

TEXTE

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Interim report

# Cost allocation and incentive mechanisms for the environment, climate protection and resource conservation along global supply chains

Roadmaps for the implementation of sustainable  
supply chain management approaches and instruments

by:

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**Abstract: Cost allocation and incentive mechanisms for the environment, climate protection and resource conservation along global supply chains**

The research project “Cost allocation and incentive mechanisms for the environment, climate protection and resource conservation along global supply chains” (project number 3722 14 101 0), commissioned by the German Environment Agency, investigates (dis)incentives for and barriers to the implementation of environmental measures as well as the exchange of information between different actors along selected global supply chains. It aims to provide guidance to business and policy makers to facilitate the practical implementation of effective environmental upgrading measures along global supply chains and to allocate the distribution of the resulting cost and benefits more equitably.

This report contains the results of the third work package of the project. It presents four roadmaps for companies in the cotton-garment, coffee, iron ore-steel and tin-solder supply chains to implement effective environmental and climate protection measures. The roadmaps are based on the results of previous research conducted as part of the project and a series of interviews and workshops with practitioners and industry experts. Each includes a description of an environmental target, effective sustainable supply chain management approaches and instruments, key actors for implementation, interactions between instruments, and necessary framework conditions. They are intended to help translate the high-level observations from previous work packages into tangible actions. The report concludes with a synthesis of the overarching observations and recommendations for effective approaches and instruments relevant to all four supply chains.

**Kurzbeschreibung: Kostenverteilungs- und Anreizmechanismen für Umwelt- und Klimaschutz und Ressourcenschonung entlang globaler Lieferketten**

Das vom Umweltbundesamt in Auftrag gegebene Forschungsprojekt „Kostenallokation und Anreizmechanismen für Umwelt-, Klima- und Ressourcenschutz entlang globaler Lieferketten“ (Forschungskennzahl 3722 14 101 0) analysiert (Fehl-)Anreize und Barrieren für die Umsetzung von Umweltschutzmaßnahmen sowie den Informationsaustausch zwischen verschiedenen Akteur:innen entlang ausgewählter globaler Lieferketten. Das Projekt soll Unternehmen und politischen Entscheidungsträger:innen als Orientierungshilfe dienen, um die praktische Umsetzung wirksamer Umweltschutzmaßnahmen entlang der globalen Lieferketten zu erleichtern und die daraus resultierenden Kosten und Nutzen gleichmäßiger zu verteilen.

Dieser Bericht fasst die Ergebnisse des dritten Arbeitspakets des Projekts zusammen. Er enthält vier Roadmaps für Unternehmen in den Lieferketten Baumwollbekleidung, Kaffee-Konsumkaffee, Eisenerz-Stahl und Zinn-Lötzinn. Die Roadmaps basieren auf den Ergebnissen bisheriger Forschungsarbeiten, die im Rahmen des Projekts durchgeführt wurden, sowie auf einer Reihe von Interviews und Workshops mit Praktiker:innen und Branchenexpert:innen. Sie umfassen jeweils eine Beschreibung eines Ziels zur Steigerung der Umweltleistung, wirksamer Ansätze und Instrumente für ein nachhaltiges Lieferkettenmanagement, der zentralen Akteur:innen für die Umsetzung, der Wechselwirkungen zwischen den Instrumenten sowie der erforderlichen Rahmenbedingungen. Die Roadmaps sollen dazu beitragen, die wesentlichen Beobachtungen aus den vorangegangenen Arbeitspaketen in konkrete Maßnahmen zu übersetzen. Der Bericht schließt mit einer Synthese der übergreifenden Beobachtungen und Empfehlungen für effektive Ansätze und Instrumente, die für alle vier Lieferketten relevant sind.

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## List of abbreviations

Abbreviation	Explanation
<b>ASM</b>	Artisanal and Small-scale Mining
<b>CBAM</b>	Carbon Border Adjustment Mechanism
<b>CFRPP</b>	Common Framework for Responsible Purchasing Practices
<b>CMiA</b>	Cotton Made in Africa
<b>CoC</b>	Code of Conduct
<b>CSDDD</b>	Corporate Sustainability Due Diligence Directive
<b>CSO</b>	Civil Society Organisation
<b>CSRD</b>	Corporate Sustainability Reporting Directive
<b>DRI</b>	Direct Reduced Iron
<b>EMS</b>	Environmental Management Systems
<b>ESG</b>	Environmental, Social and Governance
<b>ESRS</b>	European Sustainability Reporting Standard
<b>EU</b>	European Union
<b>EUDR</b>	European Union Deforestation Regulation
<b>GHG</b>	Greenhouse Gas
<b>GOTS</b>	Global Organic Textile Standard
<b>GRS</b>	Global Recycled Standard
<b>ICMM</b>	International Council on Mining and Metals
<b>IRMA</b>	Initiative for Responsible Mining Assurance
<b>ISO</b>	International Organisation for Standardisation
<b>ITA</b>	International Tin Association
<b>LkSG</b>	Lieferkettensorgfaltspflichtengesetz (German Supply Chain Due Diligence Act)
<b>LME</b>	London Metal Exchange
<b>MCC</b>	Model Contract Clauses
<b>MoU</b>	Memorandum of Understanding
<b>MRSL</b>	Manufacturing Restricted Substances List
<b>MSI</b>	Multi-Stakeholder Initiative
<b>NGO</b>	Non-Governmental Organisation
<b>OCS</b>	Organic Cotton Standard
<b>OECD</b>	Organisation for Economic Co-operation and Development
<b>OSH</b>	Occupational Safety and Health

TEXTE Cost allocation and incentive mechanisms for the environment, climate protection and resource conservation along global supply chains – Roadmaps for the implementation of sustainable supply chain management approaches and instruments

<b>Abbreviation</b>	<b>Explanation</b>
R&D	Research and Development
RCS	Recycled Claim Standard
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RPP	Responsible Purchasing Practices
SSCM	Sustainable Supply Chain Management
TSM	Towards Sustainable Mining
WBCSD	World Business Council for Sustainable Development
WPU <sub>s</sub>	Wet Processing Units
ZDHC	Zero Discharge of Hazardous Chemicals

## Summary

The research project “Cost allocation and incentive mechanisms for the environment, climate protection and resource conservation along global supply chains”, commissioned by the German Environment Agency, investigates (dis)incentives for and barriers to the implementation of environmental measures as well as the exchange of information between different actors along selected global supply chains. It aims to provide guidance to business and policy makers to facilitate the practical implementation of effective environmental measures along global supply chains and to allocate the distribution of the resulting cost and benefits more equitably.

The project focuses on global supply chains in key sectors for German industry and show a high potential for adverse environmental and human rights impacts. In this report, we analyse the following four supply chains from raw material to the end product:

- ▶ Cotton and the manufacturing of cotton-based ready-made garments
- ▶ Coffee for retail and consumer brands
- ▶ Iron ore and quality steel for the automotive industry
- ▶ Tin and tin solder for the manufacturing of electronics

The report presents the results of the third work package of the project, which focuses on translating research insights into practical roadmaps. The roadmaps are each based on barriers and opportunities for the effective implementation of environmental and climate protection measures along global supply chains. They also draw on research findings on a potential mix of sustainable supply chain management approaches and instruments to address these challenges and achieve a more equitable distribution of costs and benefits in the implementation of environmental measures along supply chains. They are aimed at helping to translate higher-level observations from former work packages into concrete actions.

The roadmaps are meant to provide business and policy actors with guidance regarding the following questions:

- ▶ How can more cooperative and incentive-based sustainable supply chain management approaches and instruments be introduced that help achieve a specific environmental upgrade target?
- ▶ Which activities have to be implemented by which actors in which time horizon and under which regulatory and market framework conditions in order to achieve the environmental upgrade target?
- ▶ Where do we recognise interactions between different sustainable supply chain management approaches and instruments and which key measures can be identified to enable effective implementation?

**Chapter 1** of the report provides background information on the objectives of the work package and describes in detail the process through which the four supply chain-specific roadmaps were developed. They are based on the results of previous research conducted as part of the project and a series of interviews and workshops with practitioners and industry experts (including business associations, international organisations and multi-stakeholder initiatives, civil society, certification and standard organisations and other intermediaries). Roadmap 1 (cotton-garment; chapter 2.2) and roadmap 3 (iron ore–steel, chapter 2.4) were each developed in close collaboration with a focal company from the sector.

**Chapter 2** contains the four individual roadmaps, each with a description of the environmental upgrade target to be addressed by the roadmap, the description of the sustainable supply chain approaches and instruments contained in the roadmap, and key stakeholders necessary for their implementation, their interaction and the necessary framework conditions. The approaches and instruments contained in the roadmaps are each assigned to a category, depending on whether an instrument is initiated by an individual company (usually the buyer, i.e. buyer-initiated), at the level of a collective supply chain (supply chain-collective initiated) or by a third party (third party-initiated). They were chosen and designed based on the current institutional and operational barriers and disincentives to environmental and climate protection in the respective supply chains identified in work package one and two of the research project.

**Roadmap 1 (cotton – garment;** chapter 2.2) describes the possible interplay of different sustainable supply chain management approaches and instruments for improved water management, chemical management and wastewater treatment in the cotton-garment supply chain. To this end, the roadmap includes measures initiated by the buyer which are to be combined with each other: codes of conduct and environmental performance clauses, process certifications, offtake agreements, responsible purchasing practices (RPP), improved supplier/factory communication, training and capacity building, environmental performance platforms, green financing and direct sourcing/ vertical supply chain integration. These are supplemented by the supply chain-collective initiated instruments and approaches water stewardship programme and policymaking/ lobbying. **Roadmap 2 (coffee;** chapter 2.3) focuses on enhancing sustainability along the coffee supply chain by addressing deforestation. The roadmap features the third party-initiated approach audit and certification processes, the supply chain-collective initiated instruments extensive stakeholder collaboration, enhanced data management and traceability systems and educational training programmes for farmers as well as the buyer-initiated approaches responsible contracting and price premiums. **Roadmap 3 (iron ore–steel,** chapter 2.4) describes a possible combination of measures to significantly reduce greenhouse gas emissions at all stages of the iron ore-steel supply chain. It covers the buyer-initiated sustainable supply chain approaches and instruments supplier development, climate-aligned clauses in supplier code of conducts and contracts and supplier performance monitoring, as well as the supply chain-collective initiated approaches harmonised carbon accounting framework, enhanced data verification and traceability systems, joint research and development projects and third-party verification and cross recognition. **Roadmap 4 (tin-solder,** chapter 2.5) is also aimed at the reduction of greenhouse gas emissions along the tin supply chains. To this end, it proposes a combination of the third-party initiated approaches: audits and certifications and green loans; supply chain-collective initiated instruments such as harmonised greenhouse gas emission accounting transparency tools for the reporting of verified information, capacity building and training programmes for suppliers; enhanced data management and traceability systems; and buyer-initiated incentive measures such as price premiums and collaborative financing.

Overarching observations regarding similarities and differences between the roadmaps are summarised in a synthesis (**chapter 3**): The comparative analysis shows that RPP, environmental performance clauses, price premiums, offtake agreements, green and collaborative financing, and capacity building and training can be recommended as effective approaches and instruments in all four supply chains.

In the further course of the research project, the findings presented in this and earlier reports will feed into a final report. The final report will highlight selected incentive mechanisms that were repeatedly mentioned in various formats during the implementation of the research (interviews, workshops, desktop research) and across the supply chains investigated and which,

consequently, seem to be most promising to make cost-benefit sharing and information exchange along global supply chains more equitable and efficient via a collaborative approach. The report will illustrate the potential design of these selected incentive mechanisms, describe how to build the necessary framework conditions for their effective implementation along the supply chain and provide (best practice) examples of similar incentives already applied in selected raw material-specific supply chains. The final report will also include recommendations for selected stakeholder groups, including (German and European) companies, sponsors of certification and auditing systems, sector and multi-stakeholder initiatives, other intermediaries like stock exchanges, banks, financial institutions and governments and international organisations, on actions they need to take in order to effectively implement and support the mainstreaming of the promising incentive mechanisms.

## Zusammenfassung

Das vom Umweltbundesamt in Auftrag gegebene Forschungsprojekt „Kostenverteilungs- und Anreizmechanismen für Umwelt- und Klimaschutz und Ressourcenschonung entlang globaler Lieferketten“ analysiert (Fehl-)Anreize und Barrieren für die Umsetzung von Umweltschutzmaßnahmen sowie den Informationsaustausch zwischen verschiedenen Akteur:innen entlang ausgewählter globaler Lieferketten. Ziel des Projektes ist es, Unternehmen und politischen Entscheidungsträger:innen sowie verschiedenen weiteren Akteur:innen eine Hilfestellung für die praktische Umsetzung effektiver Umweltschutzmaßnahmen entlang globaler Lieferketten zu geben und die daraus resultierenden Kosten und Nutzen besser zu verteilen.

Das Projekt konzentriert sich auf globale Lieferketten in Sektoren mit einem hohen Potenzial für Umwelt- und Menschenrechtsrisiken. Es werden vier Lieferketten, die wichtige deutsche Branchen repräsentieren, vom Rohstoff bis zum Endprodukt analysiert:

- ▶ Baumwolle für Konfektionsbekleidung
- ▶ Kaffee für den Vertrieb durch Einzelhandels- und Verbrauchermarken
- ▶ Eisenerz und Qualitätsstahl für die Automobilindustrie
- ▶ Zinn und Lötzin für Elektronikprodukte

Der Bericht enthält die Ergebnisse des dritten Arbeitspakets des Projekts, das auf die Überführung der Forschungsergebnisse in praktische umsetzbare Roadmaps abzielt. Die Roadmaps tragen den bestehenden Hindernissen und Chancen für die effektive Umsetzung von Umwelt- und Klimaschutzmaßnahmen entlang globaler Lieferketten Rechnung. Sie setzen sich aus wirksamen Ansätzen und Instrumenten des nachhaltigen Lieferkettenmanagements zusammen, die diese Hindernisse überwinden und zu einer besseren Verteilung von Kosten und Nutzen bei der Umsetzung von Umweltschutzmaßnahmen entlang der Lieferketten führen können. So sollen wesentliche Erkenntnisse aus früheren Arbeitspaketen des Forschungsprojekts in konkrete Maßnahmen umgesetzt werden.

Die Roadmaps sollen Unternehmen und weiteren Stakeholdern Orientierungshilfen zu folgenden Fragen bieten:

- ▶ Wie können kooperativere und anreizbasierte Ansätze und Instrumente des nachhaltigen Lieferkettenmanagements eingeführt werden, die dazu beitragen ein spezifisches Umweltziel zu erreichen?
- ▶ Welche Aktivitäten müssen von welchen Akteur:innen in welchem Zeitrahmen und unter welchen regulatorischen und marktwirtschaftlichen Rahmenbedingungen umgesetzt werden, um das Umweltziel zu erreichen?
- ▶ Wo sind Wechselwirkungen zwischen verschiedenen Ansätzen und Instrumenten des nachhaltigen Lieferkettenmanagements erkennbar und welche Schlüsselmaßnahmen können identifiziert werden, um eine effektive Umsetzung zu ermöglichen?

**Kapitel 1** des Berichts bietet Hintergrundinformationen zu den Zielen des Arbeitspakets und beschreibt detailliert den Prozess, mit dem die vier lieferkettenspezifischen Roadmaps entwickelt wurden. Sie basieren auf den Ergebnissen bisheriger Forschung, die im Rahmen des Projekts durchgeführt wurde, sowie auf einer Reihe von Interviews und Workshops mit Praktiker:innen und Branchenexpert:innen (einschließlich Wirtschaftsverbänden,

internationalen Organisationen und Multi-Stakeholder-Initiativen, zivilgesellschaftlichen Organisationen, Zertifizierungs- und Standardorganisationen und anderen Vermittler:innen). Roadmap 1 (Baumwolle – Konfektionsbekleidung; Kapitel 2.2) und Roadmap 3 (Eisenerz – Qualitätsstahl, Kapitel 2.4) wurden jeweils in enger Zusammenarbeit mit einem Unternehmen aus dem Sektor entwickelt.

**Kapitel 2** enthält die vier individuellen Roadmaps, die jeweils eine Beschreibung des Umweltziels enthalten, das durch die Umsetzung der Roadmaps adressiert werden soll, sowie eine Beschreibung der in der Roadmap enthaltenen Ansätze und Instrumente des nachhaltigen Lieferkettenmanagements. Außerdem beschreiben die Roadmaps die für die Umsetzung notwendigen Akteur:innen, wichtige Wechselwirkungen zwischen den Instrumenten und die für die Umsetzung notwendigen Rahmenbedingungen. Die in der Roadmap enthaltenen Ansätze und Instrumente werden jeweils einer Kategorie zugeordnet, je nachdem, ob ein Instrument von einem einzelnen Unternehmen (in der Regel dem einkaufenden Unternehmen; eng. ‚buyer-initiated‘), kollektiv durch verschiedene Akteur:innen der gesamten Lieferkette (eng. ‚supply chain-collective initiated‘) oder von einer unabhängigen dritten Partei (eng. ‚third party-initiated‘) initiiert wird. Sie wurden auf der Grundlage der in den Arbeitspaketen eins und zwei des Forschungsprojekts ermittelten bestehenden institutionellen und operativen Barrieren und Fehlanreizen für den effektiven Klima- und Umweltschutz in den jeweiligen Lieferketten ausgewählt und gestaltet.

**Roadmap 1 (Baumwolle – Konfektionsbekleidung; Kapitel 2.2)** beschreibt das mögliche Zusammenspiel verschiedener Ansätze und Instrumente des nachhaltigen Lieferkettenmanagements für eine Verbesserung des Wasser- und Chemikalienmanagements und der Abwasserbehandlung in der Baumwolle-Konfektionsbekleidungs-Lieferkette. Zu diesem Zweck enthält die Roadmap verschiedene Maßnahmen, die vom einkaufenden Unternehmen initiiert werden und miteinander kombiniert werden können: Verhaltenskodizes, Vertragsklauseln zur Umweltleistung, Prozesszertifizierungen, Abnahmeverträge, verantwortungsvolle Einkaufspraktiken, verbesserte Kommunikation mit Lieferant:innen, Schulungen und Kapazitätsaufbau, Umweltleistungsplattformen, grüne Finanzierung und direkte Beschaffung/vertikale Lieferkettenintegration. Diese werden ergänzt durch die kollektiv initiierten Instrumente und Ansätze Wasserbewirtschaftungsprogramm und Politikgestaltung/Lobbyarbeit.

**Roadmap 2 (Kaffee; Kapitel 2.3)** konzentriert sich auf die Verbesserung der Nachhaltigkeit entlang der Kaffee-Lieferkette durch die Bekämpfung von Entwaldung. Die Roadmap umfasst drittpartei-initiierte Audit- und Zertifizierungsprozesse, die lieferketten-kollektiv initiierten Instrumente einer umfassenden Zusammenarbeit zwischen Stakeholdern, eines verbesserten Datenmanagements und von Rückverfolgbarkeitssystemen, von Bildungsprogrammen für Kaffeebauern und -bäuerinnen sowie die von einkaufenden Unternehmen initiierten Instrumente einer verantwortungsvollen Vertragsgestaltung und Preisprämien.

**Roadmap 3 (Eisenerz – Qualitätsstahl, Kapitel 2.4)** beschreibt eine mögliche Kombination von Maßnahmen zur signifikanten Reduzierung der Treibhausgasemissionen auf allen Stufen der Eisenerz-Stahl-Lieferkette. Sie umfasst die von einzelnen einkaufenden Unternehmen initiierten Ansätze und Instrumente Lieferant:innenentwicklung, Klimavertragsklauseln in Verhaltenskodizes und Verträgen und Überwachung der Leistungen von Lieferant:innen, sowie die lieferketten-kollektiv initiierten Ansätze harmonisiertes Rahmenwerk der Treibhausgasemissionsbilanzierung, verbessertes Datenmanagement und Einführung von Rückverfolgbarkeitssystemen, gemeinsame Forschungs- und Entwicklungsprojekte, sowie die Auditierung durch Dritte und gegenseitige Anerkennung von Zertifizierungssystemen.

**Roadmap 4 (Zinn – Lötzinn, Kapitel 2.5)** zielt ebenfalls auf die Reduzierung von Treibhausgasemissionen ab, jedoch entlang der Zinn-Lieferkette. Zu diesem Zweck wird eine Kombination aus den von Drittparteien initiierten Instrumenten Audits und Zertifizierungen und grünen Darlehen, den lieferketten-kollektiv initiierten Instrumenten harmonisiertes Rahmenwerk für die Treibhausgasemissionsbilanzierung, Transparenz-Tool für die Berichterstattung verifizierter Informationen, Kapazitätsaufbau- und Schulungsprogrammen für Lieferant:innen und Verbesserung des Datenmanagements und der Rückverfolgbarkeitssysteme sowie den von einkaufenden Unternehmen initiierten Instrumenten Preisprämien und kollaborative Finanzierung vorgeschlagen.

Übergreifende Beobachtungen zu Ähnlichkeiten und Unterschieden zwischen den Roadmaps der vier Lieferketten werden in einer Synthese (**Kapitel 3**) zusammengefasst. Die vergleichende Analyse zeigt, dass verantwortungsvolle Einkaufspraktiken, Vertragsklauseln zur Umweltschutzleistung, Preisprämien, Abnahmeverträge, grüne und kollaborative Finanzierung sowie Kapazitätsaufbau und Schulungen als effektive Ansätze und Instrumente in allen vier Lieferketten empfohlen werden können.

Im weiteren Verlauf des Forschungsprojekts werden die in diesem und in früheren Berichten präsentierten Ergebnisse in einen Abschlussbericht einfließen. Der Abschlussbericht wird ausgewählte Anreizmechanismen hervorheben, die in verschiedenen Formaten während der Durchführung der Forschungsarbeit (Interviews, Workshops, Desktop-Recherche) und über die untersuchten Lieferketten hinweg wiederholt genannt wurden und die folglich am vielversprechendsten erscheinen, um die Kosten-Nutzen-Verteilung und den Informationsaustausch entlang globaler Lieferketten durch einen kooperativen Ansatz besser und effizienter zu gestalten. Der Abschlussbericht wird die Gestaltungsmöglichkeiten dieser ausgewählten Anreizmechanismen veranschaulichen und beschreiben, wie die notwendigen Rahmenbedingungen für ihre wirksame Umsetzung entlang der Lieferkette geschaffen werden können. Zudem wird er (Best-Practice-)Beispiele liefern, die in ausgewählten rohstoffspezifischen Lieferketten bereits angewandt werden. Der Abschlussbericht wird abschließend Empfehlungen für ausgewählte Stakeholder-Gruppen, darunter (deutsche und europäische) Unternehmen, Träger:innen von Zertifizierungs- und Auditsystemen, Branchen- und Multi-Stakeholder-Initiativen, andere Intermediäre wie Börsen, Banken, Finanzinstitutionen sowie Regierungen und internationale Organisationen, zu Maßnahmen enthalten, die sie ergreifen können, um das Mainstreaming der vielversprechenden Anreizmechanismen zu unterstützen.



# 1 Background and objectives

The research project “Cost allocation and incentive mechanisms for the environment, climate protection and resource conservation along global supply chains”, commissioned by the German Environment Agency, investigates (dis)incentives for and barriers to the implementation of environmental measures as well as the exchange of information between different actors along selected global supply chains. It aims to provide guidance to business and policy makers to facilitate the practical implementation of environmental measures along global supply chains and to improve the distribution of cost and benefits between buyers and suppliers in the process.

The project focuses on global supply chains in essential sectors in German industry that also show a high potential for adverse environmental and human rights impacts. In this report, we analyse the following four<sup>1</sup> supply chains from raw material to the end product:

- ▶ Cotton and the manufacturing of cotton-based, ready-made garments
- ▶ Coffee for retail and consumer brands
- ▶ Iron ore and quality steel for the automotive industry
- ▶ Tin and tin solder for the manufacturing of electronics

The report presents the results of the third work package of the project, which focuses on translating research insights into practical roadmaps. The roadmaps are each based on information on barriers and opportunities as well as a potential mix of approaches and instruments for the effective implementation of environmental and climate protection measures and the improved distribution of costs and benefits of environmental measures along supply chains.

The report thus draws heavily on the findings of the previous research in the project. Work package one and the associated interim report (Strasser et al. 2024) have provided a comprehensive understanding of the current structure and organisation of the selected supply chains. The dominant actors as well as the concentration and manifestation of power along the supply chains, the main environmental impacts, and the institutional barriers and (dis)incentives for environmental protection, information sharing and cost-benefit distribution with which various supply chain stakeholders are confronted were identified. Work package two explored and catalogued the diverse sustainable supply chain management (SSCM) approaches and instruments deployed by companies to foster environmental and climate protection within their supply chains. Firstly, a general overview of the many approaches and instruments that are available today to companies for driving (environmental) sustainability in supply chains was given. These approaches and instruments are initiated and offered by various actors (incl. buyers, suppliers, third parties and government organisations) to achieve a wide range of objectives (for more details, please view Grüning et al. 2024, Chapter 2). The report from work

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<sup>1</sup> Work package one and two of the project focussed on five raw material-specific supply chains, covering “natural rubber and car tyres for the automotive industry” in addition to the four supply chains mentioned here. In close collaboration with the German Environment Agency, we decided to focus work package three on only four different supply chains. This allows for a necessary in-depth examination in close cooperation with a focal company and in exchange with various relevant stakeholders via interviews. The decision not to investigate further the supply chain of natural rubber tyres reflects the observation that key features of the supply chain are very similar to the coffee supply chain, which include e.g. a prevalence of labour-intensive harvesting by smallholder farmers of the raw material, power dynamics which are largely skewed in favour of downstream buyers and the (expected) strong influence of the European Union Regulation on Deforestation-free Products (EUDR) on transparency, traceability and sustainability performance of various actors along the supply chain (for more details, please view Strasser et al. 2024, chapter 3.3.8). By analysing the four selected supply chains mentioned above, this work package aims to cover the broadest possible range of different supply chain and market structures.

package two also examines which of the numerous possible approaches and instruments are already being used by actors in the raw material specific supply chains, at what scale and in what form. It became clear that, for the most part, a coercive strategy is applied, in which sustainability requirements are forced upon business partners through the threat or implementation of penalties. Such coercive strategies often lead to the ineffective implementation of environmental measures, because compliance is prioritised over effectiveness and costs and benefits are unevenly distributed between the actors in the supply chain. In contrast to this, the cooperation strategy seeks mutually beneficial solutions and encourages the implementation of environmental requirements along the supply chain to a greater extent through the use of (financial and non-financial) incentives. This is associated with the expectation of a more effective implementation of climate and environmental protection, as a collaborative approach and innovative incentives create trust, knowledge sharing and an increased willingness for transparency between the actors in the supply chain (for more details, see Grüning et al. 2024, Chapter 4).

Those findings were presented to industry experts from companies active along the respective raw material specific supply chains, business associations, international organisations and multi-stakeholder initiatives (MSI), civil society, certification and standard organisations and other intermediaries in various raw material-specific workshops. During those workshops, experts and practitioners explored how to combine existing and new sustainable supply chain management approaches into a ‘smart mix’<sup>2</sup> (Home et al. 2021) that emphasises collaboration. This approach aims to provide better incentives for environmental and climate protection along global supply chains, benefiting both buyers and suppliers. The outcomes of these discussions formed the starting point for the roadmap development process described in detail in Chapter 2 of this report.

In the further course of the research project, the findings presented in this and earlier reports will feed into a final report. The final report will highlight selected incentive mechanisms that were repeatedly mentioned in various formats during the implementation of the research (interviews, workshops, desktop research) and seem to be most promising to improve cost-benefit sharing and information exchange along global supply chains via a collaborative approach. The report will illustrate the potential design of these selected incentive mechanisms, describe the necessary framework conditions for their effective implementation along the supply chain and provide (best practice) examples of similar incentives already applied in selected raw material-specific supply chains.

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<sup>2</sup> Following Home et al. (2021), a ‘smart mix’ of SSCM approaches is defined in this project as a strategic combination of regulatory and governance instruments that aims to enhance the effectiveness of sustainability efforts by aligning flexible, innovative market-based solutions with authoritative legal regulations, ensuring they collectively address specific environmental and social goals across global supply chains. Such a mix includes both public and private instruments at national and international levels and integrates binding and voluntary measures.

## 2 Roadmap development

### 2.1 Objectives and methodology

This report aims to translate the insights gained on barriers and opportunities as well as a potential ‘smart mix’ of approaches and instruments for the effective implementation of environmental and climate protection measures and the improved distribution of costs and benefits of sustainable supply chain activities into four supply chain-specific roadmaps for practical implementation. The roadmaps are thus aimed at helping to translate higher-level observations from former work packages into tangible actions.

The roadmaps are intended to provide business and policy actors with guidance on the following questions:

- ▶ How can more cooperative and incentive-based SSCM approaches and instruments be introduced that help to achieve a specific environmental upgrade target?
- ▶ Which activities have to be implemented by which actors in which time horizon and under which regulatory and market framework conditions in order to achieve the environmental upgrade target?
- ▶ Where do we recognise dependencies between different SSCM approaches and instruments and which key measures can be identified to enable effective implementation?

To this end, a specific environmental upgrade target was defined for each of the four selected raw material-specific supply chains. This target was derived on the one hand from previous analyses of the main environmental impacts along the supply chains (cf. Strasser et al. 2024) and from findings from workshops and interviews with various practitioners and industry experts (including business associations, international organisations and MSIs, civil society, certification and standard organisations and other intermediaries).

