya & Bhutani, 2023). Once again, research also points out shortcomings of EPR schemes in addressing EoL challenges outside of domestic borders (Arya & Bhutani, 2023; Calisto Friant et al., 2022; Organisation for Economic Co-operation and Development [OECD], 2024; Röling & Darut, 2023). Firstly, PROs are obliged to report on collection rates and recycling, but not on final destinations of exported products (Arya & Bhutani, 2023; Campbell-Johnston et al., 2021). Secondly, EPR fees do not follow exported products to their destination, meaning receiving countries do not receive the resources supposed to finance EoL management of imported products (Arbinolo, 2023; Arya & Bhutani, 2023; OECD, 2024; Thapa et al., 2023; The OR Foundation, 2023). Arya and Bhutani (2023) estimated that African economies miss out on €340-380 million in EPR fees associated with EEE each year based on averaged data of transboundary flows. As transboundary movements of goods are not followed by transboundary movements of EPR funds, NGOs and experts increasingly call for the EU to ensure financial compensation, through EPR systems or other means (European Environmental Bureau et al., 2023; Thapa et al., 2023).

#### **2.1.4 E-waste in West Africa**

Research on West Africa shows how the region and the whole continent are highly dependent on imports of EEE, among other product categories as well (Baldé et al., 2024; Mama, 2017; The OR Foundation, 2023). It also confirms that considerable amounts of WEEE are illegally

shipped to the African continent often disguised as UEEE, predominantly from developed countries (Arya & Bhutani, 2023; European Environment Agency, 2012). Recent studies found that up to 30% of UEEE imports into Nigeria and Ghana are not functional (European Environment Agency, 2012; Odeyingbo et al., 2017). Estimates of WEEE shipped to Africa range from 150 to 250 kilotons per year, and Nigeria and Ghana were found to be important receiving countries (Schluep et al., 2012; Trinomics et al., 2021). According to a study by the Basel Convention Secretariat (Secretariat of the Basel Convention, 2011), 75% of EEE reaching Nigeria comes from Europe. The same study found that around 30% of the UEEE imported into Ghana was in fact WEEE. Arya and Bhutani (2023) found this percentage to reach an estimated 70% in Nigeria, with around 20% of imports unrecorded due to poor border controls and fraud.

African countries have been structuring policies for WEEE management in the past decades, although with no specific provisions for solar PV waste (Mama, 2017; Ndzibah et al., 2022; Tsanakas et al., 2020). Nigeria and Ghana in particular made steps forward in combating illegal imports and e-waste. In Nigeria, the Harmful Waste Act 2004 aimed at stopping imports of hazardous waste was updated in 2011 to include e-waste. In 2019, Nigeria also passed a Hazardous and Electronic Waste Control and Management Bill. Nigeria also has set up an EPR scheme for e-waste, with a single private PRO monitored by the government (National Environmental Standards and Regulations Enforcement Authority [NESREA] et al., 2021). Unfortunately, despite these efforts, there is evidence of significant irregular imports into Nigeria and of poor enforcement of regulations (Basel Action Network, 2019; Odeyingbo et al., 2017; Thapa et al., 2023). As a result, WEEE imports into Nigeria continue, often disguised as UEEE, ending up in dumping and burning sites or reprocessed into highly informal and lucrative activities in e-waste hotspots such as the “computer village” in Lagos (Reichstadt et al., 2023). Ghana, in similar fashion, adopted its Hazardous and Electronic Waste Control and Management Act and developed technical guidelines on e-waste management in 2016 (Republic of Ghana, 2016). It has, however, no EPR scheme in place (instead, e-waste management is financed through a dedicated public fund) and has not ratified the Bamako Convention (Basel Action Network, 2019; Republic of Ghana, 2016). As a result, no effective ban is imposed on WEEE imports, lucrative activities remain common in e-waste hubs such as the Agbogbloshie area, and the informal sector managing e-waste is largely ignored (Basel Action Network, 2019; Oteng-Ababio, 2012). In both Nigeria and Ghana, these situations pose huge environmental and health risks. The World Health Organization (WHO) estimated that in 2021 almost 30% of Nigeria’s health burden was linked directly to e-waste (Falaju, 2021).

In light of this, studies from academia, NGOs and local stakeholders have exposed these issues and proposed changes. One of the most pressing issues across reviewed articles regards the recognition and inclusion of the informal sector. As Tsanakas et al. (2020) point out with regards to solar PV, most repair or refurbishment activities in developing countries are not performed under formalised or standardised schemes. Several authors argue that the informal sector should be integrated and formalised rather than displaced, as their expertise, historical contribution and current vulnerability make them crucial stakeholders in WEEE management (Magalini et al., 2019; Talbott et al., 2022; Thapa et al., 2023). As such, governments in receiving countries are encouraged to enact laws granting legal rights and accreditation systems to informal waste workers (Fair Circularity Initiative & Systemiq, 2024; Taqi Ghulam & Abushammala, 2023). As EPR policies are also considered crucial for developing countries (Kabir et al., 2023), authors also push for increased implementation of EPR schemes in African countries like Ghana (Magalini et al., 2019; Ndzibah et al., 2022) and for increased recognition and inclusion of informal workers in existing EPR schemes such as the Nigerian one (Thapa et al., 2023).

Several reviewed studies, however, stressed the responsibility of the EU in dealing with this crisis, by closing leakages, regulating exports and reducing the burden posed on importing countries (Arya & Bhutani, 2023; Cotta, 2020; European Environment Agency, 2012; Vermeulen et al., 2022). The EU Green Deal already includes collaboration with partners in the African context, and some authors advocate for increased policy cooperation through channels such as the AU-EU Summit and the EU CE Missions to African Countries (Basel Action Network, 2019; Trinomics et al., 2021). Others also push for voluntary partnership agreements between countries (Strupeit & Tojo, 2023) and for increased assistance towards developing infrastructure for EoL management (Reichstadt et al., 2023). Brown et al. (2023) point out, however, that development assistance provides less than 2% of the financial needs for waste management in low income countries. Additional measures are thus needed to address imbalances in the global CE. As the Basel Action Network (2019) puts it, CE should not be a password for the EU to externalise costs to developing countries, as – researchers argue – is currently the case when producers do not bear full responsibility for their products when these leave the EU (Talbot et al., 2022). Vermeulen et al. (2021) also argue that the legitimacy of EU EPR schemes depend on the control over the full volume of waste generated, which is undermined by exports. Since exported products were first put on the market in the EU, many demands of increased EU action concern precisely EPR policies and have generated a debate about expanding the scope of EPR schemes to additional impact categories such as exported items, as recently acknowledged by the EEA and the OECD (Brown et al., 2023; European Environment Agency, 2012; OECD, 2024).

### **2.1.5 International EPR Proposals**

Proponents of an extension of the geographic scope of EPR argue that producers should bear the responsibility for their products regardless of their destination (Brown et al., 2023). Proposals to expand the scope of EPR beyond domestic borders to cover exported products mainly come from academia and NGOs and depart from wider and more fundamental critiques to the way EU policies account for their impact on third countries. As pointed out by Thapa et al. (2023), the EU wants to prevent waste exports and acknowledges the just transition movement in its new CEAP (European Commission, 2020b, 2020a, 2020c), however gaps between policy rhetoric and practices have generated widespread criticisms (Calisto Friant et al., 2021; Gregson et al., 2015). This is especially true in the context of leakages from EPR schemes through exports of used products or waste (Basel Action Network, 2019).

Reactions to these criticisms and proposed solutions arise from diverse sectors, including not just EEE (and solar PV) but also plastics and textiles. All of them, however, share aspects and aspirations of increased international value chain collaboration and accountability for generated waste. Ghana, for example, recently proposed a global plastic production fee, administered through a common fund, whose revenues could finance the elimination of legacy plastic pollution and implementation aspects such as capacity building (Ghana, 2023). Similarly, Forrest et al. (2019) propose the application of a voluntary plastic production fee to be passed along the value chain. Further research from Ghana focused on solar PV reach similar conclusions on the need for value chain collaborations and alliances between governments of exporting and importing countries to allocate responsibilities for EoL management, including under EPR schemes (Ndzibah et al., 2022).

Research on international EPR schemes and related proposals has been conducted mainly in Nigeria and Ghana. Thapa et al. (2023; 2022) co-created with Nigerian experts and stakeholders a proposal for extending producer responsibility internationally, called ultimate producer responsibility (UPR). UPR foresees that the financial responsibility for collecting and recycling falls upon the original manufacturers regardless of the products' ultimate destination (Thapa, Vermeulen, Olayide, et al., 2022). As such, UPR includes a financial transfer mechanism from

EU EPR programmes to importing countries (Vermeulen et al., 2022), making the original producer responsible for EoL management either through a fee transfer between PROs (see Figure 2-1 below) or through the establishment of a fund (Thapa et al., 2023). The OR Foundation in Ghana recently developed a similar proposal for managing textile waste, envisioning a fund transfer mechanism to make EPR “globally accountable” (The OR Foundation, 2023) and inclusive towards downstream actors in other geographies. Raubenheimer and Urho (2020) also envision a global EPR scheme for plastics, developed through intergovernmental efforts. More recent studies by Arya and Bhutani (2023) and Röling and Darut (2023) also advocated for EPR flows such as UPR between exporting and importing countries to close dangerous loopholes in EU legislation for importing countries.

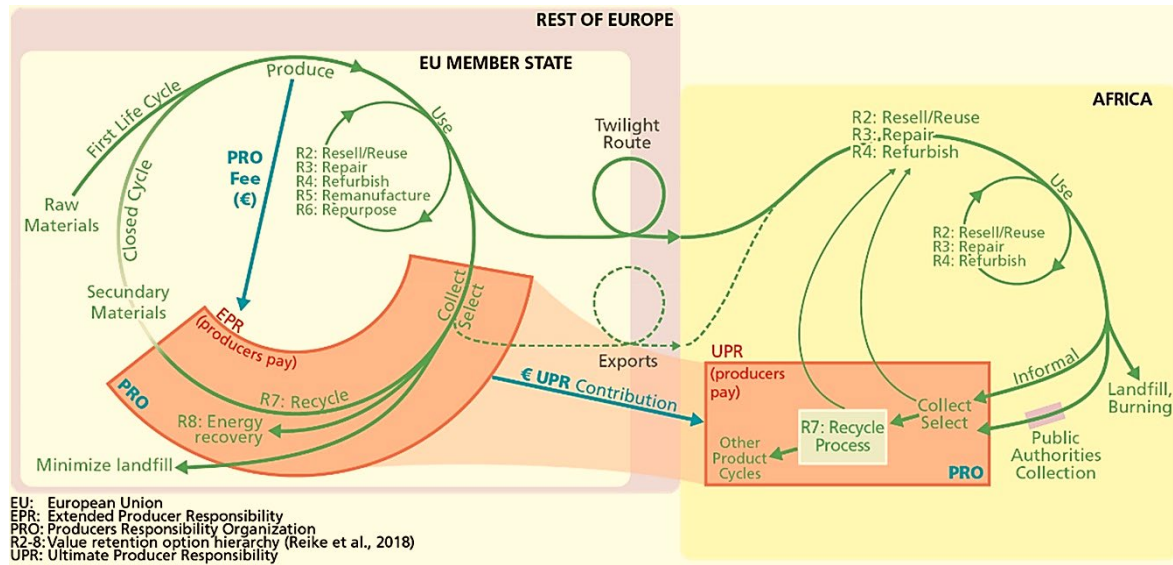


Figure 2-1 Diagram of Ultimate Producer Responsibility between an EU country and an African country, according to used products exports. Source: Thapa et al. (2023), licensed under CC BY 4.0.

Numerous NGOs have been supporting international extensions of producer responsibility (European Environmental Bureau et al., 2023; Major Groups and Stakeholders, 2024). The European Environmental Bureau et al. (2023), for instance, argued that EPR schemes could finance clean-up costs of WEEE exports in the Global South, while the Major Groups and Stakeholders for the 6<sup>th</sup> UN Environment Assembly (2024) explicitly called for international EPR schemes to handle leakages of EEE such as batteries and solar PV. More recently, The Roundtable on the Responsible Recycling of Metals (RRMR), a multi-stakeholder organisation working on EoL value chains, also included UPR in its recommendations to the OECD Forum on Responsible Mineral Supply Chains (RRMR, 2024a, 2024b). Despite increasingly widespread recognition of these issues and of these proposals from practitioners as well as regional and international organisations such as the EEA (2012) and the OECD (2024), international EPR currently remains primarily a theoretical construct (Brown et al., 2023). Lack of transparency and traceability currently hinder the allocation of producer responsibilities internationally (Brown et al., 2023), and the quantity of producers, importers, distributors and resellers make the monitoring of products and waste difficult, especially across jurisdictions (Campbell-Johnston et al., 2022).

At present, proposals of international EPR arise in response to shortcomings of EU policies, EPR policies in particular, to regulate EoL value chains internationally and address leakages to third countries. The underlying rationale is that (i) initial consumers in the EU paid their share for proper recycling in the product price, therefore recycling should be ensured no matter where products become waste (Vermeulen et al., 2022) and (ii) receiving countries should not bear the

burden of EoL management of imported products with only their own resources (Arya & Bhutani, 2023; Cotta, 2020; Röling & Darut, 2023). Reviewed literature showed, however, that current proposals do not discuss aspects of governance – that is, how such schemes should be implemented and administered. Moreover, the current feasibility of international EPR schemes to be adopted and set up remains underexplored. As Gupta et al. (2007) point out, a crucial aspect for any policy to exist is for it to gain institutional feasibility. Hence, there is a need for analyses of institutional factors enabling or hindering the feasibility of proposed international EPR schemes, which is the primary aim of this thesis.

## **2.2 Theories, Concepts and Frameworks**

This section provides an overview of useful concepts, theories, and perspectives to inform this research. First, the concept of CE and different problematisations related to social sustainability are reviewed (2.2.1). Then, policy evaluation in its theory-driven form (2.2.2) combined with institutional analysis (2.2.3) is identified as a fitting framework to guide this study's analysis.

### **2.2.1 Circular Economy and Social Sustainability**

The concept of circular economy is widely renowned to lack a universal definition (Kirchherr et al., 2017). Different interpretations and conceptualisations exist in different academic and professional fields, and the concept has largely evolved through the years. This review focused on literature highlighting the social implications of CE and policies towards CE, as well as problematisations of CE related to globalisation and exchanges between global north and south.

Reike et al. (2018) provide an historical account of the evolution of CE as a concept. They start in the 1970s with CE 1.0, focused on waste management. CE 2.0 between the 1990s and 2010s incorporated considerations of input reductions and efficiency. CE 3.0, from the 2010s until today, focuses on value retention strategies and shows increasing attention towards international value chains (Reike et al., 2018). Their review highlights how value retention strategies increased over time, going from classic notions of “reduce, reuse, recycle” (3R) to more complex frameworks such as the hierarchical 10R framework of Potting et al. (2017), including higher value retention strategies such as reduce, rethink and reuse, and lower ones like recycle and recover. Higher R-strategies aim not only at closing material loops, but also to slowing resource use and narrowing or “degrowing” the CE (Hobson & Lynch, 2016a). Risks of dangerous CE leakages however are also stressed in their discussion (Reike et al., 2018).

In an increasingly global CE where material loops expand and multiply internationally, CE especially in its reflection into public policies has been criticised for not entailing social, moral and political dimensions (Calisto Friant et al., 2020; Gregson et al., 2015; Schröder, 2020). Scholars argue that framings of CE as a primarily technological challenge have been dominant (Hobson & Lynch, 2016b; Pansera et al., 2021), narrowing the focus and ignoring wider complex impacts and global societal implications. Reichstadt et al. (2023) also found this reflected in practice looking at EU policy and highlighting a lack of knowledge on impacts of CE policies on third countries. In response, academics and practitioners called for and proposed more comprehensive conceptualisations of CE. Schröder (2020), for instance, adds just transition to CE, calling for fair governance and accountable institutions to support a CE transition globally. Pansera et al. (2021) call for a “politicisation” of CE away from overly technocratic framings, and on a similar line Purvis et al. (2023) propose their own framework for a responsible CE incorporating socio-political aspects into CE policies design. In particular, they call for an explicit inclusion of anticipation, inclusion, reflexivity and responsiveness when designing policies and institutions for CE, stressing the importance of posing questions related to global north-south exchanges (Purvis et al., 2023). These values were found especially relevant to inform the present work, its analysis, and the interpretation of results.

Looking at transboundary movements of used products, several reviewed concepts apply and can be used to describe underlying issues and dynamics. Some authors link transboundary movements, related shortcomings of EPR schemes and the ultimate burden born by receiving countries to waste colonialism, namely the idea that rich countries export waste to be dealt with out of their sight, thereby burdening local communities with the negative consequences of the waste management (Röling, 2023; The OR Foundation, 2023). If policies look at isolated geographies, as current EPR policies do, they run the risk of not accounting for environmental injustices that work against a global CE transition and have negative consequences elsewhere (Cotta, 2020; Thapa et al., 2023). In particular, Cotta (2020) underlines the importance of considering aspects of access to resources and allocation of responsibilities when dealing with global north-south exchanges, as their research exposes several shortcomings of EU policies in this regard, including in the context of transboundary movements of used products and waste. Similarly, Thapa et al. (2023) and Calisto Friant et al. (2022) stress how EU aspirations for CE are inextricably tied to global justice and call for more plural analyses and discussions on topics such as transboundary movements of products for reuse and EPR. Proposals of international EPR such as UPR arise precisely from these concepts and perspectives (Thapa et al., 2023; Thapa, Vermeulen, Olayide, et al., 2022). This study takes these considerations into account by examining how the presence – or lack of – anticipation, inclusion, reflexivity, and responsiveness in current CE policies can affect the institutional feasibility of international EPR proposals.

### **2.2.2 Theory-driven Policy Evaluation**

This study aims at assessing the institutional feasibility of a policy not yet implemented. Hence, the field of policy analysis provides useful insights to inform this research. Policy analysis or policy evaluation is defined as a discipline using multiple methods of inquiry to generate policy-relevant information that can be utilised to resolve policy problems (Dunn, 1981). A distinction is often made between ex-post and ex-ante policy evaluation, where the former empirically reviews outcomes and the latter anticipates mechanisms and/or effects of a given policy (Smismans, 2015). Presently for international EPR, given the lack of implemented policies, any evaluation can only be ex-ante.

