

Research
on
Double Materiality Assessment
Fully AI-driven DMAs vs Human-driven DMA

Course: Sustainability Transformation Lab

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Abstract

The European Sustainability Reporting Standards under the Corporate Sustainability Reporting Directive have shifted sustainable reporting for many companies in Europe from voluntary to mandatory. The report needs to be structured around double materiality, which includes the impact materiality and the financial materiality. The impact materiality assesses the effects of companies' activities on society, people, and the environment, and the financial materiality assesses companies' financial risks and opportunities in relation to sustainability issues. By analyzing a company's overall operations, risks, and opportunities, a double materiality assessment (DMA) provides strategic guidance to corporate decision makers. However, despite the value of DMA, conducting a DMA requires both time and resources. As a result, leveraging Artificial Intelligence (AI) to generate a DMA may serve as a more efficient alternative, particularly for small and medium-sized companies. Nevertheless, the differences between the results of AI-driven and human-driven DMAs remain unclear.

This study focuses on addressing the current gap by conducting an inductive study to compare three DMA approaches applied to Stormossen, a waste management company operating in Finland. The three DMAs include a human-driven DMA facilitated by ExecutESG with stakeholder workshops and voting, an ExecutESG internal AI-driven DMA using a purpose-built model and Stormossen's internal data, and a ChatGPT-driven DMA leveraging only public information. The study compares dimensions such as topic identification and the prioritization of impacts, risks, and opportunities across all three DMAs.

Our findings show that all three DMAs were able to identify core ESRS topics including circular economy (E5), pollution (E2), own workforce (S1), etc. However, the depth and grounding of the results vary across the three DMAs. The human-driven DMA performed best in capturing contextual nuance and stakeholder perspectives. AI tools demonstrated efficiency in processing data and structuring IROs, with the ChatGPT-driven DMA producing an ESRS-aligned matrix and the internal AI-driven DMA provided a more detailed assessment.



The study concludes that AI tools are capable of generating a structured DMA efficiently, which is practically efficient for data processing, yet remains a starting point rather than a final product, as human-driven validation is essential for contextual justification.



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1. Introduction

1.1 Sustainability reporting under CSRD/ESRS

Sustainability reporting has become a central issue for companies operating in Europe because it is no longer only a voluntary communication exercise, but increasingly a regulatory and strategic requirement. With the introduction of the Corporate Sustainability Reporting Directive (CSRD) and the European Sustainability Reporting Standards (ESRS), companies are expected to identify, assess, and disclose the sustainability matters that are most significant both for their business and for society and the environment. This shift is anchored in the ESRS framework, where double materiality functions as the basis for determining which sustainability matters are significant enough to be disclosed and addressed in corporate reporting (EFRAG, 2024). This makes Double Materiality Assessment (DMA) highly important, as it provides the foundation for determining what should be reported, what should receive managerial attention, and how sustainability is integrated into strategic decision-making. In this way, DMA matters not only because companies are required to conduct it, but because it shapes how organizations understand their role, responsibilities, risks, and long-term value creation in a changing regulatory and societal context.

1.2 What DMA is and why it matters

Within this context, the Double Materiality Assessment (DMA) has become a key mechanism in ESRS-based sustainability reporting. A DMA is a structured process through which a company identifies, assesses, and prioritizes sustainability matters from two complementary perspectives, being impact materiality and financial materiality. Impact materiality, which concerns how the company affects people, society, and the environment, and financial materiality, which concerns how sustainability-related matters create risks and opportunities for the company's financial position and long-term value creation. As described in prior literature, DMA is typically operationalized through a structured process of identifying relevant sustainability topics, assessing their significance across both dimensions, and prioritizing them using stakeholder input and defined criteria (Seidel et al., 2024). In practice, this means evaluating relevant impacts,

risks, and opportunities, often referred to as IROs, and determining which sustainability matters are significant enough to be treated as material for reporting and strategic decision-making. In this sense, DMA serves not only as a compliance mechanism, but also as a framework for translating sustainability information into strategic managerial priorities (Seidel et al., 2024; Huang et al., 2025). Rather than being a purely technical exercise, the DMA functions as the foundation for deciding which sustainability issues should receive attention in both corporate reporting and managerial practice.

1.3 Why DMA is difficult in practice

Despite its structured logic under the ESRS, conducting a Double Materiality Assessment in practice is far from straightforward. A DMA requires companies to interpret a wide range of sustainability-related impacts, risks, and opportunities across their operations, stakeholders, and broader business environment. This process often involves balancing quantitative and qualitative information, integrating different stakeholder perspectives, and making judgements about which issues are most significant. Existing research shows that DMA processes are often affected by selective prioritization, superficial stakeholder engagement, and uneven integration of risks and negative impacts, despite the formal structure provided by regulation (Dragomir et al., 2024; Dunfjäll, 2025). As a result, DMA is not only a technical reporting exercise, but also an interpretive and context-dependent process in which human judgement plays an important role. Critical accounting research further suggests that materiality assessments are socially constructed and shaped through interpretation, negotiation, and organizational context rather than neutral technical evaluation alone (Kapplmüller et al., 2025). This complexity makes it challenging for companies to ensure that the assessment captures both the strategic relevance of sustainability matters and the broader societal and environmental consequences of their activities.

1.4 Why AI has become relevant in this process

In this context, the growing availability of artificial intelligence (AI) tools has created new interest in how sustainability reporting processes can be supported and potentially transformed. AI-based systems are able to process large volumes of data, identify patterns, and generate structured outputs with a level of speed and efficiency that is difficult to achieve through fully

human-driven processes alone. Recent studies therefore highlight AI as a potentially valuable support tool in materiality assessments, particularly because it can process large datasets and structure sustainability information efficiently (Francia et al., 2025; Soori et al., 2024). This makes AI particularly relevant in relation to DMA, which often requires companies to synthesize complex information within limited time and resource constraints. At the same time, the use of AI in DMA raises important questions, since materiality assessments depend not only on data processing, but also on contextual understanding, qualitative interpretation, and sensitivity to stakeholder perspectives. At the same time, prior research stresses that AI-based approaches remain dependent on data quality, predefined input structures, and continued human oversight, especially in contexts where implicit risks and contextual nuance are important (Francia et al., 2025; Geschickter & Oyen-Ustad, 2025). The relevance of AI in this setting therefore lies both in its potential to improve efficiency and consistency, and in the uncertainty surrounding whether it can adequately capture the more nuanced dimensions of double materiality.

1.5 Why Stormossen is a useful case

This study is conducted in collaboration with Stormossen, a waste management company operating in Finland. According to company information, Stormossen is active in waste treatment, recycling, energy recovery, and broader circular economy activities, which makes sustainability central to its operational model rather than a peripheral reporting concern (Stormossen, n.d.). This makes the company a particularly relevant case for examining Double Materiality Assessment in practice, since environmental and social issues are closely connected to its everyday operations and stakeholder relationships. Stormossen's activities are linked to matters such as emissions, resource efficiency, waste handling, and local environmental effects, while also involving households, businesses, and surrounding communities. The case therefore provides a strong context for studying DMA in a sector where sustainability is both operationally central and strategically significant.

1.6 Research Objectives and Comparison Framework

Against this background, the aim of this paper is to examine the potential of artificial intelligence in Double Materiality Assessment by comparing AI-driven and human-driven DMA approaches in the case of Stormossen. More specifically, the study compares a human-driven DMA

conducted in collaboration with ExecutESG, an internally developed AI-driven DMA, and a ChatGPT-driven DMA based on available company information, ESRS logic, and relevant contextual data. Rather than starting from a predefined hypothesis about which approach performs best, the paper adopts an inductive orientation in which similarities, differences, strengths, and limitations are allowed to emerge through the comparison itself (Simolin, 2026). In this way, the study seeks to understand how different DMA approaches identify, interpret, and prioritize sustainability-related impacts, risks, and opportunities in an ESRS-oriented assessment.

2. Literature Review

The literature review is centered around four main themes: DMA as a regulatory and strategic framework, challenges and limitations in DMA implementation, the interpretive and socially constructed nature of materiality, and opportunities and limitations with artificial intelligence in materiality assessments.

2.1 DMA as a regulatory and strategic framework

Sustainability reporting under the CSRD is operationalized through the concept of double materiality, which requires companies to assess both their impacts on society and the environment, as well as the financial risks and opportunities arising from sustainability-related issues. According to Seidel et al. (2024), a Double Materiality Assessment (DMA) is typically conducted through a structured process that involves identifying relevant sustainability topics, evaluating their significance across both dimensions, and prioritizing them based on stakeholder input and predefined criteria. This process is often supported by scoring mechanisms and visualized through materiality matrices, which help organizations translate complex sustainability data into strategic decision-making tools. As such, DMA serves not only as a compliance mechanism, but also as a structured approach for integrating sustainability considerations into core business strategy.

Sustainability reporting has increasingly become embedded within formal regulatory and institutional frameworks, particularly in the European Union. Rather than focusing solely on disclosure practices, recent literature emphasizes how the introduction of the CSRD and the ESRS has reshaped the way companies conceptualise and operationalise materiality. In this context, double materiality is not only a reporting requirement but a framework that expands corporate accountability by integrating both financial risks and broader societal impacts into decision-making processes. Existing studies highlight that this shift reflects a move toward more stakeholder-oriented governance and long term value creation. However, despite the increased structure provided by ESRS, research such as Scamans (2024) suggest that challenges remain in practice, particularly in ensuring balanced stakeholder representation and avoiding selective prioritization of sustainability issues. This indicates that while the framework provides guidance,

the application of double materiality remains dependent on how organizations interpret and implement it. Taken together, these studies suggest that while DMA is increasingly formalized through ESRS, its practical application remains dependent on organizational interpretation and stakeholder dynamics.

The growing importance of double materiality is also reflected in its financial implications. Huang et al. (2025) demonstrate that environmental double materiality disclosures are positively associated with firm valuation across EU companies, indicating that sustainability reporting is not only a regulatory requirement but also a strategic tool that influences market perception and financial performance. This finding reinforces the relevance of DMA as a decision making framework rather than a purely compliance-driven exercise. However, while Huang et al. (2025) provide strong empirical evidence on the outcomes of sustainability disclosures, their study does not address how material issues are identified in the first place. This highlights an important gap in the literature, as the process of identifying material topics remains underexplored, particularly in relation to different methodological approaches such as AI-driven versus human-driven assessments. This creates a distinction between the outcomes of DMA, such as firm valuation, and the underlying process of identifying material issues, which remains underexplored in the literature.

2.2 Challenges and limitations in DMA implementation

At the same time, existing research highlights that the process of conducting a DMA is complex and often inconsistent in practice. Dragormir et al. (2024) show that while companies increasingly disclose impacts, risks and opportunities, these disclosures are often influenced by legitimacy concerns and stakeholder pressures rather than deep strategic integration. The study finds that although firms increasingly engage with DMA related disclosures, these are often influenced by legitimacy concerns and stakeholder expectations rather than being fully included in strategic decision-making processes. As a result, companies tend to emphasize positive impacts while giving less attention to financial materiality, risk exposure, negative externalities and mitigation strategies. The authors also highlight limitations in current practices, including superficial stakeholder engagement, selective disclosure of negative impacts and weak integration of risks into overall assessments. These findings are directly relevant to this project

as they point to structural weaknesses in how materiality is currently constructed and communicated. In particular, the tendency toward surface-level engagement and selective reporting suggests that existing DMA processes may fail to capture the full complexity of sustainability risks. While the study focuses on disclosure quality and governance structures, it does not examine how material topics are identified or how different methodological approaches influence this process. This represents a key gap in the literature. In the context of this project, the gap becomes particularly relevant when considering the role of AI. An AI-driven approach, which relies heavily on structured data and predefined inputs, may struggle to capture the contextual nuances, implicit risks and stakeholder perspectives that human driven processes can uncover through dialogue and interpretations. This highlights a tension between formal compliance and substantive integration of sustainability, which is directly relevant when comparing structured AI outputs with human-driven assessments.

Building on this, Dunfjall (2025) highlights the operational challenges companies face when implementing DMA, including the difficulties in collecting relevant data, the absence of standardized methodologies and the tendency to overlook negative impact. This reinforces the idea that, contrary to regulatory guidance, the process remains highly dependent on organizational capabilities and interpretation. At the same time, the study focuses primarily on challenges at the implementation level and does not explore how different methodological approaches might influence the identification and prioritization of material issues. These implementation challenges further suggest that methodological choices may significantly influence DMA outcomes, an aspect that remains insufficiently addressed in existing research.

This interpretive nature of materiality is further emphasized in critical accounting literature. Kapplmuller et al. (2025) argue that double materiality is not simply a technical exercise but a process that shapes organizational change and reflects internal decision-making structure. Materiality assessments are influenced by organization's priorities, stakeholder engagement process and institutional pressures, making them inherently subjective and socially constructed. This aligns with findings from the broader literature which suggests that materiality outcomes are not neutral reflections of sustainability risks but are shaped through dialogue, negotiations and interpretation within organization. As a result, human judgement plays a central role in

determining what is considered material, particularly in relation to qualitative and context-specific issues. This perspective reinforces the idea that materiality assessments are shaped by interpretation and organizational context.