Subsequently, two rounds of workshops were conducting for each of the supply chains. The first phase consisted of two workshops for each supply chain (eight in total). During these workshops, various industry experts and practitioners were presented with key barriers and challenges to improved environmental performance and a collection of SSCM approaches and instruments that are already available to companies today for driving (environmental) sustainability in their raw material specific supply chains (see Grüning et al. 2024). Workshop participants then discussed how existing and new SSCM approaches and instruments could be combined in a ‘smart mix’, which introduces a (more) collaborative and incentive-based approach to effectively achieving the environmental upgrade target along the supply chain.

For the second round of workshops, efforts were made to identify a focal company for each of the four raw material-specific supply chains<sup>3</sup>, with which to jointly develop a roadmap for practical implementation. The workshops, which were held with selected focal companies (applies to: cotton-garment and iron ore-steel), were organised along the lines of the ‘Visual Roadmap’ methodology as developed by the Institute for Innovation and Technology (IIT) (Kind et al. 2011). This methodology uses a backcasting approach – a method that involves looking backwards from a specific goal in order to identify the changes and measures required to achieve this pre-defined target. Participants were provided with a range of input materials as a

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<sup>3</sup> Potential focal companies were identified via a snowball method, starting with members of an Expert Advisory Board comprising individuals from businesses, civil society and academia, as well as contacts that had already been established in the course of the project via interviews with different practitioners and industry experts.

basis for the process. They received the results from the first work package (supply chain profiles) as well as the second work package (collections of barriers and challenges and approaches and instruments). In addition, they were informed about the results of the discussions during the first round of workshops (regarding a 'smart mix' of instruments). Then they were presented with a pre-defined specific environmental target and the overall goal of improved cost-benefit sharing that had been defined in the process leading up to the roadmap development.

During the workshop, participants jointly developed the most efficient way to achieve the target. The 'Visual Roadmap' approach is based on moderated dialogues in which representatives of the respective focal companies were asked to contribute their individual views on necessary steps, time horizons and actors in order to arrange important SSCM approaches and instruments in a roadmap and discuss their respective necessary design and framework conditions. For each instrument that had been identified as relevant in the previous working steps, participants discussed its suitability and area of application, concrete actions and necessary resources as well as stakeholders that would need to be involved for its successful implementation. Challenges were also discussed, as a result of which they were classified either as obstacles that would be surmountable under certain conditions (which should be considered during the implementation of instruments) or as factors limiting an instruments' prospects of success.

Subsequently, through a moderated dialogue among the participants, a consensus was reached on the final roadmap, which includes the most relevant SSCM instruments and approaches, and describes incentives and their respective design. Interactions and dependencies between instruments were taken into consideration.

Following the roadmap development workshops with the focal companies, the roadmaps were subjected to a consistency and completeness check by the project team. Possible overlaps and synergies or conflicts between components of the roadmap were identified and resolved. In addition, the findings were supplemented with further results from previous workshops and interviews as well as research results from work packages one and two. The results of the workshops and the subsequent reviews by the project team are presented below in chapters 2.2 to 2.5.

Unfortunately, it was not possible to identify a focal company that agreed to participate in a corresponding roadmap development workshop for each raw material-specific supply chain. Where no focal company could be identified (applies to: coffee (chapter 2.3) and tin-solder (chapter 2.5)), the roadmaps below are based on desk research, the findings of the previous workshops on 'smart mix' development and additional interviews with industry experts.

## 2.2 Roadmap 1: Cotton-garment

### 2.2.1 Environmental target and background

Water is a key topic in the cotton-garment industry, as it is widely and intensively used throughout the supply chain. Its relevance has increased even more over the past years due to the exacerbation of extreme weather events, such as droughts and floods (e.g. Pakistan 2022), and steadily increasing water scarcity in various places, such as China, Pakistan, northern India, Egypt and the Mediterranean (Mann 2022). Although the water footprint of cotton is contested and depends a lot on the farming methods (Transformers Foundation 2021), in some geographical areas large quantities of water are required for the irrigation and processing of cotton. According to Morgan et al. (2022) cotton farming (Tier 4 of the cotton supply chain) accounts for the largest share of water consumption (65%), while raw material processing (Tier 3) consumes 12%, fabric production (Tier 2) 6% and assembly (Tier 1) 5%.

In 2022, only 24% of the total cotton production was covered by one of the preferred sustainability programmes<sup>4</sup>, while only 1% of the global cotton is organic (Voora et al. 2023); (Textile Exchange 2022). The most important voluntary sustainability standards differentiate between certified sustainable sources for the origin of the cotton raw material, like sustainable cotton such as Better Cotton or Cotton Made in Africa (CMiA), organic cotton such as Global Organic Textile Standard (GOTS), Organic Cotton Standard (OCS), or recycled cotton such as the Global Recycled Standard (GRS) and the Recycled Claim Standard (RCS). In terms of sustainable cotton, these standards certify and ensure that sustainable (Better Cotton, CMiA) or organic (e.g. GOTS, OCS) agricultural practices have been used. In terms of recycled content, the relevant standards (GRS, RCS) ensure the origin and composition of recycled cotton. Initiatives like Zero Discharge of Hazardous Chemicals (ZDHC) and process certifications, such as bluesign, Cradle to Cradle Certified™, STeP by OEKO-TEX, OEKO-TEX Eco Passport or Made in Green by OEKO-TEX and product certifications such as OEKO-TEX Standard 100 promote safe chemical use and sustainable practices particularly between Tier 3 and Tier 1. In addition to these process and product certifications, some of those certifications that cover the entire supply chain (e.g. GOTS, OEKO-TEX Standard 100) emphasise strict standards for approved chemicals and processes in the relevant wet processes. Even though they do not specifically require adherence to a specific standard, their principles are compatible with the requirements of chemical management schemes as suggested by ZDHC or bluesign (bluesign 2020; Global Organic Textile Standard 2023; ZDHC 2024a).

Wastewater is one of the main sustainability concerns in the textile and fashion industry due to several significant environmental and health impacts. Wastewater is produced when textile factories engage in wet processes such as pre-treatment, dyeing and finishing (e.g. mostly in Tier 2; minimal in Tier 1). After the use of a significant amount of chemicals (Fashion For Good 2023), the effluents are discharged to treatment plants and surface waters, often leading to pollution if inadequately treated. As wet processes have considerable impact on water quality determined by chemical, (e.g. oxygen, nitrogen), physical (e.g. temperature) and biological parameters (e.g. biological oxygen demand), water – as a public resource – requires improved governance and management for it to benefit both industrial users and household consumers.

The textile industry's lax water governance over many years led to the founding of the Greenpeace Detox My Fashion campaign and the ZDHC initiative in 2011 (Greenpeace 2020).

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<sup>4</sup> Textile Exchange uses the term “preferred sustainability programmes” to refer to a range of initiatives, certifications and standards that align with Textile Exchange’s definition of preferred fibres and materials that offer improved environmental and social outcomes compared to conventional alternatives (Textile Exchange 2023).

Today, ZDHC is known in the sector for providing guidelines for chemical and wastewater management; however, according to interviews, adoption rate varies with the specific requirements and the capabilities of the factories to meet those. The ZDHC Wastewater Guidelines specify limit values for conventional wastewater parameters (e.g. BOD, COD, temperature, pH level), heavy metals (e.g. antimony) and chemicals listed in the ZDHC Manufacturing Restricted Substances List (MRSL) (ZDHC 2024b).

Based on this along with key informant interviews and a review of sustainability reports, we focus this cotton roadmap on water pollution in wet processing units (WPU) at Tier 1 (product manufacturing<sup>5</sup>) and Tier 2 (fabric production). This focus is also owed in large part to the fact that brands/retailers have more direct relationships with Tier 1 in particular, increasingly also with Tier 2, and thus have a greater influence here than on spinners (Tier 3) or the cotton farming (Tier 4). Cotton supplies at Tier 4 are often intermediated by traders or sustainability initiatives such as Organic Cotton Accelerator (OCA) or Better Cotton.

Studies and corporate sustainability reports have shown that many fashion companies have been slow, not very ambitious and rather vague in setting and achieving targets to reduce water consumption and pollution throughout the supply chain. The targets and goals are usually set for water management, chemical management and wastewater treatment during pretreatment, dyeing, washing and finishing (H&M Group 2023; Inditex 2023). However, the reports do not consistently specify the tiers included, but generally speak of relevant wet processes, which typically fall under Tier 2 suppliers (see above), sometimes of suppliers and business partners, and sometimes of Tier 1 and Tier 2 supplier factories when discussing their water stewardship approach.

Based on several workshops and interviews with a wide range of actors (companies, suppliers, sustainability initiatives, MSI, banks and investors, business associations), we selected a target that was considered as relevant and ambitious to develop a roadmap for the cotton supply chain. The roadmap was developed and discussed in detail with a focal company and validated through further discussions and desk research. The following targets were defined on this basis:

#### **Short-term environmental upgrade target – cotton**

Within three years, all high-volume WPU<sup>6</sup> show at least 80% ZDHC MRSL conformance of their input chemicals and their wastewater quality complies with the highest level of the ZDHC Wastewater Guidelines.

#### **Mid-term environmental upgrade target – cotton**

Within six years, all high-volume WPU show 100% ZDHC MRSL conformance of their input chemicals.

The focal company is a European retail chain that is known for its wide range of consumer goods, including textiles and fashion. The company focuses on sustainability clothing collections, uses sustainable materials like organic cotton, and participates in MSIs to improve social and environmental standards in its supply chain.

Like any other European brand/retailer in the textile and fashion industry, the focal company is embedded within a complex regulatory framework that includes international agreements,

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<sup>5</sup> Tier 1 involves garment assembly but can also include dyeing and washing processes. Most of the wet processes take place in Tier 2, such as pretreatment, dyeing, printing, and finishing.

<sup>6</sup> High-volume WPU make in total around 80% of the order volume of the focal company.

supra-national (e.g. European Union (EU) directives and regulations) and national regulations (e.g. EU member state level). Relevant international regulations and standards encompass e.g. the United Nations Guiding Principles for Business and Human Rights and the Organisation for Economic Co-operation and Development (OECD) Guidelines for Multinational Enterprises on Responsible Business Conduct, which provide global guidelines for preventing and addressing the risk of adverse impacts of business activities on human rights. The International Labour Organisation core conventions do not specifically address chemical, water and wastewater management. The Occupational Safety and Health (OSH) Convention (No. 155) promotes safe and healthy working conditions, which can include aspects of chemical, water, and wastewater management.

At the supranational level, the **Corporate Sustainability Reporting Directive (CSRD)** and its European Sustainability Reporting Standard (ESRS) E3 “Water and marine resources” requires obliged companies to disclose information in its policies, targets and actions related to water consumption in the value chain, particularly if it is taking place in geographical areas with high water-related quality, quantity, regulatory or reputational risks. According to ESRS E2 “Pollution”, companies are obliged to disclose their pollutant emissions to air, water and soil and their use of substances of very high concern and a larger group of chemicals classified as substances of concern. Reference is also made to the **EU REACH regulation** (Registration, Evaluation, Authorisation and Restriction of Chemicals), which regulates the production and use of chemical substances to ensure environmental and human health protection (EFRAG 2022; EC 2024c). REACH requires companies to identify and manage the risks associated with the chemicals they manufacture and market in the EU and to provide actors in the supply chain appropriate safety information.

Starting from July 2026, the **Corporate Sustainability Due Diligence Directive (CSDDD)** will oblige large EU companies, including the focal company for this study, to conduct business while respecting human rights and the environment. The CSDDD requires companies and other organisations to assess their entire “chain of activities” (European Union 2024), i.e. the upstream value chain and the distribution, transport and storage of their products for potential negative human rights and environmental impacts and address these impacts by passing on relevant information and support (e.g. on restricted substances) to their supply chain partners. Obligated companies need to conduct due diligence when, for instance, activities of upstream business partners like not continuously using an effluent treatment plant lead to environmental degradation affecting specific human rights, such as the right to food, health or water.

At the national level, the **German Supply Chain Due Diligence Act (LkSG)** obliges large companies, including the focal company, to implement comprehensive human rights-related due diligence obligations and selected environmental due diligence obligations. The protected legal positions according to § 2 (2) No. 9 LkSG include environmental damage to soil, water, and air, noise emissions and excessive water consumption that results in a violation of human rights, such as denying a person access to safe and clean drinking water (Bundestag 2021). This means that, following a due diligence process, they must assess the risks in their supply chain with regard to water pollution and associated human rights violations, which may occur in Tier 1, but very often also occur further down the cotton-garment supply chain (Tiers 4 to 2), and take appropriate action to address them.

### 2.2.2 Description of the roadmap

The roadmap presented includes the results of research and findings from interviews and workshops with various actors from companies (brands/retailers, suppliers), civil society, academia, service providers and technical experts. In two workshops, a smart mix of supply

chain management instruments and approaches, especially incentive-based, was developed and analysed by a wide range of actors of the cotton-garment supply chain. This mix of instruments was then discussed with a representative of the focal company and translated into a roadmap that identifies and describes which instruments need to be implemented by which actors and by when in order to effectively address the environmental upgrade targets defined above. This approach ensures that broader lessons from the project, beyond the experience of the individual focal company, are incorporated into the roadmap, which will also require other actors in the cotton-garment supply chain to contribute to its effective implementation. The roadmap highlights only the most effective instruments, starting with those identified as most relevant to the focal company, which, through its involvement in relevant industry collaborations (e.g. Partnership for Sustainable Textiles), provides a realistic example for similar buying companies in the cotton-garment supply chain. Some may be of particular importance to the focal company as for other buyers, such as a corporate code of conduct (CoC), while their impact is critically discussed in the literature. They have been critically considered and adapted through timely recommendations (e.g. environmental performance clauses), which often have not been implemented at scale.

Figure 1 shows that most instruments are initiated by buyers and accompanied by collective initiatives in the supply chain, such as sustainability initiatives (e.g. water stewardship programme) or MSIs<sup>7</sup> to achieve the environmental target of reduced water pollution in general, and improved conformance with ZDHC requirements in particular. The individual and collective measures span over a timeframe of six years to achieve the environmental target, which is in line with similar targets set by other companies and industry initiatives (e.g. Partnership for Sustainable Textiles). Not every instrument is implemented from the outset. For instance, the foundation for cooperation between buyers and their suppliers is a CoC to which suppliers are expected to commit throughout the entire business relationship. However, CoCs rarely set specific environmental targets. Only after the sustainability performance of suppliers is understood and trust is built, are buyers willing to go deeper (e.g. direct sourcing), trade on responsible terms (e.g. RPP) and offer more incentivised instruments (e.g. offtake agreements, collaborative financing) to achieve their corporate targets.

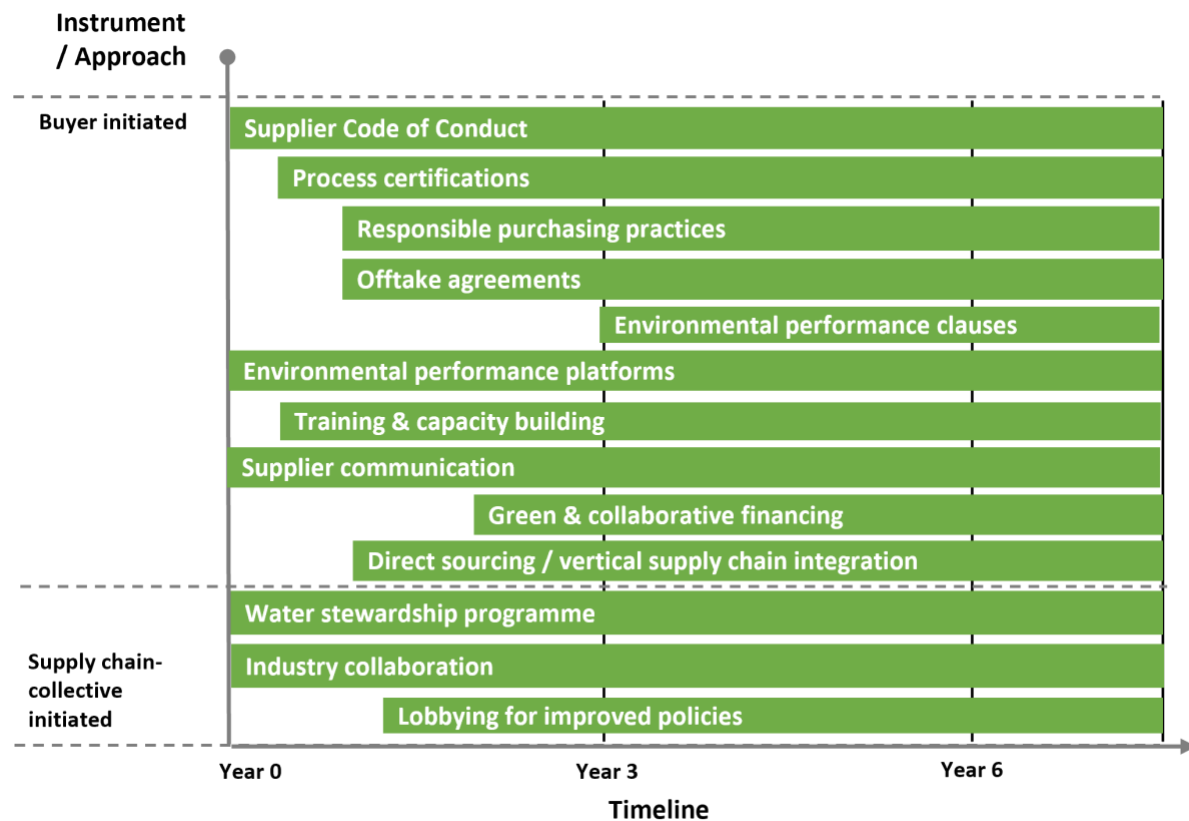
Each instrument and the measures recommended for the respective actors will be explained in detail in section 2.2.2.1 to 2.2.2.11.

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<sup>7</sup> For more information on the categorisation of the instruments, see Grüning et al. (2024).



**Figure 1: Roadmap for improved environmental performance in the cotton-garment supply chain**



Source: own illustration (adelphi research gGmbH)

### 2.2.2.1 Instrument 1: Water stewardship programme

Textile brands and retailers often report that they embed their water management measures into a water stewardship/management programme, which can focus on specific tiers (e.g. wet processes in Tier 2) or, ideally, extends back to the level of raw material cultivation (Inditex 2023; World Business Council for Sustainable Development 2024). The overall goal is to improve water management practices in order to increase water efficiency and reduce water pollution. The focal company has such a programme in place, but concentrates its measures primarily on the wet processes in Tier 2, preferring the greater dynamics in these tiers and the higher leverage effect. One of the main objectives of a water stewardship programme for WPU is to reduce water consumption and minimise the environmental impact from hazardous chemicals and untreated or not sufficiently treated effluents. Such a programme can provide guidance to ensure compliance with local and international regulations, thereby reducing legal and reputation risks associated with water pollution. It can explore industry benchmarks for technologies and processes to optimise water use and reduce water and wastewater treatment costs. Water stewardship programmes work towards resource conservation, ensuring long-term availability for both industrial and communal use (UN 2024). These programmes typically adopt a multi-stakeholder approach to identify and disseminate solutions to comprehensively improve the water use and minimise the supply chain (H&M Group 2023; Inditex 2023; UNEP 2023).

Given the priority placed by the focal company on wet processes at Tier 2 (pretreatment, dyeing, finishing), and given the limited scope and space of this roadmap, water-intensive processes at the raw material production level will be excluded from the analysis. There is a broad range of actors involved driving the initiative of a water stewardship programme:

**Table 1: Key actors and actions for implementing a water stewardship programme**

Key Actors	Actions for Implementation
Brands/retailers	<ul style="list-style-type: none"> <li>- In general, join environmental performance programmes (e.g. platforms, initiatives, certifications) that aim to improve the water footprint along the supply chain.</li> <li>- In particular, develop a strategy to improve the use and consumption of water and chemicals in WPUs.</li> <li>- Define guidelines and standards for chemical and water management in the supply chain.</li> <li>- Eliminate harmful substances right from the beginning of the manufacturing process by providing access to chemicals conformant with ZDHC requirements.</li> <li>- Communicate to direct (Tier 1) and indirect suppliers (WPUs) to comply with the ZDHC MRSL and the ZDHC Wastewater Guidelines or similar requirements (e.g. bluesign, STeP by OEKO-TEX) and compensate for the additional cost.</li> <li>- Work closely with suppliers to ensure compliance with ZDHC (or equivalent) requirements.</li> </ul>
Direct suppliers	<ul style="list-style-type: none"> <li>- Make sure that WPUs adapt their processes in water and chemical management practices as follows below.</li> </ul>
WPUs	<ul style="list-style-type: none"> <li>- Adopt and implement the ZDHC MRSL to ensure that restricted chemicals are not used in the manufacturing process.</li> <li>- Maintain a detailed inventory of all chemicals (chemical management) and ensure that all chemicals comply with the ZDHC MRSL.</li> <li>- Work closely with chemical suppliers to source safe alternatives that are compliant with ZDHC (or equivalent) requirements.</li> <li>- Conduct regular training sessions for relevant employees (e.g. sustainability/production/OSH/chemical managers) to increase awareness of chemical safety and ZDHC compliance requirements.</li> <li>- Optimise processes to reduce chemical use and hazardous waste and implement best practices for chemical handling and storage.</li> <li>- Follow the ZDHC Wastewater Guidelines to monitor and manage the wastewater quality.</li> <li>- Regularly test effluents to ensure it meets ZDHC requirements.</li> <li>- Document and report purchase, use and disposal of chemicals.</li> <li>- Register at the ZDHC Gateway for auditors to upload ZDHC wastewater reports (e.g. ZDHC ClearStream).</li> <li>- Regularly review and update chemical and water management practices to align with the latest standards.</li> </ul>
Sustainability initiatives/MSIs	<ul style="list-style-type: none"> <li>- Provide comprehensive guidelines and resources that contain best practices for chemical and water management and compliance with ZDHC (and equivalent) requirements.</li> <li>- Organise capacity building for relevant staff of brands/retailers, suppliers/WPUs and chemical suppliers on ZDHC requirements, chemical safety and sustainable practices.</li> <li>- Facilitate platforms for collaboration and information exchange among brands, suppliers, and chemical manufacturers to share knowledge and solutions (e.g. Partnership of Sustainable Textiles, Cascale).</li> <li>- Develop tools and frameworks for self-assessment to help facilitate and evaluate their compliance status and identify areas for improvement (e.g. Higg FEM). ZDHC is an initiative that collaborates with brands and facilities to recognise those achieving high compliance through its ZDHC Gateway, which tracks and shares progress of textile facilities. Cascale also provides tools like</li> </ul>

Key Actors	Actions for Implementation
	the Higg Index that allow brands and facilities to measure and score their sustainability performance, offering recognition to those with high scores.
Certification bodies/third-party auditors	<ul style="list-style-type: none"> <li>- Assess compliance with ZDHC requirements, identify areas for improvement and upload wastewater reports at the ZDHC Gateway.</li> <li>- Organisations like OEKOTEX (e.g. STeP by OEKOTEX) and bluesign offer certifications to facilities that meet specific environmental requirements, including management.</li> </ul>
International organisations	<ul style="list-style-type: none"> <li>- Provide technical expertise for and capacity building in chemical, water and wastewater management e.g. through national or international consultants.</li> </ul>
Industry associations	<ul style="list-style-type: none"> <li>- Facilitate access for sustainability initiatives and development organisations to manufacturers and encourage peer-learning among the members.</li> <li>- Introduce and roll out key requirements for improved water and chemical management among the members.</li> </ul>

Governmental and regulatory bodies in producing countries need to be involved if the programme touches upon local regulations (e.g. inspection and enforcement). Engaging local communities and civil society organisations (CSO) ensures that the community’s water needs are taken into account.

### 2.2.2.2 Instrument 2: Codes of Conduct vs. Environmental Performance Clauses

Companies in the textile and fashion industry typically impose unilateral codes of conduct (CoC) onto their suppliers for several reasons (Grüning et al. 2024) – these, however, rarely refer to actual performance targets. A CoC typically addresses sustainability concerns, as pressure from CSOs, consumers and regulation to become more sustainable increases. While specific performance targets are rarely mentioned, suppliers are expected to commit to monitoring and reporting on their social and environmental impacts. CoCs are also intended to help manage both economic and non-economic (environmental and social) risks through SSCM.

Brands/retailers often dictate the contents and leave the responsibility (and cost) for sustainability audits to the suppliers themselves (Hoek 2023). However, for buyers and suppliers to engage in equal partnerships, it is important that contracts are not one-sided, imposing requirements and expectations on suppliers, without sharing responsibility for the way the goods are produced. Instead, contracts should be designed to incentivise suppliers to meet or exceed environmental (and social) standards as suggested by the Responsible Contracting Project and The Chancery Lane Project (RCP 2023; The Chancery Lane Project 2023; Dadush et al. 2023). According to interviews, the textile and fashion industry has not adopted these practices yet. The focal company interviewed for this study also has no contracts based on sustainability performance. Their contracts with strategic suppliers only stipulate that both brand/retailer and supplier work on the topic of sustainability, without any further details.

Instead, contracts should be designed in such a way that both buyers and suppliers improve their sustainability performance, adding specific sustainability criteria and environmental performance metrics to the contracts. Brands/retailers could further incentivise compliant suppliers to receive preferred (nominated) status or join a tiered supplier programme depending on their environmental performance score, which would pave the way for more business opportunities and longer-term contracts.

**Table 2: Key actors and actions for implementing environmental performance clauses**

Key Actors	Actions for Implementation
Brands/retailers together with suppliers	<ul style="list-style-type: none"> <li>- Develop clear and detailed contracts that outline expectations, responsibilities, and environmental performance metrics.</li> <li>- Include clauses that provide incentives for meeting environmental performance targets and penalties for non-compliance, such as financial rewards (e.g. bonuses or discounts on future contracts), a preferred supplier status to those who meet or exceed the targets in future contract opportunities, or access to resources (e.g. technical assistance, training). Penalties could include imposing fines or requiring payments to an environmental fund if targets are not met, excluding non-compliant suppliers from bidding on future contracts or reducing their contract volume.</li> <li>- Incorporate environmental performance metrics in the environmental performance clauses that address chemical, water and wastewater management. These may include reducing water consumption (e.g. by a certain percentage in 2025), meeting the ZDHC MRSL and complying with the ZDHC Wastewater Guidelines.</li> <li>- Design these incentives and consequences in such a way that they drive positive environmental outcomes (see above).</li> <li>- Conduct an initial baseline of the supplier’s performance in the environmental target areas to understand the current performance.</li> <li>- Set realistic and achievable targets (SMART) for improvement over the duration of the contract.</li> <li>- Link financial (e.g. price premiums) or other incentives (e.g. offtake agreements; 30 days-LC) for achieving the environmental performance targets.</li> <li>- Implement penalties or a reduction payment for failing to meet the sustainability criteria that were agreed upon.</li> <li>- Set up a system that enables suppliers to regularly (e.g. quarterly) monitor and report their environmental performance.</li> <li>- Pay for third-party audits to verify compliance and accuracy of the reported data.</li> <li>- Provide support (e.g. technical assistance, training, access to resources, tools and guidelines) to suppliers to help them achieve the environmental performance targets.</li> <li>- Encourage continuous improvement by setting progressively higher targets over time.</li> <li>- If financially feasible, use traceability tools (e.g. blockchain-based) and platforms (e.g. Higg Index) to track the environmental performance of suppliers.</li> </ul>
Suppliers/WPUs	<ul style="list-style-type: none"> <li>- Align environmental performance targets with customers and work together to achieve them, following the principle of shared responsibility.</li> <li>- Evaluate technology and processes available to meet these targets and invest in upgrades if necessary.</li> <li>- Reach out to customers to discuss sustainable and/or collaborative financing options.</li> <li>- Commit to continuous improvement practices in the specific performance areas to demonstrate willingness to improve.</li> <li>- Participate in industry initiatives that advocate for responsible business conduct and sustainable practices.</li> <li>- Only engage in robust contracts with customers that foster long-term partnerships. Set up incentive-based business relationships and contracts with own suppliers (e.g. material and/or chemical suppliers).</li> </ul>

These clauses ensure fair treatment, promote sustainability, and foster long-term partnerships built on shared responsibility. To be more effective, environmental performance clauses should

be linked to RPP to ensure that contracts explicitly refer to sustainability requirements that suppliers must meet.

### 2.2.2.3 Instrument 3: Responsible purchasing practices

The Common Framework for Responsible Purchasing Practices (CFRPP) provides a structured approach to incentivise suppliers to improve their overall sustainability performance through RPP. Five elements are key to establishing RPP between buyers and suppliers in the textile and fashion industry: integration and reporting, equal partnership, collaborative production planning, fair payment terms and sustainable costing (Ethical Trading Initiative et al. 2022). By aligning purchasing practices with environmental performance targets, the CFRPP can help create the conditions that value and reward improved environmental performance, encouraging suppliers to adopt and maintain sustainable practices. Some of these recommendations are partially implemented between brands/retailers and their strategic suppliers, but not comprehensively. This approach is seen as too costly and time-consuming for occasional suppliers, who, according to various interview partners, usually account for 80% of suppliers, but only cover 20% of production volume. In general, buyers argue that they have more leverage with their strategic suppliers and therefore focus sustainability measures on them.