A crucial aspect of policy analysis is the choice of evaluation criteria, that is, what exactly is to be examined about the policy (Mickwitz, 2003). This study focuses on institutional feasibility, which is therefore taken as the evaluation criterion. Richter and Mundaca (2015) interpret institutional feasibility in their policy evaluation as pertaining to political acceptability and administrative burden. Administrative burden refers to the time and resources necessary for public authorities – and stakeholders – to implement and enforce a policy to generate outcomes (Harrington et al., 2004; Mundaca & Neij, 2009). A high administrative burden can hinder the institutional feasibility of a policy and can in turn be affected by different governance structures and policy design choices, as well as different levels of administrative capacity in different contexts. This makes it highly relevant for this study. Political acceptability is a crucial precondition for a policy to be adopted and implemented (Webber, 1986). It is affected by the policy's context and stakeholder interactions (Mundaca & Neij, 2009; Webber, 1986). These two factors were included by Scoones et al. (2006) in their concept of “policy space”, which they defined as the extent to which actors, interests and narratives restrict or enable decision-making. This is a dimension often under-looked in linear framings of policy processes according to the authors, and one that was found particularly insightful for the research at hand, given the focus on stakeholder views. In this study, the concept of policy space was slightly adapted to include not only political acceptability, but also current policy landscapes in the EU and West Africa, as well as dominant narratives and stakeholders' bargaining power and competing interests.

This study utilises elements from a specific type of policy analysis, namely theory-driven evaluation. This approach focuses on underlying mechanisms through which outcomes



originate and changes occur (Mickwitz et al., 2021). When applied ex-ante, theory-driven evaluation can uncover intended and unintended impact mechanisms as well as outcomes and contextual factors (Mickwitz, 2003). This type of evaluation is often perceived as more difficult and even seen as overly ambitious as exceeding the realm of evaluation (Herrick & Sarewitz, 2000; Scriven, 1998). However, many argue in favour of using ex-ante evaluations to outline theories of change, state underlying assumptions and expected causal chains to provide reflexivity on policy design by identifying preconditions for effectiveness (Linnér et al., 2012; Mickwitz, 2003). This fits the purpose of this study – to investigate the ex-ante institutional feasibility of a proposed policy whose design is not fixed. A pivotal element of theory-driven policy evaluation that is employed in this work is a model of different steps, links and relationships for a given policy, called intervention theory.

### Intervention Theory

Intervention theory can be understood as a model of linkages in the causal path from program to ultimate outcome (Rogers et al., 2000). The purpose is to understand how a policy intervention is expected to work, the actors and components necessary to achieve the intended outcomes and contextual factors that may affect them (Mickwitz, 2003). To construct an intervention theory, it is necessary to identify relevant actors, inputs, intended outputs and outcomes (Mickwitz, 2003).

Different methods and sources of information can be used to construct an intervention theory. Donaldson (2001) outlines four sources of information, namely (i) previous theories and research, (ii) beliefs held by program operators, (iii) observations after policy implementation, (iv) exploratory research testing assumptions about the intervention. Ex-ante intervention theories do not allow for ex-post observations, thus Linnér et al. (2012) point out that assumptions can also be generated and tested by logical inferences or through scientific theory. Inspired by both these approaches, this study constructs an intervention theory based on policy proposals coming from research (i), to be tested through exploratory research (iv).

Mapping out an intervention theory can help identify where and from whom further data needs to be collected (Mickwitz, 2003). This is especially relevant in the context of this ex-ante exploratory work. Hence, a “stakeholder approach” as outlined by Vedung (2017) is used to map out the major stakeholder groups involved in or interested by the policy in question. This makes this evaluation a responsive one, in which the intervention theory outlined is refined through the responses of stakeholders (Vedung, 2017). It is important to acknowledge, however, that stakeholder views can be adjusted for strategic behaviour (Vedung, 2017), which could represent a limitation of this approach and required to often go back to the “original” intervention theory derived by policy proposals.

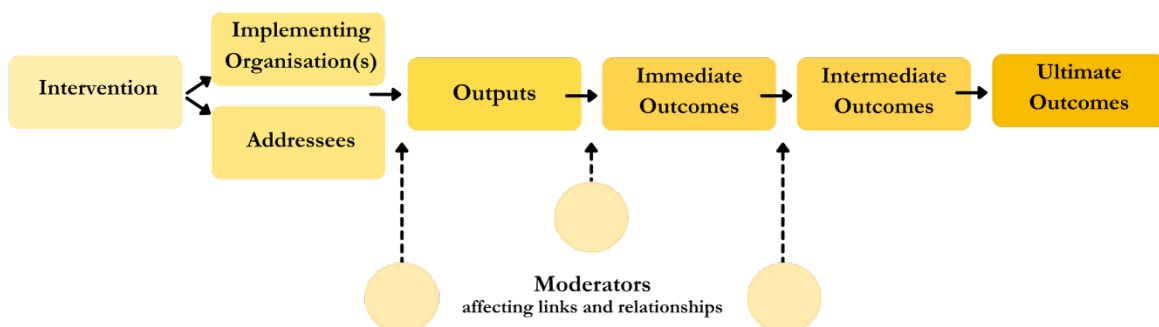


Figure 2-2: Intervention theory structure. Source: own illustration, adapted from Donaldson (2001) and Mickwitz (2003).

Regarding the structure of the intervention theory, this thesis draws inspiration from a variety of sources. An intervention theory is linear by nature, however previous work by Mickwitz (2003), Donaldson (2001), Linnér et al. (2012) and Chen (2014) introduce complexity into intervention theory in different ways. Donaldson (2001) introduces mediator variables, namely factors affected by the intervention which in turn affect outcomes. Mediators can also be considered as immediate outcomes, according to Mickwitz (2003). Donaldson (2001) also introduces moderating variables, contextual factors affecting the strength of relationship between the intervention and immediate, intermediate or ultimate outcomes. The template structure guiding this study is shown in Figure 2-2.

Theory-based approaches and frameworks such as intervention theory are subject to inherent limitations. Some argue that uncertainty restricts their ability to guide policy development (Herrick & Sarewitz, 2000), as biases could arise from anticipations of how a policy is intended to work. Van der Knaap (2004), for instance, expresses this claiming that “tunnel vision and rigidity are never too far away from theories”. This could hinder the usefulness of intervention theory especially if it omits certain stakeholders from the analysis (van der Knaap, 2004). This study specifically aims at including different perspectives and at refining the intervention theory based on these to mitigate the abovementioned risks.

### **2.2.3 Institutional Analysis in Policy Evaluation**

Investigating the ex-ante institutional feasibility of a policy necessarily calls for methods and tools to capture the administrative and governance factors enabling or hindering the viability of the given policy. Insights in this regard can be found in the field of institutional analysis. The role of institutions has been gradually integrated into policy analysis (Polski & Ostrom, 1999), however the last few decades have seen growing awareness of the need for institutional perspectives into policy assessments. As Polski and Ostrom (1999) point out, institutions delimit capacity for change and impose constraints on feasible reforms. As such, institutional feasibility is a fundamental criterion for policies to exist (Gupta et al., 2007), and institutional analysis is a crucial aspect of policy analyses concerned with ex-ante feasibility of future policies.

Particularly useful insights for the analysis in this thesis come from the work of Theesfeld et al. (2010), Schleyer et al. (2006) and Aznar et al. (2010), all involved in SEAMLESS, an EU research project focused on developing an integrated framework for ex-ante evaluations of agricultural and environmental policies (Schleyer et al., 2006). Aznar et al. (2010) reviewed several ex-ante policy assessment methods and argued for the need to supplement them from an institutional perspective. As a result, the authors developed an explorative and flexible framework to assess the institutional compatibility of policies for ex-ante evaluations, namely the Procedure for Institutional Compatibility Assessment (PICA) (Aznar et al., 2010; Schleyer et al., 2006; Theesfeld et al., 2010).

#### ***Procedure for Institutional Compatibility Assessment***

Responding to a need for increased integration of institutional analysis into policy assessments, the PICA method represents a standardised procedure for ex-ante modelling institutional aspects for policy implementation (Aznar et al., 2010). In other words, it outlines a procedure to identify potential institutional incompatibilities for a certain policy in a given context at an early stage (Theesfeld et al., 2010). The authors define it as an explorative tool able to provide “early warnings” for institutional incompatibilities (Schleyer et al., 2006; Theesfeld et al., 2010). This makes it particularly appropriate for guiding this ex-ante research work.

The method consists of four main steps: (i) identification of policy options, (ii) choice of relevant critical institutional aspects (CIAs) to assess, (iii) choice of indicators to evaluate the potential of each CIA, and (iv) qualitative assessment of each (or aggregated) CIA(s) and evaluation of

the policy option (Aznar et al., 2010). The authors stress how each PICA step allows for the integration of stakeholders' opinions and views both during and after the evaluation, explicitly mentioning semi-structured interviews as a method for data collection (Theesfeld et al., 2010), which makes PICA particularly relevant in the context of this thesis. Moreover, they provide an extensive list of CIAs for each policy type, to be adopted and/or adapted and complemented in one's analysis (Schleyer et al., 2006). This is precisely the way the PICA method will inform this thesis. Not every step will be followed, but selected CIAs from the PICA method will first serve as guiding themes for the analysis and then feed into the evaluation criteria of administrative burden and policy space. It is important to acknowledge, however, as the authors state, that the PICA method does not incorporate the probability that CIAs themselves may change after policy debates or implementation (Aznar et al., 2010).

### 2.3 Summary and Analytical Framework

Three main takeaways emerge from the literature review as it relates to the research problem. First, literature evidenced numerous shortcomings of EPR policies in each stage of the solar PV value chain, connected to (i) lack of incentives for reuse in the EU, (ii) lack of transparency of exports and (iii) ambiguous responsibilities for EoL management of exported products. Second, several proposals of international EPR between the EU and Africa were discussed, and a research gap was identified in the current lack of understanding of governance implications of international EPR and of the institutional feasibility of implementing related principles. Third, ex-ante intervention theory was found to be a fitting framework for analysis, complemented by elements of institutional analysis integrated into the evaluation, as shown in Figure 2-3.

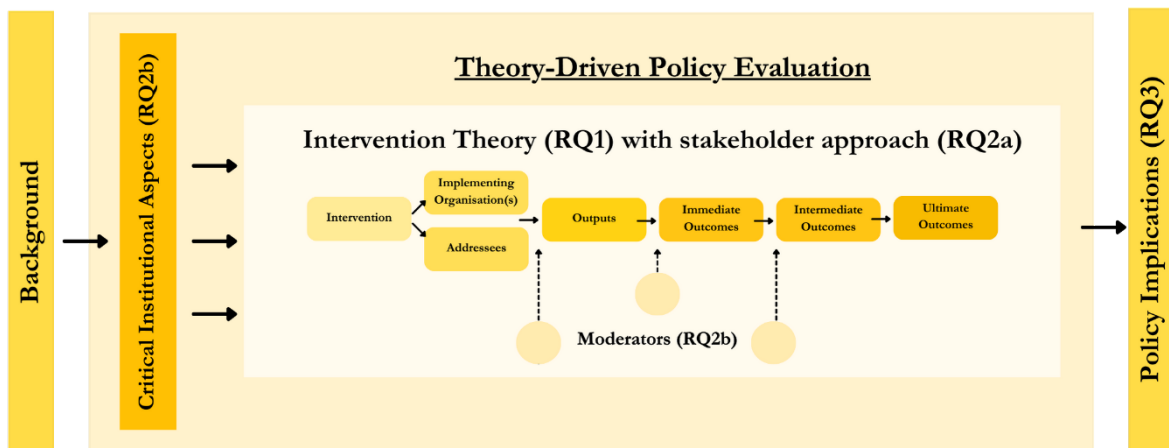


Figure 2-3: Analytical framework and connections to RQs. Source: own illustration.

### 3 Research Design and Methodology

This chapter contains a detailed description of the research design and methods employed to answer each RQ and achieve this study’s research aim. It includes the overall research approach, an overview of the research process, a description of procedures for data collection and of methods for data analysis. It also further clarifies the interrelations between RQs and discusses possible limitations.

#### 3.1 Research Design

The research topic and the RQs are exploratory in nature. Given the centrality of stakeholder views and policy design to the research aim, the research approach was qualitative (Creswell & Creswell, 2018). Underpinning the study was a constructivist worldview, seeking an understanding of multiple stakeholder views and meanings to discuss overlaps and differences in the evaluation. However, the research also espoused pragmatist elements, by necessarily taking an approach reflective of political aims and social justice and aware that research is always context-dependent (Creswell & Creswell, 2018). An overview of how the RQs interrelate and link to chosen methods is provided in Table 3-1 below.

Table 3-1. Research questions: methods, purpose, and interrelationships.

RQs		Method	Purpose & relation to other RQs
RQ1	What are the intended <b>impact mechanisms</b> of proposed international EPR schemes?	Literature analysis and expert interviews (R1-R3) into intervention theory framework	Outline intervention theory  Inform interview guide for RQ2 and policy considerations in RQ3
RQ2	How can an international EPR scheme be <b>designed</b> for reuse solar PV?	See RQ2a and RQ2b	Core of research objective
RQ2a	How would relevant <b>stakeholders</b> along the value chain and in policy set it up?	Stakeholder interviews (R4-R14) and insights from events (E1-E5)	Explore (in)compatibilities, refine intervention theory
RQ2b	What <b>institutional aspects</b> and contextual factors enable or limit the current <b>feasibility</b> of international EPR for reuse solar PV?	Stakeholder interviews and insights from events to refine intervention theory framework	Inform policy considerations in RQ3
RQ3	What are the <b>policy implications and needs</b> in sending countries and receiving countries contexts?	Stakeholder interviews and insights from events	Provide policy recommendations (to gain or increase feasibility)
<b>Objective</b>	Assess the institutional feasibility of an international EPR scheme for transboundary movements of reuse solar PV between the EU and Nigeria/Ghana		

Source: own illustration.

The research design is primarily informed by policy evaluation. Policy evaluation for this thesis is understood as an applied social science discipline using multiple methods of inquiry to generate and transform policy-relevant information that can be utilised to resolve policy problems (Dunn, 1981). This definition suits this research particularly well seeing as no international EPR policies are currently in place and the identified knowledge gap centres around analyses of institutional feasibility of proposed schemes. Thus, the defined analytical framework is informed by ex-ante policy analysis. This makes it possible to keep the study structured despite its exploratory and qualitative nature, while still allowing for slight adaptations along the research process. The analysis is theory-driven, departing from an intervention theory (Vedung, 2017). The research process essentially follows three main steps. First, an initial intervention theory is built based on relevant literature and expert views (RQ1). Secondly, this

intervention theory is then tested (RQ2) by analysing stakeholder views on governance aspects (RQ2a) and institutional factors (RQ2b). Thirdly, insights from stakeholders on critical institutional aspects are evaluated against the main criterion of institutional feasibility and the two sub-criteria, representing the core of the research aim and allowing to answer RQ3 (see Figure 3-1).

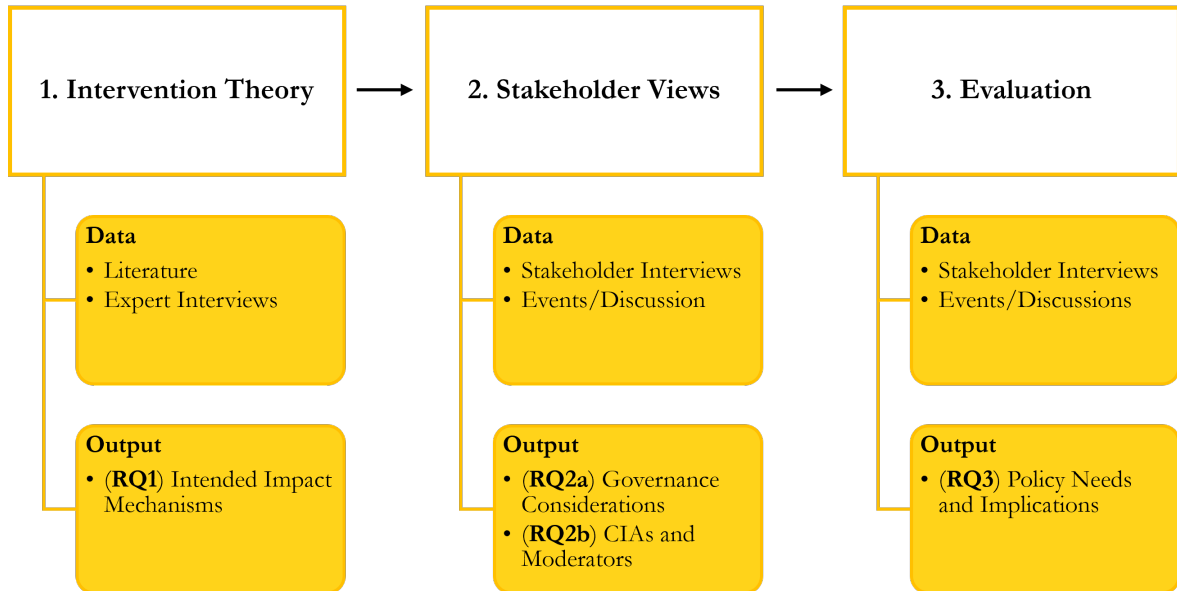


Figure 3-1: Research process representation in three steps. Source: own illustration.

## 3.2 Methods used to collect Data

Following a qualitative research approach, data needs for this thesis centre around relevant literature and respondents’ opinions, experiences, and reactions. The primary methods used to collect this data are a literature search and online interviews with experts and relevant stakeholders, aided by the participation in related events, webinars, and discussions. What follows is a description of the two main methods of data collection.

### 3.2.1 Literature Search

Background knowledge on EPR as a policy tool and its role in a global circular economy was collected through journal articles, book chapters and reports. Answering RQ1 required gathering literature in order to outline the intended impact mechanisms of proposed international EPR schemes. The core of the literature search thus centred around proposals of international EPR schemes – articles, position papers, letters, and reports – and on policy documents from sending and receiving countries. Moreover, additional literature was collected related to current national EPR schemes and their shortcomings in the EU and in African countries, as well as studies that offered quantitative estimates of trade flows of used goods between the EU and the African continent and of EPR fees not transferred when products are exported. These provided useful insights to inform interviews.