2.3 Opportunities and limitations with artificial intelligence in materiality assessments

In response to these challenges, there has been increasing interest in the use of artificial intelligence to support the sustainability process. AI-based approaches offer the potential to improve efficiency, consistency and scalability by processing large volumes of data and identifying patterns in a systemic way. Francia et al. (2025) propose an Automated Materiality Assessment (AMA) model, which uses document-based data and hierarchical topic modeling to generate materiality rankings. This approach demonstrates how AI can operationalize complex sustainability data into structured outputs, reducing reliance on time-intensive stakeholder interviews. Similarly, the report on leveraging AI to enhance DMA highlights how AI can support continuous materiality assessments, automate data collection, and improve consistency across reporting processes. These developments are directly relevant to this project, as they provide the methodological foundations for conducting an AI-driven Double Materiality Assessment. In particular, they demonstrate how AI can replicate key components of the DMA process, such as identifying material topics and structuring sustainability risks based on available data. However, while these studies highlight efficiency and scalability of AI driven approaches, they primarily focus on technical capabilities and process improvements. They do not examine how AI-generated outputs compare with human-driven assessments in handling context and stakeholder-related concerns. This limitation is central to the present study, which builds on this literature by exploring not only what AI can produce, but how its outputs differ from those shaped through human interpretations and engagement. While these approaches improve efficiency and consistency, they also raise questions about whether structured data-driven models can capture the contextual and stakeholder-driven dimensions emphasized in prior literature.

However, while AI offers clear advantages in terms of efficiency and objectivity, the literature also identifies important limitations. It is emphasized that AI systems are highly dependent on

data quality and predefined topic structures, which may limit their ability to capture emerging risks or context specific issues (Francia et al. 2025). The Garner report (Geschickter & Oyen-Ustad, 2025) further highlights that AI implementation in sustainability reporting is constrained by data availability, reliability and the need for human oversight. These limitations are particularly relevant in the context of DMA, where stakeholder perspectives, ethical considerations and implicit risks play a huge role. AI systems may struggle to capture these elements as they are not always explicitly represented in structured data. Overall, the literature reveals a fundamental tension between standardization and interpretation in DMA processes. While AI offers scalability and efficiency, human-driven approaches remain central for capturing context-specific and stakeholder-sensitive issues. This gap forms the foundation for the present study, which compares AI-driven and human-driven DMA approaches in a real organizational setting.

2.4 Human-driven DMA and subjectivity

As an extension, research also highlights the inherently subjective nature of materiality assessments in sustainability reporting (Reimsbach et al., 2019). Research provides experimental evidence demonstrating that materiality is not an objective property of information, but rather depends on the perspective of the stakeholder evaluating it. Their findings show that different stakeholder groups, such as capital market participants and potential employees, assign varying levels of importance to the same nonfinancial information (Reimsbach et al., 2019). For instance, investors tend to prioritize information that can be translated into financial risk, whereas employees evaluate materiality more broadly in line with personal values and social considerations. This divergence suggests that materiality assessments are shaped by underlying decision-making processes, including both analytical and intuitive reasoning. Importantly, the study concludes that materiality “lies in the eye of the beholder,” reinforcing the idea that sustainability issues cannot be universally ranked without interpretation (Reimsbach et al., 2019). These findings are highly relevant for double materiality assessments, where firms are required to integrate both financial and impact perspectives, as they imply that such processes inevitably rely on human judgement, stakeholder selection, and subjective prioritization (Reimsbach et al., 2019).

According to Saraswati et al. (2024) the determination of materiality is not a purely technical or objective exercise, but is significantly influenced by managerial discretion in selecting, prioritizing and disclosing sustainability information. The study highlights that management has the ability to shape reporting outcomes by emphasizing certain issues while omitting negative or unfavorable information, thereby affecting the overall equality and credibility of sustainability reports (Saraswati et al., 2024). Furthermore, the process of stakeholders engagement, which is often positioned as a mechanism to enhance objectivity, is itself subject to interpretive bias (Saraswati et al., 2024). Organizations must decide which stakeholders to include, how to weigh their input, and how to resolve conflicting interests, leading to how to weigh their input, and how to resolve conflicting interests, leading to inconsistencies in materiality outcomes. This is further added to by the lack of standardized methodologies across reporting frameworks, which allow for flexibility but also increase the potential for selective disclosure (Saraswati et al., 2024). Importantly, the study demonstrates that internal organizational dynamics, particularly the involvement of the board of directors, play a significant role in shaping both materiality and stakeholder engagement disclosures. These findings suggest that materiality assessments are not a neutral reflection of sustainability impacts, but rather social constructed processes embedded in organization decision-making and influenced by strategic consideration (Saraswati et al., 2024). This has direct implications for double materiality assessments, as it indicates that the integration financial and impact perspectives inevitably relies on human interpretation, judgement, and negotiation rather than purely data-driven evaluation(Saraswati et al., 2024).

3. Methodology

3.1 Research design

This study is designed as a qualitative, comparative case study of three Double Materiality Assessment (DMA) approaches applied to the same company context. A qualitative design is appropriate because the purpose of the study is not to measure DMA performance statistically, but to examine how different approaches identify, interpret, and prioritize sustainability-related impacts, risks, and opportunities. The comparative case study design makes it possible to analyze variation in both process and outcome across the three approaches while keeping the organizational setting constant.

The study follows an inductive orientation. Rather than testing a predefined hypothesis, the analysis is guided by the outputs produced by the three DMA approaches and uses their similarities and differences as the basis for developing insights. This means that the study seeks to understand how the approaches differ in their identification of impacts, risks, opportunities, and final material topics, and what these differences reveal about the role of human judgement, stakeholder engagement, and AI in DMA processes. The unit of analysis is therefore not Stormossen as an organization in itself, but the three DMA approaches applied to the Stormossen case. These are a Human-driven DMA conducted in collaboration with ExecutESG, an Internally developed AI-driven DMA, and a ChatGPT-driven DMA based on available company information, ESRS logic, and contextual data. By comparing these three approaches within the same case setting, the study is able to examine how methodological differences influence both the structure of the assessment process and the sustainability matters that are ultimately treated as material.

3.2 Case selection

Stormossen was selected as the case company because it offers a suitable empirical setting for comparing different DMA approaches within the same organizational context. The case is analytically useful because sustainability-related issues are closely connected to the company's

operational activities, which makes it possible to observe how different assessment approaches identify and prioritize material matters in a sector where environmental and social considerations are highly salient.

A key reason for selecting Stormossen is that the case enables a like-for-like comparison across the three DMA approaches examined in this study. The collaboration with ExecutESG provides access to a human-driven DMA process that includes stakeholder input, iterative assessment rounds, and workshops. At the same time, the availability of company information and sector-relevant contextual material makes it possible to generate comparable AI-based assessments using both ExecutESG's Internal AI model and ChatGPT.

The case is therefore not selected to represent all waste management companies, but because it provides a strong basis for examining how methodological differences influence DMA outputs under the same case conditions. In this respect, Stormossen functions as a strategically chosen case that allows the study to compare how human judgement, stakeholder engagement, and AI-supported analysis shape the identification and prioritization of material sustainability matters.

3.3 Data sources

The three DMA approaches in this study were based on different source materials. This is important to clarify, since the comparison concerns not only the final outputs of the assessments, but also the information base that each approach relied on. Across all three approaches, the purpose was to assess Stormossen in light of ESRS-oriented double materiality, but the type of input, degree of stakeholder involvement, and level of automation differed.

The human-driven DMA was based primarily on workshop-based and stakeholder-based input collected through the ExecutESG process. This included internal and external stakeholder input, iterative assessment rounds, and employee voting used to rank and prioritise proposed impacts, risks, and opportunities. In addition, a limited AI-supported output was used at an early stage to support the identification of ESG topics and the scope of the assessment, but the overall process was mainly shaped through human discussion, refinement, and prioritisation.

The internal AI-driven DMA relied on a more document-driven source base. The main inputs were Stormossen's internal strategic presentation material, academic background material on waste management and double materiality, and relevant EU regulatory guidance. In practice, this means that the internal AI model was fed company-specific documentation together with academic and regulatory sources that helped define operational boundaries, strategic priorities, and relevant sustainability matters. The master's thesis by Törrönen (2025) was particularly useful as a reference point for how double materiality can be implemented through a combination of company data, scientific and industry-specific sources, and ESRS-based assessment logic (Törrönen, 2025). In addition, the EFRAG materiality guidance was used to align the assessment with ESRS terminology and process logic, especially regarding understanding context, identifying IROs, assessing materiality, and reporting (EFRAG, 2024).

The ChatGPT-driven DMA relied on publicly available material that it selected by itself. The main sources were Stormossen's public website and company information, supplemented by public regulatory and sector-related sources relevant to Finnish waste management and ESRS-based materiality assessment. These included EFRAG's implementation guidance, Finnish public information on waste and environmental regulation, and additional public material used to better understand the regulatory and operational context in which Stormossen operates. This gave the ChatGPT-driven DMA a broader public-information base, but without access to the same direct stakeholder input as the human-driven process.

3.4 Comparison criteria

To compare the three DMA approaches, the study uses a framework that focuses on both process and outcome. The purpose is not only to examine what each approach identifies as material, but also how the assessments are carried out. This matters because a DMA is not simply a final list of topics, but a process of identifying, assessing, and prioritising sustainability-related impacts, risks, and opportunities.

First, the comparison looks at the process behind each DMA. This includes how the assessment is organised, what steps are involved, how information is gathered, and whether the process

relies on stakeholder input, workshops, or AI-driven analysis.

Second, the study compares the impacts identified in each assessment. Here, the focus is on which positive and negative impacts are linked to Stormossen's operations, value chain, stakeholders, and wider sustainability context.

Third, the comparison examines risks and opportunities. More specifically, it looks at how each approach captures sustainability-related financial risks and opportunities, and whether these are clearly connected to Stormossen's business model and long-term value creation.

Fourth, the study compares how the different approaches prioritise and rank their findings. This makes it possible to see whether the same issues are considered most significant across the three assessments, or whether the methods lead to different priorities.

Fifth, the analysis looks at overlap and differences between the assessments. This includes identifying which impacts, risks, opportunities, and material topics appear across all three approaches, and which appear only in one or two. Such patterns help show where there is broad agreement and where the approaches diverge.

Sixth, the study compares the final material topics proposed by each approach. These are assessed using the ESRS topic structure across environmental, social, and governance matters. The comparison therefore considers whether the three approaches converge around the same ESRS-related topics, or whether they lead to different conclusions about what should be treated as material for Stormossen.

Finally, the comparison considers contextual nuance and stakeholder sensitivity. This is included because DMA under the ESRS is not only about technical scoring, but also about understanding local conditions, sector-specific issues, and the perspectives of affected stakeholders. This dimension is particularly important when comparing human judgement with AI-driven assessment. Together, these criteria provide a structured basis for comparing the human-driven DMA, the internal AI-driven DMA, and the ChatGPT-driven DMA.

3.5 The three DMA approaches compared

Designing a solid comparison model starts with understanding the workflow of each individual approach. Analysis reveals that the Human-driven DMA and the Internal AI-driven DMA, follow the same sequence with the difference of conducting workshops. The ChatGPT's approach is slightly simplified, having fewer steps, however, it also follows the same course of action. For a comprehensive overview of these stages, refer to the process mapping in Table 1.

Table 1
Comparison of Human and AI-assisted DMA Processes

Human-driven DMA	Internal AI-driven DMA	ChatGPT-driven DMA
Planning	Create DMA	Understanding context
	Form Project Team	
	Select Stakeholder Groups	
	Invite Project Team to propose impacts	
Pretask Workshop 1	Proposing impacts	Identifying actual and potential IROs
Workshop 1	Refining and Validating Impacts	
Stakeholder Engagement		
Pretask Workshop 2	Impact results	
Workshop 2	Comparative Graph for Impacts	
Workshop 2	Proposing ROs	
Workshop 2	Refining and validating ROs	
Stakeholder Engagement	Stakeholder Engagement	
Pretask Workshop 3	Prioritized ROs results	Assessing material IROs
Pretask Workshop 3	Comparative Graph ROs	
Workshop 3	Preparing for Decision Making	Reporting
	Deciding on material and strategic IROs	
	DMA report	

Note. Created by the authors (2026)

3.5.1 Human-driven DMA

The human-driven DMA followed a nine-step process organized into three main stages. The process began by assigning a process owner with overall responsibility for coordination and progress.

Stage 1: Planning

The first stage focused on planning and scoping the assessment. A project team of three to twelve participants was established, and relevant internal and external stakeholder groups were identified. This stakeholder mapping was important, as these groups later contributed to the validation and prioritization of impacts, risks, and opportunities.

Stage 2: Qualitative data collection

The second stage focused on identifying and refining impacts, risks, and opportunities through workshops and stakeholder input. It began with “Pretask Workshop 1” in which the project team proposed positive and negative impacts related to Stormossen’s operations. These proposals were then discussed and refined in “Workshop 1”. After this, selected stakeholders were invited to rank and prioritise the proposed impacts through an anonymous voting process.

The same overall structure was then repeated for financial risks and opportunities. In the second pretask phase, “Pretask Workshop 2”, the project team identified relevant risks and opportunities, which were further discussed and refined in “Workshop 2”. These were then evaluated by stakeholders through another anonymous voting round in order to establish a clearer basis for prioritisation.

Stage 3: Strategic decision making

The final stage brought together the results from the earlier phases. In “Pretask Workshop 3”, the project team reviewed the identified impacts, risks, and opportunities and proposed a set of final material topics. These proposals were then discussed and validated in “Workshop 3”. At this stage, the focus shifted from identification to strategic relevance, as the final material topics were intended to support decision-making and provide a basis for the company’s overall sustainability direction.

3.5.2 Internal AI-driven DMA

The Internal AI Double Materiality Assessment uses advanced AI automation to simulate the entire assessment based on factual research about Stormossen. In order to facilitate a comprehensive background for the assessment, the following steps were taken.