**Table 3: Key actors and actions for implementing responsible purchasing practices**

Key Actors	Actions for Implementation
Brands/retailers	<ul style="list-style-type: none"> <li>- Integrate RPP into corporate strategy and decision-making process.</li> <li>- Build long-term sourcing relationships with suppliers and pursue win-win situations, sharing responsibility to improve in specific performance areas (e.g. chemical, water and wastewater management).</li> <li>- Collaboratively plan production with suppliers, reducing samples, increasing forecasting accuracy, and balancing orders, among other things, and ensure that changes are agreed upon mutually.</li> <li>- Ensure that suppliers are paid in a timely manner and at fair prices (e.g. Letter of Credit (LC) at sight or LC 30 days) that provides them with the financial stability they need to invest in improved environmental performance (fair payment terms).</li> <li>- Agree with suppliers on reasonable penalties (see 2.2.2.2).</li> <li>- Make sure prices cover all production costs and enable responsible business conduct. To make this happen, long-term partnerships provide suppliers with the stability needed to invest in sustainable practices.</li> <li>- Work closely with suppliers on production schedules to avoid last-minute changes, which can increase waste and inefficiencies (collaborative production planning).</li> <li>- Encourage suppliers to regularly report on their environmental performance (integration &amp; reporting).</li> <li>- Consider using the data to recognise and reward suppliers who demonstrate significant improvements.</li> <li>- Implement costing models that account for environmental impacts to incentivise suppliers to improve their chemical, water and wastewater management (sustainable costing).</li> <li>- Treat suppliers as equal partners where both parties are invested in pursuing improved environmental performance (equal partnership).</li> </ul>
Suppliers/WPUs	<ul style="list-style-type: none"> <li>- Engage in transparent communication with brands/retailers, maintaining open lines of communication with customers to discuss expectations, challenges, and opportunities for improvement.</li> <li>- Provide regular updates on production status, potential delays, and any issues that may affect delivery timelines.</li> </ul>

Key Actors	Actions for Implementation
	<ul style="list-style-type: none"> <li>- Negotiate fair payment terms and reasonable lead times that allow for sustainable production without excessive pressure.</li> <li>- Work with customers to develop accurate forecasts, preventing overproduction and waste.</li> <li>- Share information about production capacity and constraints to align expectations and avoid unrealistic demands.</li> <li>- Implement sustainable practices, monitor progress and communicate proactively.</li> <li>- Meet relevant requirements (e.g. ZDHC) and obtain relevant certifications (e.g. OEKO-TEX, bluesign) to demonstrate commitment to RPP.</li> </ul>

#### 2.2.2.4 Instrument 4: Offtake agreements

Brands/retailers in the fashion industry can make use of offtake agreements in several ways to incentivise suppliers to enhance their environmental performance, such as the conformance with ZDHC requirements. According to interviews with industry actors, offtake agreements with suppliers are used to secure stable supply of materials or products. By providing a long-term purchasing commitment, offtake agreements can offer suppliers the financial stability needed to invest in, for instance, water-saving technologies and other environmentally friendly practices related to the target. This assurance can reduce the risk associated with making such investments. Agreeing to purchase a specific volume of products can encourage suppliers to optimise their production processes, leading to more efficient use of resources (water, energy, chemicals) and reduced waste. If suppliers know they have consistent demand, they might be more willing to implement environmentally friendly practices and purchase chemicals that are safe, sustainable and conformant with the ZDHC requirements. Linking offtake agreements to environmental performance metrics related to chemicals, water and wastewater could provide an incentive for suppliers to improve their performance in the environmental target areas (see 2.2.2.2; FasterCapital 2024a; FasterCapital 2024b). Offtake agreements can also include clauses that offer higher prices for products that meet certain environmental standards, such as 100% conformance with the ZDHC MRSL or any other water/chemical-related requirements. This financial incentive can motivate suppliers to adopt environmentally friendly practices to qualify for the premium.

**Table 4: Key actors and actions for implementing offtake agreements**

Key Actors	Actions for Implementation
Brands/retailers	<ul style="list-style-type: none"> <li>- Commit to purchasing a specified quantity of goods over a set period of time, providing suppliers with financial stability and predictability.</li> <li>- Arrange agreements that lock in prices, protecting both parties from market fluctuations and ensuring cost predictability.</li> <li>- Include options that i) incorporate clauses that adjust prices based on inflation indices, allowing for periodic price reviews and adjustments, ii) implement flexible pricing models that account for changes in raw material costs, labour and other inflation-related expenses, iii) establish cost-sharing agreements, where both parties share the increased cost, or iv) schedule regular negotiations to reassess and adjust prices based on current market conditions and inflation rates.</li> <li>- Include environmental performance metrics focusing on chemical, water and wastewater management.</li> <li>- Include clauses that reward suppliers for consistently meeting sustainability benchmarks in the areas of water, wastewater and chemical management.</li> </ul>

Key Actors	Actions for Implementation
	<ul style="list-style-type: none"> <li>- Encourage suppliers to develop new materials or processes by offering rewards for successful innovations in terms of water efficiency and chemical safety.</li> </ul>
Suppliers/WPUs	<ul style="list-style-type: none"> <li>- Use the guaranteed revenue from offtake agreements to invest in environmentally friendly technology upgrades, among other things, to meet the demand and improve the environmental performance in terms of chemical, water and wastewater management.</li> </ul>

### 2.2.2.5 Instrument 5: Process certifications

Process certifications in the textile and fashion industry can significantly enhance supplier performance in chemical, water and effluent management by setting clear standards and providing frameworks for best practices. In the absence of mandatory regulatory requirements, voluntary sustainability standards and certifications can provide a framework for a performance-based approach and provide information about the supplier’s capabilities (Botta and Forbicini 2023; Strasser et al. 2024). The following non-exhaustive list of certifications encourages continuous improvement, compliance with regulations, and adoption of best practices, ultimately leading to better chemical, water and wastewater management. Some of these certifications like bluesign or STeP by OEKO-TEX provide a systematic approach for textile manufacturers to manage chemicals responsibly and reduce environmental impact. As they are also aligned with the ZDHC requirements, companies prefer to work with/onboard factories that are certified and thus have already established some sort of management system. ZDHC itself is not a certification but provides guidelines and tools for managing hazardous substances, helping suppliers improve towards industry best practices (ZDHC 2024a; ZDHC 2024b).

- ▶ **bluesign** is primarily a business-to-business certification system verified by a third-party audit. It provides a chemical management system that enables manufacturers to select and use safe chemicals. Bluesign-approved chemicals meet stringent safety criteria that align with the ZDHC objective to eliminate harmful chemicals from the textile supply chain. Products that meet the stringent bluesign standards can carry the consumer-oriented bluesign label.
- ▶ **STeP by OEKO-TEX** is a certification system aimed at promoting sustainable manufacturing processes in the textile and leather industries. It evaluates production facilities based on six performance areas: chemical management, environmental performance, environmental management, social responsibility, quality management, and health and safety. The STeP by OEKO-TEX requirements align well with the environmental target set by the focal company for this roadmap. It ensures chemical safety and effective resource management through several measures, such as the implementation of a chemical management system, the evaluation and improvement of the environmental performance, effective waste management, continuous improvement by setting targets and monitoring progress, training of relevant staff, and certification and auditing (OEKOTEX 2023).
- ▶ **ISO 14001** encourages the continuous improvement of environmental performance through the establishment of an Environmental Management Systems (EMS), which is based on a continuous Plan-Do-Check-Act (PDCA) cycle. The environmental performance and the function of the management system are regularly monitored and measured based on targets and performance indicators, internal audits and management reviews (ISO 2021; ISO 2023). While ISO 14001 does not explicitly reference ZDHC, companies already certified as ISO 14001 might find it easier to integrate ZDHC requirements into their management systems.

Adopting best practices for chemical management and ensuring conformance with e.g. the ZDHC MRSL can also complement the environmental management objectives of ISO 14001.

**Table 5: Key actors and actions for implementing process certifications**

Key Actors	Actions for Implementation
Brands/retailers	<ul style="list-style-type: none"> <li>- Only onboard suppliers with certifications that cover chemical and water management or who are registered with ZDHC or equivalent schemes.</li> <li>- Set high standards for both environmental and social requirements. If suppliers do not have the required certifications, brands/retailers may refuse to work with them.</li> <li>- Check which certifications integrate or align with other industry standards to prevent suppliers from complying with differing requirements. Ensure that certifications (e.g. STeP by OEKO-TEX) provide access to industry-wide environmental performance platforms (e.g. ZDHC Gateway, Higg Index), so that wastewater testing results automatically translate into a ZDHC ClearStream report, which simplifies the overall process and reduces cost. This access can help suppliers improve their sustainability practices and increase their readiness for certification.</li> <li>- Provide incentives to suppliers for obtaining relevant certifications related to chemical and water management, such as ZDHC, bluesign or equivalent requirements.</li> </ul>
Tier 1 suppliers	<ul style="list-style-type: none"> <li>- Make sure to only source from WPU's that meet ZDHC requirements or have a certification that is aligned with ZDHC requirements.</li> <li>- Advocate to their customers that WPU's with which they preferably work, but which are not yet on the customer's nomination list, are included in the water stewardship programme.</li> <li>- Closely engage with preferred WPU's to meet the entry barriers (e.g. ZDHC conformance, social and environmental standards) for the water stewardship programme.</li> <li>- Offer bonuses to WPU's for meeting the required standards, certifications and requirements.</li> <li>- Negotiate long-term contracts with customers in return for purchasing from reliable, certified sources.</li> </ul>
WPU's	<ul style="list-style-type: none"> <li>- Adopt the ZDHC MRSL to ensure that only approved chemicals are used in the manufacturing process.</li> <li>- Implement a comprehensive chemical management system with a detailed inventory of all chemicals that meet ZDHC (or equivalent) specifications.</li> <li>- Work closely with chemical suppliers to make sure that they source chemicals that are compliant with the ZDHC requirements.</li> <li>- Conduct regular training for their employees to use and handle chemicals safely and meet the ZDHC requirements.</li> <li>- Optimise processes to reduce chemical use and improve efficiency, minimising environmental impact.</li> <li>- Follow the ZDHC Wastewater Guidelines to monitor and manage wastewater quality, ensuring it meets the ZDHC requirements.</li> </ul>
Standard setting organisations (e.g. ISO, OEKO-TEX, GOTS)	<ul style="list-style-type: none"> <li>- Build standards on relevant sustainability requirements that have been increasingly adopted by the industry (e.g. ZDHC MRSL, ZDHC Wastewater Guidelines, Greenpeace Detox). For instance, OEKO-TEX® DETOX TO ZERO was developed to proactively work towards achieving Greenpeace Detox goals that are similar to the ZDHC goals.</li> </ul>



Key Actors	Actions for Implementation
	<ul style="list-style-type: none"> <li>- If possible, work closely with other standards and sustainability initiatives to harmonise requirements and create a unified approach to environmental performance.</li> <li>- Engage a diverse range of stakeholders (e.g. manufacturers, CSOs, researchers) in the standard development process to ensure that the standards are comprehensive and practical.</li> <li>- Include detailed guidelines for chemical and wastewater management across the supply chain.</li> </ul>
Conformance assessment bodies/certification bodies	<ul style="list-style-type: none"> <li>- Conduct third-party audits to verify compliance with relevant environmental standards. Provide factories with detailed feedback on areas for improvement.</li> <li>- Provide feedback to standard setting organisations for improving standardised processes for environmental management, data collection, and reporting.</li> <li>- Offer training programmes to brands/retailers and supplier factories to understand and implement environmental management standards</li> </ul>

### 2.2.2.6 Instrument 6: Environmental performance platforms

Continuous monitoring of supplier performance in environmental performance areas can best be achieved by joining environmental performance platforms. Here, suppliers record and upload data from different performance areas, such as chemical use or water and energy consumption. Environmental performance platforms like ZDHC and Higg Index/Worldly provide comprehensive assessment tools to improve the sustainability performance, facilitating data sharing and benchmarking, offering training and capacity building, and fostering collaboration across the industry (Cascale 2024; ZDHC 2024b).

- ▶ The **ZDHC Gateway** is an online platform that is designed to promote safer and more sustainable practices in the textile, apparel, leather, and footwear industries (Stichting ZDHC Foundation 2023b; Stichting ZDHC Foundation 2023d). It consists of two modules: chemical and wastewater. The Chemical Module is a comprehensive database of safer chemistry for the industry. It allows suppliers and manufacturers to register their chemical products and make public their ZDHC MRSL conformance levels. The website also offers complete safety and sustainability information on registered chemicals (ZDHC Gateway 2018). The Wastewater Module allows suppliers to share verified wastewater data and demonstrate their performance to customers (Stichting ZDHC Foundation 2023c). It provides guidance on opportunities for improvement and generates wastewater reports (ZDHC ClearStream Report) that were verified by ZDHC Accepted Laboratories. Additional tools and reports help ensure supply chain transparency and promote the use of safer chemicals. The ZDHC ChemCheck Report serves as a chemical formulation product passport that confirms compliance with the ZDHC MRSL (Stichting ZDHC Foundation 2023a). The Performance InCheck Report provides an overall score of conformance with the ZDHC MRSL (ZDHC 2020).
- ▶ The **Higg FEM** (Facility Environmental Module) provides a comprehensive framework for facilities to assess their environmental performance across several key areas, including energy use and greenhouse gas (GHG) emissions, water use, wastewater, emissions to air, waste management, and chemical use and management. Following a self-assessment, the accuracy and credibility of the data provided is verified by an accredited third party. The scores generated from the verified data allow facilities to benchmark their performance against industry standards. The scoring system helps facilities identify where they stand in

terms of environmental performance and highlights areas for improvement. Based on the assessment results, facilities can develop and implement improvement plans. The Higg FEM provides guidance on best practices and strategies to improve environmental performance in specific areas.

**Table 6: Key actors and actions for using environmental performance platforms**

Key Actors	Actions for Implementation
Brands/retailers	<ul style="list-style-type: none"> <li>- Set clear standards, such as the ZDHC MRSL and the most recent ZDHC Wastewater Guidelines, which define specific criteria and expectations for chemical, water and wastewater management that suppliers must meet.</li> <li>- Jointly implement with suppliers/WPUs monitoring technologies that enable WPUs to track water usage and chemical discharges in real-time and communicate them to their clients.</li> <li>- Regularly verify the performance through internal and/or third-party audits that also identify areas for improvement. Give regular performance feedback to strategic suppliers and offer technical assistance for implementing corrective measures and best practices.</li> <li>- Have strategic suppliers join platforms for sharing data and insights into relevant reports (e.g. ZDHC ClearStream).</li> <li>- Include specific clauses in supplier contracts that mandate the use of Higg FEM and conformance with ZDHC requirements. Stipulate the expectations, timelines and consequences for non-compliance.</li> <li>- Offer training programmes and technical assistance to help suppliers use the Higg FEM and meet the ZDHC requirements. Work together with strategic suppliers to address the identified issues and implement best practices, building a trust-based long-term relationship.</li> <li>- Offer financial incentives, such as bonuses or discounts on future orders, for suppliers who successfully implement these requirements and meet the environmental performance targets.</li> <li>- Establish financial support programmes to help suppliers with the initial cost of implementing necessary changes.</li> <li>- Pay for regular third-party audits to verify that suppliers are meeting the requirements.</li> <li>- Require suppliers to share their Higg FEM scores and ZDHC conformance data. Maintain regular communication with suppliers to discuss their progress, challenges, and any support they might need. Integrate the use of Higg FEM and ZDHC conformance with other sustainability initiatives and certifications (e.g., OEKO-TEX, bluesign, ISO 14001) to ensure that all relevant sustainability aspects are addressed.</li> </ul>
Suppliers/WPUs	<ul style="list-style-type: none"> <li>- Install sensors and automated monitoring systems (e.g. smart water meters, chemical inventory trackers, wastewater monitoring solutions, environmental monitoring systems to track emissions) to track water usage, chemical inputs, and emissions in real-time.</li> <li>- Regularly collect data and develop management systems to analyse and report on environmental performance.</li> <li>- Use the monitoring data to implement continuous improvement processes, optimise the resource use and reduce waste (e.g. chemicals, water), thereby saving cost.</li> <li>- Upload the data to relevant platforms that can be accessed by customers (brands/retailers).</li> <li>- Collaborate with brands/retailers and align monitoring practices with their sustainability goals and reporting requirements.</li> <li>- Use the assessment results to identify improvement areas, particularly in chemicals, water and wastewater. Implement, for instance, the Higg FEM</li> </ul>

Key Actors	Actions for Implementation
	<p>best practice guidelines and resources for each area of assessment. Use the resources to implement more sustainable practices, such as water-saving measures or chemical management systems.</p> <ul style="list-style-type: none"> <li>- Conduct periodic assessments to track progress and make adjustments to the improvement plans.</li> <li>- Share verified environmental performance data with customers through the Higg Index platform, where brands/retailers can access the results.</li> </ul>

### 2.2.2.7 Instrument 7: Green and collaborative financing

Green financing programmes can significantly enhance the environmental performance of textile and fashion suppliers by providing the financial resources and incentives needed to implement sustainable practices. This may include upgrading machinery and equipment to more efficient models, installing water treatment systems, or adopting closed-loop systems that minimise chemical emissions. Financial support can come either from brands/retailers through supplier financing programmes or collaborative funding mechanisms, from international organisations (e.g. grants) or from international or national financial institutions (Ahi and Searcy 2015; Khurana and Ricchetti 2016; Köksal et al. 2017; IFC 2021). Many green financing programmes offer incentives such as lower interest rates or grants for companies that meet certain sustainability criteria. This encourages suppliers to adopt practices that reduce chemical use and water pollution. Very often, however, the focus is still on the transition to a low-carbon textile industry (H&M Group 2024). Green financing can also be used to reduce the use of hazardous chemicals and/or switch to water-saving and energy efficient alternatives, such as enzymes (Juniper Policy Consulting (Pvt.) Limited 2024). This involves changing processes and using improved technology.

**Table 7: Key actors and actions for implementing green and collaborative financing**

Key Actors	Actions for Implementation
Brands/retailers	<ul style="list-style-type: none"> <li>- Set up supplier financing programmes that offer preferential loan terms or lower interest rates for suppliers who invest in environmentally friendly technologies and practices (e.g. water-saving technologies, new processes for sustainable chemical substitutes).</li> <li>- Reward suppliers that achieve their environmental performance targets, such as improved water efficiency, less water pollution, or full conformance with ZDHC requirements.</li> <li>- Collaborate with banks or financial institutions to create dedicated financing lines for suppliers and secure better financing terms for suppliers.</li> <li>- Offer long-term contracts or guaranteed order volumes to provide suppliers with the financial stability needed to invest in improved environmental performance.</li> <li>- Provide technical assistance and capacity building to support suppliers on relevant environmentally friendly practices and technologies. This could include workshops, access to technical experts, or guidance on achieving relevant certifications/requirements.</li> <li>- Set up partnerships with sustainability initiatives or MSIs (e.g. Cascale, Textile Exchange), suppliers and non-governmental organisations (NGOs) to co-fund environmental performance programmes. This could help reduce risk and lower the entry barriers for suppliers to participate.</li> </ul>

Key Actors	Actions for Implementation
Suppliers/WPUs	<ul style="list-style-type: none"> <li>- Implement EMS to set the groundwork for improved environmental performance.</li> <li>- Participate in self-assessment tools/programmes, such as the Higg Index, to increase transparency and improve reporting.</li> <li>- Actively engage with customers by communicating environmental performance goals and progress to customers.</li> <li>- Create detailed plans for environmental performance improvements.</li> <li>- Clearly outline the expected environmental and financial benefit.</li> <li>- Demonstrate how the project aligns with the customer’s environmental performance goals.</li> <li>- Implement digital tools for better data collection and reporting.</li> </ul>
Financial institutions	<ul style="list-style-type: none"> <li>- Provide green loans specifically designed for improving environmental performance with favourable terms, such as lower interest rates, longer repayment periods or deferred payments, to encourage investments in the key areas.</li> <li>- Provide sustainability-linked loans; these are loans with interest rates linked to the borrower’s sustainability performance. If the supplier meets predefined environmental performance targets, they benefit from reduced interest rates.</li> <li>- Implement financing models where repayment terms are linked to the achievement of specific environmental outcomes. This ensures that suppliers are incentivised to meet performance targets.</li> <li>- Require suppliers to provide regular reports on their environmental performance as a condition of financing. This ensures transparency and accountability.</li> </ul>
International organisations	<ul style="list-style-type: none"> <li>- Collaborate with governmental agencies and financial institutions to provide grants for environmental projects to help suppliers cover the initial cost or get funding at affordable interest rates.</li> <li>- Offer advisory services to help suppliers understand the benefits of their investments (e.g. business cases, feasibility studies, cost-benefit analyses).</li> <li>- Provide guarantees to reduce the risk for lenders (e.g. local banks).</li> <li>- Collaborate with industry initiatives like ZDHC and Cascale/Higg to ensure that financed projects align with industry standards and certifications.</li> </ul>

### 2.2.2.8 Instrument 8: Training/capacity building

Capacity building, training and education are crucial for suppliers to develop their employees in focus areas that determine their sustainability performance (e.g. data collection, monitoring, chemical inventory, etc.). While brands can offer capacity building and training to their suppliers, sustainability initiatives and MSIs also play an important role since: i) they bring together diverse perspectives and expertise from different actors, ii) they can leverage their extensive networks and reach a larger audience through their members, increasing impact, iii) and they may foster collaboration among actors, enabling sharing knowledge, resources and solutions, and fostering peer learning.

**Table 8: Key actors and actions for implementing training and capacity building**

Key Actors	Actions for Implementation
Brands/retailers	<ul style="list-style-type: none"> <li>- Brands/retailers provide technical assistance, training and resources to help suppliers improve their environmental practices and meet</li> </ul>

Key Actors	Actions for Implementation
Suppliers/WPUs	<p>compliance with e.g. ZDHC requirements. This technical assistance could be linked to a ‘preferred supplier programme’ where compliant suppliers receive preferred status, leading to more business opportunities as well as better and more long-term contracts.</p> <ul style="list-style-type: none"> <li>- Conduct a thorough needs assessment to identify the specific training and capacity-building needs within the facility and employees. Use surveys, interviews, and audits to understand the current state and areas needing improvement.</li> <li>- Develop training content that is tailored to the specific needs and challenges of the facility. Partner with sustainability experts, industry associations, and certification bodies to develop and deliver high-quality training programmes.</li> <li>- Ensure that effective training methods (e.g. interactive, in-person, peer-learning) are used to engage participants and enhance the outcome.</li> <li>- Ensure access to resources, such as manuals, guidelines and best practice documents that employees can use.</li> <li>- Establish key performance indicators (KPIs) to monitor the effectiveness of the training programmes, regularly assess the impact of the training programme and consider third-party verification to ensure the accuracy and credibility of the performance data.</li> <li>- Align training with organisational goals and secure top management commitment.</li> </ul>
MSIs/sustainability initiatives	<ul style="list-style-type: none"> <li>- Develop comprehensive training modules on chemical, water and wastewater management. This training should be tailored to the specific needs of the suppliers and ensure hands-on experience.</li> <li>- Create and distribute educational materials, such as guidelines, case studies, and best practice documents. These materials can serve as reference points for suppliers.</li> <li>- Engage with digital platforms to provide access to webinars and interactive tools. Platforms like the ZDHC Academy offer specialised training in sustainable chemical management.</li> <li>- Organise workshops, roundtables and conferences where both brands/retailers and suppliers can learn from industry experts and share experiences with peers.</li> <li>- Develop certification programmes that recognise suppliers who have successfully completed training and implemented sustainable practices.</li> <li>- Collaborate with international organisations and financial institutions to offer grants and subsidies for training and capacity building.</li> <li>- Offer technical assistance to help suppliers implement the knowledge gained from training and educational programmes.</li> <li>- Implement monitoring and evaluation systems to track the progress of the suppliers.</li> </ul>
National/international organisations	<ul style="list-style-type: none"> <li>- Offer impact-oriented training programmes, workshops and webinars to educate suppliers on best practices in chemical, water and wastewater management.</li> <li>- Provide technical assistance and resources to help suppliers implement sustainable practices and technologies.</li> </ul>

While sustainability initiatives and MSIs can play an important role in providing guidelines, resources and training, their impact often has been criticised as limited and intransparent (MSI Integrity 2020). MSIs often rely on voluntary compliance and lack the enforcement and monitoring mechanisms needed to ensure that all participants adhere to agreed standards and

practices. One criticism is that improvements in human rights and the environment on the ground with rights holders have been scarce, as capacity-building measures often only focussed on output, instead of outcome or even impact level (MSI Integrity 2020).

### 2.2.2.9 Instrument 9: Improved supplier/factory communication

Effective communication between buyers and suppliers is key to enhancing sustainability performance. Brands/retailers and their suppliers (Tier 1, WPU) need to engage in proactive, structured communication to foster a collaborative environment that drives improvement in chemical, water and wastewater management.

**Table 9: Key actors and actions for improved communication between brands/retailers and suppliers/factories**

Key Actors	Actions for Implementation
Brands/retailers	<ul style="list-style-type: none"> <li>- Clearly communicate sustainability standards, guidelines, and performance expectations regarding chemical, water, and wastewater management right from the beginning of the business relationship, when initiating the contact.</li> <li>- Offer training programmes, resources, and technical support to help suppliers understand and implement monitoring that allows for constructive feedback on the suppliers’ performance, identifying areas for improvement.</li> <li>- Encourage open and transparent communication channels where suppliers can discuss challenges, share progress, and seek guidance without fear of repercussions (e.g. sanctions, contract termination).</li> <li>- Work collaboratively with suppliers to develop and implement solutions to any identified issues, leveraging expertise from both sides.</li> <li>- Create incentives for suppliers/WPUs that meet or exceed sustainability performance targets, such as preferred supplier status or financial rewards (see 2.2.2.7).</li> </ul>
Suppliers/WPUs	<ul style="list-style-type: none"> <li>- Ensure a thorough understanding of the brand/retailer sustainability expectations and align internal processes accordingly.</li> <li>- Provide regular, transparent reports on chemical usage, water consumption, and wastewater management practices, including any challenges faced.</li> <li>- Implement industry best practices and technologies to improve chemical, water and wastewater management.</li> <li>- Provide space for employees to participate in training, workshops and capacity-building activities offered by brands/retailers, MSIs, national and international organisations.</li> <li>- Proactively communicate with customers. Work closely with brands/retailers to develop and implement effective solutions to challenges in chemical, water and wastewater management, sharing insights and innovations.</li> </ul>

### 2.2.2.10 Instrument 10: Direct sourcing/vertical supply chain integration

Direct sourcing and vertical supply chain integration can provide companies with greater control and transparency in implementing sustainable chemical, water, and wastewater management practices in the textile and fashion industry. Sourcing from composite units (e.g. Tier 1-2 or Tier 1-3, in few geographies even Tier 1-4 is possible, like in China or Pakistan) allows brands/retailers to have greater control over multiple stages of the production process. This also improves the negotiating position of suppliers, diminishing power imbalances between brands/retailers and suppliers.

**Table 10: Key actors and actions for direct sourcing/vertical supply chain integration**

Key Actors	Actions for Implementation
- Brands/retailers	<ul style="list-style-type: none"> <li>- Source from composite units that address sustainability issues, such as chemical use, water consumption and wastewater discharge.</li> <li>- Ask for chemical, water and wastewater data from composite units and make decisions based on their resource use and their chemical, water and wastewater management.</li> <li>- If composite units are not available, build business relationships with WPUs, testing their sustainability performance and nominating them as preferred fabric suppliers. Incentivise Tier 1 suppliers to only source from nominated/preferred WPUs.</li> </ul>
- Tier 1 supplier	<ul style="list-style-type: none"> <li>- Expand into areas like textile production, knitting/weaving, and dyeing if financially feasible. If that is not possible, establish multi-tier supplier collaboration with WPUs/Tier 2 fabric suppliers.</li> <li>- Coordinate and plan between internal departments and WPUs to ensure optimised supply chain flow, following sustainability performance requirements.</li> <li>- Collaborate with WPUs to develop and agree on common sustainability standards and best practices for chemical, water and wastewater management.</li> <li>- Join training programmes and workshops to ensure both tiers are aligned on the latest best practices and regulatory requirements.</li> <li>- Establish agreements with WPUs for sharing relevant data on chemical usage, water consumption, and wastewater treatment processes.</li> <li>- Engage external experts and consultants to provide guidance and support for implementing advanced sustainability practices in chemical, water and wastewater management.</li> </ul>
- WPUs	<ul style="list-style-type: none"> <li>- Engage in multi-tiered supplier collaboration with Tier 1 factories (see above).</li> <li>- Participate with chemical suppliers and other actors in industry-wide sustainability initiatives and multi-stakeholder platforms to stay informed about emerging trends in chemical, water and wastewater management.</li> </ul>

For more information on multi-tiered supplier collaboration, see Sabri (Sabri 2023).

