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Life Cycle Thinking in Small and Medium Sized Enterprises

A case study of SMEs in the renewable energy industry

Master's thesis in Industrial Ecology and Design and Construction Project Management

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Summary

This thesis explored the adoption and learning process of Life Cycle Thinking (LCT) among small and medium-sized enterprises (SMEs) in the renewable energy sector. As environmental sustainability has become more imperative, SMEs, representing a significant portion of businesses and carbon emissions in the EU, faced unique challenges in implementing sustainable practices due to limited resources. This study, conducted in collaboration with the Swedish Life Cycle Centre, aimed to identify key challenges and needs in the greening process of SMEs. Through two qualitative methods, a literature review and a case study based on interviews, the research investigated how SMEs adopted LCT, the components involved in their learning process, and strategies to advance their learning. Findings indicated that while SMEs exhibited a range of greening activities, these varied significantly based on company size and resources. Key steps in the learning process included recognising internal ambition, targeting easily achievable improvements, and fostering collaboration within the supply chain. The study highlighted the necessity of adopting standards and frameworks to streamline LCT adoption. The research underscored the importance of tailored support from stakeholders and a supportive organisational culture in fostering sustainable practices. SMEs could advance their learning by embracing a triple loop learning mindset, incorporating strategic work, and leveraging stakeholder support effectively.

Keywords: SME, LCT, renewable energy industry, organisational learning, greening process, stakeholder support, environmental sustainability, EU green deal

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Emil Eriksson, Gothenburg, June 2024
Joanna Nyberg, Gothenburg, June 2024

Contents

List of Acronyms

Below is the list of acronyms that have been used throughout this thesis listed in alphabetical order:

B2B	Business to Business
CSO	Chief Sustainability Officer
CSRD	Corporate Sustainability Reporting Directive
EoL	End of Life
ESRS	European Sustainability Reporting Standards
GHG	Greenhouse Gas
ISO	International Organisation for Standardisation
LCT	Life Cycle Thinking
NGO	Non-Governmental Organisation
RDAP	Reactive, Defensive, Accommodative, Proactive
SMEs	Small and Medium-Sized Enterprises
VGR	Västra Götalandsregionen
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute

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1
Introduction

At a time where environmental sustainability is no longer optional but a must, small and medium-sized enterprises (SMEs) emerge as key actors in the quest for environmentally sustainable change. Despite their significant impact, SMEs have been challenged in adopting sustainable practices to undergo change. This thesis delves into the life cycle thinking of Swedish SMEs, exploring their journey towards environmental sustainability.

1.1 Background

The European Commission launched a policy package in 2019, aiming the European Union to undergo a environmental transition by achieving a net-zero of greenhouse gas emissions by 2050 (European Council, 2023). The package, named the EU Green Deal consisted of a set of policies including climate, energy, transport and taxation policies. Part of the EU Green Deal, the EU Commission introduced a new directive on corporate sustainability reporting (CSRD) forcing the industry to be transparent and report on their environmental and social impact, starting at the financial year of 2024. SMEs were directly or indirectly affected by the directive to show transparency on societal and environmental issues. In the EU, SMEs represented 99 percent of all businesses and their collective share of carbon emissions within the union was 63 percent (European Commission, 2022a). Despite their significant impact, SMEs were challenged in adopting comprehensive sustainable practices as they are limited in their financial and human resources (European Commission, 2022b). The current literature on how well prepared SMEs were for the environmental transition as a consequence of the EU Green Deal, was limited. This report aimed to fill this research gap by exploring SMEs' life cycle thinking (LCT), i.e. how SMEs adopt the life cycle perspective. LCT considers the entire life cycle of a product or activity, providing a holistic view of its environmental impact (Baumann & Tillman, 2004).

This project was conducted on request from Swedish Life Cycle Center, a center of excellence gathering competence within the field of life cycle thinking. The main objective was to connect the Center with SMEs to improve their understanding and implementation of LCT.

1.2 Aim and Research Questions

The aim of this project was to study SMEs' learning process of life cycle thinking to identify key challenges and needs in SMEs' greening process towards environmental sustainable change. This project aimed to answer the three following research questions:

1. How do SMEs adopt life cycle thinking in their operations?
2. What are the steps of SMEs' learning process of life cycle thinking?
3. How can SMEs advance their learning process?

1.3 Delimitations

This study was limited to focus on the environmental aspect of sustainability, with less emphasis on social and economic sustainability. Additionally, the study was based on two qualitative methods, a literature review and a case study based on interviews. The case study focused solely on SMEs within the Swedish renewable energy sector.

2

The environmental transition

This chapter introduces relevant topics on environmental sustainability to understand SMEs' environmental transition. It explores areas of change management, organisational learning, greening of supply chains, life cycle thinking, the EU environmental transition and SMEs of the energy supply chain.

2.1 Change management

To undergo an environmental transition it is important for organisations to manage organisational change. Kotter's eight-step model, developed in 1995, remains useful to guide organisations in change management (Hallin et al., 2019). Rather than serving as a toolbox with specific instruments, it offers guidance on actions to take to successfully manage change. The eight steps are as follows:

1. Establishing a sense of urgency: The first step is to create awareness and urgency for action by identifying and internally discussing the need for change.
2. Forming a powerful guiding coalition: The next step is about to assemble a strong group of individuals capable of driving change. Trust and collaboration within this group are essential.
3. Creating a vision: Next is to develop a vision to guide the company's strategy. This involves understanding why change is necessary and considering employees' perceptions and the prevailing organisational culture.
4. Communicating the vision: This step require the management team to share the vision with employees, by for example using weekly meetings, online platforms, or direct dialogues.
5. Empowering others to act on the vision: Remove obstacles such as formal structures and skill gaps that hinder people from participating in the change.
6. Planning for and creating short-term wins: Recognise and reward employees who contribute to improvements. Highlight individual changes in behaviour and attitude to encourage broader engagement.
7. Consolidating improvements and producing more change: Maintain the momentum for change. Senior management should continue to support change efforts and guide change agents in reducing resistance.
8. Institutionalising new approaches: Embed new directions into the organisational culture. Continuously highlight the results of the change to ensure lasting success.

Integrating sustainability into the core of the business is essential to succeed with the economic, societal and environmental pillars of sustainability (Miller & Serafeim, 2014). According to Galpin and Hebard (2019), sustainability efforts should begin with implementing a strategy. Acting more strategically, leaders often create business models, systems and procedures that aim to tackle societal and environmental issues while also maximising long-term profitability (Miller & Serafeim, 2014).

2.1.1 Internal drivers of change: internal ambition, change agents and Chief Sustainability Officers

An organisation's internal ambition reflects how it manages environmental issues and challenges by adopting varying levels of responsibility. This ambition is influenced by the extent of investments in resources like competence or other capabilities (Hart, 1995). Higher levels of specialised and dedicated investments correlate with higher ambition levels.

To evaluate the ambition level, a common method called the RDAP-scale developed by Clarkson (1995) can be used. The acronym stands for reactive, defensive, accommodative and proactive. The level of the organisation's posture or strategy as well as performance relates to either of these four categories, described in table 2.1

Rating	Posture or strategy	Performance
1. Reactive	Deny responsibility	Doing less than required
2. Defensive	Admit responsibility but fight it	Doing the least that is required
3. Accommodative	Accept responsibility	Doing all that is required
4. Proactive	Anticipate responsibility	Doing more than is required

Table 2.1: The RDAP-scale (Clarkson, 1995)

Several recent studies acknowledge the crucial role of change agents in implementing sustainability within organisations (van der Heijden et al., 2012). These change agents can be managers or employees responsible for managing change processes (van der Heijden et al., 2012) or those engaged in personal activism (Corbett et al., 2018). They act as champions, striving to create change in products, processes, or methods (Corbett et al., 2018). In the absence of these environmental champions, decision-making tends to be driven by financial and other market-driven considerations.

Change agents can also serve to make sense of sustainable change (van der Heijden et al., 2012). Embedding sustainability through change agents is an emergent process characterised by small, incremental steps and unpredictability. There are two main challenges in implementing change. First, it is challenging to translate the broad concept of corporate sustainability into practical actions. Second, it confronts managers and employees to adapt to a new reality requiring development of

new routines and ideas. Therefore, implementing sustainability requires context-dependent sense-making. The sense-making involves understanding the nature of sustainability, human interactions and continuous internal embedding. In achieving successful sense-making, change agents must possess skills of communication, action spirit and building organisational relationships.