The literature search started by systematically using different combinations of keywords (e.g. “reuse solar PV/electronics”, “transboundary movements/exports/leakage”, “international EPR”) on databases – Scopus and Google Scholar – for academic articles and through the web search engine Ecosia for grey literature. Resources were selected based on their direct relevance to international dimensions of EPR, transboundary movements of reuse products and waste, and circular economy policy in EU and Africa. Snowballing through reference lists of collected articles was another important step of literature search, with selection criteria similar to the ones

described above. As such, the literature search structure could be seen as increasingly “ramified”. All literature gathered was collected and categorised on a Zotero online library for analysis.

Challenges in collecting literature were mainly related to the fact that international dimensions of EPR are generally under-researched compared to national implications. This is further complicated by the scarcity of official and reliable data on trade flows of used goods, including solar PV, and of e-waste, which often follows illegal routes. Furthermore, most studies that do discuss international dimensions – and shortcomings – of EPR and that provide quantitative estimates of the extend of the issue tend to come from global north perspectives. Ensuring the centrality of stakeholder views in this study and an equal representation of views from both contexts of sending and receiving countries is crucial, hence the importance of interviews as the primary data collection method.

### **3.2.2 Interviews and Events/Discussions**

Interviews were employed as the main method of primary data collection in this study. Qualitative research often makes use of interviews to obtain in-depth information about the respondents’ experiences, allowing for rich answers to emerge (Taherdoost, 2022). In this study, RQ1 involved initial “expert interviews” with academics and experts in circular economy and solar PV, to enrich the overall understanding of the issue at hand with particular attention to existing knowledge and data gaps of EPR in international contexts and for solar PV in particular, as well as to answer RQ1. Expert interviewees were recruited based on their expertise either in solar PV or in EPR and waste policies internationally. Expert interviews were unstructured, that is they were conducted without following an interview guide, as the focus was not to obtain specific information but rather to develop ideas, complement literature to answer RQ1 and prepare for interviews with stakeholders. In total, three expert interviews were conducted.

Interviews with stakeholders along the value chain and in policy were conducted to answer RQ2 and RQ3, testing and refining the intervention theory before performing the evaluation. These “stakeholder interviews” constituted the core of the research. They were semi-structured interviews, to ensure comparability while allowing some degree of flexibility to ask more precise questions according to the type of stakeholder interviewed. For an overview of general and more specific questions asked, see the interview guide in Appendix I. As stakeholders spanned along the value chain from manufacturing to recycling and across different geographies, and keeping in mind ethical considerations discussed in 1.4, ensuring equal representation of all relevant stakeholder groups was crucial. This was achieved through a purposive sampling strategy for recruiting stakeholder interviewees, namely their intentional selection based on their experience and the focus of the enquiry (Robinson, 2023). Criteria for selection were their role in the value chain or in policy as well as their geography (EU or West Africa), as outlined in Appendix II. Interviewees were identified through the researcher’s own network, snowballing and networking, and via desktop research of relevant entities and multi-stakeholder initiatives. A total of 11 stakeholder interviews was conducted. All interviews were conducted online to provide all interviewees with equal settings, and all were audio-recorded and transcribed.

Data collection through interviews was complemented by participation in events such as webinars and discussions in the field of EPR and CE. These were not recorded nor transcribed, but notes were taken during presentations, discussions, and Q&As. These notes served as complementary data, often representing views of experts and NGOs directly involved in EPR and waste management policy in the EU and in West Africa. In total, 5 events were attended. For an overview of the speakers and discussants, see Appendix III.

### **3.3 Materials Collected**

Following the exploratory nature of this study, the research called for data to be collected from a variety of sources, to reduce inevitable uncertainties and reduce risks of speculation. Data collected is differentiated by the RQ(s) it is intended to assist in answering. Background information collected to feed into the literature review and inform data collection included solar PV trends related to CE, studies on transboundary flows of UEEE/WEEE and policy literature on EPR in an international context. For RQ1, gathered materials included existing proposals of international EPR policies and measures, related academic articles, position papers and reports. In total, 25 related documents were collected and analysed. Moreover, expert views were gathered through expert interviews and participation in events. Answering RQ2 required collection of primary data through stakeholder interviews and through participation in events/discussions, to test and refine the intervention theory and evaluate its preconditions and moderators before the evaluation. Interview data collected consisted primarily of the eleven stakeholders' opinions, experiences, reactions, and feedback, and of notes from the five events attended. Lastly, RQ3 tied together data collected from stakeholder interviews and literature with the results of the evaluation and involved triangulation and external auditing (Creswell & Creswell, 2018) to enhance the validity of the results and finally outline policy needs and implications.

### **3.4 Methods used to analyse Data**

This section outlines the methods used for data analysis in line with the types of data collected and the analytical framework. All data, literature and interviews, was analysed through thematic coding. The PICA method from the field of institutional analysis assisted by providing pre-set codes for the thematic analysis of stakeholder views. Lastly, criteria to evaluate the institutional feasibility of proposed EPR policies were selected.

#### **3.4.1 Thematic Analysis**

All data collected was thematically analysed. Thematic analysis is a common tool to identify and categorise patterns and themes across qualitative datasets, often through qualitative coding (Braun & Clarke, 2006). First, data collected was organised and prepared for coding. Subsequently, I developed a general understanding of the data before the analysis. Thematic analysis was chosen for its flexibility (Kiger & Varpio, 2020) and ability to generate rich descriptions and themes particularly suited for informing policy discourses (Braun & Clarke, 2006). A hybrid approach was applied, utilising pre-set as well as emerging codes. The exploratory nature of the study fits this kind of thematic analysis as it called for an iterative approach that allowed for emerging themes to be integrated gradually into the analysis. Attention was paid to keep the coding structure connected with the analytical framework and RQs, to ensure a structured analysis instead of mere description (Mickwitz et al., 2021). Two separate thematic analyses were carried out, for literature and interview data respectively.

First, literature analysis was necessary both to gain background knowledge prior to expert and stakeholder interviews, as well as to answer RQ1. Background literature came from a variety of sources and covered several topics, while answering RQ1 required analysing relevant literature collected on international EPR proposals and related studies. The document analysis of collected literature involved first grouping literature into categories to thematically colour-code relevant portions of text on Zotero. Then, coded sections were organised into a separate document. The coding approach did not aim to be comprehensive but rather predatory, specifically looking for considerations on the theory behind proposed international EPR schemes and their design, to identify intended impact mechanisms in order to outline the intervention theory within RQ1.



On the other hand, interview data was analysed to inform RQ1 (expert interviews) and answer RQ2 and RQ3 (stakeholder interviews). Notes from attended events were also analysed at this stage. After preparing the data for analysis by transcribing interviews and polishing notes, thematic analysis was used to analyse all interview and event data and identify common themes. Unlike literature analysis, coding of this data took place on NVivo, a qualitative data analysis software, to assist and add rigour to the analysis. A hybrid approach was pursued, where some main codes were pre-defined while some others emerged directly from interviews. Codes were revisited iteratively and after all interview data was coded, the coding structure itself was adapted according to how each main code related to each RQs, to easily transition from data analysis to the elaboration of findings. The final coding structure is reported in Appendix IV.

### 3.4.2 Procedure for Institutional Compatibility Assessment (PICA)

The PICA method was adopted for data analysis of interviews and event notes to first inform the coding process and subsequently to help it feed into the policy evaluation. Given that the PICA method was used as a means to an end and not an end in itself, the analysis did not follow the entire procedure. Rather, step (ii) and (iv) outlined by Aznar et al. (2010) were performed, namely (ii) choice of relevant critical institutional aspects (CIAs) to assess, and (iv) qualitative assessment of each (or aggregated) CIA(s). The choice of CIAs was necessarily deliberate, based on their direct relevance and applicability for the policy at hand. CIAs were selected and categorised as reported in Table 3-2 below. This first categorisation was utilised in the coding structure that guided the thematic analysis of collected data (see Appendix IV for the coding structure in detail).

Table 3-2: Critical institutional aspects (CIAs) selected for analysis.

Critical Institutional Aspects (CIAs)			
Asymmetries and ambiguities	Experience with EPR policies	Interests and lobbying	Political factors
<ul style="list-style-type: none"> <li>• Ambiguous responsibilities</li> <li>• Dispersion of responsibilities and number of actors</li> <li>• Information asymmetries</li> <li>• Private transaction costs</li> <li>• Undifferentiated policy measures</li> </ul>	<ul style="list-style-type: none"> <li>• Experience with related policies (EPR)</li> <li>• Stakeholders' capabilities and mental models</li> </ul>	<ul style="list-style-type: none"> <li>• Bargaining and decision-making power</li> <li>• Endowment effects</li> <li>• Heterogeneous interests</li> <li>• Risks of opportunism</li> <li>• Trust</li> </ul>	<ul style="list-style-type: none"> <li>• Administrative public costs</li> <li>• Corruption</li> <li>• Policy mix frictions</li> <li>• Political and administrative inertia</li> <li>• Political continuity and stability</li> </ul>

Source: own illustration, adapted from Schleyer et al. (2006).

Given that selected CIAs provided pre-set codes for the thematic analysis of interview data, aimed at uncovering relevant institutional aspects influencing feasibility, the PICA method essentially represents the link between (i) the thematic analysis of data from interviews and events and (ii) the evaluation of institutional feasibility according to the chosen criteria. The following subchapter covers the evaluation criteria more in depth and also further elaborates on how analysed CIAs informed the institutional feasibility evaluation.

### 3.4.3 Evaluation Criteria

Policy evaluation and institutional analysis informed this study's approach, departing from a research gap identified in analyses of feasibility and discussions of governance aspects of proposed international EPR policies. In particular, research showed the importance of



institutions in shaping policy processes and defining a policy’s ex-ante feasibility. The overarching criterion chosen for this study was therefore institutional feasibility.

Institutional feasibility can be interpreted and thus assessed in different ways, hence the need for further definition of sub-criteria composing institutional feasibility to be analysed in this study. Especially aspects related to stakeholder views influencing the policy debate, more qualitative and exploratory in nature, were found relevant for the policy at hand, since this was still in its proposal stage during the research. Informed by previous work in environmental policy evaluation (Richter & Mundaca, 2015) and policy processes (Scoones et al., 2006), institutional feasibility for this study was broken down into two sub-criteria of administrative burden and policy space.

It is important to note how the evaluation in this study, both aspects of administrative burden and of policy space, were highly dependent on stakeholder views on governance and critical institutional aspects of international EPR design and implementation. As such, insights from the thematic analysis – informed by CIAs – fed directly into the evaluation of administrative burden, policy space, or both. Moreover, additional moderating factors emerged from stakeholders were also integrated into the evaluation under one of the two sub-criteria. This is visible in Table 3-3, where each CIA (or category of CIAs, in bold) falls under one of the two evaluation sub-criteria.

Table 3-3: Evaluation criteria and corresponding critical institutional aspects (CIAs).

Institutional Feasibility	
Administrative Burden	Policy Space
<ul style="list-style-type: none"> <li>• Administrative public costs</li> <li>• Private costs</li> <li>• Dispersion of responsibilities and number of actors</li> <li>• Information asymmetries</li> <li>• Policy mix frictions</li> </ul> <p>+ other identified moderating factors</p>	<ul style="list-style-type: none"> <li>• <b>Political factors</b></li> <li>• <b>Interests and lobbying</b></li> <li>• Ambiguous responsibilities</li> <li>• Undifferentiated policy measures</li> <li>• Policy mix frictions</li> <li>• <b>Experience with EPR policies</b></li> </ul> <p>+ other identified moderating factors</p>

Source: own illustration.

## 4 Findings and Analysis

This chapter presents the results of the analysis following the analytical framework. First, the findings from the document analysis and expert interviews used to answer RQ1 are presented by constructing the intervention theory, central to the subsequent RQs. Then, findings from stakeholder interviews are analysed and presented in line with the chosen methodology to answer RQ2a and RQ2b, discussing governance aspects and identifying critical institutional factors and additional moderators along the intervention theory. These findings are assessed against the criteria of administrative burden and policy space, and subsequently RQ3 outlines policy needs and implications expressed by stakeholders.

### 4.1 Intended Impact Mechanisms

This subchapter presents the key findings from the literature analysis and the expert interviews conducted to answer **RQ1**. Among reviewed literature, the most thoroughly developed conceptualisation of international EPR came from Thapa et al. (2023) with their concept of UPR co-created between the Netherlands and Nigeria, and from The OR Foundation (2023) in Ghana with their proposal of a globally accountable EPR. Their work, the expert interviews conducted (R1, R2, R3), the events/discussions attended, and other relevant literature helped frame the underlying mechanisms through which international EPR schemes intend to achieve their outcomes. This formed the basis of the intervention theory to be later tested with stakeholders. Constructing the intervention theory was an iterative process, although it is presented linearly. As the policy in question is still in its proposal stage, a comprehensive action model focusing on the exact relationships between actors was not pursued as it was less likely to produce relevant results. Instead, the intervention theory outlines the steps and links that according to authors and experts are necessary to achieve the ultimate goal (Rogers et al., 2000).

Reviewed documents allowed to make the main components of the intervention theory explicit, namely key actors (implementing organisation and addressees), outputs and outcomes, the latter separated into immediate, intermediate and ultimate outcomes (Mickwitz, 2003). By definition, the intervention theory was built on assumptions about intended mechanisms (Mickwitz, 2003) from literature and expert views, which is why the constructed intervention theory was later tested through stakeholder interviews. It is important to acknowledge how at the time this study was conducted international EPR and related proposals still remained mostly theoretical in nature and design (Brown et al., 2023).

#### 4.1.1 Intervention Theory for International EPR

Analysing different proposals, a first preliminary step carried out was to identify relevant **actors** that would implement and be impacted by an international extension of EPR for exported solar PV. This represented a crucial step for the ensuing analysis and the construction of the intervention theory. Overall, reviewed documents do not portray a single **implementing organisation**. However, Thapa et al. (2023) urge the European Commission to take action and implement UPR for EEE and includes recommendations to the Nigerian government. Similarly, Arya and Bhutani (2023) conclude their study by endorsing UPR and provide suggestions for a revision of the WEEE Directive. Both Thapa et al. (2023) and The OR Foundation (2023) envision in their proposal legislative requirements for PROs in the EU to provide a fee or fund transfer to receiving countries according to export shares. The OR Foundation (2023) also envisions supervision of fund transfers by third parties. On a similar line, R3 also mentioned the importance of NGOs in supervising the funds for increased transparency, and Forrest et al. (2019) also envisioned a global audit system in their global EPR proposal for plastics to enable governance of such a scheme. PROs are clearly the primary **addressees**, called to gather and share information and transfer funds along the value chain (R2, R3). While Thapa et al. (2023) envision linkages between sending and receiving PROs or waste management authorities,

Forrest et al. (2019) propose the establishment of a global PRO gathering data and allocating responsibilities for fund transfers. On a similar line, Vermeulen et al. (2021) propose the establishment of circular value chain organisations to coordinate and integrate the numerous actors involved in EoL value chains internationally, and Röling (E3, 2024) mentioned the potential of an organisation alongside national PROs for similar purposes. Other relevant actors targeted include customs and port authorities (Thapa et al., 2023) who would need to increase checks and information exchange both on intra-EU and outside-of-EU exports (Arya & Bhutani, 2023), national governments in sending and receiving countries (Thapa et al., 2023) in charge of adapting existing legislation and enforce EPR nationally, as well as local authorities in charge of utilising resources to improve EoL management infrastructure. Finally, downstream actors (waste pickers, sorters, resellers, recyclers) would receive allocated funds (The OR Foundation, 2023).

It is important to note how the nature of the contribution to be transferred to receiving countries varies among proposals. On one hand, The OR Foundation (2023) and Arya and Bhutani (2023) envision a financial contribution to be passed downstream. Thapa et al. (2023) also propose a fee transfer along with exported products but include in their proposal the possibility of providing capacity building in the form of technology and knowledge transfer as well. Thapa (E4, 2024) also mentioned the possibility of having EU producers setting up recycling facilities in receiving countries or EU countries establishing bilateral partnerships with receiving countries for capacity building financed through EPR funds. This would open up possibilities for international cooperation along value chains. Thapa et al. (2023) also stress how a fund transfer mechanism of UPR would not represent a charity transfer or development aid, but a fair contribution transferred to responsible parties. All proposals stress the mandatory character of international EPR schemes, although Arya and Bhutani (2023) point out how voluntary international EPR schemes serving as pilots could be a short-term option to be explored. Brown et al. (2023) also present already existing voluntary international EPR programmes as proof of how producers can in fact fulfil their responsibility in third countries. In this intervention theory, the contribution to be transferred represents “resources”, which can virtually encompass the abovementioned options emerged from literature.

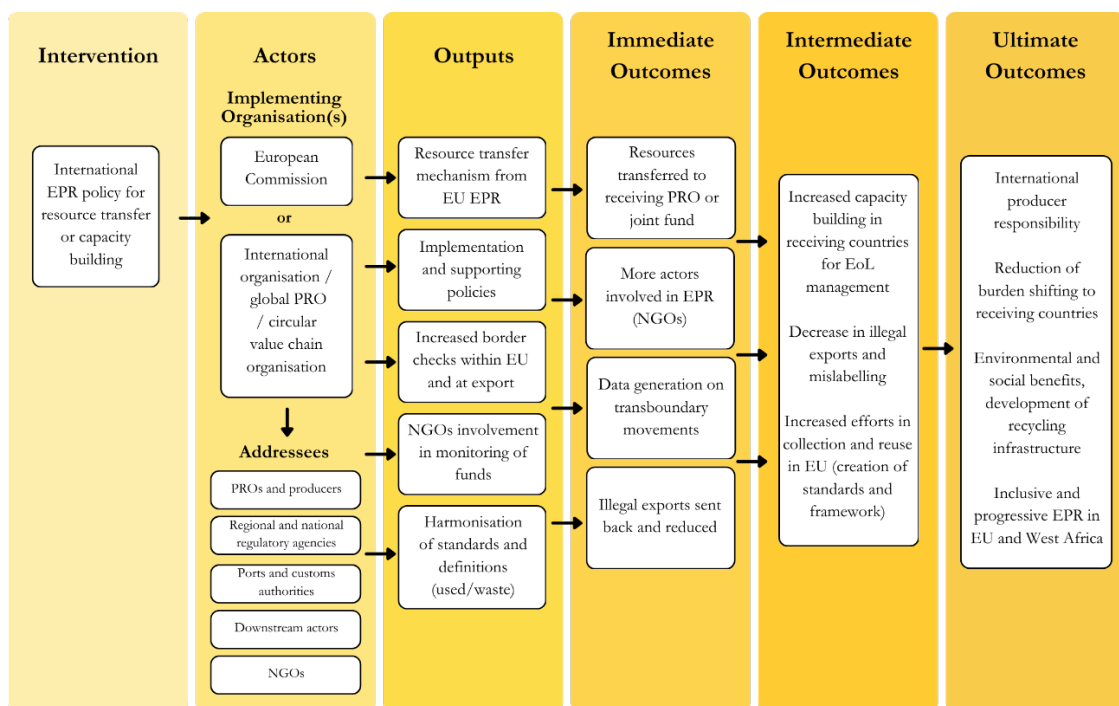


Figure 4-1: Intervention theory for international EPR from literature and expert views. Source: own illustration.