Phase 1: Defining the Double Materiality Context

The context was derived from raw materials including Stormossen's strategic presentation, Academic Master's theses regarding regional waste management and EU regulations (CSRD and EFRAG materiality guidelines). Following that, a single source of truth was clarified enabling structured research containing the company's operational boundaries, strategic objectives and known environmental challenges. Finally, to prevent Large Language Model(LLM) hallucinations, strict operational boundaries and strategic goals were established along with environmental challenges based on the real documentations. The following prompt was fed to the LLM, ensuring clear data without hallucination of generic waste management concepts:

“Company: Ab Stormossen Oy

Founded: 1985

Location: Kvelvax, Vaasa region, Finland

Industry: Municipal waste management & circular economy

Operations:

-13 waste reception stations

-Biogas plant (powers 12 city buses)

-Minimossen recycling mall

-Composting and soil production

Policy Commitments (2025)

-Carbon neutral by 2030

-65% material recycling by 2035

Known Environmental Challenges:

-Odor emissions affecting nearby residents

-Groundwater contamination risk from leachate

-Methane leaks from biogas infrastructure”

Phase 2: Synthetic Stakeholder Engagement & IRO Generation

Synthetic data generation is handled by a dedicated TypeScript module designed for scalability. The system leverages the DeepSeek API (DeepSeek Chat) to simulate stakeholder perspectives, utilizing specific prompt engineering techniques to generate realistic Impacts, Risks, and Opportunities (IROs). The process followed these steps:

Coding Stakeholders Prompts

```
{  
  name: 'Jenni Sandberg',  
  role: 'HR Manager',  
  perspective: 'Employee wellbeing, workplace safety culture, training and competence  
development, diversity, labor rights, sick leave reduction...'  
},  
{  
  name: 'Jarno Rajamäki',  
  role: 'Development Manager',  
  perspective: 'Innovation in waste processing, circular economy technology, digital  
transformation, process optimization...'  
}
```

The Impact Prompt

The script iterates over each persona and sends the following prompt, appending the company context and the specific persona perspective:

*"You are an expert sustainability consultant helping {Persona Name}, the {Persona Role}. Based on the company context and their specific professional perspective ({Perspective}), propose exactly 3 sustainability IMPACTS (positive or negative) that the company has on the environment or people.
Focus on concrete, operations-specific impacts. Keep descriptions under 140 characters."*

Risks and Opportunities Prompts

Once impacts are generated, the script executes a second pass to identify financial materiality:

"Now propose exactly 3 financial Risks or Opportunity that environmental/social issues pose to the company's financial value, specifically from the perspective of {Persona Role}.

Focus on regulatory changes, physical risks, shifting consumer demands, or resource efficiency. Keep descriptions under 140 characters."

Output Compilation

The script standardizes data into a validated JSON schema to ensure structural integrity and type accuracy. This structured output generates a consistent array of Impacts and R&Os, facilitating seamless integration with the Playwright automation suite for downstream testing.

Mathematical Calibration (Significance and Magnitude)

The significance of impacts is mathematically derived from the Pairwise Comparison 'Win Rate.' For example, an impact that 'wins' in 85% of comparisons is automatically assigned a Critical (5) rating. To ensure the synthetic data mathematically mimics the exact logic of the ExecutESG platform, the significance for the impacts and the magnitude for the risks and opportunities are strictly derived from the generated Win Rate according to the following scale:

- 5 (Critical): 85% - 100% win rate
- 4 (High): 70% - 84% win rate
- 3 (Medium): 50% - 69% win rate
- 2 (Low): 30% - 49% win rate
- 1 (Negligible): 0% - 29% win rate

Scope & Irremediable Character AI Evaluation

The platform utilizes AI to evaluate and assign integer values (1-4) for Scope and irremediable character based on the impact statements.

System Prompt:

"You are an assistant designed to evaluate the magnitude of environmental and social impacts."

User Prompt:

"You are designed to first translate the user's input into English if it is in a different language (DO NOT PROVIDE TRANSLATION IN THE RESPONSE).

Evaluate the input provided to determine the scope of the statement's impact. Scope means how widespread the negative or positive impacts are. For environmental impacts, this might be the extent of damage or geographical spread. For impacts on people, it might be the number of people affected. Evaluation results should be a number from 1 to 5, where 1 is the lowest and 5 is the highest. Consider the context provided about the company.

Evaluate the input provided to determine the irremediable character of the statement's impact. Irremediable character means whether and to what extent the negative impacts can be reversed. Evaluation results should be a number from 1 to 5, where 1 is the lowest and 5 is the highest. Again, consider the company context.

The response should be in English and follow this format: "Scope: [scope evaluation result as integer]. Irremediable character: [irremediable character evaluation result as integer]."

Phase 3: Automated Platform Integration & Validation

The execution of the DMA process is entirely automated using Playwright, a web site that enables reliable web automation for testing, scripting, and AI agents and ensuring the reliable and identical showcase run every time and simulating human interactions at speed.

The TypeScript

This TypeScript file is the main script executed via the command line, using Stormossen's profile provided as an environment variable.

Dynamic Seeding

The script reads the generated JSON profile and dynamically creates the company environment within the ExecutESG platform. It bypasses manual typing by intercepting platform inputs and forcefully injecting the AI-generated Impacts and R&Os into the application's forms.

Resolving UI Race Conditions

To handle asynchronous DOM rendering and dynamic button states, the script utilizes deterministic evaluation. This ensures the automation waits for elements to become fully interactive, effectively preventing race conditions by skipping disabled buttons during complex Pairwise Comparison loops.

```
// Example: Safely waiting for the 'Next' button to be enabled before clicking
await page.waitForFunction(() => {
  const btn = document.querySelector('#nextBtn') as HTMLButtonElement;
  return btn && !btn.disabled;
});
await page.locator('#nextBtn').click({ force: true });
```

Worker Execution

While the platform typically handles AI classification as a background process, this can introduce delays during testing. To ensure real-time data integrity and bypass background processing latency, the system triggers worker execution via direct server-side commands. This ensures that background tasks are completed immediately, allowing the script to proceed with a fast and predictable execution without waiting.

Simulating Stakeholder Ecosystem

Rather than simply automating form entry, the script programmatically simulates the Pairwise Comparison phase. By utilizing the stakeholder configurations defined in the JSON profile, it calculates proportional 'votes' and injects them directly into the database via Artisan (command-line interface) commands. This allows for the instantaneous simulation of hundreds of concurrent stakeholder surveys, bypassing the UI to ensure rapid, large-scale data generation.

Phase 4: Synthetic Results & Downloads

The final stage of the AI-driven simulation transforms raw synthetic data into actionable compliance reporting. The platform aggregates the assessed Impacts, Risks, and Opportunities to generate a comprehensive Materiality Matrix, mapped directly to the official European Sustainability Reporting Standards (ESRS). The results represent the simulated materiality profile for Stormossen, providing a high-fidelity preview of the export files and analytical insights as they appear in a live production environment.

3.5.3 ChatGPT-driven DMA

In contrast to the complex Human and Internal AI approaches, the ChatGPT-driven DMA follows a simplified, four-step sequence. While it maintains the core logic of the original

framework, it significantly reduces the timeline by consolidating the collaborative workshop phases into direct results.

Prompts

To initiate the ChatGPT-driven DMA, a comprehensive system prompt was developed to provide the AI with the necessary expertise, regulatory framework and operational context. This prompt functioned as a structured briefing ensuring the AI's output aligned with the professional standards of Human assessed DMA. The full text of this briefing is provided in Appendix A.

The first part of the prompt established the AI model as an expert in sustainability reporting, specifically within the Finland waste management sector. By explicitly invoking the Corporate Sustainability Reporting Directive (CSRD) and the European Sustainability Reporting Standards (ESRS), the prompt ensured that the AI would use the correct technical terminology and legal framework. As shown in the “Instructions” section of Appendix A, this was essential for maintaining a level playing field for the comparison with the Human-driven DMA and Internal AI-driven DMA, which followed these same regulations.

The prompt was provided with a crucial element by specifying the context for Ab Stormossen Oy, the Finnish waste management company. As detailed in Appendix A, it directed the AI to consider sector specific activities such as hazardous waste handling, energy recovery and other, rather than generating a generic response. This required the AI model to take into account the unique geographical and regulatory environment of the Finnish market.

The prompt defined the “Double Materiality” logic that ChatGPT was required to follow. The task was divided into two distinct analytical lenses which are “Impact Materiality” and “Financial Materiality”. By instructing the AI model to evaluate specific criteria, the outcome replicated the scoring systems used by human project teams. Finally the prompt aimed for a highly structured reporting format, including a longlist of matters and a final assessment table. This allowed for a direct comparison with the results generated by the human-driven DMA and the internal AI-driven DMA.

Results

Phase 1

The initial phase of the assessment focuses on establishing a comprehensive understanding of the organizational context. This involves identifying the company's operational profile, which in this case is the Finnish municipal waste management company and its specific economic and regulatory framework. By analyzing core business activities, the assessment identifies the primary impacts where the company interacts most significantly with the environment and society.

Phase 2

Once the context is defined, a longlist of potential sustainability matters is generated by screening ESRS standards for relevance. This step ensures that the assessment captures a broad range of environmental, social and governance factors, such as climate change, pollution and workforce safety and business conduct. This objective is to determine which topics are relevant to the company's specific value chain, including operations and upstream and downstream activities.

Phase 3

The evaluation of double materiality serves as the methodological foundation of the assessment, requiring an analysis of both impacts and financial perspectives to determine the significance of a sustainability topic. For impact materiality, the process focuses on the company's influence on the environment and society. Parallel to this, the financial materiality examines the risks and opportunities that could influence the company's financial position.

Phase 4

The final phase involves synthesizing these evaluations into an assessment table to conclude which topics meet the baseline for Double Materiality. Topics that rank high in both impact and financial significance are prioritized as leading material issues. The structured approach concludes with a final outcome that aligns the company's strategic goals with its reporting obligations.

4. Findings and comparison

4.1 Impact comparison

For the impact comparison only the most frequent topics with the significance 4 and 5 and explain them. This is to shine light on impacts that have been deemed as important. These scores correspond to the highest levels of agreement in the pairwise comparisons, with a win rate of approximately 70% to 100%. The reason for selecting only levels 4 and 5 is to focus the analysis on impacts that were consistently prioritised across participants, rather than those with mixed or uncertain evaluations. This helps reduce noise in the data and ensures the results reflect the most important and strongly perceived impacts from the human judgement process.

4.1.1 Human-driven DMA

The human-driven DMA results show that the participants mainly judged Stormossen's most significant impacts through its core role as a waste management and circular economy actor. In total, the data includes 151 significant impact results, where 83 are positive impacts and 68 are negative impacts. This already shows an important pattern. The human judgement did not only focus on negative impacts, but also strongly recognised the positive societal and environmental role Stormossen can have.

The stakeholder groups reflected in the Excel data include a mix of consolidated system level actors, operational units, and specific stakeholders. The most frequently appearing stakeholders are grouped categories such as “Board of Directors (Consolidated)”, “Board of Directors SV (Consolidated)”, “Management Team (Consolidated)”, and “Waste Boards (Consolidated)”, which represent broader stakeholder categories that capture aggregate impacts across the organization. In addition to these, there are more specific stakeholder distinctions such as “FI” which stands for “Finnish” and “SV” which stands for “Swedish”, which indicate linguistically differentiated groups. Stakeholders like “Waste Boards FI”, and “Waste Board SV” point towards actors involved in operations, while categories like “Management Team FI”, “Owner Municipalities” and “Board of Directors” reflect the management and leadership. The presence of both consolidated and disaggregated stakeholders shows that the human-driven DMA captures impacts at multiple levels, from system wide effects to more localised or context specific

experiences. This structure, therefore, shows that Stormossen's impacts are not concentrated in a single stakeholder group but are distributed across operational, regional and different actors, reinforcing the idea that sustainability outcomes depend on interactions between the entire system rather than being isolated.

E5 Circular economy

The clearest pattern in the data is that E5 "Resource use and circular economy" dominates the human-driven DMA results. Out of the 151 significant impacts, 121 are connected to E5. This is not surprising since Stormossen's activities are directly linked to waste collection, sorting, recycling, biowaste treatment and material recovery. However, it is still important because it shows that the workshop participants did not treat circular economy as a general sustainability label. Instead, they connected it to very practical impacts, including the efficiency of collection points, the accuracy of waste sorting, the conversion of biowaste to biogas, the stability of fees, and the prevention of environmental littering. This suggests that the participants understood circular economy as something closely tied to how the waste system works in practice. A very strong pattern in the human-driven DMA is that many of the highest scoring impacts are connected to sorting, collection points, customer behaviour and waste system design. One of the clearest examples is the repeated impact that "a well-designed and implemented network of collection points increases the recycling of materials", which appears across several stakeholder groups and reaches both significance level 4 and 5. This is not only about having collection points, but about the environmental impact created when the system makes it easier for people and companies to sort correctly. The opposite impact also appears strongly, where "a poorly designed and implemented network of collection points could reduce the recycling of materials." This is important because the human-driven DMA captures both sides of the same issue. The same system can either increase recycling depending on how well it is planned and implemented. This shows that human judgement does not only identify the topic "recycling", but also understands the conditions that make the impact positive or negative.

S4 Customer behaviour

Another important pattern is that customer behavior is central to Stormossen's impact. Many impacts focus on communication, knowledge, sorting habits, waste fees and the ease of using

Stormossen's services. For example, well executed external communication is judged as significant because it makes everyday life easier for people and reduces the negative environmental impact of waste management. Similarly, better knowledge and responsibility among ordinary people is seen as important. This shows that the human-driven DMA sees Stormossen's impact as partly dependent on people's actions. Waste management is not only a technical process after waste is collected. It begins with how people understand the system and whether they are willing and able to sort correctly.