It is important to empower change agents by involving them in decision-making processes (Petts et al., 1998). Therefore, there is great value in appointing Chief Sustainability Officers (CSOs) in an organisation (Miller & Serafeim, 2014). CSOs can be appointed to be responsible for a range of activities, including formulating and executing sustainability strategies, identifying material sustainability issues, managing stakeholder relations, learning from external sources, reporting sustainability data, and educating employees about sustainability. Researcher suggest that the CEO cannot take this responsibility alone, assistance from others is necessary (Miller & Serafeim, 2014). The CEO can initiate change by creating a vision and maintaining sponsorship. However, a centrally positioned CSO can oversee the development and implementation of the strategies needed to guide the company through the more complex stages of change.

2.1.2 External drivers of change

The external drivers to sustainability change are multiple (Galpin & Hebard, 2019). A selection of external drivers are:

- Consumer demands
- Demographics
- Geographic Markets
- Competition
- Regulations
- Non-governmental Organisations (NGOs)
- Investor desires
- Ecological issues and natural resource availability

Among the external drivers, similarities in demands can exist but the variety of drivers can also lead to conflicting sustainability priorities for an organisation (Galpin & Hebard, 2019). For example, customers may demand environmentally sustainable products, which could imply higher costs for the company, while investors may seek maximised profit. This creates a trade-off for the organisation in deciding what to prioritise, especially as demands change over time. Hence, to successfully implement sustainability, companies must analyse and evaluate the impact of both external and internal drivers on the organisation through their strategic work (Galpin & Hebard, 2019).

2.2 Organisational learning and internal competence

Theories of organisational learning are essential to incorporate when undergoing an environmental transition (Petts et al., 1998). Specifically, they can help organisations increase system thinking. In this section, organisational learning is described as three dimensions: single, double and triple loop learning. This section also manages the theory of the Dunning-Kruger effect which refers to the effect of overconfidence in learning organisations.

2.2.1 Single, Double and Triple Loop Learning

Organisational learning can be described through three different approaches: single loop learning, double loop learning, and triple loop learning (figure 2.1).

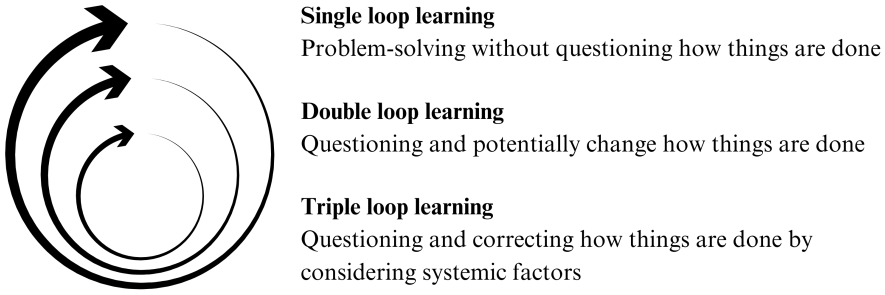

Figure 2.1: Single, double and triple loop learning

The concept of single loop was coined by Chris Argyris and Donald Schön in the late 1970s defining it as occurring "when the error detected and corrected permits the organisation to carry on its present policies or achieve its present objectives" (Argyris & Schön, 1978). This type of learning is about problem-solving within existing parameters without questioning underlying assumptions or fundamental ways of doing things (Snell & Chak, 1998).

Double loop learning occurs "when error is detected and corrected in ways that involve the modification of an organisation's underlying norms, policies, and objectives" (Argyris & Schön, 1978). In double loop learning, organisations not only seek to improve performance within the existing framework but also critically examine and potentially change the fundamental beliefs, norms, and strategies that shape their behaviour (Snell & Chak, 1998). To adopt double loop learning organisations must prevent defensive attitudes and behaviours and open for free discussion. (Romme & Van Witteloostuijn, 1999).

Triple loop learning is defined by a profound level of reflection and transformation, surpassing questioning of assumptions and correction of errors, to adressing systemic factors (Snell & Chak, 1998). It goes beyond changing behaviours and

practices by reshaping larger structures and norms within the organisation. This holistic approach acknowledges the interconnection between individual behaviours, organisational practices, and cultural norms. In triple loop learning, members of the organisation reflect on how past actions have contributed to or hindered learning (Romme & Van Witteloostuijn, 1999). They then develop new systems and strategies to advance the learning process.

2.2.2 The Dunning-Kruger effect

Learning can be driven or hindered by overconfidence described as the Dunning-Kruger Effect (figure 2.2). Individuals who are unskilled in a certain area often lack the meta cognitive ability to recognise their own incompetence (Dunning & Kruger, 1999). Essentially, their limited knowledge prevents them from accurately assessing their own performance, resulting in overconfidence in their own ability or competence.

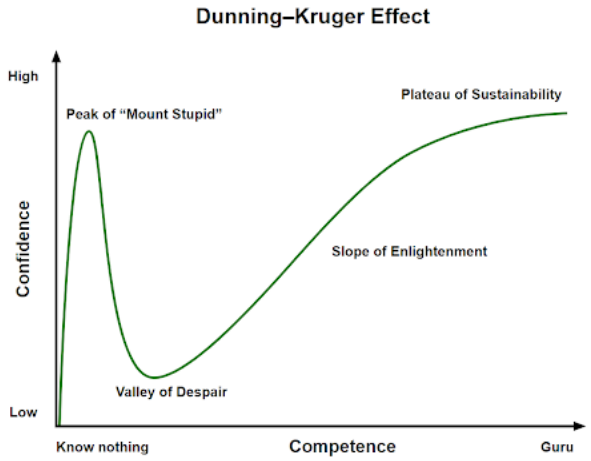

Figure 2.2: The Dunning-Kruger Effect.

Overconfidence in organisations can influence sustainability performance both positively and negatively (Wang et al., 2023). The positive aspect is that companies led by overconfident executives often maintain an optimistic perspective on profitability, which can lead them to overestimate the financial returns from sustainability investments. This may result in a greater allocation of resources towards sustainability initiatives. Additionally, these leaders may work hard to increase sustainability performance to gain recognition and attention, driven by their desire for acknowledgement and belief in their abilities. The negative aspect is that executives may rely too much on their own judgements and maintain overly positive views about the company's future (Wang et al., 2023). This can cause them to underestimate operational risks and downplay the positive impact of sustainability initiatives on corporate values, potentially leading to reduced investments in sustainability efforts.

2.3 SMEs and stakeholder management

This section introduces the EU definition of SMEs and stakeholder management.

2.3.1 Definition of SMEs

Small and Medium-sized Enterprises (SMEs) represent 99 percent of all the businesses in the European Union and play a pivotal role for the environmental transition (European Commission, 2003a). They are defined based on the number of employees and either on financial turnover or annual balance sheet total. Additionally, the organisation must be autonomous, meaning that an external enterprise can hold no more than 25 percent of its capital or voting rights. Table 2.2 presents the difference between a micro, small and medium-sized enterprises.

Company category	**Staff headcount**	**Turnover**	or	**Balance Sheet Total**
Medium-sized	<250	≤ € 50 m		≤ € 43 m
Small	<50	≤ € 10 m		≤ € 10 m
Micro	<10	≤ € 2 m		≤ € 2 m

Table 2.2: Table presenting the factor determining Medium-sized, Small and Micro companies (European Commission, 2003b).

In the transition of becoming environmentally sustainable, SMEs face challenges in financial and human resources (European Commission, 2022b). Lack of financial resources can hinder investments, while limited human resources challenge the SMEs in time and competence. To overcome challenges, SMEs must adopt an effective stakeholder management.

2.3.2 Stakeholder management

A stakeholder is "any group or individual who can affect or is affected by the achievement of the organisation's objectives" (Freeman, 1984). Examples of stakeholders are the following (Galpin & Hebard, 2019):

Internal Stakeholders
- Management
- Employees

External Stakeholders
- Customers
- Investors
- Suppliers
- Partners
- Regulators
- Public
- NGOs

Stakeholders can be categorised based on their possession of three attributes: power, legitimacy and urgency (Mitchell et al., 1997). Power refers to the influence a stakeholder has on the organisation, legitimacy refers to objectives alignment between the stakeholder and the organisation, and urgency refers to stakeholder's claim on the firm. These variables define the stakes of a stakeholder. By analysing different individuals or groups, organisations can manage to identify their stakeholders.