**Outputs** of implementation can be defined as the measures that addressees are immediately faced with (Mickwitz, 2003). In this intervention theory, these would therefore include financial responsibility for exported products imposed on PROs in the EU, most likely enforced through EU and national legislation. Increased efforts – and resources – towards checks and monitoring of exports would also be required, and third parties like NGOs (Thapa, E4, 2024) would be in charge of monitoring EPR schemes and related resource transfers. **Immediate outcomes** of these requirements would be transfers of EPR funds or other resources between PROs or regulatory bodies in receiving countries, either directly or through a dedicated (international) entity, and increased activities of monitoring and reporting at customs and port authorities, which in turn would help data generation. Authors and experts argue that new technologies for traceability such as digital product passports (DPPs) would highly enable tracking of products and related fee transfers and allocation of responsibilities, reducing the burden posed on PROs for data collection and exchange (Barczak, E3, 2024) (Arya & Bhutani, 2023; The OR Foundation, 2023). Until then, The OR Foundation (2023) argues that transfers could be made according to estimates and export data. **Intermediate outcomes** according to authors would include a reduction in mislabelling of UEEE and trade of WEEE (Arya & Bhutani, 2023) resulting in higher quality of exports and reuse, including in the EU. Transferred funds would also increase capacity building for proper collection and recycling in receiving countries (Thapa et al., 2023).

**Ultimate outcomes** of international EPR schemes include increased sustainability and circularity of EPR systems worldwide, including reduction of waste generation (Arya & Bhutani, 2023; Thapa et al., 2023) through higher quality of reuse (inner loops) and improved responsible processing of materials (R1). Increased reuse of functional and durable solar PV would also increase energy access and security in receiving countries. Moreover, the distributional effects of EPR would also be adjusted so that original producers and importers are held responsible for their waste internationally without imposing unjust burdens on receiving countries and communities (R1, R2) (Thapa et al., 2023; The OR Foundation, 2023). Importing countries would be able and required to invest funds into development of collection and recycling facilities, supporting policies for WEEE management and inclusion of the informal sector (Thapa et al., 2023), to achieve the standards of EoL management equivalent to those mandated in the EU, which EPR fees were intended to achieve (Arya & Bhutani, 2023). Transfers would be facilitated by traceability technologies such as DPPs and monitoring of funds on both sides (EU and receiving countries) would be ensured by third parties (Thapa, E4, 2024).

Overall, reviewed international EPR proposals made it possible to broadly outline their intended impact mechanisms and goals, as represented in Figure 4-1. Big questions however remained after analysing literature and expert interview data regarding the appropriate governance structures needed to administer such schemes (R1, R3), as well as concerning the current feasibility of implementing these proposals according to stakeholders (R1). Concerns regarding traceability and illegal exports were identified as potentially important moderating factors affecting the intervention theory. The focus of the rest of the analysis was indeed on governance and moderators influencing the relationships outlined in the intervention theory as well as its ex-ante feasibility.

## 4.2 Governance Aspects

Stakeholder interviews were carried out to explore views on how international EPR can be implemented and governed. Interviewees were familiarised with concepts and proposals of international EPR and asked to express their reactions and opinions as to what governance structures would be best to administer international producer responsibilities for an EEE category such as solar PV. This subchapter presents the results of the analysis of stakeholder interviews together with insights from attended events and discussions to answer **RQ2a**.

Overall, views and reactions on governance structures and implementing organisations for an international EPR scheme were varied. First, proposals of fee/fund transfers were discussed. Stakeholders in Nigeria expressed interest and openness to a scheme such as UPR (R7, R12, R13, R14). Nigeria already has an EPR system in place for handling WEEE which entails a private PRO monitored by the government, hence interviewees from Nigerian regulatory bodies believed a similar governance structure would be appropriate for international EPR in connection with exporting countries (R12, R14). Interviewees from the E-waste Producer Responsibility Nigeria (EPRON) specifically pointed out how Nigerian legislation is easily adaptable to an extension of EPR, while at the EU level this would pose a challenge (R7). However, they also expressed concerns regarding the differences on average between EU and Nigerian EPR fees, which would likely need to be harmonised or otherwise balanced. Private-driven pilot projects were also mentioned as a viable option to explore feasibility and improve tracking (R12). The need for involvement of customs, port authorities and shipping companies was also highlighted. R8 from the Amsterdam Port Authority stressed how mandating an international EPR scheme would expose shipping companies to increased reputational risks in case of waste exports, making them crucial stakeholders to engage with to make such a scheme functional. Stakeholders in the EU policy space confirmed how EU legislation does not currently allow fee transfers but, on the contrary, allows PROs to remove exported products from estimates of waste generated, decreasing the amount of EPR fees paid (R11). As such, R5 argued that there is no “excess fund” to be transferred according to current EPR legislation. However, both R11 and R5 stated the presence of an EPR scheme in the receiving countries would open possibilities for exchange of funds, provided that these are governed transparently.

Considerations of international EPR by stakeholders, especially when concerning linkages between sending and receiving PROs, often revolved around the presence or lack of a receiving EPR system. Although many African countries have been setting up EPR policies for WEEE, this is not the case in all countries. While some stakeholders argue that increased implementation of EPR schemes across Africa is crucial to handle WEEE (Masolia, E2, 2024), others point out how action needs to be taken regardless of whether a receiving country has an EPR scheme or not (Barczak, E3, 2024; Brown, E4, 2024). In Ghana, for instance, WEEE management is not under an EPR scheme but is administered publicly through a fund where eco-levies are versed by producers (R10). Other options in this case were discussed, such as the establishment of a joint fund administering and transferring contributions. Barczak (E3, 2024) for example argued for the European Commission to increase measuring of exports and set up a fund. R1 and R3 had also highlighted similar options, with the possibility of involving NGOs in overlooking funds (R3) (Thapa, E4, 2024). On a similar line, R4 from the solar PV trade association SolarPower Europe argued in favour of a hybrid fund, administered jointly by producers/PROs and governments.

Governance levels of implementation of discussed options were another recurring theme. Global governance and international institutions seem to offer space for discussion, for example through platforms and fora at the UN level (R9, R13). R5 also highlighted past discussions around an international agreement on WEEE at UN level, which would be crucial to harmonise definitions and standards. However, stakeholders both in EU and in West Africa seemed to agree that although international platforms can act as conveners and facilitators (R9), even if an agreement is reached provisions will have to be translated into regional and national efforts (R7, R9). Representatives from EPRON, for instance, pointed out that although it would be desirable to adapt existing international agreements such as the Basel Convention including clauses related to international EPR, a regional approach appears more viable (R7). Similarly, R9 from the International Alliance of Waste Pickers stressed the importance of regional and national action, and R4 mentioned the EU Global Gateway as an important forum for discussion.

Following the logic of international agreements and forums serving as conveners, several stakeholders also stressed the importance of bilateral cooperation between countries in incentivising collaboration along international EoL value chain actors. On this theme, R14 from the Basel Convention Coordinating Centre in Africa pointed out how support from exporting countries could come in the form of investments for recycling infrastructure, while R10, founder of a WEEE recycling company in Ghana, underlined the role of policy to enable private sector collaboration networks, for instance connecting producers to recyclers via voluntary schemes. Whereas these solutions could be more easily implementable, R5 also pointed out how bilateral agreements between e.g. the EU and Ghana for tracking and extending producer responsibility would expose risks of leakage by simply redirecting exports to other countries with less strict regulations. The same risk would be present in cases of bilateral cooperation between PRO (R5). Again, increased implementation of EPR policies in African countries was deemed necessary (R5, R6).

The semi-structured nature of the interviews also allowed to discuss alternative views. A concept stressed by a few stakeholders linked to value chain collaborations was that of product stewardship as an alternative approach to EPR that could be oriented towards international EoL value chains (R5) (Fry, E1, 2024). It was also acknowledged, however, how this concept is mostly alien to the EU space (R5). Stakeholders in EU (R5, R6), Nigeria (R12) and Ghana (R10) showed openness to piloting take-back schemes for solar PV exported for reuse, something that could be enabled by the fewer number of actors in the solar PV value chain compared to other product groups (R11) but hindered by issues of traceability and communication between producers and collectors in receiving countries (R10). R6 from a PRO for solar PV operating in the EU, also hypothesised a take-back scheme that incorporates elements of bilateral cooperation without however being as exposed to leakage risks, as the two countries would need to establish procedures for shipping back solar PV after collection to the exporting country in the EU, something which would also align with EU objectives of critical raw materials security and strategic autonomy (R4, R11). Further alternative mechanisms proposed by stakeholders that are less influenced by barriers related to traceability of products are offsetting of waste generated by producers. R10, for instance, proposed a waste offsetting scheme enforced at the EU level where producers contact recyclers and contribute to them financially. This was also envisioned by R1 by means of a similar book-and-claim system, to be regulated at the UN level (R12) or at the EU level (R10). Concerns remained, however, as to how to ensure effective communication along value chains from producers to recyclers. Barczak (E3, 2024) suggested that new tools such as DPPs will become crucial in enabling information and data exchange both for communication purposes but also to enable mandatory schemes of international EPR as envisioned in proposals.

In sum, the analysis of interview data on governance structures needed to govern an international EPR scheme for solar PV generated diverse insights and alternative views. Overall, they seemed to suggest a high degree of willingness from stakeholders regarding implementation of measures towards international EPR and increased value chain cooperation. A regional approach seemed to be preferred, although no consensus on governance aspects was observed. Different governance structures discussed imply different policy changes needed, with different administrative procedures and responsibilities for actors involved. Hence, stakeholders were also invited to reflect upon the factors influencing the current feasibility of different measures mentioned and proposed, which allowed for important moderating factors to emerge and inform the analysis. This is the focus of the following subchapter, which feeds into the intervention theory and the subsequent evaluation.

### 4.3 Moderating Factors

Interviews with stakeholders provided insights into the contextual factors that affect the current feasibility of setting up an international EPR scheme for solar PV or UEEE between the EU and Nigeria and Ghana. Most of these factors play a role before the intervention, while some others were found to affect links in the intervention theory. As a result, moderating factors emerged and were differentiated between those identified through pre-set codes arising from CIAs – which play a role before the intervention theory in influencing its institutional feasibility – and those that emerged directly from interviews – that influence the strength of the links between different steps of the intervention theory itself. This allowed to refine the original intervention theory and answer **RQ2b**.

#### 4.3.1 Critical Institutional Aspects

Selected CIAs were utilised to analyse interview data regarding factors influencing ex-ante institutional feasibility of the policy at hand. The diversity of stakeholders allowed for diverse views and insights to emerge on relevant CIAs, categorised and presented here according to recurring themes encompassing cost considerations, political aspects and current EPR policies in place and related incentives and structures.

##### **Cost Factors**

First, stakeholders pointed out factors related to increased costs and difficulties in setting up and enforcing an international EPR scheme. **Dispersion of responsibilities and the number of actors** involved in transboundary movements was identified as a barrier by R5, including actors involved in illegal trade e.g. brokers on which PROs do not have enforcement authority. Moreover, when used products reach a destination country, actors multiply and allocation of responsibilities becomes difficult due to lack of data (R5). Traceability and related costs are thus once again a crucial aspect of the discussion, although the solar PV value chain contains less players compared to other products (R11) and emerging tools like DPPs are likely to become important enablers when adopted (Barczak, E3, 2024; Rostang, E2, 2024; Thapa, E4, 2024). R6 also highlighted difficulties in implementation that would arise when a potential EU provision gets passed onto the national level, especially in those countries like Germany where local authorities have more decision-making power. Closely related to traceability are **information asymmetries** that also increase costs of monitoring and reporting. R5 and R6, both representing PROs, stressed the need for clear standards, definitions, and protocols to make data less patchy. R6 in particular argued for increased efforts between the EU and third countries to improve data reporting and exchange. EPR policies in receiving countries were highlighted as enablers in this regard (R5, R11), consistently with previous findings. Initiatives in this regard were seen as likely to reduce **private transaction costs** between value chain actors either reporting data to authorities or engaging in collaboration efforts, and as a crucial first step for international EPR considerations to gain institutional feasibility (R5, R11) (Masolia, E2, 2024). **Administrative costs**, however, are likely to arise both in relation to negotiations, design, and implementation at regional and national levels (R5, R7, R10), but also due to data needs and monitoring (R6). Increasing checks at borders would also require significant resources to be directed to customs and ports (R5).

##### **Political Factors**

Next to cost considerations, and closely related to public administrative costs, are political factors influencing the feasibility of the policy under analysis. First, **political and administrative inertia** was highlighted both in the EU and West African context. Especially as national EPR policies have been in place in the EU for years with relatively little consideration for international dimensions (Barczak, E3, 2024), cooperation with third countries is lacking (R1, R6). R6 stated that EU waste administrations already receive data from PROs and should

cooperate among them and with third countries. Current policies in place however, for instance EU waste-related legislation, do not aid in this regard, providing little incentives and rules on how to monitor and regulate trade in used products (R11). This kind of **policy mix frictions** highlight important gaps in EU CE policy (R8), confirming previous findings (R1, R3). Stakeholders also expressed concerns related to **corruption** both in the EU and West African space. Illicit activities involving brokers, customs and port authorities were highlighted (R5, R8, R14). Moreover, stakeholders in the EU expressed concerns about the fate of potential EPR fees transferred abroad in the absence of monitoring (R5) due to lack of **political stability and continuity** of efforts to combat e-waste (R6, R10). These findings suggest once more the need for increased traceability, transparency, monitoring of funds and supporting policies.

### **EPR Policies in Place**

Discussing the extension of a policy such as EPR which has been in place for years in the EU naturally brought up aspects related to current institutions and rules in place in **current experiences with EPR**, and how these affect the feasibility of a potential international extension. Analysing views of stakeholders showed how **ambiguous responsibilities** exist in current EPR governance, which can impact how this deals with transboundary movements out of the EU. First, ambiguities were identified by stakeholders in the position held and incentives faced by PROs in the EU concerning reuse both in and out of domestic borders. As PROs often have not only financial and operational but strategic responsibility as well in the design and implementation of EPR (Röling, E3, 2024) and since PROs act to keep EoL management costs low for producers (R4) (Röling and Darut, E3, 2024), some argued that having producers in charge orients the business model of PROs excessively towards short-term and domestic cost considerations (Röling and Darut, E3, 2024; Barczak, E3, 2024). Sales-oriented businesses in charge of EPR were said to negatively impact the progressiveness of EPR policies for reuse (R8, R11). Moreover, according to some respondents this creates a perverse incentive to ship as EPR fees of exported products are retained in sending countries while the responsibility is considered fulfilled (R8, R9) (Röling and Darut, E3, 2024), to often cover the following year costs of EoL management (R5). This was partially confirmed by R11 when mentioning that EPR legislation foresees a reimbursement of fees to producers for exported products. In absence of clear guidelines to distinguish between WEEE and UEEE and between durable and non-durable UEEE, this can be seen as an unfairly **undifferentiated policy measure**, whereas on the contrary distinctions are urgently needed to prevent waste exports (R4, R11, R14). **Risks of opportunism** therefore arise from legislative gaps, loopholes, and unclear incentives (R4, R9, R8, R11, R14). Further ambiguities regarded precisely the responsibility for exported products. Numerous stakeholders argued for original producers to be responsible for exported products, in line with international EPR principles (R7, R13) (Barczak, E3, 2024; Thapa, E4, 2024). R5 argued instead that significant legal issues arise when products get repaired or refurbished in a destination country to be resold, and that the repairer should become responsible under a destination country EPR scheme. This not only shows disagreements that need a solution, but also exposes risks of responsibilities being lost especially in countries where an EPR scheme is not present such as Ghana (R10). Even in countries that have implemented EPR like Nigeria, moreover, stakeholders pointed out difficulties in allocating responsibility to importers (R13, R14), although clearly the presence of a PRO would make it easier to establish connections with sending countries with the help of harmonised data and tracking tools (R6, R11) (Thapa, E4, 2024), compared to Ghana where e-waste regulations are still being finetuned (R10) and private actors established platforms to connect formal and informal stakeholders.

Closely linked to the central role played by PROs in governing EPR schemes in the EU came considerations on stakeholders' visibility, **bargaining and decision-making power**. Stakeholders especially from NGOs pointed out producers and PROs have been involved in lobbying activities in the EU, where decision-making power has for long been significantly in



the hands of PROs. This is seen by many as an excessive power imbalance which gives rise to **endowment effects** and inertia, and a reason why other actors should, but are not currently, included in decision-making in EPR (Röling and Darut, E3, 2024; Thapa, E4, 2024). R9 in particular argued for the voices of downstream actors such as waste pickers and other informal workers to be amplified to start discussing measures together with all stakeholder groups. Stakeholders in Nigeria, particularly from regulatory bodies, argued that when it comes to international EPR decisions depend on producers and authorities in the EU, and have showed willingness to engage in dialogues through international bodies or, if necessary, through written letters or requests (R12, R13). As R4 pointed out, decision-making power currently sits in the EU, and if priorities of EPR are to be changed, the highest chances to do so are likely to be through EU legislation and its revisions. The analysis so far showed how changes to EPR systems and in particular international extensions of EPR policies expose **heterogeneous interests** from stakeholder groups upstream and downstream. Reactions from stakeholders also showed relatively low **levels of trust** among different actors and geographies. On one hand, stakeholders in the EU have expressed concerns regarding the capacity of administrations in receiving countries to administer potential funds transferred, as well as regarding corruption in export activities and in regulatory bodies (R5). On the other hand, stakeholders in Nigeria and Ghana appeared aware that competing interests are at stake when speaking of transferring fees from EU producers to a receiving country and showed little confidence in EU actors to act in this regard if not pushed through clear legislation (R7, R12, R13).

