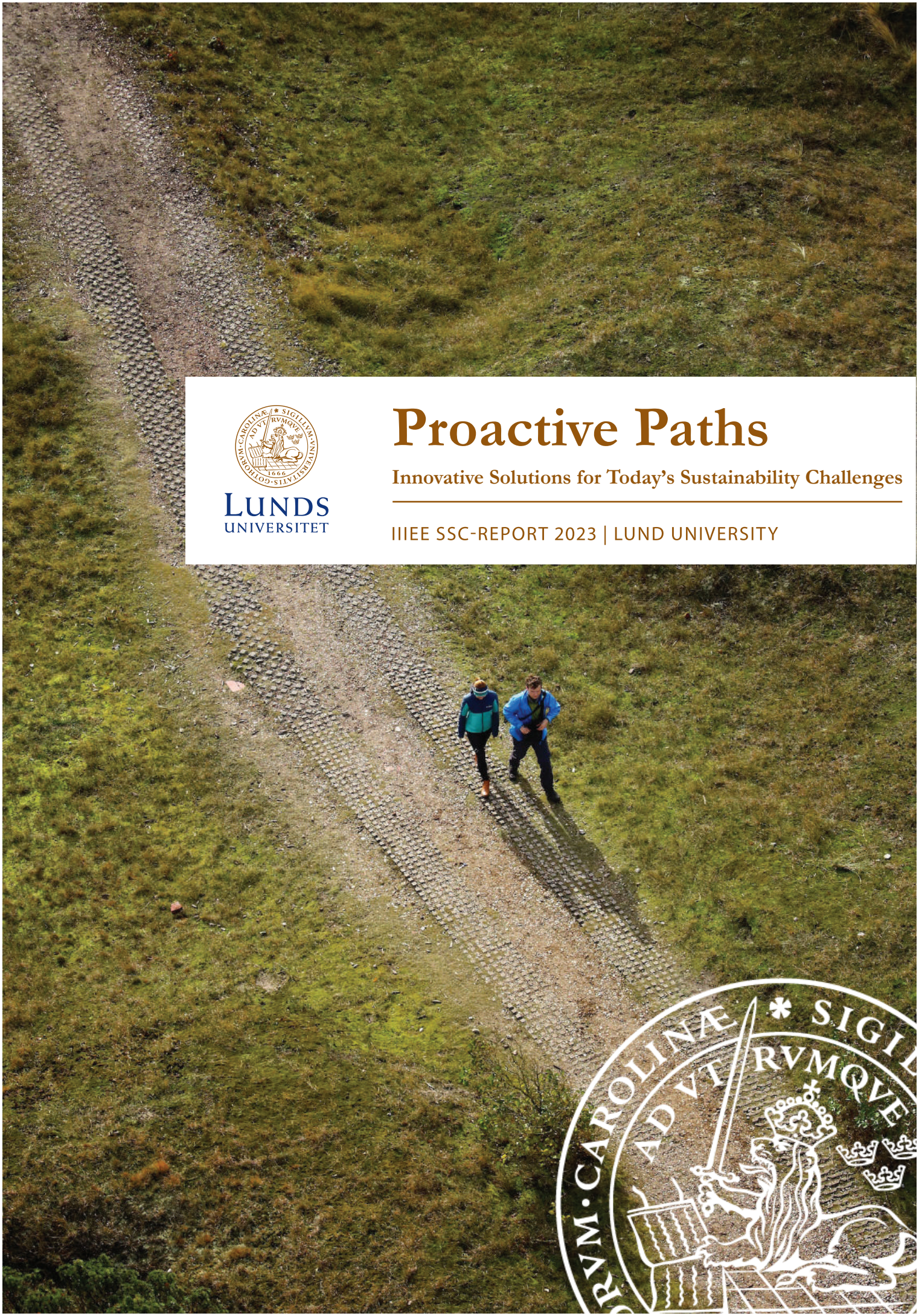

LUNDS UNIVERSITET

Proactive Paths

Innovative Solutions for Today's Sustainability Challenges

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Cover Image "People Walking on the Dirt Path Between Green Grass Fields" by Niklas Jeromin

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Executive Summary

Current global events, from geopolitical tensions to climatic warnings underscored by the latest Intergovernmental Panel on Climate Change report, shine a spotlight on our global interdependence and vulnerability. Acting now is necessary to enable individuals, organisations, and societies to tackle the different environmental, social, and economic issues that lie before us.

How can we advance and deliver solutions to these pressing sustainability challenges? This is the type of question that motivates the students of the Master's Programme in Environmental Management and Policy (EMP) at Lund University's International Institute for Industrial Environmental Economics (IIIEE).

As part of their curricula, students in the Sustainability Solutions in Context (SSC) course are challenged to apply their sustainability knowledge to address different real-life issues for businesses and organisations worldwide. This year IIIEE partnered with diverse clients, all looking to tackle different sustainability challenges, offering students a unique opportunity to explore, analyse and propose solutions. The nine projects cover different topics, reflecting current sustainability trends and needs, such as circular economy, energy storage, sustainability reporting, sustainability education, carbon markets, climate adaptation, and resilience.

This joint report is more than the sum of the specific frameworks, analysis, and insights derived from each project. It is a testament to the synergies that emerge from teamwork and a reflection of the authors' commitment to sustainability and our collective future.

About the IIIEE, EMP programme, & SSC course

The International Institute for Industrial Environmental Economics (IIIEE) produces and shares actionable knowledge for sound decision-making at all levels, from the local to the global. The IIIEE's research and education advance the transitions to climate-neutral and resource-efficient economies. Environmental Management and Policy (EMP) is the original Master's programme of the IIIEE. It develops future leaders and change agents by equipping them with the knowledge and skills needed to advance sustainable solutions.

Sustainability Solutions in Context is the capstone course of the EMP programme. The 5-week course offers students the opportunity to translate theory into practice by exercising the knowledge gained in the first year of the programme in the outside world. The course projects aim to address pressing sustainability problems faced by external partner organisations and society more broadly. This joint report is the culmination of the capstone course. The projects have relatively little direct collaboration, but numerous synergies exist, from lessons on the circular economy to communications for sustainability. Batch 29 invites you to draw your own connections and conclusions.

EMP Batch 29 at Wanås, October 2023

Acknowledgements

Batch 29 would like to express our gratitude to the IIIEE and its partners for organising the Sustainability Solutions in Context (SSC) course and for facilitating such a diverse set of interesting and inspiring projects. We strongly believe that the problem-solving skills and practical knowledge we gained over the past weeks will set us up for future success in the sustainability field.

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Through a wide range of approaches, the clients are pushing for a more sustainable world through holistic thinking and innovation. They offered their time, resources, and knowledge, and for this, we are deeply grateful.

RWE Offshore

Circularity of rare earth elements in the offshore wind industry

Project Brief

The circular use of Rare Earth Elements (REEs) is gaining importance at the EU level. REEs are essential for the green transition, but actors operating within the EU are highly dependent on Chinese suppliers. This calls for advancing circularity of REEs as well as exploring efficient alternatives that can overall reduce the supply chain risks and environmental impacts.

The offshore wind industry plays a pivotal role in addressing this challenge, where the demand for REEs is increasing. The demand is driven by the rising need for renewable energy-build out in order to phase out the use of fossil fuels. Consequently, the task for the offshore wind industry is to develop circular strategies for the REEs used in wind turbine components.

Project Team

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Sergei is from Russia and is experienced in legal advice and compliance.

Introduction

Context

The offshore wind industry has developed dramatically in recent decades. It has grown from around 1% of global wind power generation to around 7% in 2022 [1]. Over the last decade, offshore wind power capacity has increased from less than 4 GW in 2011 to more than 62 GW in 2022. This outstanding development has been driven by the growing competitiveness of wind energy and political demands to boost the share of energy generated from renewable sources. At the same time, the rapid expansion of the industry poses many challenges, such as securing a stable supply of critical components for wind turbines associated with high environmental impact in their production. It is, therefore, a recent development to in the EU to increase the circularity of the valuable materials used in key components and retain them within the European market after the end of their lifetime.

As of November 2023, there are no policy frameworks or technical infrastructures in place in the EU which aim to enhance the circularity of Rare Earth Elements (REEs) used in wind power generation. At the same time, the initial decommissioning phases of the *offshore* wind farms using many of these elements are not expected to commence until approximately 2030 and onwards [2]. Nonetheless, the wind industry is already facing rising pressure as the European Commission recently proposed the EU Critical Raw Material Act (EU CRM Act) and launched the EU Wind Power Action Plan — both aimed at regionalising the supply chain of REEs [3] [4].

In this context, the IIIEE project group aims to investigate the role and the current state of circularity of REE-containing permanent magnets in the offshore wind industry, identify the main stakeholders along their lifecycle, determine the major political and economic pressures, and benchmark other industries' efforts. In this report, the 5Rs framework for circularity, as shown in Figure 1, will be followed to systemise various circular solutions.

Figure 1: Circularity Pyramid (5Rs)

The Client

For this project, the client is RWE Offshore, the second-largest offshore wind operator globally and a subsidiary of the German multinational energy company RWE. RWE is currently undertaking a rapid transition towards sustainable energy sources, and thus, RWE Offshore has been witnessing rapid expansion in the European market. RWE Offshore currently operates 3.3 GW of installed capacity between Germany, the United Kingdom, Belgium, Denmark, and Sweden, aiming to reach 10.3 GW by 2030 [5].

Circular ambitions for the wind industry

In recent years, substantial progress has been made towards recycling blades and steel used for towers. For instance, RWE Offshore is installing numerous new-generation turbines with 100% recyclable blades in new wind farms [2]. To meet its circularity ambitions, RWE Offshore is now beginning to analyse the complex processes required to recycle the permanent magnets (PMs) within many of the latest generation of turbines. The magnets in a wind turbine are located inside the generator, which, driven by the rotation of the blades, converts the kinetic energy from the wind into electrical energy. The magnets play a crucial role in creating a magnetic field that, during the rotation of the generator's rotor, starts an alternating electric current, which then feeds into the grid and is ultimately transported to the end consumers as electricity. PMs, materials that have natural magnetic properties, find use in offshore wind turbines due to their small size and high efficiency relative to field coils — another type of magnet that requires external electrical excitation to enable its magnetic properties. The magnetic properties of PMs are ensured by the presence of REEs. These metals are widely distributed throughout the Earth's crust but are difficult to extract due to their very low concentration [2]. Within the wind industry, four of these elements are mainly used: Neodymium, Dysprosium, Terbium and Praseodymium; and of these REEs, roughly 9% of the

global demand is used in the production of permanent magnets for wind turbines [6]. REEs are primarily mined in China by a very limited number of companies, accounting for 67% of global production [7]. Additionally, the production of PMs is almost entirely concentrated in China (90-95%) [7]. This results in a significant supply chain dependency for operators like RWE Offshore and an overall imbalanced power dynamic, as there are very few actors in the upstream stages compared to the numerous operators [7].

Research Questions

The subsequent four research questions were developed to guide the project and the analysis:

1. Why is it *relevant* for offshore operators to understand the circularity of Permanent Magnets (PMs)?
2. What is the *status of circularity,* and what are the main *challenges* and *solutions* to advance the circularity of Rare Earth Elements (REEs) within PMs?
3. What *actors* engaging with circularity solutions exist?
4. What can offshore operators learn from *other industries* that deal with REEs and critical raw materials?

Methodological Approach

With the four research questions in mind, the report aims to summarise findings from interviews, a literature review, a site visit to an offshore wind farm, and an internal workshop with RWE Offshore. The research process followed a structured approach described below.

First, the team conducted a literature review to develop a general understanding of the offshore sector, the functioning of permanent magnets, their applications in other sectors and the technologies available today to recycle, repurpose, reproduce, and recover them. The data collection was first used to create an initial outline of the PM supply chain for the offshore sector in the EU. A preliminary map of the stakeholders involved, shown in Figure 2, was created. The map was also used to identify possible interviewees.

Second, the team reached out to key people in each group of stakeholders relevant to the circularity of permanent magnets and drafted an interview guide to support the data analysis process. The team conducted 15 semi-structured interviews with people at RWE Offshore, other operators, original equipment manufacturers (OEMs), industry associations, academics, companies, and start-ups involved in REE and PM end-of-life management. The interviews were solely conducted online. A visit to the offshore park in Öland, Kalmar (Sweden),

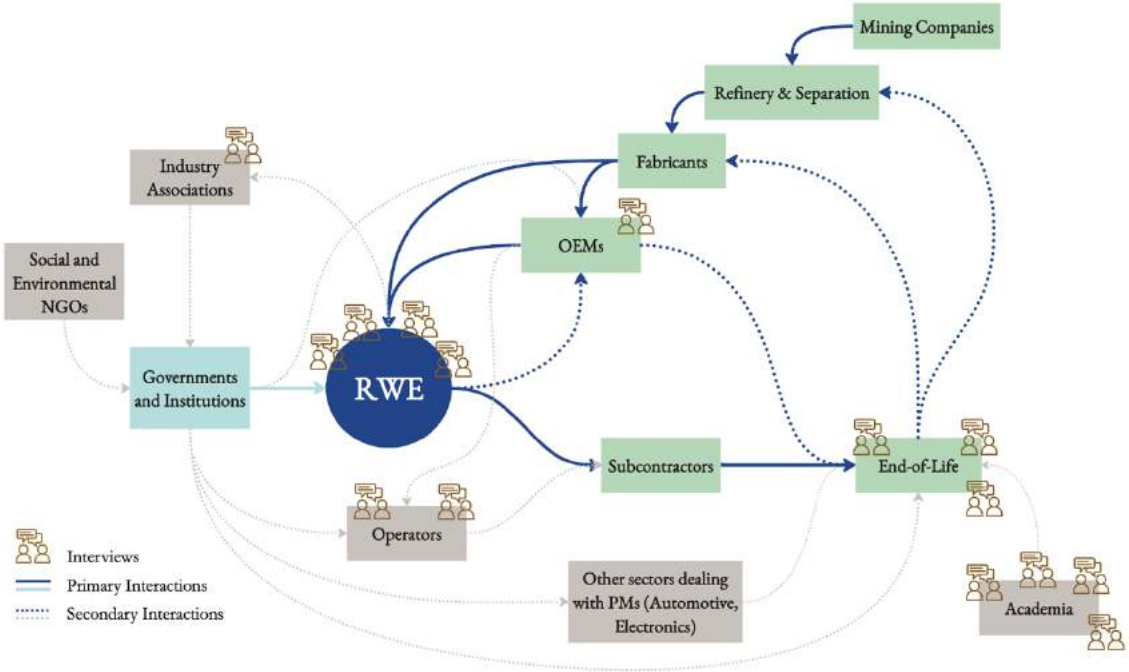

Figure 2: Stakeholders Map

was crucial to see first-hand the operations behind a wind farm and to understand the day-to-day challenges related to circularity and sustainability for offshore operators.

Third, the analysis of data collected from interviews, literature review and site visit commenced. The data analysis consisted in creating different matrixes for both the interviews and the literature using the research questions as guidelines. This process was conducted in preparation for an internal workshop attended by approximately 30 employees occupying different critical roles within RWE Offshore. The primary purpose of the workshop was to present the findings gathered so far, to receive feedback, and to collect further input from the participants aimed at refining the results of our analysis and populating the final report for the company.

Findings

The following section will present the findings from the described research process and target the four research questions. Any information obtained from the interviews with stakeholders will be sourced as an "interview" rather than mentioning the specific stakeholders to ensure the anonymity of the interviewees.

Operators: Balancing Regulatory Requirements and Supply Risks

The literature review, the interviews conducted, and the workshop all demonstrated the importance of understanding the challenges and solutions to advance the circularity of PMs. It also emphasised the need for operators to start planning for more circular decommissioning practices as soon as possible.

First, there is increasing policy pressure in Europe to enhance the circularity of REEs. The European Commission has proposed the EU CRM Act this year, comprising various measures to guarantee a *'secure, diversified, and sustainable'* supply of REEs and other critical raw materials (CRMs) intended as economically important raw materials with a high risk of facing supply disruptions due to source concentration and lack of substitutes [3].

Together with the mounting regulatory pressure in the EU, operators will be obliged to provide more information regarding the environmental impact of their offshore farms and the circularity of components in the new tender requirements. Presently, auctions held only in the Netherlands mandate transparency in the use of critical raw materials and alternative materials, but the general industry trend is heading in this direction [2]. Additionally, the EU Wind Power Action Plan recently presented underlines the strengthening of non-price criteria in tender requirements [4].

Second, taking a proactive role in the pursuit of circular solutions would confer a social license to operate and a stronger reputation, as REEs are mainly mined in countries that lack transparency in their processes and fail to provide information about the working conditions of miners or the environmental mitigation practices used in such mines. Investing in circularity processes would entail investing in more transparent, monitored, and reliable supply chains. Furthermore, it would also enable capturing the residual value of PM used in wind turbines. The concentration of more than 30% [2] of REEs and the relative ease of disassembling give the PMs a significant economic value. However, demagnetisation and recycling processes represent critical challenges as they are very costly and require large amounts of energy.

Status Quo: Scattered Demand and Supply for Circularity

For the status quo on the circularity of REEs within PMs, three overall trends emerged from the data processing.

First, there is a general acknowledgement across all stakeholder groups interviewed that there is a *limited availability of decommissioned PMs.* The reasons are the relative youth of the offshore wind industry, the long lifespans of the wind turbines and differing decommissioning cycles. The differing decommissioning cycles result in a relatively scattered supply of PMs reaching end-of-life at the same time. Ultimately, these factors result in the current limited availability of decommissioned PMs ready for reintegration into the supply chain and thus into a circular loop [2].

Second, there is a clear understanding of the current *discrepancy between the supply and demand of recycled PMs,* as well as a similar expectation for

the future [2]. While external inflows from other industries, such as the electric vehicle (EV) sector, will increase the availability of recycled REEs, they are not expected to be able to meet the demand for the general wind industry [2]. The industry association interviewed estimates that the current demand for REEs greatly outweighs the supply of recycled PMs.

Third, both representatives from academia and an OEM highlighted the current *focus on increasing turbine longevity* through modular component design to facilitate longer operation cycles for all components in the turbine, including the generator within which the PMs are placed.

Challenges: Power Dynamics, Economy, and Knowledge Gaps

Four themes emerged from the interviews and literature on the challenges to advancing the circularity of REEs within PMs.

The first theme is the *skewed power relations and lack of information-sharing within the supply chain*. All operators interviewed, and the representative from an OEM expressed that there exists a clear dependence on the few Chinese suppliers that control a large part of the mining and processing of REEs and the manufacturing of the PMs. Seemingly, this decreases downstream actors' ability to negotiate and increase transparency, thus challenging circularity practices [2]. Both interviews with academia and operators expressed that advancing circularity is challenged by the lack of information-sharing between the OEMs and the operators, in particular on the product details, which ultimately risks blurring the picture of what materials the operators have under management and eventually need to decommission [2].

A second theme is *the current harsh economic situation for the offshore wind industry*. Multiple factors, such as rising raw material prices [2], inflation rates and slow wind-farm installation processes cause negative economic effects across the entire supply chain [8]. As voiced by the industry association and operators, including RWE Offshore, the current economic situation risks complicating the short-term prioritisation of circularity efforts [2]. However, advancing circularity requires pro-activeness and long-term planning, as proved by the development of the circularity of steel and blades.

The third theme relates to *the lack of knowledge and infrastructure of circular decommissioning practices*. The lack of knowledge is connected to the relative youth of the offshore wind industry and the fact that the bulk of decommissioning phases will initiate from 2030 onwards [2]. In practice, downstream recycling companies stress both the potential safety risks associated with manually handling wind turbine PMs due to the potency of their magnetic fields and potential chemical hazardousness. Moreover, the substantial energy requirements of the demagnetisation process risk undesirable carbon dioxide (CO_2) emissions. The lack of infrastructure is specifically connected to the complexity of demagnetising and disassembling PMs at offshore locations [2]. De Waal furthermore found that it *'[…] takes approximately two days to disassemble the magnets from a single generator'* [9] and a minimum of 138 days for a wind farm consisting of 69 turbines. The disassembly of PMs from a large wind farm is, therefore, clearly a labour and time-intensive task [2] [9].

A final and fourth challenge to advancing circularity is *the potential legal challenges standing in the way of extending permitting for wind farm operations*. This challenge was specifically highlighted during the site visit to Öland as well as in Svensson's thesis on *'An assessment of circular economy measures in the construction value chain for offshore wind turbines'* [10]. Operators need to obtain a permit to build offshore wind farms; however, the permitting process itself differs from country to country. Additionally, it was highlighted by both mentioned sources that receiving permits in the first place can take a long time. Moreover, this challenge is further augmented if operators wish to extend permitting contracts after the initial period ends. Allowing for permit extensions, however, could increase the lifetime of the turbines and thus improve the circularity efforts [2] [10].

Solutions: Policy, Collaboration and Technology

Three solution clusters emerged from the interviews and literature on how to advance the circularity of REEs within PMs. Figure 3 below is an illustrative summary of these solutions and how they are placed in a circular life cycle of PMs.

The first solution cluster considers more ambitious *regulatory requirements* such as the EU CRM

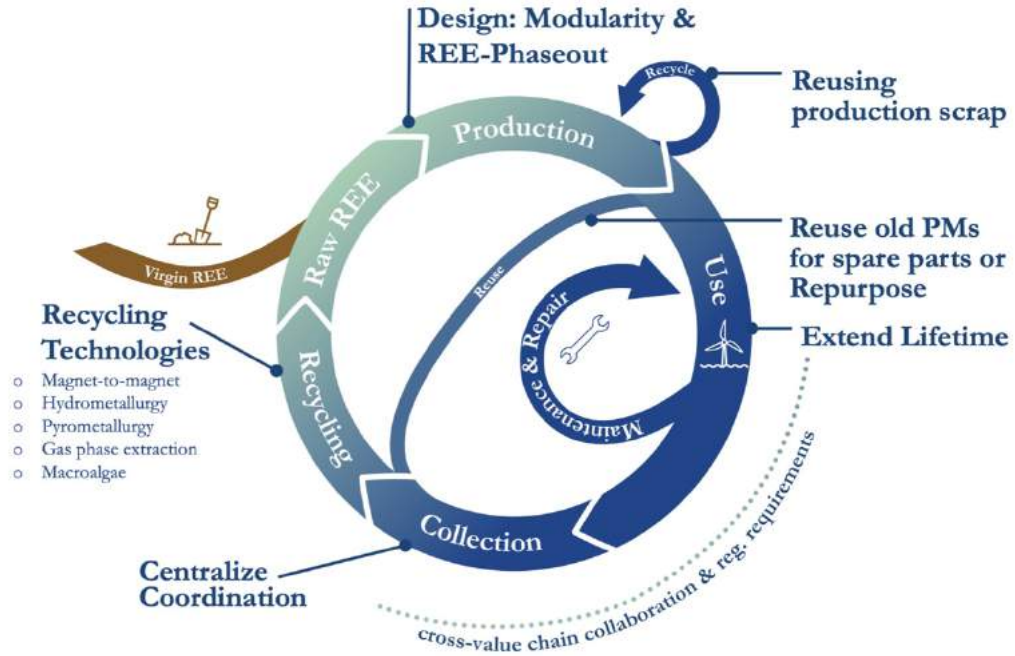

Figure 3: Circular life cycle of permanent magnets in offshore wind turbines

Act and the recent Wind Power Action Plan. They are broadly recognised across all stakeholders interviewed as a driver for advancing circular initiatives throughout a large part of the supply chain. While it is clear that circular policy initiatives will target both OEMs in the production phase and downstream suppliers in the recycling phase, it is important to underpin that these policies will also become a key consideration for operators in the use phase when planning for both purchasing increasingly circular turbines and later on decommissioning them.

The second cluster includes *technological solutions*. Circularity-focused technology solutions have been particularly explored in literature and ongoing research projects. Among the circularity framework (see Figure 1), recycling is notably advanced compared to other strategies. Recycling offers significant advantages, with both manufacturing scraps and end-of-life magnets containing high REE content, making them valuable for recovering metals like Neodymium, Praseodymium and Dysprosium [11]. Magnet-to-magnet recycling offers two major benefits: (1) it recovers all magnet materials for reuse, reducing waste and resource depletion, and (2) it employs mechanical processes, lowering the environmental impact compared to chemical methods [12]. Further methods are applied with either a temperature-smelter (pyrometallurgy) or by dissolving the metal-containing material in a liquid (hydrometallurgy) [13]. However, hydrometallurgy (Binnemann) entails disadvantages due to the high chemical use and wastewater generation, despite the high recovery rate and product purity [11]. Pyrometallurgy demands substantial energy use, while the gas phase extraction method may use fewer chemicals, although the advantages are less clear [13]. Additionally, experiments using bacteria and seaweed for separation processes, called bioleaching, delivered promising findings [14].

In addition, modular design, refurbishment, maintenance, and repair programs are other technical solutions. While they, academically speaking receive less attention, they are more advanced in practice [2]. The effects vary from prolonging the lifespan of the turbines to improving repairability. These measures eventually lead to reducing the demand for raw materials. Moreover, OEMs are already exploring wind turbine magnetic system designs using fewer or no REE materials without sacrificing performance [15]. Repurposing efforts were undertaken by some operators, focusing on reusing PMs as spare parts or in new applications. However, this approach has only been implemented sporadically thus far, with limited case numbers and no mention in the literature.

The third solution cluster considers the potential of *cross-value chain collaboration*. The increased value of partnerships was highlighted by both

RWE Offshore, a downstream recycling company and an OEM. One specific case was highlighted, namely the so-called 'DecomBlades' project, partly funded by the Danish Government and featuring a consortium of major OEM competitors (Siemens Gamesa, GE and Vestas), Ørsted, downstream recycling companies and two universities on making wind turbine blades more circular [16]. The project shows that collaboration across both upstream and downstream suppliers is feasible, and in particular, the involvement of governments can help reduce the financial and reputational risks for the parties involved. Large-scale collaboration, however, can be complex and requires substantial resources. As pointed out by several stakeholders, including RWE Offshore and an OEM, operators can also have an influential role through their internal actions. Concrete measures could be for operators to proactively plan for circular decommissioning practices and commit to ambitious circularity targets.

Insights from Other Industries

While other industries, particularly EVs and electronics, strive to improve the circularity of CRMs, they have different levels of progress and different strategies compared to the offshore wind industry. Despite car manufacturers being OEMs and not having an operational position like RWE, conclusions can still be drawn solely from their operational, functional, and supply chain structures. The relevance of the EV sector lies in its parallel trajectory with the offshore wind industry. As the circularity of critical raw materials for batteries gains momentum due to policy-driven initiatives, it is conceivable that similar demands for PMs and REEs will follow suit. The transition towards circularity in the offshore wind industry is likely to mirror the experiences and challenges faced by the EV sector. Even though the wind industry currently holds a larger share of global REE demand, the EV sector will soon surpass it due to the growth of the mobility electrification (see Figure 4).

The EV industry differs from the wind industry in that it benefits from robust regulatory frameworks such as the EU *BATT2 directive*. Moreover, alliances between OEMs, battery manufacturers, and recycling companies, coupled with supply risks, have put substantial policy pressure on achieving circularity. Notably,

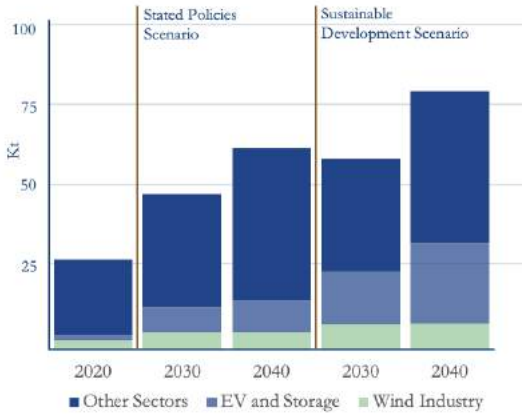

Figure 4: Demand projection of neodymium by industry and different policy scenarios. Source: IEA.

the BATT2 directive stipulates specific targets for recycling. By 2027, OEMs must disclose the quantities of recovered raw materials. From 2031 onwards, industrial, traction, and starter batteries must be accompanied by documentation indicating the minimum levels of reclaimed materials in their active components (e.g., 16% Cobalt, 6% Lithium). These targets will almost double by 2035 (26% Cobalt, 12% Lithium). Additionally, the introduction of a *digital product passport* for industry batteries will require OEMs to be transparent and accountable about the materials they use and their sources by 2026. The *Eco-design directive* encourages OEMs to reduce their usage of CRMs and increase recyclability.

Moreover, the *continuous supply* of materials resulting from ongoing EV production plays a vital role in ensuring the availability of CRMs for recycling companies, in contrast to the highly fluctuating supply of REEs used in offshore wind turbines.

Prominent OEMs, like Volkswagen and Mercedes-Benz, alongside smaller firms like Accurec and Duesenfeld, are already actively involved in battery recycling and even *collaborate for decentralised recycling*. Obsolete lithium-ion batteries are considered hazardous waste, requiring specific permits for cross-country transportation. Therefore, In-house recycling at each OEM manufacturing plant using the Duesenfeld method is considered by Volkswagen, which not only reduces costs but also lowers CO_2 emissions.

In contrast, the electronics sector, particularly with fluorescent bulbs, experienced significant

supply disruptions between 2009 and 2011, which were attributed to China's export restrictions on REEs. Prices surged by up to 600% in response to these Chinese quotas [17]. To mitigate future supply risks, the EU has made substantial efforts to reduce and substitute REEs in product components and recycling. Lamp producers and EU municipalities covered the costs of collection and recycling, facilitating REE chemical separation as mandated by the WEEE Directive. This process was coordinated by regional *Extended Producer Responsibility boards*, leading to the establishment of recycling centres across Europe. Initiatives focused on separation and remanufacturing incurred costs only from the fraction acquisition stage.

Circularity Actors: An Advancing Landscape of Innovation

The market for increasing circularity in PMs for offshore wind turbines is evolving rapidly, with a growing emphasis on phasing out REEs, reducing material usage per MW, and ensuring recyclability, as seen in Figure 5. In the beginning, this shift towards greater circularity was academically catalysed by early EU-funded REE-recovery *research projects* such as REEproduce, SecREEts, SusMagPro, BioRecover, and REE4EU, which concentrate on the recovery and subsequent utilisation of REEs in PM manufacturing. *Startups* focused on REE recovery, such as N9ve, Carester, and established companies, like Stena Recycling, are already actively involved in REE recovery. Notably, companies with *recycling and remanufacturing plants* like Neo Materials in Estonia, MagREEsource, and the Japanese corporation Hitachi are at the forefront of producing PMs from recycled and self-owned separated REEs, reducing dependence on virgin materials. Interest in Neo Materials is particularly high due to being the first European manufacturer of permanent magnets with western-sourced rare earth elements and future high recycling content [18]. Currently, their supply is solely reliant on electric vehicles and not on magnets from offshore sources.

OEMs, like Vestas and Siemens Gamesa, are also pioneering *substitution and reduction strategies* to diminish REE content. Siemens Gamesa is already experimenting with recycling (achieving a 98% recovery rate) and plans to incorporate recycled materials into mid-30s decommissioned PM turbines [2]. In 2022, GreenSpur Wind, in collaboration with Niron Magnetics, has developed a 15 MW generator for offshore wind turbines using rare-earth-free magnets, leading to a substantial 56% reduction in mass, with support from ORE Catapult and plans to establish an industry consortium for its introduction to the market [19].

However, this transition is not without its challenges. The development and implementation of new magnet materials and recycling processes will still require substantial investments in R&D. There are initial cost implications and potential hurdles in achieving comparable magnet performance. Additionally, the success

Figure 5: Circularity-focused actor map. Circle size corresponds to project scale.

of these pilot projects hinges on effective collaboration across the industry, OEMs, operators, different innovative actors and regulatory support.

Implications for circularity strategies in the offshore wind industry

As the findings reveal, the circularity of PMs is a topic of significant discussion and extensive research. The IIIEE project team, therefore, realised that to deliver more value to actors in the industry, it was necessary to move beyond answering the initial research questions and propose concrete options for operators to assess in their pursuit of circularity. For RWE Offshore, the two most immediate material topics are increasing policy pressure and increasing competitiveness in tenders on circularity. The IIIEE team has, therefore, distilled three key insights from the research and their resulting implications for RWE Offshore's circular strategies.

First and foremost, there are evident power imbalances with OEMs and other upstream suppliers (PM manufacturers, REE refiners and miners). These suppliers are few, and PM users, such as offshore wind operators, depend highly on them. This implies that their primary efforts should be directed internally and/or downstream.

Second, the demand for REEs is projected to increase, while the forecasted supply of recycled materials will not meet this growing demand. This presents a compelling case for the operators to adopt circularity strategies beyond recycling and to collaborate across industry to communicate to policymakers and tender organisers the value of circularity indicators other than recyclability and recycled content — such as prolonged product lifespan, durability, material efficiency and others.

Lastly, the progress in R&D, as presented in the findings, suggests that by the time a significant number of wind turbines and other PM-containing equipment start reaching the end of their lifetime, the technology, and the capacities for REE's recovery and recycling will most likely be available. What may be lacking is a transparent supply chain for wind turbine components post-decommissioning and a credible certification system to acknowledge the operator's efforts in improving the turbines' end-of-life circularity. It falls to operators to connect with and link currently disjointed downstream suppliers into a functioning system and advocate for the desired recognition from policymakers and tender organisers.

Based on these key insights, in the following chapter, three potential options for combining the circularity efforts for REEs within PMs in the offshore wind industry will be presented and discussed.

Discussion

Three Options for Circularity

The options presented differ in their ambitiousness, position in the circularity hierarchy, and the resources required from an operator for implementation, as seen in Figure 6. These options can be viewed as complementary rather than mutually exclusive. Moreover, as the findings show, some of them are already being implemented; hence, the feasibility of implementing each of them is dependent on the operator's context.

Option One suggests focusing on internal circularity efforts such as wind turbine life extension and refurbishment. This pathway is plausible since wind operators already have a high degree of control over its implementation, and minimal collaboration efforts are needed. Moreover, prolonging the operation is an explicit techno-economic benefit — an argument that RWE Offshore's employees reinforced during the workshop. Nonetheless, this approach does require lobbying efforts to be successful and in compliance, as circularity tends to be quantified through the rate of recyclability or recycled content [2]. However, as the interviews have shown, older wind farms may face legal limits to extending their lifetime, as well as technological and economic challenges of repowering. Therefore, Option One might be, in some cases, fully implemented only in certain jurisdictions and/or within newer wind farms.

Option Two suggests engaging with start-ups, research centres, and recycling companies to build a transparent supply chain for increased

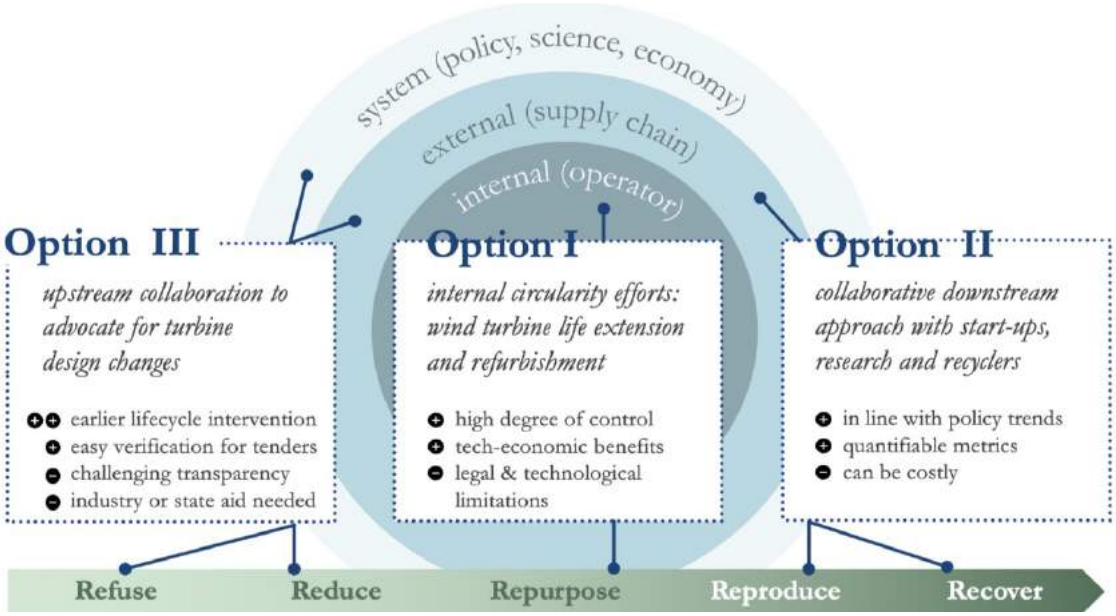

Figure 6: Three strategy options for operators embedded in the three spheres of influence and the 5R-framework.

circularity after the decommissioning of the turbines. It will require a collaborative approach directed downstream where operators hold significant influence as potential suppliers of recyclable PMs and other materials.