2.4 Green Supply Chain Management and Life Cycle Thinking

This section introduces the concepts of green supply chain management and life cycle thinking while also presenting a life-cycle based toolkit.

2.4.1 Green Supply Chain Management

The concept of greening, as defined by UNESCO, refers to "the process of pursuing knowledge and practices with the intention of becoming more environmentally friendly" (UNESCO & UNEVOC, 2017). This involves organisations adopting environmentally sustainable practices through greening activities aimed at reducing their environmental impact (Saget et al., 2022). Greening activities are related to improvements within life-time extension, dematerialisation, manufacturing efficiency, substitution, and material recovery (Olivetti & Cullen, 2018).

Green Supply Chain Management (GSCM) is defined as implementing greening activities to assess and improve the environmental performance of their supply chain (Darnall et al., 2008). Greening of supply chains also involves developing strategic relations with suppliers (Sarkis, 2006). It requires a shift in attitudes and closer collaboration among actors in the supply chain. This collaboration could involve activities such as raising awareness and assisting suppliers in developing their own environmental agendas (Rao, 2006). Closer collaboration can also lead to competitive advantage. Organisations can gain access to new markets or strengthen customer relationships and consequently improve profitability (Chin et al., 2015).

2.4.2 Life Cycle Thinking in Supply Chains

Life Cycle Thinking (LCT) is a systemic way of thinking to which is made operational through Life Cycle Management (LCM). LCM ensures a holistic perspective on environmental impact throughout the life cycle of a product extending from raw material extraction to product end of life (Nilsson-Lindén et al., 2021). It encompasses a system thinking approach considering the environmental impact from the supply chain, going beyond the impact from a single organisation or production site. The main purpose with LCM is to reduce resource use and emissions, while providing an understanding of the connections between environmental, economical and social impact (Remmen et al., 2007). LCM can also be described as facilitat-

ing circular economy, i.e. the transition from traditional linear economy to a more sustainable economy (Nilsson-Lindén et al., 2021).

2.4.3 The LCT toolkit

To implement LCT in practice, organisations can utilize a variety of tools, including: Life Cycle Assessment (LCA), Environmental Management Systems (EMS) and The Green House Gas Protocol (GHG Protocol).

Life Cycle Assessment (LCA) is a methodology for quantitatively calculating resource use and pollutant emissions across the product life cycle to relate these to different environmental impacts such as global warming, land use, ozone depletion, and toxicity (Baumann & Tillman, 2004).

Environmental Management Systems (EMS) provide a structured framework that helps organisations effectively manage their environmental issues (Darnall et al., 2008). Organisations that implement EMSs, in any format, can also improve their regulatory compliance, which can subsequently enhance their corporate image and profitability. How an EMS framework is implemented varies across organisations, although all EMSs include the following five steps: (Darnall et al., 2008):

1. Adopting an environmental policy or plan
2. Reviewing company activities to see what impact they have and how they have changed over time
3. Setting environmental sustainable targets, allocate resources and training employees
4. Monitoring the implementation process to ensure the targets are met
5. Adjusting deviations from target achievement and reviewing management

An organisation may choose to have its EMS certified according to the ISO 14001 standard. The standard is developed by the International Organisation for Standardisation (ISO), a non-governmental entity establishing consensus on the best methods and practices for various fields and industries (ISO, 2024).Adhering to this standard enables organisations to actively reduce their environmental impact, comply with legal requirements, and achieve their environmental goals (ISO, 2015). The framework encompasses multiple areas, including resource use, waste management, environmental performance monitoring, and engaging stakeholders in environmental efforts.

Organisations implementing ISO 14001 might pursue eco-labelling, governed by various specific standards within the ISO 14000 series. Eco-labelling can help organisations to make informed decisions as it quantifies environmental impacts associated with the production, use, and disposal of products and services (Galarraga Gallastegui, 2002). Additionally, it can encourage producers, governments, and other stakeholders to enhance the environmental standards of their products and services. The ISO standard classifies eco-labels into the following three types:

- Type I labels (ISO 14024) compare the environmental quality of products against each other and are often supported by government initiatives. They are awarded based on meeting specific environmental criteria.

- Type II labels (ISO 14021) consist of self-declared environmental claims made by manufacturers. These claims highlight certain environmental benefits or attributes of a product without third-party certification.

- Type III labels (ISO 14025) provide detailed, quantified environmental information about products, verified by independent sources. These labels offer comprehensive data to help consumers and businesses make informed decisions based on the product's environmental performance.

The Greenhouse Gas Protocol (GHG Protocol) was developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) (WRI & WBCSD, 2011). It provides a global standardised framework of measurement of GHG emissions and consists of different guidelines for private and public companies to measure, manage and report on their GHG emissions. By using the GHG Protocol, companies can create thorough and trustworthy inventories of greenhouse gas emissions from their operations and the supply chain towards achieving their climate objectives.

One widely used standard of the GHG protocol is the Corporate Standard, first published in 2001. The standard is built upon three classifications, called scopes, of a company's direct and indirect GHG emissions (WRI & WBCSD, 2011). Scope 1 emissions refers to direct emissions caused by the company's own operation. Scope 2 emissions refers to indirect emissions stemming from the consumption of purchased energy utilised by the company. Scope 3 emissions accounts for all other indirect emissions stemming from a company's value chain. When adapting the Corporate Standard, Scope 1 and 2 emissions must be accounted while Scope 3 is a complementing standard.

2.5 The EU environmental transition: the EU Green Deal

The European Green Deal is a policy package, launched in 2019, designed to drive the European Union towards an environmental transition (European Council, 2023). The package encompasses policies related to climate, the environment, energy, transport, industry, agriculture, and sustainable finance. Its goal is to achieve net-zero greenhouse gas emissions by 2050, while fostering a modern and competitive economy.

2.5.1 Extended Producer Responsibility

Extended Producer Responsibility (EPR) is a policy under the EU Green Deal that mandates producers to take responsibility for their products throughout the products entire life cycle (OECD, 2024). Under EPR regulations, producers have three main responsibilities: physical, economic, and informative (Compagnoni, 2022). They must manage the physical disposal of their products at the end of their life, cover the costs associated with waste management, and provide public stakeholders with information about the amount of waste collected and how it is managed

2.5.2 The Battery Regulation

Under the EU Green Deal, a new Battery Regulation was introduced in 2023 to comprehensively address the environmental, social, and economic impacts associated with batteries throughout their entire life cycle, from design to waste management (Directorate-General for Environment, 2023). The regulation aims to ensure that future batteries have a low carbon footprint, contain minimal harmful substances, reduce reliance on raw materials from non-EU countries, and promote extensive collection, reuse, and recycling within Europe. It is based on mandatory requirements for all types of batteries in the European market, including electric vehicle batteries, waste portable batteries, industrial batteries, and batteries for light means of transport (European Union, 2023).

2.5.3 The EU Corporate Sustainability Reporting Directive

To help organisations report on their environmental, social, and economic performance and enhance accountability, various reporting standards have been developed. One widely adopted standard is the voluntarily Global Reporting Initiative (GRI) sustainability reporting guidelines, developed in 2000. Used by more than 700 reporters from 43 countries, it aimed to enhance responsibility and transparency on environmental, social, and economic impacts (Moneva et al., 2006). However, it has been criticised for showing a different reality. Some GRI reporting organisations has not acted responsible in terms of sustainability issues such as greenhouse gas emissions, social equity, or human rights (Moneva et al., 2006).

In contrast to the voluntarily GRI standard, the Non Financial Reporting Directive (NFRD) was developed in 2014, which legally forced organisations to report on their sustainability practices. This was then replaced by the Corporate Sustainability Reporting Directive (CSRD), published in 2023 as part of the EU Green Deal (European Union, 2022). Through this directive, the EU aimed to prevent greenwashing and to become the global front-runner in sustainability reporting standards (European Parliament, 2022). At the time of the study, the adoption of CSRD was divided into three phases (Spinaci, 2024). The phases and what organisations were subject is presented in table 2.3.