The institutional factors discussed so far play a role in influencing possibilities for debate, design, and implementation of an international EPR system. As such, it can be argued they should be seen as a precondition for the intervention itself, hence their placement before the intervention theory in Figure 4-2. This is consistent with the framework guiding this study, focusing on ex-ante institutional feasibility. Aspects discussed so far should therefore not be seen as quantifiable links or measures, but as factors emerged from the analysis that directly or indirectly shape potential debates on international EPR.

### **4.3.2 Other Moderating Factors**

The analysis found other contextual factors not covered by CIAs that instead have the potential to enhance or weaken links in the intervention theory itself, after implementation, in turn influencing outputs and/or outcomes. These are naturally related to CIAs as well but are represented here as additional moderators potentially influencing relationships at different stages of the intervention theory. They are reported as M1-M7 in Figure 4-2 in 4.3.3.

#### ***Traceability and Illegal Exports***

One crucial factor that could affect fundamentally the allocation of funds between sending and receiving countries is traceability of exported products, linked to the current **lack of data** (M1) on transboundary movements, **fraud** (M2) and waste crime, and insufficient checks in customs and ports. Shipments of products are not subject to regulations on waste exports (R11), and HS codes do not aid in differentiating products (R14) which opens up possibilities for fraud e.g. exporting products near their EoL (R4, R6, R7, R14). R8 from the Port of Amsterdam agreed that clearer regulations in this regard would help, something that the EU is working towards (R11). So far, however, regulations in the EU and West African countries like Nigeria, as well as the Basel Convention, have not been effective in countering illegal trade of disguised WEEE (R13, R14) (Thapa, E4, 2024). This was confirmed from stakeholders' experience in both Nigeria and Ghana (R7, R10, R14). Even with an international EPR scheme in place, these factors would cause negative consequences in receiving countries and perpetuate injustices by allowing waste exports. As such, R6 argued these issues should be solved first. Although EPR actors have no enforcement authority in these regards (R5), monitoring efforts must be

increased and resources need to be dedicated to tracking improvements, including with new technologies such as DPPs in the near future (R7, R14) (Rostang and Nobell, E2, 2024). Port authorities and customs would also benefit from this in their shared efforts (R8), in turn easing the process of exchanging information – including a potential fee transfer – between countries (Barczak, E3, 2024). Furthermore, clearer protocols and increased transparency would aid data collection necessary for allocating responsibilities under EPR. At present, port authorities and customs are not able to generate clear data (R8) and stakeholders in West Africa rely on estimates from previous studies (R7). Once again, traceability was identified as a crucial aspect in enabling data exchange, preventing fraud, and allowing allocation of responsibilities along the value chain (Barczak, E3, 2024).

### ***Incentives to Ship and Reuse in West Africa***

Additional factors that can affect relationships along the intervention theory pointed out by stakeholders were the extent of **demand for reuse products in receiving countries** (M3), **supply of reuse products from sending countries** (M4) and the **incentives to ship** (M5) abroad for EU actors. Overall, stakeholders in Nigeria and Ghana confirmed how West Africa is a consuming region highly dependent on imports (R7, R10, R13, R14) (Barczak and Thapa, E4, 2024), as imported products can increase economic opportunities both in the use phase and in EoL (R7, R8). Although stakeholders in Nigeria stated solar PV waste compared to other WEEE categories has so far had a smaller impact – likely due to the longer lifespan of solar PV – (R7, R12) stakeholders seemed to agree that this market is set to grow significantly (R4, R6, R11, R12). As both supply and demand for reuse solar PV are set to increase, the extent to which this can impact the mechanisms of an international EPR scheme come back to the number of actors involved (R8, R11), and the incentives to ship or to reuse faced by EU actors (R9, R11) (Röling and Darut, E3, 2024) which could impact quantities of exports. Once again, however, the importance of preventing leakages from EPR systems was stressed as a prerequisite by stakeholders (R9, R14) (Laubinger, E1, 2024).

### ***Supporting Policies***

The functioning of an international EPR scheme can clearly be affected by other **supporting policies in the EU** (M6) **and in receiving countries** (M7). These were already mentioned as a factor influencing ex-ante feasibility of international EPR; however, policies can also impact the way potential outputs of an international EPR scheme would translate into outcomes within the intervention theory. Here, discussions with stakeholders expanded beyond EPR policies to discuss other EU legislation. The adopted Ecodesign for Sustainable Products Regulation 2024/1781 (ESPR) and related provisions on DPPs were mentioned several times as crucial enabling factors for enhanced transparency, data and easier product disassembly and repair (R4, R7, R11). In particular, Barczak (E3, 2024) argued that DPPs have the potential to allow for secure data exchanges downstream directly to recyclers in receiving countries, enabling appropriate fund transfers under international EPR. It needs to be pointed out, however, that solar PV ecodesign requirements as of 2024 are not set to be developed under ESPR which implements DPPs for a variety of products in the EU, rather under the Ecodesign Working Plan 2022-24, based on the previous Ecodesign Directive. R4 and R11 pointed out how this represents a transitional measure towards the development of ecodesign requirements under ESPR for solar PV at a later stage. The policy approach pursued by the EU towards strategic autonomy, as reflected in the Critical Raw Materials Act was also highlighted as a factor potentially reducing incentives to export and increasing reuse and recycling in the EU to secure secondary materials in the solar PV value chain and beyond (R4).

Several stakeholders also stressed how further measures to incentivise reuse in EPR systems can help prevent leakages (Röling and Darut, E3, 2024). To achieve this, eco-modulation of fees and the inclusion of more actors in EPR decision-making was deemed necessary (Röling and

Darut, E3, 2024). Furthermore, as stated by R5, since PROs often do not have access to all generated volumes, an all-actors approach to EPR would be desirable to enhance transparency. Potentially, this would also reduce the administrative burden posed on PROs (R11) in a scheme such as UPR, sharing responsibilities with retailers, distributors, import/export actors, and administrative agencies on both sides (R4, R5).

Supporting policies in West African receiving countries were also outlined, especially to make sure that ultimate outcomes are in fact achieved in a potential international EPR system. Firstly, stakeholders argued for increased commitment to WEEE management including through the establishment of EPR schemes in countries that currently do not have any in place (R4, R6) (Masolia, E2, 2024). Having EPR systems in place between two countries covering the same products was seen as an important enabler for smoother information exchange (R6). Policies aimed at including and supporting informal workers in EPR systems were identified as paramount to make sure funds actually go towards their intended use of EoL management while at the same time reducing the burden posed on waste pickers and informal recyclers outside of EPR schemes (R8, R9). These arguably represent the most important aspect to ensure ultimate outcomes of proposed international EPR schemes can actually be achieved.

### 4.3.3 Refined Intervention Theory

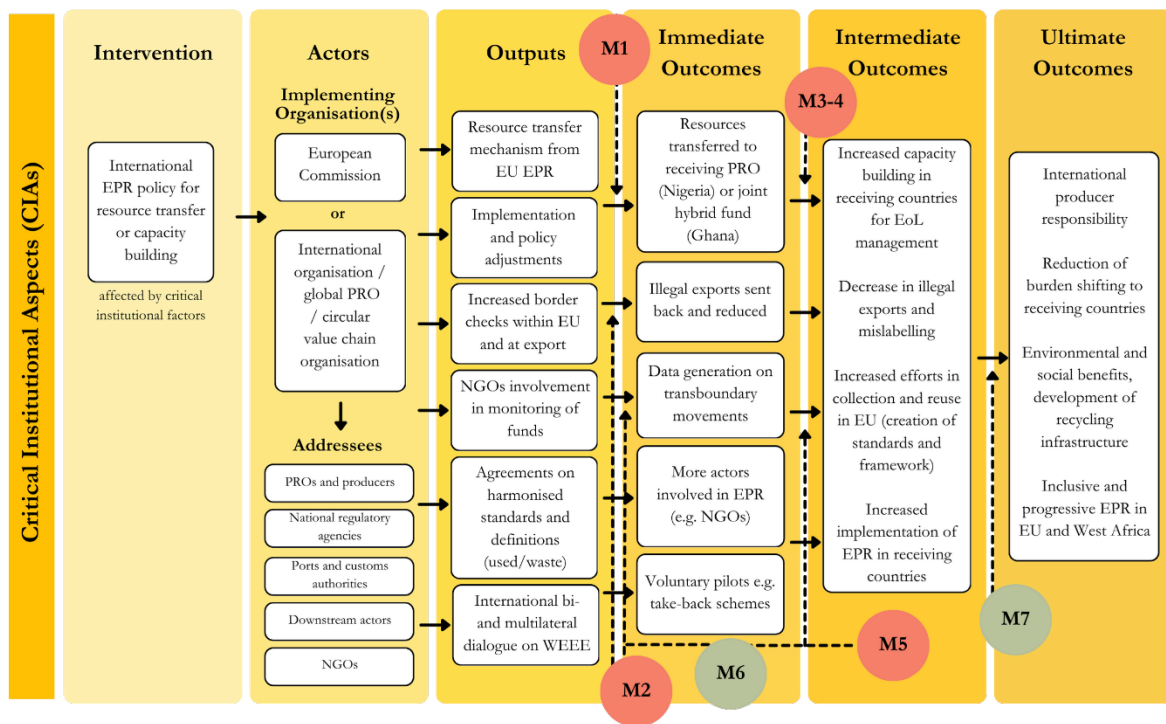


Figure 4-2: Intervention theory refined with identified moderators (M1-M7). Red moderators weaken links and relationships, while green moderators strengthen them. Source: own illustration.

Analysing stakeholder views regarding CIAs affecting the ex-ante feasibility and other moderators potentially influencing the mechanisms of international EPR allowed to further refine the original intervention theory. To some degree, overlaps are present between identified relevant CIAs and additional moderators. However, this was accepted and justified since the aim of this analysis was not to obtain precise links throughout the intervention theory but rather discuss together with stakeholders important factors potentially affecting the institutional feasibility of international EPR principles in practice. The refined intervention theory (portrayed in Figure 4-2 above) still departs from EU action since interactions with stakeholders tended to

favour regional action, even in the potential presence of future international agreements on WEEE (R5, R7, R9). This was consistent with the original intervention theory derived from proposals, which pushed for the EU to take action (Arya & Bhutani, 2023; Thapa et al., 2023; The OR Foundation, 2023).

The refined intervention theory with moderators in turn – analysed together with stakeholder views – provided insights on each of the chosen evaluation criteria, allowing for findings to emerge regarding the institutional feasibility of international EPR for solar PV, thus feeding into the policy analysis at the core of this thesis. This, together with consequent policy needs and implications arising from interview data, is the focus of the following subchapter.

## **4.4 Institutional Feasibility**

This subchapter provides insights into the evaluation of the current institutional feasibility of international EPR for solar PV in light of the analysis conducted – which resulted in the refined intervention theory – and according to the evaluation criteria. Then, it answers **RQ3** by outlining policy needs and implications that arose from interactions with stakeholders and from the evaluation. In other words, it discusses the actions needed for concepts of international EPR to gain and retain institutional feasibility.

### **4.4.1 Evaluation – Administrative Burden**

Keeping administrative burden low is usually seen a crucial prerequisite for any policy to gain and maintain institutional feasibility. Different governance structures, discussed in 4.2.1, imply different implementing organisations and administrators of an international extension of EPR, in turn giving rise to different administrative tasks and burdens for involved stakeholders. From a policy perspective, implementing organisations envisioned by stakeholders primarily included the EU and administrative agencies at the national level. Some stakeholders also mentioned possibilities for international action at the UN level but acknowledged the difficulties in taking forward an initiative such as a global e-waste treaty (R5), with or without international EPR provisions. At the EU level, whereas some stakeholders believed administrative capacity not to be a restricting factor for feasibility but rather focused on political will (R3) (Thapa, E4, 2024), others expressed concern about the establishment of an international EPR scheme which would require PROs and national waste authorities to gather and exchange data when these processes already take place domestically (R5).

Besides implementing organisations, key actors would be required to take on additional tasks for which resources would be needed, or to adjust national legislation. Regarding the latter, stakeholders in West Africa appeared confident that their legislative framework could be swiftly adapted to accommodate for an EPR fund transfer (R7, R12, R13, R14). Actors in the EU space, however, expressed concern regarding the capacity of their African counterparts to administer such a system while ensuring that funds get utilised for the intended purposes (R5, R6). Proponents of international EPR propose a solution that entails having third parties such as NGOs monitoring funds from the EU to African authorities. Clearly, the costs of administration here depend highly on the possibilities to track products and corresponding funds (R7, R12). It is believed by many that innovative tools for traceability will highly contribute to bring administrative burden down in this regard for PROs, waste management authorities and port and custom agencies (Barczak, E3, 2024). In the short-term, however, stakeholders seemed to agree that ports and customs would face increasingly burdensome tasks in the event of implementation of a mandatory international EPR scheme, for which resources would be needed (R14) (Thapa, E4, 2024). Factors such as the number and dispersion of actors involved in trade of used products further complicates monitoring in the absence of tools like DPPs, deepening information asymmetries which in turn make it difficult to design effective

international EPR systems. Some stakeholders however argued that while this is a barrier, allocations of responsibility can still be carried out by contributing to an EPR fund between the EU and African countries (R13) (Barczak, E3, 2024) to set up recycling facilities, whose contributions could be decided according to trade data and estimates.

Regarding data on shipments for reuse, stakeholders highlighted how current deficiencies in waste-related legislation make it hard to distinguish between legal shipments of products and illegal shipments of waste. Developing standards for reuse, something proposed by stakeholders in particular for solar PV, despite obviously representing additional administrative procedures to be dealt with, seems to be an initiative already underway at least in the EU (R4). As such, it is likely – and believed by many stakeholders – that measures such as reuse standards (including aspects of reliability, durability, and safety) (R4) will decrease administrative burden posed on actors in import/export such as customs authorities (R8), especially if linked with product passports (R14). The establishment and fine-tuning of EPR policies in receiving countries, where not already in progress, can ease data exchanges and potential fund transfers, potentially keeping the process within private PROs monitored by the government (as it already happens in Nigeria for instance) and/or supervised by NGOs (Thapa, E4, 2024). EPR policies have already been implemented in several African states including Nigeria and are being debated in others like Ghana, although as stakeholders stressed it remains crucial to include all actors in the design, implementation, and administration of EPR systems (R9) (Röling, E3, 2024).

Overall, administrative burdens linked with potential international EPR policies were found to highly depend on future developments related to traceability of products, reuse standards and adoption of EPR policies in receiving countries. Considerations of implementation costs appeared comparatively less pronounced, although arguably this represents a more speculative aspect for stakeholders to express their view on. It can be concluded, however, that at least until more concrete measures towards effective traceability of transboundary movements and developments of reuse standards are taken, prospects of administrative burden related to international EPR schemes will remain significant, especially for PROs and ports and customs authorities.

#### **4.4.2 Evaluation – Policy Space**

The evaluation of the policy space where international EPR is currently being debated includes aspects of political willingness, dominant narratives and views, policies in place and potentially contrasting interests, all of which can affect the institutional feasibility of the policy at hand. Similarly to administrative burden, policy space is shaped and influenced by several CIAs discussed above and other contextual factors identified by discussing solar PV reuse trends and market opportunities together with stakeholders. Overall, the analysis of stakeholder views showed how the policy space for international EPR to emerge is currently restricted, especially in the EU context. What follows is an overview of the different factors shaping this policy space emerged from the interviewed stakeholders.

Stakeholders in Africa, notably Nigeria, showed significant interest and willingness to adopt policies allowing EPRON to manage funds transferred from exporting countries, monitored by governmental agencies like NESREA, and to invest the funds into recycling infrastructure and increased checks in ports (R7, R12, R13). Some also stated, however, how at present the attention of the government both in Nigeria and Ghana towards WEEE, especially solar PV waste, comes more from future predictions of a waste crisis rather than present concerns and urgency of action, potentially showing signs of political inertia (R6). However, this is likely to change in the near future as waste volumes globally are set to increase (R4, R6). Moreover, as R8 stated, political willingness from Nigerian and Ghanaian stakeholders is likely to become even stronger as proposals of international EPR represent both environmental and economic

potential upsides. Although stakeholders in Nigeria stated they had not formally pushed for and demanded change from EU exporting countries in this regard, they firmly showed openness to do so (R13). Moreover, a petition was launched by the authors of UPR to the Nigerian government and the European Commission, which was recently discussed in the 5<sup>th</sup> Circularity Africa Conference in Nigeria (Olayide, E5, 2024).

Looking at the EU space, political willingness and momentum towards CE seemed to be directed rather towards internal policies. Recurring themes were for example the importance of strategic autonomy (R4, R11), particularly relevant for the solar PV industry to increase production in the EU and reduce dependencies on imports. On a similar line, the importance of securing and retaining critical raw materials within the EU was also stressed by stakeholders (R8, R11) as an increasing focus point for EU CE policy. This, according to R8, could decrease incentives toward exports to third countries, although it would do little to prevent illegal activities and exports. Current policies in place, particularly waste-related ones, also did not appear as potential enabling factors, as they do not currently cover reuse products. Revisions of the EU Waste Shipments Regulation, for instance, according to stakeholders do little to affect the policy space related to international EPR for exported products (R11). The theme of reuse within the EU, including of reuse solar PV, was also found to be gaining traction in the EU space. Stakeholders in the PV space stressed the importance of developing clear frameworks and standards for reuse solar PV, complemented by incentives at the national level (R4, R11), something that the EU has been working on, through its Ecodesign Working Plan 2022-24 which included solar PV and the adoption of the ESPR in 2024 (R11). Facing widespread criticisms, especially from environmental NGOs, stakeholders in the EU EPR space also increasingly focused on reuse (Darut and Barczak, E3, 2024). Here, the current focus is on eco-modulation of EPR fees, harmonisation of definitions according to EU legislation, and more generally on the upcoming revision of the WEEE Directive by 2026 (R4, R11).