The upcoming policy and auction requirements on circularity show that there is a strong appeal towards Option Two among regulators and operators. It provides transparent and quantifiable means of increasing the circularity of REEs, such as the percentage of recycled content in PMs and/or their expected recyclability after decommissioning. These figures can be certified by the companies handling the recycling and backed by R&D, demonstrating concrete progress to governmental agencies in charge of tender processing. As illustrated previously with the example of the BATT2 directive, the main circularity metrics of CRMs tend to be quantified through minimum recovered content, so fewer lobbying efforts are expected in this approach. Option Two also received the most positive comments from the workshop participants. They noted that this approach might pay off with both streamlined access to non-virgin REE content and increased internal knowledge of the processes downstream in the operators' supply chain, potentially leading to techno-economic and sustainability benefits to the company.

At the same time, Option Two may require a substantial investment of time and resources to coordinate and harmonise with various stakeholders. Some of the workshop participants agreed that the costs of the sectoral collaboration can be high compared to the benefits derived.

Lastly, the most 'ambitious' *Option Three* predominantly focuses on upstream collaboration, specifically with OEMs, to advocate for turbine design changes and increased transparency. This approach is more circularly advanced as it intervenes at the earlier stage of the PM lifecycle. It therefore allows for a range of circularity improvements, such as reducing the use of or completely substituting REEs, improving repairability, and the potential for reusing and disassembling the PMs and the turbine in general. At the same time, this Option enjoys an established system for validation of indicators for tenders and compliance. The operators are already in close contact with OEMs requesting technical information for other compliance purposes.

Nonetheless, the barriers for Option Three are immense: as mentioned in the "Challenges" chapter, full product material transparency is currently not available in the supply chain due to factors such as unattainable traceability and commercial sensitivity. Respondents in the workshop also underpinned that the offshore wind industry is indeed a supplier's market. Therefore, this option is only viable through cross-value chain collaborations and sharing of the costs and/or with support from national governments. A clear example of this is the mentioned DecomBlades project. Furthermore, upcoming policy interventions

demanding more transparency in product designs and content will also enhance upstream supplier transparency and thereby make Option Three more feasible. The input from the workshop reinforces the findings since respondents indicated that even though this approach is the most powerful in reaching circularity targets, the costs for upstream collaboration are challenging unless internalised by the tenders' budget.

Reflections and conclusion

The IIIEE project team discovered that while PMs play a vital role in electricity generation as a critical component in offshore wind turbine generators, the transition toward circular use of REEs in PMs is still in its early stages. Nevertheless, the topic has gained increasing attention, particularly in the EU, due to serious concerns regarding the security of REE supply from China and the environmental implications of mining them. As discovered in the research process, an array of technologies and initiatives on recyclability, recovery, or substitution of REEs in PMs exist. Even though most of them are still in the R&D phase, the trends of developing circularity requirements in other industries show that their findings are likely to be in high demand sooner or later due to policy pressure.

The material processed during the project has led to several reflections. First, as is often the case with complex socio-technical systems, there is an innate trade-off between various sustainability dimensions of offshore wind power generation and, in this case, material circularity. Conflicting objectives arise in the need for more power capacity build-up to phase out fossil fuel for energy generation, the human rights issues in the mining of REEs across the world and the economic feasibility of new offshore developments for the operators under increasing policy pressure while trying to increase REE circularity.

Second, the dependence of PM supply on the European market from geopolitical factors challenges the projections for REE circularity. Most forecasts for the consumption of REEs depart from the baseline scenario of stable supply from China and gradually starting trends for diversification and use of secondary material. However, as the example of the short-lived but impactful 2010 Chinese REE export ban to Japan and strict quotas for the EU showed, the situation can change rapidly. In these circumstances, policy and the industry might move in a direction that the existing research could hardly predict.

Finally, another important uncertainty must be considered when it comes to strategies for future circularity. As the interviewees emphasised, the issue of offshore wind farms' mass decommissioning, as well as the stable material flow of used PMs, is expected to emerge no earlier than the 2030s. Given the rapid pace of technological advancements, it's possible that REEs may no longer be used in wind turbine designs in the future, or they may be significantly replaced by more common materials.

Overall, it became apparent that political, socio-economic, and technological factors can have a substantial influence on the immediate goals of advancing circular practices in wind power. While the current project does not delve deeply into this, it could be a goal for future research to investigate the economic feasibility of circularity amidst market fluctuations and how to strike a balance between short-term expenses and long-term environmental advantages.

Figure 7: Team photo. From the left to right: Björn, Emiliano, Bjarke and Sergei

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Circular Electronics Initiative

Setting ambitions towards a circular future for IT

Project Brief

Moving towards a circular economy has become a priority for the Information Technology (IT) sector. Worldwide, various producers and service providers are now seeking to narrow, slow and close resource and material loops. The Circular Electronics Initiative (CEI) is an alliance of IT producers and organisations that seeks to become one of the most progressive circular electronics networks in Europe. As a crucial step towards this goal, the IIIEE team worked together with the CEI to kickstart its policy advocacy work by developing a nine-point policy platform; this document contributes to setting the circularity vision for the CEI members to raise the ambition of circularity in the IT sector, taking into account ongoing and upcoming policies at the EU level that can determine the course of actions around circularity for the IT sector. It also reflects key trends, perspectives, and insights from CEI members and external stakeholders.

Project Team

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Ariel is from Indonesia, with prior experience in waste and marine debris management.

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Simone is from Italy, with prior experience in the energy sector and in sharing economy.

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Introduction and Objectives

Context and Problem Description

The market size of global Information Technology (IT) sector is huge. In 2023, the market is worth 8852 billion USD, growing 8.2% from the previous year [1]. However, this significant growth is not a sustainable one, as electronic waste generated from linear production and consumption reached a staggering 53.6 million metric tons in 2019 and is projected to reach 120 million metric tons in 2050 [2]. Furthermore, the soaring demand in the industry leads to an intense use of energy and high emissions of greenhouse gasses (GHG), contributing to around 1.4% to 5.9% of global GHG emissions, 31% of which comes from IT devices such as desktops, smartphones, netbooks, and displays [3].

To tackle environmental issues related to production and consumption in the IT sector, the concept of circular economy is gaining increased attention. This approach is beneficial as it leads to resource efficiency and significantly more sustainable material use compared to the environmentally damaging linear production. Various producers and service providers now seek to enhance circularity in their own operations as well as advocate for more ambitious related policies.

The Client

The Circular Electronic Initiative (CEI) is an association of 28 electronic goods producers and service providers, manufacturers and distributors, certifiers, repairers, refurbishers, remanufacturers, recyclers, academia, and online marketplaces. The alliance was initiated by TCO Development, a certifier company for electronic products, and strives to create a society that produces and uses electronic products more sustainably. The CEI operates on three core activities that they have agreed upon; knowledge exchange, public relations activities and lastly, starting the work on policy advocacy, which is the focus of this report.

The Task

The CEI has agreed that it wants to engage in policy advocacy as one of its three core activities. Up until now however, the initiative has not agreed on common positions to advocate for. The consultancy project, therefore, aims to kickstart the CEI policy advocacy work by developing a policy platform that sets CEI's circularity vision and ambition for the IT sector in the medium term (2 – 3 years). This policy platform is actualized as a position paper, consisting of nine advocacy points, reflecting the CEI members' aspirations to push forward more ambitious policies on IT circularity, mainly focusing on the EU level. To deliver a meaningful policy platform to the client that reflects the CEI's members as well as relevant EU policies, stakeholder and policy mapping were conducted. The stakeholder and policy mapping respectively illustrate the CEI members' stance and position in the IT sector circularity and the EU policy landscape related to circular economy in the sector. In addition, the work entailed reviewing and gathering insights from key internal and external stakeholders on existing and potential future policies at the EU level that can increase circularity in the IT sector to inform the policy platform. Following the completion of the project, the policy platform is set to be discussed, voted upon and formally adopted by the CEI.

Approach to the Project

Theoretical Approach

Circular Economy and Strategies towards its Implementation

The circular economy is seen as a promising approach to tackle the ongoing resource consumption and climate affections derived from human activities [4]. In a circular economy the value of products and materials is maintained, waste is avoided, and resources are kept in the economy when a product reaches its end of life. A circular economy relies on a circular design that enables circularity in all life cycle stages, that can further realize circularity through synergies and cooperation [5].

Various approaches, known as R-Strategies, have been developed to achieve a circular

economy at the product and service level and to achieve less material consumption in product chains and make the economy in general more circular [6]. Potting et al. [6] present a hierarchical 10-R framework for circularity strategies within production chains; the lower the R, the more circular. These 10 Rs are grouped into "smarter product use and manufacture" (R0-R2), targeting the reduction of resource use associated to product and production processes (narrowing material loops); "product and materials lifespan extension" (R3-R7), targeting the prolonged use and reuse of goods over time (slowing material loops); and "useful application of materials" (R8-R9), which seeks to the reuse of materials through recycling and recovery (closing material loops) [4]. A description of each R-strategy is presented in **Table 1**.

R - Strategies. *R0 (most circular) – R9 (least circular).*	
Narrowing material loops: Smarter product use and manufacture.	**R0 – Refuse** Make product redundant by abandoning its function or through offering the same function with a completely different product.
	R1 – Rethink Make product use more intensive via sharing products, putting multi–functional products in the market, etc…
	R2 – Reduce Use of fewer natural resources and materials through efficient manufacturing and use.
Slowing material loops: Product and materials lifespan extension.	**R3 – Reuse** Reuse of functioning discarded product by another or the same user.
	R4 – Repair Repair of maintenance of defective products to keep its original function.
	R5 – Refurbish Restore and update an old product.
	R6 – Remanufacture Use existing parts in a new product with the same function.
	R7 – Repurpose Use existing parts in a new product with a different function.
Closing material loops: Useful application of materials.	**R8 – Recycle** Process materials to obtain the same (high grade) or lower (low grade) quality.
	R9 – Recover Incineration of materials with material and energy recovery.

Table 1. The 10R framework. Adapted from [4], [6].

Life Cycle Thinking

A circular economy transition can be informed and supported by using life cycle thinking for highlighting areas of action and potential improvement [7] or, in the context of this project, identify where the actors are intervening or are willing to work, and help identify touch-points on where to advocate.

Using life cycle thinking allows to look beyond production sites or manufacturing processes, helping in including environmental, social and economic impacts throughout the entire life cycle of a product or a service [8]. Moreover, life cycle thinking enables individuals to make decisions for the longer term consider the different environmental and socioeconomic associated to a product or service [8], [9].

The life cycle stages are broadly defined as follows:

- Raw materials extraction.
- Product design and manufacture.
- Distribution and retail.
- Use and maintenance.

- End of life management (including WEEE collection, recycling and recovery).

This project's methodological approach followed the 10R framework and the life cycle stages mentioned above by mapping the IT-product life cycle stages where the CEI members operate and identify what circular economy R-strategies they are working towards.

Through this, it is possible to identify what are the main areas to set ambitions for the CEI policy platform.

Data Collection

To support the policy platform formulation process, primary and secondary data were collected. Primary data in this project were the perspectives and aspirations on circular IT products of relevant stakeholders which were gathered through survey responses, focus group discussions, and interviews. Meanwhile, secondary data were collected through desktop research to map internal stakeholders and EU policies on IT circularity.

Desktop Research

Desktop research was carried out for an initial mapping of stakeholders and relevant EU policies for circularity in the IT sector, by mainly browsing CEI members' websites and public reports, EU websites and documents. Secondary data gathered through desktop research also informed the survey design and the content of discussions and interviews.

Survey

A survey was developed to gather the perspectives and input of the 28 CEI members. The survey was structured into three main sections: organisation context, organisation's capacity and aspiration on circular economy in the IT sector, and policy advocacy on EU legislation on circular economy in the IT sector. The first section aimed to obtain a basic profile of the organisation. The second section aimed to understand the organisation's current and future focus areas in the 10Rs framework and aspirations for each of the R, and the capacity of the organisation to work on policy advocacy. Lastly, the third section aimed to understand the positions and ambitions regarding current and upcoming EU policies related to circularity in the IT sector. The survey got responses from nine CEI members in total. Overall, survey respondents were quite varied and included private sector, academia and non-profit actors, thus giving survey results a fair degree of representativeness of the CEI as a whole.

Focus Group Discussions and Interviews

The Focus Group Discussions (FGDs) and interviews aimed to gain in-depth information on participants' views on the necessary policy changes for IT circularity. FGDs were designed for the six stakeholders in the CEI that were set as the reference group of the project. The reference group consisted of six members of the CEI that the client deemed to be representative of all the members and that committed to supporting the policy platform development. The rationale for using FGDs was to gain input into the policy platform as well as to see the dynamics between the participants and assess how aligned the members are. The FGDs were designed for three participants in each session, so two FGDs were conducted. Meanwhile, the interviews aimed to gather individual in depth perspectives, be it from stakeholders inside or outside the CEI, regarding IT circularity. Questions asked on both FGDs and interviews were the same, revolving around further aspirations on IT circularity, challenges, social issues in circularity, overconsumption, and the future of sustainable IT.

Study Visits

During the project, study visits to two CEI members were conducted. The study visits aimed to provide insights into the actual implementation of circularity aspect in the business or operation of the organisations. Discussion with the visited members also took place to understand better the challenges they are facing and the perspectives that they have in raising ambitions for IT circularity.

Data Analysis

Coding was used to analyse the obtained data from the surveys, FGDs, and interviews. The data was coded into four different categories based on if they were specific policies connected to legislation, general policies, approach to policy platform and IT circularity, and lastly radical proposals on IT circularity. After the coding was finished, five core policy recommendation areas for the policy platform emerged. These were narrowing the loops (reducing resources in the production of the IT goods), slowing the loops (designing IT products to be more long-lasting), closing the loops (recycle of materials in the IT goods production), social aspects (safeguarding social issues in IT circularity), and transversal points (action points that are relevant to more than one of the areas outlined above).

Results

Having outlined the approach to the project and its objectives, what follows is an overview of the project's results informed by desktop research, the survey responses and the input from interviews, study visits and FGDs altogether. It should be noted how findings related to stakeholder and policy mapping not only bring value as results themselves but also in turn informed the development of the CEI policy platform.

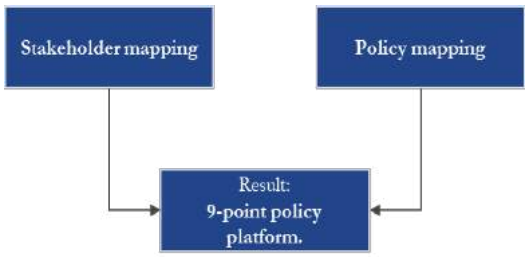

Figure 1. Relationship between the results of stakeholder and policy mapping and the ultimate result, the CEI policy platform.

Stakeholder Mapping

Following the research and mapping stage, it was possible to obtain a clear image of where CEI members are operating in the IT landscape and to categorise and locate them according to the chosen conceptual framework. Moreover, the nine analysed survey responses provided primary data on the members mapping. This section presents the main results from these two stages.

CEI Members Categorisation

Desktop research was instrumental in understanding what kind of stakeholders the CEI is composed of. The main preliminary findings looking at each member's website and reports are presented in Table 2.

Stakeholder category	CEI members
Private sector	3StepIT, Advania, Aliter Networks, Atea, Blocket, Circular Computing, Cistor, Closing the Loop, Compare and Recycle, DELL, Dustin, GIAB, InnoVent, INREGO, Indeed, Lenovo, Prime Computer, Recipo, Smithereens, Towards Zero Waste, Tradera, WEEE Centre.
Academia	International Institute for Industrial Environmental Economics (IIIEE), Chalmers, Swedish Environmental Research Institute (IVL).
Non-profit	European Remanufacturing Council (ERC), European Toner & Inkjet Remanufacturers Association (ETIRA), TCO Development.

Table 2. CEI members categorisation.

Private sector organisations, which make up the majority of CEI members, include manufacturers, service providers, online marketplaces, a refurbishing company and a recycling centre, while academia organisations are research institutions based in Sweden. Non-profit organisations like ERC and ETIRA represent the interests of remanufacturers in Europe, while TCO Development is the certifier company behind the IT ecolabel TCO Certified.

10R framework		Product-Service life cycle stages				
		Raw materials extraction	Product design and Manufacturing	Distribution and Retail	Use and maintenance	End of Life management
Smarter product use and manufacture	R0 Refuse	2	2	2	4	3
	R1 Rethink	2	2	2	3	3
	R2 Reduce	2	2	3	5	4
Extend lifespan of products and its parts	R3 Reuse	3	2	5	7	5
	R4 Repair	2	2	3	5	3
	R5 Refurbish	3	2	5	7	5
	R6 Remanufacture	2	2	1	3	2
	R7 Repurpose	0	0	0	0	0
Useful application of materials	R8 Recycle	2	2	3	4	4
	R9 Recover	2	2	2	4	3

Legend (count): 0 7

Figure 2. CEI circularity mapping matrix (min. 0, max. 7 responses).

CEI Circularity Mapping Matrix

This section presents the results of the survey concerning the stated role of CEI members in the life cycle stages of IT products and services and in the 10R framework. Considering the degree of representativeness of the survey responses for the CEI at large, the matrix in Figure 2 is a useful tool to understand the areas where most CEI members are operating. Out of nine survey respondents, two answered their work is not applicable to the life cycle stages or not operational in any of the 10 Rs yet, and thus were excluded from the matrix.

As shown in Figure 2, most respondents stated they are operating in the use and maintenance stage of IT products, mainly in "reuse" and "refurbishing". This finding supports previous desktop research on the 28 CEI members at large, which also found most of them operating in the use and maintenance stage, with a focus on extending the lifespan of products (R3 to R7).

Policy Mapping

This section discusses the results of the policy mapping conducted through desktop research, interviews, and surveys. Survey results mapping the perspectives of CEI members on different policies are also presented.

EU Policy Mapping

Seven upcoming and existing EU legislations and policies were identified as important regarding circular IT based on desktop research, surveys, and interviews. A short description of the seven existing and upcoming EU legislations and policies is provided in Table 3. The policies were selected on the basis that they already have or have the potential to intervene in different life cycle stages of IT products to enhance the circularity in the sector. The policies therefore serve as potential intervention points for where CEI could focus their advocacy work and the policy platform.

Survey Results on EU Policies

The survey included questions on the CEI members views on the five EU policies that had been identified as relevant at the time the survey was designed. The respondents were asked to grade the EU policies in two different aspects: first, impact of the EU policies on their organisation and second, how important they think the policies are to promote circularity in the IT sector in general. The respondents also had the opportunity to give suggestions on changes to these five policies and/or other EU policies of their choice, which fed into the policy platform and therefore would not be covered in this section.

The results from the survey showed that almost all respondent 7-8 out of 9 thought that all five policies had a high or very high impact on their organisation (4 or 5 on the scale), see Figure 3. When it came to how important these policies are when it comes to promoting circularity in the IT sector in general, the variation between the policies were greater.

The upcoming Eco-design Regulation and upcoming "Right to Repair" Directive had the highest number of respondents, 8 each out of 9, answering that they were important or very

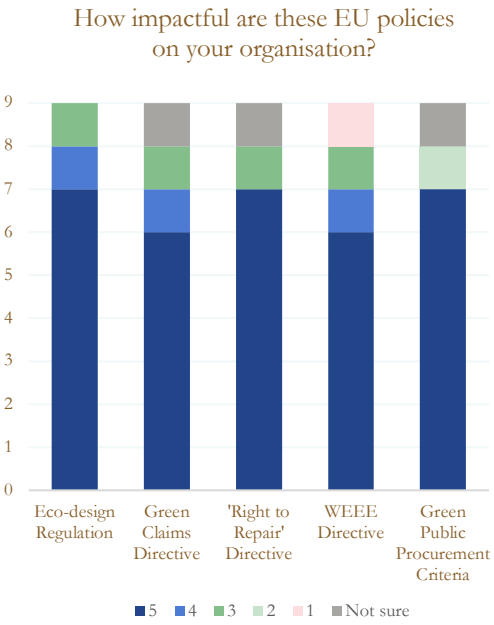

Figure 4. Rating of EU policies in terms of impact on organisation (1: very low impact, 5: very high impact).

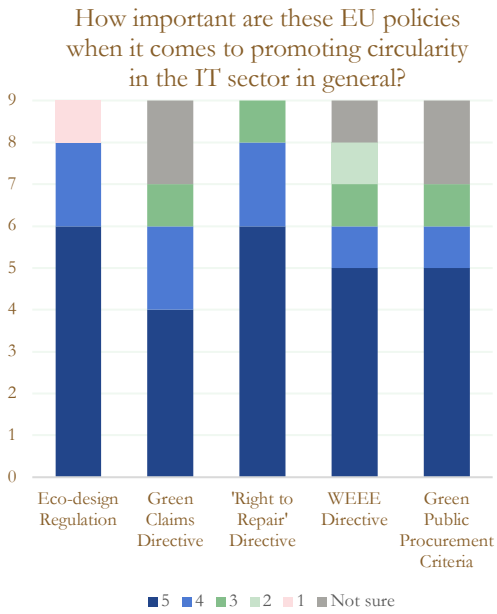

Figure 3. Rating of EU policies in terms of importance to promote circularity in the IT sector in general. (1: very low importance, 5: very high importance).

important (4 or 5 on the scale) to promote circularity in the IT sector. For the remaining three policies, 6 out of 9 respondents answered that they were important or very important.

The Green Public Procurement Criteria and the upcoming Green Claims Directive were the two policies that most respondents were unsure about regarding how important they are to promote circularity in the IT sector in general, with two respondents each being unsure, see Figure 4.

To summarise, the results of the survey show that close to all respondents assessed that the policies had a high impact on their organisation. Regarding the importance of the policies on the IT sector in general the upcoming "Right to Repair" Directive and the upcoming Eco-design Regulation had most respondents answering that they were important. Overall, the findings support that the five policies are relevant to cover in the policy platform.

EU legislation/policy	Short description
Eco-design Regulation	An upcoming EU legislation, proposed by the Commission in March 2022. The proposal expands on the current Eco-design Directive and establishes a framework to set eco-design requirements for specific product groups to improve their circularity, energy performance and other environmental sustainability aspects. [10]
Green Claims Directive	An upcoming EU legislation, proposed by the Commission in March 2023. The proposal aims to make green claims reliable, protect consumers from greenwashing and promote circularity. [11]
'Right to Repair' Directive	An upcoming EU legislation, proposed by the Commission in March 2023. It aims to promote repair in the after-sales context when the goods are used by consumers. [12]
WEEE Directive	Existing EU rules on the treatment of waste electrical and electronic equipment to contribute to a circular economy. [13]
Green Public Procurement Criteria	Existing common EU criteria for public procurement of goods, services or works with reduced environmental impact, to green public purchases and drive demand for more environmentally sustainable business practices. [14]
Waste Shipment Regulation	Existing EU rules for transporting waste across borders. It constitutes EU's implementation of the obligations of the Basel Convention (1989) on the control of transboundary movements of hazardous wastes and their disposal. [15]
Corporate Sustainability Reporting Directive	Existing EU rules requiring large and listed companies to publish regular reports on the social and environmental risks they face, and on how their activities impact people and the environment. [16]

Table 3. Seven existing and upcoming EU legislations/policies relevant to promoting circularity in the IT sector.

Policy Platform

Based on the results from the data analysis of the survey, FGDs, interviews with the stakeholders and policy mapping, nine policy advocacy points were developed.

The nine advocacy points aim to narrow, slow and close resource loops and address social aspects in IT product's life cycle. Four advocacy points touch on more than one of these and are classified as transversal points.

Narrowing loops

1. Set quantitative targets to reduce environmental footprint and climate impact from IT products.
This advocacy point aims at reducing the amount of material that enter that resource loop in the first place by setting quantitative targets on environmental footprint and climate impact from IT products. In addition, separate targets should be set for reuse and repair.

Slowing loops

2. Improve eco-design rules.
Design of products must incorporate and drive circularity through all life cycle stages, through modularity and ease of disassembly to facilitate repair, refurbishing and repurposing. Reused and recycled content targets for IT products should be set to shift the balance between the use of virgin raw materials and reused and recycled contents. Initiatives for standardisation of IT parts should be incentivized and spread.

3. Value retention through reuse and right to repair.
Research and development and innovation efforts should target reuse, repair, refurbish, remanufacture, and repurpose practices. These activities should be incentivised and rewarded through different mechanisms.
This value retention relies on a levelled-playing field for extended product warranties, long-term software support, and empowered consumers about their right to repair.

Closing loops

4. Improve IT products' end of life responsibility and management.
WEEE management practices need to keep up with current IT development, knowledge, and best practices. The collection stage should be enhanced via incentivised consumer involvement, prioritising product reuse. WEEE recycling should consider separate quotas for different materials, and all requirements should be enforced consistently.

Social aspects

5. Ensure a socially just transition for IT Circularity.
To achieve a sustainable IT circularity, social aspect must be considered. This calls for a due diligence process and the implementation of transparency and traceability instrument to minimize the risk of social issues.

Transversal topics

6. Policy support to shift from linear to sustainable and circular business models.
Policy should promote circular business practices inter alia by addressing barriers for circular business models in financial accounting and shifting economic incentives in favour of circular practices. Policy should also prohibit the most linear and resource inefficient business practices such as the destruction of unsold goods. In addition, metrics and benchmarks for circular business should be established so that their environmental performance can be demonstrated.

7. Clarify and enforce rules on transboundary movements of IT-waste.
Policy should enable IT product waste from being collected and sent to the country where it can be further processed for recycling, thus increasing its circularity. This also calls for stricter monitoring and intervention towards illegal e-waste exports especially towards developing countries.

8. Transition from green towards a circular and sustainable public procurement.
Public procurement criteria in the EU and beyond must incorporate and drive circularity in IT public purchases to facilitate the uptake of circular business models by rewarding frontrunners and fostering eco-innovation. Criteria on durability, repairability, reused and recycled content should be set to reward leaders of circular business practices. Procurement contracts should be extended and explore alternative purchasing schemes.

9. Green claims and empowering consumers to make informed decisions.
Information and data used to substantiate green claims should be easily accessible and understandable by consumers. Mechanisms for punishing non-compliance must become more severe. Harmonized requirements and methods on how to substantiate claims are also needed, to keep costs for companies low and allow them to communicate their sustainability performance. This needs to be coupled with harmonization efforts in non-financial reporting.

Final Remarks

This project was the first step for the CEI to embark in the field of policy advocacy, which the team from the IIIEE was able to gladly support. The policy platform proposed by the team, containing nine advocacy points to push towards more ambitious policies on IT circularity, was well received by the CEI. In addition to that, the team was also able to support CEI with a stakeholder mapping of some of its members which serves as a support for assessing the focus area of each member in term of circularity, as well as a policy mapping of EU legislations and policies that provides insights on potential intervention points in upcoming advocacy work.

The student team, see Figure 5, received many important lessons on environmental policy advocacy, and after concluding the project, is optimistic about the positive impact that the CEI can bring. The student team is hopeful that the deliverables that were produced for the initiative can support them to reach their ambitious goals to ramp up circularity in the IT sector and become one of the most progressive circular electronics networks in Europe.

Figure 5. IIIEE Consulting Team.

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Hydrogen King

Circularity in Hydrogen King, collection model sustainability approach

Project Brief

This project was carried out for Hydrogen King, a Malmö based start-up company producing hydrogen vessels. The vessels are primarily intended for use in the mobility industry in vehicles such as cars, trucks, and buses, but could also be used for stationary use in industry. The vessels are composed primarily of carbon fibre, but also contains polyamide and graphene.

Hydrogen King has a strong ambition of a circular material flow regarding the vessels. The main task was to develop a model for recollection of the vessels involving key actors throughout the value chain, especially focusing on the mobility industry.

Project Team

Daniel Rojas Arias
Daniel is from Colombia and has prior experience in waste management systems.

Sascha Börgemann
Sascha is from Germany and has prior experience in sustainability consulting.

Wanying Liu
Liu is from China with prior experience in environmental NGO's.

Jacob Willer Holm
Jacob is from Denmark, with prior experience in the logistics industry.

Circularity of Hydrogen Vessels and Sustainability Implications

Abbreviations

HK - Hydrogen King
GHG - Greenhouse Gas
EoL - End of Life
LCA - Life Cycle Assessment

Introduction

The mobility sector stands out as a main contributor to greenhouse gas emissions, prompting a concerted effort to pursue sustainability. Renewable energy has emerged as a prominent solution in this endeavour. While electrification has become the prevailing trend for smaller vehicles like cars, hydrogen is garnering increasing attention for heavy vehicles such as buses and trucks. The hydrogen market presents substantial opportunities, with an estimated annual growth rate of approximately 40% [1] (see also Figure 1).

Hydrogen vessels play a pivotal role in storing hydrogen, but there is currently a shortage of them, accompanied by sustainability concerns. Existing hydrogen vessels are not recyclable and typically end up in landfills after reaching the end of life (EoL). Malmö-based startup company Hydrogen King (HK) is motivated by the aspiration to manufacture recyclable and reusable hydrogen vessels. Furthermore, HK is dedicated to promoting circularity by implementing a reverse logistics system to collect their vessels and recycle the materials, driven by both financial and sustainability considerations.

One of the key reasons for the significance of this case is the forthcoming change in the policy landscape concerning material circularity within the automotive industry. With the introduction of the new proposal for the "End-of-Life Vehicle Directive," there is a potential for Extended Producer Responsibility to be applied to vehicle manufacturers in the future [2]. This would require manufacturers to take a more active role in the EoL management of vehicles and develop systems for recollection.

The circulatory ambitions of HK carry evident financial benefits due to the exceptional high residual values associated with used vessels. This constitutes one of the primary reasons why recollection is of paramount importance for HK. Additionally, the recollection of used vessels yields several sustainability benefits, both for HK and its downstream stakeholders. The most apparent benefit is that recycling the vessels mitigates landfilling and reduces the consumption of raw materials in the production of new vessels. Improved circularity also serves the interests of HK's downstream customers, particularly Tier 1 customers like vehicle manufacturers such as Volvo, as it aids in

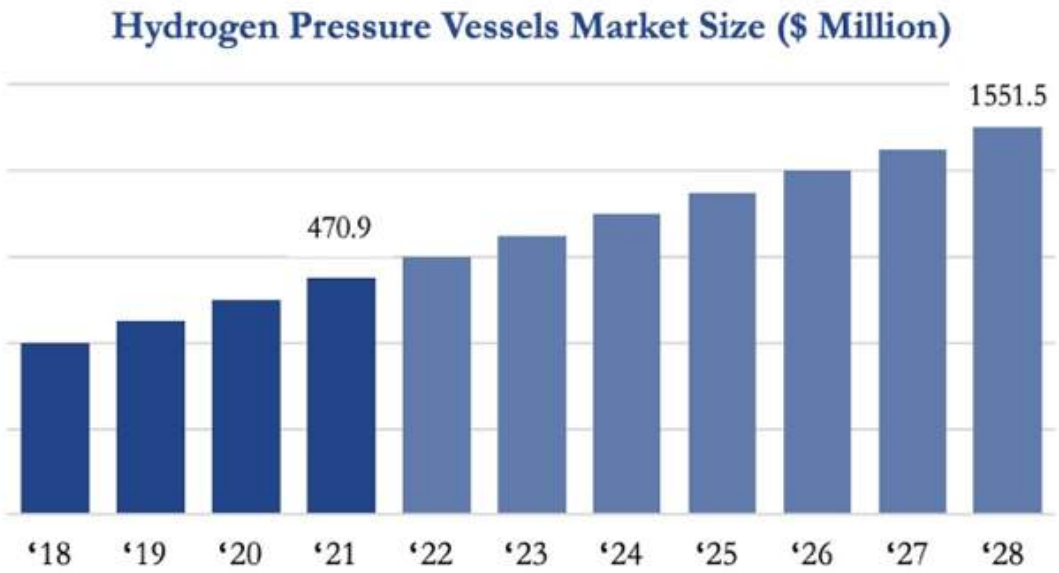

Figure 1: The development of the hydrogen pressure vessel market (Source: HK company presentation)

achieving their sustainability goals. The recollection and reuse of vessels can contribute to reducing Volvo's scope 3 GHG and enhancing the circularity of their vehicles.

About Hydrogen King

HK is driven by the ambition to revolutionise the pressure vessel market through innovative production techniques and a comprehensive sustainable circularity approach. To tackle this challenging endeavour, they have joined forces with Volvo, collaborating within the framework of a joint venture named Cellcentric, established in partnership with Daimler. Cellcentric conducts extensive research into hydrogen applications within the mobility sector. Additionally, HK has formed a partnership with the British recycling company, Cygnet TexKimp, which supplies the necessary machinery to support their circularity goals.

Given the advanced stage of the partnership with Volvo, it is highly probable that Volvo will serve as the primary customer to kickstart this endeavour. While other automotive manufacturers may also be potential customers, this report will primarily centre on the collaboration with Volvo as HK's Tier 1 customer. Customers situated downstream in the value chain can be geographically dispersed across the globe, wherever hydrogen vehicles are in operation.

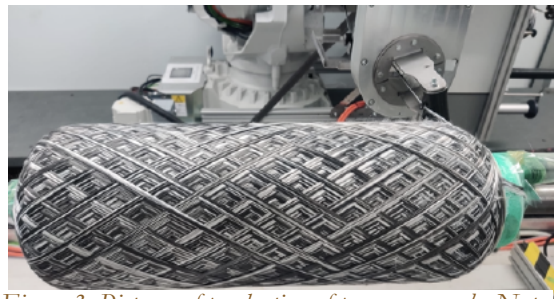

Figure 3: Pictures of production of pressure vessels. Note how the materials are winded together (Source: HK company presentation)

While the company's initial venture involved the creation of a water purification vessel system, this served as a precursor to the pivotal future direction of the company. HK is strategically shifting its core focus towards the development of pressure vessels designed for both natural gas and especially hydrogen applications.

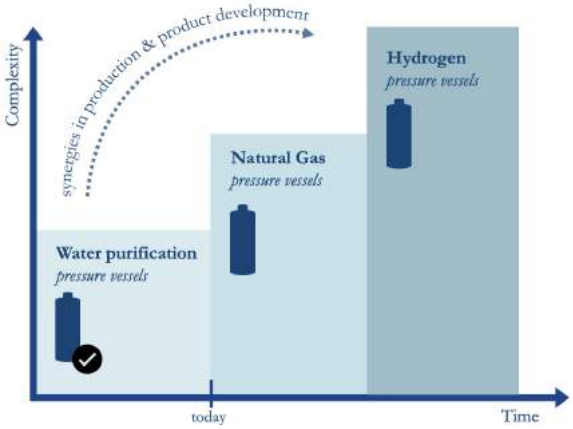

Figure 2: The development plan of HK's product line (Source: HK company presentation)

After accumulating capital from producing vessels for water purification and natural gas, the final ambition of HK is to develop type 5 hydrogen vessels for the mobility industry. The production process involves the utilisation of high-quality carbon fibres, which are intricately winded with graphene and thermoplastic polyamide through a winding process. The role of graphene is pivotal, as it serves to prevent the diffusion of hydrogen, a central challenge in effective hydrogen storage. The long-lasting carbon fibres is the material HK aims to reuse in manufacturing a new vessel. Figure 3 and 3.1 show pictures from the production of vessels.

These vessels are designed to be incorporated into land-based transportation, starting with trucks and buses as a pilot project. Additionally, there's potential for their utilisation in maritime vessels and aircraft. Another avenue of application involves stationary use within industrial settings, where the vessels can be installed in various plants.

HK's pressure vessels stand out from those currently available on the market, providing a substantial competitive edge on various fronts.

The reason for that, in terms of the production perspective, is a so-called dry-winding method, a departure from the prevalent wet-winding method. This allows for a significantly faster

production rate, leading to reduced production costs.

From a sustainability standpoint, the composition of HK vessels renders them recyclable and have a 10-15 years' lifetime. HK plans to efficiently decompose the vessels into their three constituent materials, with the majority being reusable carbon fibres. This contrasts with currently available pressure vessels that rely on epoxy in their production, making recycling challenging. Consequently, the existing pressure vessels typically end up in landfills, contributing to environmental hazards and perpetuating a linear model of buy-and-discard.

From a quality perspective, HK's vessels will be so-called Type 5 vessels, which is the top-quality vessel type, normally used in industries such as military and aerospace. Hydrogen vessels currently offered on the market are Type 4. Figure 4 gives an overview of the pressure vessels divided by market types.