Financial year	Organisations concerned	Reporting due
2024	Large public-interest companies previously subjected to NFRD, with over 500 employees	2025
2025	Large companies (with more than 250 employees and/or €40 million in turnover and/or €20 million in total assets) previously not subjected to NFRD	2026
2026	Listed SMEs	2027-2029

Table 2.3: The phases of CSRD adoption

2.5.4 European Sustainability Reporting Standards (ESRS)

Organisations subject to CSRD are obliged to report according to the European Sustainability Reporting Standards (ESRS) (European Commission, 2023). The ESRS were developed to cohere with the GRI standards and with the International Sustainability Standards Board (ISSB) to facilitate transition to CSRD (EFRAG, 2023).

ESRS adopt a "double materiality" , approach, requiring companies to disclose both their impacts on people and the environment, as well as how social and environmental issues pose financial risks and opportunities for the company (European Commission, 2023). It refers to the concept that sustainability reporting should consider both the financial materiality and the environmental and social impact materiality of a company's activities (Adams et al., 2021).

2.6 SMEs in the energy supply chain and their stakeholders

This section introduces the SMEs of the case study and the energy supply chain they operated in. It also provides a selection of projects initiated to support SMEs.

2.6.1 The SMEs in the energy supply chain

The case study included interviews with six SMEs in the renewable energy sector, presented in table 2.4.

SME	Purpose	Number of employees	Turnover (kSEK)	Founding year	Region
Company X	Distributed energy storage and optimisation solutions	21	80000	2017	Stockholm
Hydroc	Produced thermal energy storage in bedrock	2-10	1000	2019	Göteborg
Midsummer	Produced thin-film solar cells	127	200000	2004	Stockholm
Proplate	Produced steel foundations for wind turbines	140	400000	1999	Oxelösund
Sellpower	Distributes solar panels and energy storage solutions	10-20	100000	2010	Göteborg
Rivus Batteries	Produced flow batteries with organic electrolytes	5	300	2019	Göteborg

Table 2.4: The SMEs' organisation facts

The SMEs position in the energy supply chain is illustrated in figure 2.3. The energy supply chain was created considering energy as a product and using a general product life cycle including the six steps raw material extraction, material processing, production, distribution, use and maintenance, and end of life (Mazzi, 2020).

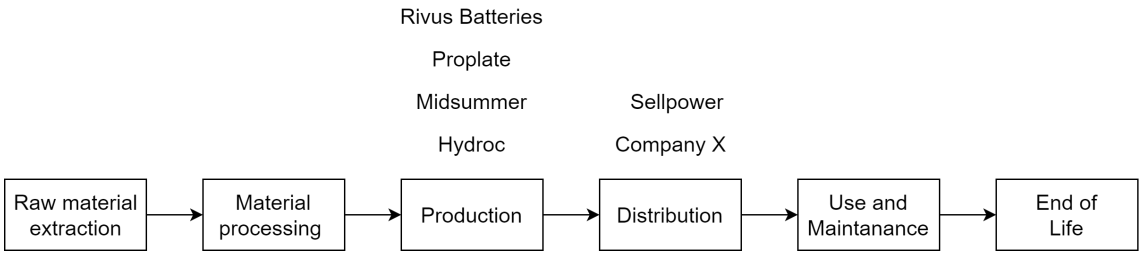

Figure 2.3: The SMEs' position in the energy supply chain

2.6.2 SME-specific support

Part of SMEs external stakeholders are Swedish organisations working to support organisations in different sectors. These are authorities, sector organisations, regional organisations, networking platforms, research institutes and other interest organisations. Among many activities and projects offered to support SMEs are education, innovation support, lobbying, advisory. Table 2.5 presents a selection of larger projects aimed to give SMEs specific support.

Project name	Description of project	Involved actors
EU SME Support	The project support SMEs through guidance in applications and implementation of EU funds (www.eusme.se)	Tillväxtverket, Vinnova, Energimyndigheten, Almi Malmö, IVL Gothenburg, LTU Business, Rise and Uminova Innovation
The Sustainability Wheel	A series of workshops that support SMEs in increasing profitability through strategic sustainability efforts (www.businessregiongoteborg.se)	Business Region Göteborg
Industriell Dynamik	The project supports SMEs in VGR in skills development, innovation, and business opportunities as well as provides advice free of charge on business intelligence, EU regulations etc. (www.industrielldynamik.se)	Business Region Göteborg, Chalmers Industriteknik, Conncet Sverige, Göteborgs Tekniska College, Handelshögskolan vid Göteborgs Univeristet, Högskolan i Borås, Högskolan Väst, IDC, IUC, Johanneberg Science Park, RISE, VGR
Hållbarhetscheck	The project supports SMEs in VGR to meet new conditions and societal transitions. SMEs can apply for the grant to bring in new expertise to help them undergo a sustaiable transformation (www.vgregion.se)	Västra götalandsregionen

Table 2.5: A selection of SME-specific support

3
Method

To address the aim and to answer the research questions of this study, two qualitative methods were used: literature review and a case study of SMEs within the Swedish renewable energy sector. This sector was chosen based on the assumption that SMEs in renewable energy operate with sustainable business models and are familiar with LCT, making them valuable sources of experience. The case study involved interviews with SMEs and selected stakeholders. Thus provided in-depth information on SMEs' LCT and complemented literature findings.

3.1 Data collection

This section presents how the data was collected. The goal was to explore SMEs' LCT, including drivers, challenges, need for support and offered support from stakeholders to answer the research questions.

3.1.1 Literature review

The literature review was conducted continuously throughout the project and served two purposes. The first was to explore previous research in the area and the second was to help interpret and deepen the interview findings. Literature sources were selected based on their relevance of research area, citation frequency and publication date to ensure credibility. The literature included books, institutional reports, scientific articles and website publications. A list of utilised databases and keywords is presented in table 3.1.

Subject Field	Database/Search Engine	Keywords
Change management	Chalmers Library, Google Scholar	change management, Kotter, strategic management, change agents, internal drivers, external drivers, external drivers for sustainability
Greening of supply chains	Google Scholar	greening process in SMEs, green supply chain management
Life Cycle Thinking	Google Scholar, ISO	life cycle thinking, life cycle management, life cycle tools, LCA, GHG, ISO14000, environmental management system
Organisational Learning	Chalmers Library, Google Scholar	triple loop learning and SME, organisational learning and greening process, organisational learning and triple loop learning, the Dunning Kruger Effect
SME support	Google Search Engine	EU SME Support, Industriklivet, Hållbarhetscheck
SMEs	European Commission Website, Google Scholar	SME definition, SMEs and stakeholder management
Stakeholder management	Google Scholar	SMEs and stakeholder management, RDAP
The EU Green Deal	European Commission Website, Google Scholar	CSRD, ESRS, EU Battery Regulation, Extended Producer Responsibility, GRI

Table 3.1: Overview of databases and keywords

3.1.2 Case study

The case study aimed to give insight into SMEs' LCT within a specific sector for comparative analysis. The interview sample comprised SMEs from the energy sector along with their primary and secondary stakeholders. Interviewing both primary and secondary stakeholders aimed to explore differences in the support they offered and in their perception of SMEs' LCT. Primary stakeholders represented either the SMEs or the energy sector, and therefore provided a detailed perspective. Secondary stakeholders, who supported SMEs and large companies across various industries, contributed to a more general perspective. The stakeholders were selected based on their adherence to at least one of the following criteria:

- Working up- or downstream the energy supply chain
- Being a sector organisation representing SMEs operating in the industries of solar energy, wind energy, or batteries
- Representing SMEs across various industries
- Offering support to SMEs in the region of Västra Götaland
- Running research projects aimed for SMEs

Based on the criteria, five categories of stakeholders were selected. Their relation to the SMEs is illustrated in figure 3.1.