E2 Pollution

E2 "Pollution" as a theme appears less often than E5, but it remains analytically significant.. This appears in 8 significant results, especially linked to microplastics and harmful substances from digestion residue, and littering around Stormossen's locations. Even though this topic has fewer entries, it should not be ignored, and can still be serious because environmental damage may be harder to reverse. Under the ESRS, any one of the severity dimensions can make a negative impact critical, especially if the impact is difficult to repair. This matters because pollution impacts may not appear as often as sorting or recycling impacts, but they can still be serious if they spread into nature or are hard to reverse. In the data, most impacts have an irreparable(IRR) nature rate of 2, but a few pollution related impacts have higher IRR values, including 4. This suggests that the workshop participants were more cautious of the environmental issues that could not be repaired.

4.1.2 Internal AI-driven DMA

The internal AI-driven DMA provides a structured assessment of impacts using pairwise comparison logic, whereas in this dataset, that threshold was met by impacts scoring a 4 out of 5. This means that the selected impacts of 20 results reflect a relatively high level of agreement, even though no impacts reached a higher level of differentiation. As a result, the dataset presents a set of impacts that are all considered important, but without strong variation in how they are prioritised. This creates a more even representation of impacts across different themes, where multiple areas are recognised as relevant at a similar level. It is also noticed that there are some topics that do not overlap with the human DMA topics such as S3 Communities and G1 Business Conduct.

E5 Circular Economy

The impacts identified are mainly concentrated within resource use and circular economy, reflecting Stormossen's core role in waste management and material flows. A central group of impacts related to how waste is collected, processed, and redirected into productive use. This includes impacts such as ensuring that waste is properly handled and does not end up in nature, collecting sorted waste and transferring it to material recycling processes, and converting waste streams into energy such as heat or biogas. An example of this is "Waste-to-energy partnership converts non-recyclable waste into energy, avoiding landfill". Such impacts highlight the function of the system when it comes to reducing landfill, supporting recycling, and enabling circular use of resources. Closely connected to this are impacts related to the reduction of natural resource use, where sorting and recycling reduce the need for virgin materials and contribute to more efficient resource use across the system.

However negative sides related to circular economy are that "Micropastic contamination in compost poses quality and soil risks without sorting improvement", and "Handling non-recyclable PVC and fiberglass leads to landfilling under exception permits, causing contamination risk". These impacts from the AI show that Stormossen performs below satisfactory when it comes to the circular economy and how there are chain impacts when it comes to the impacts on waste systems. This leads to Stormossen having risks on the nature of falling short in complying to acceptable recycling practices.

E1 Climate Change

Another set of impacts relates to climate and energy outcomes. The AI-driven DMA captures impacts such as the utilization of biowaste, which reduces emissions that would otherwise be released into the atmosphere, but instead is turned into renewable fuel, and the role of waste in energy production. These impacts show how waste management activities are connected to broader climate considerations, particularly through emissions reduction and energy recovery. In addition, impacts linked to enabling local energy production and improving the carbon footprint of customers and stakeholders are also included, suggesting a connection between Stormossen's operations and wider energy systems.

E2 Pollution

Environmental impacts related to pollution and ecosystem effects are also present in the dataset. These include impacts such as emissions from waste collection and transportations, wastewater and discharge related effects, and the potential for harmful substances to affect the environment if waste is not properly handled. In the results, the examples are “ Fugitive methane leaks undermine carbon neutrality goal by 2030,” and “Microplastic contamination in compost risks soil quality and local ecosystems”. Impacts related to littering and local environmental conditions are also included, reflecting how waste management activities influence the surrounding environment. These impacts are generally described in broader terms, focusing on environmental outcomes rather than specific operational sources.

S1 Own Workforce

The AI-driven DMA also captures several impacts related to societal and user level outcomes, although these are more closely linked to service delivery, accessibility, and local community effects. For example, impacts such as “mobile services ensure equitable waste access for remote areas across Vaasa” shows how the company contributes to equal access to waste management services. Similarly, impacts like “ Minimossen recycling mall creates jobs and diverts materials from waste streams” highlight both social and economic benefits at the local level. There are also impacts connected to living conditions, such as “odor emissions negatively affect air quality and living conditions for nearby residents,” which show how waste operations directly influence communities. In addition, the dataset includes impacts related to system transparency and user interaction, such as “WiseMaster ECO and AI enhance waste stream transparency for resource recovery,” which reflected how information and system visibility can shape how waste is understood and managed. Together, these examples show that the company’s impacts extend beyond environmental outcomes and include accessibility, local economic effects, and quality of life for surrounding communities.

An important feature of the AI-driven DMA is that impacts are presented as individual statements without strong repetition. While similar themes appear across different impacts, they are not emphasised through repeated selection in the same way as in the human-driven analysis. This means that the dataset provides a broad coverage of relevant impacts, but with less visible

concentration around specific drivers. At the same time, the impacts are structured according to ESRS categories, such as resources use, climate, pollution, and societal effects, which helps organize the results in a consistent framework.

4.1.3 ChatGPT-driven DMA

As stated in the methodology, the ChatGPT-driven DMA differs from the human-driven DMA and the internal AI-driven DMA in how the results were produced. It was not based on the data with stakeholder proposals or pairwise comparisons. Instead, ChatGPT was given a detailed prompt and asked to conduct a DMA for Stormossen in line with CSRD and ESRS logic. The prompt asked the model to consider both impact materiality and financial materiality, use ESRS categories, and adapt the assessment to Stormossen as a Finnish waste management and circular economy company, using only public information.

Basis for the ChatGPT impact assessment

The assessment starts by placing Stormossen in its company and sector context. ChatGPT describes Stormossen as a municipally owned waste management company with activities such as waste reception, sorting, recycling, biowaste and sludge treatment, compost soil, transport biogas, public biogas filling stations, and the Minimossen recycling mall. Based on this, the model treats Stormossen as a circular economy actor, not only as a company that collects waste. This starting point affects the rest of the assessment. Since Stormossen is understood as part of a municipal and circular economy system, ChatGPT mainly looks for impacts connected to resource use, pollution control, climate effects, public service quality, worker safety, and local community trust. The assessment is therefore quite broad, but still clearly shaped by the waste management sector.

At the same time, the ChatGPT output is careful about its own limitations. It states that the assessment is not a substitute for a formal company DMA based on internal data, stakeholder interviews, incident records, permits and quantified scenario analysis. This is important because the results are based on available information and assumptions, not direct stakeholder input.

Environmental impact themes

The environmental part of the ChatGPT-driven DMA is mainly built around E5 “Resource use and circular economy”, E2 “Pollution”, and E1 “Climate change”. These are presented as the most important environmental themes for Stormossen.

E5 Resource use and circular economy is treated as the most central topic. ChatGPT links this directly to Stormossen’s business model, especially material recovery, reuse, recycling, nutrient circulation, compost, biogas, and residual waste minimization. The assessment identifies positive impacts when waste is reused, recycled, or turned into biogas and nutrient products. However, it also points out potential negative impacts if sorting quality is weak, recovery processes do not work well, or recycled outputs become contaminated.

E2 Pollution is also assessed as highly relevant. Here, ChatGPT focuses on hazardous waste, spills, emissions to air, soil and water, odor, contaminants, leachate, runoff, and impurities in recycled outputs. The reason this becomes important is that pollution from waste operations can move beyond the company’s own sites and may be difficult to repair. This makes pollution a core impact area for a waste treatment company.

E1 Climate change is described in a more mixed way. On one side, Stormossen may contribute to emissions through transport, energy use, treatment processes, and residual waste handling. On the other side, the company may also create positive climate effects through biogas, improved sorting, and higher material recovery. In this sense, ChatGPT gives Stormossen a dual climate role: the company has climate-related impacts, but it can also be part of climate solutions.

Social impact themes

The ChatGPT-driven DMA also identifies several social impacts. The most important ones are connected to *S1 Own workforce*, *S3 Affected communities*, and *S4 Consumers and end-users*.

Under *S1 Own workforce*, ChatGPT highlights occupational health and safety. This includes chemical and biological exposure, physical injury, traffic risk, hazardous materials, and operational accidents. These issues are treated as material because safe operations are necessary in waste management, especially when employees work with mixed waste, hazardous waste,

machinery and transport.

Under *S3 Affected communities*, the assessment focuses on local nuisance, trust, safety, odor, traffic, noise, visual impact, accident risk and local legitimacy. This fits with Stormossen's role as a municipal service provider. The company is not only judged by technical performance, but also by how local communities experience its activities. ChatGPT also identifies positive impacts here, especially through public education, sorting advice and support for circular behaviour among residents.

Under *S4 Consumers and end-users*, the main focus is safe, affordable and accessible waste services. ChatGPT connects this to sorting guidance, clear information and user trust. This is relevant because Stormossen's environmental results partly depend on whether households and users understand and use the waste system correctly. If the service is confusing, expensive or difficult to access, this can weaken sorting behaviour and reduce circular economy outcomes.

Governance-related impacts

ChatGPT also includes *G1 Business conduct* as a relevant impact area. This mainly concerns regulatory compliance, transparency, governance integrity, public accountability and permit adherence. Compared with the human-driven DMA, this is less connected to concrete everyday situations and more to the overall conditions for responsible waste management.

Still, the inclusion of G1 makes sense. Stormossen operates in a regulated municipal context, where weak governance could quickly affect trust, compliance, pricing, environmental control and legitimacy. In the ChatGPT assessment, governance is therefore not treated as a standalone ethical topic only, but as something that supports or weakens environmental and social outcomes.

Tiering and prioritization of impacts

The most central impact areas identified by ChatGPT are *E5 Resource use and circular economy*, *E2 Pollution*, *E1 Climate change*, *S1 Own workforce*, *S3 Affected communities*, *S4 Consumers and end-users*, and *G1 Business conduct*.

It also identifies a second tier of topics: *S2 Workers in the value chain*, *E3 Water and marine resources*, and *E4 Biodiversity and ecosystems*. These are seen as relevant, but less central. For

example, water is mostly discussed through leachate, runoff, wastewater and sludge-related risks. Biodiversity is mostly linked to land use, litter, runoff and contamination, rather than being treated as a separate main issue.

Compared with the other approaches, the ChatGPT-driven DMA presents the impacts in a more synthesized and narrative form, rather than through stakeholder-based scoring or Excel-based significance levels.

Overall interpretation of the ChatGPT impact assessment

Overall, the ChatGPT-driven DMA captures many of the topics one would expect for a Finnish municipal waste management company. It identifies circular economy, pollution, climate change, workforce safety, affected communities, consumers and end-users, and governance as central areas. This suggests that ChatGPT can apply ESRS logic in a structured and sector-relevant way when it receives a detailed prompt.

4.2 Risk and opportunity comparison

4.2.1 Human-driven DMA

E5 Circular Economy risks and opportunities

The human-driven DMA for risks and opportunities for Stormossen is split across 2 workshops as touched upon in the methodology section. They are closely linked to how the waste system works in practice, not just what the company intends to do. A clear pattern in the data is that many risks come from situations where a positive impact can easily turn negative if the system is not functioning properly. This is very visible in areas such as sorting, collection systems, communication, and cost management. One of the most repeated risks is that rising waste management costs reduce people's willingness to sort waste. This highlights an important dynamic where financial factors directly influence environmental outcomes. If costs increase or are perceived as unfair, users may sort less, which leads to more mixed waste, lower recycling rates, and higher system costs in the long run. This creates a negative cycle where economic pressure weakens environmental performance.

Operation reliability is another major source of risk identified in the data. Several impacts point to issues such as inadequately functioning plant processes, unclear or confusing services, and discontinued services. These risks show that the effectiveness of the system depends heavily on consistency and clarity. For example, when services are discontinued or change frequently, sorting behaviour weakens because users lose trust or become unsure about how to sort correctly. Similarly, unclear instructions or ambiguities in operations can lead to Stormossen's services not being used at all. This suggests that even small operational weaknesses can have wider consequences, not only for efficiency but also for environmental outcomes. In addition, risks related to quality of waste streams, such as unknown content in mixed waste sent for incineration, show that poor sorting upstream can create technical and environmental challenges downstream in the system.

A key opportunity lies in strengthening circular economy processes. The data shows positive impacts related to biowaste and sludge being processed into biogas, waste being used for energy production, and materials being recycled instead of being disposed of. These activities reduce the use of natural resources, lower emissions, and contribute to more sustainable resource use. In addition, Stormossen is seen as a pioneer in the circular economy in its area of operation, which suggests a reputational and strategic opportunity. By continuing to develop these activities, Stormossen can strengthen its position as a key actor in regional sustainability and innovation.

E2 Pollution

Environmental risks are also present and should not be overlooked, even if they appear less frequently in the dataset compared to E5 Resource use and circular economy. These include impacts such as microplastics and harmful substances entering nature through digestion residue, emissions from waste collection and transportation, wastewater impacted, and littering around Stormossen's locations. What makes these risks important is not only their occurrence, but their potential severity. Some of these impacts are harder to reverse, which is reflected in higher irreparable nature scores for certain cases. This suggests that participants recognize that environmental damage, once it occurs, may have long term consequences. Therefore, even if these risks are less dominant in how frequent it is, they still represent critical areas where careful

management and preventative measures are necessary.