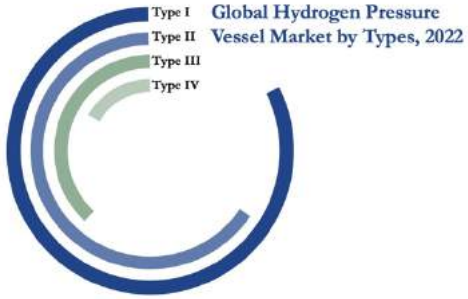

Figure 4: Type 5 vessels are limited in production due to cost reasons. (Source: HK company presentation)

Problem Statement

HK wishes to put a strong emphasis regarding material circularity of their business model, intending to leverage this aspect as a marketing strength.

The primary objective of this project is centred around developing a model for the efficient retrieval of these vessels. This will give an appropriate EoL management to HK's vessels, involving collaboration with key stakeholders across the entire value chain. Emphasis was particularly placed on the mobility industry throughout this process.

However, during the process HK widened their focus. They sought a model that not only met financial considerations but also maximised the sustainability offering. This additional dimension was intended to provide HK with a model that could be presented to potential clients, framed from a more sustainable perspective.

Thus, the project formulated these research questions to guide the work:

1. How can a recollection system of EoL hydrogen vessels be structured within the mobility industry?
2. What financial and environmental costs are implicated within that logistic process?
3. What are the main sustainability potentials and risks for HK in relation to their sourcing, operations, and business proposal?

Methodology

To address the research questions, various methods for data collection were employed, encompassing desk research and interviews. Desk research involved online investigations and literature reviews.

To gain a comprehensive understanding of reverse logistics, an extensive examination of best practices was carried out, with a focus on cases involving components with high residual value, such as batteries.

Regarding the design of the recollection model, the initial phase involved an exploration of both financial and non-financial incentives for vessel return, alongside an assessment of their potential and implementation challenges. However, given the predominantly business-to-business (B2B) nature of HK's operations, the decision was made to primarily focus on financial incentives.

To formulate a practical collection model, data was collected through interviews with pertinent stakeholders. These interviews included discussions with influential industry figures, including Stena Recycling, Volvo Trucks, Volvo CE, and BilRetur (Swedish Car Dismantler Association). Additionally, to garner general knowledge on recollection models and the financial aspects of HK's operations, interviews were conducted

with relevant academics and experts, such as Lisa Heldt, Emma Johnson, and Alexander Lidgren from Lund University.

To consolidate the diverse perspectives and insights gathered, a workshop was organised, bringing together many of the stakeholders previously interviewed. This collaborative session facilitated discussions on key objectives and challenges, fostering a more holistic understanding of the subject.

For the assessment of the financial and environmental aspects of the collection model, a scenario calculation was created. This calculation accounts for a range of critical variables, albeit in a simplified form due to the uncertainty surrounding future developments and the absence of current data. Nevertheless, the model is designed to be flexible, capable of accommodating future data inputs and thereby enabling data to simulate more precise scenarios as they become available.

Result 1: Collection System and EoL Management

The initial stage of the research was segmented into three primary focal areas. The first aspect involved the exploration of the **downstream journey of the vessel**, with a particular emphasis on mapping out the key actors and stakeholders involved. The second facet revolved around the identification of **three challenges** encountered during the application of the collection models. Lastly, an **evaluation of various potential collection models** was conducted. It's important to note that this evaluation encompassed both financial and non-financial incentives; however, considering that transactions within the value chain primarily occurred between B2B actors; the decision was made to concentrate exclusively on financial incentives.

Vessels Downstream Journey

To develop a practical collection model for HK, it was necessary to map the downstream value chain alongside identifying key

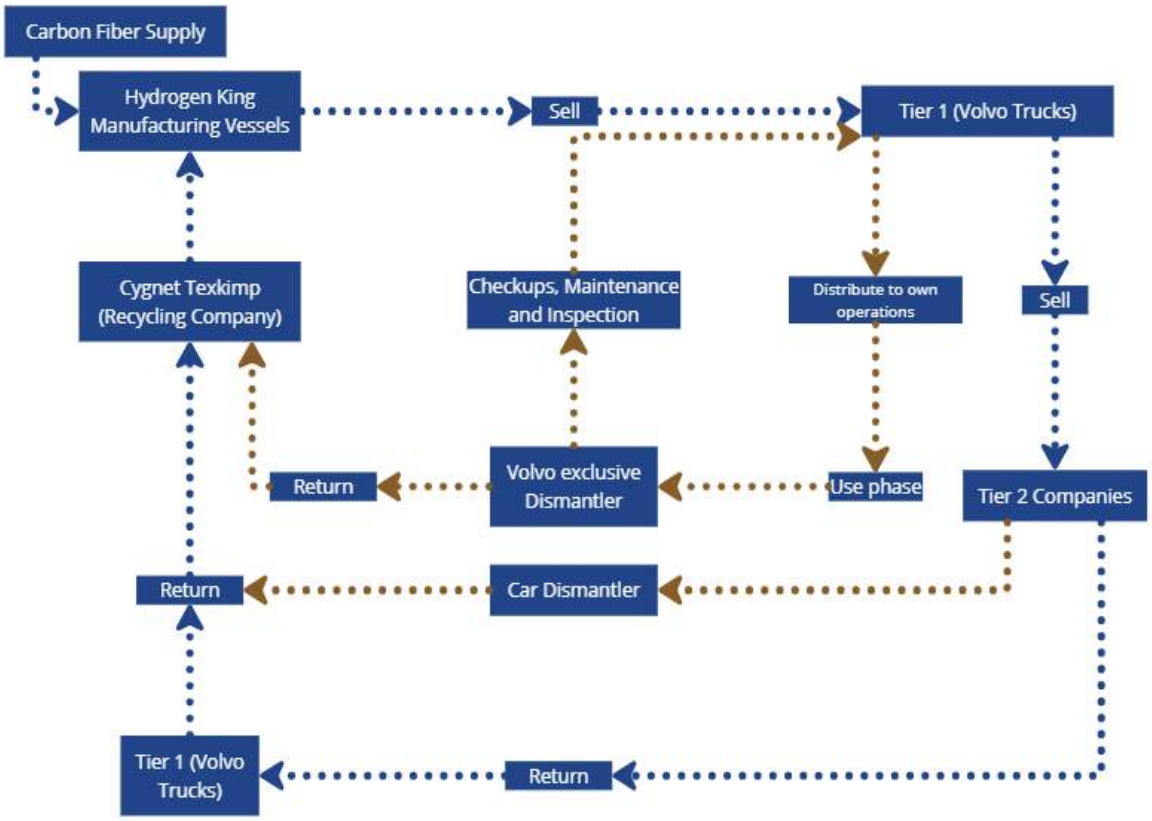

Figure 5: Vessels' downstream journey

stakeholders. Therefore, a process map was made to outline the flow of the vessels, providing a comprehensive overview of the tank's journey before ultimately returning to HK. The model (illustrated in Figure 5) commences from HK (located at the top left corner) and continues to traverse around until it returns to the starting point. The blue arrows signify the fundamental process from cradle to cradle, while the bronze arrows indicate potential deviations in the process. Subsequent collection models were subsequently formulated by drawing upon insights from this process map and the remaining research.

Based on IIIEE interviews, a typical life journey of trucks is shown. A truck typically remains in operation in Sweden for approximately three years following its production. Subsequently, it is often sold to companies operating in other regions, such as Eastern Europe. The truck may undergo multiple resale transactions, eventually reaching EoL outside the EU and becoming part of the global circulation. At this point, these vehicles might either be directed to a local third-party dismantler or be recollected by the vehicle manufacturer. The potential global dispersion of these vehicles presents a considerable challenge in terms of tracking their movements.

Challenges

Limited Availability of Best Practices

The initial research showed that best practices in reverse logistics are very limited. Recollection schemes in companies often encounter difficulty in benchmarking themselves against established best practices due to the limited availability. An exception to this is the Caterpillar Remanufacturing scheme, which has been functioning for a significant period of time, and which served as inspiration for the design of the collection model.

Financial Challenges

Implementing collection models entails significant financial challenges. The costs associated with financing the operations and administration of such systems, especially when operating across large geographical areas, are substantial. Striking a balance between the economic feasibility of the system and its environmental benefits poses a persistent challenge. This also implies that the designed collection model must be rather simple and not involve several different collection schemes in order to minimise administration costs.

Traceability Challenges

Traceability is critical, as companies often struggle to maintain control and oversight of their products, making retrieval a challenging task. Nevertheless, advancements in technology, especially in vehicle production, are expected to address this challenge. The integration of GPS and blockchain technology and other tracking mechanisms in automotive manufacturing processes will likely enhance the traceability of products throughout their lifecycle.

Discussion of Financial Incentives Within the Collection Model

The four financial incentive models taken into consideration were discount schemes, buy-back schemes, deposit-refund systems, and product-as-a-service solutions. Through the insights gained through research and interviews, the proposed model is a hybrid of a discount and a buyback model.

Discount

The discount model is structured around offering returning customers a discount on a new vessel in exchange for returning an old one. The primary advantage lies in its potential to enhance customer retention, as customers are incentivized to continue their partnership with HK by availing discounts on new vessels, without binding additional capital on the vessels. On the other hand, the discount scheme is only applicable to direct buyers of hydrogen vessels.

However, a key challenge is that this incentive model is most directly applicable to HK Tier 1 clients. The nature of the discount may not align with the needs or expectations of other client tiers, potentially limiting the broader applicability of this model. As a result, tailoring the incentive structure to various client segments is essential for maximising the model's effectiveness.

A notable challenge is the significant financial burden placed on HK. Committing to the buyback of EoL vessels entails potential costs that could impact the company's financial standing. Striking a balance between creating a robust incentive structure and managing the associated

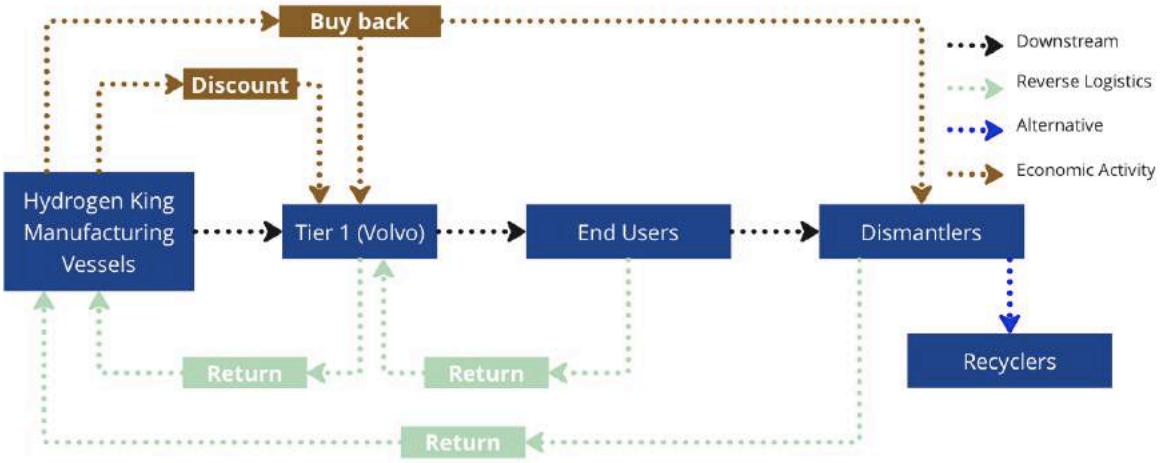

Figure 6 Suggested collection model, discount, and buy-back.

financial implications become a critical consideration in the implementation of this model.

Buyback

The buy-back model involves HK guaranteeing the repurchase of EoL vessels from any actor in the value chain who returns the vessel. The primary advantage of this model is the creation of a compelling and direct incentive and it's easy to implement for all actors involved in the value chain. This incentivizes the responsible disposal and return of EoL vessels, aligning with HK circularity goals.

A notable challenge is the significant financial burden placed on HK. Committing to the buy-back of EoL vessels entails potential costs that could impact the company's financial standing. Striking a balance between creating a robust incentive structure and managing the associated financial implications becomes a critical consideration in the implementation of this model.

Deposit-Refund

HK had previously explored the possibility of implementing a deposit-refund scheme for the collection of vessels, with one of the initial objectives being to assess the feasibility of this incentive system.

Initially, a deposit-refund system presents several compelling advantages from a sustainability standpoint. By associating a deposit with the vessel's purchase, it creates an incentive for the buyer to ensure the return of the vessel to reclaim the deposit. In theory, this mechanism exerts significant pressure on vessel owners to facilitate their return [3]. For HK, the deposit-refund system holds considerable financial advantages, as they would have the opportunity to retain the interest accrued on the deposit. This interest could be substantial, given the 10–15-year lifespan of the vessel.

As previously mentioned, the deposit-refund system initially appeared to be a viable option. However, during interviews with key stakeholders in the value chain, it became apparent that the scheme encountered various feasibility challenges. Several significant stakeholders within the value chain raised concerns related to accounting issues associated with the deposit-refund system.

In the deposit-refund system, companies would be required to retain the deposit on their balance sheets for an extended period, spanning 10-15 years. Several stakeholders highlighted that this extended duration could limit the acceptance of downstream stakeholders. Additionally, given the substantial residual value of the vessels, the deposit would need to compete with the potential income that these stakeholders could otherwise earn by recycling the vessels. Tier 1 clients, such as Volvo, who place substantial orders, might face a considerable financial burden due to the size of the required deposit.

Implementing a deposit-refund system alongside a buy-back option poses significant challenges, as it will result in HK potentially reclaiming the deposit from Volvo if they agree to repurchase vessels from dismantlers originally linked to Volvo's vehicles. This scenario would also shift the responsibility for the entire collection system onto Volvo, potentially leading to reduced acceptance by Volvo. Taking

these factors into account, it is not advisable to adopt a deposit-refund system for the collection of vessels.

Product-as-a-service

An alternative financial incentive scheme was grounded in the product-as-a-service model, where HK would maintain ownership of vessels to ensure a high return rate. Within this framework, leasing or rental arrangements could play a pivotal role, either between HK and manufacturers like Volvo or between Volvo and their clientele.

The product-as-a-service model holds a notable advantage in terms of retaining vessel ownership for HK or Tier 1 customers such as Volvo, consequently enhancing vessel traceability. However, research and interviews led to the conclusion that this scheme was not feasible in the mobility sector.

Insights garnered from industry experts and sector-specific interviews revealed that the mobility industry predominantly adheres to a "buy-and-own" approach. This is largely influenced by the preference of Small and Medium-sized Enterprises (SMEs) to own the hardware they operate and maintain a clear financial overview of their expenses. While Volvo Trucks has explored leasing-based business models, finding a viable approach has proven to be a challenge.

Consequently, it can be inferred that the product-as-a-service model is not feasible within the mobility industry due to the strong preference for ownership. It's worth noting that in other contexts, such as the industrial or construction equipment sectors, leasing or renting models may enjoy greater acceptance. Paradoxically, a product-as-a-service model could offer more flexibility to end users, such as small transportation companies, by alleviating the high capital expenditure associated with products like hydrogen trucks and avoiding technological lock-in effects that restrict them to a specific solution.

Suggested Collection Model

Based on the research findings, a hybrid model that combines a buyback option with a discount incentive, tailored to suit various potential vessel returners, is proposed, and illustrated in Figure 6. This model includes a buyback incentive for both Volvo and dismantlers, with an additional discount offered exclusively to Volvo.

The EoL stage for the vessel can be initiated by various actors within the value chain. If Volvo's end users opt to return their EoL vehicles to certified Volvo service shops, Volvo becomes the incentivized entity responsible for the vessel's return. Conversely, end-users may choose to sell their vehicles to independent dismantlers, in which case these dismantlers become the incentivized actors.

The proposed approach advocates utilising the buyback scheme as the primary financial incentive for all potential direct returners, including Volvo and local dismantlers. In addition to the buyback, a discount incentive is recommended, especially for Volvo, to enhance their motivation and cultivate stronger, loyal relationships with the company. However, no direct incentive from HK to the end user is contemplated, as they are not the direct returners of the vessel. The details and rationale for this model will be discussed further below.

HK and Volvo

Between HK and Volvo, the buyback approach is implemented, with HK offering a financial incentive to Volvo when they return the vessels. This financial incentive can vary depending on the volume of vessels returned, with higher returns resulting in more significant rewards for Volvo. Notably, Volvo has already established its own recollection logistics channels through the Reman project, allowing customers to exchange broken vehicle core parts for refurbished ones. This pre-existing relationship with end-user's positions Volvo as a key contributor to the collection and return of vessels. Given Volvo's significant role in returning vessels, they will receive a discount on new procurement as a gesture to foster greater trust and loyalty. This discount serves as a token of appreciation for their active participation in the process.

HK and Dismantlers

For smaller, independent third-party dismantlers, the proposed incentive is only a buyback scheme. Since these dismantlers are not engaged in purchasing vessels, the discount approach is not applicable to them. Instead, a straightforward financial incentive in the form

of a buyback scheme is more appropriate to motivate them to return the vessels.

Conversations with car dismantlers have shed light on the fact that hydrogen vessels pose inherent safety risks due to their combustible nature. It became evident that the disposal of hazardous materials like hydrogen vessels and batteries is intricate and can impose a burden on dismantlers, especially since the storage process necessitates specific permits and licences. Given the safety risks and storage challenges, the financial incentive offered to dismantlers need not be overly generous. The primary objective is to strike a balance between providing a compelling incentive for responsible disposal and acknowledging the practical obstacles and safety concerns associated with handling potentially explosive materials.

HK and recyclers

Another significant stakeholder in this model is third-party recyclers, who can assume roles as either competitors or allies to HK. Given the substantial residual value of vessels, recyclers may emerge as competitors aiming to acquire vessels from dismantlers and subsequently handle the recycling process independently.

Conversely, HK could position recyclers as allies by providing them with substantial economic incentives. In this collaborative scenario, recyclers could play a vital role in the collection, storage, and logistics aspects, while HK retains responsibility for the ultimate recycling process. During interviews with recyclers, it was discerned that they are inclined to invest in the necessary infrastructure for recycling hydrogen vessels.

Key considerations

The hybrid model offers various advantages. Firstly, it introduces incentives for both Volvo and dismantlers to return the vessels. Additionally, Volvo's added discount serves as an extra motivator, potentially encouraging Volvo to further develop their take-back schemes or agreements with customers and facilities, while also increasing the likelihood of Volvo purchasing new vessels. This aligns well with Volvo's strong commitment to integrating circular practices into their overall sustainability strategy.

Hybrid model is widely acknowledged in the industry for its minimal administrative costs and its straightforward and efficient implementation process.

Nonetheless, HK should consider the uncertainties regarding the future of the hydrogen vessel and carbon fibre markets. Given that the collection system optimally activates 10-15 years after the vessels are sold, predicting price developments in a rapidly changing and volatile environment can be challenging. Nevertheless, the high residual value of the vessels should offer flexibility to counteract price fluctuations. Additionally, the buy-back option has emerged as the most preferred and feasible model, aligning with the preferences of stakeholders.

Result 2: Collection Costs

Concerning the adopted collection model, the vessels necessitate a sophisticated logistics system for their return to Sweden, where HK can recycle and repurpose the vessels that have reached their EoL. The collection cost model encompasses expenses incurred from the moment the vessels are removed from their place of use to when the recycled vessels become operational again at the facility in Sweden. These costs are delineated across two dimensions. The first pertains to financial aspects, encapsulating the tangible expenditures involved in maintaining the logistical network. The second dimension encompasses costs associated with the environmental impact emitted by the reverse logistics network, quantified in $kgCO_2$ equivalents.

Grasping the dimensions of the reverse logistic network entails initially identifying the quantity of vessels reaching their EoL each year. This occurrence can stem from factors like damage due to accidents, disintegration of components, or regulatory reasons.
The following table illustrates vessels reaching the end of their life, premised on the assumption that production commences with 10,000 vessels annually, escalating by 10,000 vessels each year until reaching a production capacity of 50,000 vessels per year.

The average lifetime of a vessel spans approximately 10 - 15 years. Operating under the assumption that vessels exhibit durability within the first 10 years, the following approximate estimates have been selected. During the initial 5

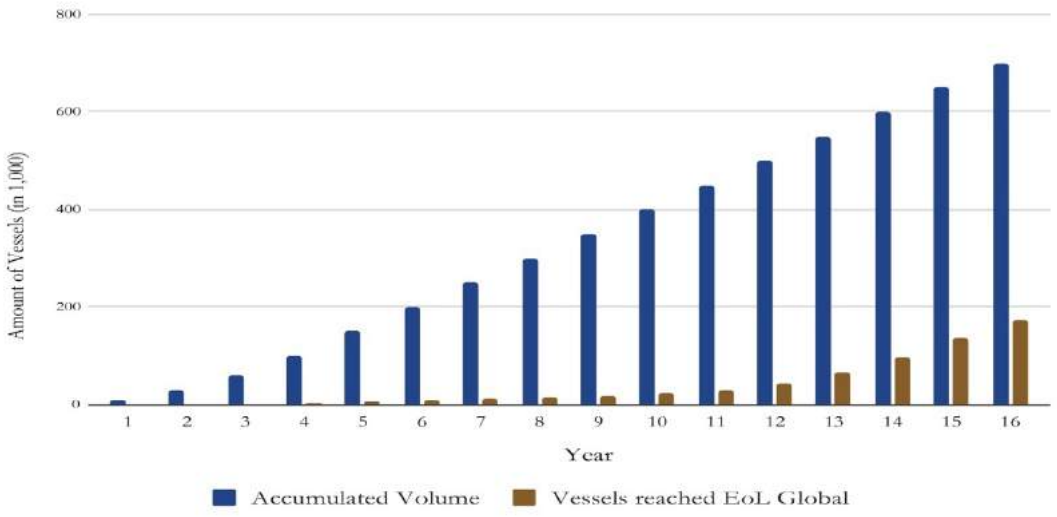

Figure 7: Vessel projections, volumes over time

years, only 5% of all vessels reach their EoL. Between years 5-10, approximately 10% reach their EoL. From years 10-14, 80% of the vessels approach their EoL, and by year 15, all remaining vessels reach their EoL.

Given that the vessels are distributed to various customers, and these customers, in turn, may sell them to others globally, the termination point of the value chain becomes geographically diverse. Accordingly, the regional context assumes significance, with an estimated distribution of approximately 35% in the Nordics, 30% in the EU, 15% in Asia, 15% in North America, and 5% in the rest of the world.

Given the uncertainty regarding the termination point, each region encompasses three randomly selected countries. In these selections, the largest harbour within each country is utilised as a reference point. To simulate a plausible road route, a connection is established from one of the major cities within the region to the chosen port. Subsequently, the average road and sea transportation costs for these three countries are calculated, thereby yielding a regional average.

Logistics Costs

In calculating logistic costs, numerous variables come into play, necessitating a comprehensive consideration. Given the project's scope, a simplified model has been employed to gain a fundamental grasp of the logistics costs implicated. The variables included incentives for the scrapper to facilitate the vessel's return, recycling costs associated with reusing the vessels, storage expenses for the vessels, and transportation costs via either ship or truck. It's crucial to acknowledge that certain variables, such as administrative costs for maintaining the logistics network, have not been factored in. The assumption underlying the financing of the logistics system is the high residual value can sufficiently offset these expenses.

Even when modelling a highly conservative scenario, the presence of a substantial overhead due to the residual value remains evident. This means that even when transporting a relatively low number of pressure vessels, the logistics process remains economically viable and should be taken into consideration. It can be concluded that if the expected figures are reasonably accurate, the logistics process is feasible.

Environmental Costs

Circularity enables recycling and significantly reduces emissions. However, to reallocate the vessels back to Sweden, emissions are generated as a result of logistics and transport.

To quantify these environmental costs, a comprehensive estimation of emissions resulting from both road transport and shipping transport has been conducted. Notably, emissions generated during the scrapping and recycling phases have been excluded from the calculations due to data limitations.

	Opportunities	Risks
Sourcing	Green carbon fiber Supply chain transparency	Fossil based carbon fiber Social sustainability risks
Manufacture & Design	Energy input HK plants Design for recyclability	Production waste GHG emission
Usage	Prolonging vessel lifetime HK as service provider	Healthy & safety risks Theft and fraud
End of Life	Recollection system Refurbishment & recycle	Landfill Greenwashing

Figure 8: Sustainable opportunities and risks in every life cycle stages.

For calculating the shipping and road transportation GHG intensities the CSN EN 16258 Methodology for calculation and declaration of energy consumption and GHG emissions of transport services (freight and passengers) has been applied.

Figure 8 offers an overview of the GHG emissions linked to the reverse logistics process, contingent on the region of origin from which the vessels must be collected and transported back to Sweden. The pie chart illustrates the emissions for the production year 15, involving the return of all 1,585 containers (equating to 700,000 vessels) to Sweden. The findings indicate that when considering all regions collectively, the total emissions amount to approximately 2 million kilograms of CO_2 equivalent. When breaking this down to emissions per vessel, it averages out to 10.85 kilograms of CO_2 equivalent per vessel. The emissions are notably low, especially when considering that each vessel contains approximately 30-50 kilograms of carbon fibre. In contrast this with the production of 1 kilogram of new carbon fibre, which emits around 24.83 kg-CO_2eq/kg [4], it becomes evident how practical the collection approach is from an environmental perspective.

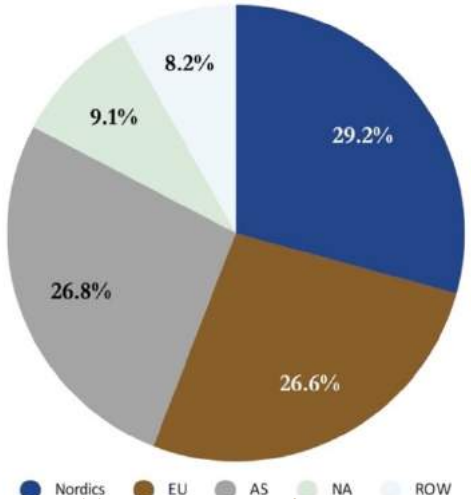

Figure 9: Transport emissions for 1585 containers divided by regions (kg CO_2 eq)

Result 3: Sustainability risks and opportunities for HK

In addition to devising a recollection model for EoL management, the client's mission is closely linked with crafting an "optimal" sustainability framework for HK's model. This endeavour primarily entails identifying key areas where HK can bolster its sustainability proposition while also pinpointing potential sustainability-related risks. The outcomes of this endeavour are summarised in the figure 9, which is subsequently followed by a more comprehensive discussion.

Sourcing phase

In the sourcing phase, HK has the opportunity to transition towards utilising green carbon fibres. This type of fibre is sourced from lignin obtained from trees, with a primary focus on production using renewable energy sources. Additionally, due to the simplicity of their raw materials, HK can ensure transparency,

traceability, and social sustainability throughout their supply chain.

Conversely, carbon fibres are predominantly derived from fossil-based sources and entail a highly energy-intensive production process, posing substantial sustainability risks. Presently, the bulk of carbon fibre
production is concentrated in China and Japan, which carries inherent risks related to social sustainability.

Manufacturing and Design

HK can adopt a design-for-recycling approach by using materials that can be readily separated at the EoL stage. Furthermore, transitioning towards renewable energy sources in HK's production and incorporating lower energy consumption compared to other vessel production methods, such as the dry-winding technique, can enhance their sustainability efforts.

A potential risk during HK's production phase relates to the generation of production waste, which may arise from production errors or quality issues. Additionally, even though the production process may not be as emission intensive as carbon fibre production, it necessitates the use of green energy to achieve as close to emission neutrality as possible.

Use phase

HK aims to provide continuous inspection, maintenance, repairs, and refurbishment services with the goal of prolonging the vessels' operational lifespan. Original equipment manufacturers (OEMs) like Volvo are increasingly emphasising robust service-based customer relationships, which creates opportunities for suppliers to vehicle manufacturers to assume a more significant role in this context.

During the use phase, the primary risk is the substantial flammable and explosive hazard associated with hydrogen vessels, which can lead to significant health and safety concerns if mishandled. Another risk pertains to potential fraud and theft involving the vessels. While HK can address this risk to some extent, it remains primarily the responsibility of the manufacturer to secure the vessel in a safe location.

End of Life

The most significant opportunity for HK lies in the success of its collection model. This success not only carries a financial residual value but also ensures that old vessels do not end up in landfills. Furthermore, HK has the potential to explore other forms of worn-out carbon fibres for repurposing and recycling in various products, enhancing circularity beyond their own product line.

Conversely, a substantial risk is associated with the failure of the collection model. If the incentives provided are insufficient to encourage end-users to return the vessels, there is a high likelihood that these vessels will ultimately find their way into landfills, posing environmental hazards.

As sustainability and circularity represent a critical marketing advantage that HK aims to underscore, it is imperative for them to avoid engaging in "greenwashing" in their communication efforts. The forthcoming "Green Claim Directives" [5] will dictate how corporations communicate their sustainability actions. HK must be diligent in adhering to these regulations to mitigate the associated risks of non-compliance.

Conclusion

The establishment of recollection systems through reverse logistics is grounded in a straightforward concept, yet it proves to be a complex and costly endeavour when put into practice. In a broader sense, recollection systems grapple with challenges like expenses and traceability.

Within the scope of this project, the objective was to devise a recollection model for hydrogen vessels within the mobility sector. The proposed model is a hybrid one, incorporating a buy-back incentive scheme alongside a discount model. This choice stems from its simplicity and its capacity to address key challenges that might arise with alternative incentive schemes, such as deposit-refund systems.

The report also delves into the costs linked to setting up a reverse logistics system for HK, and it confirms the financial and environmental viability under the evaluated assumptions.

Key potentials for HK to enhance the sustainability aspects of their business model include

Figure 10: Hydrogen King J.r Consultants Team, from left to right: Sascha, Daniel, Liu, and Jacob.

transitioning towards green carbon fibre production and extending the lifespan of vessels by offering inspection and repair services. Potential risks are also acknowledged, encompassing communication pitfalls like greenwashing and safety concerns associated with hydrogen.

A key takeaway from this project has been that when designing recollection systems, it's important to make careful assessments of the given industry the product operates in. In this case, specific considerations regarding the structure of the mobility industry greatly influenced the design of the recollection model.

As junior consultants for Hydrogen King, the team of four students embarked on a mission to define a visionary circularity approach for the company's sustainable future. Through meticulous research, innovative thinking, and collaborative spirit, we have crafted a strategic roadmap that not only aligns with Hydrogen King's values but also propels it into a greener, more sustainable tomorrow. The collective dedication, passion, and teamwork have been the driving force behind this endeavour. Figure 10 encapsulates not just the team's roles as consultants but also the shared commitment to shaping a more circular and environmentally responsible HK.

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Wines of Alentejo Sustainability Programme & the Green Claims Directive

Project Brief

The project team helped **Vinhos do Alentejo** gain a practical understanding of how the upcoming EU Green Claims Directive will impact their operations. The team investigated the intentions, guidelines, and requirements of the Directive and identified the additional actions, communications, and materials necessary to ensure that client's third-party certified sustainability label, **Wines of Alentejo Sustainability Programme (WASP)**, aligns with the criteria set in the Directive.

During the research, the team interviewed various stakeholders and conducted site-visits to investigate how WASP certified producers use the certification and green claims in their marketing, information material, to **identify potential risks** and **unexplored opportunities**.

Project Team

Lukrecija Vaišytė
Lukrecija is from Lithuania, with prior experience in PR and communications.

Justine Auvrignon
Justine is from France, with a background in Business Administration.

Jonelle St. Lewis
Jonelle is from the US, with prior experience in education and stakeholder management.

J.S
J.S is from Saudi Arabia, with prior roles at UNDP, Saudi Government.

Background

In 2020, the EU Commission conducted a study among more than 200 environmental claims (labels, communication) and concluded that **53%** of the **environmental claims** provided **vague**, **misleading**, or unfounded information and that **40%** of the claims were **not substantiated**. This means that as a consumer, it becomes increasingly **difficult to make informed decision**s on which products are the most sustainable and actually have a lower impact on the environment compared to others.

To address this issue, in March 2023, the EU Commission approved the Proposal for a Directive of the European Parliament and the Council concerning the substantiation and communication of specific environmental claims (**Green Claims Directive**). This Directive Proposal is part of a wider project at a European level to tackle greenhouse gas emissions: the **EU Green Deal**. Therefore, the Alentejo Regional Winegrowing Commission or Comissão Vitivinícola Regional Alentejana (CVRA) approached the International Institute for Industrial Environmental Economics (IIIEE) with the aim of understanding how this Directive might impact their sustainability label.

Aim of the project

The goal of the project is to understand how the EU Green Claims Directive will impact the sustainability label of the CVRA. To achieve this, the team had three main objectives:

- **Investigate and analyse** the intentions, guidelines, and requirements of the Directive.
- Investigate how certified producers use the certification in their marketing, supporting information material, etc., to **evaluate fair** and **just statements** and **potential risks**.
- To look for potential **unexplored opportunities** to inform market actors about the sustainability aspects of certified products.

What is CVRA and WASP

The CVRA is a commission that was founded in 1989. It functions as a private institution with a dedicated mission of certifying, controlling, and safeguarding the various protected designations that the CVRA can award to wines. It also oversees **promoting the regional wines** both domestically and internationally.

In 2015, the CVRA introduced its own sustainability label known as WASP or Wine of Alentejo Sustainability Programme. This initiative is aimed at promoting more sustainable winemaking practices. As illustrated in Figure 1, WASP consists of comprehensive guidelines presented across 18 chapters and includes 171 criteria that wine producers must adhere to in order to display this label on their bottles and in their communications. The criteria cover various aspects, including water consumption, energy management, soil management, and pest management. To obtain this label, producers are required to complete a self-evaluation, which is subsequently reviewed by the CVRA before being audited by a third-party verifying body.

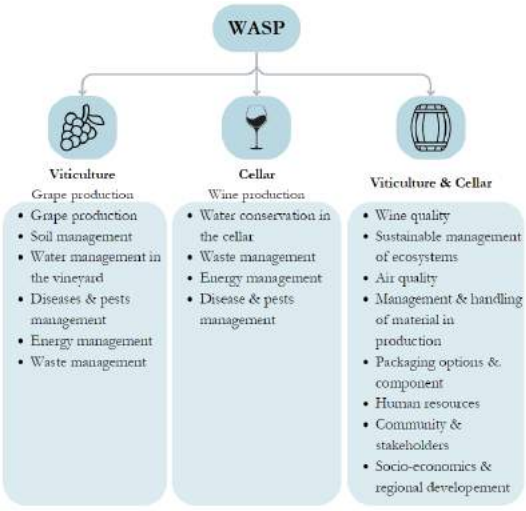

Figure 1: WASP label scope including 18 chapters

Green Claims Directive

To gain a deeper comprehension of the Directive's focus, it is crucial to define what a green claim is. Within the Directive, green claims are characterised as: "any message, representation, that is not mandatory under Union or national law (...) which states or implies that a product or trader has a positive or no impact on the environment."

The Directive has two objectives: firstly, to **tackle greenwashing** and potentially misleading information for consumers, and secondly, to ensure that **green claims are reliable,**

comparable, and verifiable throughout the EU. Its overarching aim is to contribute to the establishment of a circular and green EU economy by protecting consumers from deceptive practices and enabling them to make informed purchasing decisions. Ultimately, it will help foster a level playing field regarding the environmental performance of products.

The Directive targets companies that have **more than ten employees** and **a yearly turnover exceeding 2 million euros**. The implication of this Directive is that it obligates companies to prove and substantiate their environmental claims. In the case of non-compliance with this Directive, the traders can be issued **fines** (up to **4% of annual turnover**) or can face lawsuits initiated by any actor.

Examining the Directive's timeline, it currently remains in the **proposal stage**, which was validated by the EU Commission in March 2023. Before it can be formally adopted, it must progress through several stages. This includes the preparation of a draft report, followed by a committee vote, trilogue negotiations, submission, and a plenary vote. The **anticipated adoption** date is set for **2024**. After adoption, Member States will have an 18-month window to align their legislation with the Directive before its full implementation can commence.

Research design

This section outlines the project methodology and research design. The research focuses on understanding the implications of the Green Claims Directive on Vinhos do Alentejo vineyards and wineries, particularly in the context of marketing and its influence on the chosen sustainability criteria and data collected within the production phase of the lifecycle process. The research design includes literature reviews, interviews, and data analyses.

Method for data collection

The research employs a multifaceted approach to data collection, encompassing various sources and methods. The methods included both primary and secondary data. Initially, secondary data was gathered through an extensive literature review, which enabled the documentation of Directive articles and stipulations that are most relevant to sustainability label criteria, verification, and vineyards' marketing efforts. This information was used to identify relevant stakeholders and build interview guides.