The revision of the WEEE Directive was a recurring theme identified across interviews with EU stakeholders. R11 provided insights from the EU policy arena, stating how the focus of this upcoming update will surely emphasise the importance of critical raw materials, possibly specifying material-specific quantities to be recovered in the EU. Arguably, however, until the WEEE Directive will allow producers to get reimbursed for quantities of exported products and to deduct these from estimates of total waste generated in the EU, the Directive is likely to still provide little incentives against exports. Solar PV is a particular area of focus for the upcoming WEEE Directive revision, as a separate category is currently being debated (R4), encompassing separate targets and possibly take-back schemes to be implemented (R11). Following the increased discussions on reuse, R11 also stated this revision will be an opportunity to revisit priorities of EPR actors in this regard, agreeing with other stakeholders that throughout the years EPR in the EU has in some cases been steered more towards cost considerations rather than long-term environmental sustainability (R4) (Barczak, E3, 2024). R11 also pointed out, however, that at present it is too early to foresee the direction this revision will take to improve WEEE management and EPR systems in the EU, which highlights how its potential to significantly improve the policy space for international EPR considerations is not to be taken for granted, especially if the focus remains restricted to EPR within the EU.

Although the upcoming WEEE Directive revision could represent an opportunity for African stakeholders to enter the debate – e.g. through public consultations, which will likely take place in 2025 (R11) – other factors remain that restrict the policy space. First, interviews showed low levels of trust between EU and West African stakeholder groups, which is likely to cause resistance to change towards collaboration between exporting and importing countries. Furthermore, dominant voices in the EU policy space, when looking at EPR legislation, primarily come from EU producers and PROs. This is in line with current EU legislation,

although according to some it unfairly restricts voices of other actors involved in or impacted by EU EPR systems, including those coming from third countries (Barczak, E3, 2024). Some stakeholders also criticised the heterogeneous interests of PROs which while carrying out their mandate to enact an environmental policy, also represent the interests of producers – economic by nature – namely to keep costs low to remain competitive. Furthermore, stakeholders argued that until the focus of EPR – and therefore of PROs – remains domestic, performance of EPR schemes will continue to be measured solely in its national dimension, omitting considerations related to leakages. Although several stakeholders agreed on the need to account for broader impacts of EPR policies, this was believed to be hard to change without appropriate legislative changes which for now do not seem to be a priority in the EU policy landscape.

Summing up, discussions about the current policy space between the EU and West African countries showed how on one hand political willingness and momentum towards CE policies is present and increasing. On the other hand, whereas some stakeholders seemed to believe in the potential of EU legislation to increasingly account for its external impacts (R8), many others pointed out factors such as contrasting interests, lack of transparency and trust, differing narratives, and policies already in place in the EU as factors hindering concrete debates on international EPR implementation given the current policy space. In particular, in light of the upcoming WEEE Directive revision, it was found that revising the priorities of EPR schemes, the way they are designed and how responsibilities are assigned, and the voices represented in bargaining and decision-making processes need to be further explored as issues to resolve promptly.

#### **4.4.3 Policy Needs and Implications**

Following discussions with stakeholders regarding critical factors enabling or hindering the advancement of international EPR proposals into more concrete developments, touching upon aspects of administrative burden and policy space, data from stakeholders allowed for policy needs and suggestions to emerge, summarised here according to recurring themes identified in the analysis. These contribute to answering RQ3.

The first identified theme was the need for harmonised criteria and definitions to distinguish UEEE and WEEE, to allocate responsibilities, and to generate and report data on transboundary movements and WEEE management globally. Stakeholders highlighted this need both within the EU (R6, R11) through clearer criteria in the WEEE Directive and common methodologies to report on reuse (R11), and internationally (R5, R8, R14) in the Basel Convention and HS codes utilised in international trade. Some viewed this as a precondition for any effective international action to counter WEEE movements (R6), pushing for harmonised definitions of waste, used products, and EoL management strategies. R5, for instance, envisioned the potential of an international e-waste treaty to align on definitions of not only waste, but also who is considered a producer in EPR schemes, in order to appropriately allocate responsibilities along international value chains, also allowing for alternative approaches such as product stewardship to be discussed (R5). These actions would directly target identified critical aspects related to ambiguities, risks of fraud and opportunism, policy mix frictions and gaps, as well as information asymmetries. Furthermore, room for discussions and alignment offered by a potential e-waste agreement would improve the current policy space where discussions on international EPR are positioned.

Another recurring theme, closely related to definitions of UEEE, is the need for clear standards and a framework for reuse products, including solar PV. Several stakeholders pointed out that a framework for reuse needs to be developed in the EU, accompanied by clear criteria on durability, repairability, reliability and safety (R4). On one hand, this would incentivise reuse in the EU, reducing at least partly incentives to ship abroad and aligning with broader interests of

EU strategic autonomy and critical raw materials supply (R4, R8, R11). At the same time, it would also contribute to reduce ambiguities on the functionality and durability of exported products, hence reducing the risk of waste exports. As pointed out by stakeholders, efforts in this regard are underway in the EU already, through Ecodesign legislation – such as the recently adopted ESPR – and the development of ecodesign requirements for energy-related products (such as solar PV) so far under the Ecodesign Working Plan 2022-24 (R4) to be followed by ESPR requirements in the next few years. Stakeholders also argued for the possibility of establishing take-back schemes for reuse solar PV (R6, R11, R12), given its relatively more business-to-business nature when it comes to reuse, and the fewer quantity of actors involved (R11). Once again, however, a clear standard and framework for reuse was found to be paramount to the implementation of a similar scheme.

The governance of current EPR schemes was another recurring theme, which is connected to reuse but, for most stakeholders, formed part of wider debate on the overall performance of EPR schemes and on how they are designed and run at present. Some stakeholders for instance pointed out the poor performance of EPR schemes in high value retention strategies such as reuse over recycling and linked this poor performance to “flawed governance” structures. Röling (E3, 2024) argued that current EPR schemes do not separate the financial and operational responsibility of PROs from the strategic one, giving them a predominant voice in EPR decision-making. Stakeholders especially from NGOs demanded increased transparency regarding PROs, their operations and their lobbying activities, pointing out how EPR represents a mandate to carry out an environmental policy, not simply a compliance mechanism to cover financially costs of waste generated in the EU (Barczak, E3, 2024). R11 partially confirmed this when discussing how (i) EU legislation allows to deduct quantities of exported products from estimates of waste generated in the EU, potentially providing an incentive for shipments, and (ii) PROs represent the interests of profit-driven businesses whose aim is to keep costs low and sell more, which helps to explain the current situation with regard to reuse in EPR in the EU (R11). R4 also made a similar point arguing that barriers identified for international EPR schemes could be solved by revisiting – through EU legislation – PROs’ business models.

What many stakeholders mentioned as an opportunity for improvement is the upcoming WEEE Directive revision in 2026 (R4, R11). R11, for example, acknowledged the widespread criticisms related to EPR systems’ performance in the EU and mentioned the revision of the WEEE Directive as an opportunity to set priorities and improve the system. R7 from Nigeria also pointed out how EU legislation would need to be adapted to open up opportunities for international EPR discussions. Other stakeholders, however, remained sceptical and referred to the bargaining power of producers as an important barrier to more progressive EPR considerations, including international EPR, reinforcing the status quo. A more inclusive EPR governance was advocated in some discussions, particularly with reference to the inclusion of other voices and other actors into EPR design, target-setting and operations, and more requirements for transparency of PROs. Some even directly proposed requirements on diversity of actors represented in the boards of PROs, to include equal representation of all voices. Others, like Barczak (E3, 2024), argued that EU legislation already mandates a democratic decision-making process for EPR policies and thus stresses the responsibility of governments to ensure it, potentially even setting EPR funds aside to make sure underrepresented parties can partake in discussions. Once again, EU legislation was found to be a potential channel for change, which many hope and believe should not fall victim of political inertia (R8, R11). However, according to R11 it is too early to foresee the developments of the WEEE Directive revision, especially before the public consultation rounds in 2025. In short, respondents indicated how revisiting current EPR legislation and governance in the EU can not only improve its performance and progressiveness but also allow for more actors to get involved and for inclusive solutions to arise. As such, the upcoming revision of the WEEE Directive represents



for many an opportunity to set priorities towards long-term sustainability, thereby reducing incentives to ship abroad, ambiguities related to responsibilities for exported products, and tackling other aspects of imbalances in bargaining and decision-making power, and endowment effects.

Looking specifically at exports and international EPR mechanisms, traceability was found to be the most important aspect in need of improvement according to stakeholders, thus representing another recurring theme across interviews. Even in the presence of clear criteria and frameworks for UEEE and agreed upon definitions, allocating producer responsibility – especially internationally – cannot be done if volumes and destinations of reuse products are unknown or unreliable (R5). Increased checks at customs and port authorities can help in reducing risks of fraud but were found to represent a significant administrative burden and likely expenditure for public authorities (R8). As a result, numerous stakeholders stressed the importance of traceability tools such as DPPs as a prerequisite not only for EPR and its international dimensions but also for CE as a whole looking ahead (R6, R7, R10, R14) (Nobell, E2, 2024). Barczak (E3, 2024) appeared confident that DPPs implementation, following EU legislation efforts such as the recently adopted ESPR, will gradually allow harmonised data to be generated and transferred seamlessly reducing the administrative burden on PROs, waste management agencies and ports and customs authorities, therefore enabling international EPR mechanisms (Thapa, E3, 2024). Strictly linked to traceability of products, however, transparency of transferred funds in an international EPR scheme would need to be ensured. DPPs can assist in transferring and reporting data and therefore to allocate responsibilities, but some stakeholders also pointed out the possibility of having third parties overlooking EPR funds in the EU as well as in receiving countries (Thapa, E4, 2024), to make sure they serve their purpose according to EPR legislation. Measures towards increased transparency and traceability of exported products were found to be of paramount importance for international EPR considerations, as they have potential to reduce administrative burden, ambiguities and risks of fraud, as well as corruption and private monitoring costs. Furthermore, more accurate data can be generated as well.

Supporting policies in receiving countries were also highlighted as crucial. First, the inclusion of the informal sector in existing and new EPR systems was stressed as crucial to tap into their expertise, allow them to shape and benefit from EPR programs, making sure these do not have socially unsustainable pitfalls (R9). Increased implementation and enforcement of EPR policies was found to be crucial to enable transparency (Masolia, E2, 2024), improving data reporting between exporting and importing countries (R5) and allowing international solutions to be discussed (R6). However, as R9 pointed out, ensuring EPR systems run smoothly – including their relationship and inclusion of informal actors – at the domestic level should be a precondition to international EPR considerations. Measures and supporting policies in receiving countries were found critical in targeting critical institutional aspects of trust, risk of opportunism, corruption, and political inertia. Increasing experience with EPR programs and aligning between exporting and importing countries was also highlighted as an important enabler for international EPR discussions (R6). Explicit efforts to decrease political inertia in West Africa came especially from Nigeria, where a petition for the establishment of a UPR scheme between the former and the EU was published in 2023 and is set to be further discussed in 2024 (R2) (Olayide and Thapa, E5, 2024).

In conclusion, discussions with stakeholders allowed different policy needs and implications to emerge. Suggestions were aimed at tackling the current institutional aspects hindering the feasibility of international EPR policies, but also exceeded this area and touched upon broader aspects of EPR domestic performance and democratic governance. Overall, recurring themes were the need to harmonise criteria and definitions on used products and waste, develop clear

standards for reuse products, revisit the governance model and incentives in current EPR schemes – including via the next WEEE Directive revision – improve traceability of products to generate data and allocate responsibilities, as well as to enact supporting policies in receiving countries, especially aimed at including the informal sector as an integral part of EPR systems without which international EPR schemes would not be able to reach their ultimate outcomes. All these aspects target different critical institutional aspects from different angles and represent therefore important action points to tackle in order for international EPR to gain traction in the current policy space, and for it to become institutionally feasible in the future.

## 5 Discussion

This study found that the institutional feasibility of international EPR policies between the EU and a West African country like Nigeria or Ghana is currently limited primarily by the existing policy space, including current policies in place, dominant narratives, and competing interests. This chapter reflects on the results by relating them to previous knowledge, highlighting this study's contribution (5.1). Additionally, it also discusses the implications and limitations of the methodological choices and the framework applied to answer the RQs (5.2). Overall, the findings fit into and add to previous research by offering new insights into governance implications and institutional aspects influencing the current debate on international EPR. Finally, the limited generalisability of findings outside of the EU and Nigeria/Ghana is balanced by providing a framework for investigation of other policies and other contexts.

### 5.1 Findings in the Context of prior Knowledge and Theory

Comparing the key findings of this study with previous research and knowledge is challenging, given the lack of prior exploration of governance aspects of international EPR and the niche nature of the research topic itself. However, the results of this study position themselves into wider debates identified in the literature review that are worth re-exploring after the analysis and in light of the results, to highlight what can be positively learned from this study.

#### 5.1.1 Findings and Reviewed Literature

This thesis departed from a research gap identified in different proposals of international EPR policies and schemes for different product groups. Governance aspects of international EPR were found to be underexplored, and a lack of feasibility analyses was identified and later confirmed by expert interviews. This work advanced knowledge in this regard by discussing with stakeholders aspects of governance and institutional feasibility, as well as policy needs. The findings did not aim to be a comprehensive account or analysis, but rather capture diverse views to move forward the overall understanding of a topic that so far has remained theoretical (Brown et al., 2023). After a conceptual contribution in **RQ1** in the form of an intervention theory outlining the necessary steps for international EPR measures to achieve their ultimate outcomes, **RQ2** represented the core of this research, providing governance considerations according to stakeholders, as well as institutional constraints and moderating factors, and can be regarded as the primary academic contribution to knowledge on international EPR.

Findings on governance structures for potential international EPR schemes (**RQ2a**) did not reach a definitive conclusion but rather shed light on the approaches preferred by stakeholders, before discussing with them aspects related to institutional feasibility. This study showed how written proposals, experts and stakeholders tended to agree on the centrality of the EU as a regulator, not only as an implementing organisation of potential measures but also in furthering collaboration efforts with African countries. This is in line with previous research on transboundary movements of used products and waste focusing on Africa (Basel Action Network, 2019), as well as more specific literature arguing for the potential of international collaborations for EoL management of solar PV in West Africa (Ndzibah et al., 2022). Alternative approaches were also discussed, which can be traced back to literature on solar PV (Strupeit & Tojo, 2023) as well as recent studies on EPR and its international dimensions which mentioned voluntary programs (Brown et al., 2023). International organisations, platform and fora were mainly mentioned as conveners for facilitating dialogue and alignment, to be followed up by regional action. This can be found in literature as well, where dialogue through platforms such as the Global Alliance on Circular Economy and Resource Efficiency (GACERE) within UNEP was encouraged (Arbinolo, 2023). In line with the exploratory approach of this research, findings did not reach a definitive answer, but they strengthened an already existing call to action towards EU policymakers and laid the groundwork for subsequent analysis.

The critical institutional aspects (CIAs) and other moderating factors (M1-M7) identified in **RQ2b** to perform the evaluation connect with and advance previous literature. Aspects of traceability, information asymmetries, complexity and dispersion of responsibilities, ambiguities and policy gaps, endowment effects and bargaining power imbalances, among others, can all be traced back to different literature both related to international EPR proposals (Arya & Bhutani, 2023; Brown et al., 2023) and more broadly to transboundary movements of products and waste (Basel Action Network, 2019), and international dimensions of EU policies for CE (Reichstadt et al., 2023). What this study did, however, was to analyse how stakeholders consider these factors as hindering or enabling the feasibility of international EPR, thus contextualising these factors between the EU and West Africa and uncovering the role they play in shaping the administrative burden arising from potential international EPR policies and the policy space in which these are currently positioned (the two evaluation sub-criteria).

Evaluating results demonstrated how the current institutional feasibility of international EPR between the EU and Nigeria and Ghana is limited by a restricted policy space and likely significant administrative burdens in implementation and enforcement. On a wider theoretical level, the analysis conducted in this study and the findings confirmed previous research and theory in the field of institutional analysis, evidencing how institutional aspects and their magnitude can shape concrete possibilities for policymaking (Polski & Ostrom, 1999; Theesfeld et al., 2010). This was also found in the concept portrayed by Scoones et al. (2006), in that characteristics of a policy space can significantly limit the room for manoeuvre in which a policy can be discussed and potentially brought to reality. This contributes to justify the theoretical choices made to achieve the research objective, while at the same time moving forward the overall understanding of how integrating institutional aspects into evaluations of policy proposals can shed light on their feasibility. Consequently, further research focusing on institutional factors shaping possibilities for progressive and inclusive public policies is warranted.

Following the evaluation, this study discussed policy needs and implications in **RQ3**, which represent the more practical contribution of this thesis. Apart from their practical relevance, however, these findings also contribute to several discourses highlighted in the introduction of this study and in the literature review. First, a key aspect emerged in this study was the need for increased traceability of exported products. Whereas most literature only mentioned this as a barrier to data generation on transboundary movements (Baldé et al., 2020; Habib et al., 2022; Huisman et al., 2015), this study found it to be crucial, if not a prerequisite, for international EPR policies to gain feasibility. Tools like DPPs and their increased application would significantly reduce the administrative burden posed on ports and customs, as well as ease transfers of data and funds. Although literature showed efforts at the EU level to develop and implement DPPs for solar PV (CIRCUSOL, 2023), while this research was being conducted the EU adopted its ESPR (European Commission, 2024) – foreseeing the implementation of DPPs – for a variety of products but excluding solar PV and other energy-related products from its priority products for which ESPR requirements will be developed first (European Parliament, 2024). This study therefore joins other evidence for the urgent need of similar measures for solar PV and energy-related products. Other crucial policy needs identified which connect to previous research are harmonised standards and definitions both in the EU and internationally to distinguish between UEEE and WEEE. Similarly to traceability issues, this was mentioned across reviewed literature as an obstacle to data generation (Arya & Bhutani, 2023; van der Heide et al., 2022; Yamaguchi, 2021), however this study showed its impact on the current feasibility of international EPR, and how alignments of definitions and standards could highly benefit international action countering e-waste, including international EPR considerations. Looking at solar PV specifically, a standard for reuse solar PV was also identified as a need by previous research (Christiansen, 2021), both to incentivise reuse in the EU, and to reduce

ambiguities in exports outside of the EU. This study also showed how stakeholders would be open to piloting take-back schemes for exports, something that could be done under voluntary agreements as suggested by Strupeit and Tojo (2023).