### 2.2.2.11 Instrument 11: Policymaking/lobbying

Drawing on interviews with the focal company and other experts, actors in the textile and fashion industry should advocate for improved policymaking regarding chemical, water, and wastewater management through multiple strategic actions:

**Table 11: Key actors and actions for policymaking/lobbying**

Key Actor	Actions for Implementation
- Brands/retailers + suppliers	<ul style="list-style-type: none"> <li>- Actively lobby for stricter regulations and policies that promote safer chemicals (e.g. the phase-out of hazardous chemicals) and improve water and wastewater management standards in regions where cotton is produced, and the textiles are being processed.</li> <li>- Engage actively in MSIs that support sustainable practices in chemical, water and wastewater management.</li> </ul>

Key Actor	Actions for Implementation
	<ul style="list-style-type: none"> <li>- Form partnerships with NGOs and environmental organisations that have expertise in chemical, water and wastewater management.</li> <li>- Publish detailed sustainability reports that showcase the brand's/retailer's actual results in chemical, water and wastewater management across the supply chain.</li> <li>- Clearly demonstrate sustainability performance with strategic and occasional suppliers, providing transparency.</li> </ul>
<ul style="list-style-type: none"> <li>- MSIs</li> </ul>	<ul style="list-style-type: none"> <li>- Develop in collaboration with other actors (e.g. industry associations, international organisations, governmental organisations in producer countries) and submit policy proposals to government agencies and regulatory bodies, outlining specific measures and standards for sustainable chemical, water and wastewater management.</li> <li>- Participate in public consultations and hearings on environmental regulations, providing expert knowledge and data to support more stringent policies. Give constructive feedback on policies.</li> <li>- Organise and participate in industry forums and conferences that focus on sustainability and regulatory improvements in chemical, water and wastewater management.</li> </ul>
<ul style="list-style-type: none"> <li>- National/International organisations</li> </ul>	<ul style="list-style-type: none"> <li>- Work with industry associations or umbrella initiatives (e.g. STAR Network) to advocate for sustainable practices and improved regulations on chemical, water and wastewater management.</li> <li>- Launch public awareness campaigns to educate consumers and actors about the importance of sustainable chemical, water, and wastewater management.</li> </ul>

For more information on the STAR Network (Sustainable Textiles of the Asian Region), see Asia Garment Hub (Asia Garment Hub 2024).

### 2.2.3 Other instruments

Some instruments were not considered by the focal company as suitable for the target to increase the compliance with ZDHC requirements and reduce water pollution. However, they may be in use for other environmental targets (e.g. carbon emission reductions):

- ▶ **Price premiums:** are already used by the focal company to pay the organic differential and for certified facilities. For chemicals and wastewater, the company admits that pressure by civil society and consumer awareness are not high enough to justify increased prices.
- ▶ **Collaborative financing:** an instrument that could be used for larger investments, mostly in topics such as carbon emission reductions where political pressure is higher and conversion to different fuels or more environmentally friendly technology (e.g. 'clean' boilers) is imminent.
- ▶ **Shared audits:** according to the focal company, this instrument is not very common for environmental topics; for wastewater and chemical targets, environmental performance platforms like ZDHC or Higg Index are more relevant.



## **2.2.4 Discussion of the roadmap for the cotton-garment supply chain**

The key instruments presented in the roadmap are intended to overcome some of the challenges described in section 2.2.1 that the focal company and their supply chain partners face in reducing water pollution and improving chemical management. The roadmap includes only those instruments that the focal company and relevant stakeholders believe have the greatest leverage and does not represent a comprehensive guide to implementing SSCM to reduce water pollution.

According to interviews with the focal company and other relevant stakeholders, supplier codes of conduct are key for brands/retailers to start a business relationship with suppliers, stating guidelines and expectations and ensuring that suppliers adhere to sustainable practices. To make this instrument more effective in terms of environmental performance, comprehensive codes of conduct eventually would need to be integrated into contractual agreements between buyers and their suppliers.

In order to achieve environmental performance targets, in particular chemical, water and wastewater management targets, brands/retailers prefer onboarding and sourcing from suppliers that carry relevant process certifications (e.g. STeP by OEKO-TEX, bluesign) or meet sector-specific key requirements, such as the ZDHC MRSL or the ZDHC Wastewater Guidelines.

Once the quality of the product and a basic level of sustainability have been assured, brands/retailers enter into contract negotiations. Contracts that integrate sustainability-linked offtake agreements, environmental performance clauses and RPP ensure that sustainability is at the core of the business relationship. These measures should start early, but not at the outset, as there is a need to establish trust first. Although contracts are binding, power imbalances in the sector mean that they are sometimes not honoured in the event of force majeure, as was the case during the COVID-19 pandemic.

Setting environmental performance targets and defining rewards and sanctions in contracts means assigning responsibilities and timelines and working towards them. Investments in technology and infrastructure are needed to meet these requirements. This includes, for example, upgrading machinery and/or implementing new effluent treatment systems, but also the adoption of cleaner production processes and general process improvements. Access to finance is essential for suppliers aiming to achieve ambitious environmental performance targets. The process of obtaining certifications and ensuring compliance with ZDHC requirements can involve significant costs, including fees for audits, testing, and documentation. Buyers and international organisations (e.g. multi-lateral banks) have opportunities to support key suppliers with funding to initiate the necessary actions. Green financing instruments, such as green loans or sustainability-linked loans, and collaborative financing schemes can help the focal company and their key/strategic suppliers to set long-term goals and achieve greater improvements through significant investment in environmentally friendly technologies and processes. Such measures are typically only offered to trusted suppliers.

Supplier capacity building and transparent communication can be effective tools to overcome challenges and improve in relevant performance areas (chemical, water and wastewater management) – if adequately designed.

Environmental performance platforms can play a crucial role in enhancing the effectiveness of offtake agreements and model contract clauses (MCC), as they provide the necessary tools and resources for suppliers to regularly monitor data and manage and improve specific performance areas (e.g. water consumption, energy efficiency, conformance with specific MRSL).

Sourcing from composite units (e.g. Tier 1-2, Tier 1-3) is not always possible but when it is, it can give the focal company greater control over the resources used and the overall sustainability performance.

Supply-chain collective initiatives, such as water stewardship programmes, ensure that all relevant actors are involved in water, chemical and wastewater management activities in certain segments of the supply chain. Challenges are often systemic and can only be addressed through concerted action by key stakeholders. Industry collaboration is vital to improving sustainability performance in the textile and fashion industry and achieving the environmental targets. It enables companies to share knowledge from the outset, align practices with regulatory requirements, and create a culture of innovation to tackle the challenges in the industry.

Policymaking in both consumer and producer countries of the cotton-garment supply chain is crucial for achieving improved environmental performance. Effective policies can establish clear environmental standards and regulations that guide the industry towards sustainable practices. This includes setting limits on emissions, waste, and resource use. Very often, these standards and regulations are not in place in producer countries or are not effectively enforced due to a lack of inspection capacity (Strasser et al. 2024). To bring about change, MSIs, brands/retailers and suppliers need to actively advocate for improved policies that enhance chemical, water and wastewater management (e.g. phasing-out hazardous substances; testing for strict limits of pollutants), creating a level-playing field. Policymaking can provide financial incentives, such as tax breaks or subsidies, for companies that invest in sustainable technologies and practices. This encourages innovation and adoption of environmentally friendly methods. In this context, it is important that policies in producer countries are aligned with international environmental standards and agreements (e.g. the Stockholm Convention) to ensure that their industries remain competitive in the global market.

## 2.3 Roadmap 2: Coffee

### 2.3.1 Environmental target and background

This roadmap is intended as a strategic guide for companies in the coffee industry, focusing on enhancing sustainability by addressing deforestation, a critical environmental challenge due to its significant impact on climate change and ecosystem degradation. While deforestation is the primary focus, it should be acknowledged that there are other important environmental impacts in the coffee value chain not addressed here, such as water use, waste management and pollution, among others. The emphasis on deforestation is driven by the need to comply with the EU Regulation on Deforestation-free Products (EU Deforestation Regulation – EUDR). Compliance with the EUDR is crucial for meeting legal requirements and for positioning the industry in environmental stewardship.

Between 1990 and 2020, global deforestation resulted in the loss of approximately 420 million hectares of forest (FAO 2020). Coffee production is recognised as a significant contributor to this deforestation, with forest loss estimated at 130,000 hectares per year over the past twenty years (Panhuisen and Pierrot 2020). As global demand for coffee continues to rise, the expansion of coffee farms often links to the destruction of forests. The expansion not only leads to habitat destruction and a decline in biodiversity, but also intensifies climate change by releasing carbon stored in forests and diminishing the planet's capacity to absorb greenhouse gases (Giam 2017; Panhuisen and Pierrot 2020; UN 2022; Faria et al. 2023; Pfenning-Butterworth et al. 2024; Weiskopf et al. 2024).

Moreover, deforestation disrupts hydrological cycles, altering precipitation patterns and water availability (Ellison et al. 2017; Dhaliwal 2023). The removal of forest cover also leads to increased soil erosion and degradation, reducing soil fertility (Samec et al. 2022). The magnitude of these impacts highlights the critical need to tackle deforestation within coffee supply chains aiming not only for environmental sustainability but also for ensuring the long-term viability of the coffee industry itself.

At the global level, initiatives like the United Nations' REDD+ (Reducing Emissions from Deforestation and Forest Degradation) (UN-REDD Programme 2016) provide a framework for valuing forests' carbon storage capacity and incentivising forest conservation. The EU has taken a leading role with the introduction of the EUDR, which came into force on 29 June 2023. The EUDR significantly impacts the coffee supply chain (as one among other commodities, such as cattle, wood, cocoa, soy, palm oil, and rubber) by requiring that coffee imported into or exported from the EU must be produced on land that has not been subject to deforestation after 31 December 2020.

The EUDR mandates strict due diligence processes, compelling coffee companies to provide comprehensive traceability and sustainability documentation. This regulation aims to leverage the EU's market power to reduce global deforestation, thereby reshaping the coffee industry's approach to environmental sustainability and supply chain management (EC 2023a; EC 2023b). Consequently, coffee producers, traders, and retailers must adapt their practices to ensure compliance, potentially leading to changes in sourcing strategies, increased costs, and a shift towards more sustainable production methods. In other words, the EUDR is expected to significantly reshape market dynamics, potentially also favouring larger, more organised producers who can more easily comply with traceability requirements, and more of a producers' environment, such as local infrastructure, market access. At the national level, countries are responding differently. For instance, Brazil has implemented strict forest monitoring systems,

while countries like Vietnam and Uganda are proactively working on national traceability systems to comply with the EUDR (Quynh Chi and Meulensteen 2023).

Many coffee roasters, particularly those with a significant presence in the EU market, have proactively responded to the EUDR, recognising the critical environmental impacts of coffee production, especially concerning deforestation. In light of these regulatory requirements and industry efforts, the goal is to ensure that 100% of coffee products sold in the EU market are deforestation-free. Taking into account the postponement of the application of the EUDR, the following target was defined on this basis:

**Environmental upgrade target – coffee (large companies)**

By 30 December 2025, 100% of coffee products sold in the EU market are deforestation-free.

**Environmental upgrade target – coffee (small and medium sized companies)**

By 30 June 2026, 100% of coffee products sold in the EU market are deforestation-free.

According to information gathered through interviews and expert contributions from some coffee companies, current coffee sourcing practices normally involve a mix of direct purchases from farmers and acquisitions through intermediary traders. This approach allows companies to leverage established trade networks while maintaining direct relationships with coffee growers, particularly small-scale farmers. To ensure supply chain resilience, these companies source from a geographically diverse base, including regions in Asia, America, and Africa. Additionally, a portion of the coffee beans are certified by organisations such as Fairtrade, Rainforest Alliance, or Organic, further supporting sustainable and ethical production practices.

In pursuit of deforestation-free targets, a comprehensive network of actors throughout coffee supply chain needs to be involved. This network encompasses many actors – including coffee companies (roasters, EU importers and exporters), farmers, intermediaries (traders or intermediaries), local governments, NGOs, consumers, external auditors, and certification bodies. Within larger coffee company, various key internal departments, including finance, information technology (IT), procurement, legal, marketing, quality assurance and sustainability can take part by providing specialised knowledge in environmental issues and sustainable practices. Additionally, representatives from the management board can ensure alignment with the overall company strategy and facilitate high-level decision-making. By integrating these diverse perspectives, the efforts will be well-positioned to drive the company's sustainability agenda forward, ensuring that deforestation-free initiatives are seamlessly integrated across all aspects of the business operations. Many coffee companies have implemented regular activities to support coffee farmers in supply countries, such as training programmes on sustainable cultivation practices, coffee certification programmes for strategic farmers, joining MSIs such as the Coffee Public-Private Task Force by the International Coffee Organisation (ICO 2023), World Coffee Research aiming at developing more climate resilient varieties (World Coffee Research 2024), or stronger alignment between sustainability programmes and procurement practices.

Implementing deforestation-free practices in the coffee industry has revealed several significant challenges. The predominance of smallholder farmers coping with inadequate levels of infrastructure and low traceability in some countries makes implementing and monitoring anti-deforestation measures complex and costly (Sjoerd Panhuysen and Frederik de Vries 2023). Coffee production varies significantly across producing countries, with small producers, especially those not organised in cooperatives or associations, being the most vulnerable. Their coffee, often sold to intermediaries and mixed, poses traceability challenges (Charles 2024).

While importers bear legal liability for EUDR compliance, the burden of data gathering falls heavily on producers. Small coffee farmers may struggle to provide the required geodata, potentially leading to their exclusion from the EU market due to lack of data rather than actual deforestation practices. This situation may force farmers to shift sales to non-EU countries, contradicting the regulation's goal of reducing deforestation risk (International Coffee Partners 2024). As a result, there are questions that must be asked, namely who bears the cost/burden of collecting farm-level data, who can scale up such data gathering, and who ensures data quality, including across time. Intermediary (midstream) actors are crucial in data collection and sharing, but integrating their databases with other digital systems presents unresolved technical challenges. They may favour easily traceable farmers and exclude others, potentially making the roasters' final supply less inclusive and less diversified. Under EUDR, roasters must conduct risk analyses, but some traders withhold crucial information, e.g. geocoordinates. This reluctance stems partly from concerns about conflicting assessments between traders and roasters. Moreover, the process of data verification for the EUDR Regulatory Platform has led to duplicated efforts and overlapping data sets, further complicating compliance (Fanarioti and Pirola 2024).

Economic pressures, including price volatility and increased production costs (due to increasing input costs), prevent coffee farmers from implementing sustainability practices and investments that help them to improve their income in the long term (Fairtrade International 2023). Climate change is projected to render significant portions of current coffee-growing lands unsuitable by 2050, particularly for Arabica coffee, potentially exacerbating existing challenges for farmers. Consequently, there might be the need for them to expand production to maintain income, which can drive further deforestation (Bunn et al. 2015). The complexity of supply chains, with multiple intermediaries between farmers and exporters, further complicates traceability efforts (Grabs and Carodenuto 2021).

### **2.3.2 Description of the roadmap**

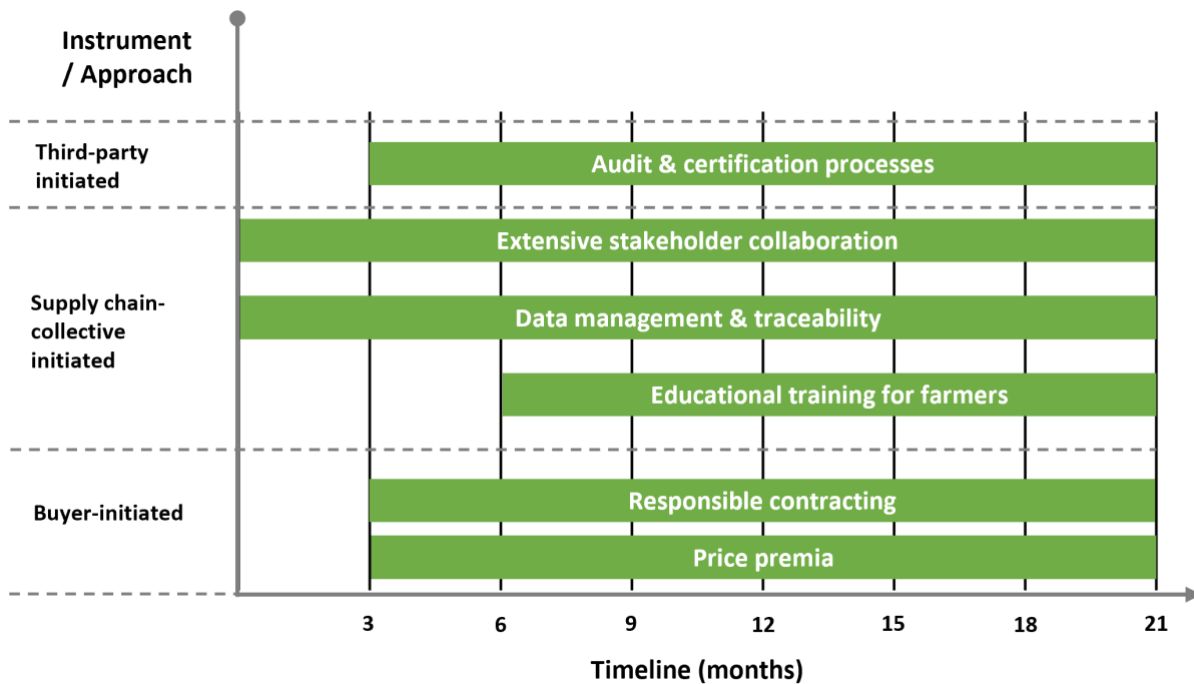
The following roadmap is based on the results of research, findings from workshops and interviews with industry experts from business, civil society, research institutions, etc., and insights shared by experts from coffee companies. The roadmap does not entail all possible SSCM instruments that companies could apply in the coffee supply chain, but only those identified as the most impactful for deforestation. This multifaceted approach aims to prevent the unintended consequence of shifting deforestation issues to other locations – a potential risk associated with the EUDR. It should be noted that, this roadmap assumes that the company applying the SSCM instruments operates as a coffee roaster, importer, and/or exporter, serving markets within the EU.

Figure 2 presents a roadmap with a combination of different instruments (audit and certification process, extensive stakeholder collaboration, data management and traceability, education and training for farmers, responsible contracting, and price premiums) initiated by individual companies (usually buyers) for enhancing environmental performance with focusing to achieve deforestation-free in the coffee supply chain. The implementation of the instruments covers a timeframe of approximately two years to achieve the mentioned environmental target, taking into account the postponement of the application of the EUDR until 30 December 2025 and for 30 June 2026 for small and medium sized companies. However, the timeline can be considered applicable for other companies when aiming for achievement deforestation-free in their supply chain. The roadmap illustrates a timeline with different instruments divided into three categories (third-party, supply chain-collective, and buyer-initiated) and their implementation periods. These instruments are designed to be implemented concurrently and span the entire

time period. This means that while they may have different starting points, they require ongoing activities to further adapt and monitor their effectiveness. While all instruments can be initiated promptly, certain ones, like ‘extensive stakeholder collaboration’ and ‘data management’ and ‘traceability’, can commence immediately. Once these instruments are established, others can follow. The initiation of each instrument also depends on available resources, for example, company personnel, experience, and knowledge of the instrument.

Each instrument and action for the respective actors will be explained in detail between 2.3.2.1 and 2.3.2.6. A more detailed description of the interconnections and dependencies between different approaches and instruments in the roadmap is presented in section 2.3.3.

**Figure 2: Roadmap for improved environmental performance in the coffee supply chain**



Source: own illustration (adelphi research gGmbH)

### 2.3.2.1 Instrument 1: Extensive stakeholder collaboration

Achieving deforestation-free coffee production is a complex challenge that requires the coordinated efforts of multiple stakeholders across the entire supply chain. All actors, including companies (and their relevant internal departments), farmers, suppliers, NGOs, local governments, and other industry partners are part of this instrument. Effective collaboration among these diverse groups is crucial for developing and implementing successful sustainability strategies, particularly in the context of complying with the EUDR.

This instrument aims at creating a unified approach to achieving deforestation-free targets, leveraging diverse expertise and resources for innovative solutions, ensuring alignment of sustainability efforts across the supply chain, enhancing transparency and trust among all stakeholders, facilitating knowledge sharing and best practice dissemination, and addressing systemic challenges that require collective action.

Involved key stakeholders and their roles are provided in Table 12:

**Table 12: Key actors and actions for implementing extensive stakeholder collaboration**

Key Actors	Actions for Implementation
Company	<ul style="list-style-type: none"> <li>- Highlight the importance of collaboration (such as partnerships with farmers and cooperatives, collaboration with sustainability initiatives) and allocate resources, and participate in high-level stakeholder forums (management board).</li> <li>- Coordinate overall stakeholder engagement strategy and facilitate connections between different stakeholder groups (sustainability team).</li> </ul>
Farmers and Intermediaries	<ul style="list-style-type: none"> <li>- Provide ground-level insights on challenges and potential solutions and participate in collaborative initiatives and feedback processes.</li> </ul>
NGOs and relevant organisations	<ul style="list-style-type: none"> <li>- Offer expertise on deforestation issues and conservation strategies (such as shade-grown coffee initiatives, water management, climate-smart coffee farming) and collaborate on community-based sustainability projects.</li> </ul>
Local Governments	<ul style="list-style-type: none"> <li>- Support for company efforts by creating enabling environment for sustainability initiatives and develop policies and action plans for sustainability in their jurisdictions.</li> </ul>
Industry Partners	<ul style="list-style-type: none"> <li>- Collaborate on sector-wide sustainability initiatives and share knowledge and resources for collective impact</li> </ul>
Research Institutions	<ul style="list-style-type: none"> <li>- Provide scientific insights and innovative approaches and conduct studies on the effectiveness of sustainability measures</li> </ul>
Consumers	<ul style="list-style-type: none"> <li>- Provide feedback on sustainability initiatives and participate in awareness and behaviour change campaigns</li> </ul>

Efforts to join collaboration platforms (e.g. ICO, Specialty Coffee Association) for on-going engagement and budget allocation for stakeholder meetings and projects are required. Effective communication tools ensure regular updates and transparency. Key levers focus on building trust through transparency, showcasing the benefits of collaboration, leveraging stakeholders' unique strengths, and maintaining open communication. It is expected that the traceability will be improved, relationships among different actors can be enhanced, implementation risks can be reduced, among other things.

This instrument is fundamental to the success of all other instruments, including traceability systems, responsible contracting, price premiums, educational programmes, and audit and certification.

### 2.3.2.2 Instrument 2: Enhanced data management and traceability systems

The complex supply chain, involving numerous smallholder farmers and intermediaries, presents significant traceability challenges. The EUDR mandates comprehensive documentation and traceability, making this a critical issue for compliance and sustainability efforts.

End-to-end traceability from individual farms to the final consumer product needs to be in place. Enhanced data management and traceability systems aim to verify the deforestation-free status

of all coffee sources, ensure EUDR compliance, provide transparency, enable quick identification and resolution of sustainability issues, and support fair pricing. The system should track key data points such as farm location (including geolocation data), farming practices, harvest dates, processing methods, and transportation routes.

Key actors and their roles are provided in Table 13:

**Table 13: Key actors and actions for implementing enhanced data management and traceability systems**

Key Actors	Actions for Implementation
Company	- Design and develop their traceability system and data collection solutions (in-house solutions), or utilise third-party solutions (such as Global Coffee Data Standard for data collection (Meems 2019), Dimitra, INATrace, Sourcemap (Pirola and Criscione 2024)), ensure security and data protection (IT team, Sustainability team. Define traceability requirements, oversee implementation and integration with existing processes, and clarify data points for EUDR compliance, review data regularly (Sustainability team).
Farmers	- Provide accurate data, participate in system design consultations, attend training, and use the system regularly.
Intermediaries	
External technical providers	- Supply necessary technology, provide technical expertise and on-going support.
Consulting firm/expert or research institution	- Develop multilingual training materials, conduct training sessions, provide on-going support.

To implement traceability systems, the company, as the initiator, will likely cover the majority of the investment cost in technology infrastructure, develop data collection tools, leverage technical expertise, create multilingual training materials, and deploy on-ground support staff in coffee-growing regions. It is also possible that the company might seek financing from industry partners or government. Producers might bear some of the costs of implementing and maintaining new traceability systems through various means. However, in the long term, these costs may be compensated through price premiums, long-term contracts, access to new markets, efficiency gains, shared value programmes, microfinancing, and gradual implementation. To ensure long-term sustainability and the equitable distribution of costs and benefits, the company should collaborate closely with producers, understanding their financial constraints and developing mutually beneficial solutions. Success is ensured by user-friendly technology suitable for low-connectivity areas, clear demonstration of benefits to actors, incentives for accurate data input, and a commitment to continuous support and training.

This system forms the foundation for other instruments, supporting audit and certification processes, responsible contracting, training programmes and stakeholder collaboration.

### 2.3.2.3 Instrument 3: Responsible contracting

The actors in the coffee supply chain need to demonstrate due diligence in preventing deforestation, necessitating clear contractual obligations with all suppliers. Additionally, recognising that the burden of compliance with sustainability standards and regulations, including the EUDR, often falls disproportionately on producers, particularly smallholder



farmers; a shared responsibility approach is necessary to address this imbalance. This instrument aims to create a legally binding framework for sustainability, ensuring all suppliers, including intermediaries, commit to deforestation-free practices. Creating a mutual agreement, which is based on an equal partnership that defines responsible practices, including labour standards, business conditions, payment terms, and the buyer’s commitments regarding purchasing behaviour is considered crucial (Ethical Trading Initiative 2024). Shared responsibility supports the distribution of the costs and efforts of EUDR compliance more evenly, particularly supporting smaller suppliers and farmers. Ultimately, this instrument aims to increase engagement from all stakeholders, improve sustainability outcomes through collaborative efforts, and align incentives for deforestation-free coffee production throughout the supply chain. It also establishes clear accountability for sustainable practices and provides a basis for on-going monitoring and improvement as regards deforestation-free practices.

Key actors and their roles are provided in Table 14:

**Table 14: Key actors and actions for implementing responsible contracting**

Key Actors	Actions for Implementation
Company	<ul style="list-style-type: none"> <li>- Establish overarching principles for shared responsibility and allocate resources for implementation and support mechanisms (management board).</li> <li>- Review existing contracts, draft new clauses addressing deforestation and sustainability based on principles of shared responsibility and equal partnership, ensure compliance with international and local laws (legal team).</li> <li>- Communicate new requirements to suppliers, negotiate terms, and manage the contract update process, integrate shared responsibility principles into supplier relationships, and collaborate on developing support mechanisms for suppliers (procurement department).</li> <li>- Develop clear, measurable sustainability criteria for inclusion in contracts, provide expertise on deforestation issues, develop detailed actions for shared responsibility, and coordinate implementation across departments and with external partners (sustainability team).</li> <li>- Develop and implement models for fair cost-sharing across the supply chain and allocate funds for support mechanisms and collaborative initiatives (finance department).</li> </ul>
Intermediaries	<ul style="list-style-type: none"> <li>- Review existing contracts, contribute and agree to new contract terms from their buyers. Review existing contracts with suppliers and integrate deforestation and sustainability aspects into the new contract terms based on principles of shared responsibility and equal partnership.</li> <li>- Provide necessary data and documentation.</li> </ul>
Farmers	<ul style="list-style-type: none"> <li>- Review, contribute and agree to new contract terms, implement required practices, provide necessary data and documentation.</li> </ul>

Key Actors	Actions for Implementation
External legal advisors (if needed)	- Provide expertise on international environmental law and trade regulations.

To ensure success of this instrument, clear communication of benefits and requirements to all actors is required. A phased implementation approach is required for adaptation, incorporation of potential incentives (such as price premium, long-term contract, marketing support, access to the training) and early adopters of new standards. This approach also allows on-going support for suppliers (such as technical assistance, training programme, financing support, gradual implementation) and maintaining these new sustainability requirements.

This instrument provides the legal framework for implementing other sustainability measures, such as traceability systems, price premiums on sustainability practices, audits, and educational programmes.

#### 2.3.2.4 Instrument 4: Price premiums

The economic pressures often hinder coffee farmers, especially smallholders, from adopting sustainable and deforestation-free practices. The costs associated with transitioning to and maintaining these practices can be significant, while the benefits may not be immediately apparent. Price premiums can address this challenge by providing direct financial incentives for sustainable practices. A collaborative approach for developing a price premium programme through dialogue with farmers and other supply chain actors should be considered, so that it effectively meets their needs. Key elements include stakeholder engagement through dialogues with farmers and intermediaries, participatory impact assessments, transparent communication channels, and capacity-building initiatives.

While the collaborative approach aims to create an equitable and effective premium programme that genuinely supports sustainable practices while benefiting all stakeholders in the coffee supply chain, the primary goal is to incentivise farmers to adopt and maintain deforestation-free practices by making them economically viable and attractive. For deforestation-free practices, a price premium can compensate farmers for deliberately foregoing expansion into forested areas, ensuring this approach is economically viable. At the same time, it promotes sustainable techniques on existing farmland to enhance productivity without expansion. This dual approach recognises that avoiding deforestation requires specific incentives beyond general sustainability measures. Traceability systems will help prevent the risk of farmers selling deforestation-free coffee to the EU while clearing forests for production destined elsewhere. The expected outcomes are increased adoption of sustainable and deforestation-free practices, improved farmer livelihoods, reduced pressure on forests, and a stable supply of verifiably deforestation-free coffee.