The second and most crucial method for data collection was interviewing producers and other stakeholders. The responses from the interviews collected were transcribed according to the chosen focus areas within green claims. Following the compilation of qualitative data from the Directive and initial interviews, eight codes were developed to break down the literature and interview findings into themes, facilitating the identification of similarities and patterns. These codes allowed for the provision of relevant information on how WASP aligns with the Directive and what changes may be necessary. The data analysis section will provide further details on the research design and the codes used.

Grey literature review

An extensive literature review was conducted, encompassing various sources, including:

- The EU Green Claims Directive: A review of the Directive and its provisions.
- WASP Reports: An analysis of reports related to the WASP labelling scheme.
- Directive Briefs from the EU Commission: An exploration of briefs and documents issued by the Commission detailing the timeline and Member State positions.
- Consultancy Briefs: Examination of consultancy briefings relevant to the best practices, trends, patterns, gaps, and implications of the Directive.
- The UK's Competition and Markets Authority's Greenwashing Review: A comprehensive look at the UK's greenwashing review, which requires companies to substantiate the voluntary green claims using a life cycle perspective.

Image 1: IIIEE team at the CVRA HQ, Évora

Implication for Marketing	Understand how the Green Claims Directive impacts marketing strategies in the wine industry, with a specific focus on WASP.
Implication for Retailers	Investigate the implication of the Directive on what retailers prioritise when selecting and promoting sustainable wine products.
Data Collection, Aggregation & Access	Assess how vineyards, wineries, third-party certifiers and WASP collect, aggregate, and present data related to sustainability claims and examine its accessibility to consumers.
Transposition & Compliance	Explore how the Directive is transposed into National law in most relevant Member States and the mechanism in place to ensure compliance.

Figure 2: Research scope and key areas

These secondary sources provided valuable insights into the legal and regulatory landscape across different European countries. Identifying the responsible bodies in countries such as Portugal, the UK, Poland, Germany, Scandinavia, Switzerland, the Netherlands, and other pertinent markets was critical for this project.

The decision to include the UK within the scope of this consultancy, despite its status as a non-EU member state, was informed by several factors. This choice was influenced by feedback from the client, insights from interviewees, and findings from the previous WASP report, which indicated an increased willingness among UK customers to purchase WASP certified wines. Furthermore, the UK has already implemented a similar regulation to combat greenwashing, making it a relevant case for understanding how the EU Green Claims Directive may impact WASP marketing strategies in other markets.

Focus area & questionnaire

Figure 2 illustrates the research scope on key areas, including implications for marketing, retailers, data collection and access, transposition, and compliance.

Interviews

The process of stakeholder identification commenced with the compilation of a key stakeholder list, considering their roles and potential influence concerning the WASP label in the realms of greenwashing prevention, data substantiation, and consumer protection. This compilation was achieved through collaborative efforts with the client, independent research, and leveraging the IIIEE alumni network. Subsequently, structured questionnaires were tailored to address the scope of auditors, producers, marketers, government officials, non-profit organisations and wine sellers.

Interviews * Denotes on-site interview conducted		
Retailers and Distributors: Marcus Ihre (Systembolaget) Rolf Eriksen (Vinmonopolet) Dom de Ville (The Wine Society)	**Marketing and Communication:** Rowan Drury (Purple Ivy) Thiago Caravana (CVRA) Carmen Huidobro (GSCC) Catarina Santos (Treebud)	**Wine producers and Wineries:** Antonio Graça (SoGrape) Helena Manuel (Herdade dos Lagos)* Helena Ferreira (Adega de Borba)* Ricardo Silva (Herdade da Lisboa)* Carina Neto (Esporão)* José Luis (Esporão)
Government and Regulatory Amanda Arleko (EU Green Party) Sanna Due (European Environmental Agency)	**Association and Organisation:** Ignacio Sanchez Recarte (FIVS/CEEV) Catarina Grillo (WWF) Elsa Agante (DECO) Inês Costa (Deloitte)	**Auditors and Certification Bodies:** Sofia Rodrigues (KIWA) Luis Vaz-Freire (CERTIS) César David Lopes de Oliveira (ASAE)

Figure 3: List of stakeholders interviewed

The wine seller questionnaires placed particular emphasis on the Nordic regions as they have more stringent certification label guidelines and are large-scale buyers. To ensure sufficient data collection, a combination of 23 on-site and online interviews were conducted.

On-site interviews were conducted with vineyards and wineries in the Alentejo region to gain insights into their processes, marketing strategies, and compliance with the EU Directive.

Data analysis

The research culminates in a thorough analysis of the collected data, leading to the development of a comprehensive set of recommendations for the CVRA and the vineyards and wineries under their WASP label in the form of a roadmap, a list of best practices, and an implementation guide. To analyse the interviews and literature, both a thematic analysis (a method for identifying, analysing, and reporting patterns or themes within data) and a SWOT analysis (an evaluation of the internal strengths and weaknesses and external opportunities and threats) were undertaken.

For the thematic analysis, eight codes were developed to organise info into themes. Some codes were structured from the beginning, and others emerged as more research was conducted. A matrix was created to systematically categorise pertinent information concerning the Directive and its potential effects on the WASP label and associated producers, aligned with the eight specified codes below. These interviews and reference materials guided the development of two distinct sets of recommendations: one aimed at the CVRA and the other tailored to wineries and vineyards operating under the WASP label. These are the codes used for the analysis of the interviews:

1. **Substantiation requirements:** Information about the rules and regulations related to the substantiation of environmental claims made.
2. **Verification requirements:** Information about the rules and regulations related to the verification of environmental claims made.
3. **Environmental claims:** Information about the types of environmental claims that are within the scope of the Directive.
4. **Advertising and marketing:** Information about the requirements for advertisements and marketing materials that make specific environmental claims.
5. **Environmental labels:** Information about the rules and regulations related to environmental labels and how they can be used to convey information about a product's environmental impact.
6. **Consumer information:** Information about the requirements for providing accurate and useful information to consumers about a product's environmental impact.
7. **Standardised methodologies:** Information about standardised methodologies for calculating environmental impact that are recognised and approved by the EU.
8. **Compliance and enforcement:** Information about the enforcement mechanisms and penalties for non-compliance with the Directive.

SWOT analysis

Using the knowledge gained, the project team conducted a SWOT analysis, illustrated in Figure 4, to assess the WASP label's internal strengths and weaknesses alongside the

Figure 4: SWOT analysis of WASP

opportunities and threats it might face concerning the Directive. The SWOT analysis aids in understanding how the CVRA can leverage its label's strengths and address its weaknesses to enhance credibility with stakeholders and compliance with the Directive.

Findings

According to the team's findings, the Wines of Alentejo Sustainability Programme **seems well prepared** for the upcoming Directive on Green Claims and is taking a proactive approach. By default, WASP-labelled producers must collect and monitor various data. This will serve as a good base for the upcoming need for substantiation of any green claims made since data is a core part of the Directive - **"no data, no claim."** Moreover, WASP-certified producers do more than just talk when it comes to sustainability; thus, the **threat of greenwashing is rather low**. The following section will explain the research findings.

Directive proposal

One of the most evident findings is that currently, in October 2023, the knowledge about how the Directive will affect the wine industry and, more particularly, third-party sustainability labelling schemes is rather limited. Since the Directive text is still in the proposal stage and can be changed, there are **many grey areas**.

For instance, currently, there is no concrete methodology for verifying green claims and no responsible designated verification bodies. There are also uncertainties when it comes to sector-specific rules, as the Directive will cover a variety of sectors. Additionally, there are some grey areas regarding the stakeholders that are implementing the Directive at the National level. In Portugal, the National Parliament is responsible for transposing this Directive, and historically they do not make many changes when transposing; therefore, the national legislation is not expected to differ from the final Directive text. To stay up to date with the development of the Directive, it is important to follow up on the changes; thus, designating such responsibility to a person or a team is recommended.

Marketing

One of the findings gathered from the interviews conducted is that it will no longer be possible for companies to use green claims as a marketing strategy since anything that is said will have to be **justified** and **substantiated**. This means that at a marketing level, the job will become more challenging. There are also fears among some stakeholders that marketing will not become as creative as before and that all companies will have very similar ways of differentiating themselves.

An important aspect of aligning with the Directive is that everyone in an organisation must be **on the same page** and stay informed. Within the organisations, there should be **ongoing communication** amongst the employees who may have different tasks but ultimately are a part of the process that green claims or labels might communicate about. Thus, marketing or communications managers must be **adequately informed** of what the staff on the vineyards are doing and how, understand the practices and see the monitored evidence of those. This would ensure the ability to determine what green claims can be made safely without the risk of misleading consumers. Generally, CVRA should take a more active role in marketing the WASP label since they represent the entire region and can significantly influence the label's narrative and recognition. This influence can guide small vineyards in making appropriate claims.

Wine industry & retailers

The wine industry is a small sector in comparison to other industries, and it is not expected to be affected as much as bigger industries. The vineyards under the WASP label are generally smaller companies (SMEs) that do not make many explicit green claims. SMEs with limited marketing budgets may face greater challenges with the costs of verifying claims. In contrast, larger companies with greater financial resources may be most affected by the Directive, as they are making most of the green claims. However, they also have the means to cover the fees for verification.

From the interviews with alcohol retailers, more specifically Systembolaget in Sweden and Vinmonopolet in Norway, the project team has found that they are looking forward to this Directive entering into force. Retailers view the

Directive as a tool to **reduce the overwhelming number of sustainability labels** present that are not all stringent when it comes to certification criteria. Currently, retailers are spending money and time resources to develop benchmarks that help them compare labels. This benchmarking of labels is expected to become easier since only trustworthy evidence-based labels will prevail. Since the WASP certification scheme is based on 171 criteria and is third-party certified, there is a strong reason to believe that WASP will be one of the sustainability labels that will triumph. As shown in the SWOT analysis, once the Directive is implemented, it will **reduce the competition** in the market.

In addition, because major Scandinavian retailers like Systembolaget are establishing benchmarks to promote sustainability labels with a strong emphasis on social and governance aspects (including labour practices), WASP needs to enhance their label criteria by **adding biodiversity and labour-related standards**. Labour is a significant aspect of social sustainability, and the Alentejo region faces labour challenges. Tracking labour practices not only ensures compliance with labour laws but also enhances credibility and safeguards against greenwashing accusations. Biodiversity is crucial for agriculture, especially given the development of WASP 2.0 in collaboration with the World Wide Fund for Nature (WWF).

Wine producers

By participating in sustainable practices and achieving certifications, like WASP, wine producers **gain access to bigger markets**, such as the Scandinavian market, which eventually leads to business growth. Sustainable practices grant market access rather than higher product value when sold. Some markets will only let a product enter if they have a certain certification, like Scandinavia. A trend found in the consultants' thematic analysis is that consumers tend to prioritise price over sustainability when it comes to their purchasing decisions. Consequently, there is a reduced willingness to pay extra for certified wines. This can be attributed to two main reasons: firstly, wine is not a necessary good, and secondly, consumers think the responsibility for sustainability lies on the producer.

The main findings from the interviews with WASP-certified wine producers are that they generally do not feel threatened by the upcoming Green Claims Directive since they believe they have enough data to support any claims made. From the project team's observations, the producers are doing much more in the field than they market, and they consistently aim for improvements. However, they would like to market their sustainability efforts more.
Thus, a good starting point for wine producers to get familiar with the Green Claim Directive is to look at the Environmental Product Declarations (**EPD**), as they have been established for years. EPD looks at the product's environmental performance from a life cycle perspective and demonstrates the trade-offs of the product. Two out of the nine criteria on how to substantiate a claim according to the Green Claims Directive are already covered under the EPD; these criteria will be listed in a following section.

One of the requirements of the Directive is to be transparent and make information behind any green claims available to the consumers. For producers, the **QR code** mandated by Regulation 2021/2117 for the wine industry (in effect from December 8, 2023) presents a valuable opportunity to ensure the availability of substantiation data to consumers. Embedding substantiation information within the QR code can enable consumers to easily access the details behind explicit environmental claims. It is also important for this information to be accessible in terms of language; thus, English is internationally preferred.

Some producers believe that it is important to educate consumers about the different sustainability labels so their purchasing can be based on informed choices. It would also empower and build consumers' trust. To this end, WASP should invite Associação Portuguesa para a Defesa do Consumidor (**DECO**), a consumer organisation that provides purchasing recommendations to 300,000 subscribers in Portugal, to audit and conduct site visits at WASP vineyards in order for their certified wines to be included in DECO newsletters and marketing communications. If DECO approves WASP, it can lead to increased consumer exposure, enhancing the label's credibility and recognition.

Political uncertainties

A number of interviewees were not confident if the Green Claims Directive proposal would follow the intended timeline. They believe **it will pass later** than the expected date due to the strong lobbying against it from businesses. Moreover, after the **European elections** of June 2024, the political leadership in the EU will change. The EU Green Claims is perceived as **too ambitious** since the aspirations of the EU Parliament can diverge from the more conservative objectives of the EU Council.

Enhancing WASP compliance

The project team identified some aspects that the WASP label needs to address in order to ensure its compliance with the Directive so far:

- WASP must develop a complaint and resolution mechanism that is required by Article 8 of the Directive.
- Procedures for dealing with non-compliance and the possibility of withdrawal or suspension must be in place.
- To ensure consumers' access to information, WASP criteria should be translated into English and displayed on the website.

Environmental claims framework

In Figure 5, the potential Environmental Claims Framework for wine producers aims to ensure that there is a structure in place for the substantiation of green claims. The crucial is that all green claims must start as a recognition of what data is available within the organisation and what practices are followed, and only then can a green claim be created. This step is emphasised because, within business, it is common to first think of what you want consumers to think about the company and only then "dig" for evidence of it. This infographic displays six important steps that have to be followed by the CVRA and producers for any green claims that are being made:

1. Producers should provide existing data that has been monitored and recorded to marketers in a clear and digestible form.
2. Marketing teams, whether internal or external, should create a claim based on the data. Marketers should refer back to producers to ensure accuracy. Ensure consumers have access to the data (QR code).
3. The marketing claim should be assessed by **a committee created by the CVRA** consisting of representatives from sustainability, marketing, and legal (internal or external to the committee). This step serves as a support mechanism before the claims reach the official third-party verifying body.
4. To ensure neutrality, a third-party verifier will audit the claim and the data supporting it. Article 11 of the Directive sets out that the 'verifier' must be an officially accredited independent body with no conflicts of interest to ensure independence of judgment and hold the highest degree of professional integrity. Also, they must have the required expertise, equipment, and infrastructure to carry out the verifications.
5. If the verification step is successful, the verifier issues a **certificate of conformity**. This certificate will be recognised across the EU and shared between Member States via the Internal

Figure 5: Environmental claims framework developed by the IIIEE project team

Market Information System. It will allow companies to use the claim in commercial communications to consumers across the EU market.

6. Lastly, review the claims and data behind them at least every five years.

Criteria for substantiating claims

As there is a fine line between credible environmental claims and greenwashing, it is crucial to follow a set of criteria that rigorously assess and validate environmental statements and assertions. On page 18, under section 6.2. in the Green Claims Directive, a set of 9 criteria is provided to guide companies on how to reach the minimum requirement when substantiating environmental claims. The list below presents the nine criteria simplified by the project team:

1. Demonstrate the scientific evidence behind the green claims.
2. Highlight the impacts, aspects, and performance from a holistic life-cycle point of view.
3. Include all aspects and impacts of the performance.
4. Illustrate if the claim is true for the whole life cycle or just certain stages (like the production phase or end-of-life phase) and if the claim is true for the whole product or part of it. In other words, be specific with the claim.
5. Make sure that the claim is not already mandatory by law; the claim should demonstrate that it is beyond compliance.
6. Make a comparison to common practice to show that the product performs environmentally better than other products.
7. Explicitly show trade-offs.
8. Provide a transparent report of the greenhouse gas offsets.
9. Include primary or secondary data.

In essence, these criteria collectively contribute to preventing misleading claims and falling into the trap of greenwashing. The criteria establish a rigorous framework for assessing the validity of claims, ensuring that they are grounded in **sound science**, **transparent reporting**, and a **comprehensive understanding** of a product's impact throughout its **life cycle**. Compliance with these criteria promotes responsible communication and builds trust with consumers, as they can have confidence in the authenticity of the claims made.

Do's and Don'ts when making Green Claims

In an era where environmental consciousness is paramount and consumers are increasingly seeking sustainable products and practices, making green claims has become a common marketing strategy. However, it is crucial to avoid greenwashing. This section presents a list of do's and don'ts that serve as a guide of best practices for businesses before making green claims in marketing messages and ads:

Do

- *Use quantifiable data*
- *Get verified by third-party bodies*
- *Comply with the 9 criteria*

***Don't** use taboo words such as:*

- *"Ecological"*
- *"Climate neutral"*
- *"Net-zero"*
- *"Nature's friend"*
- *"Green"*
- *"100% CO2 compensated"*
- *"Eco"*

Roadmap for CVRA

The project team has developed a roadmap, illustrated in Figure 6, to guide the CVRA and their WASP label towards continuous alignment with the evolving Directive. As steps are taken at the EU level, the national bodies and relevant authorities in each Member State, this roadmap ensures that WASP remains in **strict**

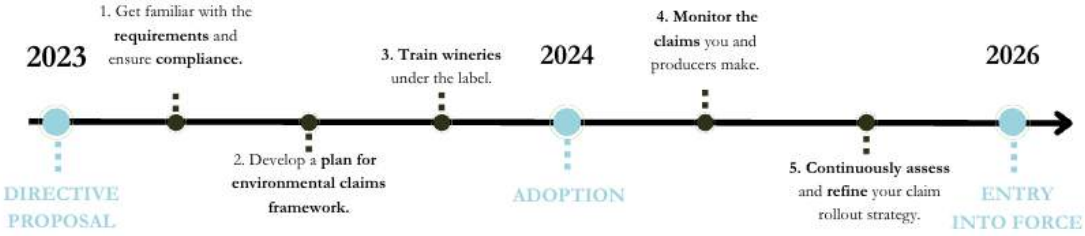

Figure 6: Roadmap for CVRA

compliance and alignment with the Green Claims Directive.

Steps WASP can take before the Directive's expected adoption:

1. **Get familiar with the Directive requirements and ensure WASP compliance:** Stakeholders, including the sustainability director, the marketing team, and legal experts responsible for compliance at the CVRA, should familiarise themselves with the requirements of the Directive. This will ensure adherence to substantiation, communication, and verification standards. Moreover, WASP should establish a dedicated complaint and resolution mechanism on their website, allowing the public to report any perceived non-compliance of producers under the scheme. This step is essential to ensure alignment with private label requirements under Article 8 of the Directive.
2. **Environmental claims framework:** Develop a clear plan for incorporating the Directive's claims into marketing materials, ensuring the accurate communication of the wine's environmental impact. The CVRA should adapt the provided environmental claims framework to ensure there is a process that WASP and its certified producers adhere to before making a claim.
3. **Training:** Provide guidance and training to wineries under the label on how to utilise the Directive's guidelines and codes to guarantee the accuracy and substantiation of claims. Ensure vineyards are knowledgeable about the best practices, environmental claims framework, and compliance.

Steps WASP can take after the Directive's expected adoption in 2024:

4. **Monitoring:** Implement regular monitoring of claims made in advertising, product packaging, and other marketing materials from CVRA and producers to ensure compliance. Monitor the availability and updates of data on producers' websites.
5. **Continuous improvement**: Stakeholders, including the sustainability director and other relevant CVRA members, should continuously assess and refine the claim rollout strategy as needed to ensure ongoing compliance with the Directive. Continue to monitor the respective authorities outlined in the section below for updates.

By following this roadmap, both WASP and certified producers can navigate the complexities of the Green Claims Directive and promote the sustainability of their wine production effectively and transparently.

Bodies to monitor

The proposal is currently **under development** within the European Commission and is **subject to potential changes** through lobbying and trilogues (formal negotiations between the European Commission, European Parliament, and Council of the EU). Due to this, it is imperative for WASP and wineries to remain vigilant regarding shifts in the Directive at both the EU level and the prominent markets where WASP-labelled wines are sold.

Even though the project scope has been expanded to encompass additional EU markets, the Directive, which mandates that claims and labels need approval in **only one Member State** for acceptance throughout the EU, might render it unnecessary for WASP to monitor governing bodies outside of Portugal. However, monitoring relevant bodies in other Member States, especially in areas like Scandinavia, known for rigorous and swift regulatory standards, remains wise.

Bodies to monitor on the EU Level

In the **European Parliament and Commission**, the proposal was allocated jointly to the Committees: Committee on Internal Market and Consumer Protection (IMCO) and the Committee on the Environment, Public Health, and Food Safety (ENVI). The European Environment Agency (EEA) may be responsible for evaluating the Directive's EU-level implementation.

Bodies to monitor on National Levels

For Portugal, after transposition by the National Parliament, the local bodies responsible for implementing the Directive will most likely be the **Directorate-General for Economic Activities** (DGAE) and the **Portuguese Environment Agency** (APA). Monitor these bodies for any updates on verification bodies and assistance for SMEs for policy implementation.

For most EU countries, implementation will fall under the jurisdiction of the national consumer agency. However, information about these agencies is not readily available for all markets within this project's scope. It is advisable to seek updates for the following countries: Poland, Germany, Switzerland, and Norway, as no information has been listed yet.

The following countries have identified responsible bodies:

- **Denmark:** Danish Consumer Ombudsman
- **Sweden:** Konsumentverket (Swedish Consumer Agency)
- **Finland:** The Finnish Competition and Consumer Authority and The Finnish Consumer Ombudsman
- **Netherlands:** The Netherlands Authority for Consumers and Markets
- **The UK:** The Competition and Markets Authority

Conclusion

In conclusion, the Green Claims Directive is currently in the proposal stage, which means that there is still potential for adjustments prior to its final adoption.

The WASP label has proactively taken steps to investigate the Directive Proposal by collaborating with the IIIEE consultancy team, positioning itself ahead of the game. The findings from this project show that the structure and requirements of the WASP certification scheme and their pursuit of a strategy to ensure alignment with the Directive are likely to yield positive outcomes for them and their certified producers. Utilising the Environmental Claims Framework, the roadmap, and other insights from this report will undoubtedly prepare them for the regulations coming ahead.

Furthermore, it is recommended that companies consider a comprehensive strategy to address the spectrum of forthcoming green directives, encompassing initiatives like the Green Claims Directive, the ECO Design Directive, the Corporate Social Responsibility Directive, EU Digital Product Passport, the common agriculture policy, and LCAs among others. An integrated approach to address these Directives collectively can optimise resource allocation, saving both time and money and prevent the duplication of efforts. From that global vision, WASP and its certified producers can visualise and understand how they can efficiently meet all the demands of the upcoming regulations under the Green Deal.

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Image 2: The project team from left to right: J.S, Jonelle, Justine, Lukrecija, Åke (team supervisor), Ricardo Silva (Herdade da Lisboa)

Image 3: The project team in the vineyard

Beetroot

Supporting an impact-driven software company to catalyse their current sustainability strategy.

Project Brief

Beetroot is a tech ecosystem rooted in Sweden committed to creating a positive impact at scale through tech team extensions, software development, and upskilling. In recent years, the Beetroot team has begun to formally document their initiatives for positive change, integrating them into their Corporate Responsibility Strategy and Public Reporting.

Through interviews, workshops, and desk research, the IIIEE team identified current strengths, challenges, and opportunities within the company. We formulated three primary action plans to initiate a new refinement phase within their strategy. The recommendations are based on principles of global reporting standards, impact measurement, and sustainability communications.

Project Team

Annisa Nur Diana
She is an Indonesian Environmental Engineering graduate, with hands-on experience in sanitation and solar energy, Diana applies her technical expertise to socio-environmental challenges.

Zinyat Gurbanova
Azerbaijani physicist turned into environmental consultant after a 4-year banking career. She is focused on impact assessments, business support, and

Arianna Sofia Campos M.
Originally from Mexico, she has worked on impact entrepreneurship, biodiversity conservation and regenerative agriculture projects in Mexico and India. Arianna holds a B.A. in International Relations.

Background

Beetroot builds dedicated teams and software solutions that create an impact for businesses and the world. The "Beetroot Ecosystem", which is the organisational structure that can accurately reflect the cultural and impact dynamic of the company, is currently comprised of three different initiatives:

- **Beetroot Tech***:* This was the first unit in the ecosystem, born from the idea that tech team extensions and work with remote teams can be done in a very people-centred and integrated way that doesn't sacrifice in-house quality. Beetroot is dedicated to solving tech challenges for 200 clients in 25 countries, focusing on areas such as Greentech, Healthtech, and Edtech.
- **Beetroot Academy***:* Beetroot Academy is a social enterprise committed to providing accessible professional education and development opportunities for all, regardless of their background. Statistics tell that 5% of all new tech specialists in Ukraine are graduates of Beetroot Academy, with a strong focus on gender diversity (61% of students are women). With over 10,000 graduated students and a 70% employment rate for their graduates, they are transforming careers in the digital economy.
- **Tech Relief Fund "Aid for Ukraine"***:* This fund directs donations to grassroots aid projects, prioritising those that support vulnerable families and children affected by the war. Beetroot covers the whole administrative cost, taking no cut, ensuring that 100% of donations go directly to the intended relief causes, and they aim to have as high an impact as possible per donated cent. [1]

After having a "Sustainability Initiative Group" since 2018, it evolved to its recently formed Sustainability Department to professionalise and standardise its strategies, being this a natural step for a company the size of Beetroot. As with any recently formed team, there were multiple needs, interests, and courses of action to explore, which made this project a fun, creative and challenging endeavour.

Whereas other projects in this report began with a concrete proposal from the client, we started with a collaborative ideation phase to identify needs and develop the project plan jointly with the client. The following methodology, problem statement, findings and final delivery include one extra step: the project ideation phase for Beetroot's approval.

Methodology

The first step by the Project Team was to perform an initial literature review of the three sustainability reports Beetroot published in 2020[2], 2021[3] and 2022[4]; the company's materiality matrix, their GHG Accounting tool and a benchmark of sustainability strategies in the industry.

The main objective of conducting this literature review before the initial interaction with the company was to speed up the learning curve and achieve a better understanding of the different initiatives the company has. This approach also allowed the consultants to take a guiding role in the conversation and incentive reflection among the team.

After the literature review, the team had a first exploration meeting with Beetroot's Sustainability team to learn more about the current state of the company and their different priorities. The collected data in these two steps was analysed through a Gap Analysis Matrix based on the Global Reporting Initiative (GRI) standards. The project ideation phase prioritised ideas that fulfilled the objectives Beetroot has in their Sustainability Strategy, but that also could bring them closer to global sustainability requirements.

Once all the parties agreed on the project, the team conducted seven interviews with internal stakeholders of the company, one with a former external consultant for Beetroot and one with a GRI professional consultant. These interviews had four objectives:

- To understand the general responsibilities of the area within Beetroot's Ecosystem and their involvement in the design of the current Sustainability Strategy.
- To learn how different employees view sustainability within Beetroot and throughout their daily tasks, projects, and goals.

- To assess the familiarity of the different departments with global reporting standards and the level of interest and readiness for them to adopt them.
- To map potential opportunities or challenges for change management processes within the Sustainability Strategy of the company.

The interview results were coded according to these four objectives, which allowed us to assess the stage Beetroot's Sustainability Strategy across the company. The workshop was designed to bridge the gaps some teams had that could potentially slow down the adoption of standardised tracking and reporting sustainability processes. This workshop was delivered to +20 attendees from different areas within Beetroot, giving a platform for capacity development, dialogue between teams and space for reflection; ultimately preparing the company to implement the recommendations given by the IIIEE Consultants. The present report summarises our findings.

Project Design

The IIIEE Consultants identified three main themes covering the different needs, challenges, and expectations of the client. Table 1 shows the results of the comparative study between the Gap Analysis and Beetroot's Sustainability Strategy

To design a project that could address most of these needs, the IIIEE Team brainstormed different initiatives at first; however, based on these identified longer-term challenges, the IIIEE team concluded that it was crucial to prioritise initiatives that build a solid foundation by strengthening processes, professionalising reporting, and fostering cross-functional collaboration. The consultants concluded that, before bringing innovation or new projects to the table, it was imperative to develop a process of "putting the house in order"; therefore, the team chose to focus on performing a review and improvement of the current strategy through a GRI lens. Table 2 shows the

Problem Mapping		
Sustainability as a Driver for Growth	**Resource Efficiency for Sustainability**	**Sustainability to Build Credibility and Trust**
Company's concerns: • How can we effectively promote sustainability on a global scale? • What strategies can we employ to make sustainability a unique selling point for our business? • In what ways can we use sustainability to drive our company's growth? • How can we position sustainability as the flagship of our marketing efforts?	**Company's concerns:** • How can we integrate sustainability on the existing structure? • How can we achieve more while utilizing or doing less? • How can we prioritise sustainability initiatives to maximise our impacts?	**Company's concerns:** • How can we expand our client base and appeal to bigger clients through sustainability efforts? • What strategies can we implement to attract more investors? • To reassure clients about our stability and health, how can we demonstrate our commitment to sustainability as a sign of reliability and trustworthiness?
Challenges: • Identify regulatory compliance in global markets. • Develop a comprehensive marketing strategy that aligns sustainability with the company's brand and values while reaching bigger clients.	**Challenges:** • Navigate resistance to change within the organisation. • Balance the need for resource efficiency. • Assess existing operations to identify areas for improvement	**Challenges:** • Develop transparent reporting mechanisms to demonstrate the company's sustainability progress and build trust with clients and investors. • Find ways to effectively communicatee and market the company's sustainability efforts.

Table 1: Results from Comparative Analysis for Problem Mapping

different projects that were initially designed, highlighting in red the project that the IIIEE consultants and the company commonly agreed on.

Problem Statement

For Beetroot to achieve its Sustainability goals, the consultants identified three different priorities:

- For the company to use their impact as a marketing tool or product differentiator among its competitors, the sustainability team had to adopt impact measurement and global reporting initiatives that could give authenticity to its claims. As they are now expanding to different continents, adopting GRI standards would also facilitate the crafting and translating of their policies and strategy across borders.
- To be able to prioritise resources and incentivise the participation of different stakeholders, it is necessary to design standard procedures and implement common KPIs.
- To ensure that external stakeholders such as clients, investors and potential employees perceive Beetroot as a steady, stable, and trustworthy partner, it is important that every claim, report and initiative is backed by data and is reported in a consistent way. Following GRI standards is a way to acquire this credibility.

Our Findings

After performing the Gap Analysis based on their sustainability reports, internal policies and Materiality Assessment, the consultants identified different challenges that could hinder the implementation of GRI Standards in the organisation. One initial challenge that constantly came up during the Gap Analysis was that, even though the company complies with basic standard requirements for components such as Governance, Energy Efficiency and Waste Management, the lack of standardised processes or KPIs to follow up on these material topics becomes a great barrier for transparent reporting.

The second barrier that the IIIEE Consultants identified was that the current engagement from external and internal stakeholders was very low. Beetroot's Sustainability Team conducted a Materiality Analysis for their latest sustainability report; however, they could not engage external stakeholders for the analysis or bring internal supporters to the sessions designated to map the material topics. Performing a Materiality Analysis with a low engagement from stakeholders can lead to biased results, mainly because the material topics mapped will not truly reflect the risks from all the relevant actors. It is important to mention that exchanges between stakeholders and the sustainability team should not be a one-time interaction, but rather a continuous dialogue; therefore it is key to build strong and constant stakeholder relations.

Project Title	Sustainable Business Development	Sustainability Training for Employees	Sustainability Revamp through GRI	Greentech for Wildlife in Ukraine
Objective	To develop Beetroot as a trustworthy IT supplier to reach bigger clients	To improve internal sustainability awareness and pushes sustainability within the company	To compile and structure the sustainability strategy of the company using GRI as tool	To initiate project portfolio strongly linked to Beetroot's value proposition
Brief description	Consultants identify the root causes of challenges, carefully map out the ideal target clients, and develop actionable plans to effectively engage these target clients.	Consultants employ a comprehensive approach by analysing the current training set, relevant data and trends in training, evaluating career and progression plans to craft a customised internally focused sustainability training program.	Consultants conduct a thorough sustainability assessment of the company to facilitate the development of a structured, systematic approach to sustainability strategies, aligned with the Global Reporting Initiative (GRI) standards.	Consultants conduct research in wildlife, conflict resolution, and Greentech, with the aim of inspiring innovative product development for the company.
Suggested deliverables	• Supplier development manual • Benchmarking results with competitors and industry frontrunners • Workshop on developing Beetroot as a trustworthy IT supplier	• Training catalogue • Impact indicator to measure • Training for trainers and demo course • Suggested progression plan to mandatory implement	• Gap analysis • Booklet with analysis, results, roadmap, and suggested action plans • Workshop on corporate sustainability and different functional tracks (depends on data analysis)	• Target indicators to monitor with the tool • Sustainability communications strategy • CRM of potential clients for new market segment • Workshop on wildlife, biodiversity and conflict, or B2G sales and proposal development, or sustainable business models and design thinking

Table 2: Different Projects designed by the IIIEE Consulting Team.

The following interview stage was a great opportunity to deepen the consultants' understanding of these initial findings. Throughout the interviews with Beetroot's employees and former consultants, there were very consistent themes brought up by the different teams or identified by the interviewers. The findings can be classified into four main categories: Sustainability-related, Communications-related, People and Organisational Development-related and Leadership-related.

Sustainability-related Findings

Even though the Sustainability department was created recently, the team has shown great commitment to the organisation's development and transformation. It is natural for the different departments to talk about impact-oriented topics, and employees see great value in Sustainability Reporting. However, the general knowledge of sustainability from the employees and their awareness of the company's different Corporate Social Responsibility (CSR) and Sustainability strategies was very low. This uneven understanding of one of the main values of this purpose-led company might seem surprising, yet it is important to highlight this is a normal outcome for an organisation that has just started to professionalise its impact through a Sustainability team.

One of the reasons that can explain the difficulties of the Sustainability team in engaging other stakeholders and departments came up during the interview with the Finance team. They mentioned that the lack of KPIs, standardised impact measurement tools or tracking for the Return of Investment of the initiatives makes it difficult to build a business case for sustainability where different internal and external stakeholders can see the financial and strategic importance of these initiatives and how they relate to their daily tasks [11].

Communications-related Findings

Despite having an annual Sustainability Report publicly available that shares the different initiatives the company has developed, every team that was interviewed had different answers when asked, "Which examples would you give to prove that Beetroot is an impact-driven/sustainable provider of IT solutions?". This could be a potential risk in the short term, especially for the areas that are in constant contact with external stakeholders such as potential employees and prospective clients. For example, the different CSR initiatives that Beetroot has designed and delivered until their 2022 report have very transparent and direct ways to demonstrate their impact, and the different teams involved in the projects can state important impact data, such as the number of beneficiaries or the amount of money fundraised [4]. However, if employees cannot share meaningful examples about the impact of a company that openly differentiates itself as an impactful and sustainable provider of IT Solutions, different stakeholders might unfairly question the authenticity of such a statement, even if it is true.

Apart from the reputational risk of not properly communicating or backing up sustainability-related claims, in March 2023, the European Union adopted a proposal for a Directive on Green Claims, which aims to stop companies from making misleading claims about the environmental merits of their products and services [5]. Once the Directive is officially adopted, the continuity of this communications challenge could also signify a legal risk.

Even though the communications gap can become a great barrier, it is important to highlight that this is a common challenge among corporations working remotely [6]. After Covid-19, there are many new different tools and strategies that can be easily implemented to overcome this threat.

People and Organisational Development-related Findings

One commonality throughout all the interviews with the Beetroot teams was the pride and genuine interest every employee has in having a purposeful career that generates a positive impact in the world. This finding can be directly linked to the high value people have in Sustainability and Reporting.

Another finding that can be a positive catalyser for any innovation the Sustainability team wants to implement is that the Human Resources department reported a high retention rate of employees with an average of six years [12]. Capacity development programmes for employees and the implementation of new processes are initiatives directly affected by the employee retention rates of an organisation, as

low rates translate into bigger barriers to knowledge transfer and process professionalisation [7]. Linking the purpose-driven mindset of the employees with the high success factors for change management can give a competitive advantage to the Sustainability Team in their next growth stage.