S1 Own Workforce opportunity

There are also broader system level opportunities linked to stability and trust. If Stormossen can maintain reliable services, moderate costs, and consistent communication, it can support long term sorting behavior among users. This creates a positive cycle where better system performance leads to better user participation, which again improves recycling outcomes and reduces costs. Some impacts also point to wider societal benefits, such as increasing environmental awareness, supporting local energy production, and contributing to crisis preparedness through effective waste management systems. These suggest that Stormossen's role goes beyond waste handling and extends to supporting resilience and sustainability in the region. The risks and opportunities identified in the human-driven DMA show that Stormossen's sustainability performance is highly dependent on the interaction between infrastructure, behaviour, and system reliability. The company has strong potential to create positive environmental and societal outcomes, but this depends on maintaining effective operations, clear communication, and accessible systems. At the same time, the results show that if these elements are not managed well, the same system can create negative impacts. This highlights that sustainability in this context is not fixed, but depends on continuous management and improvement of the systems.

4.2.2 Internal AI-driven DMA

The AI-driven DMA identifies a set of risks and opportunities closely connected to the impacts observed in the dataset, particularly those related to circular economy processes, emissions, operational systems, and local environmental effects. Similar to the human-driven DMA, the risks and opportunities are not separate from the impacts, but rather reflect how these impacts may develop over time depending on how the system is managed. The most significant risks and opportunities are therefore directly linked to the most frequently occurring and high agreement impacts, such as biogas productions, waste to energy processes, microplastics contamination, emissions, and system accessibility.

S1 Own Workforce Risks

A key opportunity identified in the AI-driven DMA is related to biogas production and energy recovery. Many of the most significant risks are directly linked to compliance and performance targets. For example, impacts related to sorting and recycling translate into risk such as “difficulty meeting 65% recycling targets, leading to non-compliance and penalties” and potential loss of municipal contracts. Similarly, environmental impacts such as microplastic contamination and groundwater risks are connected to financial consequences like increased insurance premiums, liability claims, and additional monitoring costs. This shows that AI-driven analysis connects environmental impacts more directly to measurable business risks, especially in terms of cost, regulations, and long term financial exposure.

At the same time, the opportunities identified are closely linked to system expansions, efficiency improvements, and revenue generation. For example, impacts related to biogas production and waste to energy systems are connected to opportunities such as expanding biogas sales, diversifying into commercial fleets, and generating new revenue streams. Similarly, impacts related to data and transparency are linked to opportunities such as “AI-driven sorting,” which can improve efficiency, reduce costs, and enhance waste separation outcomes. There are also opportunities linked to circular economy development, such as producing higher value, soil products, carbon credit generation, and aligning with EU taxonomy requirements. In addition, partnerships with municipalities to improve biowaste separation are identified as opportunities to increase feedstock quality and improve system performance.

Another major risk area identified in the AI is material quality, especially related to microplastics and waste composition. Impacts such as “microplastic contamination poses soil quality and ecosystem risks” show environmental risks such as “groundwater or odor liability claims could raise insurance premiums”. Such risks are related to product quality, compliance, and market trust. If compost products are perceived as contaminated, this can reduce demand and create economic losses. At the same time, there is an opportunity to improve sorting systems, waste input quality, and processing technologies to reduce contamination and strengthen the value of recycled outputs.

E5 Circular Economy Risks and Opportunities

There are also risks and opportunities related to operational and circularity. For example, impacts such as “Fugitive methane leaks from biogas infrastructure contribute to GHG emissions, undermining 2030 carbon neutrality,” highlight risks related to community acceptance and local environmental quality such as “EU regulations could force costly biogas and composting upgrades, raising expenses”. If not managed properly, these issues can lead to complaints, reputation challenges, and the need for additional mitigation investments. At the same time, addressing these issues creates an opportunity to improve operational practices, invest in emissions control technologies, and strengthen relationships with local communities.

In addition, there are risks related to material handling and long term environmental liabilities, particularly for waste streams that cannot be easily recycled. Impacts such as “Groundwater contamination risk from landfill leachate requires ongoing monitoring and treatment to prevent pollution.” show that certain waste streams create long term environmental and possible financial risks. These impacts suggest that Stormossen faces challenges in dealing with materials that do not fit easily into the circular systems. At the same time, this highlights an opportunity to explore alternative treatment methods, reduce reliance on landfill, and improve circular solutions for complex waste streams. An example of the opportunity suggested by the AI was to “expanding sustainable schooling with employee-led workshops could enhance social license and employee skills”.

4.2.3 ChatGPT-driven DMA

As described in the previous ChatGPT section, the ChatGPT-driven DMA was not based on stakeholder voting, workshops, or pairwise comparison. The risks and opportunities were instead generated from the same prompt-based assessment, where ChatGPT was asked to apply ESRS logic to Stormossen using public information and sector-specific reasoning.

Basis for the ChatGPT risk and opportunity assessment

In the output, risks and opportunities are not treated as separate from the impacts, but as possible financial consequences of the same sustainability issues. For example, these issues are presented as matters that may affect Stormossen’s finances and long-term position, such as pollution

control, workforce safety, and circular economy performance. This creates a clear link between impact materiality and financial materiality.

However, the link is made by ChatGPT through ESRS-based reasoning rather than through direct stakeholder input or internal company data. The results should therefore be read as a structured estimate of likely risks and opportunities, not as a validated assessment of Stormossen's actual financial exposure.

E5 Circular economy-related risks and opportunities

The most important risk and opportunity area in the ChatGPT-driven DMA is *E5 Resource use and circular economy*. This is because ChatGPT treats the circular economy as central to Stormossen's business model. The assessment links this topic to material recovery, reuse, recycling, compost, nutrient circulation, biogas, and residual waste minimization.

The opportunities are mainly connected to strengthening Stormossen's circular economy. Better sorting, higher recycling rates, increased reuse, compost production, and biogas development may support both environmental performance and business value. These activities may strengthen both resource efficiency and Stormossen's regional role.

At the same time, ChatGPT identifies risks if circular economy performance is weak. Poor sorting quality, underperforming recovery processes, contaminated recycled outputs, or continued dependence on residual waste can create financial pressure. These risks may affect treatment costs, investment needs, compliance performance, and public legitimacy. In this way, ChatGPT presents the circular economy not only as a positive opportunity, but also as an area where weak performance can create strategic and financial risk.

E2 Pollution-related risks

Pollution is the second major risk area in the ChatGPT-driven DMA. The assessment connects *E2 Pollution* to hazardous waste, emissions, odor, spills, leachate, runoff, contaminants, and impurities in recycled outputs. These risks are important because pollution incidents may create direct financial consequences for a waste management company.

ChatGPT highlights that pollution can lead to direct financial and regulatory consequences. This makes pollution a license-to-operate issue. If Stormossen fails to control pollution risks, the

consequences may not only be environmental, but also regulatory and financial. Compared with the human-driven DMA, this framing is less detailed in terms of local everyday practices, but it clearly connects pollution to formal risk categories such as compliance, liability, and reputation.

E1 Climate-related risks and opportunities

The ChatGPT-driven DMA also identifies *E1 Climate change* as both a risk and an opportunity. On the risk side, Stormossen may face financial exposure from emissions related to waste treatment, residual waste handling, transport, and energy use. These risks may become more important if climate policy, energy costs, carbon-related regulation, or investment requirements become stricter.

On the opportunity side, ChatGPT highlights Stormossen's potential role in climate transition. Biogas production, improved sorting, material recovery, and circular economy services may help reduce emissions and create value from waste streams. This means that climate change is not only presented as a compliance risk, but also as a strategic opportunity. In this respect, ChatGPT gives a relatively balanced view of Stormossen's climate position, which is that the company has emissions-related exposure, but also offers climate-related solutions.

Social and governance-related risks and opportunities

ChatGPT also links financial materiality to social and governance topics. Under *S1 Own workforce*, occupational health and safety is treated as financially relevant because operational disruptions and staff absence can affect the business. This makes workforce safety both a social impact issue and a business continuity issue.

Under *S3 Affected communities* and *S4 Consumers and end-users*, the risks and opportunities are mainly connected to trust, service quality, accessibility, and legitimacy. If local residents experience odor, traffic, noise, poor communication, or unsafe services, this may create complaints, opposition, reputational damage, or weaker municipal support. At the same time, good sorting guidance, accessible services, and public education may strengthen customer trust and improve waste sorting behaviour. This can support both environmental outcomes and operating efficiency.

G1 Business conduct is also treated as financially relevant. ChatGPT connects governance to regulatory compliance, transparency, permit adherence, pricing fairness, and public accountability. Since Stormossen operates in a municipal and highly regulated context, weak governance could create legal, operational, and reputational consequences.

Overall interpretation of the ChatGPT risk and opportunity assessment

Overall, the ChatGPT-driven DMA identifies risks and opportunities that are closely linked to Stormossen's sector and business model. The main financial materiality areas are circular economy performance, pollution control, climate transition, workforce safety, local trust, service quality, and governance. This makes the output useful as a structured overview of where financial risks and opportunities are likely to appear. However, because the assessment is based on public information and sector-based assumptions, it does not show how these risks are experienced or prioritized by Stormossen's stakeholders. The findings should therefore be understood as plausible and ESRS-based, rather than empirically validated in the same way as the human-driven DMA.

4.3 Final materiality comparison

4.3.1 Human-driven DMA

The final stage of the human-driven DMA translates the previously identified impact into a set of strategic risks and opportunities that can guide decision making. In this case, a total of 42 risks and opportunities were identified as strategically significant through the structured process involving “Pretask Workshop 2” and “Workshop 2”, and final validation in “Workshop 3”. These results are based on both internal project team input and stakeholder voting, meaning they reflect not only internal priorities but also external perspectives. This makes them particularly relevant for ESRS aligned DMA, where stakeholder validation is an important requirement. The strategic risks and opportunities therefore represent a filtered and prioritised version of the earlier impact analysis, moving from a broad and detailed understanding of impacts to a more focused set of issues that are considered most important for the company's future direction.

E5 Circular Economy

There is a clear connection between the impacts discussed earlier and the strategic risks and opportunities identified in this stage. Rather than introducing completely new topics, the strategic results build directly on the same underlying themes, such as sorting, system design, communication, cost structures, and environmental performance. For example, impacts related to collection points and sorting systems appear at the strategic level as risks if systems are poorly designed or not maintained, and as opportunities if they are improved to increase recycling rates. Similarly, impacts related to rising waste management costs are translated into strategic risks concerning reduced customer participation and weaker system efficiency. This shows that the DMA process is not linear, but repetitive, where the same can appear first as an observed impact and later as a future risk or opportunity depending on how it develops over time.

What is important here is that the strategic risks and opportunities are more aggregated and simplified compared to the impact level. While the impact analysis captures detailed cause and effect relationships, including both positive and negative versions of the same issues, the strategic level focuses on broader categories that are easier to act on. This means that some of the nuance present in the impact analysis may be reduced, but it also makes the results more usable for decision making.

Consequently, the strategic opportunities highlight areas where Stormossen can strengthen its role as a circular economy actor. These include improving sorting systems, increasing recycling rates, expanding the use of biogas and energy recovery, and raising environmental awareness among users. By focusing on these areas, the company can not only reduce risks but also create positive environmental and societal outcomes. All in all, the strategic risks and opportunities show that Stormossen's sustainability performance depends on how well it manages the interaction between infrastructure, user behaviour, and operational reliability. The DMA process makes this visible by linking detailed impacts to strategic priorities, ensuring that sustainability is not treated as a separate issue but as part of the company's core decision making.

S1 Own Workforce

The usefulness of identifying these 42 strategic significant risks and opportunities lies in their direct link to decision making and resource allocation. They provide a clear prioritization of where the company should act, based on both impact severity and stakeholder relevance. In the context of DMA, this is critical because the purpose is not only to understand impacts, but also to integrate them into strategy. The results suggest that Stormossen should focus on maintaining reliable and accessible systems, improving communication and guidance to users, managing cost structures to avoid reducing participation, and ensuring high quality operation processes. In addition, environmental risks such as pollution, emissions, and waste leakage should be carefully monitored, even if they appear less frequently, because of their potential severity.

E2 Pollution risks and opportunities

The pollution-related impacts and risks identified highlight a small but important set of environmental concerns linked to Stormossens operations. The main negative impacts are related to microplastics and other harmful substances that enter nature from the biogas plants and that pollution affects the surface and groundwater in the area of the waste center. Both such impacts indicate that participants view these types of environmental damages as difficult to reverse once they occur. This suggests that these pollution effects are considered serious in the long term for ecosystems and water quality.

At the same time there are opportunities such as when sludge produced by Stormossen ends in the correct and legal place. It shows that participants see this as proper waste handling can present environmental harm and ensure compliance with regulations. On one hand, there are risks related to contamination and environmental damage when it comes to biogas processes and waste handling. On the other hand, there is an opportunity to manage these processes that ensure safe disposal and reduce harm. This suggests that Stormossen should focus on strengthening monitoring systems, improving treatment processes, and ensuring strict control over waste outputs, especially in relation to digestion residue and water contamination. Even though pollution impacts appear less frequently compared to other topics, their potential severity and irreversibility make them a critical area for careful management within the overall DMA.

E1 Climate Change

The climate-related risks and opportunities identified in the DMA reflect Stormossen's exposure to both physical and transition risks linked to climate change. At the strategic level, key risks include the potential reduction in biogas production if access to organic waste inputs becomes uncertain, as well as increasing operational costs tied to climate adaptation measures. At the same time, significant opportunities emerge from Stormossen's role as a producer of biogas and recovered energy, positioning the company as an active contributor to the transition away from fossil fuels. The results suggest that climate change is not only an eternal threat but also a driver of strategic relevance for Stormossen, particularly given that biogas production is identified repeatedly as a significant factor in the circular economy context. Managing climate-related risks therefore requires close attention to operational continuity, energy recovery efficiency, and the company's ability to communicate its climate contributing credibly to stakeholders.