Looking at importing countries, policy needs revolved around EPR policies and the informal sector. Previous research highlighted the importance of EPR policies as well as supporting measures directed towards informal actors engaged in waste management (Arya & Bhutani, 2023; Kabir et al., 2023; Magalini et al., 2019; Talbott et al., 2022; Taqi Ghulam & Abushammala, 2023). Findings confirm the importance of aligning EPR systems to the experience of informal actors beyond isolated initiatives, granting legal and participatory rights to informal workers. Moreover, this study found that whereas EPR policies can certainly be instrumental in enhancing EoL management in developing countries, confirming findings from (Kabir et al., 2023), it is important not to blindly transpose EU policy principles to different geographies without adapting them to the local context, including for EPR. For instance, this study highlighted the importance of including more actors in the design and implementation of new EPR policies. This is in line with previous findings from Thapa et al. (2023) which suggested how international EPR could be fulfilled in different ways, leaving it to stakeholders in receiving countries to choose how to structure their systems, through EPR (as in Nigeria) or other forms (as in Ghana). Findings also showed how overcoming political inertia is crucial, referring to initiatives such as the UPR petition launched by Thapa et al. (2023), to push exporting countries and the EU to at least recognise and start measuring external impacts of their CE policies to enable debates about resource transfers and similar measures.

### **5.1.2 Contribution to wider Discourses**

The discussion so far presented several ways in which findings of this study relate to previous literature. Findings on institutional feasibility and policy needs and implications, however, also contributed to wider debates on the role of EPR internationally and domestically and how EU CE policies account for their impacts outside of the EU.

A central discourse to which this thesis as a whole contributed is about the role of EPR itself and its governance in an increasingly international circular economy, and how producer responsibility should “circulate” accordingly. This study confirmed several shortcomings of current EPR policies in accounting for exported products identified in literature, suggesting the presence of an incentive to ship products abroad according to EU legislation. From this, the discussion expanded and fed into a wider fundamental discourse on what EPR should achieve and incentivise, whether it should entail responsibilities until a certain geographical border or until a product’s ultimate EoL. EU legislation and stakeholder views did not offer a consistent view on this issue. EPR was already found to be object of critique in the literature regarding the activities and performance of PROs, the producers’ interests they serve and their mandate under EU and national laws. This study did not seek definitive answers on this, but findings suggest PROs’ business model could be further steered towards long-term sustainability rather than short-term cost minimisation.

Findings showed how the WEEE Directive revision in 2026 could represent an opportunity to revisit current EPR schemes in the EU, including the incentives faced by PROs, requirements and distinctions between UEEE and WEEE, as well as to include more actors in decision-making processes. These aspects partially reflect previous research on EU policy and current EPR systems (Arya & Bhutani, 2023; Basel Action Network, 2019; Röling & Darut, 2023). Some interviewees argued that this revision could also represent a window of opportunity for receiving countries to demand change through formal requests focusing on WEEE and UPR, something that was suggested in literature as well (Thapa et al., 2023). However, findings show it is still too early to say which direction the revision will take, especially considering the upcoming EU

elections in 2024 and further public consultation rounds in 2025. As such, offering provisions towards the WEEE Directive revision is arguably more speculative compared to empirical findings on feasibility and EU policy gaps.

There is a nexus to be drawn between expressed criticisms towards EU EPR schemes, both domestically and internationally, in past research as in this research's findings, and the original definition of EPR as conceptualised by Lindhqvist (2000), one entailing an entire life cycle approach to products, which current EU legislation does not seem to pursue successfully now that CE is an increasingly global reality. This is linked domestically to criticisms related to reuse and how it is (not) sufficiently incentivised by EPR systems (Campbell-Johnston, 2021; Right to Repair Europe et al., 2024; Röling & Darut, 2023; RREUSE, 2024), especially for products like solar PV where a framework for reuse is not present and much focus has been on recycling (Tsanakas et al., 2020), and internationally to the lack of measures to prevent leakages from EPR systems impacting third countries (Arya & Bhutani, 2023; Basel Action Network, 2019), which has its origin in EU legislation, as this study confirmed.

These considerations directly feed into the wider discourse of EU CE policies, their impact on third countries, and the kind of CE policymakers in the EU aim to achieve. This study was not centred on this but showed that current EU legislation does not adequately consider its potential impact outside of EU jurisdiction, disregarding aspects of anticipation, inclusion and reflexivity (Purvis et al., 2023), and confirming previous findings from Reichstadt et al. (2023) and critiques from Calisto Friant et al. (2020) on the lack of social considerations in CE policies, as well as externalities and burden shifting towards the global south resulting from EU policy gaps (Cotta, 2020). Positioned in this wider context, this study's findings complement previous research and urge EU policymakers and official bodies to increase efforts to expand the scope of their impact assessments and ex-post evaluations, with subsequently more concrete efforts on current and upcoming policies, including via open dialogues with third countries affected by EU CE policies.

Ultimately, the dilemma at the heart of this study lies in the multiple dimensions of CE and which of these are truly considered in policymaking when this is said to be pushing for a CE transition. While this thesis does not address this issue directly, acknowledging this is crucial to interpret findings and conclusions drawn from it, particularly for the identified policy needs and implications looking ahead. A just transition to a circular economy in the EU and beyond is not one that narrowly focuses on isolated geographies or impacts. As such, integrating aspects of equity and justice into policies for a circular economy transition is essential.

## **5.2 Implications and Limitations of Methodology**

The methodology and frameworks applied to answer the RQs in this thesis have implications for the results of this work and how these were generated. It is thus appropriate and useful to reflect on the use of the chosen frameworks, the methods applied to collect and analyse data, and the scope of the RQs in light of the findings.

### **5.2.1 Ex-ante Policy Analysis and Intervention Theory**

This research utilised an ex-ante intervention theory as part of its analytical framework, not only to uncover the intended impact mechanisms of different international EPR proposals but also to inform interviews and add structure to the rest of the analysis, focused on preconditions and moderating factors within the intervention theory. Overall, this framework proved highly conducive to achieving the research aim. In the scientific field, ex-ante policy analysis and the use of intervention theory is subject to controversy in academic and scientific debates. Some criticise the inherent uncertainties and oversimplifications of ex-ante intervention theories (van der Knaap, 2004), while others see intervention theory as a useful tool to identify the

preconditions for the implementation and effectiveness of a policy (Mickwitz et al., 2021). In this study, starting from general principles and ultimate outcomes derived from literature helped to avoid prematurely narrowing down on specific mechanisms or assumptions. Utilising expert interviews as well as literature to construct the intervention theory made the approach more robust. Furthermore, using stakeholder interviews to refine the intervention theory, assess critical institutional aspects and identify other moderating factors was instrumental in generating meaningful insights from the intervention theory, integrated into a wider analytical framework. There is merit to this stakeholder approach (Vedung, 2017) to intervention theory, as stakeholders typically have diverging views on how a policy is expected to work (Mickwitz et al., 2021).

This thesis argues in favour of the application of intervention theory to uncover the underlying logic and intended impact mechanisms of a policy before its implementation, in line with Mickwitz et al. (2021) and Linnér et al. (2012). Moreover, it also found the use of moderators particularly instrumental to proactively search for contextual factors affecting links in the intervention, as well as in reducing the linearity inherent in intervention theory frameworks (Donaldson, 2001; Mickwitz, 2003). Given the lack of literature on international EPR mechanisms, and the fact that moderators were derived exclusively from interview and event data coded through CIAs, this study could be limited in that further moderating factors which did not emerge from the data remained underexplored. However, this was justified by the non-exhaustive aim of this study, instead focusing on stakeholder views on institutional factors relevant according to their experience and position, in a constructivist approach. Overall, this is in line with methodological considerations from previous research in policy evaluation (Coryn et al., 2011; McConnell, 2019; Mickwitz et al., 2021), which corroborates this approach focused on fundamental mechanisms and identification of critical factors instead of quantification of links and impacts. In sum, the analytical framework incorporating intervention theory and institutional analysis proved appropriate to this research and highly flexible. The framework and exploratory approach utilised in this thesis can be replicated for similar analyses in other contexts or research efforts on the institutional feasibility of other policies in similar “proposal” stages to be evaluated ex-ante. It would also be adaptable to different nuances of institutional feasibility, e.g. different sub-criteria other than administrative burden and policy space.

### **5.2.2 Data Sources and Methodology**

This study followed an exploratory approach and qualitative design. The focus on expert and stakeholder views meant interviews were used to collect data to build and refine the intervention theory, and a purposive sampling strategy was applied to recruit respondents, aiming at capturing insights along the value chain and in policy. Overall, the unstructured and semi-structured nature of the expert and stakeholder interviews respectively was found to be appropriate for the exploratory approach pursued. The internal validity of findings would have benefited from a larger sample of interviewees, reducing the impact of potential individual biases (Verschuren, 2003). However, significant data saturation was reached during the final interviews, and the overlap between interview data and literature increased the confidence in the intermediate and final results. In retrospect, carrying out focus group discussions with participants instead of – or alongside – individual interviews would have provided further insights into diverging views of stakeholders and reduced potential strategic behaviours during individual interviews (Vedung, 2017). Participation in events/discussions partly served this purpose, as it was useful in observing discussions among participating stakeholders. It was also useful to represent a stakeholder group, that of NGOs and civil society, which was not part of the value chain and policy interview sample, and to ensure triangulation of interview data (Mickwitz, 2003).

As the thematic analysis of interview data departed from selected critical institutional aspects (CIAs) from Schleyer et al. (2006), it could be argued that the analysis could have covered single CIAs more in detail, for instance by discussing them explicitly during interviews to generate findings specific to each of them. However, this approach was not followed for two reasons. First, the research topic was subject to the limitations of a niche emerging topic that most stakeholders were only starting to explore and needed to be familiarised with before expressing views from their perspective. As such, at this stage it was unlikely that interviewees would be sufficiently familiar with international EPR policies – which are not formed yet – to provide insights specific to specific CIAs. Second, such an approach would have made interviews significantly more structured – which would have played against the exploratory approach of this study – and run the risk of asking guiding questions to interviewees, something which I paid special attention to in developing the interview guide and conducting interviews. Moreover, maintaining this degree of flexibility allowed to move seamlessly from the identification of CIAs to policy needs and implications, both for the interviewees and for myself when presenting the findings.

### **5.2.3 Scope and Research Questions**

The scope of this study was geographically limited to the EU and West Africa. Moreover, it focused on solar PV, a peculiar category of EEE, exported for reuse, and had a policy focus on the role of EU EPR schemes in addressing the multiple cycles of products exported for reuse from the EU to West African countries, until their EoL. The legitimacy of this scope and the defined RQs require further elaboration a posteriori with respect to findings.

Treating the EU as a single entity was a deliberate choice to focus on EU policy and the way this sets out producer responsibility within and outside EU territory. Whereas this could be seen as an oversimplification, as it does not account for differences in implementation of EPR across EU countries, it was observed to be in line with previous research focusing on the impact of EU policies on third countries and on the international dimensions of EPR (Arya & Bhutani, 2023; Basel Action Network, 2019; Reichstadt et al., 2023). Moreover, this focus allowed for wider insights on the EU policy landscape and outlook to emerge during interviews. Aspects related to national politics, in Nigeria and Ghana as in EU countries, were not covered in depth, a decision taken since the start which proved useful to prioritise – as intended – insights on policy design, governance, and analysis of different critical institutional factors not only in policy but also along the value chain. Results are not easily generalisable outside of the given scope, as research was conducted interviewing stakeholders in the EU and in Nigeria and Ghana on their experience in their contexts. As previously mentioned, however, this research can be replicated in other contexts as well.

The product focus on solar PV was extensively justified in the literature review. However, several interviews produced insights applicable more broadly to electronic products. Occasional difficulties in keeping the discussion specific to solar PV, however, were not seen as a limitation since insights on EEE were applicable to solar PV as well, and characteristics specific to solar PV (such as its longer lifespan, the smaller number of actors in the value chain, falling outside of the scope of the current EU EPR) were still extensively discussed and integrated into the analysis whenever possible. On the contrary, the relevance of insights generated was augmented by their broader applicability to EEE and e-waste more broadly. Moreover, the overall analysis gradually steered towards the role of EPR itself as a policy and how it is implemented in the EU in the first place (under the WEEE Directive), highlighting fundamental issues to be resolved before arguably any form of international EPR can be institutionalised. Although this exceeded the expected scope of the defined RQs, which in retrospect could have been formulated to partly account for this, it contributed to move forward the understanding of EPR as a policy more broadly, as well as in an international context.



Overall, RQs were satisfactorily answered, complementing each other sequentially as it was originally envisioned. RQ1 intended to uncover the impact mechanisms of international EPR proposals. Although it did not directly contribute to the research problem and did not centre around stakeholder views, it represented a necessary step for the analysis of the preconditions for institutional feasibility. As this RQ was answered mainly from literature data complemented by expert interviews, it can be argued that it could have been covered at least partially in the literature review. However, constructing the intervention theory as an intermediate result and a necessary step for the subsequent RQs ensured the legitimacy of this step within the overall research process. RQ2 and its two sub-questions represented the core of the research objective and represent the main academic contribution of this thesis. Compared to other RQs, RQ2a was less comprehensively answered, as insights from stakeholders on governance structures were not sufficiently cohesive, given the theoretical nature of analysed proposals. Research gaps related to single governance configurations, including alternative measures mentioned by stakeholders, could be further and better explored individually. RQ2b, on the contrary, provided in-depth insights into the critical institutional aspects representing preconditions for institutional feasibility, and succeeded in identifying moderating factors to refine the intervention theory and inform the evaluation. It also allowed the overall discussion to expand and connect to wider relevant themes brought up in this discussion. Following the analysis, RQ3 was answered by identifying policy needs and implications from stakeholder views, which ensured the practical aim of this research was achieved alongside the academic one.

## 6 Conclusions

This thesis addressed a research problem originating in transboundary movements of UEEE between the EU and West Africa, focusing on solar PV. It explored the role of EPR policies in preventing that waste management burdens are shifted to importing countries without transfers of EPR resources to take care of the exported volumes at EoL. Proposals for international action, including extensions of current EPR schemes internationally, were identified, but a research gap was found in governance considerations and feasibility analyses of such proposals.

After studying the intended impact mechanisms of different “international EPR” proposals through literature and expert views, discussions with stakeholders on governance aspects were carried out and stakeholder views were collected and analysed thematically to uncover the critical institutional aspects restricting or expanding possibilities for international EPR concrete dialogues and action. This allowed to assess the current institutional feasibility of international EPR according to criteria of administrative burden and policy space. Subsequently, stakeholder views also provided policy needs and implications. Combined, these represent the empirical and practical contribution of this thesis. Moreover, methodological conclusions can be drawn from the analytical framework and methods applied, and future research avenues can be outlined.

### 6.1 Empirical Conclusions

This study achieved its overarching research aim to investigate the institutional feasibility of international EPR for reuse exports between the EU and West Africa, focusing on solar PV. Empirical conclusions are reported here following and answering the defined RQs.

***RQ1** – What are the intended impact mechanisms of proposed international EPR schemes?*

Proposals of international EPR schemes primarily target PROs and national authorities, envisioning as main output a resource/fee transfer system or a joint EPR fund coordinated at EU or international level. Other necessary outputs include harmonised standards and definitions of used products and waste, increased checks at export borders, and involvement of other actors in EPR decision-making. Outcomes of increased data generation on transboundary movements and resource transfers to receiving countries would be achieved. A decrease in illegal exports and investments in recycling infrastructure in importing countries are consequently envisioned, ultimately reducing the waste burden shifted to receiving countries.

***RQ2** – How can an international EPR scheme be designed for solar PV?*

The institutional feasibility of international EPR measures for reuse solar PV is currently limited. Necessary outputs would entail high administrative burdens, and the current policy space in the EU restricts possibilities for concrete developments. Nevertheless, upcoming and further policy and industry efforts in ecodesign, traceability of products, standards for reuse and EPR governance could reduce administrative burdens and improve space for dialogue and action.

***RQ2a** – How would stakeholders in policy and along the value chain set it up?*

Stakeholder views on international EPR governance were varied. Overall, a regional approach between EU-West Africa emerged as preferable. This could take form in a resource transfer between EPR systems, or in a joint EPR fund. These options necessarily entail agreeing on harmonised definitions and standards for products and producer responsibility, as well as increased efforts in transboundary movements traceability and transparency of funds transferred. Bilateral cooperation efforts between countries were also envisioned, but risks of geographical leakage were pointed out. Finally, voluntary measures such as take-back pilot schemes and waste offsetting programs were discussed as additional options.

***RQ2b – What institutional aspects and contextual factors enable or limit the current feasibility of international EPR for reuse solar PV?***

Several factors were found to affect the institutional feasibility of international EPR measures. The intervention theory aided in positioning identified factors either before the intervention itself (critical institutional factors) or within the intervention theory (moderators). Critical institutional factors broadly encompassed cost factors, political factors, and policies in place. Cost factors included information asymmetries, dispersion of responsibilities, and administrative and private costs. Political factors included administrative inertia, corruption, political continuity, and policy mix frictions. Current EPR policies showed ambiguous responsibilities, policy gaps, risks of opportunism, heterogeneous interests as well as bargaining and decision-making power imbalances and endowment effects. Moderators were mainly related to traceability and illegal exports, incentives to ship for reuse, and supporting policies in EU and West Africa. Traceability issues e.g. lacks of data, insufficient checks of exports and fraud were recurring factors potentially affecting international EPR mechanisms such as allocation of responsibilities. Incentives to ship were linked to demand and supply of reuse PV, as well as incentives to reuse in the EU and policy loopholes. Supporting policies included ecodesign and traceability measures as well as reuse incentives under EPR in the EU, and measures to ensure informal actors can benefit from EPR schemes in receiving countries.