On the other hand, the current talent structure still has not been able to incorporate sustainability throughout the employee's life cycle. One of the factors that the HR team suggested as possibly explaining the miscommunication of the current Sustainability Strategy is that the employees don't have to ensure they understand it throughout their professional careers at Beetroot for them to achieve success and career progression. Similarly, as outlined above, employees appear to struggle to grasp the link between sustainability and their own daily work. Based on the employee life cycle described by the People Department during the interview and different the research the consultants did about different Human Resources strategies adopted by other companies, here are some examples of how to incorporate sustainability-related activities into different Human Resources Processes:

- **Employer Branding and Recruitment:** As a company that is popular among purpose-driven professionals, it is imperative that recruiters are capable of fully explaining the different CSR and sustainability strategies during interviews and at different career events.
- **Employee Onboarding**: Incorporating mandatory readings or sessions with different teams to understand the relationship between impact, sustainability, and Beetroot can be beneficial. A more professional approach for a second stage would be for employees to understand the sustainability dimensions of their KPIs and daily tasks.
- **KPIs and Performance Evaluations:** In a company that has transversally incorporated sustainability throughout its core strategy, every employee has specific goals to advance the company's impact. For example, if the company wants to expand their Green Tech projects, the sales team would have specific targets to sign up projects related to that category.
- **Rewards & Recognition Systems:** Teams are incentivised to design projects within their areas that advance set Sustainability Goals.
- **Ownership of the Organisational Culture:** There is constant communication and understanding of what a person who embodies the "Sustainability" value looks like. Employees know that delivering impact is everyone's task.
- **Capacity Development:** Employees receive technical knowledge on different new trends in Sustainability that can have an impact on their daily work.
- **Progression Plans***:* Employees must take certain Sustainability training or achieve a certain percentage of the Sustainability-related KPIs to compete for a promotion.

Lastly, it is important to mention that Beetroot strongly commits to their employees' mental health and well-being. Due to the challenges Ukrainian employees are currently facing due to the war, it is more relevant than ever that Beetroot keeps on prioritising employee well-being through organisational change.

Leadership-related Findings

Even though it is clear that having a purpose-led culture can be directly attributed to Beetroot's leaders, there is still a gap between the Sustainability-driven vision that wants to be achieved and the CSR-driven strategies that are happening in the company. To shift this mindset, a sense of ownership must be promoted and cultivated across teams [9]. Due to the horizontal hierarchy and decentralised organisational structure, employees having ownership of the core strategies of the company is crucial to take Beetroot's impact to the next level.

The IIIEE Consultants also perceived that the Sustainability team could benefit from extra support from the CEO and other company leaders to advance the strategies dependent on cross-functional work or on external stakeholders.

The Workshop

Due to the outcomes from the Gap Analysis and the current challenges identified within Beetroot, the IIIEE Consultants realised that there are still several steps the company has to undertake before they can start standardising their sustainability management and reporting processes through GRI. To improve their communications, foster ownership throughout the teams and reach a higher level of professionalisation across the company, the consultants re-designed the pathway suggested for Beetroot. First, the workshop was divided into two main sections:

1. **A general session** that aimed to give a Sustainability context for all the attendees that allowed them to connect Beetroot's initiatives and their daily work to the strategy. The participants were able to identify the different sustainability projects the company is doing so far, learn to place them in an ESG context and identify windows of opportunity to grow their impact. The session focused on the following topics: "Brief overview of Corporate Sustainability for the IT sector; Difference between CSR and Sustainability strategies"; "How to incorporate sustainability into Beetroot's value proposition?"; "Overview of current sustainability projects within Beetroot"; "Sector benchmarking – How are IT companies pushing their Sustainability goals?", and "Tools to strengthen Beetroot's Sustainability Strategy."

2. **Three functional tracks** to give specialised information to each team where we divided the attendees into break-out rooms. The objective was that by giving tailor-made knowledge to each team, it would be easier for them to connect it to their daily work and projects.

The functional tracks people were able to choose from were:

Materiality Analysis and Sustainability Reporting by Zinyat Gurbanova | *Suggested attendees: CEO, Finance, Legal and Sustainability*
This track covered the basics of Materiality Analysis (MA) and its significance, highlighting its role in prioritising sustainability issues. Attendees learned a step-by-step approa
ch to conducting a MA while prioritising stakeholder expectations. The attendees also learned to map materiality topics. The workshop explored the links between MA and GRI, emphasising the importance of MA for strategy shaping and setting targets.

Sustainability Communications by Arianna Campos | *Suggested attendees: HR, Sustainability, Sales and Marketing*
In this workshop, the attendees learned how to communicate Beetroot's sustainability work effectively and make it a market differentiator with potential clients, employees and investors.

Theory of Change and Impact Measurement *by Annisa Nur Diana* | *Suggested attendees: Beetroot Academy, Sustainability, Sales, Product and Human Resources*
In the 'Navigating Impact Measurement' workshop, participants explored what is a Theory of Change, SMART goal-setting and how to create a personalised impact measurement toolkit. The workshop guided participants through these essential aspects of designing purpose-driven projects and following up on their impact measurement, helping them gain a comprehensive understanding of the why and how behind driving and measuring impact.

The workshop became a crucial component of the consultancy because of the great attendance from Beetroot's employees and the findings the consultants were able to confirm through multiple interactions. Just one week after the workshop, Beetroot shared with the consultants that the different teams that attended the sessions were already implementing different strategies they had learned through the workshop. As the workshop's main objective was to build a joint understanding of sustainability and to let employees see and practice how to integrate this into their daily work, the workshop can be considered effective.

Main Recommendations

Building on the material covered in the workshop's functional tracks, the recommendations outline the next steps for Beetroot.

Navigating the process for a Material Analysis

A recommended step-by-step approach for Beetroot to overcome their challenges to perform a more complete Materiality Analysis (MA) is:

Defining Stakeholders

To get a balanced Materiality Assessment, it is important to start the materiality process by creating a list of relevant stakeholder groups, to map them later and prioritise them. It is also important to identify key contacts within each stakeholder group who can provide a meaningful perspective on Beetroot's impact assessment.

Conduct a Stakeholder Outreach strategy and Initial Workshops for Crucial Stakeholders

Due to the low engagement of different stakeholder groups that was previously mentioned, complemented with the analysis of various materials from previous MA, template survey and the feedback provided in the workshop, the IIIEE Consultants identified the following opportunities for improvement:

- Engaging most internal stakeholders is a challenging task due to the current organisational structure and a weak understanding of the importance of participating in a survey.
- There is not a strong business case for external stakeholders to prioritise this process, which hinders their participation.
- The sustainability team can re-design the communication strategy before the actual implementation, so the different stakeholders understand the importance and value of doing a Materiality Analysis. This step is crucial for the participation of the Management Team as the company's culture is already favourable towards this process; it can be just a matter of communication.
    - Doing an early outreach to all the stakeholders can be a big differentiator for people's participation.
- Using the different strengths and interests of each stakeholder, the sustainability team can build a "participation pitch". Each participant group can be pitched on why their unique insights are valuable and how the information will be used.

Identify the list of actual or potential positive and negative material topics and design survey templates

To achieve this step, the Sustainability team can suggest different material topics listed on GRI or SASB frameworks. Some suggested topics can be found on Table 3

Regarding the survey design, the materiality assessment must be conducted as a formal, structured engagement involving stakeholders. The consultants' recommendation is to employ a combination of in-depth interviews with key stakeholders and a traditional survey format for other participants. Typically, surveys can give mixed results, foster confusion in the target groups or provide less diversified topics, whereas interviews with stakeholders who are well-informed on certain topics can bring more insights. This approach ensures ease of completion for stakeholders and facilitates a straightforward analysis of the results.

Evaluate and synthesise the survey response and prioritisation

This step involves collecting all the results to be reviewed collectively and put on a materiality matrix. It is highly recommended that the group doing the review is diverse and that is preferably includes representatives from the management, financial and human resources teams. Including some employees from the development team or programmers can also be beneficial as this increases transparency of the process.

A Materiality Analysis demands considerable time, effort, and resources, yet it proves invaluable for steering company strategy and facilitating meaningful reporting. It is the initial step in integrating Beetroot's sustainability strategy with its overall business strategy. By following this structured approach, Beetroot can ensure that its materiality assessment is integrated into the fabric of its operations, guiding its strategic decisions, commitments, policies, and actions while providing a framework for setting targets and measuring progress.

	Economic	Environmental	Social			
GRI	1. Economic performance 2. Market presence 3. Indirect economic impact 4. Procurement practices	1. Materials 2. Energy 3. Water 4. Biodiversity 5. Emissions 6. Waste 7. Products and services 8. Compliance 9. Transport	**1. Labor practices and decent work** a) Employment b) Labor/management relations c) OHS d) Training and education e) Diversity f) Equal remuneration for women and men g) Supplier assessment for labor practices h) Labor practices grievance mechanisms	**2. Human rights Investment** a) Freedom of association b) Child labor and forced labor c) Security practices d) Indigenous rights e) Suppliers human right assessment f) Human rights grievance mechanisms	**3. Society** a) Local communities b) Anti-corruption c) Public policy d) Anti competitive behavior e) Supplier assessment for impacts on society f) Grievance mechanisms for impacts on society	**4. Product responsibility** a) Customer health and safety b) Product and service labelling c) Marketing communications d) Customer privacy e) Compliance
SASB	Environmental Footprint of Hardware Infrastructure	Data Privacy & Freedom of Expression	Data Security	Recruiting & Managing a Global, Diverse & Skilled Workforce	Intellectual Property Protection & Competitive Behaviour	Managing Systemic Risks from Technology Disruptions
	1. Total energy consumed, percentage grid electricity and renewable 2. Total water withdrawn, consumed 3. Discussion of the integration of environmental considerations into strategic planning for data centre needs	1. Description of policies and practices relating to behavioural advertising and user privacy 2. Number of users whose information is used for secondary purposes	1. Number of: a) Data breaches, b) Percentage involving personally identifiable information (PII), c) Number of users affected 2. Description of approach to identifying and addressing data security risks, including use of third-party cybersecurity standards	1. Percentage of employees that are: a) Foreign nationals and b) Located offshore 2. Employee engagement as a percentage 3. Percentage of gender and racial/ethnic group representation for a) Management, b) Technical staff, and c) All other employees	Total amount of monetary losses as a result of legal proceedings associated with anticompetitive behaviour regulations	1. Number of: a) Performance issues, b) Service disruptions; c) Total customer downtime 2. Description of business continuity risks related to disruptions of operations

Table 3: Suggested Material Topics for Beetroot.

Incorporating Impact Measurement Processes

Measuring the impact of Beetroot's sustainability and CSR efforts is essential. Beetroot has been making significant progress in these areas, and it is crucial to show the results of these initiatives. The IIIEE team suggests prioritising impact measurement aligns with Beetroot's mission and values. It is not just a formality; it is a proactive commitment to corporate responsibility. This approach will not only improve Beetroot's reputation but also guide its future actions. Impact measurement offers several benefits for Beetroot, including:

- **Mission alignment:** Impact measurement is a compass guiding Beetroot to work on intended results. It ensures that the Beetroot's efforts align with its mission and values.
- **Accountability and transparency***:* Impact measurement demonstrates a commitment to accountability and transparency. It allows Beetroot to show stakeholders, including employees, investors, and the community, that their efforts are driven by measurable, positive outcomes, and that it is actively tracking its progress.
- **Informed decision-making***:* Impact measurement provides valuable data to make informed decisions. It helps Beetroot understand which initiatives are effective, enabling the allocation of

resources to the most impactful programs.
- **Continuous Improvement:** Regular measurement enables Beetroot not just to assess past performance but also to identify areas for improvement. By understanding what is and isn't working, Beetroot can adapt and enhance their strategies for better effectiveness.

To start implementing impact measurement at Beetroot, the following steps can be considered:
- **Define clear objectives***:* Clearly define the goals and objectives of Beetroot's CSR initiatives. Having specific, measurable, achievable, relevant, and time-bound (SMART) objectives is crucial.
- **Design a Theory of Change***:* Develop a Theory of Change that maps the causal relationships between CSR activities and intended outcomes. This provides a structured framework for understanding how change occurs. This phase also includes outcome mapping and determining indicators that align with the objectives.
- **Monitoring***:* Determine data collection processes and continuously monitor the progress of CSR activities, gathering data on indicators at regular intervals to ensure alignment with goals.
- **Reporting and communication***:* Regularly communicate the progress and impact of Beetroot's CSR initiatives to stakeholders through reports, demonstrating Beetroot's commitment to positive change.

Strengthening Sustainability Communications

Once Beetroot's strategy is strongly linked to its Material Topics and the initiatives have strong and solid Impact Measurement processes in place, the company can be ready to confidently use its Sustainability and Purpose-led vision as a market differentiator and communications tool.

Having a strong Communications strategy that is backed up with data can build trust among stakeholders and help Beetroot find clients and corporate partners that have similar values to catalyse their positive influence. As a Software Development company, one of the biggest ways to exponentially grow its impact is to partner with clients with whom to create projects for a better world.

As previously mentioned, before developing an External Communications strategy, Beetroot should focus on training its communicators. Building an internal campaign that can socialise the current strategies and sustainability reports is crucial to increase the awareness of existing initiatives and align the knowledge across areas and projects.

To facilitate this process, Beetroot can also benefit from having one overarching corporate strategy that includes Sustainability and Communications as building blocks instead of having separate strategies. Doing this can facilitate embedding Sustainability into people's daily jobs and into the company's operations. Communications should not only be seen as a marketing tool or an action plan for a crisis; they can also hold a mirror up to the claims the company is making by comparing the sustainability plans and the company's performance to the communications and overall strategy [8].

The IIIEE Consultants also suggest running a thorough communications audit periodically as it can give Beetroot the confidence that they are being consistent and not over-promising while underdelivering. These audits will become more relevant as new regulation against Green Claims comes into effect.

Conclusions

In a world where 53% of green claims give vague, misleading or unfounded information and 40% of the sustainability claims have no supporting evidence [5], backing your impact and sustainability initiatives with high-quality data is more relevant than ever. It is rare to find companies that have such a purpose-driven mindset and that are so passionate about making the world a better place; however, not everyone has the privilege to have a five-week consulting project with Beetroot to transparently and genuinely learn that.

As it has been talked about throughout this chapter, it is clear that it takes a village to push sustainability forward in any organisation. It is

important that companies realise that the main driver of sustainable change is understanding that Sustainability is everyone's responsibility and that it has to be cultivated from a place of ownership.

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IIIEE Consultants for Beetroot. From left to right, Zinyat Gurbanova, Arianna Sofia Campos Madrigal and Annisa Nur Diana

Space of Biodiversity Fund

Developing mental resilience in Ukrainian children via nature-based learning

Project Brief

This project is in partnership with the Space of Biodiversity Fund, a Ukrainian-based NGO with an overarching goal of identifying how people can sustainably coexist with nature. The fund maintains a focus on nature-based solutions and eco-education for local communities in Ukraine.

The goal of this project is to support the Space for Biodiversity Fund's efforts in expanding the use of nature-based learning practices in Ukrainian kindergarten and elementary schools as a way to combat the rising levels of stress and anxiety in children due to the war. This project uses Sweden as a baseline for nature-based learning implementation, as the concept is well-established nationwide. Additionally, various schools in Ukraine with nature-based learning practices already in place are investigated. This project identifies the benefits of nature-based learning, the success factors for implementation and longevity, and the challenges nature-based learning practices will likely face in Ukraine. From these results, an implementation framework is presented which intends to assist with the practical steps for pursuing nature-based learning activities in Ukrainian schools. results, an implementation framework is presented which intends to assist with the practical steps for pursuing nature-based learning activities in Ukrainian schools.

Project Team

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Introduction

In a complex terrain shaped by ongoing conflict and the devastating consequences of the COVID-19 pandemic, the well-being of Ukrainian children is suffering severely. According to UN estimates, about 7.5 million children have been directly affected by the conflict in Ukraine [1]. Current conditions dramatically increase children's anxiety, leading to post-traumatic stress disorder (PTSD), depression, and even suicidal tendencies [2], [3].

In addition, the shift to online forms of education in Ukraine in several regions has brought forth a new challenge, as children have become increasingly dependent on technology. Especially in early childhood, several negative impacts on health and development have been identified, such as speech delay, attention deficit, learning problems, and even mental disorders that can impact their character [4].

Yet, while extensive research has examined the psychological effects of conflict on children, there remains an unaddressed research gap. The potential of innovative approaches, specifically nature-based learning (NBL), for mitigating the psychological and emotional distress of these children within the Ukrainian context remains underexplored. This knowledge gap is of paramount importance, as it has the potential to offer fresh insights into effective strategies for enhancing the well-being of children in conflict-affected regions.

Figure 1 – Image of a schoolyard from a Swedish private kindergarten with implemented NBL practices.

Project aim

The research project has a multi-pronged objective, motivated by a commitment to the welfare of Ukrainian children. At its core, this project seeks to promote nature-based learning practices within Ukrainian kindergartens and elementary schools. Fig. 1 presents a schoolyard that has incorporated NBL practices in Sweden. NBL, a broad term, represents the team's approach to a wide range of nature-related educational practices, including the 'Forest School' program, which should occur in the natural environment.

NBL offers a holistic approach to learning at the intersection of education, psychology, and environmental science [5]. For this project, NBL is used as a therapeutic tool, recognising nature's healing potential for the body, especially in children. A second significant body of research highlights the psychological and emotional benefits of nature involvement, from reducing stress and anxiety to enhancing cognitive development and focus. This project intends to use these inherent advantages of nature to reduce the psychological distress of Ukrainian children in conflict and post-pandemic challenges.

Furthermore, an essential part of the presented research focuses on analysing the current situation of NBL in Ukraine. These insights are gained through interviews and interactions with administrators, teachers, and educational practitioners. This grassroots understanding provides nuanced insights into existing practices, challenges, and opportunities around NBL in the Ukrainian context.

Project Approach

In order to implement more NBL practices in Ukrainian kindergartens and elementary schools, the approach of this project was to use a country with a long history of NBL practices as a benchmark. Sweden has been using an NBL concept in kindergartens and elementary schools named "I Ur och Skur," which is roughly translated to "Come Rain or Shine" since 1985 and has therefore been chosen as a reference point for this project [6].

I Ur och Skur is a pedagogy based on outdoor life, outdoor education, and experiential learning in line with the objectives of the national curriculum [7]. This type of pedagogy has been developed by the educational department of "Friluftsfrämjandet", the largest non-governmental outdoor association in Sweden [8]. Friluftsfrämjandet is regarded as the umbrella organisation for this NBL concept in Sweden, providing support, networks, and educational training for teachers and leaders.

For this project, using a benchmarking approach gives the advantage of exploring the benefits of NBL, the success factors for implementation and longevity in the context of Sweden, as well as the challenges that might arise with this concept in Ukraine. This project aims to investigate these findings to achieve further successful implementation of NBL in Ukraine.

Methodology

To identify the benefits of NBL, the success factors for implementation and longevity of NBL, and the implementation challenges, a comprehensive literature review was complemented by interviews involving multiple stakeholders, as well as study visits to I Ur och Skur schools in Skåne, Sweden. The literature review focused on finding empirical evidence to support the interview findings. The interviewed stakeholders were principals, teachers, parents, children, an organisation in Sweden and various independent schools in Ukraine that use NBL practices, combined with one educator in Canada and one in the UK that uses NBL techniques.

The results from the literature review and the interviews were then included in a synthesis matrix, which was coded to analyse the findings. The coding resulted in overarching categories for each of the three themes of investigation: Benefits, Success Factors, and Challenges. To assess the transferability, the findings were also used to create a SWOT for NBL practices in Sweden and Ukraine, respectively, and a PESTEL for Ukraine as a nation. Lastly, an implementation framework and a stakeholder map were developed based on the findings.

After coding, the initial findings were presented to relevant Ukrainian stakeholders in an online workshop. The workshop's focus was not only to present the benefits, success factors, and challenges but also to gain feedback on the Ukrainian SWOT, the implementation framework, and the stakeholder map. The feedback provided by the participants was noted and used for further analysis.

An important limitation of this project was that data from the interviews was primarily based on observation, not psychological studies of children. Additionally, it should be considered that the benefits of NBL are highly subjective to each child and their context. Therefore, a child will likely experience a range of the presented benefits.

Results

Benefits of NBL

The coding of the benefits of NBL resulted in five overarching categories: Health, Environmental Awareness, Physical Activity and Motor Function, Child Development, and Psychological Improvement, all of which are illustrated in Table 1. All of these are significant benefits, but for the purpose of this project, Psychological Improvements are highlighted due to the ongoing war and the consequences it has had on the mental state of children.

Health	Reduced Sickness Better Sleep
Environmental Awareness	Improved Connection with Nature Willingness to be Outside
Physical Activity & Motor Function	Improved Physical Health Improved Motor Skills
Child Development	Long-lasting Knowlege Critical Thinking Improved Motivation Improved Concentration Improved Creativity/Curiosity Confidence Risk Management Being Kids Longer Using All Senses
Psychological Improvements	Reduced Anxiety Feeling Safe Stress Reduction Improved Relationships with Others

Table 1 - Table of the benefits from NBL presented in five categories: Health, Environmental Awareness, Physical Activity and Motor Function, Child Development, and Psychological Improvements.

In the category of Health, it became evident that NBL often results in a reduction of the spread of sickness, not only in the children attending the school but also in teachers and parents. This is mainly based on the fact that teachers and children are outside more. While cold weather can reduce immune system efficacy, it does not cause illness; pathogens do. Therefore, spending time outside, even if it is cold, rather than inside a confined building reduces the risk of spreading pathogens, resulting in lower illness rates [9]. Additionally, it was found that NBL practices induce better sleep patterns in children as they are more active throughout the day.
In the category of Environmental Awareness, it was evidently observed that the children exposed to NBL had an improved connection with nature while simultaneously having a greater will to spend more time outside [10], [11]. This is likely due to the fact that children are spending more time outdoors and, therefore, feel more comfortable in nature.

The category of Physical Activity and Motor Function showed that NBL practices will likely improve both the physical health of children and their motor skills, which are especially important for the development of children in kindergartens and elementary schools [11].

The Child Development category demonstrated several vital aspects. Firstly, NBL practices ensure that children use all their senses while learning, which helps stimulate long-lasting knowledge [12], [13]. It was also found that children experience improved critical thinking, motivation to learn, concentration, creativity, curiosity, and confidence. Simultaneously, outdoor learning enables children to develop their risk management skills at early ages while at the same time letting them enjoy their childhood longer [11], [13]- [15].

The final and most impactful category identified is Psychological Improvement. The findings illustrate that children educated with NBL practices will likely experience reduced anxiety and stress, which is especially crucial due to the ongoing war in Ukraine. Scientific studies have demonstrated that war induces anxiety disorders such as PTSD and depression [16]. Nonetheless, research has also shown that anxiety and stress can be reduced by spending more time in nature and green environments [17], [18].

Additionally, children may feel safer during NBL activities. This is because NBL encourages a higher teacher-to-student ratio, fostering an environment where children inherently feel more seen and heard. It was also found that many children improve their relationships with others, both teachers and other children, as they spend more time engaging with students of various ages and genders as well as spending more one-on-one time with their teachers [19].

Successful factors for implementation and longevity

Success factors for implementation and longevity were coded into four overarching categories: Teacher Engagement, Special Forms of Education, Support, and Resourcefulness, all of which are presented in Table 2.

Teacher engagement	Teacher Trainings Support For Teachers
Special Form of Education	Conscious Leadership Smaller Class Size Various Times Outside Child Influenced Education
Support	Umbrella Organisation Support From the Government Support For Parents & Communication with Parents
Resourcefulness	Make Use of the Environment

Table 2 - Table of the success factors for implementation and longevity presented in four categories: Teacher Engagement, Special Form of Education, Support, and Resourcefulness.

In the category of Teacher Engagement, the primary success factor identified is support from teachers. This is about having engaged and passionate teachers who are willing to pursue the NBL concept, as the concept's success is contingent upon their active involvement and commitment. An additional vital factor within this category is adequate teacher training. Teachers must be provided with the necessary resources and knowledge for this type of education to feel fully equipped and comfortable while teaching. As seen in the Swedish context, having an umbrella organisation to manage this education can add

additional support for teachers. Other forms of support for teachers provided by the school are also necessary, such as being equipped with suitable outdoor clothing and easy access to training books.

Another category for success is Special Forms of Education. In this category, there is a significant emphasis on conscious leadership. Conscious leadership is a term used in the Swedish I Ur och Skur schools, which is about co-experiencing, co-discovering, co-investigating and co-acting together with the children. Instead of having a group of teachers in a cluster, they are dispersed in the schoolyard, actively pursuing learning by doing with the children [12]. To make this conscious leadership feasible, the class sizes need to be reduced, as previously mentioned in the benefits section.

Another contributing factor to this category is spending different periods of time outside. Within the context of NBL, there is no prescribed duration for the time children need to spend outside. The team's research has found that it can vary from having classes outside every day to having a full forest day once a week or monthly [12], [20]. While it is evident that children acquire more benefits with increased outdoor exposure, both educators and students who are new to the concept would find a stepwise implementation process more advantageous.

Lastly, the findings underscore the importance of a child-influenced education, which fosters a heightened sense of responsibility in children while empowering them to actively shape their educational journey according to their individual needs and preferences [21].

The next category of success factors is Support. As previously mentioned, having an umbrella organisation in Ukraine for these NBL practices would provide support regarding, for example, teacher training. This organisation could also offer guidelines and other forms of assistance, such as communication channels through their networks for knowledge sharing. Simultaneously, having the support of the government and the municipality could also assist NBL practices in general. Lastly, it is necessary to support parents through well-established communication to address any concerns they might have with the NBL practices.

The last category is Resourcefulness, which is about using the existing environment around the schoolyard. There is no need to invest in an expensive playground; instead, natural materials can be used to build what is needed. For example, instead of buying an expensive swing, the teachers and the children can make one using a tree, a rope and a wooden plank. Resourcefulness may also extend to external avenues, as exemplified by proactive engagement with municipal authorities to explore the availability of surplus or unused resources [20]. A study visit to a public I Ur och Skur school in Sweden showed that the municipality had provided the school with planters and a sink, which could be reused for gardening and outdoor cooking. Fig. 2 shows the planters the public school acquired from the municipality.

Figure 2 - image of planters for gardening from a Swedish public elementary school with implemented NBL practices. Planters were acquired through the municipality.

Perceived challenges in Ukraine

Coding the perceived challenges in Ukraine resulted in four overarching categories: Mindset, Practicalities, Environment, and Bureaucracy and Finances. These are illustrated in Table 3. Although these factors could be considered barriers, the team's research has shown that a significant portion of these issues can be overcome, thereby leading us to classify them as challenges rather than barriers.

Within the category of Mindset, the most significant challenge identified was the teacher's unwillingness to change. Currently, according to the interview data, teachers in Ukraine have a traditional worldview and are less inclined to make the changes that are required for NBL practices. However, Ukraine is a country with

over 300,000 teachers, and even if not all of them support NBL practices due to individual resistance, there are still many teachers who would be interested in this concept [22]. Therefore, the most effective approach for addressing this issue would be to initiate the adoption of NBL practices with teachers who are willing to change. Subsequently, as NBL practices become more widespread in the country, the following steps would be to expand the practices to more conventional teachers. In addition to teachers, parents are also critical in this category. They may have some initial concerns and resistance in the beginning, as well as a lack of time and knowledge. However, over time, this can be solved with clear communication between teachers and parents regarding, for example, what activities will take place, a risk assessment of activities, and what clothing their child will need [23].

Mindset	Teachers' Unwillingness to Change Concerns and Resistance from Parents Parental Lack of Time and Knowledge
Bureaucracy & Finances	Administrative Work Government Requirements
Environment	Weather Natural and Surrounding Environment War
Practicalities	Clothing Meals Dependency on Digital Devices

Table 3 - Table of perceived challenges in Ukraine presented in four categories: Mindset, Practicalities, Bureaucracy and Finances, and Environment.

Another category of challenges considers the Practicalities of NBL. The children attending a school with NBL practices need specific clothing for various weather conditions. While this will require greater expenditures for the parents, research has shown that this does not have to be a significant issue as the school can provide extra clothing or coordinate a cloth swapping. Buying second-hand clothes from other parents is also a possibility [13], [24]. The main issue regarding clothing is that parents do not always know what is needed. Therefore, once again, parental communication is a good solution for addressing this issue.

Another practical concern is how to handle lunch during forest days. This can easily be mitigated through a range of options, from ensuring food is portable to having the children make their lunch outside with a controlled fire, allowing children to take responsibility and learn risk management and general survival skills.

Lastly, due to COVID-19 and the ongoing war, children in Ukraine have become more dependent on digital devices. Studies demonstrate that the usage of mobile phones by children can lead to several negative effects, such as obesity, inadequate sleep quality, learning problems, and even mental disorders [4], [25]. However, these issues can be solved by adopting NBL practices because the advantages offered by NBL align with and address the same concerns associated with the rising use of mobile devices among children, creating a win-win situation. Ukrainian parents have raised concerns about their children not having mobile phones during school hours due to worries of not being able to reach them due to the war. Therefore, it is crucial to emphasise that teachers consistently prioritise the immediate evacuation and safety of all children in these situations, with mobile phones being promptly returned once this primary objective is achieved [22]. Furthermore, to address parental concerns regarding reaching their children, it is essential to note that this does not entail that children need smartphones. Conventional mobile phone models, lacking the various applications that have raised concerns, remain entirely suitable for effective communication.

The third category within the challenges is the Environment, and the first component to highlight is the weather. There is an old Swedish saying stating, "Det finns inget dåligt väder, bara dåliga kläder" which translates to the notion that adverse weather conditions do not exist; instead, it is the adequacy of one's clothing that determines one's comfort. This means the children are appropriately attired for prevailing weather conditions, allowing them to engage in outdoor activities even during precipitation or snowfall. This is, however, done to a reasonable extent, depending on the severity of the weather conditions [6]. While

parents might have some initial concerns regarding this, the issue can be solved with adequate information provided for parents and communication channels, ensuring questions can be answered efficiently.

Lastly, our research has found that due to urbanisation across Ukraine, the surrounding environment of many urban schools lacks green space. This can be a challenge; however, in Ukrainian schools, it is required that there be a minimum amount of green space on the campus [26]. Therefore, there will always be some space for NBL activities.

The last category is Bureaucracy and Finances. The research revealed that while there may be a modest increase in administrative work, this is a common reality shared with more conventional educational institutions. Additionally, it is essential to consider governmental regulations and financial requirements when considering the broader implementation of NBL practices in Ukraine. However, with proper planning and resource allocation, these challenges can be effectively addressed, fostering the growth and success of NBL initiatives in the country.

Analysis of Results

Upon grouping the interview results and literature review into benefits of NBL, success factors for implementation and longevity of NBL, and overarching challenges for implementation in Ukraine, it became necessary to assess the transferability of these practices from the Swedish and small-scale Ukrainian context to the general Ukrainian context.

The limitation of this task became clear as it was accepted that the transferability of NBL to the Ukrainian context depends heavily on the individual school in question. In the interviews with Ukrainian teachers, it was mentioned multiple times that schools located in the countryside of Ukraine would likely face fewer challenges when implementing NBL activities as many of the necessary resources, primarily access to nature, are easily accessible. In contrast, schools located in city centres may face more challenges as they likely have less nature around them. This creates an issue when assessing transferability as it is context-dependent.

To navigate this challenge, a two-fold approach was taken, firstly assessing the transferability of NBL

from Sweden to the general Ukrainian context. To do this, the project group created a PESTEL to understand the current overarching context of Ukraine. Subsequently, a SWOT analysis of NBL implementation in both Ukraine and Sweden was created to be used for a clear comparison of the two countries. The second part of the team's two-fold approach addresses transferability on an individual level. To do this, the project group created an implementation framework that allows schools to consider their unique context and thereafter identify practical steps for NBL implementation.

PESTEL

To assist in assessing the transferability of NBL practices in Sweden to Ukraine, a PESTEL was created, enabling the identification of the political, environmental, social, economic, and legal context of Ukraine, all factors which could affect the implementation of NBL in Ukraine. Therefore, all these factors should be considered when pursuing the implementation of NBL as they will likely be relevant in varying degrees at all schools in the country. It is advised that schools looking to expand their NBL practices should be aware of these factors when planning implementation. The PESTEL is presented in Table 4.

An overarching factor to highlight from the PESTEL is the ongoing war in Ukraine. The war will influence schools in different ways depending on their specific context, and therefore, it must be considered when planning NBL implementation.

Additional factors of note are:

- High levels of urbanisation in Ukraine. This will influence the ease of NBL implementation as large cities have become dominated by concrete.
- A traditional worldview primarily held by older generations. This means they might be more hesitant to deviate from traditional ways of learning.

Political	Environmental	Social	Technological	Economic	Legal
War Decentralisation of municipalities Corruption EU integration	Urbanization (lack of green spaces) Weak environmental awareness Diverse climate zones Lack of biodiversity Fossil fuel dependency Air pollution	General emotional instability Traditional culture/worldview Lack of psychological specialists Short life expectancy Increase in poverty levels Gender discrimination and separation	Increased use of digital devices (children) Well-developed IT field Agricultural technological innovation	High inflation rates Strong entrepreneurship Low GDP High unemployment High emigration Large agricultural sector	Lack of transparency Insufficient labor laws General health and safety regulations

Table 4 - Illustration of the PESTEL analysis, which identifies the political, environmental, social, technological, economic, and legal context of Ukraine as a nation.

- A general lack of psychological specialists in Ukraine due to the war. This creates a greater incentive to pursue NBL.
- An agricultural focus in Ukraine. Agriculture is already an important part of many people's lives in Ukraine. This can be an avenue to ease the implementation of NBL ideas.

SWOT

To assess the transferability of NBL practices from the Swedish context to the greater Ukrainian context, a SWOT analysis for NBL implementation in each country was created. To complete both SWOTs, data from the team's interviews was used. The SWOT analysis allowed us to identify the most significant differences between the country's NBL practices and, consequently, identify the greatest areas of opportunity for NBL in Ukraine.

The most significant opportunity identified for Ukraine is the development of an umbrella organisation like that in Sweden. With the development of an umbrella organisation in Ukraine, various weaknesses and threats identified in Ukraine would also be resolved, such as a lack of guidelines for methodological support and a lack of NBL knowledge from parents and teachers.

Further, the SWOT provides insight into key actors who might influence implementation, such as the Ministry of Education, local clubs/camps, and NGOs. The SWOT also reiterates the benefits and challenges Ukrainian schools will likely face when pursuing NBL activities. The Swedish SWOT is presented in Table 5, while the Ukrainian SWOT is illustrated in Table 6.

Strengths	Weaknesses
- Strong umbrella organisation - Long history of the concept - Lots of nature around schools - Teacher engagement/ passion - Flexibility in terms of time outside and NBL activities - Improved social and psychological skills, physical abilities, health, and environmental awareness - Inexpensive implementation opportunities - General acceptance from the public	- Bureaucratic and administrative barriers - Only seven elementary FS - Extreme weather conditions
Opportunities	**Threats**
- Municipal support (at least in the public school we visited) - Opportunity to expand (because of established umbrella org.)	- Increased stringency of academic requirements

Table 5 - Illustration of the SWOT analysis, which identifies the strengths, weaknesses, opportunities, and threats of NBL practices in Sweden.

Strengths	**W**eaknesses
- Improved social and psychological skills, physical abilities, health, and environmental awareness - Flexibility in terms of time spent outside and NBL activities - Due to the war, improved psychological skills are beneficial for kids - Every school is required to have a green zone	- Lack of guidelines for methodological support - Bureaucratic and administrative barriers – lack of green spaces (big cities) - Large % of teachers with a traditional mindset - Extreme weather conditions
Opportunities	**T**hreats
- Space for the implementation of an umbrella organisation - Lack of psychological professionals for kids (NBL can supplement) - The Ministry of Education is more open now than it has been in the past - Private schools are more willing to change - Non-formal education (camps/clubs) can be used for NBL - The Ministry of Education is preparing to reform salaries - NGO's can help with teaching - Small towns will have easy implementation	- Increased stringency of academic requirements - Dangerous areas /close to front lines) - Teachers and parents lacking knowledge about NBL - Cultural barriers: getting dirty, fear of catching a cold, etc.

Table 6 - Illustration of the SWOT analysis, which identifies the strengths, weaknesses, opportunities, and threats of NBL practices in Ukraine.

Implementation Framework

To address the transferability of NBL practices from a school's individual context rather than the greater Ukrainian context, an implementation framework was created. The framework is significant as it enables schools to increase their NBL practices independently. The framework was developed from the overarching concept of evaluative thinking (ET). While a concrete definition of ET is up for debate, for the context of this project, Paproth et al. [27] elaboration of ET concerning education was used, stating, "evaluative thinkers in education demonstrate behaviours and skills such as setting clear goals, collecting and analysing data, adapting based on evidence, reflecting and seeking feedback, and making evidence-informed decisions" (p.311).

In line with ET, the framework allows schools to evaluate their context, identify where and how they can implement or enhance NBL practices, set clear goals for implementation, plan how they will measure and evaluate the success of their NBL practices, plan how they will communicate the evaluation results to their relevant stakeholders, and finally, establish how often and who will be involved in the review process. The framework is meant to be utilised by any school in Ukraine wanting to grow their NBL practices. Fig. 3 is a condensed version of the framework. It consists of six sections, all of which are differentiated by colour.