Key actors and their roles are provided in Table 15:

**Table 15: Key actors and actions for implementing price premiums**

Key Actors	Actions for Implementation
Company	- Develop financial models for premium pricing that can accommodate input from farmers and supply chain actors, assess the impact on overall coffee costs and company finances, allocate adequate budget for the premium programme (i.e. to provide meaningful incentives while remaining financially sustainable for the company), collaborate with the sustainability and

Key Actors	Actions for Implementation
	<ul style="list-style-type: none"> <li>- procurement teams to integrate the premium system into existing financial processes (finance department).</li> <li>- Define criteria for premium eligibility linked to deforestation-free practices, develop verification processes for premium qualification, monitor the environmental impact of the premium programme (sustainability team).</li> <li>- Integrate premiums into purchasing processes, communicate premium structure to suppliers and farmers, and monitor the impact of premiums on sourcing and quality (procurement team).</li> <li>- Conduct market research on consumer willingness to pay for sustainable coffee, develop strategies to communicate the value of premiums to consumers, and create campaigns highlighting the impact of premiums on sustainability (marketing team).</li> </ul>
Farmers	<ul style="list-style-type: none"> <li>- Implement and maintain deforestation-free practices, provide necessary documentation and data to qualify for premiums, participate in training and verification/auditing processes.</li> </ul>
Intermediaries	<ul style="list-style-type: none"> <li>- Facilitate the implementation of the premium system with farmers, ensure accurate tracking and distribution of premiums, and provide data on premium impact and farmer participation.</li> </ul>

Key strategic levers include clear premium criteria, transparent verification, effective communication of benefits, and integration with other sustainability initiatives.

This instrument is closely linked to responsible contracting, traceability systems, educational programmes, and audit and certification.

**2.3.2.5 Instrument 5: Educational and training programmes for farmers**

Small-scale coffee producers, who form a significant part of the supply chain, often face economic pressures and climate change impacts that can drive deforestation. While these farmers generally understand the importance of preserving forests, they may lack information on alternative income sources, methods to increase land productivity, and techniques to adapt to climate change impacts. These knowledge gaps, combined with economic vulnerabilities, can lead to the clearing of additional land as a perceived necessity for survival and growth. Thus, an educational approach is essential.

This instrument aims to empower farmers with knowledge, skills, and resources to implement and maintain sustainable, deforestation-free farming practices. The focus will be on providing information and training on: 1) diversifying possible income sources to reduce economic pressure on forest lands, 2) implementing advanced agricultural techniques to increase productivity on existing farmland, and 3) adopting climate-smart practices such as improved water management and protection against extreme weather events. By addressing these specific needs, it is expected that there will be increased adoption of sustainable, deforestation-free farming practices, improved farm productivity, enhanced farmer resilience to economic and climate pressures, and the development of a network of knowledgeable farmers who can further disseminate these practices within their communities.

Key actors and their roles are provided in Table 16:

**Table 16: Key actors and actions for implementing educational and training programmes for farmers**

Key Actors	Actions for Implementation
Company	<ul style="list-style-type: none"> <li>- Ensure training content aligns with EUDR requirements and company policies, and develop metrics for measuring training impact on actual deforestation stop or reduction by farmers (sustainability team).</li> <li>- Develop curriculum content on sustainable coffee farming, conduct training sessions and provide technical advice, and assess the effectiveness of training programmes (agricultural experts from the companies or external from agricultural institution/consulting firms).</li> </ul>
Company representatives in supply countries	<ul style="list-style-type: none"> <li>- Coordinate training activities with local actors, ensure alignment of training with company sustainability goals, and monitor and report on training outcomes.</li> </ul>
NGOs	<ul style="list-style-type: none"> <li>- Facilitate connections with farmer communities, provide local context and cultural insights for training programmes, assist in programme implementation and monitoring.</li> </ul>
Farmer Cooperatives	<ul style="list-style-type: none"> <li>- Help identify training needs and priorities, facilitate farmer participation in training programmes, and provide feedback on programme effectiveness</li> </ul>
Farmers	<ul style="list-style-type: none"> <li>- Participate in training programmes, implement learned practices on their farms, and share knowledge with other farmers in their communities.</li> </ul>

The educational programme relies on resources including a comprehensive training curriculum developed by agricultural experts and the sustainability team, a network of local trainers from local institutions/consulting firms, and partnership with NGOs, demonstration farms in key regions. Success will be driven by key levers such as a participatory approach to curriculum development, practical hands-on training methods, use of local languages and contexts, and the integration of traditional knowledge with modern sustainable practices.

This instrument is connected to traceability systems, responsible contracting, price premiums, and audit and certification.

**2.3.2.6 Instrument 6: Audit and certification processes**

Robust audit (both internal and third-party) and certification processes are crucial for ensuring compliance, maintaining credibility, and driving continuous improvement in sustainability practices throughout the supply chain. The coffee industry employs a range of certifications to promote sustainability and ethical practices throughout the supply chain. Key certifications include Fair Trade (Fairtrade International 2024), which ensures fair prices and working conditions; Organic (such as USDA (USDA Organic 2024) and EU Organic (EU 2018)), focusing on environmentally friendly farming without synthetic inputs; Rainforest Alliance, emphasising environmental conservation and social responsibility; 4C (Common Code for the Coffee Community), an independent standard for sustainability; C.A.F.E. Practices (Starbucks 2020), developed by Starbucks to assess economic, social, and environmental aspects; and Bird Friendly (Smithsonian's National Zoo and Conservation Biology Institute 2024), certified by the Smithsonian Migratory Bird Center for shade-grown coffee supporting biodiversity. These

certifications often overlap, with many producers holding multiple certifications to address various aspects of sustainability. They are typically verified by independent third-party auditors and provide frameworks for continuous improvement in areas such as fair-trade practices, organic farming, environmental conservation, and ethical labour practices. Among these certifications, Rainforest Alliance covers aspects of deforestation. The Bird Friendly certification, given its nature, likely addresses deforestation as well. The rest of certifications do not cover the aspects of deforestation explicitly. While formal certifications are important, some specialty coffee companies also use these standards as guidelines to improve their practices without formal certification, contributing to a more sustainable and ethical coffee industry overall.

Key actors and their roles are provided in Table 17:

**Table 17: Key actors and actions for implementing audit and certification processes**

Key Actors	Actions for Implementation
Company	<ul style="list-style-type: none"> <li>- Develop internal audit protocols aligned with EUDR and company standards and targets, coordinate with external auditors and certification bodies, analyse audit results and develop improvement strategies (quality assurance and sustainability team).</li> <li>- Analyse audit results and develop corrective action plans to address systematic deviations identified in audits (sustainability team).</li> <li>- Ensure audit processes meet legal requirements, including EUDR, and review audit findings for potential legal risks or compliance issues (legal team).</li> </ul>
External (Third-party) Auditors	<ul style="list-style-type: none"> <li>- Conduct independent audits, provide objective assessment of compliance and sustainability practices, and offer recommendations for improvement based on industry best practices.</li> </ul>
Certification bodies	<ul style="list-style-type: none"> <li>- Provide recognised sustainability certifications (e.g., Rainforest Alliance, Fairtrade), and conduct certification audits and verify compliance with standards.</li> </ul>
Farmers Intermediaries	<ul style="list-style-type: none"> <li>- Prepare for and participate in audits and certification processes, implement corrective actions based on audit findings, and maintain records and documentation required for audits.</li> </ul>

Implementing this instrument will be supported by resources including detailed protocols and checklists developed collaboratively, trained internal auditors complemented by external ones, educational materials for suppliers, and allocated budget for certifications and external audits. Keys to success are clear communication of audit criteria, seamless integration of audit processes into daily operations, efficient use of technology for data handling, and fostering continuous improvement throughout the organisation and its supply chain. To address the financial aspects of certification, various cost-sharing approaches can be considered. These include a tiered contribution system based on supplier size and volume, performance-based incentives, a co-investment model for necessary improvements, support for group certification among smallholders, and partnerships with financial institutions to provide low-interest loans. A portion of the premium received for certified coffee might be reinvested into the certification process and shared with suppliers. This multi-faceted approach aims to distribute the financial

burden fairly, align incentives for maintaining high standards, and ensure long-term commitment to sustainable practices across the entire supply chain.

This instrument is connected to other instruments, such as traceability systems, responsible contracting, educational programmes, and price premiums.

### **2.3.3 Discussion of the roadmap for coffee**

This roadmap for achieving deforestation-free targets and EUDR compliance is built on a series of interconnected SSCM instruments. These instruments work together synergistically to address the complex challenges of sustainable coffee production. At the core of this system is the enhanced data management and traceability system, which forms the foundation for all other initiatives. This system enables end-to-end traceability from individual farms to the final consumer product, supporting EUDR compliance and providing transparency throughout the supply chain.

Building on this foundation, responsible contracting establishes a legally binding framework for sustainability. This ensures that all suppliers, including intermediaries, commit to deforestation-free practices, reducing risks of non-compliance with EUDR. Educational and training programmes complement these efforts by empowering farmers with the knowledge and skills necessary to implement sustainable, deforestation-free farming practices.

Price premium system can be deployed to incentivise these sustainable practices. This instrument provides direct financial incentives for farmers to adopt and maintain deforestation-free practices, making them economically viable and attractive. The effectiveness of these initiatives is verified through robust audit and certification processes, which ensure compliance with EUDR requirements and company sustainability standards.

Given that the burden of compliance often falls disproportionately on producers, particularly smallholder farmers, in particular in terms of the cost for implementation, several instruments need to be implemented as complements to each other, such as price premiums, traceability, and educational programmes.

Underpinning all these instruments is extensive stakeholder collaboration. This involves coordinating efforts across a comprehensive network of stakeholders, including the company (and its internal departments), farmers, suppliers, NGOs, local governments, and industry partners. This collaborative approach is crucial for developing and implementing successful sustainability strategies, particularly in the context of complying with the EUDR.

For the effective implementation of this roadmap, various stakeholders have specific roles. Farmers are expected to implement and maintain deforestation-free practices, provide necessary documentation, and participate in training programmes. Intermediaries facilitate the premium system implementation and ensure accurate data tracking. External auditors and certification bodies conduct independent assessments, while NGOs and local organisations assist in programme implementation and provide local context. Industry partners collaborate on sector-wide initiatives, local governments create supportive policy environments, and consumers provide feedback and participate in awareness campaigns.

Some necessary adaptations to the regulatory, especially local regulations, and market framework could support the roadmap's implementation. These include simplifying compliance processes for smallholder farmers, developing support mechanisms to help farmers cope with climate change impacts and economic pressures, improving integration of intermediaries' databases, creating policies to support the transition to sustainable practices, and establishing market incentives for deforestation-free coffee.

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This comprehensive and integrated approach can achieve deforestation-free targets, ensure EUDR compliance, and contribute to the long-term sustainability of the coffee industry.

## 2.4 Roadmap 3: Iron ore-steel

### 2.4.1 Environmental target and background

The iron and steel industry currently account for 7 to 10 % of total global CO<sub>2</sub> emissions (Deloitte n.d.; Drive Sustainability n.d.; IEA 2020; OECD 2023; Voigt et al. 2023), making it one of the most emission-intensive subsectors. As a result, GHG emissions are a key topic in the iron ore–steel supply chain (OECD 2023; Schreck et al. 2023). Although the CO<sub>2</sub> emission intensity of steel has remained relatively stable in recent years, the total global emissions from the sector have increased over the past decade, primarily due to rising steel demand (Kueppers 2023). Overall, the use of non-renewable energy sources for the energy-intensive steel production processes in particular leads to very high GHG emissions (Drive Sustainability n.d.; IEA 2020; Bookhagen et al. 2022; Harpprecht et al. 2022). In traditional blast furnace production, the majority of emissions come from the use of coke as a reducing agent to reduce the iron from iron ore (Kueppers 2023). Earlier stages of the supply chain are also associated with significant amounts of GHG emissions. For example, the mining industry accounts for a total of 2 to 3 % of global CO<sub>2</sub> emissions (Bellois 2022). The main source of GHG emissions in mining is the use of non-renewable energy sources such as diesel to power heavy trucks and machinery (e.g. trolleys) and poor energy management during extraction, grinding and transportation (Dietz et al. 2021), which leads to low energy efficiency (Drive Sustainability n.d.; IRMA 2023). Other relevant emission sources in the iron ore-steel supply chain are the use of electricity and natural gas for the extraction of coke and the combustion of heavy fuel oil during the transport (usually freight/overseas transport) of raw materials (Na et al. 2024). Key downstream sectors are also associated with significant GHG emissions – for example, CO<sub>2</sub> emissions from the production of cars in the EU in 2022 totalled 7.38 million tonnes, mainly due to the use of non-renewable energy sources or low energy efficiency of production processes (ACEA 2023).

Reducing GHG emissions along the entire supply chain from iron ore to steel requires far-reaching technological change, particularly at the steel production stage. Central approaches focus on improving energy efficiency and process optimisation, fuel switching and the conversion to new production routes such as a combination of (renewable) hydrogen-based direct reduction and electric steelmaking (DR-EAF production route). Converting steel production plants to the DR-EAF route and securing access to renewable hydrogen require very high investments, especially in the early stages of transition (JRC 2022). Improving material efficiency and the circular economy are also effective means to reduce GHG emissions (OECD 2023). Due to the importance of the environmental issues for the industry and on the basis of discussions with practitioners and industry experts in workshops and interviews, we selected an environmental upgrade target that was considered as relevant and ambitious to develop a roadmap for the iron ore-steel supply chain. The following target was defined on this basis:

#### Environmental upgrade target – iron-ore steel

Within 15 years, GHG emissions at all stages of the iron ore-steel supply chain are reduced significantly.

A roadmap with approaches and instruments to achieve this target was developed together with a **focal company**. An assessment interview and a roadmap development workshop were conducted with the focal company. Representatives of the company also took part in two previous expert workshops in which general challenges and a ‘smart mix’ for the implementation of environmental upgrade targets were discussed. While the roadmap was developed in close collaboration with a specific company, it is intended to provide guidance to



any company along the entire iron ore steel supply chain. For this purpose, additional insights from research, interviews and workshops were considered for the finalisation of the document.

The focal company that supported the roadmap development process is a multinational mining company that has several iron ore operations. Over 90 % of the organisation's annual iron ore sales come from its own production, while the remaining 5 % is purchased from smaller iron ore producers. The company primarily sells high-quality iron ore products, which are required for the production of high-quality steel and are also an important raw material for (renewable) hydrogen-based direct reduced iron (DRI) production processes. The company sells most of its iron ore products directly to steel mills with which it has long-standing business relationships and multi-year contracts. A small proportion of the iron ore is sold on the spot market for price discovery reasons. The focal company is not involved in any further downstream stages of the value chain.

The focal company, selling directly to EU steel companies, is indirectly impacted by various EU decarbonisation regulations and initiatives. The EU aims for **climate neutrality by 2050** (EC n.d.), which requires a significant industrial and economic transition, and has issued related decarbonisation strategies for the EU steel sector. The **REPowerEU** project expects around 30% of primary steel production in the EU to be decarbonised by 2030 using renewable hydrogen (JRC 2022). This will also increase demand for steel scrap and high-grade iron ore suitable for the DR-EAF route (Nicolas 2024). This demand is further fuelled by the mandatory participation of steel companies in the **EU Emissions Trading System (ETS)** (EC n.d.), which imposes increasing penalties on carbon emissions emitted by steel producers (Forster 2023). The **EU's Carbon Border Adjustment Mechanism (CBAM)**, in transition since 2023 and fully effective by 2026, is also relevant. CBAM is a tax on imports from outside the EU on the estimated amount of CO<sub>2</sub> emitted in their production that is equal to the price that EU-products already pay for such emissions under the EU ETS scheme. While mining companies are initially only indirectly affected, CBAM covers iron and steel and could thus also boost the demand for high-grade iron ore for low-emission steel production (EC 2024d). In addition, the EU steel mills that the focal company is selling to must comply with the **CSDDD** from July 2026, requiring them to develop a detailed climate mitigation transition plan with intermediary targets for Scope 1, 2, and 3 (Bertazzi 2024). This might lead to an increased effort by EU-based clients of the focal company to reduce their Scope 3 emissions, thus effecting upstream and downstream business partners. In addition, all clients of the focal company listed on an EU-regulated market are covered by the **CSRD** and the related ESRS. GHG reporting under CSRD and ESRS E1 Climate Change involves disclosing direct and indirect emissions across an organisation's value chain (covering Scope 1, 2 and 3) (European Parliament and Council of the European Union 2023). This can lead to an increased demand for the provision of detailed GHG emissions data towards the focal company. The focal company, being listed on the London Stock Exchange, has also been reporting under the **Taskforce on Climate-related Financial Disclosure (TCFD) framework** since 2022, as per UK legislation (Government of the UK 2021).

The focal company has set GHG emissions reduction targets for Scope 1, 2 and 3 and **has implemented some SSCM approaches and instruments** to support the reduction of GHG emissions in its supply and value chains relevant to iron ore-steel. The basis for this is the continuous accounting and public reporting of Scope 1, 2 and 3 emissions according to a science-based and internationally recognised methodology (aligned with the GHG Protocol). The focal company cooperates with strategic customers to obtain more granular emission data from them and to work together in specific research and development (R&D) projects on how to customise their products to enable the lowest-possible emission steel production at the customer (e.g. piloting the DR-EAF production route and supplying particularly high-quality iron ore products).

The focal company also discusses with customers how product delivery can be organised as efficiently as possible with shortened transport routes between processing site and steel mill and/or improved accessibility of renewable energy near new sites. The focal company has also introduced a blockchain-based traceability solution that allows customers to view key provenance and sustainability indicators (incl. carbon intensity) of a product for each delivery via a digital label. In addition, the focal company is a member of various voluntary industry initiatives such as the International Council on Mining and Metals (ICMM) and ResponsibleSteel, where it supports collaborative efforts to improving the granularity of Scope 3 emission reporting and standardising GHG emission reporting in the industry. In addition, the focal company has had several of its mining sites externally assessed by the Initiative for Responsible Mining Assurance (IRMA), which specifies measures to reduce the company's impact on climate change through increased energy efficiency, reduced energy consumption and reduced direct/process-related GHG emissions (IRMA 2023). Additional SSCM approaches and instruments are in place, but do not cover GHG emissions specifically.

The focal company faces several **challenges and barriers** in achieving its GHG emission reduction targets. From its perspective as a mining company, the biggest challenges in reducing Scope 1 and 2 emissions relate to the (still) limited availability of hydrogen as an alternative fuel for trucks and the slow development of hydrogen systems, which are also very costly and likely to remain so in the future. Additionally, transitioning to electric vehicle fleets is costly and time-consuming. A lack of sufficient renewable energy sources near production facilities further complicates the reduction of Scope 2 emissions (depending strongly on geographical framework conditions of individual sites).

For Scope 3 emissions, the focal company encounters difficulties in their GHG emission accounting due to a complex network of upstream and downstream partners, along with delayed or incomplete GHG data from these partners. This results in reliance on spend-based calculations for important upstream categories rather than more accurate activity-based methods, complicating planning processes. Although a growing number of companies in the supply chain have set net zero targets, the industry remains in the early stages of addressing environmental issues, including CO<sub>2</sub> emissions (Kueppers 2023). Small-scale iron ore suppliers usually still lack medium or long-term GHG reduction targets, because they are usually only active for a few years due to a limited efficiency and profitability of smaller mining operations. In addition, the implementation of GHG management requirements in many key producer countries is limited and important sustainability standard schemes in the sector, like IRMA or Towards Sustainable Mining (TSM), are not yet sufficiently widely adopted.

With regard to steel companies, which account for most of the focal company's downstream Scope 3 emissions, the fact that many of these customers have set less ambitious climate targets than the focal company poses a challenge, because this affects the focal company's ability to achieve its own Scope 3 targets. In general, research, interviews and workshops with experts have shown that both the mining and steel sectors are still in the relatively early stages of decarbonisation and corresponding supply chain collaboration, despite their crucial role in the broader industrial transformation. Dealing with Scope 3 emissions and considering collaborative approaches to achieve reduction targets is still uncharted territory for many companies. And as described above, for the decarbonisation of the steel sector in particular, very high investments are required in the early stages of the transformation (JRC 2022). According to the focal company and various steel companies interviewed, funding possibilities for this are insufficient.<sup>8</sup>

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<sup>8</sup> It should be emphasised that the question of the actual costs of the industry decarbonisation as well as the necessity and amount of external funding is being intensively discussed and examined. At European and German level, for example, new financing options

In addition, investments in R&D activities are generally neglected by companies in periods of economic slowdown. In concrete terms, this also means that R&D projects that have already been launched to pilot the production of green steel – in which the focal company is involved in the form of Memorandums of Understanding (MoUs), for example – have been delayed, and the emission reduction potential of the new products and processes cannot be tested. This corresponds to the general observation that announcements of low- and near-zero GHG emission projects in the steel sector are currently often lagging behind actual implementation and the necessary scale (Kueppers 2023).

Furthermore, there is still no standardised definition of ‘green’ steel, which hinders industry-wide cooperation and financing. Moreover, demand for third-party verified products from customers in the steel and automotive sectors is low, with little willingness to pay premiums for verified low(er)-carbon products. The same applies to steel products manufactured, for example, in a plant certified by the ResponsibleSteel initiative or otherwise labelled as ‘green’ or ‘low-carbon’ steel. Here too, various experts in interviews and workshops recognised no willingness on the part of most end consumers or car manufacturers to pay a price premium to compensate for the additional costs of low-carbon production and/or corresponding external verification. One exception is reportedly the production of ‘green’ steel using renewable hydrogen as a reduction agent: for example, the Swedish start-up company Stegras (formerly: H2 Green Steel) has concluded numerous offtake agreements for its planned future ‘green’ steel production, which reportedly provide for a price premium of at least 20% compared to traditional steel (Stegra 2022; Bhat and Salazar 2023; Keating 2024). However, as these are commitments for the payment of future prices, as production is planned to start only in 2025 (Chan and Vargas 2024), corresponding premiums seem to have not (yet) reached other stakeholders in the supply chain and so far only appear to be focussed on the new breakthrough technology of renewable hydrogen-based steelmaking.

The financing of decarbonisation in the steel industry and associated supply chains is generally discussed in terms of necessary new and improved industrial policies as incentive mechanisms and the provision of loans by commercial banks and governments as the main source of funding (i.e. carbon contracts for difference) (Kim et al. 2022; Kim and Purvis 2023; Hüttel and Lehner 2024; BMWK 2024a). These were also repeatedly highlighted in the interviews and workshops conducted for the research project as the key levers for driving decarbonisation forward overall. At the same time, however, improved cooperation between business partners along the supply chain can also provide important financial and non-financial incentives for decarbonisation and make the implementation of reduction targets more efficient. The following roadmap focuses on this level of cooperation between business actors.

## **2.4.2 Description of the roadmap**

This roadmap is largely based on the results of a workshop with representatives from various departments of the focal company described above, in which the roadmap was jointly developed, and individual approaches and instruments were discussed in detail. The roadmap does not entail all possible SSCM instruments and approaches that companies could apply in the iron ore-steel supply chain, but only those identified as the most impactful ones when it comes to reducing GHG emissions. The roadmap also comprises the results of research and findings from interviews and workshops with various industry experts from business, civil society, science and standardisation organisations, etc., which were used to supplement the roadmap and make partial adjustments. This is intended to ensure that broader findings from the course of the

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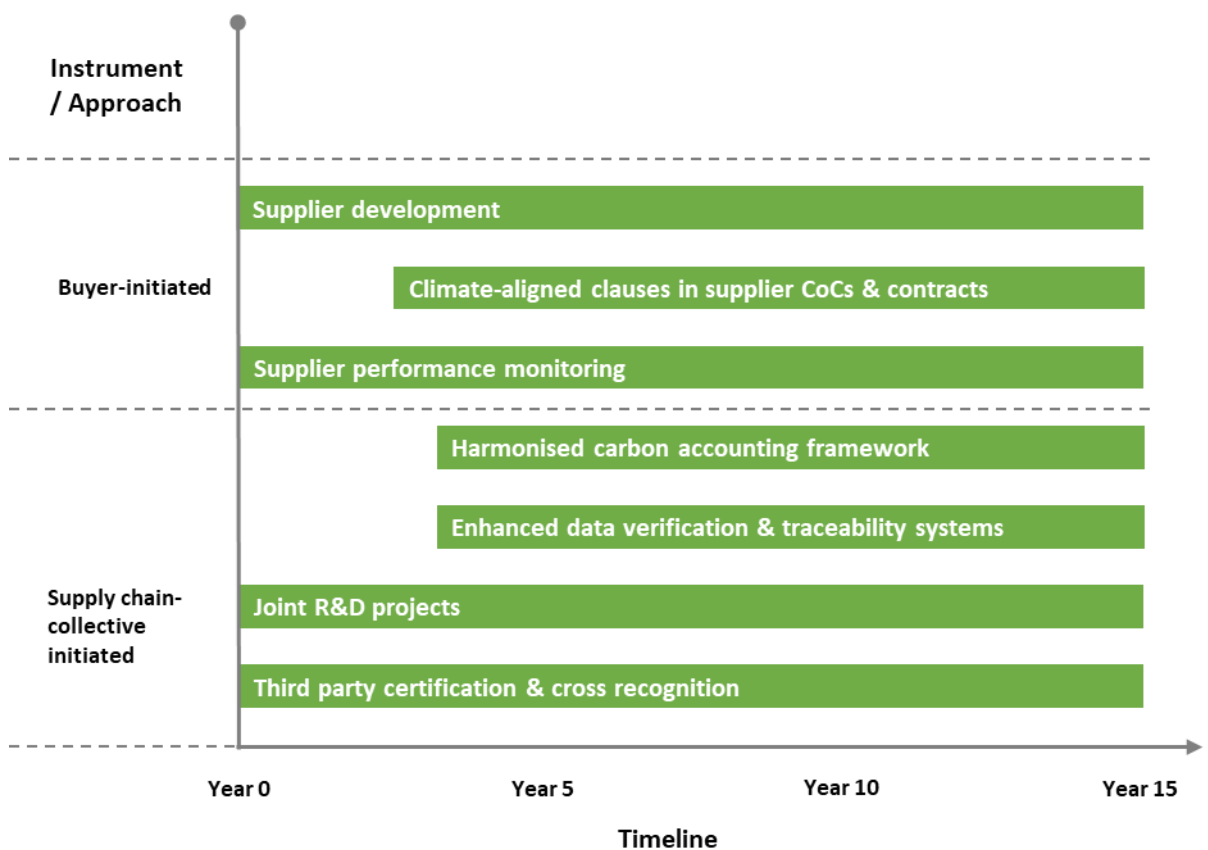
and targeted policy support are being developed and made available on an on-going basis; see amongst others (Hüttel and Lehner 2024; JRC 2022; Kim et al. 2022; BMWK 2024b).

project that go beyond the experiences of the individual focal company are incorporated into the general guidance meant for companies at different stages of the iron ore-steel supply chain and external actors.

Figure 3 shows that a combination of instruments initiated by individual companies (usually the buyer) and instruments initiated at the collective level of the supply chain is proposed. The approaches and instruments cover a timeframe of 15+ years to achieve the environmental target consistent with the goal of limiting global warming to no more than 1.5°C – as called for in the Paris Agreement – by reducing GHG emissions by 45% by 2030 and reaching net zero by 2050 (UN n.d.). Some approaches, such as instrument 1 ‘supplier development’ and instrument 6 ‘coordination of interests to enable design for sustainability in joint R&D projects’ are implemented from the outset, as it has been established that such approaches are already being implemented by various actors in the supply chain and it can therefore be assumed that they can also be applied by other businesses and other organisations in the sector in the near future. Other approaches and instruments, such as instrument 4 ‘harmonised carbon accounting framework’, can only be implemented once some of the other instruments are applied by more businesses or on a larger scale. For example, the introduction of a harmonised carbon accounting framework depends for example on supplier development activities, as many suppliers do not currently account for and report their GHG emissions at all. The timing of the approaches and instruments in the roadmap is therefore partly based on the necessary changes required to achieve a significant reduction of GHG emissions along the iron ore-steel supply chain. However, it also reflects current limitations, such as many SSCM approaches and tools not yet being utilised on a large scale or in an appropriate manner, as identified in the research conducted as part of the project.

Each approach and instrument and the specific activities recommended for the respective actors, are explained in detail in the sections 2.4.2.1 to 2.4.2.7. A more detailed description of the interconnections and dependencies between different approaches and instruments in the roadmap is presented in section 2.4.3.

**Figure 3: Roadmap for improved environmental performance in the iron ore-steel supply chain**



Source: own illustration (adelphi research gGmbH)

#### 2.4.2.1 Instrument 1: Supplier development

Large companies along the iron ore-steel supply chain often use external support to calculate their GHG emissions or have already developed sufficient internal resources (i.e. in the form of dedicated sustainability departments) and established systems for their emissions accounting. However, smaller companies along the supply chain often lack sufficient resources and require support both in calculating their GHG emissions and in the definition of reduction targets.

This is where the instrument ‘supplier development’ comes in, which can be designed either as a **buyer-individual approach** (see Grüning et al. 2024, chapter A.1.9) or as a **buyer-collective approach** (see Grüning et al. 2024, chapter A.2.4). When a company screens its existing suppliers and discovers that those with high emissions are lacking GHG-emission reduction targets, it can provide targeted support.