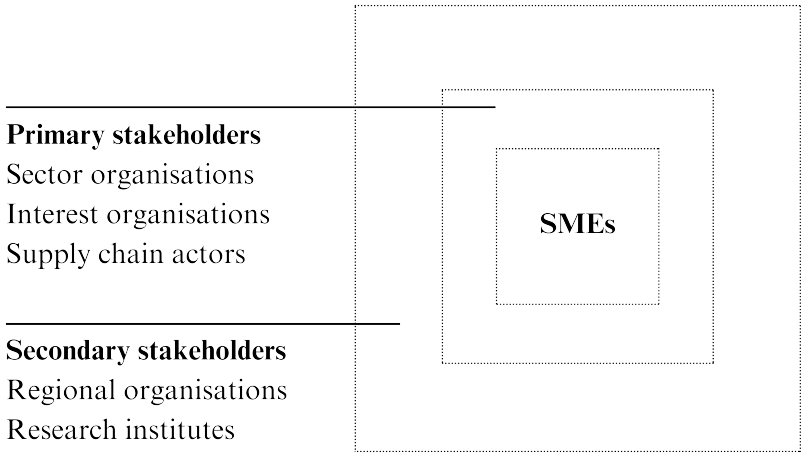

Figure 3.1: Relation between SMEs, primary and secondary stakeholders

Organisations were found using the broad network of Swedish Life Cycle Center. Contact was initiated via email, most by the thesis authors and the rest by the Center to encourage participation. A comprehensive overview of the organisations selected is provided in the table 3.2.

Companies in the energy supply chain	**Purpose**	**Role of interviewee**	**Interview medium**
El-kretsen	Small sector-based company in the EoL stage, offered collection and recycling systems for electronics and batteries	Head of Marketing and Communication with sustainability responsibilities	Microsoft Teams
Höganäs	Large company in the material processing stage, offered metal powder used in solar panels and batteries	Head of Sustainability	Microsoft Teams
Sector organisations			
Fordonskomponentgruppen, FKG, (The Scandinavian Automotive Supplier Association)	Represented the Swedish automotive sector	Communications and Strategy Officer	Microsoft Teams
Svensk Solenergi (Swedish Solar Energy Association)	Represented the Swedish solar energy sector	Business developer	Microsoft Teams
Svensk Vindenergi (The Swedish Wind Energy Association)	Represented the Swedish wind energy sector	Head of Sustainability	Microsoft Teams
Interest organisations			
Företagarna (The Swedish Federation of Business Owners)	Represented Swedish entrepreneurs	Industrial Policy Expert on environment and climate	Microsoft Teams
Småföretagarna (The Swedish Federation of SME Owners)	Represented Swedish SMEs	Board member and entrepreneur	Microsoft Teams
Regional organisations			
Business Region Gothenburg, BRG	Supported companies in the Gothenburg area	1. Deputy CEO and Head of Sustainability 2. Project Manager	1. Microsoft Teams 2. In person
CSR Västsverige	Supported companies in Region Västra Götaland in sustainable business development	Project Manager	Microsoft Teams
Johanneberg Science Park	(Out of business). Supported companies in the Gothenburg area	Innovation Matchmaker and SME Relations	In person
Energikontor Väst (Regional Energy Agency in West Sweden)	Supported companies in Region Västra Götaland in energy efficiency	Project Manager	Microsoft Teams
Research institute			
Research Institute of Sweden, RISE	Supported industry academia and the public sector	Researcher	Microsoft Teams

Table 3.2: Introduction to the selected organisations

The SMEs were selected through official member databases of CSR Västsverige, Svensk Solenergi, Svensk Vindkraft, and the Network of Green Innovations - Greenups. To find additional SMEs, the "snowballing" technique was used, which involved asking each interviewee to suggest other potential contacts (Longhurst, 2003). All SMEs were contacted via email and had to meet the following three criteria:

- Being defined as an SME according to the EU definition (European Commission, 2003a), excluding the ownership requirements
- Operating in Sweden
- Supplying or demanding products or services from any part of the energy supply chain

To ensure the SMEs met the criteria, staff headcount, turnover, and balance sheet total were initially checked using the company information-based website "Alla

bolag", which was later confirmed by the interviewees. The selected SMEs are presented in table 3.3. One SME was anonymised and referred to as "Company X".

SME	Purpose	Role of interviewee	Interview medium
"Company X"	Distributed energy storage and optimisation solutions	Head of Marketing and Production with sustainability responsibilities	Microsoft Teams
Hydroc	Produced thermal energy storage in bedrock	CEO with sustainability responsibilities	Microsoft Teams
Midsummer	Produced thin-film solar cells	Head of Materials Development and Sustainability	Microsoft Teams
Proplate	Produced steel foundations for wind turbines	Sourcing and Sustainability Manager	Microsoft Teams
Sellpower	Distributed solar panels and energy storage solutions	1. CO-owner/Sales and Marketing manager 2. Sales Coordinator with sustainability responsibilities	Microsoft Teams
Rivus Batteries	Produced flow batteries with organic electrolytes	Chief Technology Officer with sustainability responsibilities	Microsoft Teams

Table 3.3: Introduction to the selected SMEs

All interviews followed a semi-structured format with a predefined set of questions, also allowing for follow-up questions (Longhurst, 2003). The questions were organised around seven themes but varied according to the organisation type (table 3.4). Each interview lasted approximately 60 minutes and was conducted by one of the thesis authors, with the other ensuring all themes were addressed.

Themes	Questions to the SMEs	Questions to companies in the energy supply chain	Questions to other organisations
Organisational matters	Organisational purpose Organisational roles for sustainability matters and number of employees	Organisational purpose	Organisational purpose Number of SME members Communication with SMEs
The supply chain	Collaboration between actors Understanding of its position in the supply chain Awareness of the concept LCT Greening activities	Collaboration between actors	Collaboration between actors
EU directives	Alignment with CSRD		Lobbying activities
External pressure	External pressure	Pressure from SMEs Procurement criteria	External pressure
SMEs' challenges	Challenges in the greening process	Challenges in the greening process	Challenges in the greening process
Need for support	Need for support	Need for support	Need for support Offered support
The learning process of LCT		Key success factors	Key success factors

Table 3.4: Interview themes and questions

3.2 Data management

This section provides an outline of how the data was managed and transformed into results. The interviews were transcribed manually, using notes and time-stamps while also categorise them into the four overall themes: organisational matters, LCT, EU directives and the learning process. Relevant data from each interview was then extracted and grouped according to the themes presented in table 3.4 . By

using colour coding, the responses from different organisations was distinguished. Both the raw transcription material and the data from the second sorting were utilised throughout the data management process.

3.2.1 Inventory of SMEs' characteristics, drivers, challenges, needs and stakeholders' support

To identify differences and similarities in characteristics between the SMEs, data was extracted on the following six elements:

- Company size
- Environmental management
- Preparation for CSRD
- Sense of responsibility
- Realising competitive advantage
- Customer demands
- Investor demands

A table was created to illustrate the SMEs' characteristics. The comparison was then used in the analysis to explain how the SMEs implement LCT. Identifying SMEs' internal and external drivers, challenges and needs as well as stakeholders' offered support was made through extracting data on these elements and group them together.

3.2.2 Characterising SMEs' greening activities and ambition level of LCT

To get an overview of the SMEs' greening activities, the activities were identified and grouped according to similarity. A table displaying the prevalence of each activity was created for comparison. To determine which activities required an LCT, the activities were compared with the three scopes in the GHG protocol (WRI & WBCSD, 2011). Using the table and the RDAP-scale (Clarkson, 1995), the activities were then classified as reactive, defensive, accommodative, or proactive. This helped to determine each activity's required investments and competence, which were illustrated in a graph. Using the graph, SMEs' internal ambition and level of LCT were illustrated in another graph. Internal ambition related to the number of greening activities performed, while the level of LCT was determined based on alignment with scope 3 in the GHG protocol.

3.3 Analysis Strategy

The research questions were formulated to serve as the focal point of the analysis and allowed for a structured and comprehensive understanding of the results.

RQ1: How do SMEs currently adopt life cycle thinking in their operations?
To explain SMEs' adoption of LCT, findings from the case study were analysed. The graph illustrating the levels of greening activities was examined in conjunction with the characteristics of the SMEs. The objective was to evaluate what factors driving SMEs to adopt LCT.