The first section of the framework asks the user to assess their school's context. They are prompted to reflect on the environment around them, such as green space and nearby amenities, enabling them to identify what resources they can utilise for NBL. Secondly, they are asked to reflect on what NBL practices are already in place at their school. This reflection is intended to create a starting point for further NBL implementation.

The second section of the implementation framework helps the user identify NBL growth opportunities. In line with ET, it provides space to set clear goals for further implementation. A comprehensive list of both NBL activities and actions, all identified through interviews and secondary research, is provided within the framework. The NBL practices have been divided into four categories: 1. NBL requiring no/few resources 2. NBL requiring few/mid-level resources 3. Infrastructure change to support NBL, and 4. Community engagement to support NBL. Each of the four categories is composed of further subcategories, all providing actionable ways to increase NBL practices. A supporting document detailing key

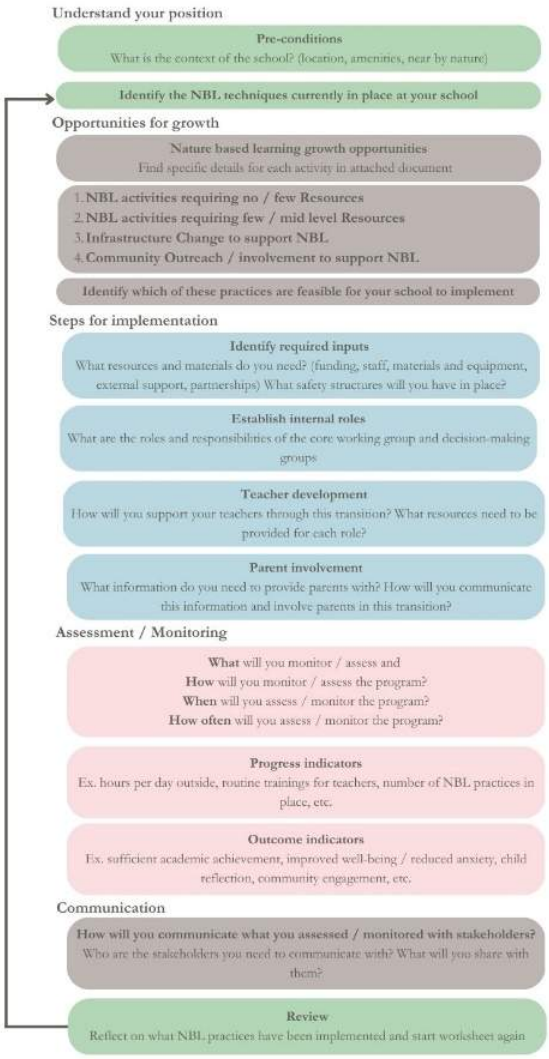

Figure 3 - Illustration of the basic structure of the implementation framework, which is presented in a step-wise process, including review and evaluation, to enable schools to independently increase their NBL practices.

components and considerations for each activity and action was also developed to provide further information regarding each activity and action.

The third section provides space to reflect on the required steps for implementation. It is broken down into four categories. Firstly, identifying needed inputs requires the user to evaluate what resources are important for implementation. Such inputs include funding, staff, materials and equipment, external support, partnerships, and safety measures that need to be put in place. Secondly, the user must establish internal roles. Who is responsible for what? Thirdly, users must plan how they will provide teacher development and what resources will be needed. Lastly, they must consider how they will engage and communicate with parents. All of the presented four steps have been identified through interviews as critical for successful implementation.

The fourth section is especially vital in ET as it requires the user to identify how they will collect and analyse data for assessing the success of the NBL practices. The framework prompts users to consider what, how, when, and how often they will monitor using both progress indicators and outcome indicators. Through the team's interview research, it has been made clear that using indicators is a vital component of the evaluation and longevity of NBL practices. While some indicators can be identified easily, such as time spent outside or the number of NBL practices in place, indicators to assess children's well-being, such as stress and anxiety reduction, can be much more complex. Not only is assessing children's well-being highly complicated but it has also been identified in the team's research as a keystone indicator to show the success of NBL.

In Sweden, the most common practice to evaluate the well-being of children identified was conducted through child and teacher mood surveys. These surveys either prompt students to assess their feelings after NBL activities or prompt teachers to evaluate students' well-being after NBL activities. One methodology is Ferre Laevers's emotional well-being and involvement scale. This methodology provides a structure for teachers to evaluate their students' well-being and involvement [28]. While these surveys can assist in showing the well-being of a child, it was acknowledged that further research into more advanced methods for evaluating a child's well-being should be conducted.

The fifth section of the framework asks the user to identify how they will communicate the progress of NBL practices to relevant stakeholders. This requires the user to determine who their most important stakeholders are and how they will stay in contact with them. The following section provides further analysis of the relevant stakeholders.

Finally, as an essential step in ET, the framework requires users to review their NBL

practices. They are asked to reflect on the NBL practices that have been implemented and start the worksheet over. This is a critical step as it provides an opportunity to reflect on and improve their current practices. It is suggested that users review it at least once a year to make sufficient use of this framework. However, it can be done more frequently if the school sees fit.

Stakeholder Analysis

Successful implementation of NBL practices in Ukraine depends on a thorough understanding of the participants and their activities. To meet this need, a materiality matrix was developed to identify the key actors, which is illustrated in Fig. 4. Additionally, it was used to identify potential actors who could push this concept further in Ukraine. The x-axis of the graph represents the interest the stakeholder will likely have in the project, while the y-axis represents the likely influence they will have.

In the presented graph, the top right section represents key stakeholders, those who have both the highest level of interest and influence. These stakeholders include principals, teachers, and parents. For the successful implementation of NBL, their participation and support are vital.

Stakeholders with high influence but less perceived interest are located in the top left section. They include social NGOs, social funding organisations, the Ministry of Education, and city planners. These stakeholders are highly influential and have the potential to increase NBL practices significantly but will likely move slower and have less incentive to participate than those in the top right section.

Both the bottom left and right sections represent stakeholders with lower levels of influence and, therefore, should be of lower priority to involve. While they will likely not be as influential as those previously mentioned,

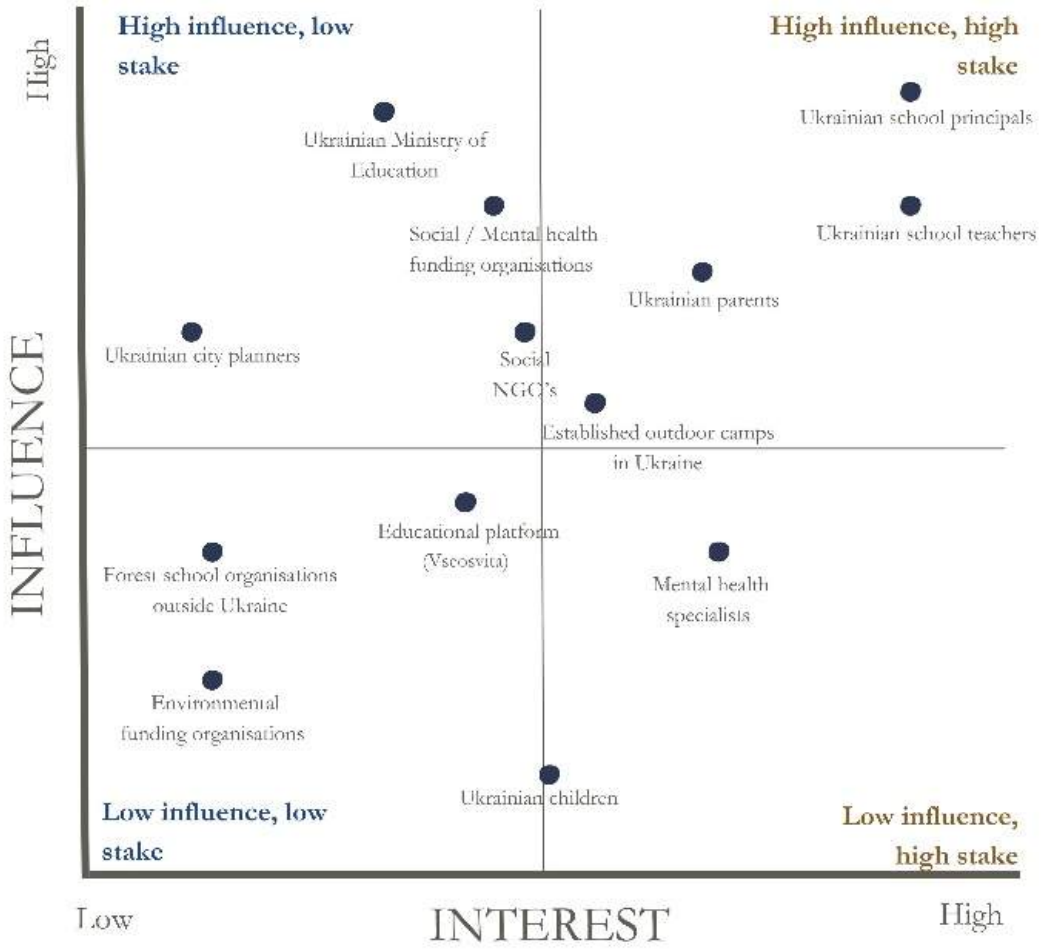

Figure 4 - Illustration of the materiality matrix with the identified key stakeholders according to their interest in and influence over the project. Influence is presented on the x-axis, while influence is presented on the y-axis.

there is still potential for them to be beneficial and, therefore, should not be neglected in full. These stakeholders include NBL organisations outside Ukraine, environmental funding organisations, educational platforms, and psychological specialists.

Conclusions

This project aimed to aid further implementation of NBL in Ukraine through a baseline assessment of NBL practices in Sweden. To do this, interviews and study visits were conducted, and a literature review was performed to identify the benefits of NBL, factors for successful implementation and longevity, as well as potential challenges of implementation that might be faced in Ukraine. Upon gathering the results of all of these factors, the project group analysed the general transferability of NBL to Ukraine through a PESTEL and SWOT analysis. Further, to address schools on an individual level, an implementation framework was created which provides individual schools with practical steps for NBL implementation. Additionally, a stakeholder analysis was created to illustrate the most important actors for further application of NBL in Ukraine.

Upon concluding the presented research, the project group would like to reiterate the importance of an interconnected community for implementing NBL practices. It is suggested that the next steps for NBL in Ukraine involve creating a network of educational practitioners who can support and learn from one another. The future of NBL in Ukraine is exciting and highly possible. The project group believe that the current research presented can assist in expanding NBL practices across Ukraine and help children recover from traumatic times.

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Figure 4: Clothing and footwear for children at school during the autumn season

Figure 5: Backyard of the private kindergarten with natural elements

Nomad Energy Solutions

Towards a definition of value that drives the decarbonisation of buildings in the UK

Project Brief

The IIIEE project team consulted Nomad Energy Solutions Ltd., a startup that offers data-driven insight and advisory services for efficiency optimisation and decarbonisation strategies. Nomad was founded in 2019 and their target market is public and commercial buildings in the UK.

The objective of the project is to gain a stronger understanding of Nomad's customers needs, and what value Nomad delivers to them. Furthermore, it aims to explore how Nomad can demonstrate their value in a manner that resonates with customers to advance decarbonisation in the UK heating market.

The consultancy team would like to acknowledge the invaluable support of the project supervisor Lars Strupeit and primary contacts at Nomad, Peter Öhrström and Jason Wilkinson. Lastly, the team wants to thank the interviewees and workshop participants for their time and insights.

Project Team

Ari Ronai-Durning *is originally from the US. He holds a Bachelor's degree in Political Science and Environmental Studies. Previously, he worked for Tesla and a US based solar developer. His main passion is making coal, oil, and gas history.*

Patricia Pasaribu *came to the IIIEE from Indonesia and studied Urban and Regional Planning for her Bachelor's degree. After graduation she worked as convener for public-private partnerships focused on sustainable development strategies in Indonesia.*

Florencia Linarez *is from Argentina and holds a B.A. in International Relations. She worked in sustainability communications at NGOs and IOs before joining the EMP program. Alongside her studies, she works as a communications assistant at Hyme Energy.*

Background

Buildings consume 30% of global primary energy, and operating them generates more than one-quarter of all energy-related emissions [1]. Tackling these emissions presents an enormous challenge. Globally, approximately 80% of the buildings expected to be occupied by 2050 are already constructed [2]. Luckily, there is a developing trend to retrofit existing buildings reliant on fossil fuel-based heating and cooling with electrified and renewable-based energy systems [3].

Heating, ventilation, and air conditioning (HVAC) of commercial buildings in the UK is the market focus of this report, and here, too, there is substantial momentum in the direction of decarbonisation. Rapidly retrofitting existing buildings presents a key challenge for the sector, especially in the UK, which has one of the world's oldest building stocks [4]. Many commercial buildings still rely on outdated gas boilers, poor insulation, ageing distribution systems, and other inefficient infrastructure. In order to address this challenging context, the client company for this project, Nomad Energy Solutions, offers innovative solutions that will be further explored and developed in this report.

About Nomad

Nomad Energy Solutions is a UK-based startup established in 2019 operating within the building sector, with a particular focus on HVAC systems. The company specialises in optimising heating, cooling, and ventilation systems in buildings through data-based recommendations. Their services include operational adjustments focused on reducing energy consumption, carbon emissions and improving air quality. Additionally, they offer long-term strategies for the decarbonisation of heating and cooling, incorporating infrastructural, behavioural, and other modifications. The data is gathered through advanced sensors and meters, and this information is then processed using an in-house platform. The processed data are further refined by experts who provide specific insights and recommendations based on the unique context of each building. Nomad is actively working to develop AI to assist human analysis.

The Nomad team has extensive experience in low/zero carbon buildings, HVAC engineering, management, artificial intelligence, and more. The company's primary market segment is commercial buildings in the private sector, such as portfolio managers, property owners, real estate investors, and more, as well as entities within the public sector, for instance, city councils and universities. Furthermore, Nomad's position and role in the market impacts various stakeholders within the supply chain, including heat pump and gas boiler manufacturers, HVAC installers, building operators and technicians, and more.

Detailed Project Description

After the first meeting with the client company, the IIIEE project team recognised four main challenges:

a) diverging internal perspectives about Nomad's value proposition,
b) a need to define the unique value proposition from the customer's perspective,
c) a demand to align external views and perspectives into the company's value proposition,
d) and the growing importance of effectively demonstrating the value proposition to drive sales.

Recognising these challenges, the following task description was defined (see Figure 1).

First, to gain a stronger understanding of Nomads customers needs, what is the primary value Nomad creates, and how the two can align.

Secondarily, to explore how Nomad can demonstrate their value in an effective manner that resonates with customers to better drive decarbonization in the UK heating market.

Figure 1: Task Description

The project carried out by the IIIEE project team contributes to Nomad Energy Solutions in three aspects, as explained in Figure 2.

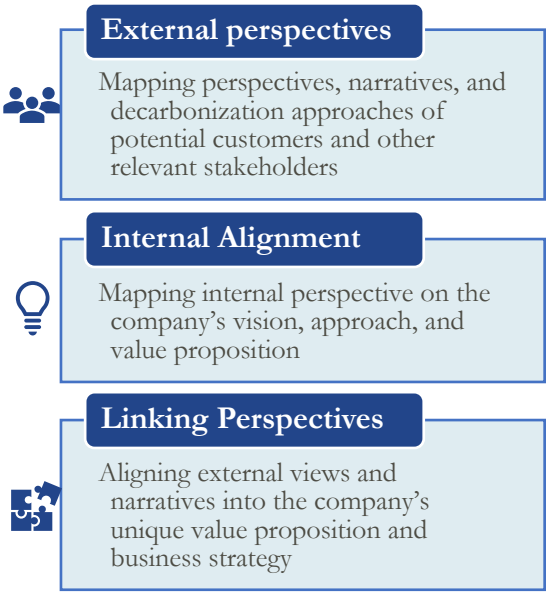

Figure 2. Contribution from the IIIEE project team to the client company.

The Approach

The project team followed five systematic steps (see Figure 2). First, the team conducted an extensive literature review to understand the context of decarbonisation and gain a clearer understanding of the initial assumptions about the current internal perspective on Nomad's value proposition. The literature review focused specifically on the policy landscape, technical and market developments, and the value proposition of Nomad's competitors. The team applied the Jobs-to-Be-Done approach [5] to the study to ensure customer needs remain at the forefront of the analysis, along with Stakeholder Theory [6], to place weight on other stakeholder perspectives instead of focusing solely on customers.

Second, the consulting team hosted an internal workshop to gain a clearer understanding of the initial assumptions about the current internal perspective on Nomad's value proposition. Simultaneously, 11 semi-structured interviews were conducted with professionals in the UK building sectors. They were divided into five groups of stakeholders: customers, business partners, associations, shareholders, and competitors. The interviews were designed to gain stakeholders' perspectives on what value Nomad delivers and to identify future collaboration opportunities for Nomad's business development.

Inputs from internal workshops and stakeholder interviews were mapped using the Stakeholder Value Creation Map [7] to look for intersections and potential improvements for Nomad's value proposition. This step is particularly important to ensure external perspectives are communicated and addressed in Nomad's future activities. Additional emphasis was put on the non-monetary values Nomad could potentially capture from engaging with these stakeholders.

The outputs were categorised into a map of Nomad's value offering, value capture, value creation activities, and future value creation opportunities for each stakeholder group. These outputs were then further analysed to generate keywords and phrases, which the project team workshopped into several full value proposition alternatives and suggestions for

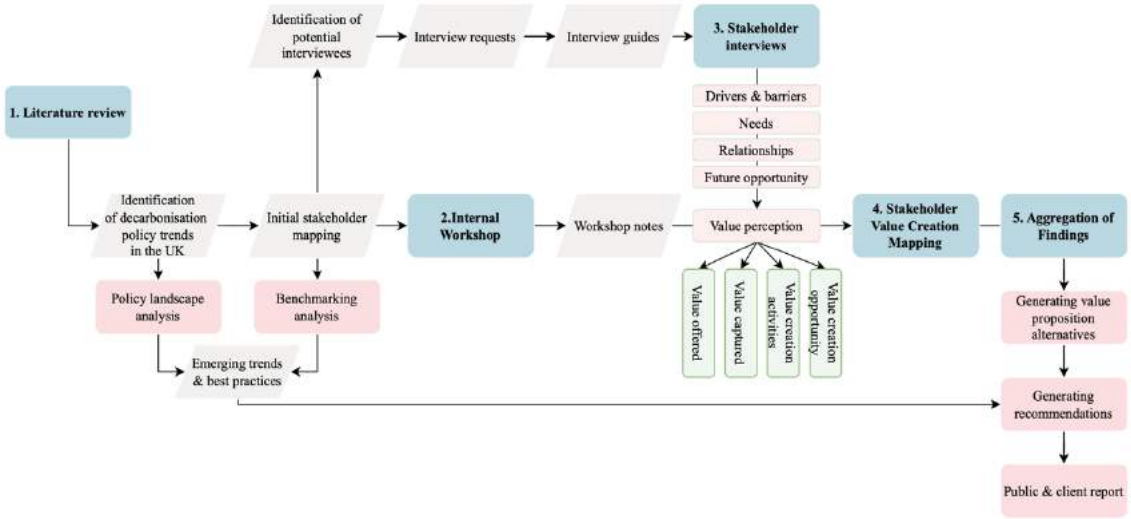

Figure 3: Research design

future improvements to aid Nomad in delivering its enhanced value proposition.

Business Ecosystem

The section explains the business ecosystem in which Nomad. The following information was utilised for interview design and generating recommendations.

Policy Landscape

The UK government presented strong commitments in the Net-Zero strategy part of their "Ten Point Plan for a Green Industrial Revolution". As a country, the UK is resolved to become net zero by 2050. This ambition is accompanied by policies that enhance the decarbonisation of the UK's economy, including buildings [8].

The main policies at the national level include subsidies and economic support to private and public entities and individuals to decarbonise commercial and residential buildings. One of the policies includes the phase-out of natural gas boilers by 2035, which was postponed in early September without an updated date confirmed at the time of writing. Other policies include support via grants for local public authorities to decarbonise energy in their buildings [9].

Image 1: the IIIEE consultancy team, from left to right: Ari, Patricia and Florencia

Benchmarking Competitors

Due to rapid changes in the property technology market, the IIIEE project team recognised the opportunity to update Nomad's competitive analysis. As an initial step, the project team developed a competitive benchmarking matrix. Rather than highlight specific advantages or disadvantages, the matrix focuses on external communication regarding each company's value proposition based solely on its website. It then supplements this with background information such as company size based on employee headcount and the number of square metres under management, etc. The data draws on a variety of external sources cross-referenced with publicly available data on LinkedIn. The final matrix includes nine companies and over 20 different data categories, but for the purposes of the public report, the consulting team is presenting a greatly simplified version. The full documentation is provided to Nomad directly as one of the project deliverables. See Table 1 to view the simplified matrix.

Findings

Diverging Internal Perspectives

The initial assumption of diverging perspectives within Nomad's internal ecosystem was confirmed through the internal workshop. Differing ideas about for whom Nomad creates value were identified: some focus primarily on building owners and managers, while others consider other stakeholders, including building occupants, local government, and the public.

The project team identified a similar level of understanding on how Nomad answers to stakeholders' needs: understanding of buildings, cost reduction and de-risking of building operations, improving occupancy comfort in an ageing building stock and, to some degree, a need for decarbonisation and CO2 reporting. The internal perspective in this issue mainly focuses on clients, while also touching on tenants' perspectives.

When discussing what benefits Nomad offers, there were quite clear distinctions of focus between two perspectives. On the one hand, it is a tailored approach emphasising in-depth analysis and advisory services for problem-solving. On the other hand, it is full-scale automation,

which focuses more on utilising data automation to scale up the business.

Demonstrating Added Value

One important insight the project team gathered from the interviews is how measuring added value is a challenge for Nomad and other companies offering similar solutions. Since Nomad is a relatively new company, data points on carbon reduction and behaviour changes are limited, and thus, the intermediate value of decarbonisation and energy efficiency is still hard to prove. Highlighting immediate changes could be one way for Nomad to answer customer's needs by demonstrating their impact. Currently, existing customers are in the early stages of measuring the immediate changes in energy cost savings and risk reduction. Since there are several factors that play into the cost reduction, attributing these changes to Nomad's solution was not easy from the customer's perspective. On the other hand, risk reduction is even more challenging since avoided risk is not easily noticeable unless documented properly. Putting significant effort into measuring these immediate impacts and communicating them with tangible evidence to its customers could help Nomad build validity and ultimately expand their business.

Access to Data

Throughout the interviews, a range of stakeholders raised concerns regarding data sharing, data privacy, and data management. Nomad

	Nomad Energy Solutions	Brainbox AI	Leaftech	Thermosphr
Launch Date	2019	2019	2018	2019
Markets	UK	20+ countries (unspecified)	Germany and others	France, Germany and Poland
M2 managed	Unespecified	9,290,304	500,000	400,000
Tagline	We are an analytics and advisory service that works alongside, and improves upon, existing building systems.	Decarbonize and optimize your buildings with autonomous AI	Make data-driven decisions. Optimize building performance // ""Move towards a net-zero building stock with our data services."	"HVAC smart control for energy efficient real-estate."
The solution	"We provide our customers with the fastest most financially beneficial route to building energy optimisation and decarbonisation."	HVAC optimization solution connects to your existing HVAC systems and autonomously sends real time optimized control commands to minimize its emissions and energy consumption	"With the building Digital Twin from Leaftech, you can access highly accurate data to understand your building's performance, make informed decisions on upgrades, and work on the required building optimization measures"	Data and thermodynamics-based / science-based analysis of the BMS data to improve energy systems and reduce energy consumption and costs with low CAPEX
The service	"We are a hybrid between building management and advisory consultancy providing hard facts along with human insights."	1) ("Measure") Data collection , 2) ("Reduce") HVAC optimization via AI , 3) ("Offset") facilitating the purchase of carbon offsets that fund recognized green initiatives such as carbon capture technology, nature-based solutions, and renewable energy projects.	1) Modelling ('Digital Twin'), 2) Analytics, 3) Control: "With the building Digital Twin from Leaftech, you can access highly accurate data to understand your building's performance, make informed decisions on upgrades, and work on the required building optimization measures.	TOU Arbitrage Optimization, Building Inertia, Physical Model of building heat loss, NOT AI. Smart Solutions don't require it, CTO had deep experience with heating systems at GE and BMW (EV batteries)

Table 1: Competitor benchmarking matrix

requires access to data for the functionality of their AI solution to deliver tailored insights and recommendations for operational and decarbonisation improvements. This has the potential to raise concerns among their customers and prospective clients.

This challenge is applicable to both customer target groups, encompassing both the private and public sectors. On one hand, the public sector is apprehensive about granting access to its internal systems, which often contain sensitive government operations data. In that sense, the interviewees mentioned that it is useful to explain the comprehensive data needs from the beginning. On the other hand, the private sector exhibits a marked reluctance to divulge their data. In particular, tenants often own the data on energy consumption, and that represents a bigger barrier to the installation of energy optimisation solutions.

Barriers and Drivers

The IIIEE project team identified key barriers and drivers based on an analysis of the interviews with experts in the sector, an internal workshop with the Nomad team, and the literature review [10]. The main findings are presented in Table 2.

Stakeholder Value Perception

A Stakeholder Value Canvas Map (SVCM) was developed after processing data from workshops and interviews to find out how the five groups of stakeholders view Nomad's business. This canvas (see Figure 4) highlights the value exchange between Nomad and stakeholders, particularly how each stakeholder perceives Nomad's current and potential future value offerings and, complementarily, what Nomad can capture from them. The value exchange can be direct or indirect, monetary or non-monetary.

Other stakeholders to consider in future studies include tenants, political actors, employees and utilities.

Barriers	Drivers
• Insufficient and incomplete data on building performance available to decision-makers	• Demand for data due to ESG reporting requirements
• Uncertainty in regulatory and policy frameworks	• Need to reduce risk of building assets from investors
• Insufficient skilled labor and supply chain shortages	• Adoption of green tariffs that promote the deployment of renewable energy
• Limited grid capacity for accommodating renewable energy	• Growing public interest in sustainability
• Lack of collaboration due to profit motive in along market participants	• Increasing prioritization of sustainable and energy efficient aspects from tenants
• Insufficient financial support from the public sector towards both private and public commercial retrofits	• Escalating prices of natural gas and overall inflation in the UK

Table 2: Barriers and driver for building decarbonisation in the UK

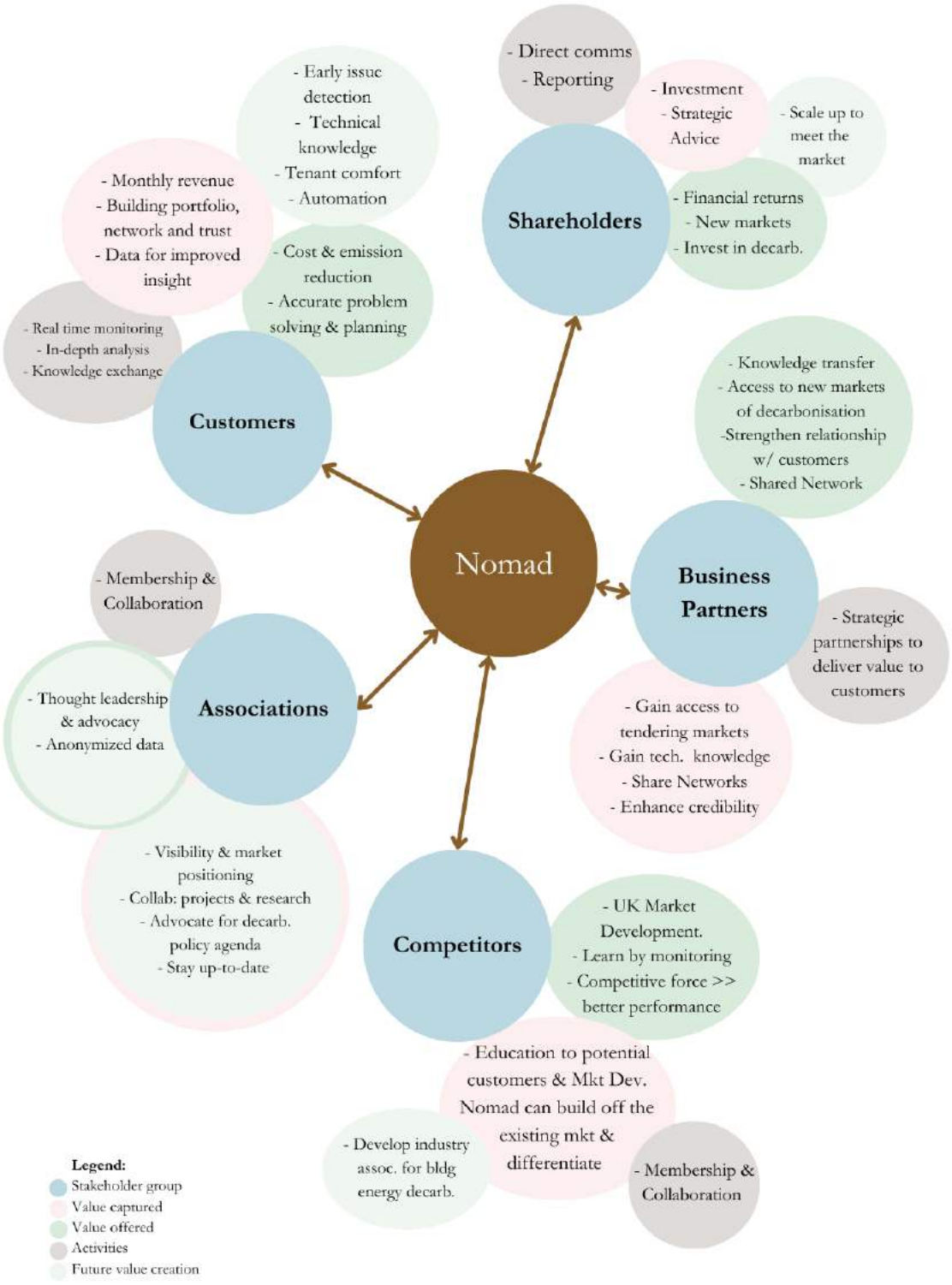

Figure 4: Stakeholder Value Creation Map

Value Proposition

Design

In designing the value proposition statements as a key deliverable for the project, the IIIEE team's intention was to place the primary focus of each value proposition sentence on direct customer benefits. The service and methods Nomad offers to achieve those customer benefits should be secondary. The first and second value proposition alternatives offer the most active, customer-centric sentence structure, while the third alternative is structured in a more traditional manner. The goal of the third alternative is still to emphasise customer benefits but to use a template that is instantly recognisable as a traditional value proposition by using the term "provides". However, a description of the service and how it functions is de-emphasized by placing it in the final clause of the sentence while customer benefits gained from the service remain in the foreground.

Furthermore, the customer benefits highlighted in these statements came directly from synthesising stakeholder interviews and the stakeholder value mapping exercise. After collecting feedback on stakeholders' perspectives from the Nomad team, the IIIEE project team eliminated some key messages that had other connotations in other client contexts that the team was not able to interview. Examples of keywords include Energy savings, cost savings, tailored advisory, data-based insight, and operational efficiency.

After gaining further perspective from the second client workshop, the project team refined the value proposition statements with the aim of clarifying and solidifying them. This process resulted in the following value proposition alternatives (see Figure 5).

Value Proposition Alternatives

Gain a deeper understanding of energy consumption in your buildings and make informed, data-based decisions to improve efficiency and plan for decarbonisation

Unlock immediate energy savings, maximise operational efficiency, and plan smarter for decarbonisation with our data-based insight.

Nomad provides immediate energy savings, continuous optimisation, and a pathway to efficient decarbonisation through data-based insight.

Figure 5. Value proposition alternatives

Implementing the Value Proposition

The value proposition alternatives are named "alternatives" because they offer recommendations that combine stakeholder perspectives with internal recommendations based on internal workshopping. The IIIEE consulting team does not expect Nomad to replace their existing messaging immediately with these recommendations. Rather, the team hopes that these alternatives offer a guide for Nomad to continue to refine and hone their messaging and communication to external stakeholders as well as improve internal understanding and alignment on their focus as a company. That is why the IIIEE project team pursued an interactive process of co-creation.

Supplementing the Value Proposition

Nomad advances building decarbonisation with expert efficiency optimisation, offering cost savings and risk reduction through data-based advisory to commercial and public building managers.

Figure 6. What is Nomad?

While workshopping the value proposition statements, the project team also developed a related statement that better addresses the question, 'What is Nomad Energy Solutions?' which could also be rephrased as 'What does Nomad Energy do?' (see Figure 6). This sticky question is one that came up multiple times in client workshops yet has a slightly different meaning from a value proposition. It is more important for internal understanding, whereas a value proposition can have a dual purpose (internal/external) but helps communicate the value Nomad offers to its external stakeholders.

Image 2. IIIEE Consultancy team in a workshop with the client

Next Steps

Building upon the value propositions the IIIEE project team developed based on stakeholder input, this section offers a series of final recommendations to Nomad Energy Solutions organised into three categories— strategic, operational, and communications focused. At the end of this section, these recommendations are mapped based on the potential impact on Nomad's business and the suggested time of implementation.

Strategic Changes

Value Proposition Development

A. **VP development is foundational:** Place renewed emphasis on collectively defining Nomad's value proposition. Clear definition and alignment are important foundations to build all other aspects of the business.

B. **Clients:** Put the client's perspective first, not just in communications, but in market positioning, product development and as many business areas as possible (and don't forget other stakeholders). It's easy to think that you know what customers want, but needs and desires change. Stay dynamic and responsive to shifting demands and practice reflexivity.

C. **Stakeholders:** Take stakeholders' perspectives into account when defining the value proposition despite targeting clients specifically. Stakeholder network effects are often more significant than anticipated.

D. **Develop mission statement:** Develop a mission (and potentially vision) statement alongside a value proposition to further clarify Nomad's position for the benefit of employees and external stakeholders.

Competition

E. **Updated competitor analysis:** All the big players in the industry think their competition is "just a dashboard" while they offer "real/measurable efficiency improvements." As a result, perform further competitor analysis and refine the value proposition to highlight Nomad's unique selling points. It may be more challenging on a second look than originally thought.

F. **Focus on City Council momentum:** …despite the previous point, the market is sufficiently large, and Nomad has found a market niche by targeting smaller city councils in the UK. Competitors seem focused on private buildings in their respective local markets (concentrated EU countries in Western Europe). Lean into this strength.

G. **Scalability:** Don't simply accept common knowledge about scalability at face value. People prefer working with people. Technical solutions should enable Nomad employees to devote their time to the highest-order tasks and offer the best-personalised service possible rather than replace their expertise entirely.

Operational Changes

Customer Relationship

H. **Feedback platform:** Establish a platform for customer feedback loops to better understand their needs and concerns.

I. **Client Relationship Manager:** Hire a dedicated client relationship manager to build stronger relationships with customers.

Demonstrating Value

J. **Success stories:** Create detailed case studies and success stories from existing projects to showcase how Nomad can help its customers monetise their decarbonisation journey.

K. **Sustainability reporting:** Develop a sustainability report to showcase

Nomad's commitment to reducing carbon emissions and its impact on building decarbonisation in the UK.

Collaboration and Partnership

L. **Networking and advocacy:** Collaborate with industry associations, universities, and research institutions to stay at the forefront of building optimisation market trends and policy development.

M. **Partnering with supply chain:** Develop partnerships with boiler (and heat pump) manufacturers that enable Nomad to provide reassurance to clients that they can make substantial changes to existing infrastructure without risking reliability or voiding manufacturer warranties.

N. **Public narrative:** Position company executives as thought leaders in the field of building decarbonisation through speaking engagements and publications.

Communications

Branding

O. **Keywords:** The project team encourages Nomad to utilise the keywords provided directly to them as one of the final deliverables. These are selected based on research and are relevant to the niche market Nomad wants to target.

P. **One Slide, One Message:** Adopt a one-slide, one-message approach to presentations and reports. This will streamline information delivery and enhance clarity, making it easier for stakeholders to grasp the key points.

Q. **Key messages for target groups:** Because of diverse customer groups, it is recommended to introduce customer-oriented modifications to the value proposition to better address the specific customer needs and interests.

Relevant Messaging

R. **Customer education on equipment changes:** Create educational materials for customers to address concerns about significant operational changes to equipment, focusing on the provision of evidence and warranty-related information.

S. **Communication regarding risk reduction:** As mentioned, each stakeholder comprehends risk differently. It is highly recommended to create clear communication materials explaining the definition of risk for Nomad, as well as how it is addressed comprehensively by Nomad's offering.

T. **Behavioural change education:** Develop separate educational materials for both customers and tenants, emphasising behavioural changes related to heating regimes.