Information documents, dialogue formats, training courses, or workshops can be offered to selected or strategic business partners, presenting suitable GHG emission accounting methodologies and providing support for their practical implementation. For non-strategic suppliers, such offers can also be provided at a collective level together with other purchasing companies – in the context of the iron ore-steel supply chain, for example, the ICMM would be a suitable forum that brings together central mining companies, including for iron ore. In both cases, a harmonised carbon accounting framework (instrument 4) is important, i.e. the sharing of information on standards that are as widely established as possible (and possibly harmonised in the future) instead of individual accounting requirements. Purchasing companies can also refer their less-critical suppliers to a large number of existing and freely available options for GHG emission accounting standards, such as the GHG Protocol, or relevant standards of the

International Organisation for Standardisation (ISO) (ISO 14064-1 and ISO 14068) and approaches for formulating science-based reduction targets, such as the Science-based Target Initiative (SBTi) and related guidance material from CSOs, industry associations, chambers of foreign trade, consulting firms, etc. Preference should be given to options that comply with those established and recognised standards as far as possible to prevent suppliers from receiving different, potentially contradictory information from their various purchasing companies. In the iron ore-steel supply chain, this instrument is particularly relevant for the (rather small number of) small-scale iron ore miners, for whom training material from larger mining companies that have been working on GHG emission accounting and reduction for some time can be helpful. For businesses such as the focal company, most of which only purchase a small proportion of iron ore from small-scale miners, this is a measure with a low leverage effect, as emissions from small-scale miners are likely to be marginal in relation to the total emissions in the supply chain – but the measures can be a quick win for individual companies, as the corresponding offer could be made available rather fast. In addition, targeted supplier development activities by larger mining companies can help to ensure that smaller mining companies do not lose market access despite the increasing environmental requirements that result in higher expenditure and costs. This is also relevant in light of the fact that mining contributes to added local value, for example by creating jobs and promoting employment, and can thus be a driver of social development (provided that minimum human rights and social standards are also implemented in small and micro enterprises) (EC n.a.; Kickler and Franken 2017). Furthermore, the emissions from small-scale mining as a whole should not be underestimated. For the gold sector, for example, the climate impact of gold production in artisanal and small-scale mining (ASM) is in the same order of magnitude as the CO<sub>2</sub> emissions of large-scale mining, depending on the location (Fritz et al. 2024). Every company can thus contribute to reducing the overall emissions in ASM through measures in its own supply chain. In addition, targeted supplier development activities by larger mining companies can help to ensure that smaller mining companies do not lose market access despite the increasing environmental requirements that result in higher expenditure and costs.

**Table 18: Key actors and actions for implementing supplier development**

Key Actors	Actions for Implementation
Individual companies (especially large iron ore mining companies)	<ul style="list-style-type: none"> <li>- Provide suppliers (especially small-scale miners) with guidance (i.e. in the form of guidance documents, dialogue formats, training courses, or workshops) on a science-based GHG emission accounting methodology with reference to harmonised standards (instrument 4).</li> </ul>
Sector initiatives (e.g. ICMM or region-specific initiatives such as the Minerals Council of South Africa, the Minerals Council of Australia)	<ul style="list-style-type: none"> <li>- Members jointly develop targeted information material, training and workshops etc. on GHG emission accounting for small scale miners, which can be accessed by the target group for free.</li> </ul>
Other providers of information/training material (e.g. NGOs, international organisations)	<ul style="list-style-type: none"> <li>- Actors provide free guidance material, workshops or training material for companies from different sectors, referring to existing established standards (where available).</li> </ul>

Financial and human resources are required to implement the instrument at the individual buyer level, so buyers should focus on key suppliers for individual provision. The effort for individual companies in supporting their less-critical suppliers can be reduced by developing guidance and information for suppliers in a collective setting, such as sector-wide initiatives. In

these settings, lower financial resources of each member companies may be required to finance the joint development and free provision of information material and formats. Other providers of free workshops, training materials etc. – such as NGOs and international organisations – may develop training material, workshops etc. aimed at small-scale miners or other specific groups of suppliers independently or join MSIs and collaborate directly with companies in the development or review of said material and formats.

#### 2.4.2.2 Instrument 2: Climate-aligned clauses in supplier Code of Conducts and contracts

Large companies in the iron ore-steel supply chain usually already have their own CoC, which is internally orientated, as well as a supplier CoC, in which basic expectations are formulated for the implementation of certain environmental standards at least by key or strategic direct suppliers. Regarding GHG emissions, these supplier CoCs usually do not contain any quantifiable reduction targets, which in many cases would not be practicable due to a lack of detailed knowledge about the business partner’s reduction strategy. They rather require GHG emission disclosure or encourage the introduction of systems for improved management of GHG emissions at the business partner.

The integration of so called ‘climate-aligned clauses’ in supplier CoCs and contracts offers the possibility of achieving greater commitment to reducing GHG emissions on both sides – for both the buying and the selling company. To this end, the Chancery Lane Project provides guidance and concrete examples of such clauses. In particular, obligations that are included in commercial contracts should not be unilateral obligations of a contracting party; contracts should also stipulate how the achievement of higher ambition targets, for example, will be rewarded by the other contracting party. For example, a special supplier status (e.g. preferred supplier) can be linked to regular proof of maintenance of the agreed GHG emission reduction targets; improved contract terms or faster payment processes can be agreed for the achievement of certain targets. The Chancery Lane Project also provides an overview of possible starting points in this regard (The Chancery Lane Project 2024). The definition of an ambition level or target achievement should not only be aimed at ensuring that the supplier accepts the buyer’s CoC, as the targets described in the CoC may not fit the supplier’s individual strategy. Rather, such target agreements and clauses should be defined individually for each business relationship in close consultation with the strategic supplier. For legal definitions of climate-related performance obligations within a business relationship, it is also not necessary to refer to pre-defined quantitative reduction targets; the Chancery Lane Project website also includes some example clauses that business partners can use to make the mutual commitment to climate targets binding. One example is “Zain’s Clause”, which can be incorporated into commercial contracts, and which sets out mutual obligations “to allow all parties to either perform their own obligation in a way that reduces their carbon footprint and/or require other parties to do so” (The Chancery Lane Project 2021). The wording of the clause obliges both parties to work on reducing their carbon footprints, but gives them sufficient freedom in the design of specific activities. Depending on the differences in the level of ambition and the existing negotiating positions, the appropriate clause must be selected individually for each business relationship/contract negotiation.

**Table 19: Key actors and actions for implementing climate-aligned clauses in supplier code of conducts and contracts**

Key Actors	Actions for Implementation
Individual company (buyer and supplier)	- Share relevant information regarding climate ambition and strategy with business partner in negotiations. An important

Key Actors	Actions for Implementation
NGOs and other relevant organisations	<p>prerequisite for this is the establishment of a strong internal climate governance and support from the top-down management level for the introduction of the instrument in legal documents and commercial clauses. As a result, climate-aligned clauses should be introduced in supplier CoC and contracts. A process for monitoring needs to be set up and exchanges/updates with the supplier need to be scheduled in regular intervals.</p> <ul style="list-style-type: none"> <li>- Support the effective implementation and mainstreaming of climate-aligned clauses by providing guidance to frontrunner companies (i.e. via provision of MCC, workshops, legal advice).</li> </ul>

The implementation of the instrument requires human and financial resources on both sides – supplier and buyer – because such agreements and the monitoring of their compliance may take longer than traditional contractual relationships and parties involved possibly need additional legal advice. More importantly, however, the clauses described above can only be introduced if the company with the more ambitious climate targets has sufficient negotiating power to introduce corresponding requirements in contract negotiations. Compliance with the agreed targets must also be monitored (see instrument 5) accordingly and any agreed incentives (e.g. faster payment process) must be implemented so that the clauses are not simply a declaration of intent. In order to compensate for any imbalances of power and the (short-term) disadvantages of increased additional effort that can come along with the introduction of climate-aligned clauses, strong climate-related regulations and requirements for environmental due diligence are necessary, which oblige purchasing companies not to simply pass on climate commitments to their suppliers, but to actively find joint solutions to reduce GHG emissions. Under these circumstances, climate-aligned clauses could become much more attractive as an effective and flexible means of achieving climate targets in the supply chain. Alternatively, strong internal support in both companies for the agreement of corresponding legal obligations is needed. This is also reflected in the fact that the climate-aligned clauses established by the Chancery Lane Project, for example, have so far been implemented primarily by a small number of ‘frontrunner’ companies with strong, science-based decarbonisation targets, which already seek to reduce their Scope 3 emissions even in the absence of specific mandatory commitments (The Chancery Lane Project n.d.; Keating 2021).

**2.4.2.3 Instrument 3: Supplier performance monitoring**

Large companies in the iron ore-steel supply chain have typically established systems to review the sustainability performance of their suppliers, which can be organised differently depending on environmental topics and individual business relationships with suppliers. According to the focal company, monitoring regarding GHG emissions specifically is only taking place to a limited extent to date. For example, in its role as a supplier to steel companies, the focal company is increasingly being asked to complete self-assessment questionnaires (SAQs) (first-party audit), in which information on GHG emission reduction targets, existing management structures and strategies for reducing emissions must be described. From the focal company’s experience, GHG-emission related monitoring usually does not go beyond the level of SAQs. Second-party audits by clients are generally not carried out. However, a growing number of clients are recommending that their suppliers have audits carried out by third parties to prove certain levels of environmental performance at their sites (see also instrument 7). This however is



usually not a mandatory criterion for cooperation. The same applies to the cooperation between the focal company and its (few) small-scale iron ore suppliers.

The **buyer-individual voluntary instrument** ‘supplier performance monitoring’ aims to strengthen efforts in this area. For example, in order to implement the measures described in instrument 2, i.e. to link benefits such as the contract term or accelerated payment processes to the individual GHG emission reduction performance of a supplier, continuous monitoring of supplier performance is necessary.

For strategic suppliers, companies should consider carrying out second-party audits or demand that third-party audits are carried out. Instead of obliging suppliers to carry out new third-party audits, it is also possible to check whether suppliers have already had a reliable third-party audit as part of a certification programme (see instrument 7), for example, in which the desired sustainability performance can already be demonstrated. Proof of an existing assessment by a third party can be accepted/recognised in order to avoid additional costs and duplication of effort for the supplier when carrying out multiple audits.

**Table 20: Key actors and actions for implementing supplier performance monitoring**

Key Actors	Actions for Implementation
Buyer	<ul style="list-style-type: none"> <li>- Establish a continuous monitoring system and, where necessary, specify audit requirements towards all relevant suppliers.</li> <li>- Retrieve information from public supplier sustainability reports, environmental performance platforms or, if not available, consider using sector-harmonised SAQs or carry out second-party audits at supplier sites.</li> <li>- Examine the possibility of recognising the evidence of third-party audits, which have already been carried out by suppliers instead of implementing new additional checks and audits.</li> <li>- After new audits have been implemented or existing third-party results have been screened: evaluate the suppliers performance based on the monitoring results and develop corrective action plans with suppliers if necessary.</li> <li>- In addition, engage in sector initiatives or MSIs to support the development of reporting and third-party assessment standards and processes that can match the company’s individual sustainability requirements.</li> </ul>
Supplier	<ul style="list-style-type: none"> <li>- Familiarise oneself with the buyer’s requirements and information needs. Provide reliable information to customers and business partners.</li> <li>- Consider publishing a targeted sustainability report or get involved in an environmental performance platform, which can fulfil the information needs of customers and business partners and may replace the multitude of SAQs. If audits are required, prepare for them and train employees accordingly.</li> <li>- Implement necessary corrective actions, if performance is evaluated as inadequate. If third-party audits have already been carried out: publish the (key) results in order to attract customers with high(er) sustainability demands and discuss the question of whether the results of the third-party audit can replace some of the planned buyer-individual monitoring activities.</li> </ul>

Regular audits are associated with significant costs, particularly for the supplier, as well as the utilisation of personnel and time resources, as comprehensive data etc. must be made available (see also Grüning et al. 2024, chapter 3.2.7).

If, instead of conducting a new audit, proof of an existing third-party audit or certification is accepted from a supplier in order to save effort and costs, additional resources are required from the buyer. In this case, the buyer must build up sufficient capacity and knowledge of existing third-party certification schemes offered and the underlying audits, so that it can check whether its own sustainability requirements are adequately covered by them. This should be reviewed at regular intervals in the event that the underlying standards of a third-party offered scheme or audit change or the supplier's own sustainability targets are updated. In order to build up the relevant expertise and ensure that own requirements are met by certification schemes, companies can join sector initiatives in which various industry representatives, possibly from different stages of the supply chain, work on corresponding standards and processes for the comprehensive auditing of suppliers' sustainability performance (especially with regards to the management and reduction of GHG emissions). Please refer to instrument 7 (Third-party certification and cross-programme recognition) for examples of relevant MSIs.

#### **2.4.2.4 Instrument 4: Harmonised carbon accounting framework**

The basis for the reduction of GHG emissions along the entire iron ore-steel supply chain, effective target setting, prioritisation and targeted management of all other approaches and instruments in the roadmap is a reliable data basis, i.e. accurate GHG emission accounting. In addition, on the basis of reliable and comparable GHG emission reports, targeted investments for demonstrably greener production processes can be made available by financial market players and governments. The design and awarding of favourable contractual conditions to particularly sustainable suppliers, for example, also requires reliable information on the emissions intensity of individual products and production steps. In recent years, numerous different organisations have developed methods and guidelines for calculating (lifecycle) emissions of products and services and setting up GHG inventories for companies, some of which are sector-agnostic such as the Greenhouse Gas Protocol, ISO14064-1 (organisation level) and ISO 14067 (product level); others focus specifically on the steel sector such as ISO 14404, the ResponsibleSteel Standard and the Worldsteel CO<sub>2</sub> Data Collection User Guide (Biberman et al. 2022). There are fewer sector-specific standards and guidance documents available for the mining sector, but the Scope 3 Emissions Accounting and Reporting Guidance published by ICMM in 2023 should be mentioned here, for example (ICMM 2024). When accounting for Scope 3 emissions from procured raw materials and products, activity-based calculations are generally preferable to the more superficial spend-based calculations, because they provide a more accurate database. In any case, the variety of viable accounting methods, sometimes even within one standard, means that actors along the supply chain base their emissions calculations on a different footing, hindering comparability of reported information. This also makes it difficult for companies to correctly calculate their Scope 3 emissions, which must form the basis for meaningful target setting in the supply chain, prioritisation of suppliers and SSCM measures to jointly achieve a reduction of GHG emissions. If, for example, a purchasing company wants to introduce a system in which a selected number of suppliers who can demonstrate the lowest CO<sub>2</sub> emissions in a specific production process in direct comparison to their competitors receive a 'preferred supplier' status or comparable benefits, the purchasing company must first be able to create a benchmark of all suppliers and their respective contributions to its own Scope 3 emissions. Only then can progress towards a reduction in GHG emissions and differences between suppliers be reliably measured and rewarded. Activity-based calculations in particular, for which granular, product-level GHG inventory data must be collected from suppliers, are often not yet possible

due to incompatible methods or a lack of willingness on the part of suppliers to release this detailed data, meaning that Scope 3 emissions can often only be calculated on a spend-based basis or estimated from secondary data sources.

This is where the **supply chain-collective instrument** ‘harmonised carbon accounting framework’ comes in. This aims to ensure that as many companies as possible along the iron ore-steel supply chain use the same methodology for their carbon accounting. To this end, individual companies should check which general or sector-specific standards already exist and follow these as far as possible for their own carbon accounting. It is advisable to follow the GHG Protocol Corporate and Scope 3 Standards (developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development) (Greenhouse Gas Protocol n.d.) as the most widely used standard for corporate GHG emissions reporting, to which the majority of the sector-specific standards already developed are also orientated. In addition, since the GHG Protocol also leaves methodological flexibilities, companies should enter into dialogue with strategic and, where applicable, long-standing business partners and discuss which methodology they use, work out differences and, if possible, reduce them in order to harmonise carbon accounting as far as possible. However, in order to achieve the broadest possible standardisation, engagement at industry and multi-stakeholder level – i.e. between individual companies within the mining sector, within the steel sector, within the automotive industry, across industries between companies from all relevant stages of the supply chain and in cooperation with other relevant organisations from civil society, academia, standard organisations etc. – promises greater leverage. By developing a harmonised standard and approach that can then be used by a majority of purchasing companies in an industry to request emissions values from their suppliers, the effort required by suppliers can be significantly reduced. If all of their clients would request emission-related data to be delivered in the same format and based on the same calculation methodology and standards, suppliers would not have to carry out the process anew for each new buyer. This could thus reduce the problem of supplier unwillingness to share data and instead emphasise the advantages of data transparency for suppliers; those who could present their emissions data in a standardised format that numerous purchasing companies can easily work with, could gain a market advantage because such a standardised process would also simplify the subsequent buyer-supplier communication and cooperation. A similar approach is proposed specifically for the automotive value chain by the Expert Group on the Transformation of the Automotive Industry (ETA) set up by the German Federal Ministry for Economic Affairs and Climate Protection (BMWK). The proposal published in 2024 for the development of a harmonised carbon accounting methodology also emphasises that it is essential to ensure that the methods used in the automotive industry are compatible with relevant supplier industries, including steel (ETA 2024).

**Table 21: Key actors and actions for implementing a harmonised carbon accounting framework**

Key Actors	Actions for Implementation
Individual companies (at each level of the supply chain: mining, steel making, automotive)	<ul style="list-style-type: none"> <li>- Exchange with key business partners to harmonise the GHG accounting methodology currently in use.</li> <li>- Engage with business peers and other actors in (multi-stakeholder) initiatives to develop/improve sector-specific GHG accounting standards/guidance that can be applied in the future.</li> </ul>
MSIs (usually initiated by companies and/or CSOs)	<ul style="list-style-type: none"> <li>- Coordinate efforts of stakeholders from all stages of the supply chain to harmonise and/or refine existing GHG emission accounting standards.</li> </ul>

Key Actors	Actions for Implementation
	<ul style="list-style-type: none"> <li>- Develop sector-specific guidance on GHG emission accounting based on existing recognised standards that can be used by companies at different stages of the supply chain for free.</li> </ul>

In order to implement the activities listed above, the different actors need various resources. The engagement of individual companies with many different actors to harmonise GHG emission accounting standards requires considerable time and ties up personal resources. Engagement in MSIs can reduce this effort for each individual company, but the process of harmonisation in a multi-stakeholder setting can be very lengthy, so both measures should ideally be carried out in parallel. An important framework condition for the implementation of the instrument is also the commitment of civil society, academia, standard organisations etc. in MSIs and comparable organisations, which contribute external expert knowledge on carbon accounting and ensure that the level of ambition of a harmonised standard is feasible for companies of different sizes and framework conditions but is nevertheless ambitious and goal oriented. For the ultimate implementation of a harmonised standard, it is also important that governments and/or financial market players (banks or stock exchanges, etc.) provide clear guidance on the methodologies to be used for mandatory reporting obligations in order to create a level playing field for all business actors.

#### 2.4.2.5 Instrument 5: Enhanced data verification and traceability systems

The high significance of accurate (preferably activity-based) calculation of GHG emissions along the entire supply chain described in instrument 4 as a basis for setting targets, implementing appropriate reduction measures and designing the most effective incentivisation systems possible is leading to rapidly increasing requirements for the provision of data by all business actors along the supply chain. Many companies do not have sufficient resources or systems to collect and process such large volumes of data. For the calculation of Scope 3 emissions, they are dependent on secondary data from databases, or the often qualitatively inadequate data provided by their suppliers and have no way of verifying their data. At the same time, many suppliers are confronted with different, sometimes contradictory requests from their customers, to whom they are supposed to supply GHG emission data in various formats.

This is where the instrument ‘enhanced data verification and traceability systems’ comes in, which can be implemented by **individual companies using third-party offered approaches** (see e.g. Grüning et al. 2024, chapter A.6.2, and chapter A.6.3) or in **supply chain-collective settings** (see Grüning et al. 2024, chapter A.5.2).

Individual companies can develop their own digital platforms (or have them developed) to provide their customers with individualised, comprehensive information, e.g. on the emissions intensity of their products, with every delivery. Blockchain technology can be used to support the provision of reliable and verified data.<sup>9</sup> As relevant, reliable data sharing platforms have hardly been implemented along the iron ore-steel supply chain to date, this can be a competitive advantage. However, the disadvantage of such an individual approach is that, as described in

<sup>9</sup> It should be mentioned here that blockchain technology is not essential and is not a panacea for establishing corresponding data exchange platforms or systems. The decisive characteristics that such a system must demonstrate in order to create a real advantage for both sides (data providers and data retrievers), namely public verifiability, transparency, privacy and integrity, can also be established, for example, via a regular centralised database or the involvement of a trusted third party for data verification (Wüst and Gervais 2018; Egberts 2017). For such systems to be reliable, it is still crucial that the people who enter relevant information into the digital platforms are reliable and honest, a challenge that cannot be solved solely by a blockchain-based solution (Wüst and Gervais 2018). The use of blockchain solutions may also require verification by third parties to establish the necessary trust in the quality of the data provided, for example, which can significantly impair the promised simplicity and efficiency of a blockchain solution (Egberts 2017).

instrument 4, there is currently no uniform GHG accounting standard, and the comparability of this data can therefore be questionable.

In order to prevent individual companies from developing individual systems for passing on emission data that are not technically compatible with each other, the development of a standardised system or platform on which all actors in a supply chain feed in their data centrally and thus make it directly accessible to their business partners is suitable. Such a platform can also be used to coordinate third-party verification and thus the reliability of the data fed in. One possible approach for the cross-supply chain exchange of data is being piloted by the Catena-X initiative, for example (Catena-X 2023). Such a system may also render the use of company-specific (e.g. blockchain-based) solutions obsolete, as such solutions only make sense in situations “when multiple mutually mistrusting entities want to interact and change the state of a system, and are not willing to agree on an online trusted third party” (Wüst and Gervais 2018).

**Table 22: Key actors and actions for implementing enhanced data verification and traceability systems**

Key Actors	Actions for Implementation
Individual companies (at each level of the supply chain: mining, steel making, automotive)	<ul style="list-style-type: none"> <li>- Provide high-quality data and participate in the further development of harmonised and up-to-date platform requirements.</li> <li>- Establish interfaces with existing internal data management systems where possible to lower the effort of data provision and updates.</li> </ul>
MSI (or similar cross-company cooperation forum, i.e. Catena-X)	<ul style="list-style-type: none"> <li>- Coordinate open and trusted exchange of different actors along the supply chain regarding existing challenges and systems in use for data management and exchange.</li> <li>- Offer trusted forum for business stakeholders to establish minimum data requirements and rules to ensure data privacy and avoid breaches against antitrust rules. If needed: determine a trusted third party to be put in place for the verification of data provided by individual actors to the centralised system.</li> </ul>
Third-party technology provider	<ul style="list-style-type: none"> <li>- Provide the necessary digital infrastructure; ensure data security and potentially provide third-party verification of the data that is fed in.</li> </ul>

The (further) development of such an instrument requires various resources from numerous actors. Companies must invest human resources and time, and possibly membership fees, in order to fill and finance the development of a collective platform with the support of third parties. Funding can/must also be provided by governments or financial actors, especially in the initial phase.

For a collective solution to really lead to savings in efforts and resources for individual companies, such a solution must be rolled out quickly and to as many members of the supply chain as possible so that companies do not duplicate efforts to share all data in a joint initiative while continuing to receive individual requests from customers for data in a different format. The provider and the members of a collective solution must ensure that this guarantees data security and does not violate antitrust law. It must also be ensured that comprehensive transparency, for example with regard to the GHG emission intensity of various products, does not lead to poorer performing market participants simply being dropped as suppliers, but instead are enabled to improve their performance; e.g. through supplier development measures

as described in instrument 1 and in Grüning et al. 2024, chapter A.1.9 or chapter A.2.4). To achieve this, it is also necessary to design access to a possible collective solution to be as low-threshold as possible so that suppliers who do not (yet) work digitally or only to a limited extent can also participate in the system. In addition, it should be ensured that all participating companies follow a uniform standard/methodology when calculating their GHG emission data in accordance with instrument 4, so that the data is comparable. Only when sufficient members of the supply chain can provide their GHG emission data in the necessary granularity and quality will a collective data sharing platform provide benefits for all participants. If additional control is needed in order for members to trust the quality of the data provided via the centralised platform, a third party could be determined, which is responsible for verifying the data provided by individual members.

#### **2.4.2.6 Instrument 6: Coordination of interests to enable design for sustainability in joint R&D projects**

Research into and (further) development of ‘clean’ or ‘low-emission’ technologies, particularly in the area of decarbonisation of steel production as a GHG emission hotspot in the supply chain, is complex and requires a significant amount of funding. A growing number of companies along the entire supply chain have therefore already joined forces in various R&D projects in which, for example, renewable hydrogen-based DR-EAF steel production is to be tested. Examples of such MoUs and existing collaborations between mining companies, steel manufacturers and hydrogen producers are listed in chapter 5.5. of Grüning et al. (2024).

This **supply chain-collective approach** enables business actors along the supply chain to exchange knowledge with other companies and sometimes additional external actors, for example from the scientific community, as part of pilot projects (in the sense of coordination of interests and context, see Grüning et al. 2024, chapter A.5.1) in order to jointly develop the most innovative and efficient processes possible for the decarbonisation of the supply chain. In addition, these collaborative settings serve to share costs, particularly during the often complex and risky pilot phase of newly developed technologies. Existing projects usually profit from substantial financial support in the form of state financing, which is granted to various decarbonisation projects in the steel sector. The Swedish start-up company Stegra (formerly: H2 Green Steel) for example, which plans to produce large amounts of ‘green’ iron and steel via the DR-EAF production route (Stegra n.d.) and which has signed offtake agreements with a large number of customers in various industries (including steel service centres, producers of pipes and tubes, passenger vehicles and heavy commercial vehicles, whitegoods and construction products) (Bhat and Salazar 2023; Keating 2024), received significant amounts of state aid for the construction of their new plant: the company was awarded a EUR 250 million grant from the EU Innovation Fund (Stegra 2024). In addition, in June 2024, the European Commission approved support from the Swedish government for Stegra totalling EUR 265 million (EC 2024b). In July 2023, the European Commission also approved EUR 2 billion in funding from the German Federal Ministry for Economic Affairs and Climate Protection (BMWK) to promote the decarbonisation of steel production at thyssenkrupp steel Europe (BMWK 2023). The steel manufacturer SAAB, which has signed an MoU with the car manufacturer Volvo for the purchase of low carbon steel, is also receiving millions in financial support from the Swedish state (EC 2024a). The MoU between car manufacturer VW and steel producer Salzgitter AG on the purchase of low-carbon steel is also accompanied by state funding for Salzgitter AG’s decarbonisation programme (Salzgitter AG 2022). This externally provided state funding represents an important financial incentive to participate in and ambitiously implement corresponding R&D projects. In addition, participating companies can actively shape green lead markets and also gain a head start in the development of innovative products that will later offer

them an important market advantage. Such projects also usually contain offtake agreements, for example when commitments are obtained from car manufacturers that green steel produced as part of a pilot project will be purchased in certain quantities in the future. Offtake agreements or guarantees are just as important as the provision of governmental aid, as they offer companies switching to more sustainable technologies the certainty that necessary investments can be refinanced by the expected future demand for the new ‘greener’ products. In addition, offtake agreements enhance the creditworthiness of suppliers or specific R&D projects and can thus facilitate an improved access to credit or loans provided by financiers like banks and investors, which are often essential for the effective implementation of costly piloting projects (WEF 2024).

**Table 23: Key actors and actions for implementing coordination of interests to enable design for sustainability in joint R&D projects**

Key Actors	Actions for Implementation
Individual producer companies (at each relevant level of the supply chain, e.g. mining, steel making)	<ul style="list-style-type: none"> <li>- Provide knowledge and funds within the specific setting of the collaborative R&amp;D project.</li> </ul>
Clients (e.g. automotive companies)	<ul style="list-style-type: none"> <li>- Support the implementation of R&amp;D projects through future offtake guarantees to allow for the development and piloting of promising ‘green’ products or technologies.</li> </ul>
Financial institutions	<ul style="list-style-type: none"> <li>- Provide credit or loans to promising R&amp;D projects, which are aimed at the (further) development of ‘clean’ or ‘low-emission’ technologies.</li> <li>- Build internal expertise and refer to existing guidelines and criteria to assess whether a proposed project can effectively contribute to the reduction of GHG emissions in a specific sector, process or product.</li> </ul>
Governments	<ul style="list-style-type: none"> <li>- Provide additional funding for the kick-off phase of the R&amp;D project in order to secure risks and allow companies to obtain credits/loans from finance institutions.</li> </ul>

For implementation, all actors involved in a MoU/collaborative R&D project contribute human and (in some cases) financial resources that are required in addition to on-going internal R&D measures. In the longer term, however, the instrument should lead to savings in the individual resources required for R&D for all actors.

Despite reported delays in the implementation of some of the on-going collaborative R&D projects, the instrument was described by the focal company as an important approach for driving forward decarbonisation in the supply chain in the future and testing new innovative approaches. It is crucial that results from the various individual pilot projects are rolled out in a timely manner in order to actually contribute to a comprehensive decarbonisation of the supply chain.

**2.4.2.7 Instrument 7: Third party certification and cross-programme recognition**

A number of initiatives have been developed at the level of both iron ore extraction (including IRMA, TSM) and steel production (including ResponsibleSteel), which use third party audits to examine, verify and certify the sustainability performance (including GHG emission management) of individual sites on the basis of a standard developed in a multi-stakeholder setting. In the iron ore-steel supply chain, these initiatives are still in their infancy, with some of

them still having a low uptake (see also Grüning et al. 2024, chapter 5.5). Nevertheless, they provide the basis for continuous improvements in site-specific sustainability management and offer the opportunity to incentivise supply chain collaboration.