RQ2: What are the steps of SMEs' learning process of life cycle thinking
The table of greening activities, along with the graph illustrating their levels, were examined to outline the learning process. The aim was to understand the different steps of this process and to assess whether it could be described as a step-by-step model. Analysis of the literature on organisational learning and change management was then compared to the case study findings to define the SMEs' learning process.

RQ3: How can SMEs advance their learning process?
To understand how SMEs can advance their learning process, the literature on organisational learning and change management was reviewed and compared with case study findings on SMEs' external drivers, key challenges and need for support. These were put in relation to what the SMEs' stakeholders provided as support, to evaluate the stakeholders' actions in facilitating SMEs' learning advancement.

4
Results

This chapter presents the study's findings, organised into three sections. The first section discusses the SMEs' greening activities and their ambitions of LCT. The second and third sections delves into primary and secondary stakeholders' perception of SMEs' LCT.

4.1 The SMEs' LCT in the energy supply chain

This section presents the findings of the case study. It covers a mapping of the SMEs' greening activities, ambition level of LCT, characteristics, internal and external drivers, challenges and need for support.

4.1.1 The SMEs' greening activities

The SMEs in the case study varied in the number of greening activities they performed aimed at reducing environmental impact. Table 4.1 illustrates the range of SMEs' engagement in 10 different greening activities.

Greening activities	Sellpower	Proplate	"Company X"	Midsummer	Rivus Batteries	Hydroc
Networking	X	X	X	X	X	X
Energy efficiency	X	X	X	X		X
Recycling	X	X	X	X	X	
Downstream collaboration	X	X	X	X	X	
Calculating life-cycle based data	X	X	X	X		
Green procurement criteria	X	X	X			
Environmental reporting	X		X	X		
Education		X	X			
Upstream collaboration	X					
ISO certification		X				

Table 4.1: SMEs' greening activities

The most common activities were networking, energy efficiency, recycling, and downstream collaboration. The SMEs were limited in the the time they could dedicate to networking, yet most participated in various networks to collaborate and coordinate with other actors. Rivus Batteries emphasised networking as a way to share knowledge, while Hydroc networked to promote its products.

Energy efficiency practices included decreasing energy consumption and transitioning to renewable energy sources. Some of the SMEs were members in EoL organisations such as El-kretsen, Stena Recycling or Bly-batteri-retur.

Downstream collaboration was done in four different ways: working for a local supply chain, enhancing transportation efficiency, engaging in recycling projects and educating retailers. Midsummer and Rivus Batteries worked for establishing local production facilities to enable local supply chains when entering new international markets. Proplate collaborated with their transporters to enhance transportation efficiency. Midsummer was part of a research project on how to recycle the critical materials in solar panels. Both Midsummer and Company X were educating their retailers about the recycling of their products.

The second most common activities were calculating life-cycle based data, green procurement criteria and environmental reporting. Company X and Midsummer used life cycle assessment (LCA) for marketing purposes or to identify supply chain improvements. Most of the SMEs' procurement criteria were based on price and quality, although Sellpower, Proplate and Company X also valued the environmental impact. When selecting new suppliers, Sellpower required information on climate footprint, recyclability and absence of conflict metals. Sellpower and Company X sourced European products whenever possible, but market dynamics compelled them to use less traceable Asian Batteries. Midsummer and Hydroc prioritised quality. From an environmental standpoint, high quality can extend the product life time but this was not stated as the primary reason for their focus on quality.

Larger suppliers in the energy supply chain demanding environmental data required Company X to report according to Ecovadis, a platform rating companies on environmental impacts, human rights, ethics and procurement impacts (Ecovadis, 2023). Sellpower and Midsummer on the other hand, began reporting to prepare for CSRD and to showcase their efforts to gain competitive advantage.

Education, upstream collaboration and ISO certification were less common. Two SMEs engaged in educational events to learn about topics related to environmental sustainability. Only Sellpower engaged in upstream collaboration, passing on customer demands to suppliers. They conducted annual meetings with their suppliers to highlight the benefits of transparency, fostering a culture of shared responsibility and environmental practices throughout the supply chain. Regarding ISO certifications, Proplate was the only SME certified in accordance with the ISO 14001 standard.

4.1.2 Ambition level of LCT

The greening activities required different competence and investments in terms of time and money, shown in figure 4.1. Based on the RDAP scale ratings (Clarkson, 1995), they were categorised into three levels.

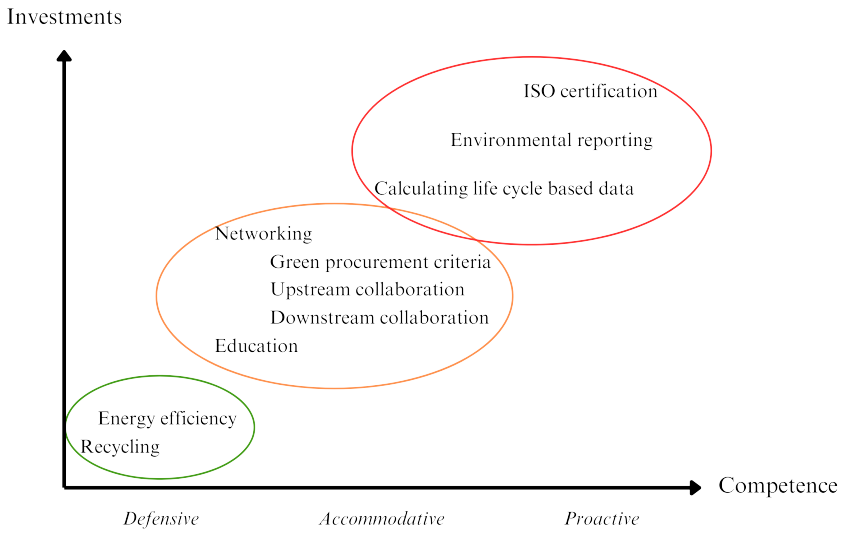

Figure 4.1: Greening activities ranked according to the level of investment and competence needed

First-level activities were defined as defensive according to the RDAP scale. Performing these activities was to admit responsibility and do the least required to meet legal requirements. Second-level activities were defined as accommodative, which was to accept responsibility and do all that was required to meet legal requirements. Third-level activities required a proactive approach, anticipating responsibility and doing more than was required.

Activities on the second and third level were scope 3 activities in the GHG protocol (WRI & WBCSD, 2011) and thus required an LCT. What level of activities an SME performed, determined its LCT and the number of activities determined its internal ambition. There were a strong correlation between the SMEs' LCT and internal ambition, shown in figure 4.2. The SMEs varied on a scale from low ambition and low LCT to high ambition and high LCT.

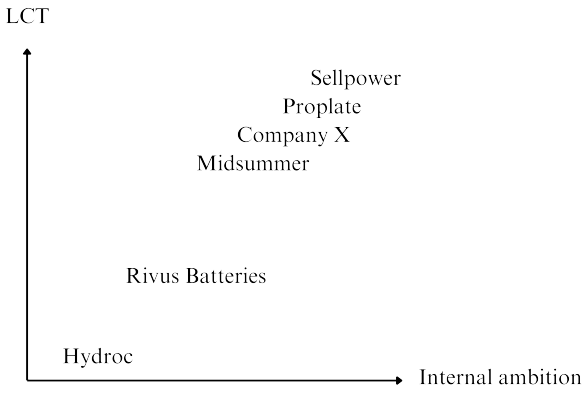

Figure 4.2: Variety of SMEs' LCT related to internal ambition

4.1.3 The SMEs' characteristics and drivers of change

There were both similarities and differences in the characteristics among the SMEs. An overview of seven identified characteristics is presented in Figure 4.2.

	Sellpower	**Proplate**	**Company X**	**Midsummer**	**Rivus Batteries**	**Hydroc**
Company size	Small	Medium	Small	Medium	Micro	Micro
Internal drivers						
Environmental management	Environmental coordinator, assisting team and employee engagement	Environmental coordinator, assisting team and employee engagement	Environmental coordinator	Environmental coordinator	Environmental coordinator	No
Preparation for CSRD	Environmental reports	Double materially assessment	Environmental reports	Environmental reports	No	No
Sense of responsibility for maintaining a green supply chain as they offered green solutions	Yes	Yes	Yes	Yes	Yes	No
Realising competitive advantage as an outcome	Yes	Yes	Yes	Yes	No	No
External drivers						
Customer demands	Yes	No	Yes	Yes	No	No
Investor demands	No	No	Yes	Yes	No	Yes

Table 4.2: The SMEs' characteristics

The characterisation of SMEs was based on SMEs' internal and external drivers. The four SMEs with high LCT and high internal ambition shared five characteristics that differentiated them from Hydroc, which showed the lowest LCT and internal ambition. The characteristics were a larger company size, environmental management, preparation for CSRD demands, sense of responsibility towards maintaining a green supply chain, realising competitive advantage and pressure from customers, except for Proplate.