***RQ3 – What are the policy implications and needs in sending countries and receiving countries contexts?***

Policy needs were identified along the recurring themes of harmonisation of criteria and standards to distinguish reuse products from waste, governance of current EPR schemes in the EU, traceability of products, and policies supporting the informal sector in receiving countries. Agreeing on common terms and definitions on WEEE in the EU and globally was seen as crucial to enable international action, allocating responsibilities, and generate data, thus reducing ambiguities, risks of opportunism, policy mix frictions and gaps and information asymmetries. A standard for reuse solar PV is also needed, to incentivise reuse in the EU and reduce risks of waste exports. Restructuring EPR towards reuse and including more actors in decision-making, including via a revision of the WEEE Directive, can enlarge the policy space by tackling aspects of power imbalances, endowment effects, and reducing ambiguities related to exports. Traceability improvements, e.g. via DPPs, are needed to reduce administrative burden for monitoring, reduce ambiguities and risks of fraud, and to aid data generation and transfers. Finally, supporting policies in receiving countries are needed, to make sure the informal sector is able to benefit from and contribute to EPR systems. Altogether, these policy implications highlight important action points that would aid international EPR considerations to gain institutional feasibility. As such, they form the basis for this thesis' policy recommendations.

## **6.2 Recommendations for Policymakers and Practitioners**

This thesis' findings have important practical implications primarily directed to policymakers in Nigeria, Ghana, and the EU. Findings show that CE policies require holistic and global approaches that do not remain stuck in narrow perspectives or in isolated geographies but take into account the full impact of policies and economic activities. EU CE policies do not sufficiently include aspects of anticipation, inclusion, reflexivity, and responsiveness. Careful assessment, design and implementation to avoid social and environmental externalities is needed, and thorough consideration of effects outside the policies' jurisdiction is crucial. To this aim, international EPR proposals represent a way forward, but measures are necessary to enable effective and inclusive developments.

Policymakers in the EU should uphold the pillar of the EU Green Deal not to leave anyone behind, by starting to assess the impact of CE policies beyond the EU and studying measures to minimise externalities. Resource transfers like those envisioned in international EPR are advised, but supporting measures are needed. Traceability of products must be improved, and

the adopted ESPR makes a relevant contribution to this via tools like DPPs. However, policymakers should work to promptly include energy-related products like solar PV – that represent significant portions of EU exports to West Africa – in the scope of ESPR Working Plans. Definitions and protocols to distinguish between used products and waste should be improved and harmonised, including via international efforts. Standards for reuse solar PV should be developed, and industry initiatives encouraged. On a deeper level, EPR policies need to be adapted to an international reality of CE. The aim and priorities of EPR need to be revisited to improve reuse domestically and account for international resource loops currently not captured. This calls for the strategic responsibility for EPR to be revised, including more actors in decision-making processes, for instance through the next WEEE Directive revision.

Policymakers in receiving countries like Nigeria and Ghana should firstly increase efforts in WEEE management, including, but not exclusively, through EPR schemes. Supporting policies are crucial to ensure that informal workers can benefit from EPR instead of being impacted negatively. Policymakers and practitioners should also engage in formal discussions, for instance through international fora, with their EU counterparts. GACERE and other UN platforms represent opportunities for dialogue on how to counter WEEE globally. If international EPR is pursued, it needs to be advocated for not only by NGOs and academia but also from importing countries. The petition for UPR directed to the EU Commission and the Nigerian government represents a first necessary step towards international action.

### **6.3 Methodological Conclusions**

The methodological and analytical choices were conducive to achieving the objectives of this research. Applying intervention theory for the ex-ante investigation of this work revealed how flexible and versatile this tool can be when applied to policy in their proposal stage. Furthermore, it showcased how it can be combined with stakeholder views, e.g. through semi-structured interviews, to make the intervention theory responsive, and complemented by insights from different disciplines such as institutional analysis. The selective application of elements instrumental to the analysis instead of a complete policy evaluation proved well suited to highlight important factors while remaining within scope. This represents the main methodological contribution of this work since the defined analytical framework can easily be adapted to different enquiries on early-stage institutional feasibility of policy proposals.

### **6.4 Recommendations for Future Research**

This thesis laid the foundation for future research on governance aspects of international EPR, expanding on generated findings. It also highlighted the versatility of the defined analytical framework. Future exploratory research could utilise a similar framework to assess institutional factors shaping the feasibility of progressive and inclusive policy proposals, allowing to gauge initial opinions and reactions from stakeholders. For international EPR, avenues for further research are varied, given the emerging topic. Looking at the existing policy space, a discourse analysis focused on power dynamics among stakeholders involved in EPR and global value chains, in solar PV or other products, within the context of international EPR could be an insightful topic, as frictions and references to power imbalances emerged from this research. Analyses of specific critical institutional aspects (CIAs) more in depth would also provide relevant insights. Further research in co-creation with local stakeholders focused on policy needs for EPR schemes, in particular including the voices of the informal sector, is also needed. Research looking at transboundary movements of reuse products could also generate more accurate data, and further investigation is needed in the role DPPs could play in global value chains for reuse products. Similarly, assessments of the impact that exported products and waste have on importing countries, their EPR systems and their informal sector would also aid in strengthening future concrete proposals and efforts towards international action.

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## Appendix I: Interview Guide and Consent Form

Interviews with stakeholders were semi-structured and took 30-45 minutes. All interviews were conducted online. The types of information elicited mainly included experiences, reflections, reactions, opinions, and feedback. General questions were asked to all stakeholders, occasionally adjusted to their role/organisation/sector. Specific questions were differentiated according to the type of stakeholder interviewed.

### Interview Guide

#### General questions:

- *Introduction of research project, topic, research problem and reminder of participant's rights*
- What is your role in your organisation? What do you focus on?
- What is your organisation's current role in extended producer responsibility (EPR) schemes and/or waste management in your country or in the countries you operate in? What other actors do you collaborate with nationally and internationally?
- What is your organisation/sector's current consideration of transboundary movements of UEEE/WEEE and/or solar PV for reuse in particular?
  - o (What risks do you think these movements pose to circular economy both at the national and international level?)
  - o How is your organisation/sector currently impacted by and/or dealing with this phenomenon?
  - o (What do you think should be done to manage them? Any particular approaches you think would be appropriate?)
- Are you familiar with existing proposals of international EPR schemes and similar schemes allowing for transfers of fees along with exported products? (For electronics, textiles, plastics...)
- What are the reactions in your sector/organisation to the proposal of an international EPR scheme for reuse solar PV or more broadly for UEEE/WEEE that would allow for EPR fees to follow exported products to their destination?
  - o How would you envision such a scheme practically? (International agreement for global EPR and monitoring? EU policy e.g. WEEE Directive revision and collaboration with African countries? Bilateral agreements EU country-African country? Private sector initiative?...)
  - o (Any alternative you see as preferable instead?)
  - o What would be the role of your sector/organisation? How would it differ from your current responsibilities?
  - o How would such a scheme fit into the policy mix of the country/countries you operate in? Do you see any (in)compatibilities with current or upcoming national or regional policies?
- What institutional/political/governance factors in your opinion can currently enable or hinder such an extension of EPR schemes for reuse solar PV?
  - o What opportunities do you see along the value chain? (Any stakeholder group that in your opinion is willing and has resources to administer this change?)

- What barriers, risks or uncertainties do you see along the value chain? (Any stakeholder group that in your opinion is not willing or does not have resources to administer this change?)
- (Do you have other relevant contacts that you can share or connect me with?)
- *Additional considerations and final remarks*

### **Industry (EU)**

- How is the solar PV industry currently dealing with risks down the value chain?
  - Reputational risks?
  - Is there any data on solar PV exported for reuse out of the EU?
- What are the reactions in your sector to the idea of an international EPR scheme for solar PV exported for reuse?
  - What role would producers play?
  - What role should policy play?
- How do you see new technologies for traceability such as digital product passports (DPPs) playing a role in this in the future?

### **Policy (EU/Africa)**

- How do you see reuse solar PV playing a role in your country's renewable energy transition?
- (Has Nigeria/Ghana had any interaction with the EU on this?)
- What can you tell me about relevant current or upcoming EU policies and their impact from and on transboundary movements of UEEE/WEEE? (In particular, how does the WEEE Directive regulate them?)
- How would international EPR fit into the EU policy mix?
- What policy changes would be needed to set up and implement an international EPR scheme for solar PV or more broadly for UEEE/WEEE between the EU and Africa?
- What is the current institutional capacity and willingness to make those changes?
- How are upcoming policies or revisions of current policies likely to affect the feasibility of an international EPR scheme for solar PV or more broadly for UEEE/WEEE?
  - How do you see the upcoming revision of the WEEE Directive impacting this? In what direction are we currently moving?
- (How do you see digital product passports playing a role in this in the future?)

### **PROs (EU/Africa)**

- *Local context information*
- (Do you handle solar PV specifically?)
- Do you collect any data or have estimates on solar PV or more broadly UEEE exported/imported for reuse?

- What can you say about the fees paid by EU producers for those products that get exported for reuse? (Does it go back to producers, invested into next year's budget etc...)
  - o (Do you have any control over it?)
- What is your reaction to the idea of an international EPR scheme that would require PROs in different countries to exchange information/data on exported/imported products?
  - o (How do you see new technologies for traceability such as digital product passports playing a role in this in the future? How will they impact your work?)
- Do you as a PRO currently interact or work with the informal sector? In what ways?

### **Port Authorities (EU/Africa)**

- *Local context information*
- Do you collect any data on solar PV or more broadly UEEE exported for reuse?
- What is your current capacity and resources to perform tests and checks of UEEE exported for reuse?
- How do you currently deal with illegal shipments and fraud?
- What is your reaction to the idea of an international EPR scheme between EU countries and a West African country that would require exporting and importing ports to exchange information on exported/imported products?
  - o How do you see new technologies for traceability such as digital product passports (DPPs) play a role in this in the future? How will they impact your work?

### **Recyclers and Informal Sector (Africa)**

- *Local context information*
- Do you also handle and recycle solar PV waste? (If not, do you know anyone who does?)
- What are your current challenges as a downstream actor? How are you impacted by reuse products or waste coming from abroad?
- (How do you see new technologies for traceability such as digital product passports playing a role in this and impacting your work in the future?)
- Do you as a formal recycler currently interact or work with the informal sector? In what ways?

### INTERVIEW CONSENT FORM

This form is to ensure that you have been given information about the research project and to give you an opportunity to confirm that you are willing to take part in this research. For all activities below, please indicate (with an X) which ones apply to you:

	I have been <b>familiarised</b> with the research project, I have had the possibility to ask questions and I have received satisfactory answers to my questions.
	As a research participant, I am aware of my <b>right to withdraw participation</b> at any time.
	I give my consent that the <b>content of my interview can be audio-recorded.</b>
	I give my consent that the <b>content of my interview can be transcribed, analysed and cited</b> in research outputs for the project.
	I give my consent to <b>be identified by my position in my organisation</b>
	I give my consent to <b>be identified by my organisation</b>
	I give my consent to <b>be identified as:</b>
	I understand that the results of the research will be presented so that <b>no information can be traced to me personally</b> , except if I choose to be identified with my name.

**Note:** Your participation is voluntary. As an interviewee, you do not have to answer all the questions asked; you reserve the right to refuse or cease participation in the interview process without stating your reason and may request to keep certain materials confidential. In addition, at any stage of the research (until May 17, 2024) you have the right as research participant to gain access to your personal data, request its correction, deletion, or limitation to processing. After completion of the research project, data will be securely stored for 10 years. After that time, any personal data collected will be deleted. In addition, you have the right to request deletion of your data at any time. Audio-recordings, if authorised, will be deleted after they have been transcribed and analysed, hence they will not be stored for 10 years. You can also file a complaint about how your personal data is used.

Please, sign below to confirm your consent – digital signatures are possible:

<b>Participant</b>	
<b>Signature</b>	
<b>Date</b>	

Thank you!

For any enquiries regarding this research, please contact:

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## Appendix II: List of Interviewees

Table II-1 below reports the list of experts and stakeholders interviewed, showing the purposive sampling strategy applied according to role/expertise related to the value chain step and geography.

Table II-1: List of expert and stakeholder interviewees.

Expert Interviews		
Experts/Researchers	(R1) The Roundtable on the Responsible Recycling of Metals (R2) Africa Circular Economy Research and Policy Network (R3) Radboud University - Faculty of Environmental Sciences	
Stakeholder Interviews	EU	Nigeria/Ghana
Industry/Manufacturers (EU)	(R4) SolarPower Europe	
PROs (EU and Africa)	(R5) WEEE Forum (R6) PV Cycle	(R7) E-waste Producer Responsibility Organisation Nigeria - EPRON
Port/Customs Authorities (EU and Africa)	(R8) Amsterdam Port Authority	
Recyclers and Informal Sector (Africa)		(R9) International Alliance of Waste Pickers - IAWP (R10) Appcyclers
Policy (EU and Africa)	(R11) "European Union institution/body"	(R12) Abuja Environmental Protection Board – AEPB (R13) Nigerian Environmental Standards and Regulations Enforcement Agency – NESREA (R14) Basel Convention Coordinating Centre for Africa – BCCC-Africa

Source: own illustration.

## Appendix III: Events and Discussions attended

**(E1)** 11<sup>th</sup> January 2024 – *Responsibility for the Circular Economy: New Aspects of EPR and Producer Responsibility along the Lifecycle*, by Global Action Partnership for EPR  
<https://www.youtube.com/watch?v=W1X8SfwDaOg>

Speakers:

Jamie Fry, Government Policy Manager, Zero Waste Scotland  
Frithjof Laubinger, Environmental Economist, OECD  
Andrew Brown, Junior Environmental Policy Analyst, OECD  
Dacie Meng, Policy and Institutions Senior Manager, Ellen MacArthur Foundation  
David Allaway, Senior Policy Analyst, Oregon Department of Environmental Quality

**(E2)** 24<sup>th</sup> January 2024 – *Circular Electronics Trends Towards 2035 Webinar*, by Circular Electronics Initiative  
<https://tcocertified.com/circular-electronics-day/circular-electronics-trends-towards-2035/>

Speakers:

Olivier Rostang, Future Strategist, Kairos Future  
Andreas Nobell, Development Manager, TCO Development  
Catherine Masolia, Chief Operations Officer, WEEE Centre  
Laetitia Cousi, ESG Customer Engagement Director, Dell Technologies

**(E3)** 14<sup>th</sup> February 2024 – *Policy Recommendations to Make EPR a More Effective Tool - Insights from Europe*, by Global Action Partnership for EPR  
[https://www.youtube.com/watch?v=rA7oa\\_6c1Po](https://www.youtube.com/watch?v=rA7oa_6c1Po)

Speakers:

Janine Röling, Researcher, Fair Resource Foundation  
Axel Darut, Public Affairs Associate, Minderoo Foundation  
Piotr Barczak, Circular Economy Program Manager, ACEN Foundation

**(E4)** 14<sup>th</sup> March 2024 – *EPR Sub-Working Group meeting: Textiles EPR systems (III) - From EPR to Ultimate Producer Responsibilities*, by PREVENT Waste Alliance

Speakers:

Kaustubh Thapa, Post-doc Researcher, Radboud University

**(E5)** 9<sup>th</sup> May 2024 – *“E-waste, Just Transitions and Circularity” in 5<sup>th</sup> Circularity Africa Conference*, by Africa Circular Economy Research and Policy Network and Lead City University  
<https://www.youtube.com/watch?v=TIIEdnROvfk>

Speakers:

Kaustubh Thapa, Post-doc Researcher, Radboud University  
Olawale Olayide, President, IMAGES Initiative



## **Appendix IV: Coding Structure**

Here is reported the final coding structure from NVivo, utilised to perform thematic analysis of all interview data and event notes, adjusted iteratively during data analysis and before the generation of findings.

- **RQ1 International EPR Theory**
  - Design
  - Intended impact mechanisms
  - Research gaps
- **RQ2a International EPR Governance**
  - Alternatives
  - Bilateral cooperation
  - EPR fund
  - International agreement
  - Private sector
  - Stewardship
  - UPR & fee transfer
- **RQ2b Critical Institutional Aspects**
  - Asymmetries and ambiguities
    - Ambiguous responsibilities
    - Dispersion of property rights and number of actors
    - Information asymmetries
    - Private transaction costs
    - Undifferentiated policy measures
  - EPR policies
    - Experience with EPR (or lack thereof)
      - EPR in Nigeria
      - WEEE management in Ghana
    - Stakeholders' capabilities and mental models
  - Interests and lobbying
    - Bargaining and decision-making power
    - Endowment effects
    - Heterogeneous interests
    - Risk of opportunism
    - Trust
  - Political factors
    - Administrative public transaction costs
    - Corruption
    - Policy mix frictions
    - Political and administrative inertia
    - Political continuity and stability
- **RQ2b Other Moderators**
  - Fraud

- Incentives to ship
- Lack of data
- Port and customs activities
- Reuse market in West Africa
- Solar PV waste trends
- **RQ3 Policy Changes**
  - Ecodesign
    - ESPR and DPPs
  - EPR changes
  - Harmonisation and standardisation
  - Informal sector
  - Reuse in EU
  - UPR petition
  - WEEE Directive revision

## **Appendix V: Applied Research Pre-study**

This research topic and project was initially developed through an applied research pre-study aimed at exploring a research area, capturing academic and practitioner views to uncover research gaps and practical issues to investigate in a master thesis.

My applied research pre-study focused on circularity of solar PV and included an academic literature review as well as three interviews with practitioners from SolarPower Europe, the CIRCUSOL EU Horizon 2020 project and the European Environmental Bureau.

Furthermore, during this project until the beginning of research for this thesis, previous Lund University master theses were consulted to take inspiration regarding research approaches, design, and methodologies. Although not referenced in this thesis, some of these indirectly contributed to the early stages of research design and planning/structuring of this work, and therefore deserve acknowledgement. The works of Leukers (2022), Driescher (2023), Richter (2012), Godinho (2021), Mehta (2017), Staub (2019) and Ekdahl (2023) were consulted.

To access a copy of my pre-study, kindly send an email to [simonecimadomo00@gmail.com](mailto:simonecimadomo00@gmail.com).