Against the background of the goal of reducing GHG emissions along the iron ore-steel supply chain, the workshops and interviews particularly discussed the (potential) role of the ResponsibleSteel initiative and standards as a **supply chain-collective** ‘third party certification and cross-programme recognition’ **instrument**. ResponsibleSteel certifies sites that produce, or process steel based on a standard developed in a multi-stakeholder setting. Companies that undergo a third-party audit in accordance with the standard can achieve different progress levels in two categories: ‘Decarbonisation’ and ‘Materials Sourcing’. The ‘Decarbonisation’ levels indicate, for example, whether a company has set an appropriate site level decarbonisation target, and measures its GHG emissions in accordance with a defined standard (see also instrument 4). In order to meet the requirements of the ‘Materials Sourcing’ category, steel companies have to demonstrate in the audit, among other things, that they “increasingly source from suppliers that participate in a recognised input material programme” (ResponsibleSteel 2024). ResponsibleSteel has so far recognised IRMA and TSM as input material programmes with relevance for the raw material iron ore considered here. Only if steel companies can prove that they encourage and support their direct and indirect suppliers to have a third-party audit carried out under one of the recognised programmes can they market their products as ‘ResponsibleSteel certified’. In order to achieve higher levels within the Responsible Steel certification system, which correspond to a better result, steel companies must prove that they not only encourage their suppliers to participate in third party certification programmes, but that a relevant proportion of their suppliers actually have their sites audited by third parties and that these suppliers achieve certain minimum performance levels as part of the recognised programmes. This initially staggered approach is explicitly aimed at generating a higher market demand among steel companies for appropriately certified input materials and thus also promoting the implementation of sustainability standards at the level of iron ore mining, for example (ResponsibleSteel 2024).

**Table 24: Key actors and actions for implementing third party certification and cross-programme recognition**

Key Actors	Actions for Implementation
Buyer ( <i>in this case</i> : steel company)	<ul style="list-style-type: none"> <li>- Participate in the ResponsibleSteel initiative by having own sites certified and revise the internal decarbonisation strategy in accordance with the requirements of the ResponsibleSteel standard. Additionally, enter into an exchange with suppliers and promote participation in one of the recognised input material programmes. Assess whether and in what form suppliers need support for the implementation of the third-party assessment through input material programmes.</li> <li>- Participate in the further development of collaborative standards in relevant multi-stakeholder processes.</li> </ul>
Supplier ( <i>in this case</i> : iron ore mining company)	<ul style="list-style-type: none"> <li>- Participate in relevant input material programmes by adapting the own production conditions to meet the programme’s site-specific standards.</li> </ul>



Key Actors	Actions for Implementation
MSIs, other sponsors of assurance/certification systems or certification bodies ( <i>in this case: ResponsibleSteel, IRMA, TSM</i> )	<ul style="list-style-type: none"> <li>- Participate in the further development of collaborative standards in relevant multi-stakeholder processes.</li> <li>- Ensure an independent third-party audit according to the standards, award certifications and organise the exchange of stakeholders at different levels of the supply chain to further develop the standard.</li> <li>- Involve external stakeholders from civil society, science, etc. to ensure the continuous development and a high level of ambition of the standard.</li> </ul>

Participation in a third-party audit and certification programme such as ResponsibleSteel and the aforementioned recognised input material programmes is initially associated with a high level of resource expenditure for both buying and selling companies. The companies must adapt their production processes to meet the requirements of the respective standard, train employees and collect and provide comprehensive data for the audits. Purchasing companies should also enter into an intensive exchange with at least their strategic suppliers and examine the possibilities of participating in recognised input material programmes together with them (also in the sense of instrument 1: supplier development). In the longer term, however, suppliers may be able to save resources by using third party audits and certification, for example if, as described in instrument 3, purchasing companies accept these certifications as proof of compliance with the highest possible environmental standards and refrain from carrying out additional individual audits as part of their supplier monitoring.

### 2.4.3 Discussion of the roadmap for the iron ore-steel supply chain

The key instruments presented in the roadmap are intended to overcome some of the challenges described in section 2.4.1 of this chapter, which the focal company and other actors along the iron ore-steel supply chain face in reducing GHG emissions in particular and improving environmental performance at all stages of the supply chain in general. The roadmap only includes those instruments which, according to experts and the focal company, promise a particularly high leverage effect and does not represent a comprehensive guide to the implementation of an appropriate SSCM approach for GHG emission reduction.

The instruments in the roadmap are divided into two categories, depending on whether an instrument is initiated by an individual company (usually the buyer) or at a collective supply chain level (see also Grüning et al. 2024 for further derivations of the categories). With regard to instruments that companies can implement individually, three instruments were identified that promise a particularly high leverage effect for the improved achievement of the environmental upgrade target. This includes the supplier development instrument (instrument 1), which should form the basis for the formulation of sustainability performance expectations in supplier CoCs or contracts (instrument 2). The implementation of continuous supplier performance monitoring (instrument 3) is necessary in order to identify supplier development needs and check the implementation of sustainability requirements. In addition to measures that individual companies can take, the roadmap focuses primarily on instruments that (must) be implemented collectively by various actors in the supply chain in order to achieve the goal of decarbonisation along the supply chain more effectively, and to keep the effort and costs for all actors as low as possible. This is also due to the fact that in the iron ore-steel supply chain, unlike the cotton-garment supply chain, for example, the power imbalance between buyers and suppliers does not run exclusively from top to bottom. Rather, the value chain is characterised by financially strong

players at all stages of the supply chain, who generally possess sufficient expertise to reduce their own GHG emissions, but who are only just beginning to take their upstream and downstream value chain into consideration when dealing with their environmental impacts. Power distribution between the actors can also change over time, depending on current market developments. According to the experts interviewed, it can be observed that negotiating power tends to shift towards the downstream sector in times of low commodity (especially: iron ore) prices, while the upstream sector has an improved negotiating position when iron ore prices rise. Depending on the current market environment, this results in different windows of opportunity to implement new environmental requirements vis-à-vis business partners.

Partly due to new legislation such as the CSRD or the CSDDD, which will oblige companies to also check their Scope 3 emissions data and report it in an increasingly granular form, efforts are initially focusing on improving the exchange of emissions data along the supply chain. The focus of supply chain cooperation is therefore initially on improved communication and harmonisation of the respective industry efforts. This is reflected in the fact that a harmonised carbon accounting framework (instrument 4) and enhanced data verification and traceability efforts (instrument 5) were considered to have a high potential leverage effect. During the workshops, it was also discussed that this improved harmonisation was necessary in order to increasingly negotiate price premiums for demonstrably 'greener' products in the future, as these instruments could improve comparability between the emissions intensity and GHG savings potential of different products.

According to various experts, discussions about a possible premium for effectively reduced GHG emissions and other comparable sustainability services (e.g. for participation in a third-party audit and certification scheme, instrument 7) are still in their infancy in the iron ore-steel supply chain. Interviewees at all levels of the supply chain (mining, steel production and automotive manufacturers) report that there is currently no significant willingness on the part of purchasing companies to pay price premiums for certified iron ore or 'green' steel from DRI production. The only exception at present appears to be commitments for the future payment of premiums for the purchase of 'green' steel, which is produced on the basis of renewable hydrogen in the DR-EAF route (Stegra 2022; Bhat and Salazar 2023; Keating 2024). However, these are currently forecasts for the future, as the corresponding 'green' steel has not yet been produced at scale (Chan and Vargas 2024). Similar investments in joint R&D projects (instrument 6), which were actually identified as a central instrument for the cross-supply chain exchange of knowledge and further development of innovative green technologies, are also repeatedly deprioritised by participating companies in times of economic downturn and are heavily dependent on governmental subsidies (tagesschau 2024).

These insights also indicate that incentives from the supply chain actors themselves are likely to only have a minor leverage effect for effective decarbonisation and environmental protection. Rather, it became clear in the workshops and interviews that the fourth-party/government enabled and enforced approaches described in chapters 2.8 and 2.9 of Grüning et al. (2024) and earlier in section 2.4.1 of this report, are urgently needed to further promote cooperation to achieve environmental protection goals along the entire iron ore-steel supply chain.

## **2.5 Roadmap 4: Tin-solder**

### **2.5.1 Environmental target and background**

The majority of CO<sub>2</sub> emissions across the tin supply chain are a result of the smelting and refining process. Focusing efforts on this stage is important for achieving GHG reduction targets, as it offers the greatest potential for significant impact. According to the International Tin

Associations (ITA) report “Life Cycle Assessment of Tin Production” 74% of GHG emissions are emitted during the smelting and refining stages (ITA 2023). Vasters and Franken 2020 support these findings, noting that one ton of crude tin production requires non-renewable fuels like coal and fuel oil, along with significant electrical energy for electric furnaces for tin ore reduction, which leads to significant GHG emitted during the processing stage of tin. During the mining phase, major emissions stem from the application of diesel to power the equipment used for mining (Rüttinger et al. 2020).

Industry expert interviews confirm the importance of addressing GHG emissions. A solder producer interviewed in the frame of this study mentioned that their companies’ environmental initiatives began with GHG accounting and reduction measures due to client requests, particularly from producers of consumer electronics.

The interviewed solder producer, after beginning GHG accounting and aiming to reduce their emissions, sought suppliers with lesser GHG footprints. This led them to switch to purchasing tin from recyclers within the EU. This might reflect a broader industry trend. For instance, electronics producer brand Apple has shown a preference for recycled tin in their products (Apple 2023). Additionally, supplier requirements for GHG accounting are highlighted in the CoC for tin recycling companies (Aurubis 2022). However, the industry experts have indicated a lack in availability of recycled metal (including tin) to cover all the future demand.

Based on discussions with industry practitioners and literature review, we selected an environmental upgrade target that was considered as relevant and ambitious to develop a roadmap for the tin supply chain. The following target was defined on this basis:

#### **Environmental upgrade target – tin**

Within 15 years, GHG emissions are reduced throughout the tin supply chain but particularly during the smelting phase.

Unlike the development of roadmaps for the cotton (chapter 2.2) and iron ore-steel (chapter 2.4) supply chains, which involved collaboration with a focal company, the roadmap for the tin supply chain had to be created without such a partnership. Instead, it was developed based on the findings of the first and second work package of this research project (Strasser et al. 2024; Grüning et al. 2024), a comprehensive literature review, and interviews with industry experts and practitioners.

Due to the lack of a concrete focal company, discussion with experts in workshops and interviews were informed by a fictional scenario that reflects typical characteristics of companies active within the supply chain. The scenario was developed by the project team based on an interview with an integrated tin company. It is focussed on the fictional integrated tin company A, which owns several tin mines and operates smelting and refining facilities, producing solder. It is registered as a brand on London Metal Exchange (LME). The company serves global electronics manufacturers and establishes annual tin sales contracts, typically during LME Week.

Company A has identified the smelting phase as the primary source of its GHG emissions, followed by transportation. Although the company has initiated GHG accounting, it is still in the early stages. While clients occasionally inquire about GHG accounting, they have shown limited interest in purchasing carbon-neutral tin due to higher price, despite the company’s offer.

Clients of Company A located in the EU must, in the future, comply with the CSDDD, which requires the implementation of climate transition plans addressing Scope 1, 2, and 3 GHG emissions (Haythornthwaite et al. 2024; Watershed 2024). This requirement may drive EU-

based clients to intensify their efforts to reduce Scope 3 emissions, thereby influencing both upstream and downstream partners in the supply chain. Additionally, many clients will fall under the CSRD and associated ESRS. This directive mandates, among others, that companies disclose their Scope 1, 2, and 3 GHG emissions, along with associated risks, and report on the actual or potential impacts across their entire value chain, including operations, products and services, business relationships, and supply chain (European Parliament and Council of the European Union 2023).

Within the scenario, company A utilises a range of SSCM tools and approaches that, although not initially intended for GHG emission reduction, positively impact this environmental target. Additionally, the company has begun participating in initiatives directly addressing GHG emission reduction within the tin supply chains. They aim to prioritise this topic in their sustainability strategy in the coming years.

As an LME brand, Company A complies with the LME's responsible sourcing policy, which mandates, among others, ISO 14001 certification and adherence to OECD guidelines on responsible supply chains. The LME also collects data on some other metrics, such as adherence to the Tin Code. It adheres to local environmental laws and regulations.

When sourcing tin from mining cooperatives, Company A collaborates with those that comply with local environmental laws and have completed the necessary environmental impact assessments. The company facilitates connections to the electricity grid, which it financed for its operations, allowing cooperatives to reduce reliance on high-emission generators.

Additionally, Company A is a member of industry associations like the ITA and contributes to initiatives targeting emission calculations in the tin industry. The company also supports suppliers, such as mining cooperatives, by assisting with environmental liabilities. For example, if a cooperative lacks funds for a necessary study, Company A may provide an advance payment to help them secure the required licenses.

Achieving the specific environmental target presents several challenges and barriers. Company A believes it is possible to meet the target, despite technological barriers like high energy consumption in smelting and refining. The company already uses clean energy for most operations but offsetting the remaining carbon emissions would incur additional costs. However, clients are reluctant to pay for carbon-neutral products due to the competitive market's focus on affordability (Strasser et al. 2024). Company A generally secures about 80% of its contracts with clients a year in advance. Fluctuating tin prices<sup>10</sup> can influence the company's willingness to invest in sustainability initiatives. According to the report authors, if prices are volatile, the company might prioritise maintaining cost stability and competitiveness over incurring extra expenses. Low market prices could restrict the funds available for sustainability efforts, indicating that such uncertainty can lead to hesitation in committing to long-term investments in these areas.

## 2.5.2 Description of the roadmap

The roadmap is designed to serve as a guide for companies within the tin supply chain, particularly targeting smelters. It aims to provide practical guidance on effectively addressing GHG emissions. This roadmap was developed through research, drawing on findings and insights from previous project reports (Strasser et al. 2024; Grüning et al. 2024). It incorporates newly proposed instruments based on current SSCM practices, with adaptations and innovations

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<sup>10</sup> This volatility arises because tin is a commodity, and its prices are determined by market rather than by the producers themselves. For more information, refer to report Cost allocation and incentive mechanisms for environmental, climate protection and resource conservation along global supply chains (Strasser et al. 2024).

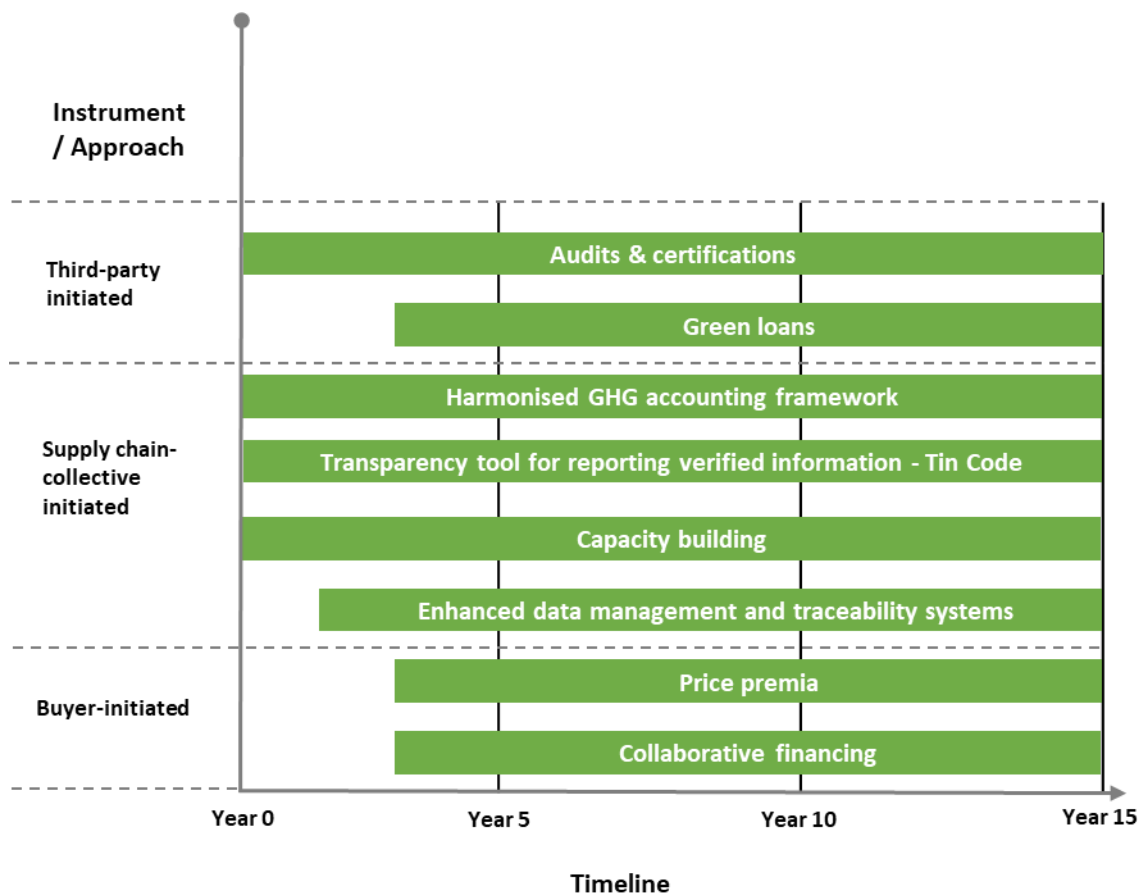
inspired by more advanced industries. The development process included interviews and workshops with stakeholders from companies, civil society, academia, and technical experts, which helped refine and adjust the roadmap.

It is important to note that this roadmap is not a depiction of the current state of GHG emission management within the supply chain. Instead, it provides a vision of what could be achieved in the future. While it offers examples of SSCM instruments and incentive mechanisms, it does not cover all possible approaches. The roadmap's applicability may vary depending on a company's specific supply chain, structure, business model, and geographical location.

Figure 4 shows that a combination of instruments initiated at the collective level of the supply chain, by individual companies (usually the buyer) and third parties is proposed. These approaches and instruments are designed to span over 15 years or more, aiming to meet environmental targets aligned with the Paris Agreement's goal of limiting global warming to 1.5°C. This involves reducing GHG emissions by 45% by 2030 and achieving net zero by 2050 (UN n.d.). Not all instruments are introduced right from the start. For example, instruments such as 'price premiums', 'green loans' and 'collaborative financing' come into play once other instruments such as 'harmonised GHG accounting framework' and 'transparency tools' are in place.

Each approach and instrument and the specific activities recommended for the respective actors, are explained in detail in the sections 2.5.2.1 to 2.5.2.8. A more detailed description of the interconnections and dependencies between different approaches and instruments in the roadmap is presented in section 2.5.3.

**Figure 4: Roadmap for improved environmental performance in the tin-solder supply chain**



Source: own illustration (adelphi research gGmbH)

### 2.5.2.1 Instrument 1: Harmonised GHG accounting framework

Achieving significant GHG emission reductions in the tin supply chain requires accurate and comparable GHG accounting of companies and their operations. This requires tools that enable efficient and reliable measurement and tracking of GHG emissions. Larger companies might afford external carbon accounting services or licenses for specialised tools, but these options can be expensive for smaller companies. Additionally, many tools and service providers rely on average emission factors, which can introduce inaccuracies. This is problematic because emission factors can vary significantly across different geographical regions. While platforms and GHG accounting standards, such as the GHG Protocol, allow the incorporation of average emission factors for purchased products and services to simplify calculations, this approach might not fully capture the actual upstream GHG emissions of companies sourcing from diverse regions. Consequently, this can lead to inaccuracies in comparisons. Therefore, it would be beneficial to develop a harmonised GHG calculation framework specifically tailored to the tin industry.

**This proposed new instrument**, ‘harmonised GHG accounting framework’ is a **supply chain-collective voluntary instrument**, and should be based on established standards like the GHG Protocol, incorporating inputs from actors across the entire supply chain by leveraging their expertise. By doing so, it will streamline GHG calculation processes, making data collection more manageable for all participants. Additionally, the framework should provide access to relevant emission factors, which may vary significantly by geographical region.

The ITA has initiated efforts in this direction through the “Life Cycle Assessment of Tin Production” project (ITA 2023). This initiative generates an accurate global LCA figure for refined tin, providing a baseline for updates and targets, and offering climate change-related information requested by actors.

Other industries, such as steel and aluminium, have compared industry-specific GHG accounting frameworks to harmonise emissions reporting, addressing discrepancies and facilitating accurate emissions tracking (Columbia Center on Sustainable Investment n.d.). Such harmonised, industry-specific framework for the tin industry will offer a comprehensive overview of its carbon footprint, simplifying data collection, emission calculations, and reporting. It can also serve as a baseline reference for monitoring companies’ progress and developing key performance indicators for emission reduction throughout the supply chain.

**Table 25: Key actors and actions for implementing a harmonised GHG accounting framework**

Key Actor	Actions for Implementation
MSIs and/or industry association (e.g. ITA)	<ul style="list-style-type: none"> <li>- Provide a platform for industry stakeholder knowledge exchange and collaboration; engage with relevant actors (such as individual companies, topical GHG accounting/LCA experts) to develop sector-specific GHG accounting framework.</li> </ul>
Individual companies (at each level of the supply chain)	<ul style="list-style-type: none"> <li>- Participate in the initiative by providing data on emissions and supply chain practices, including data on energy consumption, production processes, and transportation logistics; engage suppliers to encourage them to support framework development by sharing relevant data on emissions and supply chain practices and participating in pilot projects.</li> </ul>
Research Institutions/GHG accounting and LCA experts	<ul style="list-style-type: none"> <li>- Conduct studies to validate emission factors and framework effectiveness; provide scientific insights.</li> </ul>

The development and implementation of this instrument requires various resources from key actors. Industry associations (e.g. the ITA) can facilitate this process. However, the facilitation process and engaging the right experts (Research Institutions/GHG accounting and LCA experts) is both lengthy and costly. The funding can come from industry association member contributions and government grants. Individual companies require data management systems and training resources, which are supported internally and guided by industry associations. Suppliers need technology for data sharing and training/capacity building (instrument 5) on the framework. The capacity building can be provided by MSIs/industry associations, or by clients/sourcing companies. Given that industry decarbonisation is a key component of many national decarbonisation strategies, governments could play an important role by developing financial instruments for the development of relevant tools and services. By offering grants for the development of GHG calculation tools, harmonised frameworks, emission factor calculation and verification, and carbon accounting capacity building, the governments can incentivise the adoption of these tools and frameworks.

Key levers for successful implementation include building trust through transparency and open communication, showcasing the environmental and economic benefits of the framework, leveraging the unique strengths and expertise of each actor group, and maintaining engagement through regular updates and transparent communication. In addition, it is important that governments and/or financial market players (FIs, stock exchanges, etc.) provide clear guidance

on how the developed harmonised GHG accounting framework can be used for mandatory reporting ensuring a level playing field for all business participants.

### 2.5.2.2 Instrument 2: Enhanced data management and traceability systems

Accurate calculation GHG emission requires the input data of supply chain operations as precise as possible. The supply chains of tin, from mining to smelting, can be complex. In scenarios where a company operates an integrated structure, proving the tin’s origin is straightforward. In order to collect and assure accurate data, companies apply the instrument ‘enhanced data management and traceability systems’, which can be based on **individual companies using third-party offered approaches** (see e.g. Grüning et al. 2024, chapter A.6.2) or individual companies requesting proof of origin information for each transaction (see e.g. Grüning et al. 2024, chapter 5.2). However, complexity increases when a company sources tin ore from multiple locations (especially when involving ASMs). Given the complexity and cost associated with full traceability in the tin supply chain, particularly with ASM, a more feasible approach might involve implementing a tiered traceability system. For this purpose, mining operations could be grouped based on common characteristics, such as geographic region or mining method, rather than tracing each individual source. This approach would maintain a level of traceability and transparency sufficient for GHG accounting while reducing the financial and logistical burdens on smaller companies and ASMs.

**Table 26: Key actors and actions for implementing enhanced data management and traceability systems**

Key Actor	Actions for Implementation
MSIs and/or industry associations	<ul style="list-style-type: none"> <li>- Take a leading role in coordinating the design of such systems; provide a centralised platform for collaboration and ensure that the system aligns with industry standards and goals.</li> <li>- Offer guidance by sharing best practices and advocating for a tiered data management and traceability approach; monitor the implementation of the system, evaluate its impact, providing feedback to technology providers for continuous improvement; provide a collaborative setting where companies can discuss how traceability can be done more cost efficiently.</li> <li>- If needed: determine a trusted third party for the verification of data provided by individual actors to the centralised system.</li> </ul>
Company	<ul style="list-style-type: none"> <li>- Apply the system in their operations; define traceability requirements, lead the integration with existing processes.</li> </ul>
Third-party technology provider	<ul style="list-style-type: none"> <li>- Provision of the digital infrastructure; ensuring data security; third-party verification of the data, if necessary.</li> </ul>

The development of such an instrument can prevent individual companies from developing their own in-house systems, which can be a lengthy and costly process and lead to different data protocols which may have compatibility issues. A system developed under the leadership of an MSI or industry association would ensure the accuracy and comparability of input data. This standardisation is crucial for establishing a level playing field, because it ensures the correctness of the data, which in turn is a significant factor for the effective adoption of instrument 1.

The MSIs and/or industry associations should allocate resources to research the best available technology and lead the development of such a tiered traceability system. The financing of such



an instrument would require funds which may come from membership fees and/or government grants. By pooling resources through membership fees and government grants, the financial burden is shared, making the system more accessible to all companies, including smaller ones. In addition downstream actors can provide financial assistance by funding pilot projects, as demonstrated by Apple’s support for a blockchain-based traceability pilot project (Apple 2022). Such a collaborative funding model reduces individual costs and incentivises participation of wider range of relevant actors by demonstrating the shared benefits of improved data management and traceability.

### 2.5.2.3 Instrument 3: Audits and certifications

Process certification frameworks, such as ISO 14001, allow companies some flexibility in selecting significant environmental aspects to target, enabling companies to address key areas like waste reduction, energy efficiency, or carbon footprint as necessary. These certifications encourage continuous improvement through structured EMS, using a Plan-Do-Check-Act (PDCA) approach to meet sustainability targets (ISO 2021).

While a **third-party, voluntary, profit-focused instrument** provides credibility and certifies that company adheres to sustainability practices, it also serves as an incentive for cost allocation across company operations. Certification requirements drive resource allocation and operational focus towards environmental and social responsibility. Furthermore, by including process certification requirements in CoC’s they create incentives for suppliers and partners to align with the required sustainability standards.

Additionally, companies that are registered as LME brands are required to provide evidence of third-party audit or assurance audits. It’s important to note that the platform functions primarily as a transparency mechanism with a core focus on human rights and conflict mitigation. While LME requests evidence from third-party audits on various sustainability aspects, it often relies on existing third-party certifications rather than conducting audits directly (with certain exceptions in specific human-right scenarios). Thus, any GHG targets or environmental initiatives should be viewed as complementary to the social issues within the tin supply chain. Recognising these interconnected challenges ensures that environmental goals are pursued in a way that also considers critical human rights issues, aligning companies’ practices with broader industry standards and enhancing the scalability and practical impact of its sustainability efforts.

**Table 27: Key actors and actions for implementing audits and certification**

Key Actor	Actions for Implementation
Company Management	<ul style="list-style-type: none"> <li>- Establish an environmental policy which covers all relevant SSCM tools that are used to achieve the environmental upgrade target; Establish clear commitment to environmental protection, climate change mitigation and compliance by integrating audits and certifications into the company’s strategic goals; allocate resources and appoint responsible personnel to oversee the implementation process.</li> <li>- Develop and maintain the EMS conduct internal audits to prepare for external assessments and ensure continuous improvement.</li> </ul>
Suppliers	<ul style="list-style-type: none"> <li>- Collaborate with the company to ensure that operations meet the required sustainability standards; provide necessary documentation and data for audits and certifications.</li> </ul>

Key Actor	Actions for Implementation
Third-Party Auditors	<ul style="list-style-type: none"> <li>- Conduct thorough and unbiased assessments of the company’s practices; provide feedback and recommendations for improvements to meet certification requirements.</li> </ul>

To effectively implement audits and certifications, actors require a variety of resources. Company management needs financial resources and strategic guidance, typically provided through internal budgeting and external consultancy. Sustainability and compliance teams require access to training programmes and tracking tools, supplied by internal human resources departments and external bodies. Suppliers and partners require information on compliance standards and support, facilitated by the company’s procurement team.

In addition to these transactional elements, achieving certifications often requires significant investment to improve environmental performance, such as upgrading production processes, implementing energy-efficient technologies, and reducing waste.

The successful implementation of this instrument depends on several key levers. Clear communication of audit criteria ensures that all actors understand the expectations and requirements. Integrating audit processes into daily operations helps maintain consistency and efficiency. Efficient use of technology for data handling streamlines the collection and reporting of environmental metrics, enhancing accuracy and accessibility. Additionally, fostering a culture of continuous improvement encourages proactive identification of areas for enhancement throughout the organisation and its supply chain.

Specific framework conditions in the sector can enhance the effective uptake of audits and certifications. For instance, regulatory incentives and a supportive policy environment can drive companies to prioritise and invest in certification processes. Public awareness and client demand for sustainable practices tied to price premiums also play a critical role, creating a market-driven incentive for companies to uphold certification standards.

#### 2.5.2.4 Instrument 4: Transparency tool for reporting verified information - the Tin Code

The Tin Code is a global Environmental, Social and Governance (ESG) standard and transparent reporting mechanism adopted voluntarily by the tin industry to demonstrate a commitment to continuous improvement across exploration, mining, smelting, and recycling operations. Designed for global applicability, the Tin Code facilitates harmonised reporting and progressive improvement, with provisions for third-party verification. This instrument is initiated by producers.

This **supplier-collective voluntary instrument** provides a systematic format for sharing information with buyers. By covering (among others) GHG topics, the Tin Code offers transparency into a company’s status and progress in these areas, aiming to achieve greater accountability and environmental responsibility.