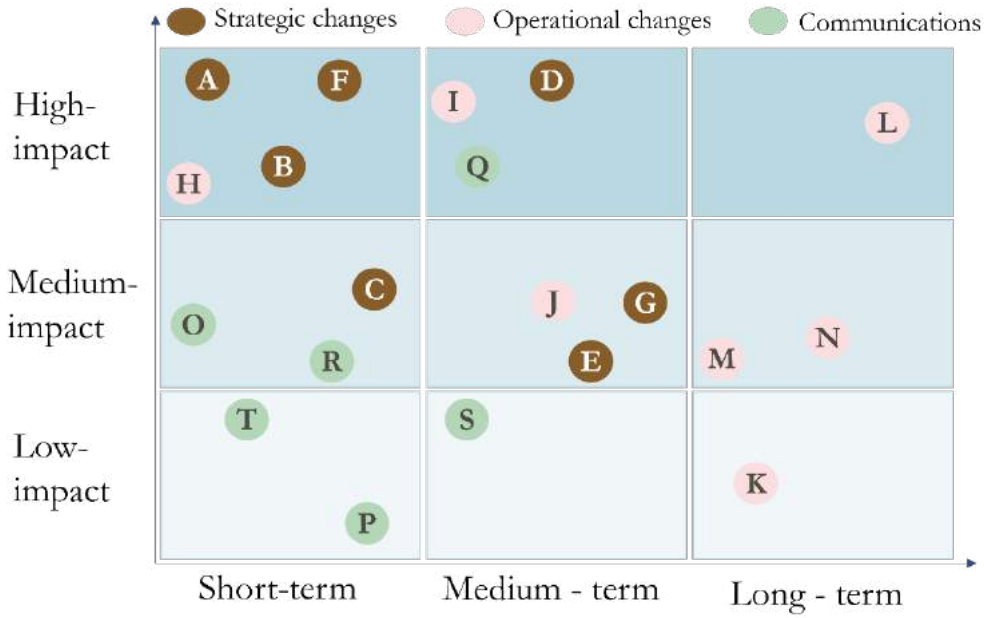

Figure 7. Priority recommendation map

Priority Recommendation

To maximise effectiveness and avoid inefficient resource allocation, the consulting team prioritised the recommendations based on impact (on Nomad's business) and suggested time of implementation. The recommendations are mapped in Figure 7, with the top left being the highest priority (rapid implementation, high impact) and the bottom right being the lowest (later implementation, low impact).

Final Remarks

This project had the objective of supporting Nomad Energy Solutions with a third-party perspective about their value proposition by aligning internal and external perspectives.

Overall, the consultancy team found that the initial assumption of a diverging perspective within Nomad about its value proposition is valid. On the other hand, it was identified that external stakeholders, especially ones that Nomad has been engaging with, have a pretty good level of understanding as to what Nomad offers, except for risk reduction. Regarding stakeholders that did not have knowledge about Nomad, the team explored their needs and understanding of similar solutions, concluding that the main driver for decarbonisation in buildings is energy cost reduction, while CO2 reductions may come in second place.

Through this process, the project team developed several value proposition alternatives for Nomad to take forward. Finally, the consultancy team offers strategic, operational, and communications recommendations to achieve the objectives of the project.

The IIIEE project team looks forward to watching Nomad's future development and success in optimising and decarbonising commercial buildings in the UK and beyond.

Image 3: from left to right, Ari, Florencia, Lars and Patricia.

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The Voluntary Carbon Market (VCM)

Ensuring integrity in an emerging market: risks, opportunities and key steps for success in the voluntary carbon market

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Project Brief

International and national regulations, customer demand, investors, new competitors, and employees are all exerting pressure on corporations to show how they are in line with, or preferably contribute to, a net zero future. While emission reduction targets are becoming mainstream and emphasised in most sustainability reports, the path to reach these are too many not possible without offsetting residual emissions. This development has caused the demand for carbon credits, representing one tonne of removed, avoided, or reduced CO_2 from the atmosphere, to surge, subsequently inviting a wide range of stakeholders with different incentives to enter the market. Today, the Voluntary Carbon Market (VCM) is a controversial topic, presenting both an opportunity to accelerate the journey to a net zero future but also posing a serious threat if exploited for profit-maximising purposes.

Project Team

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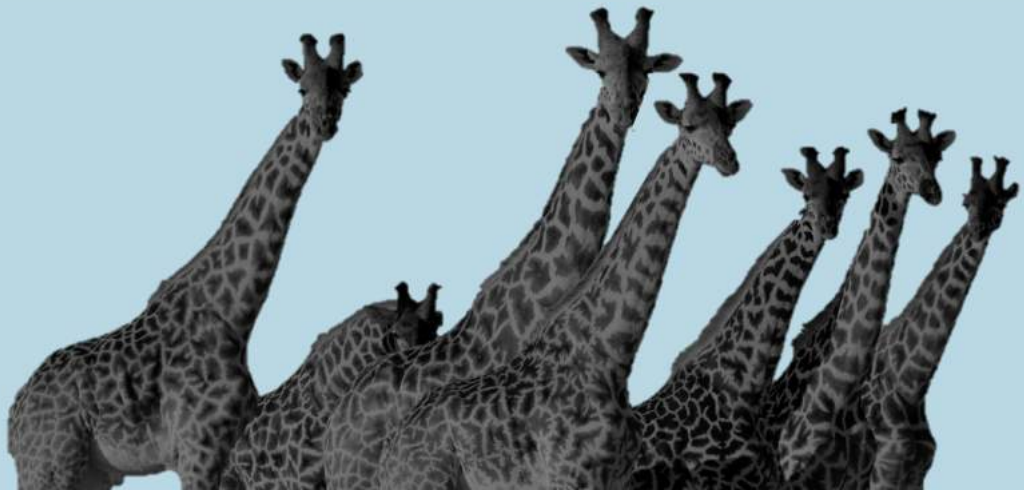


Preface

The market for trading carbon as a commodity, both mandatorily and voluntarily, is a novel and dynamic domain that can be challenging for practitioners and non-practitioners to grasp fully. This is partly due to the vast interchangeable terminology. Therefore, to reach common ground, this report begins with a compilation of common terminology to make the reading all-inclusive.

Common terminology

- **Carbon certificate,** also known as **credit:** tradable permit that represents the removal of 1 tonne of carbon dioxide (CO_2) emissions from the atmosphere. Certificates generated in a specific year are called **vintages**.
- **Carbon programme**: an initiative or a project designed to reduce or remove CO_2 emissions from the atmosphere, typically generating carbon certificates that can be traded in emission trading schemes. The phases of developing a carbon programme are project identification and design, registration, validation, implementation, monitoring and reporting, verification, credit issuance, credit retirement, and project maintenance.
- **Carbon registries and standards**: organisations that provide a set of independent methodologies to certify projects and issue certificates, which are hosted and displayed in registries. Examples: Verra and PlanVivo.
- **Rating agencies**: organisations that rate carbon certificates externally based on project data.
- **Corporates**: large-size companies that interact in the voluntary carbon market, e.g. Microsoft, Meta, Alphabet, BMW and Shell.
- **Carbon brokers**: companies that procure, transfer, and retire credits from a trader on behalf of a client. Sometimes, they assist in the development of a project in exchange for a commission or credit ownership.
- **Third-party auditors**, also known as **VVB** (validation and verification bodies): they independently verify a project's impact against a Standard methodology.
- **Industrial carbon dioxide removal (CDR)**: activities that rely on industrial processes to reduce and remove emissions, thus excluding them from achieving immediate and highly scalable removals. Examples: Direct air capture (DAC), Bioenergy with carbon capture and storage (BECCS), ocean liming, etc.
- **Nature-based solutions (NbS)**: activities that utilise the carbon sink potential of nature to avoid and remove emissions rapidly, but is subject to higher risks of non-permanence. Examples: Afforestation, reforestation and revegetation (ARR), improved forest management (IFM), etc.
- **Monitoring, Reporting and Verification (MRV)**: a system of tracking and ensuring the accuracy of CO_2 claims from a market programme.
- **Carbon avoidance**: activities that prevent, reduce, or avoid greenhouse gas (GHG) emissions that would have otherwise happened. Examples: cookstoves, forest preservation, energy efficiency, etc.
- **Carbon removal**: activities that remove GHGs from the atmosphere. Examples: reforestation, DAC, ocean liming, etc.

Introducing the VCM

Even with rapid decarbonisation, scientific research shows that cumulative emissions from now on and until 2050 will exceed the carbon budget consistent with the 1.5 degree target [1]. To stay within that target, between 70 – 225 Gt of CO_2 will need to be removed from the atmosphere by 2050 [1]. This is the underlying rationale behind the carbon market's existence and its current development, calling for both public and private sector involvement.

The mandatory carbon market made up 95% of the total carbon market in 2021, corresponding to a market value of USD 850 billion [2]. The remaining 5%, USD 2 billion, was in turn, the value of the **Voluntary Carbon Market (VCM),** which is the focus of this report. Despite its modest size relative to the mandatory market, the VCM is expected to increase fivefold until 2030 with the potential to reach a market value of USD 10-40 billion [2]. The significant growth expectation is attracting a wide range of stakeholders, each with their own agenda, contributing to an increasingly complex, stratified, and fragmented market.

In light of this, the goal of this report is to **uncover the relationship between carbon projects, certificate prices, buyers, sellers and how they interact within the VCM landscape** as they collectively represent the pillars necessary for the VCM's environmental, social and economic success, and in turn lay out the key steps on **how to craft a high integrity program** that delivers the **maximum quantifiable value** to all actors involved.

Background

As implied above, the goal of the carbon market is to mitigate climate change by avoiding, reducing or removing carbon emissions from the atmosphere. This is achieved by placing a financial value on carbon, allowing for the operationalisation of reduction and removal targets within the market.

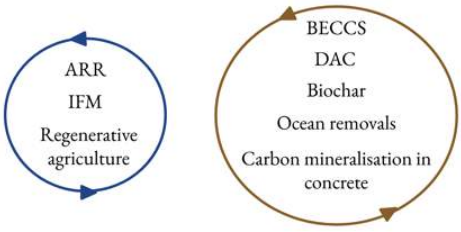
Voluntary markets

The VCM exists alongside compliance markets but enables companies, non-profit organisations, and individuals to purchase carbon certificates on a voluntary basis to achieve their decarbonisation and net-zero pledges outside of compliance purposes. To achieve this, companies can buy certificates that account for CO_2 emission reductions achieved in projects that:

- Generate **avoidance certificates by preventing GHG emissions** that would otherwise have happened (e.g. cookstoves, forest preservation, energy efficiency, etc.)
- Generate **removal certificates by removing GHG from the atmosphere** (e.g. reforestation, direct air capture, accelerated mineral weathering, etc.)

Putting the price on carbon

Regarding value, the price taxonomy depends on how long the GHG is sequestered, depending on whether it's sequestered within the short or long carbon cycle. As Figure 1 shows, the short cycle refers to the trading and pricing of carbon removals in the present, which are priced lower due to the shorter lifetime of the sequestered carbon. The long cycle, on the other hand, involves longer-term investments and strategies for carbon removals, often through technological advancements that result in a higher price on the market.



Short carbon cycle	Long carbon cycle
Allows for immediate action	Investment/R&D still in process
High scalability	Limited near term scalability
Moderate durability: 30-100 years	High durability: 300-10,000 years
Need for 10 Gt by 2030	Need for 10Gt/year by 2050
Necessary transition for sustainable future	Additional permanent CO_2 removal

Figure 1: The long and short carbon cycle

The current state of the VCM

Regulatory landscape

Without acknowledging the external influences – those existing, those in the pipeline, and general trends– the findings of the following report would be incomplete. Therefore, Figure 2 shows a fraction of the expected influencing regulations and standards that either directly or indirectly affect the voluntary carbon market.

Today, there is a lot of demand-side regulation, and more is expected in the next few years; EU Corporate Sustainability Reporting Directive (CSRD), European Sustainability Reporting Standards (ESRS) and CA Climate Disclosure Legislation[1]. These regulations require affected parties to separate net emissions across their supply chains with all internal removals, all

[1] CA Climate Disclosure Legislation: https://www.dlapiper.com/en/insights/publications/2023/10/california-pursues-greater-transparency-for-corporate-climate-claims

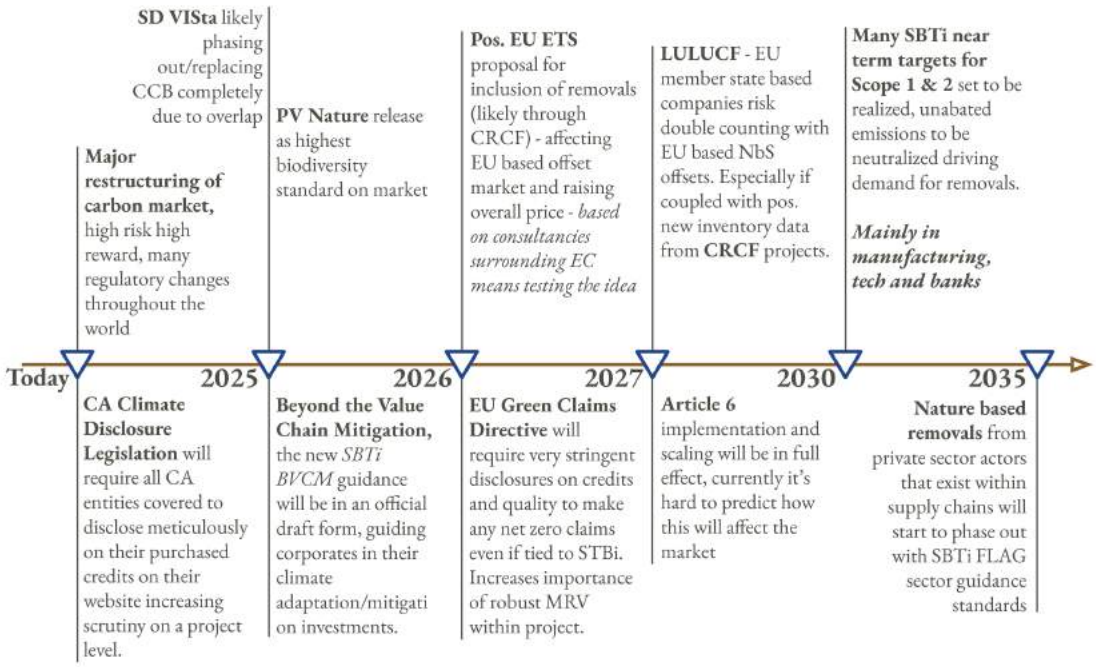


Figure 2: Estimated timeline of the regulatory landscape

financed mitigation actions, as well as reporting on any acquired carbon certificates in granular details, and certificate retirements [3].

The EU Green Claims Directive proposal requires a life cycle perspective for all environmental claims. It does not allow for any neutrality or net zero claims to be made unless it's residual emissions that are being neutralised on a product or company level[2] [4].

The Voluntary Carbon Markets Initiative (VCMI), the Nordic Dialogue on Voluntary Compensation, the Science-based Targets Initiative (SbTI) and others are setting up the guidelines for compensation and contribution claims[3]. The demand-side standardisation of claims indirectly drives the need for quality within projects and is a frame for our analysis.

Supply-side regulation has been lagging but exists within both the EU and global pipeline. The EU Carbon Removal Certification Framework (EU CRC-F)[4] and Article 6.4[5] of the Paris Agreement are both progressing towards implementation [5] - [6]. The CRC-F will set standard methodologies to cover carbon removal activities for certification and EU-level registries. Article 6.4 operates in a similar manner, where expert groups at the United Nations Framework Convention on Climate Change (UNFCCC) are putting together similar methodologies and a framework for carbon removals to translate VCM carbon certifications into Internationally Transferred Mitigation Outcomes (ITMOs), the Article 6.4 certification equivalent [6].

The way these two initiatives interact and influence the carbon market is still unknown, and exploring the potential impacts in detail are beyond the scope of the report. Instead, the IIIEE project team decided to focus its research on how to achieve the **highest levels of integrity**, well **beyond any future compliance requirements** that may be enforced on the supply side of the VCM.

[2] „Greenwashing era is over" by The Guardian: https://amp-theguardian-com.cdn.ampproject.org/c/s/amp.theguardian.com/environment/2023/may/15/greenwashing-era-is-over-say-ad-agencies-as-regulators-get-tough
An article about green claims from the Financial Times: https://www.ft.com/content/53f84f03-1f1c-4240-977f-9de0e4893377

[3] An article from Energy Post about the Nordic Code: https://energypost.eu/the-nordic-code-offsetting-should-be-used-to-exceed-not-meet-net-zero-targets/
The Beyond Value Chain Mitigation strategy by SbTI: https://sciencebasedtargets.org/beyond-value-chain-mitigation

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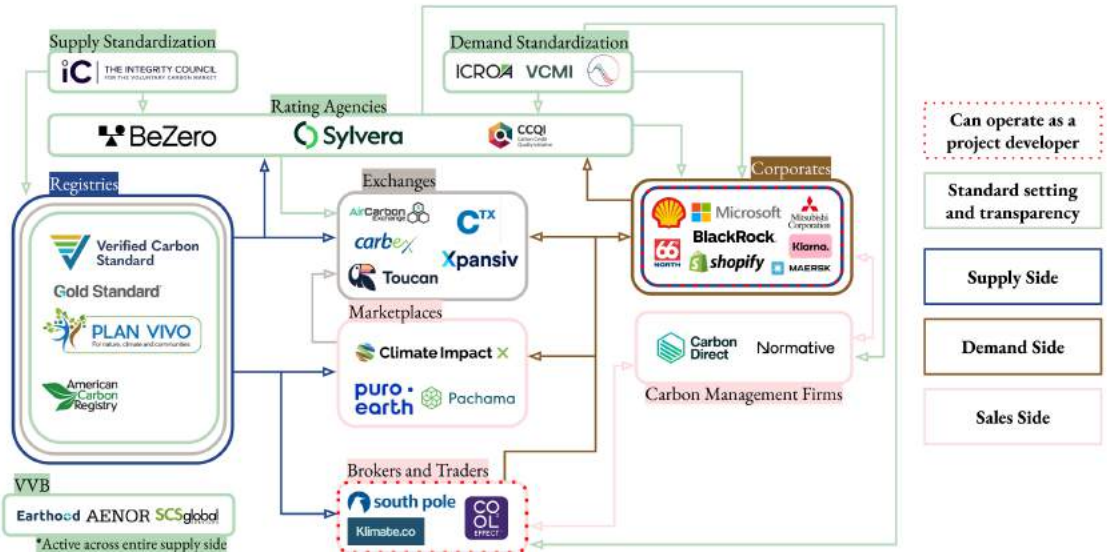

Figure 3: The VCM stakeholder landscape

Battling with Reputational Damage

While the urgency and demand for carbon avoidance and removals hits an all-time high, the trust in the carbon market has never been lower. Recurring headlines[6] from The Guardian and Follow the Money, to name two out of many, exposing the flaws and failures of the VCM such as over-crediting, resettlement of communities, and biodiversity loss, has severely curtailed demand, ultimately inhibiting the scaling of supply [7], [8].

At the same time, the need for high-quality offsets continues to increase as governments and corporates are under increasing pressure to meet emission reduction targets and comply with regulations. As a result, an increasing number of new stakeholders, such as rating agencies and monitoring, reporting and verification (MRV) providers, are entering the carbon market with the objective of rebuilding the fragmented trust by ensuring accountability and integrity. Hence, central to the understanding of the state of the VCM is a mapping of the ecosystem and its stakeholders, which is roughly outlined in Figure 3, and how they contribute to the process of turning planned offsets into real and quantifiable improvements. The objective of Figure 3 is not to understand all the interactions and interlinkages between the different stakeholders, but rather to recognise the complexity of the VCM and the inherent challenge of navigating the landscape throughout a project's lifetime.

Drivers and barriers of growth

In the footsteps of repeated reputational damage, the VCM has turned into a controversial topic characterised by loud voices both for and against its future development. Thus, a holistic understanding of it deems an acknowledgement of both its drivers of growth and the challenges that are holding it back. The drivers of growth explain why many stakeholders perceive offsetting, and thereby the VCM, as a must in difficult-to-abate sectors that depend on carbon credits in addition to serious decarbonisation efforts to reach their emission reduction targets.

Figure 4: Drivers of growth in the VCM

[6] The Kariba Lake carbon project: https://www.reuters.com/sustainability/cop/carbon-offset-firm-south-pole-cuts-ties-with-zimbabwe-forest-project-2023-10-27/

A The Guardian article on Verra's rainforest carbon credit methodologies: https://www.theguardian.com/environment/2023/jan/18/revealed-forest-carbon-offsets-biggest-provider-worthless-verra-aoe

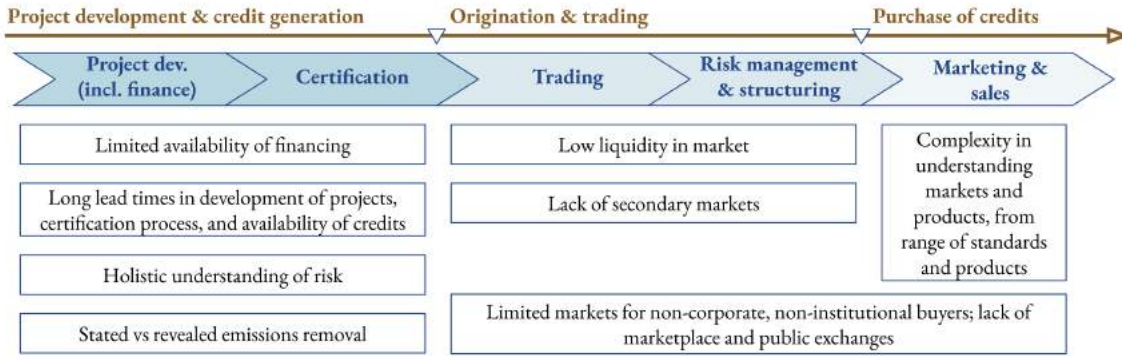

Figure 5: Barriers within the VCM

On the other side, serious challenges across value chains, on top of the lack of trust that a carbon certificate represents one tonne of removed or avoided CO_2 due to past shortfallings of projects to deliver on their promises and data reliability, result in significant transaction costs. This causes many environmental advocates to question whether resources are not better utilised elsewhere to reach emission reduction targets in time.

Key market insights

Market research was carried out, consisting of a review of various reports and interviews with industry professionals. Three key insights were identified: (1) Prices are determined on a project-to-project level, (2) The riskier the project, the lower the price, and (3) Time matters.

Key insight 1: Prices are determined on a project-to-project level.

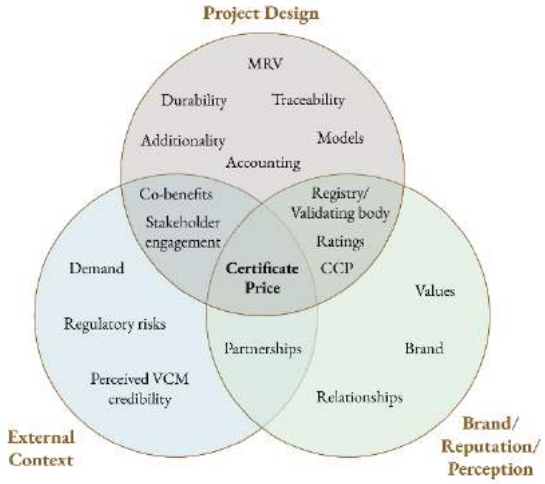

Figure 6: Determining the price of carbon certificates is complex

Determining the price of carbon certificates is a complex process due to numerous influencing factors. While it is commonly thought that the price of carbon certificates is determined by what registry they are listed on, in reality, certificates listed on the same registry vary significantly in price. The registry serves as the initial baseline, and it is crucial in verifying the project's claimed benefits.

The success of a carbon project is predominantly reliant on the project's quality. Project quality is the primary influencer of the certificates' price and is set at the project level. Quality pertains to the ability of the carbon project to sequester carbon, effectively mitigate associated risks, and generate co-benefits. An objective assessment of a project's quality is critical to its success, which is why scientifically backed baseline studies and state-of-the-art D-MRV is essential to ensure a project's quality and thereby its success.

Figure 7: D-MRV explained

Figure 8 shows how buyers rank different criteria when purchasing carbon certificates. 91% of buyers rank MRV as the top 3 most important quality criteria, as it is seen as a critical component to managing reputational risk [9]. A robust MRV is crucial for buyers to be confident that the claims they make are accurate.

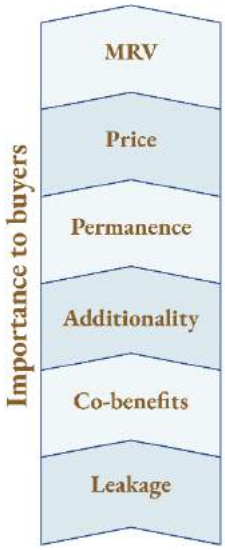

Figure 8: Certificate buyers' ranking of quality criteria (Shell & BCG, 2022)

The VCM is a market-based initiative, meaning that the basic economic principles of supply and demand determine the sale price of certificates. Due to increased market scrutiny following scandals, the demand for higher-quality certificates has increased while the demand for low-quality certificates (also commonly referred to as junk credits) has dropped significantly. This has caused prices of low-quality certificates to plummet, while higher-quality certificates are traded at increasingly higher prices.

Key insight 2: The riskier the project, the lower the price

The quality of a project is also dependent upon the level of associated risk. In a volatile market, rating agencies are becoming increasingly important as they bring more confidence and integrity to the market. Similar to bond credit ratings, rating agencies evaluate the risk of carbon projects and assign higher ratings to less risky projects. Higher certificate ratings enable brokers to sell certificates at a premium since they can ensure that risk is properly identified and mitigated. Additionally, this guarantees certificate buyers that the projects they are investing in have integrity and a positive impact.

Rating agencies such as BeZero and Sylvera evaluate projects and rate the projects' risk factors from very low to significant. This, in turn, affects the price of certificates, with low-risk projects able to sell certificates at higher prices. Different weights are placed on different risk factors to indicate the risk factors' relative importance to the overall rating [10]. A broad outline of how BeZero rates carbon projects can be seen in Figure 9.

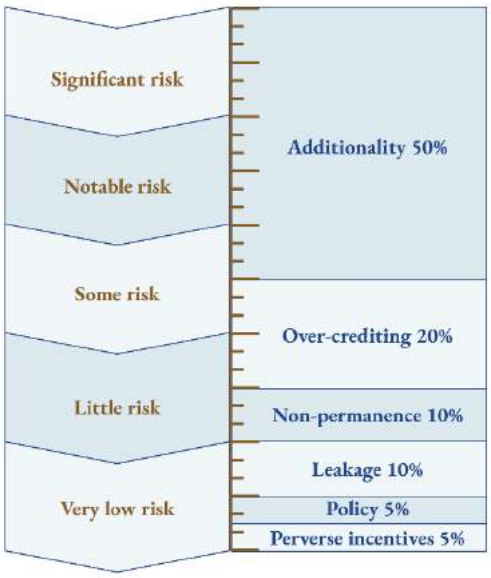

Figure 9: BeZero's rating methodology framework (BeZero, 2023b)

Figure 10: The six risk factors currently considered by rating agencies (BeZero, 2023a)

The primary risk factors evaluated by rating agencies include additionality, over-crediting, leakage, non-permanence, policy, and perverse incentives. Among these, additionality is regarded as the most crucial risk element that must be managed [10]. Carbon projects must demonstrate **additionality**, indicating that all alternative scenarios are taken into account in the absence of revenues generated by the project. A carbon project is considered additional if it is concluded that the **emissions sequestered would not have occurred without the revenues generated from certificate sales** [11].

Over-crediting is closely tied to emissions removal measuring methods utilised by projects. The risk of over-crediting **can be managed with D-MRV which measures emissions removals** along with forest growth, emissions associated with fertiliser use and seedling purchases, and more [11].

Reducing the risk of **leakage** is crucial. Is the project genuinely reducing GHGs, or is it merely **displacing emissions from the project area**? One significant form of leakage, particularly in the context of ARR projects, is the relocation of agricultural activities as a result of **resettled communities**. This can lead to the degradation of surrounding areas if land conversion is required [11].

It is essential to determine the duration of the certificate's commitment. Ensuring **permanence** for the committed time period by installing appropriate mechanisms to **protect against losses** is critical to reassure certificate buyers that the claims made are accurate. **Buffer pools** are important to mitigate the risk of non-accurate claims, as they help project developers **safeguard against any unforeseen certificate losses**. A percentage of certificates from each project is reserved in a shared buffer pool. Certificates from these buffer pools are then used to compensate for any project reversals that may occur as a result of forest fires, droughts, illegal logging etc. Hence, buffer pools act as insurance, ensuring that the number of purchased certificates correspond to the proclaimed carbon removals [11].

In addition to having a real, positive impact on the amount of CO_2 in the atmosphere, carbon projects are also assessed on their ability to have a positive impact on other aspects of their surroundings, i.e. the **co-benefits** they generate. These benefits are subject to location, scale and the stakeholders of the carbon project. Nonetheless, two benefits are recognised by VVBs and the VCM community as important, both from a risk mitigation point of view and from a project quality/value-add perspective; **biodiversity** and **community engagement**. It is worth noting that both co-benefits are primarily associated with NBS and can therefore increase the price of certificates associated with projects that conserve and restore biodiversity and promote community engagement.

Key insight 3: Time matters

When and how project developers sell their carbon certificates **significantly influences** the deals they are able to strike with offset takers and brokers.

Figure 11: Ex-ante vs ex-post carbon certificates

When matters as carbon is currently traded as a commodity, thus subject to price fluctuations on the carbon market. **How** project developers in turn decide to sell their certificates depends on whether they sell future (ex-ante) or past (ex-post) emission reductions, or a mix of the two.

Figure 11 illustrates the distinction between ex-ante and ex-post credits and how it ultimately affects the price of credits, as well as how the price for carbon credits is expected to develop in the future. Project developers are faced with a **trade-off**. They can either sell future emissions reductions and receive upfront capital that will contribute to the project's development and integrity, or find alternative financing solutions to get the project off the ground.

The latter could allow project developers to **sell the certificates at a higher price** after the emission reductions have taken place. Conversations with industry professionals revealed that **brokers buy ex-ante credits at a discount** of between 15-25%. Hence, selling all certificates before the offsets have taken place is likely to significantly reduce the profitability of the project. Alternatively, getting a carbon project off the ground is in many ways the most difficult and capital-intensive part of the project's lifetime, meaning that the capital received at that stage can be decisive to the emission reductions taking place altogether.

Finally, considering the steep demand expectations for high-quality carbon credits, a project developer betting on the market would undoubtedly maximise the number of ex-post certificates sold, assuming that profit maximisation is on the agenda.

A guide to establishing a high-integrity carbon programme

Conceptualising the end goal and prioritising key indicators for success serve as the foundation for developing a strategy that is ultimately able to deliver tangible outcomes. Figure 12 outlines the general decision-making process that you should follow as you move from vision to strategy to execution to delivery. If the goal is to ensure maximum benefits for the environment, community development, and biodiversity through the VCM, the following pathway would be recommended. Be reminded that the pathway is not static and can be deviated from based on developments in the external context, such as regulatory surprises, or due to changes internal to the project and program, such as goal priority shifts, stakeholder desires, etc.

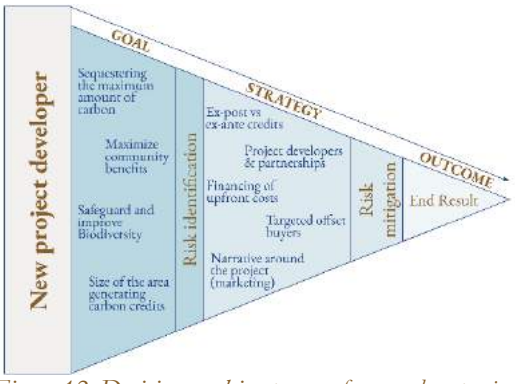

Figure 12: Decision-making process for a carbon project

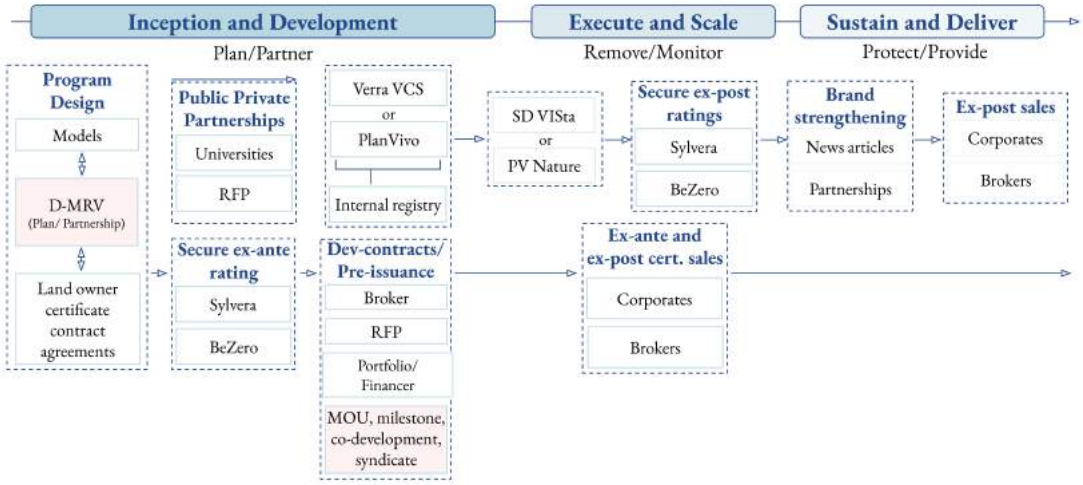

Figure 13: A pathway towards a successful carbon programme

For a nature-based carbon program, **MRV is the foundation you as a project developer will stand on.** Through extensive interviews with industry players and desktop research, the team concluded that the demand trend from the market, coupled with the increasing regulation on the supply and demand side, necessitates the establishment of high-quality carbon programs based on two fundamental principles: (1) **robust models for carbon accounting**, and (2) **transparent D-MRV plans**. Even projects that are operating without a commercial incentive should be intimately familiar with these two steps, as it is the core of the 'product' you are pitching. The weight placed on these two steps can't be overstated.

The next step would be to **identify the relevant registry**, Verra and the VCS being the largest and most well-known. Depending on the project's end goal, other registries like PlanVivo (community engagement focus) may be better suited. In the pathway presented, SD VISta and PV Nature (both are likely to be considered high integrity for biodiversity once finalised) are both disjointed from the initial certification and added later. This is because they are still under development, and can be added after the carbon program has started. These additional verified co-benefits will **add value and integrity** to the carbon programs and their target areas (biodiversity, community etc).

Securing a rating by a rating agency as you move towards finding either an agreement with a corporate, broker or project developer to help fund the program is going to both hold your program accountable and secure a trust-based relationship with the financing body you decide to engage with.

Once you have secured your financing, or/and have begun pre-issuing certificates (ex-ante), await your first few vintages to be verified. Then move on to securing your ex-post rating. With a high ex-ante, followed by a high ex-post rating, you will likely be able to both sell your upcoming vintages for a higher price and secure an even higher price for your ex-post certificates.

At this point, the process is streamlined, securing a higher price for certificates while delivering on the goals, allowing the maximum amount of money to flow into those who are keeping the program in operation. Depending on the goal, it may be beneficial to enter the market with an **ISO-certified program**, to generate revenue and bolstering reputation.

The timing of the decision to apply for a Verra, Gold Standard or Plan Vivo certification, or to engage with financiers or corporates, may vary depending on your goal. If the goal is to establish a durable brand as a project developer, there is an advantage to developing the programs as you go. If the objective is to develop a single project to benefit a small village and its surrounding environment, it may be better to do as much of the work as possible upfront to maximise the price of the certificates and the value added for local people.

Conclusions

Navigating the increasingly complex VCM, bounded by new regulations, stakeholders, and initiatives, is a difficult task. The stark contrast between low-quality certificates and high-quality certificates in their ability to have a positive impact on reducing, avoiding, or removing emissions calls for a project-to-project evaluation approach when assessing the quality, and thereby the price, of certificates.

Considering how trust is essential in any market to minimise transaction costs and stimulate growth in both demand and supply, rebuilding it is a top priority in the VCM as repeated scandals pose a barrier to scale despite the surging demand for carbon offsets. In light of this, buyers of certificates emphasise the growing importance of D-MRV as it is the primary tool suppliers have to prove accountability and minimise risks.

Equally important is for project developers to clearly define the key indicators of success of their projects, both in terms of mitigation outcomes, co-benefits and which stakeholders to involve, as this will be the backbone of the strategy.

Finally, recognising that offsetting emissions is not a substitute for actual emissions reductions in and across supply chains but merely an instrument to target residual emissions once further decarbonisation is no longer feasible. It is crucial not to let the carbon market distract us from our real goal; a low-emission, net-zero future.