Rivus Batteries shared some characteristics with both the high- and low performing SMEs. Rivus Batteries had an environmental coordinator and felt responsible for maintaining a green supply chain but had not begun preparation for CSRD, realised competitive advantage nor experienced pressure from customers or investors.

All SMEs, except Hydroc had appointed an environmental coordinator. This person also had other responsibilities. For Hydroc, the CEO was responsible for environmental issues. They would not prioritise hiring a sustainability manager as it was considered costly and unnecessary. In contrast, Midsummer, Proplate, and Company X emphasised that sustainability managers or other engaged people will put internal pressure on the organisation. Rivus Batteries and Proplate highlighted how a team of dedicated individuals is crucial for complying with upcoming laws and regulations. Proplate created a team consisting of the environmental coordinator, the Human Resource Manager, the Chief Financial officer and the Quality Manager who shared ideas and experiences on sustainability. They had also initiated a project to engage employees in reflecting on the environmental impact from their activities to identify improvements. According to Proplate, employees must understand the benefits of changing their behaviour and feel included in contributing to a sustainable

future. Targeting easy achievable improvements such as utilising reused work equipment or choosing sustainable means of transportation, are ways to engage employees.

All SMEs except Hydroc showed a sense of responsibility for maintaining a green supply chain due to their offers of green solutions. Hydroc felt less responsibility to perform greening activities because they already offered a green solution.

Proplate had not started environmental reporting but did not foresee issues complying with CSRD demands, as the required information was accessible. They believed their sustainable business model and smaller size were advantageous, but success depended on their sustainability team.

Two external drivers pushing SMEs towards environmental change were identified: customer and investor demands. While customers were considered a strong driver, most prioritised price and quality over environmental performance. Sellpower noted that purchasers often lacked understanding of the product life cycle, resulting in inadequate comparisons and low demand for environmentally sustainable products. However, SMEs with high LCT experienced pressure from larger companies to provide environmental data, comply with certifications, and ensure product traceability, leading them to incorporate environmental reporting.

Rivus Batteries and Hydroc had not yet experienced customer pressure, although Rivus Batteries anticipated it once they began selling their products. Midsummer anticipated future pressure from larger customers to comply with CSRD standards. Company X, Midsummer, and Hydroc faced investor pressure, with Hydroc being asked to familiarise themselves with the UN Sustainable Development Goals but not compelled to actively engage with them.

4.1.4 The SMEs' main challenges

The SMEs' greening process challenges related to cost and time. The SMEs argued that high costs was stated to be the major hinder to profitability which was crucial to maintain when making environmental improvements. The SMEs faced three cost-related challenges (figure 4.3).

Figure 4.3: SMEs' cost-related challenges

The SMEs viewed purchasing software licenses for calculating environmental data or other related activities as a cost to avoid. Additionally, they were reluctant to

pay for educational or networking events aimed at developing competence or facilitating connections with other companies or environmental coordinators; instead, they preferred these events to be free of charge. Hiring a sustainability manager, solely dedicated to sustainability issues, was stated as one of the largest cost-related challenges.

Four time-related challenges were identified which are presented in figure 4.4.

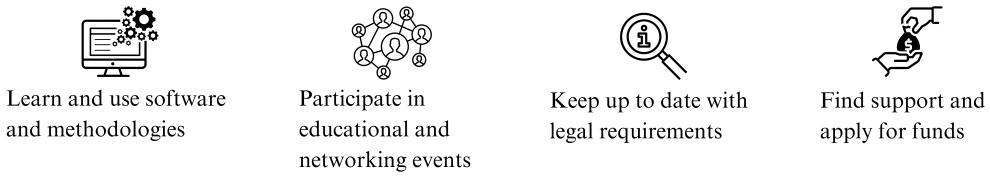

Figure 4.4: SMEs' time-related challenges

Learning and implementing software and different methodologies required significant time investments. Midsummer faced challenges in meeting the various eco-certification standards demanded by their customers. Due to insufficient time they struggled to provide multiple sets of specific data, which was necessary to fulfill the diverse checklists of different procurers, posing a risk of losing customers.

Participating in educational and networking events, as well as keeping up with new laws and regulations, were also time-consuming activities. A primary factor behind this was insufficient human resources dedicated to sustainability issues.

To overcome the cost- and time challenges, the SMEs needed to seek financial funds and other external support, such as for meeting legal requirements. However, finding appropriate, tailored support and navigating the application process of funds posed administrative challenges. Midsummer identified difficulty in securing sufficient financial support from the EU innovation fund and Industriklivet, as funding amounts were tied to the company's direct impact on climate. This made it easier to obtain funding for transitioning from non-sustainable to sustainable large-scale production compared to developing new facilities for renewable energy.

4.1.5 The SMEs' main needs for support

To overcome challenges, tools and support were necessary. The SMEs identified six main supports needed to advance their LCT (figure 4.5).

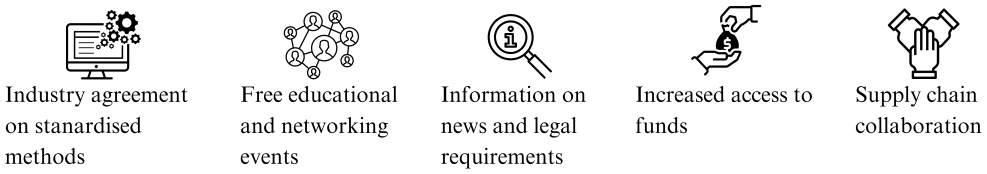

Figure 4.5: The SMEs' main needs for support

There was need for standardised methods for calculating environmental data to reduce the administrative burden. Hydroc proposed a checkbox format that is easy and time-efficient to use. Sellpower expressed a need for a unified product database to streamline access to environmental data, suggesting an industry-wide agreement led by sector organisations to establish a single common database.

Another need was educational and networking events free of charge. Rivus Batteries stated they would be more likely to participate in free events and be more prepared for the CSRD demands. Most SMEs were connected to networks but they did not want to pay for networking events.

The SMEs also wanted to be notified about news on legal requirements and industry developments rather than searching for information themselves. The most efficient communication channels were said to be emails, subscription-based newsletters, webinars, and fairs. Company X suggested that organisations supporting SMEs could increase engagement with various industry-specific channels, such as appearing in journals tailored to specific sectors.

To increase access to funds, the SMEs needed tailored support and information on suitable funding options. Sellpower emphasised the need to streamline fund application processes. Innovative SMEs with sustainable business models may be hindered in contributing to the environmental transition if they cannot secure the necessary funds. Moreover, Midsummer demanded funds tailored for SMEs actively contributing to environmental sustainability efforts.

Collaboration through projects and coordination of environmental practises among supply chain actors were considered important promoting shared responsibility in the environmental transition. For example, Sellpower, Proplate, and Midsummer stated they could offer products with less environmental impact if customers were willing to share the associated costs.

4.2 Primary stakeholders' perception of SMEs' LCT and offers to support them

This section presents primary stakeholders' perception of SMEs' LCT and what support these stakeholders offered to meet the SMEs' needs.

4.2.1 SMEs' LCT activities

The degree of LCT varied among SMEs across all industries. However, SMEs that had understood the urgency of the environmental transition had built or adapted their business models to be sustainable and thus developed an LCT.

Two important LCT-activities were identified for SMEs to advance their LCT further: complying with eco-certification standards and supply chain collaboration. Being eco-certified may help SMEs to comply with laws and regulations and once an SME gets eco-certified, it was unlikely to unlearn or abandon it.