E3 Water and Marine Resources

Water-related impacts appear at the strategic level primarily through risks associated with wastewater generation and the potential contamination of surface and groundwater near Stormossen's operational sites. The table indicates that Stormossen's operations generate significant volumes of wastewater, and that rising wastewater treatment costs represent a tangible financial and environmental risk. If wastewater treatment deteriorates or treatment capacity becomes insufficient, this could lead to regulatory consequences and reputational harm. Strategically, this area calls for investment in robust water treatment infrastructure and monitoring systems, particularly in relation to the digestion processes at the biogas facility. While water and marine resources appear less prominently than circular economy topics in the overall DMA, the potential severity of contamination events makes proactive water management an important priority.

S3 Affected Communities

The impacts on affected communities relate to how Stormossen's operations influence the environment and daily lives of people living near its facilities. Key risks include pollution events and inadequate waste handling that could hinder public trust, particularly concerns around

ground and surface water contamination near the waste centre. Strategically, maintaining transparent operations and proactive communication with local residents is essential for preserving Stormossen's social license to operate across the region it serves.

S4 Consumer and End-Users

Consumers and end-users appear as one of the slightly recurring themes in the results. Risks arise when communication is insufficient, sorting instructions are unclear, or service disruptions reduce participation rates, all of which directly affect the quality of waste inputs and therefore Stormossen's overall environmental performance. Opportunities emerge through improved guidance and accessible infrastructure that drive higher sorting and recovery rates, making user engagement a core operational and environmental priority.

G1 Business Conduct

Governance risks, while appearing less frequently than other topics, provide an important foundation for the DMA overall. Strategic concerns include ensuring effective internal communication, adequate employee onboarding, and ethical conduct in processes. Without reliable internal accountability structures, the company's ability to manage risks across all other ESRS topics is undermined, making good governance an enabling condition for Stormossen's broader sustainability commitments.

4.3.2 Internal AI-driven DMA

The final stage of the AI-driven DMA identifies a set of 29 impacts that are considered strategically material, all with a significance level between 4 and 5. These results represent the most important issues for the company to focus on according to the internal AI assessment. Unlike the broader impact list, which includes a wide range of environmental and operational effects, this stage reflects a clear prioritisation of impacts that are most relevant for the strategy, performance, and long term decision making. The selected material topics are therefore not new issues, but rather a filtered and synthesized version of the earlier impact and risk and opportunity analysis, focusing on what is considered most critical for the company's future direction.

E5 Circular Economy

A strong pattern of these 29 material impacts is the continued dominance of the circular economy and waste management processes. Many of the selected topics relate to how waste is processed, reused, or converted into valuable outputs. For example, impacts such as “biogas plant converts 2.65M Nm³ biowaste into renewable fuel for 12 buses” and “composting digestate and sludge creates soil products” highlight the role of resource recovery as a central strategic priority. These impacts are directly linked to both environmental and economic value creation, as they reduce emissions, support renewable energy production, and create market relevant outputs. At the same time, risks such as “economic conditions affect waste volumes, impacting biogas production and revenue” show that these same systems are sensitive to external factors, making them both a core opportunity and potential vulnerability.

Another key theme is operational efficiency and infrastructure performance. Impacts such as “transport emissions from mobile services contribute to carbon footprint” show that internal processes can directly impact both environmental and financial outcomes. These are complemented by opportunities such as expanding biogas production, improving energy efficiency, and optimizing waste processing systems. This suggests that improving operational performance is a central pathway for both reducing risks and creating value.

S1 Own Workforce

Another important group of material impacts relates to regulation, compliance and long term liabilities. Several risks focus on the company’s ability to meet environmental targets and regulatory requirements. For example, impacts related to risks such as “missing 65% recycling targets risks penalties and loss of municipal contract” show that regulatory alignment is a key strategic concern. In addition, impacts related to “Groundwater breaches could trigger liabilities, cleanup orders, and higher insurance,” and “EU Taxonomy and CSRD regulations increase compliance costs, impacting EBITDA.” highlight long term environmental and financial responsibilities. These impacts suggest that compliance is not only a reporting issue, but a core operational and financial factor that the company must continuously manage.

There is also a strong focus on technology and system development within the material impacts. Opportunities such as “Digital tools like PowerBI and WiseMaster® ECO could offer B2B data

analytics services.” show that digitalisation is seen as an important driver of future performance. Similarly impacts related to “AI-driven sorting improving separations efficiency across 13 stations, increasing recycling rates” show how technological systems can improve both operational efficiency and sustainable outcomes. These impacts indicate that innovation and digital infrastructure are not only supporting functions, but are central to how the company can improve its overall system performance.

Workforce and organisational impacts also appear within the material set, particularly in relation to working conditions and safety. For example, impacts such as “worker safety incidents increase sick leave, compensation, and penalties” show that employee wellbeing is directly linked to financial and operational performance. In addition, impacts related to training, such as expanding educational programs and workshops, suggest that improving employee skills and knowledge is seen as part of strengthening the overall system.

E2 Pollution

Environmental risks remain present in the 29 strategically material impacts, particularly in relation to pollution and ecosystem effects. Impacts such as “Dependency on landfilling PVC and fiberglass creates long-term environmental burden.” and “Groundwater contamination risk from landfill leachate requires ongoing monitoring and treatment to prevent pollution” highlight how environmental quality continues to be a key concern. These are often linked to both compliance risks and reputational impacts, showing that environmental performance is closely tied to both regulatory and stakeholder expectations.

E1 Climate Change Mitigation

The climate change mitigation risks and opportunities identified through the AI-assisted DMA center on Stormossen's role as a producer of biogas and biochar, both of which carry significant strategic potential. Key opportunities include expanding biogas sales to municipal vehicle fleets, generating carbon credit revenue through biochar production to establish leadership in waste data transparency. However, these opportunities are accompanied by risks, most notably the financial pressure of EU regulations potentially forcing costly infrastructure upgrades, as well as safety incidents during hazardous waste handling that could result in penalties and reputational damage.

Overall, the results suggest that Stormossen is well positioned to convert its existing recovery capabilities into climate strengths, provided that regulatory compliance and operational safety are carefully managed.

4.3.3 ChatGPT-driven DMA

As shown in the previous sections, the ChatGPT-driven DMA identifies a broad set of impacts, risks and opportunities based on public information, ESRS logic and sector-specific assumptions. In the final materiality stage, these findings are brought together into a prioritized set of topics that ChatGPT considers most relevant for Stormossen.

Final material topics

The ChatGPT-driven DMA concludes that the most likely double material topics for Stormossen are:

1. E5 Resource use and circular economy
2. E2 Pollution
3. E1 Climate change
4. S1 Own workforce
5. S3 Affected communities
6. S4 Consumers and end-users
7. G1 Business conduct

This final list follows quite directly from the earlier impact and risk assessment. E5 is placed first because the circular economy is treated as the core of Stormossen's business model. Waste sorting, recycling, reuse, compost, nutrient circulation and biogas are not seen as side activities, but as central to what the company does. For that reason, ChatGPT treats E5 as both highly impact material and financially material.

Environmental topics

The environmental topics dominate the final ChatGPT assessment. E5, E2 and E1 are all assessed as double material, but for slightly different reasons. *E5 Resource use and circular economy* is linked to Stormossen's core purpose and value creation. *E2 Pollution* is treated as

material because waste treatment creates possible risks related to hazardous waste, emissions, odor, leachate, contamination and impurities in recycled outputs. *E1 Climate change* is included because Stormossen has both emissions-related exposure and climate-related opportunities through biogas, recycling and higher material recovery.

This shows that ChatGPT understands Stormossen mainly through its environmental role as a waste management and circular economy company. The final materiality result is therefore strongly shaped by sector logic.

Social and governance topics

The ChatGPT-driven DMA also includes several social and governance topics as double material. *S1 Own workforce* is included because waste management involves physical, chemical and biological safety risks. *S3 Affected communities* are included because odor, traffic, local nuisance, safety and trust can affect nearby communities and the company's local legitimacy. *S4 Consumers and end-users* are included because Stormossen depends on residents and users understanding and using the waste system correctly. *G1 Business conduct* is also included as double material. This is mainly connected to regulatory compliance, permit adherence, transparency, public accountability and governance integrity. Since Stormossen operates in a municipal and regulated setting, ChatGPT treats governance as important for both legitimacy and operational stability.

Second-tier topics

ChatGPT also identifies *S2 Workers in the value chain*, *E3 Water and marine resources*, and *E4 Biodiversity and ecosystems* as relevant, but less central. These topics are not ignored, but they are placed below the main double material topics. This creates a clear hierarchy in the ChatGPT assessment. The most central topics are those directly connected to Stormossen's everyday operations, while the second-tier topics are treated as more indirect or embedded within other environmental issues.

Overall interpretation

Overall, the ChatGPT-driven final materiality assessment gives a clear and plausible overview of Stormossen's likely material topics. However, since the list is based on public information and

ESRS-based reasoning, it should be understood as a structured AI-generated assessment rather than a stakeholder-validated result. This makes it useful for comparison, but not equivalent to the human-driven DMA.

4.4 Cross-cutting patterns: where AI aligns and where it diverges

The comparison across the three DMA approaches shows that they largely identify the same broad sustainability areas as relevant for Stormossen. All three approaches point to *E5 Resource use and circular economy*, *E2 Pollution*, *E1 Climate change*, *S1 Own workforce*, *S3 Affected communities*, *S4 Consumers and end-users*, and *G1 Business conduct* as important topics. This indicates that the main ESRS topics are relatively stable across the different methods, especially because Stormossen operates in a sector where sustainability is closely tied to its core activities.

Overlap in main topics

The strongest overlap is found in *E5 Resource use and circular economy*. This topic appears as central in the human-driven DMA, the internal AI-driven DMA, and the ChatGPT-driven DMA. This is in line with Stormossen's activities, that are directly connected to waste sorting, recycling, reuse, biowaste treatment, material recovery, and biogas. *E2 Pollution* and *E1 Climate change* also appear across the assessments, although they are emphasized in slightly different ways. Pollution is mainly connected to hazardous waste, contamination, emissions, leachate, odor and littering, while climate change is linked to both emissions and opportunities connected to biogas and circular resource use.

Different levels of detail

Even though the main topics overlap, the level of detail differs. The human-driven DMA gives the most operational picture. It connects materiality to concrete issues such as collection points, sorting behaviour, communication, waste fees, local trust, and whether the system is easy for users to understand. The internal AI-driven DMA gives a more condensed and structured picture, where impacts are presented as individual statements with less repetition. The ChatGPT-driven DMA gives the broadest and most narrative overview, where the topics are clearly linked to ESRS logic and the waste management sector, but without the same stakeholder-specific detail.

Different ways of linking impacts to risks and opportunities

The three approaches also differ in how they connect impacts to risks and opportunities. In the human-driven DMA, risks and opportunities are closely tied to how the waste system functions in practice. For example, weak communication, rising costs, or poorly designed collection systems can reduce sorting behaviour and weaken recycling outcomes. In the internal AI-driven DMA, the link is often more direct between an environmental issue and a financial consequence, such as penalties, compliance costs, liability, revenue loss, or investment needs. In the ChatGPT-driven DMA, the connection is mainly built through ESRS-based reasoning and sector assumptions. This makes the links clear and logical, but less grounded in Stormossen-specific stakeholder input.

Different forms of prioritization

A final difference concerns prioritization. The human-driven DMA uses stakeholder voting and pairwise comparison, which means that the final priorities are shaped by participant judgement and repeated assessment rounds. The internal AI-driven DMA uses a more structured scoring logic, which creates a cleaner and more condensed set of prioritized impacts. The ChatGPT-driven DMA prioritizes through reasoning based on public information, ESRS categories, and sector relevance. This makes the ChatGPT output easy to follow, but it is not validated through the same empirical process as the human-driven DMA.

Summary of the main pattern

Overall, the three approaches agree quite strongly on *what* matters for Stormossen, but they differ in *how* they explain and justify materiality. The human-driven DMA is strongest in showing practical and stakeholder-sensitive conditions. The internal AI-driven DMA is strongest in structuring impacts and linking them to measurable risks and opportunities. The ChatGPT-driven DMA is strongest in producing a clear ESRS-based overview. This means that the main difference between the approaches is less about the broad topics they identify, and more about the depth, grounding, and form of reasoning behind the results.

5. Discussion

In this section, we will discuss patterns across all three DMAs based on our findings, focusing on how AI-driven DMAs and human-driven DMA capture structured and contextual elements, the implications of using AI tools for sustainability reporting under ESRS, and the limitations of our study.

5.1 What AI captures well in DMA

Our comparison among the three DMA approaches demonstrates that AI-driven DMAs, including both ExecutESG's internal AI and ChatGPT-driven DMA, have strengths in identifying topics and capturing regulatory requirements, as well as processing structured data efficiently within a short timeframe. Thus, for companies with limited time and resources, AI tools remain highly-relevant for sustainability reporting.

Both AI-driven DMAs show a high level of competence in identifying ESRS-related topics across impact, risk, and opportunity. ExecutESG's internal AI listed structured impacts such as Climate change (E1), Resource use and circular economy (E5), Pollution (E2), as well as social topics such as community effects. ChatGPT also generated a well-structured list of topics and an assessment table following ESRS standard (see Appendix B). As identifying and listing the relevant ESRS topics is one of the most important steps to conduct DMA, both AI tools demonstrated capability in building a strong foundation for a DMA without requiring heavy investment. Moreover, AI is able to produce tailored outputs when provided with contextual information. ExecutESG's internal AI identified sector-specific topics such as economic conditions affecting waste volumes and odor emissions on local residents. ChatGPT also considered activities such as waste collection, hazardous waste handling, and community impact.