A checklist for creating a successful carbon project

☐	Define the goal and the project's key indicators of success
☐	Develop a strategy based on the goals; choose the right pathway and identify the key stakeholders
☐	Develop an MRV framework to ensure maximum integrity of credits throughout the project's lifetime
☐	Construct a conservative and scientifically backed baseline scenario to avoid over-crediting
☐	Obtain relevant ISO certifications
☐	Ensure that there is a healthy buffer pool of certificates in case of unexpected reversal events
☐	List the project on a carbon registry
☐	Be confident about the project's additionality, both financially and from a carbon POV
☐	Predict any potential leakages of emissions
☐	Strategise how to mitigate different risk factors
☐	Work with a rating agency to receive a project rating
☐	Aim to sell a majority of the credits ex-post to avoid selling at a discount to receive a project rating
☐	Work with local communities and explore how to leverage co-benefits of your project

Figure 14: A checklist for a high-integrity carbon programme

Figure 15: The VCM Team, from left to right: Simon, Desirée, Diljá and Javier

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UNIDO

Accelerating innovation for climate adaptation and resilience in least developed countries

Project Brief

What are the key barriers for fostering a supportive global ecosystem for early-stage climate adaptation and resilience-related innovation? The team worked with the United Nations Industrial Developmental Organization (UNIDO) to help inform a global project to enhance resilience to climate change through the promotion of innovation, transfer and large-scale deployment of adaptation-oriented technologies and services by MSMEs. The growing cost of adaptation disproportionally affects developing countries, and it is estimated that five to ten times more funding is needed to address a finance gap that keeps growing. The project was particularly focused on the engagement of the private sector to help bridge that finance gap.

Project Team

Daniela Alfaro
Daniela is from Peru, with prior experience in biodiversity conservation management.

Eiður Thor Árnason
Eiður Thor is from Iceland, with prior experience in media and communication.

Marleen Mammen
Marleen is from Germany, with prior experience in strategic controlling.

Sanchita Mahajan
Sanchita is from India, with prior experience in strategic communications and engagement.

Picture Credit: Women in Energy Sierra Leone, www.womeninenergysl.com

Background

Climate change is bringing tangible negative impacts for billions of people worldwide. According to the IPCC report from 2022, 3.3 to 3.6 billion people are highly vulnerable to it, most of them in Least Developed Countries (LDCs). In addition, it has been estimated that the cost of climate inaction could bring losses and damages valued at USD 290-580 billion in 2030, and up to USD 1.8 trillion for developing countries in 2050 [1]. Considering that natural resources are the main base of these countries' economies, climate change directly affects their livelihoods, food security, and health [2]. In this context, climate change adaptation and resilience has become an urgent need.

Climate adaptation finance gap

To build resilience and adaptation, funding is needed. International forums, including the Paris Agreement and Glasgow Climate Pact, have placed adaptation finance high on the agenda. While the global finance flow to A&R has increased in the past years; a large climate adaptation finance gap is still in place, affecting mainly developing countries [3].

Case Study: Inno-Neat Energy Solutions

Having grown up in a small village in western Kenya without access to electricity and safe drinking water Godfrey Katiambo is now striving to prevent a new generation from experiencing the same. After finishing his college education and attaining over a decade of experience in the solar industry Godfrey founded Inno-Neat, a company that develops innovative solar-battery modules using repurposed lithium-ion batteries aimed at off-grid households and small businesses in low-income communities.

After evolving his business model to provide off-grid solar companies with battery modules to increase resilience through energy security, Godfrey is facing a problem many entrepreneurs in the Global South are all too familiar with: Where to get the money to scale his small purpose-driven company for it to reach its impact potential. The company is currently working with partners in Kenya, Malawi, and Rwanda.

What is the difference between adaptation and resilience (A&R)?

Resilience is the capacity of a system (human or natural system) to keep functioning while coping with the negative impacts brought by climate change; while adaptation refers to the process through which the system adjusts to the changes, to mitigate the negative impacts and/or exploit the beneficial opportunities [6]. In this sense, these two qualities complement each other and enable the systems to stay alive, while they (i) keep functioning and (ii) adapt to the new conditions.

According to the UNEP Adaptation Gap Report from 2022, the annual costs of climate adaptation is currently USD 71 billion and will be in the range of USD 160-340 billion by 2030 and USD 315- 565 billion by 2050. It has been estimated that the calculated costs are five to ten times higher than current finance flows and this gap continues growing. LDC government investment is approximated to cover a significant amount but the exact number is hard to estimate due to lack of data [4].

Private sector contribution

It has been estimated that only 8% of total global climate finance goes to climate adaptation, with the remaining mainly going to mitigation [5]. Current international adaptation funding comes mainly from public sources, such as bilateral and multilateral funds [3], while investment from private sector represents only 4%. The private sector represents a crucial component of the global financing landscape that is yet to be adequately involved. Efforts are being made by governments worldwide to engage these actors on climate adaptation solutions [4].

MSMEs as solution providers

The private sector's role in solving the climate adaptation challenge is not limited to finance. Micro, small, and medium enterprises (MSMEs), mainly in LDCs, are recognised as a driving force of local economies. These actors, besides being highly vulnerable to climate change, are also engines of innovation, growth, and green jobs, representing a backbone for the local economy. They represent approximately 80% of the private sector in LDCs and are the preferred vehicle to provide market-

based services to implement or facilitate adaptation and resilience. This is the reason why multilateral organizations like the Global Environment Facility (GEF) prioritize support towards incubation and acceleration of MSMEs, through which local climate adaptation and resilience is addressed [6].

Project Description and Methodology

The United Nations Industrial Development Organization (UNIDO) is a specialized agency of the UN with the mandate of promoting, dynamizing, and accelerating industrial development [7]. UNIDO is in the process of designing a global program aimed at climate adaptation and resilience of LDCs. The program's objective is to "reduce climate vulnerability and enhance resilience to climate change through promoting innovation, transfer, and large-scale deployment of adaptation-oriented technologies and services by MSMEs and create jobs in the water, energy, and agricultural sectors". The programme is expected to be funded by GEF.

The project task was to provide a strong evidence base that could be used to develop the programme framework document, which will be used to justify the programme proposal before GEF. Through this project, the IIIEE team provided an analysis of the current climate adaptation and resilience ecosystem, including the diversity of actors that interact within it. The team was also tasked with identifying the key barriers and opportunities in fostering a supportive global ecosystem for early-stage climate-related innovation, potential partnerships for the programme, and successful case studies. The project scope was limited to early stage MSMEs and start-ups with solutions addressing climate A&R, and thereby excludes A&R solutions originating within the public sector and corporations. UNIDO's overall priority for the project was to bring critical and unconventional perspectives into their programme design process. The project deliverables were designed to be modular and were divided into several phases.

The first set of deliverables utilised secondary and primary research that would allow UNIDO to better understand the A&R policy architecture, the global A&R ecosystem,

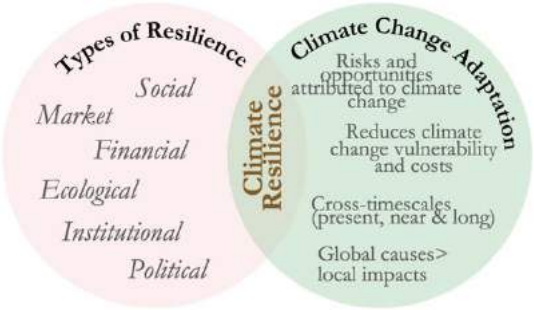

Figure 1: Climate Resilience: a growing subset of achieving system level resilience [3].

innovative financial instruments, and to find the right collaboration partners. The research included a literature review and fifteen interviews with a broad range of actors, with a special focus on A&R entrepreneurs from LDCs. In general, interviews with entrepreneurs were anonymized to help ensure interviewees could speak openly about their experience. Any direct quotes in this report have been permitted by the interviewees.

The second set of deliverables were more analytical. UNIDO's expectation was for the insights from the research to flow into strategic recommendations for the programme. This included recommendations for (i) a theory of change for the programme which attempts to create a logical chain of interventions, outcomes, and impacts; (ii) a proposal for an impact dashboard, and (iii) a communications and outreach strategy.

The insights and theory of change were validated with UNIDO and a common understanding on the problem analysis was built via a workshop with participants from multiple UNIDO programmes. This report emphasizes actor and problem mapping, while the final project deliverables to UNIDO describe the project findings with higher granularity and detail.

AGRICULTURE	WATER	ENERGY
Addressed issues: Infertile soil, droughts and floods	**Addressed issues: droughts and floods**	**Addressed issues: supply, shortage, and disruptions**
Alley cropping	Water saving- drip irrigation, water recycling	Renewable energy
Irrigation systems		Solar with energy storage
Knowledge services	Water handling: groundwater extraction, water storage and distribution	Off-grid cold storage
Agro-climatic services		Energy source diversification
Seed development	Others: Weather forecasting, flood control, river protection	Energy saving
Certification schemes		Off-grid clean cooking

Figure 2: Examples of adaptation and resilience solutions for the agriculture, water, and energy sectors.

Findings

The team utilised stakeholder analysis to plot the relevant ecosystem actors and the problem mapping analysis to gather insights on the barriers affecting A&R MSMEs. These results provided the groundwork for strategic recommendations to UNIDO to inform the program design.

Stakeholder Analysis

The global A&R ecosystem with respect to interventions in LDCs is quite fragmented. This is reflective of the highly localized nature of the issue, as well as lack of a coherent discourse at different levels of the ecosystem. Multiple A&R programmes exist. However, they are disjointed and do not foster cross-programme interactions. Stakeholder groups were identified and categorised based on their motivations towards generating demand for innovations, implementing innovations, or enabling innovations for A&R. Central to the A&R innovation ecosystem and financial flows are five main categories of actors. A detailed ecosystem map showcases them in Figure 3:

1. Those which affect the supply of A&R solutions: MSMEs and start-ups generating innovations to address A&R
2. Those which affect the demand of A&R solutions, including households, governments, and businesses.
3. Adaptation knowledge and technology providers that enhance the understanding of adaptation and visibility of possible tools for suppliers, demanders, finance providers and governments.
4. Stakeholders acting in the finance sphere either as finance providers channelling funds to MSMEs and entrepreneurs through intermediaries, or as enablers which mostly enhance the measurement of impact and risk reduction to incentivise financial flows.
5. Those affecting the enabling environment such as governance, culture, or perception of A&R solutions.

MSMEs and start-up landscape

The research focused on emerging markets in Africa to identify key trends and the landscape within which MSMEs and start-ups flourish. The main assumption during the research was that climate A&R related innovation is a niche and not many start-ups provide A&R related products and services. Consequently, the point of discovery of such MSMEs and start-ups was when the organizations had already engaged with A&R related programmes and initiatives. The research suggests that the A&R start-up and MSME innovation landscape in Africa can be seen as a subset of various other sectors including climate-tech, agri-tech, health-tech, fintech, and logistics amongst others. "A&R tech" ecosystem is quite nascent and restricted to a

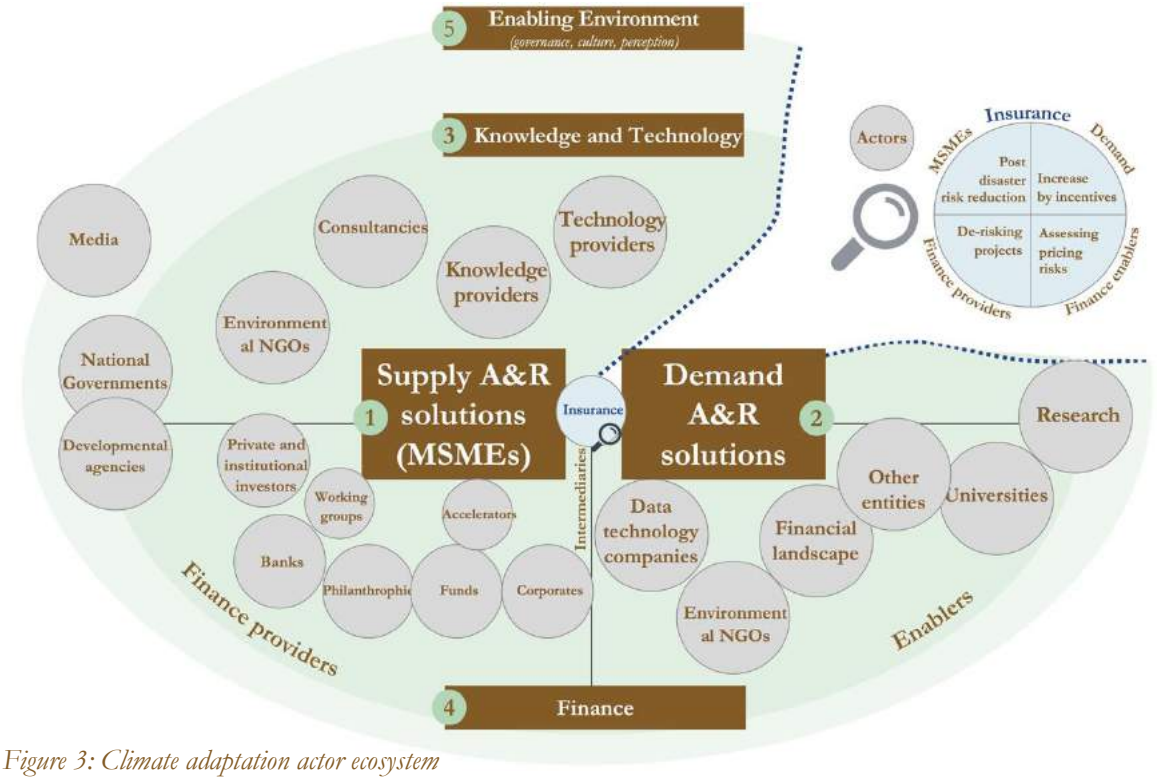

Figure 3: Climate adaptation actor ecosystem

few players. The findings include some overall observations:

- **Agri-tech models dominated the A&R landscape**. This was reflective of the A&R needs of the African continent and aligned with the CTCN assessment of adaptation solutions, and needs of the smallholder farmers [8][9].
- A&R solutions were **mostly focused on B2C business models** and addressing needs of their direct beneficiaries.
- Most A&R start-ups recognised that they were operating in a context with interconnected and systemic challenges. To address the market-fit, **their products and services would be bundled**, and they would need to innovate beyond traditional payment plans. For example, many studied start-ups had a "pay as you go" or other type of unconventional payment plan to ensure affordability of their products and services for their customers.
- **Male founders were prevalent**, even though women were highlighted as beneficiaries in many A&R start-ups. This is corroborated by primary and secondary research [8].
- Most **start-ups and MSMEs were tech-enabled** and very few start-ups were focused on inventing or creating new technologies.
- **Innovators do not directly communicate or market their product based on their A&R outcomes** and benefits.

Problem Mapping

The process of gap analysis and devising the theory of change needs to start with an overarching impact statement or challenge. In this case, it was **"Systems are not resilient to climate change in LDCs because adaptation solutions are not adequately implemented"**. This statement was aligned with UNIDO's programme objective of making systems resilient in LDCs via innovative solutions and was the starting point for identifying specific and hierarchical factors. The scope of the problem mapping process was limited to A&R solutions originating within the private sector i.e., local MSMEs and start-ups (see Figure 4).

The problem was further analysed based on four following themes: solutions needed to be available (**supply of solutions**), be requested (**demand of solutions**) and be financed (**finance gap**), while having the enabling environment to be created and developed (**overarching governance factors**). These problems were caused by different underlying factors. Thus, they were characterized into specific themes that better identified their nature and helped build causal linkages. The characterization process followed the logic of identifying specific criteria for each theme: (i) The supply of solutions face specific problems based on the entrepreneurial stages (idea generation, incubation, and scaling); (ii) the demand of solutions can come from different scales and actors that play a role there (households, local business, governments, corporations), and who have different motivations behind to generate a demand; (iii) the finance gap that involves different funding sources (public and non-profit, private corporate social responsibility, private for returns) due to different reasons; and (iv) overarching governance factors respond to LDCs' context, actors, and tools (structural factors, political hierarchy, policies).

The analysis beyond this step followed a more bottom-up approach, wherein specific challenges or gaps from secondary and primary research were clustered into cross-theme problems. While this process can be subjective and complex, the interplay of these problem clusters and dynamics with stakeholder groups are an important aspect while designing a theory of change. This process is also the starting point for any accurate, feasible, and impactful intervention to be identified for the programme. Overall, the problem mapping helped build a common understanding of the A&R landscape with UNIDO and was a fundamental step in building the theory of change. The upcoming sections describe and exemplify the problem clusters in detail.

A. Lack of awareness on climate adaptation and resilience

A critical cross-cutting problem is the availability and access to knowledge, and the level of awareness. This affects actors in different ways and at different levels. First, A&R knowledge must be related to specific geographical contexts and sectors. Climate needs and measures respond to those local factors and can hardly be standardised [3]. Specific data on climate effects and impacts must be generated and available. In addition, this technical-scientific

Figure 4: Problem Mapping Tree

knowledge should also be integrated with indigenous knowledge [4]. This is further exacerbated by enormous uncertainties about climate effects and impacts [3], which means that projections are hard to build, based on which investments returns for example are also hard to estimate. This lack of common understanding of climate impacts and needs, leads to a lack of alignment of required measures and priorities.

Supply of A&R solutions: For MSMEs to evaluate how their solution contributes to A&R outcomes they must have access to relevant knowledge. They require the tools to link their solutions with A&R, or to propose solutions that are framed on it. In fact, most of the MSMEs that contribute with their solution to enhancing climate resilience, do not realize this connection. Therefore, they are less visible to A&R investors.

Demand of A&R solutions: Once beneficiaries are more aware and understanding of climate change risks, potential impacts, and the measures needed to take, the demand of proper A&R solutions will increase.

Finance gap: Investors would need to be aware of long-term impacts of climate change, and how preventing them will be more cost-beneficial than responding to them once they have occurred. To close the financial gaps, investors will require the following information: What, where, when, why, and how must investors invest? [3].

B. Insufficient knowledge about A&R technologies

Once MSMEs and direct beneficiaries, such as farmers, have gained an understanding of how climate change affects their solutions or operations, they frequently find themselves lacking information and access to the latest technological advancements related to A&R. For instance, this could be new technologies around forecasting tools or yield-enhancing seeds.

C. Missing impact metrics and recognition of business case for A&R

Difficulties in assessing the benefits of climate adaptation projects present a common restraining force across all four thematic areas. It is not just the absence of a standardized method for quantifying intangible returns, there is also a general scarcity of appropriate metrics and data. Despite the challenges, it is important to recognize that assessing the benefits of adaptation and resilience is inherently complex, yet it remains a necessary undertaking. There is a need to emphasize in the ecosystem, that the process is more about taking gradual steps, building confidence, and accumulating knowledge, rather than avoiding it altogether due to the perceived impossibility of predicting a single definitive future outcome.
The type of metrics and data needed around climate adaptation differs among the stakeholders.

A start-up founder from the health-tech sector stated that he did not originally connect the business and climate resilience outcomes of his organisation. This framing of his business was introduced to him only when they engaged with an A&R venture capital fund.

Quantified impact of climate risk is needed to increase demand of A&R solutions. Estimation of financial impacts of climate risk resulting from production and supply chain disruptions is essential to make A&R solutions more attractive to local companies and multinational corporations [1]. Only if the benefits in terms of avoided losses are higher than the implementation costs, the business will decide to implement the provided solution. However, currently stakeholders may lack strong motivations to fund projects aimed at enhancing their resilience since they are uncertain about the returns on these investments. Next to the financial impacts, it is also crucial to underscore the importance of considering quantified non-financial implications in the decision-making process for selecting A&R solutions. This becomes specifically relevant for households and governments.

Improved business cases required to increase private financial flows towards MSMEs. Adaptation projects may be perceived as riskier due to the uncertainty and complexity of climate impacts, often yielding societal advantages rather than immediate financial profits [2]. It is not that adaptation projects are unsuccessful in generating economic benefits. In fact, the World Bank [3] found that "every USD 1 invested in resilient infrastructure in low- and middle-income countries yields USD 4 in net benefits". However, these

benefits frequently have a broader impact and do not funnel back to the project's initiators through revenue streams [4]. Moreover, the investment horizon of adaptation projects is rather long-term, often taking 10-20 years to show outcomes of implementation after large upfront investments [2]. Therefore, adaptation projects often inherently lack a profitable business model compared to mitigation projects which are easier to generalize and scale [5] [6].

Impact assessment is required by MSME funders and current quantification is insufficient. Public and non-profit funders primarily base their financial support on the outcomes achieved by a project, which assessment is done by a third-party agency. Moreover, private investors, particularly those whose investment decisions are linked to their Corporate Social Responsibility strategy and reputational risk, are progressively placing more emphasis on assessing the impact of funded MSMEs. In fact, all interviewed MSMEs emphasized that the focus of funders is on quantifying impact in terms of the effect on beneficiaries. This could manifest in the economic advantage gained, the count of clean cooking stoves sold to women or the number of individuals who gained access to medical resources following a natural disaster. While these beneficiary-centred metrics may seem straightforward to generate, relying solely on them for assessing project impact runs the risk of "impact washing," which involves inflating figures for the sake of appearances. There is also the question of who is supposed to deliver the impact assessment for private investors. Some smaller start-ups might not have the organizational strength to deliver what investors or customers are requiring.

Case Study: Inno-Neat Energy

*"**Investors want all kinds of data, but for heaven's sake I'm just starting out. I need your money to set up all these structures to provide this data**," says Godfrey Katiambo, founder of Inno-Neat. He feels stuck and wants legroom to build the business case for his solar-battery modules and demonstrate the numbers. "Without that impact investors are putting you in a situation where you can't get out. I have been in this situation a million times."*

D. Missing bridge between finance providers and MSMEs

A significant deficiency within the climate adaptation ecosystem is the disconnect between entities offering financing and MSMEs. Several obstacles impede the linkage between these two entities, subsequently restricting the flow of financial support to MSMEs.

The "missing middle": there is a lack of natural engagement opportunities between the financial industry and MSMEs. One of the main intermediary actors are accelerator programs but MSMEs as well as funders and investors confirmed that they are not sufficiently represented now. Moreover, only very limited amounts of MSMEs included in an accelerator program will really obtain investments at the end. Building relationships and networks is also a time and resource-intensive process which not many entrepreneurs in LDCs can afford.

Significant administrative burden for MSMEs to apply for funds: extensive administrative tasks and bureaucratic procedures, put in place to prevent fraud, can prove to be quite convoluted for applicants. This complexity often results in applicants losing interest or ultimately giving up on the funding.

Funding size disparity: in straightforward terms, the funds that funders offer and the amounts MSMEs require do often not align. Dividing the funds into numerous smaller portions entails additional effort and substantial transaction expenses for funders. This adds to the difficulty faced by small early-stage start-ups in securing investment. It also underscores the necessity of intermediary actors to facilitate the disbursement of funds.

Lack of adaptation benefit identification due to insufficient awareness of entrepreneurs and MSMEs: the awareness among MSMEs about their potential role in providing adaptation solutions is limited. When MSMEs discuss their impact, the focus is predominantly on mitigation efforts, largely overlooking the opportunities they hold for resilience enhancement. This prevailing lack of awareness leads to a significant challenge: there is limited visibility on where investments should be directed to enhance resilience. In fact, the adaptation start-ups are only a glimpse of all start-ups with solutions that support resilience.

Consequently, identifying the MSMEs that could contribute to these crucial adaptation efforts becomes an exceptionally daunting task.

Missing support after acceleration phase.

E. Lack of prioritization and short-term focus

An overarching lack of strategic long-term thinking and misprioritisation is a key challenge for adaptation and resilience MSMEs looking to scale and deploy their solutions. This affects multiple stakeholders, including governments, financial actors, and multinational corporations. One manifestation is a frequent prioritization of short-term profitability and quick return on investment over longer-term social impact or business sustainability that can hinder investors and corporations from seeing the value of climate adaptation and resilience. This also relates to the general lack of metrics and methods available to evaluate climate related risks and costs. The overall effect hampers the growth and scalability of MSMEs in this sector that often require patient capital and long-term commitment to prosper, or even move past the prototype stage.

Another contributing factor is that politicians and corporate executives are incentivized to focus on demonstrating visible results or returns within their limited tenure. This can come at the cost of long-term considerations such as climate adaptation and resilience projects that may not manifest within a short timeframe.

Multinational corporations are feeling growing pressure to act to increase the resilience of their supply chains. Despite this, some still prefer leveraging vast supply chains to procure their products elsewhere in case of a disruption instead of investing heavily in resilience. Many multinationals also have limited knowledge of how climate is affecting their suppliers on the ground. The mindset that local vulnerability will not significantly impact the bottom line of corporations can discourage investments in MSMEs and limit their growth opportunity.

F. Underrepresentation and negative narratives about African entrepreneurs, and lack of successful adaptation solutions in discourse

Despite most innovations for A&R being locally led, there are negative perceptions around the quality of the solutions originating within Africa, especially for early-stage entrepreneurs. There is a distrust about the credibility and reliability of the innovations, as well as a lack of confidence in the ability of the founders to lead a successful start-up. This was especially true for female entrepreneurs, who battle negative gender stereotypes and struggle to be taken seriously in male-dominated sectors.
A key example of how this problem manifests itself and how entrepreneurs try to address that is to enhance their credibility via foreign partners, offices in non-LDC countries, or having foreign members on their founding team. This can create a negative feedback loop of underrepresentation of African entrepreneurs and start-ups which are locally conceived.

These narratives get further entrenched in the A&R space. There are limited success stories which articulate how A&R is an opportunity for the business community to create value for society and economic growth.

Insights and Recommendations

The A&R ecosystem requires interventions at different levels of awareness, engagement, and action, which are currently quite fragmented. As outlined in Figure 5, different actors have a range of demands and provisions of A&R related knowledge, technical tools, and impact measurement. Convening the right actors with complementary needs will be crucial to any A&R programme in LDCs.

The project research also revealed that climate A&R terminology is inconsistent between different stakeholders. This prevents a common understanding of the subject, and shapes perceptions of stakeholders in different ways [8]. A concentrated effort needs to be made to learn from existing adaptation and mitigation projects and create synergies between existing and future programmes.

The overall insights and recommendations for the way forward are described in the following sections.

Accelerating A&R solutions

- There is a **need for entrepreneur led and peer to peer driven MSME support programmes** which are contextual to LDCs.

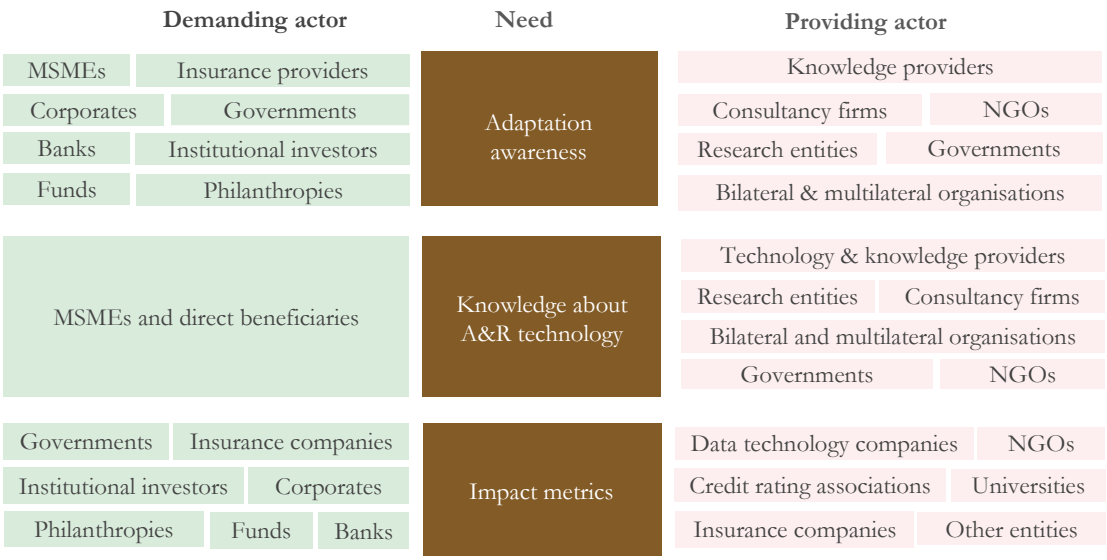

Figure 5: Connecting the right actors is important to develop the A&R ecosystem.

Thus, ground truthing of the knowledge creation and exchange process is required.

- There is not enough cross-pollination of ideas and learnings between global south countries. Also, the desire to introduce ground-breaking innovations should not impede the adoption of essential, straightforward, and community-based solutions.
- A&R sector needs to **leverage the existing momentum of the climate-tech**, clean-tech, and agri-tech innovation ecosystems in LDCs. To increase the availability and pipeline of A&R solutions, investors need to broaden the scope of their portfolio to other impact areas.

Selection process of MSMEs

When selecting MSMEs to work with, some critical aspects should be considered:

- **Avoid "adaptation washing"** and incentivize this throughout the partners. Make the links between the solution and its contribution towards A&R clear.

Case Study: Inno-Neat Energy

As for Godfrey, he says more support for research and development, as well as building a proof of context is clearly needed: "Most of the support in Africa comes when businesses are already on their feet. But before that there is zero support." He also emphasizes that the support system for start-ups should be set up and managed by experienced entrepreneurs.

- **Avoid "accelerator darlings"**, by not focusing always on favoured successful MSMEs, and engaging beyond MSMEs that have already received support.
- **Build equity for funding access in the programme.** Local innovators from LDCs might compete against innovators from developed countries for funding, which could represent unfair competition. Furthermore, concentrated effort needs to be made to discover and incubate women-led enterprises.
- Calls for **incubation and accelerator opportunities should be flexible** and support entrepreneurs in reducing their bureaucratic burden for applications.

Demand of solutions

- Findings indicate that **MSMEs often do not market their A&R related benefits or see them as a key selling point**. This in turn makes it more challenging for both beneficiaries and investors to find these solutions. Integrating A&R knowledge sharing into the general start-up accelerator ecosystem could help highlight these offerings and help impact investors locate these investment opportunities.
- Missing or **neglected national adaptation plans negatively affect demand for A&R solutions**. This could potentially be addressed with government policies that encourage businesses to evaluate and address their climate risks, as well as innovation focused public procurement meant to support local firms.

- **Municipalities and regional governments are important stakeholders** as they are often at the front lines when it comes to procuring and implementing A&R projects. Therefore, the needs of local government must be considered at various levels in the start-up ecosystem, at a national policy making level and during the development and execution of an UNIDO project.

Increasing efficient flows of private finance

One proposed method to boost private finance into climate adaptation innovations of MSMEs is the utilization of financial instruments. However, it is important to note that while a considerable number of these instruments have been used in developed nations, their application has been limited or entirely absent in developing countries, especially in the least developed ones. Moreover, finance innovation does not need to mean new financing arrangements but rather innovative thinking on how to use locally known instruments [10]. One common instrument is blended finance which involves leveraging public or philanthropic capital to reduce risks and thereby encouraging private sector participation in projects [5]. To facilitate financial support from private corporations aiming to improve their CSR performance, credit mechanisms can be employed. One such mechanism already tested in developing countries is the Adaptation Benefits Mechanism, a non-market-based approach certifying the societal, economic, and environmental benefits of adaptation activities [11]. Generally, when using any financial mechanism, it is important to recognize that entrepreneurs may require funding for developing impact metrics, and such metrics should not be mandatory for securing initial funding.

To conclude, the necessity to enhance private funding for adaptation is broadly acknowledged, but deliberations on this matter should acknowledge the complexities of financing structures and the fact that certain adaptation projects may never appear appealing to certain investors.

Expanding the scope of impact assessment

During an impact assessment, the benefits typically focus on a specific audience, but an adaptation solution might benefit one particular entity while negatively affecting another party or the wider natural environment. Consequently, it is crucial to extend the scope of impact assessments beyond the initial target group. This becomes particularly important for governments during the policy analysis phase to shed light on how unintended consequences can be prevented.

In conclusion, rising temperatures and more frequent extreme weather events call for significantly increased investment in A&R. MSMEs play a crucial role in the development and deployment of relevant solutions in LDCs but currently face significant barriers bringing them to market. A well designed, evidence based global project aimed at enhancing local start-up ecosystems, increasing private funding flows through innovative financial instruments and small-scale investments, as well as creating accessible platforms for knowledge sharing could play an important role in helping households, businesses and municipalities become more resilient. The urgency of addressing the climate crisis demands collective efforts and proactive measures from governments, international organizations, private investors, and other stakeholders to ensure a sustainable and resilient future for vulnerable nations that bear little responsibility for the current state of affairs. In the context of such investments it is also vital to consider the high cost of inaction.

Figure 6: Project Team with UNIDO staff at the HQ in Vienna. R-L: Daniela, Thor, Anais Barisani (UNIDO), Alois Mhlanga (UNIDO), Marleen and Sanchita.

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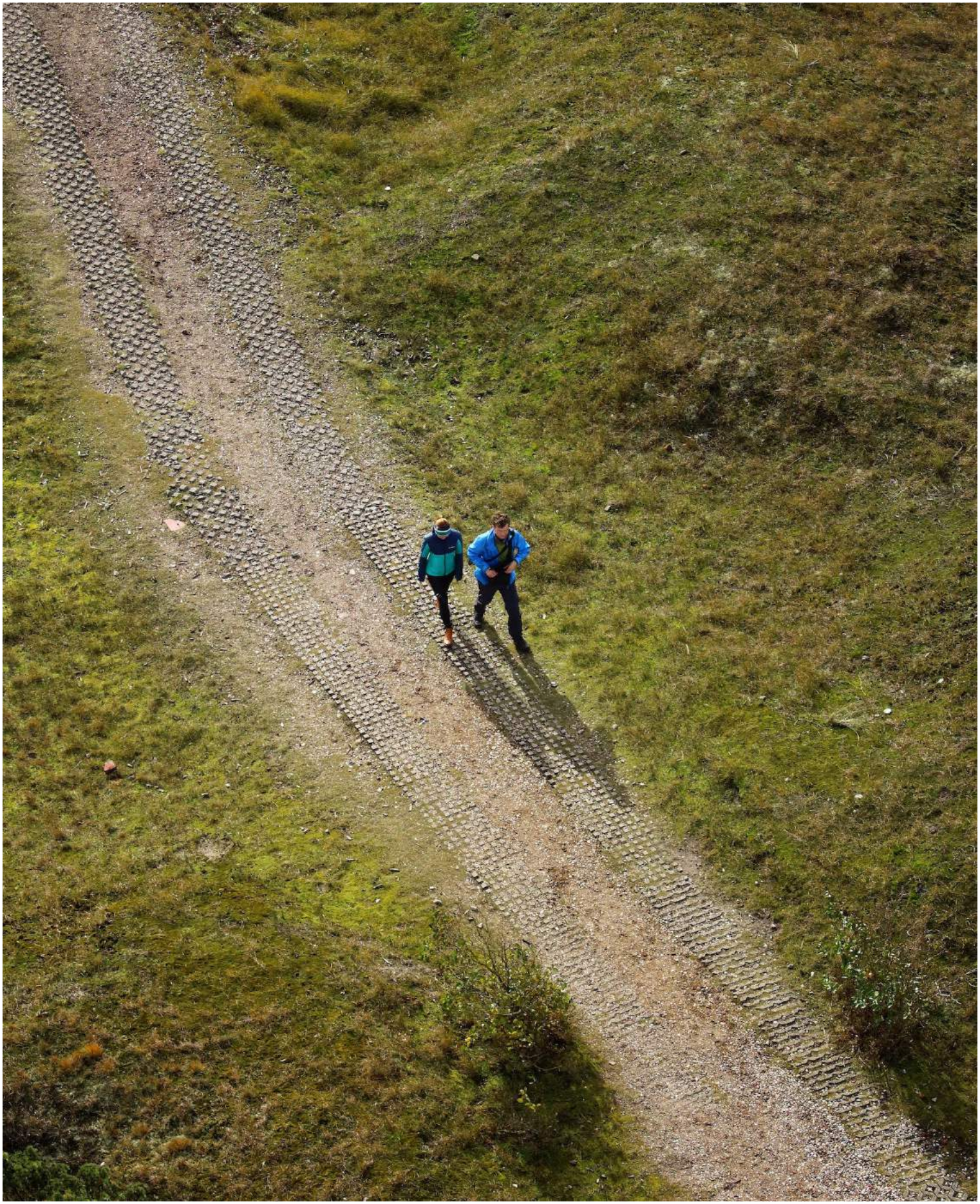
Maria van Veldhuizen, Independent Consultant for various institutions
Markus Scheffel, previously employed by the German Development Agency (GIZ)
Sandra Lopez, Inter-Amercian Development Bank



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