**Table 28: Key actors and actions for implementing a transparency tool for reporting verified information (the Tin Code)**

Key Actor	Actions for Implementation
Industry association (e.g. ITA)	<ul style="list-style-type: none"> <li>- Provide the framework and platform for reporting; ensure standards are clear and accessible; offer guidance and support to stakeholders.</li> </ul>

Key Actor	Actions for Implementation
Individual companies	<ul style="list-style-type: none"> <li>- Adopt the Tin Code and integrate it into operations; collect relevant ESG and GHG data; submit reports to the platform.</li> </ul>
Clients	<ul style="list-style-type: none"> <li>- Encourage compliance by prioritising purchases from Tin Code adherents; support transparency and sustainability initiatives within the supply chain.</li> </ul>

To implement this instrument effectively, actors require various resources. The ITA needs funding to develop and maintain the reporting platform and provide guidance, supported by membership fees, industry partnerships, and potential grants from governmental and/or environmental organisations. Tin producers require financial resources for data collection, reporting systems, and technology upgrades, typically sourced from internal budgets.

This instrument enables access to information for a wide range of actors. It could serve as a tool to communicate information from the harmonised GHG accounting framework (instrument 1), and to demonstrate adherence to various audits and certifications (instrument 3). This instrument could also be linked to price premiums (instrument 6), meaning that companies adhering to the Tin Code could potentially receive higher prices for their products, reflecting their commitment to sustainability and responsible sourcing. This premium would serve as an incentive for companies to meet and maintain the standards outlined in the Tin Code, rewarding sustainable practices and encouraging wider adoption within the industry.

Key levers for successful implementation of this instrument: ITA can foster industry-wide collaboration and promote the benefits of transparency and sustainability to encourage adoption. Tin producers should integrate sustainability goals into their core business strategies and leverage technology for efficient data management and reporting. Third-party verifiers must maintain independence and credibility to ensure trust in the verification process, using innovative audit techniques to streamline assessments. Buyers can advocate for industry-wide adoption of the Tin Code and utilise their purchasing power to drive demand for compliant tin products.

**2.5.2.5 Instrument 5: Capacity building and training programmes for suppliers**

Actors like mining cooperatives may require access to information tailored to be easily understandable and applicable to their operations. A MSI, similar to the Tin Working Group in Indonesia (Grüning et al. 2024) or the ITSCI programme in Africa (ITSCI 2020), can effectively provide these training programmes. By collaborating with downstream companies and other actors, such initiatives enhance environmental sustainability within the supply chain.

**This newly proposed supply-chain collective instrument** includes programmes that offer targeted education on sustainable practices, emissions reduction, and efficient resource management, helping suppliers align with industry expectations and regulatory requirements. The desired effect is to foster a culture of continuous improvement and innovation among suppliers. Through workshops, seminars, and on-site training, suppliers can learn best practices and access the latest technologies, improving their operational efficiency and enhancing their ability to participate in global markets that prioritise sustainability.

**Table 29: Key actors and actions for implementing capacity building and training programmes for suppliers**

Key Actor	Actions for Implementation
Companies	<ul style="list-style-type: none"> <li>- Provide technical assistance, training and resources to help their suppliers improve their environmental practices; support the identification of training needs of the mining cooperatives as important input for the development of the relevant training materials.</li> </ul>
Mining cooperatives	<ul style="list-style-type: none"> <li>- Actively participate in training sessions; apply learned practices to their operations.</li> </ul>
MSIs/Industry associations	<ul style="list-style-type: none"> <li>- Coordinate the initiative and align stakeholders; develop targeted training modules; organise workshops to facilitate learning from industry experts and peer sharing; establish certification programmes to acknowledge suppliers who successfully complete training and adopt sustainable practices, partner with international organisations and financial institutions to offer grants for training, provide technical assistance to help suppliers implement new practices, and set up monitoring systems to track their progress.</li> </ul>

To implement the training programmes effectively, actors require various resources. Mining cooperatives need access to tailored training materials and on-site support, provided by local industry associations and in their native language. Companies must allocate financial and logistical resources to support training initiatives, ensuring cooperatives have the necessary tools and materials. Local industry associations and NGOs require funding and expertise to develop comprehensive training content, which can be sourced from partnerships with companies and governmental agencies. Government agencies can provide financial support via grants for development of training materials. Clients can offer financial support directly to Industry Associations or NGOs.

Key levers for successful implementation include a participatory approach to curriculum development, ensuring training materials are relevant and practical. Engaging local trainers and using local languages and contexts will enhance understanding and application. Additionally, creating demonstration sites can provide hands-on learning experiences. Collaboration and open communication among all actors will drive the initiative’s success.

Capacity building and training programmes are essential and vital for the effective implementation of all other instruments.

**2.5.2.6 Instrument 6: Price premiums**

Decarbonisation efforts at both company and supply chain levels can be costly and require significant investments. Currently, the burden of these investments falls on the respective companies, as they are expected to comply with sustainability requirements set by clients without affecting the final product price.

**The new proposed instrument** of price premiums, **a buyer-initiated voluntary instrument**, addresses this challenge by providing direct financial incentives for sustainable practices. The goal is to incentivise actors in the supply chain to adopt and maintain sustainability practices. Paying a price premium for more sustainable and low-carbon tin could enable these actions. The LME, already gathering extensive ESG and sustainability information through its LME Passport,

has considered setting premium prices for sustainable tin (Grüning et al. 2024). Low GHG emissions could be one of the criteria for justifying such a premium price.

**Table 30: Key actors and actions for implementing price premiums**

Key Actor	Actions for Implementation
Stock exchanges, such as LME	<ul style="list-style-type: none"> <li>- Develops and maintains the framework for assessing sustainable practices and pricing systems for linking price premium to sustainability metrics, including lower GHG emissions.</li> </ul>
Company	<ul style="list-style-type: none"> <li>- Invest in sustainable practices and technologies to qualify for the premium pricing; document and report their decarbonisation and sustainability efforts through tools such as Tin Code and platforms like the LME.</li> <li>- Incorporate premiums into procurement procedures, inform suppliers about the premium framework, and assess the impact of premiums on sourcing; conduct market research to understand consumer willingness to pay premiums for sustainable tin, and devise strategies to convey the value of premiums to buyers.</li> </ul>
Suppliers	<ul style="list-style-type: none"> <li>- Invest into decarbonisation efforts and maintain them; apply traceability tools to assure source of sustainable and low carbon tin.</li> <li>- Participate in training and verification/auditing processes.</li> </ul>
Clients	<ul style="list-style-type: none"> <li>- Commit to purchasing sustainable tin at a premium price.</li> </ul>

In order to implement this instrument, companies need financial investments for sustainable technologies and practices, supported by internal budgets and potential grants from governments or loans. They also need access to reporting tools. Their suppliers need access to finance for making investments into decarbonisation measures as well as access to traceability tools (where applicable) to assure transparency in the supply chain. Buyers require clear guidelines and information on premium pricing, facilitated by the stock exchanges such as LME. The LME needs resources to develop and maintain the framework, potentially funded by membership fees and industry partnerships.

Key levers for successful implementation include fostering strong collaboration between buyers and suppliers to ensure commitment to premium pricing. Transparency in reporting by the LME is important for building trust. Buyers can leverage their purchasing power by committing to sustainable tin purchasing in year-ahead contracts, driving demand for sustainable tin. Open communication and shared goals among all actors will enhance the effectiveness of this instrument.

Price premiums are connected to all other instruments, either by using them to assure the low GHG emissions of purchased tin or by serving as a means to finance carbon reduction measures in the supply chain. Additionally, clients' commitment to paying a premium for greener tin can be crucial for companies to apply for green loans (instrument 7) and collaborative financing (instrument 8).

### 2.5.2.7 Instrument 7: Green loans

Investing in energy efficiency or transitioning to cleaner energy for smelting operations often requires substantial financial resources. A green loan is a type of financing that allows

borrowers to allocate funds specifically for projects that advance environmental goals. This instrument assists borrowers in conveying the environmental sustainability of their operations and supply chain (World Bank Group 2021).

This **third-party initiated, profit-focused voluntary instrument** involves financial institutions developing green loans specifically tied to decarbonisation efforts in the tin industry, offering favourable terms such as lower interest rates and longer pay-back periods. These loans could provide companies with access to green finance, accelerating their decarbonisation initiatives. Additionally, local governments, with a vested interest in industrial decarbonisation, could support the development of these instruments by subsidising or securing the loans, further enhancing their attractiveness and feasibility.

**Table 31: Key actors and actions for implementing green loans**

Key Actor	Actions for Implementation
Financial institutions	<ul style="list-style-type: none"> <li>- Develop framework of and offer green loans, requiring resources to design loan products with favourable terms, such as lower interest rates and longer pay-back periods; ensure the green loan aligns with the World Bank’s green loan principles.</li> </ul>
Company	<ul style="list-style-type: none"> <li>- Prepare proposals detailing how projects funded by the loan will deliver clear environmental benefits; assess, measure, and report these benefits; communicate evaluation processes for selecting projects to receive loan proceeds; explain management of environmental and social risks; manage proceeds by crediting them to a dedicated account or tracking them to ensure transparency and integrity; report outcomes using qualitative and quantitative indicators, such as energy capacity improvements and GHG emissions reductions (World Bank Group 2021).</li> </ul>
Clients	<ul style="list-style-type: none"> <li>- Can support companies with applying for green loans by committing to purchasing sustainable or low carbon tin through offtake agreements at a premium price, thereby reducing the credit risks for the bank.</li> </ul>

To effectively implement this instrument, various actors require specific resources. Financial institutions need capital to fund loans and expertise to develop suitable loan products, which can be sourced from internal financial reserves and partnerships with government programmes. Companies require detailed project proposals and financial documentation, prepared by internal teams or with the help of external consultants. Local governments can provide subsidies, guarantees, and the regulatory framework, funded through government budgets and potentially international environmental funds. Development banks, such as the European Bank for Reconstruction and Development (EBRD), play a special role by offering financial support, technical assistance, and investment security. The EBRD, for instance, supports the development of green financial systems to accelerate the transition to a green, low-carbon economy by increasing the scale and depth of local financial markets (EBRD n.d.). These banks often bridge funding gaps, particularly in emerging markets, facilitating projects that align with sustainable development goals.

Key levers for successful implementation include financial institutions establishing clear criteria for loan approval and offering competitive terms to attract companies. Companies should align their projects with sustainability and carbon reduction goals and demonstrate potential impact

and viability. Local governments can provide incentives and supportive policies, facilitating partnerships between actors.

Green loans require successful uptake, for which enhanced data management and traceability systems (instrument 2), audits and certifications (instrument 3), and the transparency tool (instrument 4) are important. Price premiums (instrument 6) and offtake agreements from clients can be used for providing financial institutions with assurance that companies will see a return on green investments.

### 2.5.2.8 Instrument 8: Collaborative financing

Access to green finance such as green loans/credit or other financial instruments may be challenging, particularly for suppliers such as smaller miners and mining cooperatives due to various reasons (e.g. poor credit ratings, lack of awareness about access to green finance). Additionally, some cooperatives may experience financial difficulties, particularly in regions where liquidity issues may arise from delayed payments by smelters (Grüning et al. 2024). These financial constraints can hinder their ability to invest in newer, energy-efficient technologies. Additionally, the price of tin is largely influenced by market demand, resulting in shifting power dynamics that are not strictly hierarchical. Miners understand that their extracted tin will eventually sell, irrespective of timing. This understanding can contribute to hesitancy in investing in further sustainability initiatives, as immediate market conditions often take precedence over long-term environmental commitments, especially when combined with financial constraints and uncertainty (Strasser et al. 2024).

A **newly proposed buyer initiated voluntary instrument** is collaborative financing (which is also closely interlinked with green loans). Buyers play an important role by leveraging their relationships (and credibility) to connect them with financial institutions. They can enhance the creditworthiness of cooperatives by providing financial guarantees, which reduce the perceived risk for lenders. Buyers also contribute by sharing the costs and risks of green investments, such as covering part of the interest payments or funding sustainability projects. Additionally, they can negotiate with financial institutions to secure more favourable loan terms, including lower interest rates and extended repayment periods. This approach could enable cooperatives to access green finance (e.g. green credit/loans), enhancing the energy and resource efficiency of their operations. Additionally, cooperatives may lack the knowledge to access these types of green and collaborative financing options. Support from smelters or industry associations would be invaluable in sharing the necessary knowledge and assisting with the preparation of required documentation, thus facilitating smoother access to financial resources.

**Table 32: Key actors and actions for implementing collaborative financing**

Key Actor	Actions for Implementation
Suppliers, e.g. mining cooperatives	<ul style="list-style-type: none"> <li>- Engage with smelters and industry associations to understand green collaborative financing options; prepare and submit necessary documentation for financing.</li> </ul>
Company	<ul style="list-style-type: none"> <li>- Continue offering support (such as advanced payments to support cooperative liquidity covering part of interest payments, support negotiations for lower interest terms and longer pay-back periods); collaborate with stakeholders to develop and promote green collaborative financing models; partner with cooperatives to offer financial support and guidance; facilitate timely payments to improve liquidity for cooperatives.</li> </ul>

Key Actor	Actions for Implementation
Industry Associations	<ul style="list-style-type: none"> <li>- Provide training and resources on accessing green collaborative finance; assist cooperatives in preparing documentation and navigating financial processes.</li> </ul>
Financial institutions	<ul style="list-style-type: none"> <li>- Develop and offer green loan products (instrument 7) tailored to the needs of mining cooperatives; provide favourable terms to encourage uptake.</li> </ul>

To successfully implement collaborative financing, various actors in the mining sector must coordinate resources and expertise. Mining cooperatives need both financial support and strategic guidance, which can be provided through partnerships with smelters and industry associations. These cooperatives often require assistance in preparing necessary documentation, a role that industry associations and financial consultants can fulfil to streamline processes and meet regulatory standards. The focal company plays an important role by providing advanced payments and leveraging its expertise in financial management, with support from internal resources and partnerships with financial institutions. In turn, industry associations need adequate funding to develop and deliver training programmes, which can be financed through membership fees and external grants. Financial institutions are crucial in designing green loan products, enabled by their financial reserves and enhanced by government incentives.

Key levers for effective implementation include fostering robust, trust-based partnerships between cooperatives and smelters, ensuring that cooperatives receive the financial support and guidance needed for growth. Industry associations should prioritise accessible training and development resources to build cooperatives’ capacities, while the company can use its influence to promote collaborative financing models that benefit the entire value chain. Financial institutions play an essential role by offering competitive loan terms and working directly with stakeholders to tailor loan products to their specific sustainability and operational needs. Through open communication, shared sustainability goals, and coordinated efforts, actors in collaborative financing can create a resilient financial support system that empowers cooperatives, enhances industry standards, and contributes to sustainable development across the sector.

Collaborative financing benefits from enhanced data management and traceability systems (instrument 2), which supports accurate and efficient data handling. Additionally, transparency tool (instrument 4) can be used to verify the relevant sustainability information.

### 2.5.3 Discussion of the roadmap for tin-solder supply chain

The instruments presented in this roadmap are designed to achieve environmental upgrades for actors throughout the tin-solder supply chain. It includes only those instruments that, based on expert input and literature review, are expected to have the greatest impact on achieving additional significant GHG emission reductions in the industry. This roadmap is not intended to serve as a comprehensive guide to implementing SSCM for GHG emission reduction.

The roadmap includes four supply chain-collective initiated instruments, among which three are newly proposed. The Harmonised GHG Framework serves as a foundational instrument, facilitating accurate and comparable carbon accounting and enhancing transparency across the supply chain. Complementing this, the newly proposed Data Management and Traceability instrument introduces a tiered approach, allowing companies to verify tin sourcing without pinpointing its direct origin. This method is particularly vital due to relatively large amount of ASMs in the supply chain, where direct tracing is both costly and, as some experts argue, unnecessary. Capacity building is another important instrument, ensuring that a diverse range of



stakeholders, especially ASMs, can access essential knowledge on implementing these initiatives effectively. This empowerment is key to equipping suppliers with the necessary skills and understanding. Additionally, the use of Tin Code as transparency tool plays an important role in communicating sustainability efforts, providing stakeholders with insights into a company's status and progress.

The roadmap also includes two third-party initiated instruments. Audits and certifications provide critical assurance and compliance with established sustainability standards, thereby reinforcing trust and reliability in the companies' environmental practices. Additionally, effective uptake of green loans as a financial instrument that can be supported by instruments such as enhanced data management and traceability systems audits and certifications, and the transparency tool.

Furthermore, two buyer-initiated instruments address specific financial and operational challenges faced by miners and cooperatives. Collaborative financing emerges as a strategic solution, particularly for miners or cooperatives struggling to access green finance, such as green loans. In this context, larger entities, like smelters, can facilitate access to green finance, enabling these cooperatives to invest in more sustainable practices. Additionally, the concept of price premiums has been highlighted in workshops and stakeholder interviews as a crucial mechanism for achieving sustainability in the tin supply chains. While upstream actors often expect their suppliers to fulfil various sustainability requirements, downstream actors frequently bear the financial burden without the ability to incorporate price premiums. This imbalance underscores the need for fair pricing strategies that reflect the true cost of sustainable practices.

Several key hurdles were highlighted that impede progress toward achieving environmental sustainability and decarbonisation in the tin supply chain. One major roadblock is the absence of incentives for applying sustainable supply chain instruments, largely due to a lack of engagement by downstream metal users in providing financial incentives. The unattainability of price premiums further exacerbates this issue. The reluctance of companies to pay a premium for sustainably produced tin a significant bottleneck, which places the financial burden solely on upstream actors. To accelerate progress toward a sustainable and carbon-neutral industry, clients must adopt fair pricing practices that reflect the true cost of sustainability efforts.

To address the reluctance of companies to pay a premium for sustainably produced tin and ensure that sustainability efforts are equitably supported, the regulatory framework should adapt in several, strategic ways. Governments and regulatory bodies could provide subsidies or grants to offset the costs associated with sustainable practices, thereby encouraging more companies to adopt them. Additionally, creating preferential market access or procurement policies for sustainably produced tin, such as prioritising it in public procurement, can stimulate demand and encourage companies to recognise the value of paying a premium.

Additionally, it is important to acknowledge that while environmental sustainability topics within the tin industry may not be as advanced as in other industries, such as coffee or cotton, industry experts emphasise that GHG targets and environmental initiatives should complement social issues within the tin supply chain. By recognising these interconnected challenges, companies can pursue environmental goals in a manner that also addresses critical human rights issues, thereby aligning practices with broader industry standards and enhancing the scalability and practical impact of sustainability efforts.

### 3 Synthesis

The report provides a comprehensive analysis of strategies, instruments and approaches aimed at enhancing environmental performance across four distinct supply chains: cotton-garment, coffee, iron ore-steel, and tin-solder. The four supply chains face different challenges in achieving improved environmental performance and require a specific set of instruments to incentivise behaviour that works towards better environmental performance. These instruments were each discussed and analysed in a roadmap for implementation that also identified key supply chain actors necessary for implementation and change.

Companies active in the iron ore-steel and tin-solder supply chains are at an early stage in addressing upstream and downstream environmental impacts. In iron ore-steel, the distribution of power is more balanced than in other supply chains, with financially strong players at different stages. However, coordinated efforts to address environmental impacts across the chain are lacking. Supplier capabilities need to be developed, and continuous performance monitoring introduced, but comprehensive incentive mechanisms such as price premiums and green finance are still rare.

Actors in the tin-solder supply chain also lag behind other industries in environmental sustainability, with current initiatives and approaches primarily focusing on human rights and conflict issues. Environmental topics are secondary but are gaining attention. There is a lack of downstream engagement in providing financial incentives, and price premiums for sustainable tin are not commonly paid. Initiatives like the Tin Code aim to enhance transparency and sustainability efforts.

Incentives to reduce deforestation in the coffee supply chain include a mix of regulatory measures (EUDR), financial incentives, and collaborative initiatives aimed at promoting sustainable practices. Certifications such as Rainforest Alliance and Fair Trade provide incentives for sustainable coffee production by offering market access and sometimes price premiums for certified products. These certifications help trace and reduce the environmental impact of coffee cultivation. Initiatives like the UNDP's Climate Promise work with coffee companies to transform production practices towards sustainability, focusing on reducing deforestation through collaborative efforts.

The cotton-garment supply chain has been exposed to sustainability standards for quite some time. While some areas have experienced progress (e.g. occupational safety and health) or are gaining more attention (e.g. decarbonisation), the industry faces enormous challenges in chemical use, water management and effluent treatment. Targets for reducing water consumption and pollution have been rather vague. The focus has been primarily on Tier 1 and Tier 2 suppliers, while upstream activities such as cotton farming have been less targeted, as brands/retailers believe that they have less direct influence on Tier 4 stakeholders.

The supply chain management instruments and approaches analysed provide a comprehensive framework for improving environmental performance across different supply chains. Some instruments can be recommended across all four supply chains, such as RPP, environmental performance clauses, price premiums, offtake agreements, green and collaborative financing and capacity building and training.

#### **Responsible purchasing practices (RPP)**

Implementing RPP helps align purchasing decisions with environmental performance targets. CFRPP was designed by stakeholders of the textile and fashion industry to level power imbalances. This approach encourages buyers and suppliers to adopt sustainable practices through integration, equal partnership, collaborative production planning, fair payment terms,

and sustainable costing. The CFRPP emphasises principles that are not industry-specific but can be adapted to enhance purchasing practices in various sectors, such as consumer electronics (e.g. tin-solder), automotive (e.g. iron ore-steel), and agriculture (e.g. coffee), where similar challenges in supply chain management and sustainability exist. The framework may need to be adapted to meet the specific needs and challenges of different industries. For example, the types of environmental impacts and the metrics used to measure environmental performance may differ between sectors.

### **Environmental performance clauses**

Including environmental performance clauses, along with climate-aligned clauses, in contracts ensures that suppliers meet specific environmental standards. These clauses can be linked to incentives such as bonuses or preferred supplier status thanks to the overall sustainability score or environmental performance score. With rising regulatory pressure (e.g. CBAM, EUDR, CSDDD), environmental performance clauses are likely to gain importance in addressing the environmental impact of production processes. However, it should be noted that some industries (e.g. fashion) rely more on informal arrangements rather than full-fledged contracts than others, while contracts in captive supply chains (Gereffi et al. 2005) are only able to equalise power imbalances between buyers and suppliers to a limited extent. Supplier verticalisation can help increase their competitiveness and negotiation power. It is important to note that the power imbalance in captive supply chains is generally in favour of the buyer, even when contracts are in place.

### **Price premiums**

The payment of price premiums for improved environmental performance or for products with demonstrably environmentally friendly characteristics offers direct financial incentives for suppliers to implement environmental upgrading measures more efficiently or to pass on environmental data and contributes directly to the improved distribution of costs and benefits. The roadmaps on coffee and tin-solder describe, for example, which framework conditions are necessary for the payment of premiums to ensure that the financial incentives are channelled into environmental and climate protection measures. They must be linked to specific metrics and corresponding monitoring mechanisms. Experiences in the coffee and cotton-garment supply chains indicate that price premiums are typically paid only under consumer and CSO pressure, as seen with organic differentials. Effective narratives for chemicals and water management are lacking, limiting similar pressure. Despite limited implementation across the four supply chains, practitioners and experts in workshops and interviews consistently highlighted the significant leverage potential of price premiums. The approach can be applied to any supply chain, but the design must be adapted to the specific circumstances of the supply chain and the environmental goal to be achieved.

### **Offtake agreements**

By providing a long-term purchasing commitment, offtake agreements can provide suppliers with the financial stability needed to invest in, for example, new technology needed to achieve certain environmental upgrade targets. At the same time, they secure the stable supply of materials or products for the buyer. This makes offtake agreements a particularly effective approach, which can support environmental activities in any supply chain. To this end, they should be linked to specific environmental performance metrics and supported by continuous monitoring systems. Offtake agreements can also serve as an instrument to regulate the payment of price premiums for certain environmental services and, as a risk-mitigating element, they can facilitate access to third-party funds by financial service providers and investors. All

four roadmaps therefore address offtake agreements as a stand-alone instrument or incentive mechanism that can be combined with sustainable supply chain instruments and approaches.

### **Green and collaborative financing**

Green financing programmes and collaborative financing schemes provide financial resources and incentives for suppliers to invest in sustainable practices. These can include green loans, sustainability-linked loans, and funding from international organisations. While these funding opportunities are relevant for all four supply chains, the industries struggle to make green funds available at scale. Despite significant pressure from consumers and regulators to improve sustainability, which has driven insular initiatives to adopt innovative financing solutions to meet these demands (H&M Group 2024), the complex nature of the cotton-garment supply chain makes it difficult to implement uniform green financing solutions. The transition to green steel production involves complex technologies like hydrogen-based steelmaking, which require significant R&D and capital investment. Initiatives to finance green steel projects are still developing and often rely on large-scale investments and public funding (Basirat 2022). Collaborative financing in the tin-solder supply chain could enable miners and cooperatives to access green finance with support from larger entities like smelters. Given tin's market-driven pricing, power dynamics fluctuate, leading miners to hesitate in investing in sustainability, as they expect their tin to eventually sell. Additionally, liquidity challenges, such as delayed payments from smelters, hinder their ability to invest in sustainable practices. Collaborative financing, involving joint investments with smelters and financial institutions, can overcome these barriers and incentivise sustainable investments. While there is interest in the financing of sustainable agriculture, the coffee sector has not yet taken full advantage of green financing opportunities. Coffee producers, especially smallholders, often have limited access to green finance due to lack of collateral and financial literacy. Efforts are being made through collaborative initiatives between governments, NGOs and private sector to mobilise green and climate finance (ICO and SCC 2018).

### **Capacity building and training**

Continuous training and capacity building are essential across all supply chains. These initiatives help suppliers develop the skills and knowledge needed to implement and maintain sustainable practices. Capacity building can facilitate the adoption of new technology and industry best practices (e.g. environmentally friendly chemicals), help optimise production processes, increase efficiencies and reduce waste and emissions. By improving the quality and environmental performance of products, trained farmers or manufacturers can access premium markets. Incorporating pay-per-performance approaches that are fair and achievable can enhance the effectiveness of capacity-building initiatives by aligning financial incentives with environmental goals. This approach not only drives improved performance but also embeds sustainability into the organisational culture.

**Multi-stakeholder collaboration** is a recurring theme, with the involvement of buyers, suppliers, governments, and NGOs being essential to drive systemic change and innovation. MSIs can promote partnerships between buyers, suppliers, NGOs, and governmental bodies to pool resources and expertise, thereby enhancing the overall capacity to implement sustainable practices. Although often criticised for stalling activities, MSIs can play a pivotal role in training and capacity building to improve environmental performance in their supply chains. By bringing together diverse stakeholders, MSIs can create platforms for knowledge exchange (e.g. Higg Index), where participants can share experiences, challenges, and solutions. This can help disseminate innovative practices and lessons learned within the supply chains. MSIs can provide customised support to different stakeholders, recognising that needs may vary between small

and medium and large companies or between different regions. MSIs can help test and refine new approaches to improved environmental performance by funding or supporting pilot projects. It is important that successful pilots be scaled up and adopted more broadly across the supply chain.

In addition to the instruments to be applied across the four supply chains, each supply chain requires specific instruments to unlock capacities to improve environmental performance:

Direct sourcing and vertical integration allow buyers from the **cotton-garment supply chain** to have greater control over sustainability practices by sourcing from composite units and integrating supply chain stages, while suppliers significantly increase their competitiveness and bargaining power. Environmental performance platforms supported by initiatives such as ZDHC or the Higg Index, help track and improve environmental performance, particularly in key areas such as water and chemical management.

In the **iron ore- steel supply chain** a harmonised carbon accounting framework for GHG emissions can help standardise and improve environmental performance. Continuous performance monitoring and supplier development initiatives are also critical for achieving environmental performance targets.

The Tin Code provided by the ITA and other transparency tools can enhance transparency and sustainability in the **tin-solder supply chain** by offering a structured compliance and performance framework. Similar to the suggestion for iron ore-steel, these tools provide a standardised framework for GHG accounting, enabling accurate emissions measurement. This transparency and comparability incentivise companies to identify and implement emission reduction strategies, as they can benchmark their performance against industry standards and peers. Effective data management and traceability tools are needed to introduce a tiered approach to verify tin sourcing, crucial due to the presence of ASMs. This instrument can simplify and standardise the process of tracking and verifying the origin and thus environmental impact of tin. By reducing the complexity and cost of traceability, especially when sourcing from small scale miners, companies are encouraged to adopt these systems, thereby improving the accuracy of data which is fed into the GHG accounting framework. The absence of price premiums for sustainability efforts is a major hurdle in the tin supply chain. The LME has explored trading sustainable tin, but currently lacks market availability. Publicly accessible price premiums, akin to stock exchange listings, would ensure transparency and incentivise sustainable sourcing, encouraging upstream investments by making sustainable tin more attractive for purchase.

Robust traceability systems and enhanced data management are also critical to comply with regulations like the EUDR and support sustainable sourcing practices in the **coffee supply chain**. They help verify the deforestation-free status of coffee sources, ensure EUDR compliance, provide transparency, enable quick identification and resolution of sustainability issues, and support fair pricing.

The final report of the research project will incorporate findings from this and previous reports, focusing on promising incentive mechanisms identified through interviews, workshops, and research. These mechanisms aim to enhance cost-benefit sharing and information exchange in global supply chains through increased collaboration. The report will outline the design of selected incentive mechanisms, detail the required framework for effective implementation, and provide (best practice) examples from specific supply chains.

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