The AI-driven DMAs also suggest that AI has strength in linking impacts to risks and opportunities. For example, ExecutESG's internal AI links groundwater risks and microplastic contamination to financial consequences including increased insurance premiums and liability claims. While the human-driven DMA also captures the environmental impact to financial consequence, AI tools are able to complete the task more systematically. Furthermore, the

internal AI-driven DMA produced 29 strategically material impacts and a corresponding set of risks and opportunities within a shorter time period compared to the human-driven DMA which requires three workshops and voting rounds. Although AI tools cannot replace the rich details from human engagements, for companies with limited resources, AI tools offer an efficient way to conduct DMA.

In addition, AI tools systematically applied the double materiality logic, covering impact materiality, financial materiality, and assessing severity through scale and scope. This provides a level of standardization that may be valuable for sustainability reporting. The ChatGPT-driven DMA in Appendix B presents a clear materiality assessment table, while the human-driven DMA also depends on subjective judgments of stakeholders.

5.2 What human-driven DMA captures better

Although AI demonstrates strengths in efficiency and processing structured information, human-driven DMA shows advantages in capturing dimensions important under ESRS, especially contextual nuance. This is crucial as the goal of conducting DMA at Stormossen is to help the company's strategic decision making and execution.

In the human-driven DMA, impacts are not simply listed but are meaningfully described. For instance, the human-driven DMA listed "a well-designed and implemented network of collection points increases the recycling of materials" and its counterpart, "a poorly designed and implemented network of collection points could reduce recycling." The AI-driven DMAs, in comparison, tend to list impacts in more static statements with less sensitivity on whether they are positive or negative impacts.

The human-driven DMA better captures stakeholder granularity and behavioral dynamics. It distinguishes different stakeholder groups including Board of Directors, Owner Municipalities, Management Team, etc., and the same impact can appear with different significance levels across stakeholder groups, demonstrating an individual subjective perspective on sustainability related issues. In contrast, the AI-driven DMAs treat Stormossen as a single unified company, and do not differentiate how the same sustainability issue may affect differently across stakeholder groups. Furthermore, in the human-driven DMA, most significant impacts are related to

customer habits and communication, revealing that Stormossen's environmental performance also depends on whether people can easily use the sorting system, this helps Stormossen design effective interventions.

Lastly, the human-driven DMA is strengthened by including participants with strong understanding on the local context and practical matters of waste collection, and the risks and opportunities identified by human-driven DMA are translated into actionable strategic priorities to help guide Stormossen's future direction.

5.3 Implications for AI use in ESRS-oriented DMA

AI tools can be very helpful in generating DMA that meet ESRS requirements without requiring much time and resource investments, this is particularly beneficial to small and medium sized companies that want to conduct DMA to support better strategy decision making. However, relying only on AI tools for DMA means the output may miss the contextual nuance that exists in the human-driven DMA. Therefore, the use of AI tools for DMA depends on the company's size and available resources, as well as the importance of the DMA for the company.

AI tools may be best positioned as a complement to a human-driven DMA, for example, using AI tools for topic identification and structuring. Moreover, the quality of AI-driven DMAs also depends on the prompting and data input. ExecutESG's internal AI produced more detailed output compared to the ChatGPT-driven DMA, as it benefited from Stormossen's internal data. This suggests that producing a detailed AI-driven DMA still requires human inputs on company context and in designing appropriate prompts.

5.4 Limitations of the study

Firstly, the study is based on Stormossen, a medium-sized company in Finland. As the company has its own specific operations and stakeholder environment, the DMA results may not directly apply to companies in other industries and locations.

Secondly, the processes of all three DMAs are not perfectly aligned, particularly on data and resources inputs. The human-driven DMA had the most data and resources inputs, the ExecutESG's internal AI-driven DMA had access to Stormossen's internal company data and a purpose-designed model, and the ChatGPT-driven DMA relied only on public information. For AI-driven DMAs, different AI models might produce different results, and AI models are developing rapidly so more advanced versions might be available soon, however, the study only compared the ChatGPT-driven DMA generated by GPT-4 and ExecutESG's internal AI-driven DMA.

Third, we noticed some of the AI categorizations are wrong, for example, an impact that should be categorized as S4 Own Workforce was categorized under E5 Circular Economy. Consequently, this means that secondary double checks are needed by humans in order to make sure that the categorization is as accurate as possible.

Forth, while the main goal for Stormossen to conduct DMA is to support its strategy positioning and execution, due to time constraints, the study does not include longitudinal tracking and follow-ups to assess the DMA outputs, such as whether the human-driven DMA can lead to better strategy execution due to factors related to human psychology.

6. Conclusion

This study compares three different Double Materiality Assessment approaches for a waste company context of Stormossen, in order to understand how sustainability impacts, risks, and opportunities are identified and prioritised under ESRS. The results show that all three approaches broadly converge on the same core sustainability areas, particularly resource use and circular economy, pollution, climate change, workforce conditions, affected communities, consumers, and governance. This indicates that at a high level, the identification of relevant ESRS topics is relatively stable across methods, especially in a sector such as waste management where sustainability is important in everyday operations and service.

However, while there is strong overlap in the main topics, the approaches are different in how materiality is constructed and interpreted. The human-driven DMA provides the most context-specific and operationally grounded understanding, which captures how impacts emerge through waste systems, customer behaviour, communication and stakeholder interaction. It highlights that the same issues can create both positive and negative outcomes depending on how effectively the system is implemented. However, in contrast, the internal AI-driven DMA offers a more structured and systemised perspective, where impacts are consistently translated into financial risks and opportunities such as regulatory compliance, costs and liabilities. The ChatGPT-driven DMA presents the most generalized and ESRS-aligned overview, effectively identifying relevant categories and structuring them into an understandable framework, but there is a low connection to company-specific experiences and stakeholder dynamics.

Despite these differences, the study does not provide a clear basis for determining which approach is better. Overall, the comparison shows relatively limited differences in the main topics identified across the three DMAs. At the same time, this does not mean that a human-driven DMA can simply be replaced by AI-driven approaches. Due to the time constraints of the project, it was not possible to evaluate how the different DMA outputs influence actual strategic decisions or long term sustainability performance. In particular, the study could not capture psychological, behavioural, and emotional dimensions of decision-making, which may matter when DMA results are discussed, interpreted, and used

within an organization. As a result, the findings should be interpreted as highlighting complementary strengths rather than establishing a hierarchy between the approaches.

A key takeaway from this study is that the role of AI in DMA is still developing, and its potential is likely to expand significantly in the future. If AI-driven DMA approaches were further refined with higher quality internal data, more precise prompt engineering, and stronger integration of stakeholder inputs, they could produce outputs that are both highly structured and more context sensitive. For example, incorporating real-time operational data, stakeholder feedback loops, and industry-specific information could allow AI systems to move beyond generalized assessments towards more company-specific and dynamically updated materiality analysis. In addition, improvements in model accuracy and categorization could reduce current issues related to misclassification across ESRS topics. There is therefore substantial room for future development, particularly in combining AI efficiency with human judgement. As AI technology becomes increasingly hybrid, where AI supports data processing and structuring while humans contribute to interpretation, validation and structural decision making .

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AI declaration: ChatGPT was used to better the structure and grammar but all research and ideas are our own.

Appendix A: ChatGPT Prompt Sequence

This appendix contains the primary prompts used to simulate the DMA process.

****Role:****

You are an expert in sustainability reporting, CSRD, ESRS, and Double Materiality Assessment (DMA), with strong knowledge of the waste management sector in the Nordics.

****Task:****

Conduct a ****Double Materiality Assessment (DMA)**** for ****Ab Stormossen Oy in Finland**** in accordance with the ****European Sustainability Reporting Standards (ESRS)**** under the ****CSRD**** framework.

****Objective:****

Identify, assess, and prioritize the most material sustainability matters for Ab Stormossen Oy from both:

1. ****Impact materiality**** perspective
2. ****Financial materiality**** perspective

Then conclude which topics are ****double material****.

****Instructions:****

1. ****Use ESRS logic and structure throughout the assessment****

* ****Base the DMA on ESRS requirements and terminology.**

* ****Align the analysis with relevant topical standards such as:**

* ****ESRS E1**** Climate change

* ****ESRS E2**** Pollution

* ****ESRS E3**** Water and marine resources

* ****ESRS E4**** Biodiversity and ecosystems

* ****ESRS E5**** Resource use and circular economy

* ****ESRS S1**** Own workforce

* ****ESRS S2**** Workers in the value chain

* ****ESRS S3**** Affected communities

* ****ESRS S4**** Consumers and end-users

* ****ESRS G1**** Business conduct

* ****Also consider the ESRS 1 principles for materiality assessment, including scale, scope, irremediable character, likelihood, and time horizon where relevant.**

2. ****Tailor the DMA specifically to Ab Stormossen Oy****



* Use company-specific reasoning based on its likely operations as a Finnish waste management and circular economy company.

* Consider activities such as waste collection, sorting, recycling, treatment, energy recovery, hazardous waste handling, circular economy services, emissions, local environmental effects, worker safety, and community impact.

* Where exact company data is unavailable, make reasonable and transparent assumptions based on publicly known characteristics of municipal/regional waste management companies in Finland.

3. **For each potentially material sustainability topic, assess:**

* **Topic**

* **Sub-topic**

* **Why it is relevant to Stormossen**

* **Impact materiality**

* Positive and/or negative impacts

* Actual and/or potential impacts

* Scale

* Scope

* Irremediable character

* Likelihood where relevant

* Time horizon

* **Financial materiality**

* Risks

* Opportunities

* Effects on cash flows, cost base, investments, assets, liabilities, access to finance, or reputation

* Time horizon

* **Stakeholders likely affected**

* **Placement in the value chain** (upstream, own operations, downstream)

* **Final verdict**:

* Not material

* Impact material

* Financial material

* Double material

4. **Produce the output in a clear structure**

Present the DMA in the following sections:

A. Company context

Briefly describe Ab Stormossen Oy, its likely business model, sector characteristics, and sustainability context.



****B. Methodology****

Explain how the DMA is performed according to ESRS and what assumptions are made.

****C. Longlist of sustainability matters****

Provide a broad screening of relevant ESG topics for the company.

****D. Assessment table****

Create a structured table with columns such as:

- * ESRS Topic
- * Sub-topic
- * Description / relevance to Stormossen
- * Impact materiality assessment
- * Financial materiality assessment
- * Stakeholders affected
- * Value chain location
- * Final materiality conclusion

****E. Prioritized material topics****

Summarize the topics that appear most material for Ab Stormossen Oy and explain why.

****F. Final DMA conclusion****

Clearly state the company's likely double material topics under ESRS.

5. ****Quality requirements****

- * Be analytical, not generic.
- * Use precise ESRS terminology.
- * Avoid unsupported claims; where assumptions are made, label them clearly.
- * Be especially attentive to sector-relevant issues in waste management and circular economy.
- * Write in a professional academic/business style.

****Output format:****

Deliver the result as a ****well-structured report**** with headings, followed by a ****summary table**** of the final material topics.

****Extra instruction:****

Where useful, highlight which topics are likely to be most important specifically for a ****Finnish waste management company operating in a regulated municipal and circular economy context****.

Appendix B: ChatGPT Generated DMA Report

A. Company context

Ab Stormossen Oy is a municipally owned waste management company in western Finland, serving six owner municipalities with a combined population of about 108,000. Stormossen states that it had around 50 employees and €17.2 million turnover in 2024. Its operating model is strongly circular: it runs waste reception and recycling stations, handles municipal waste, processes biowaste and sludge into compost soil and transport biogas, operates public biogas filling stations, and runs the reuse-oriented “Minimossen” recycling mall. Stormossen also states a 2035 goal of carbon-neutral operations and 65% material recycling. ([Stormossen](#))

This profile makes Stormossen a good example of a Finnish municipal circular-economy operator rather than a simple waste collector. At the same time, it sits in a highly regulated context: Finnish waste policy is designed to protect health and the environment, municipalities have defined waste-management obligations under the Waste Act, and Finland is still under pressure to improve municipal recycling performance relative to EU targets. That combination increases the salience of environmental compliance, service continuity, occupational safety, local community acceptance, and circular-economy performance. ([Ympäristöministeriö](#))

For DMA purposes, Stormossen’s most important exposure points are therefore likely to be:

- (1) treatment-related environmental impacts from waste, sludge, hazardous fractions and energy recovery routes;
- (2) transition opportunities and risks connected to recycling, biogas and nutrient circulation;
- (3) worker health and safety in waste handling; and
- (4) community and customer trust in a municipal service setting. ([Stormossen](#))

B. Methodology

This DMA follows ESRS 1 and EFRAG’s materiality-assessment logic. Under that approach, double materiality considers both impact materiality and financial materiality, and the process can be structured through four steps: understanding context, identifying actual and potential IROs, assessing material IROs, and reporting. The assessment should cover own operations and upstream/downstream value chain, and should use supportable evidence and objective information as far as possible.

For impact materiality, ESRS logic centers on severity and, for potential impacts, likelihood. Severity is assessed through **scale**, **scope**, and, for negative impacts, **irremediable character**. The time horizon also matters. For financial materiality, the test is whether sustainability-related risks or opportunities have had, or could reasonably be expected to have, a material effect on financial position, performance, cash flows, access to finance, or cost of capital over the short, medium, or long term.

Assumptions used

Because full internal company data is not available here, the assessment uses transparent assumptions based on public information and typical features of a Finnish municipal waste-management company:

- Stormossen’s core operational footprint includes waste reception, sorting interfaces, biowaste and sludge treatment, biogas upgrading/sales, reuse/circularity services, and hazardous-waste reception. ([Stormossen](#))
- Mixed waste is at least partly routed to energy recovery via Westenergy, which makes residual-waste treatment and associated emissions economically and strategically relevant. ([Stormossen](#))
- Stormossen operates in a municipal service and compliance environment where environmental permit performance, occupational safety, sorting performance, and citizen trust are likely to be central management concerns. ([Stormossen](#))

This is therefore a **reasoned ESRS-aligned DMA**, not a substitute for a company’s formal internal DMA supported by incident records, stakeholder interviews, permits, claims histories, and quantified scenario analysis.

C. Longlist of sustainability matters

The longlist below screens the ESRS topical standards most plausibly relevant to Stormossen:

Environmental

- **E1 Climate change**
 - Scope 1 and 2 emissions from facilities and vehicles
 - Avoided emissions / transition benefits from biogas
 - Exposure to carbon regulation and energy-cost shifts
- **E2 Pollution**
 - Air emissions, odor, dust, leachate/runoff, spills

- Hazardous-waste handling and contamination events
- Microplastics / contaminants in recycled outputs
- **E3 Water and marine resources**
 - Wastewater, runoff, leachate, sludge-related impacts
 - Water use and local water-quality exposure
- **E4 Biodiversity and ecosystems**
 - Local land-use and habitat disturbance around sites
 - Pollution-related ecosystem impacts
- **E5 Resource use and circular economy**
 - Waste hierarchy performance
 - Material recovery, reuse, recycling rates
 - Nutrient circulation, compost, recycled fertilizer inputs
 - Residual-waste dependence versus circular transition

Social

- **S1 Own workforce**
 - Occupational health and safety
 - Chemical/biological exposure
 - Competence and training
 - Workforce retention in technical operations
- **S2 Workers in the value chain**
 - Transport contractors, downstream processors, maintenance/service partners
 - Safety and compliance in outsourced handling
- **S3 Affected communities**
 - Nuisance, traffic, odor, accident risk
 - Public trust, environmental justice, local legitimacy
 - Public education and circular behavior change
- **S4 Consumers and end-users**
 - Safe, affordable, accessible waste services
 - Correct sorting guidance
 - End-user trust in recycled products and biogas services

Governance

- **G1 Business conduct**
 - Regulatory compliance and permit adherence
 - Public procurement / municipal governance integrity
 - Transparency, data quality, and pricing fairness
 - Product/waste traceability and handling controls

D. Assessment table

ESRS topic	Sub-topic	Relevance to Stormossen	Impact materiality assessment	Financial materiality assessment	Stakeholders affected	Value-chain location	Final conclusion
E5 Resource use & circular economy	Material recovery, reuse, recycling, nutrient circulation	Core to Stormossen’s business model: >99% recovery in 2024, reuse via Minimossen, compost, digestate/fertilizer pathways, and 65% material-recycling goal by 2035. (Stormossen)	Very high positive and negative impact relevance. Positive actual impacts through waste diversion, reuse, biogas and nutrient circulation. Potential negative impacts if sorting quality is poor, recovery underperforms, or outputs are contaminated. Scale high, scope broad across municipal service area, time horizon short-to-long.	Very high. Directly affects revenues, treatment economics, investment needs, compliance costs, strategic positioning, and municipal legitimacy. Also central opportunity area for circular services and biogas growth.	Municipal residents, municipalities, customers, farmers, circular-economy partners, regulators	Own operations, upstream collection/sorting, downstream users of recycled outputs	Double material

E2 Pollution	Hazardous waste, spills, emissions to air/soil/water, odor, contaminants	Stormossen receives hazardous waste, operates treatment sites, and reports environmental emissions annually; pollution control is core to permits and operating license. (<u>Stormossen</u>)	Very high negative impact relevance. Actual and potential pollution impacts can be severe; scope can extend beyond site boundary; some impacts may have meaningful irremediable character, especially contamination events. Time horizon immediate and long-term.	Very high. Pollution incidents can trigger cleanup costs, permit restrictions, claims, fines, operational stoppages, and reputational damage affecting public trust and financing conditions.	Local communities, environment, regulators, employees, contractors, downstream land users	Own operations and some downstream impacts	Double material
E1 Climate change	Operational GHG emissions and climate transition	Waste treatment, residual-waste routing, energy use and transport are climate-relevant; Stormossen also has climate-positive exposure through biogas and a carbon-neutrality goal for 2035. (<u>Stormossen</u>)	High. Negative impacts from treatment and transport emissions; positive actual impacts from biogas substituting fossil fuels and higher material recovery. Broad scope across operations and downstream fuel use.	High. Climate policy, energy prices, investment requirements, carbon-related cost pressure, and transition opportunities in biogas and circular services all affect cash flows and capex.	Municipalities, customers, regulators, local communities, transport users	Own operations, upstream transport, downstream energy/fuel use	Double material



S1 Own workforce	Occupational health & safety, chemical and biological exposure	Waste and hazardous-waste handling create clear H&S exposure; Stormossen is ISO 45001 certified and Finnish OHS guidance stresses safe handling of chemicals and wastes. (<u>Stormossen</u>)	Very high. Potential negative impacts include injury, long-term exposure, and serious incidents. Scale can be severe for individuals; irremediable character may be high in major injury cases; time horizon immediate to long-term.	High. Lost-time incidents, staffing shortages, insurance, compliance actions, productivity losses, and recruitment/retention pressures can materially affect operations.	Employees, families, labor representatives, contractors on site	Own operations	Double material
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<p>S3 Affected communities</p>	<p>Local nuisance, trust, safety, acceptance</p>	<p>Municipal waste sites can affect neighbors through odor, traffic, noise, visual impact and perceived risk; Stormossen’s municipal role makes legitimacy especially important. Its public education and advisory role also creates positive community impacts. (<u>Stormossen</u>)</p>	<p>High. Negative actual/potential impacts from nuisance and accidents; positive actual impacts from public sorting education and better waste services. Scope moderate to broad, depending on issue.</p>	<p>Medium to high. Community opposition, complaints, or reduced trust can affect permits, expansion projects, political backing, and brand reputation.</p>	<p>Residents, nearby communities, municipalities, schools, NGOs</p>	<p>Own operations, downstream public-service interface</p>	<p>Double material</p>
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S4 Consumers & end-users	Safe, affordable, accessible waste services and sorting guidance	Stormossen serves households directly and provides sorting guidance, basic-fee access to stations, and biowaste-bag distribution. Pricing and sorting incentives are part of behavior change. (<u>Stormossen</u>)	Medium to high. Positive impacts through access, affordability, and better sorting; potential negative impacts if service failures, confusing instructions, or unsafe handling occur.	Medium to high. Service quality and trust influence payment compliance, customer behavior, municipal support, and operating efficiency.	Households, housing companies, end-users of services	Downstream / customer interface	Double material
G1 Business conduct	Regulatory compliance, transparency, governance integrity	Waste management is permit-heavy and municipality-linked; Stormossen is constrained by Waste Act rules for municipal versus commercial services and uses subsidiary structures to comply. (<u>Stormossen</u>)	Medium. Governance failures can enable environmental or social harms, though governance itself is often an indirect driver rather than the primary impact.	High. Non-compliance or weak controls could have major legal, reputational, pricing, and operational consequences.	Owners, regulators, customers, communities, employees	Own operations and value-chain governance	Double material

S2 Workers in the value chain	Safety and labor conditions at contractors and partners	Waste transporters, downstream processors, subcontractors and service partners are integral to service delivery.	Medium. Potential negative impacts are real, especially around transport safety and hazardous materials handling, but less central than own-workforce impacts based on available public data.	Medium. Contractor failures can disrupt service, increase liability and raise costs.	Contractors, transporters, downstream partners	Upstream and downstream value chain	Impact material + Financial material (borderline double material)
E3 Water & marine resources	Leachate, wastewater, runoff, sludge-related water risks	Relevant due to waste-treatment and sludge operations, though water is mainly a pathway of pollution rather than a standalone strategic resource issue for Stormossen. (<u>Stormossen</u>)	Medium to high. Can be significant where contamination occurs; likely embedded within broader pollution controls.	Medium. Could become material through remediation, permit compliance, and infrastructure investments.	Local communities, regulators, receiving environment, farmers	Own operations, downstream environmental receptors	Impact material
E4 Biodiversity & ecosystems	Local habitat and ecosystem effects	Relevant mainly indirectly through land use, runoff, litter and contamination rather than as a primary business issue.	Medium. Negative impacts possible but probably narrower in scope than pollution/circularity/climate topics.	Low to medium. Usually financially material only if linked to permitting, remediation, or land-use constraints.	Local ecosystems, regulators, communities	Own operations / local surroundings	Impact material

Not prioritized	Some generic topics such as broad tax strategy, political lobbying, large-scale human-rights sourcing controversies	Less evidently central based on the current public profile of a regional municipal waste company.	Low or indirect based on current evidence.	Low or indirect based on current evidence.	Various	Various	Not material / not prioritized
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E. Prioritized material topics

1. E5 Resource use and circular economy

This is the single most central ESRS topic for Stormossen. It is not peripheral; it is the company’s operating logic. Recovery rate performance, reuse, compost, nutrient circulation, sludge treatment, sorting quality, and residual-waste minimization are all central to whether Stormossen creates positive circular-economy outcomes or locks in lower-value recovery routes. The topic is also clearly financially material because it drives treatment economics, infrastructure needs, market positioning, and compliance with future recycling expectations. (Stormossen)

2. E2 Pollution

For a waste-treatment company, pollution is structurally material. Hazardous-waste reception, site emissions, potential leakage or contamination, odor, and impurities in recycled outputs create a classic high-severity impact profile. Pollution is also highly financial because a single serious incident can trigger remediation costs, regulatory enforcement, asset impairment, and loss of public trust. (Stormossen)

3. E1 Climate change

Stormossen has a dual climate profile: it can generate emissions through treatment, logistics and residual-waste handling, but it also offers climate-transition solutions through biogas, better sorting, and higher material recovery. That combination makes climate both an impact topic and a strategic financial topic. For a Finnish municipal waste company, this is especially relevant as regulation and local climate expectations tighten. ([Stormossen](#))

4. S1 Own workforce

Waste management has a persistent exposure to physical injury, traffic risk, chemical agents, biological agents, sharps, and hazardous fractions. That makes worker health and safety highly material in impact terms even when incident rates are well controlled. For Stormossen, it is also financially material because safe operations are inseparable from stable service delivery. ([Stormossen](#))

5. S3 Affected communities

Because Stormossen is municipally owned and service-facing, local legitimacy matters more than for many purely private industrial firms. Odor, traffic, nuisance, safety perceptions, and communication quality can all influence the company’s “social license to operate.” At the same time, the company’s education and sorting-advice role creates important positive community impacts. ([Stormossen](#))

6. S4 Consumers and end-users

In a municipal context, customers are not just customers; they are residents and users of an essential local environmental service. Affordability, convenience, clarity of sorting instructions, and trust in service quality affect both social outcomes and the company’s economics. That pushes S4 above the threshold in this case. ([Stormossen](#))

7. G1 Business conduct

Governance is especially relevant because Stormossen operates in a regulated municipal framework with legal boundaries around service provision, environmental permits, and public accountability. Weak governance would quickly translate into operational, legal, and reputational consequences. ([Stormossen](#))

F. Final DMA conclusion

Based on ESRS logic and the publicly visible business model of Ab Stormossen Oy, the company’s **most likely double material topics** are:

1. **E5 Resource use and circular economy**
2. **E2 Pollution**
3. **E1 Climate change**
4. **S1 Own workforce**
5. **S3 Affected communities**
6. **S4 Consumers and end-users**
7. **G1 Business conduct**

A second tier of topics that are relevant but somewhat less likely to rank at the very top are:

- **S2 Workers in the value chain**
- **E3 Water and marine resources**
- **E4 Biodiversity and ecosystems**

What is most important specifically in the Finnish municipal waste context

For Stormossen, the DMA is shaped less by abstract ESG themes and more by a very specific Nordic municipal waste logic:

- circular-economy performance is a **core business purpose**, not a side issue;
- environmental pollution control is a **license-to-operate issue**;
- workforce safety is a **core operational integrity issue**;
- community trust and user behavior are **strategic enablers** of recycling performance; and
- climate is both a **risk topic** and a **transition opportunity**, especially through biogas and higher-value material recovery. (Stormossen)

In a formal company DMA, I would expect these topics to remain material even after stakeholder interviews and scoring calibration. The main change would likely be in **ranking**, not in the **identity of the material topics**.

Summary table of final material topics

Final material topic	Impact materiality	Financial materiality	Double material?	Why it is likely top-priority
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E5 Resource use & circular economy	High	High	Yes	Directly defines Stormossen’s purpose, targets, outputs and transition value
E2 Pollution	High	High	Yes	Core permit, contamination and nuisance risk area
E1 Climate change	High	High	Yes	Emissions exposure plus biogas/circular transition opportunity
S1 Own workforce	High	High	Yes	Waste operations inherently depend on safe handling and resilient staffing
S3 Affected communities	High	Medium/High	Yes	Municipal legitimacy and local acceptance are critical
S4 Consumers & end-users	Medium/High	Medium/High	Yes	Sorting behavior, affordability and service quality shape both impacts and economics
G1 Business conduct	Medium	High	Yes	Regulatory compliance and public accountability are fundamental
S2 Workers in value chain	Medium	Medium	Borderline	Important, but less central than own-workforce issues on current evidence
E3 Water & marine resources	Medium/High	Medium	No / secondary	Significant mainly through pollution pathways
E4 Biodiversity & ecosystems	Medium	Low/Medium	No / secondary	Relevant, but more indirect than pollution and circularity