Småföretagarna and Svensk Solenergi emphasised that actors in any supply chain needed to collaborate. When requesting environmental data, B2B customers needed to share knowledge with their suppliers on how to gather data and the purpose behind it. Höganäs had taken the opportunity to strengthen their position in the supply chain by supporting the SMEs through collaboration projects and by sharing knowledge about how to conduct LCAs. Through collaboration and coordination with their small and larger customers, Höganäs could provide LCAs covering the entire supply chain. El-kretsen helped to initiate projects on how producers can reclaim materials from the EoL stage. At the time of the study, the ambition of producers to reclaim materials were low, preventing a Swedish market enabling this to develop.

4.2.2 Primary stakeholders' perception of SMEs' drivers of change

The primary stakeholders emphasised one key internal driver of SMEs' greening process: dedicated individuals. These were considered important in SMEs of all industries no matter the level of LCT. Enthusiasts were said to help the SMEs to learn and to make improvements, especially if part of the management. An appointed manager for environmental issues was said to help with sourcing news and comply with laws and regulations.

The key external drivers were identified as legal requirements of the EU Green Deal and customer demands. For instance, the EU Green Deal pushed large companies to demand environmental data from their smaller suppliers. Småföretagarna and Svensk Vindenergi noted increasing pressure from large companies, although FKG and Företagarna argued that customer pressure on SMEs remained insufficient. Procurement was often based on price because purchasers often lack the skills to compare products based on environmental performance.

The sector organisations emphasised the importance of balancing external pressure. They noted that, since change takes time, excessive pressure could jeopardise the survival of SMEs. To much pressure could hinder the environmental transition if SMEs in the renewable energy sector were not surviving.

4.2.3 Primary stakeholders' perception of SMEs' challenges

The primary stakeholders identified three cost-related and three time-related challenges in SMEs' greening process. Like the SMEs, they emphasised that profitability was crucial to incorporate greening activities. The cost-related challenges are presented in figure 4.6.

Figure 4.6: SME's cost-realated challenges according to primary stakeholders

Like the SMEs, the primary stakeholders emphasised the challenge of purchasing software needed to calculate environmental data. They noted that SMEs often lack the capital for long-term green investments, such as in software tools or innovations. Furthermore, economic fluctuations could challenge SMEs, for example due to rising prices in electricity and goods. On the other hand it could also drive them to reduce their energy consumption or focus on material efficiency.
The time-related challenges are presented in figure 4.7.

Figure 4.7: SME's time-realated challenges according to primary stakeholders

A challenge identified was the risk of information overload. Företagarna argued that SMEs can easily be overwhelmed by an excess of information, due to lack of time to process new environmental concepts or terms. Identifying and applying for suitable financial funds was also described as a challenge. Höganäs suggested that consultants or other external stakeholders could help SMEs explore and apply for funds. Moreover, SMEs across various industries often lacked the time to explore opportunities for collaboration within their supply chains, such as finding partners that could reuse their waste.

4.2.4 Primary stakeholders' perception of SMEs' needs and offers of support

The primary stakeholders identified five areas where SMEs needed support. These are presented in figure 4.8.

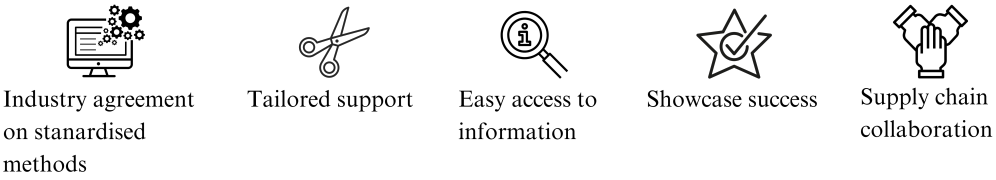

Figure 4.8: SMEs' need for support according to primary stakeholders

Agreement on standardised methods was needed to reduce SMEs' administrative burden, and to allow easy data sharing among different actors. Furthermore, tailored support in environmental practices and procurement processes were needed. Småföretagarna had observed how SMEs got disqualified in procurement processes because they struggled to answer questions correctly. FKG emphasised the importance of coordinating regional organisations to streamline support and avoid redundancy. To avoid information overload, SMEs needed easy access to information. It was argued that organisations representing them must evaluate their communication strategies, including how they explain new concepts.

The primary stakeholders also argued that SMEs needed to get inspired by others on environmental efforts. Sector- interest and regional organisations must showcase successful cases of SMEs that managed to go through environmentally sustainable change without sacrificing profitability. They also argued for showing how environmental efforts can generate competitive advantage.

As the SMEs also claimed, the primary stakeholders stated the need for SMEs to network with others in the supply chain to enhance collaboration, develop competence, and seek business opportunities, such as identifying where one company's waste can be another company's asset. FKG emphasised how such meetings not only occurred at formal networking events but also during coffee breaks at any kind of event. To increase communication with actors in the EoL stage, it was argued that larger downstream companies have to initiate contact with upstream SMEs and guide them on where and how to manage waste. Both parties could benefit from better collaboration: upstream actors could improve their waste management and cut costs, while EoL actors could connect with potential customers. The support offered by primary stakeholders depended on the SMEs' expressed interests. Examples of support they offered is presented in (Table 4.3).

SMEs' needs	Organisation	Support
Industry agreement on standards	-	-
Tailored support	Småföretagarna	Environmental and legal advisory tailored for SMEs
	Företagarna	Tailored advisory
Easy accessible information	Företagarna	"Beginners' Guide" to the greening process and ambition to structure the website by industry for easier navigation
	Småföretagarna	Ambition to develop an A-Z guide on their website
Showcase success	Företagarna	Seminars showcasing successful environmentally sustainable companies
	Svensk Vindenergi	Council showcasing and discussing sustainable solutions and successful efforts
	FKG	Awarded suppliers for sustainability efforts
Supply chain collaboration	FKG	Networking platform
	Svensk Solenegi	Networking platform
	Svensk Vindenergi	Networking platform
	Företagarna	Networking platform

Table 4.3: The primary stakeholders perception of SMEs' needs and what support they offered

4.3 Secondary stakeholders' perception of SMEs' LCT and offers to support them

This section presents secondary stakeholders' perception of SMEs' LCT and what support these stakeholders offered to meet the SMEs' needs.

4.3.1 Secondary stakeholders' perception of SMEs' LCT activities

LCT among SMEs across industries varied. RISE and CSR Västsverige argued that some SMEs were curious about emission calculation, while others were interested in understanding concepts like the CSRD standard and circularity. Then there were also SMEs who lacked understanding of the three dimensions of sustainability. Energikontor Väst expressed that some SMEs were working with circularity without having an understanding of the concept. Regional organisations argued that SMEs with high LCT had built or adapted their business models for sustainability.

Although SMEs were not yet reporting in line CSRD demands, some were using alternative environmental reporting methods, such as the GRI. CSR Västsverige

argued that SMEs need to understand the purpose behind their reporting efforts, rather than merely responding to the questions outlined in reporting guides. They wanted SMEs to gain as much competence in environmental sustainability so that they could question their suppliers' demands.

4.3.2 Secondary stakeholders' perception of SMEs' drivers of change

The secondary stakeholders agreed with the primary stakeholders that the key internal driver of SMEs' greening process is dedicated individuals, particularly if being part of the management. It was argued that an environmental coordinator aided in understanding and complying with laws and regulations, as well as recognising opportunities for competitive advantage.

The external drivers were legal requirements of the EU Green Deal, customer and investor demands. The EU directive was expected to indirectly and directly pressure SMEs to develop an LCT. Indirectly, large companies would demand environmental data and therefore exclude non-compliant networks. According to RISE, private customers were also seen as influential by demanding environmentally sustainable products and being critical of greenwashing. On the other hand, Energikontor Väst and BRG argued that customer pressure remained insufficient, resulting in minimal consequences for SMEs that ignored LCT. Unlike the primary stakeholders, BRG and RISE stated that investors were also attentive towards greenwashing and pressured SMEs to provide environmental data.

The secondary stakholders also noted that developing LCT takes time and that SMEs needed freedom to experiment without criticism for what they haven't yet accomplished, as this could risk greenwashing. Therefore, pressure needed to be balanced.

4.3.3 Secondary stakeholders' perception of SMEs' challenges

The secondary stakeholders identified two main cost-related challenges and four main time-related challenges. The secondary stakeholders also agreed on how profitability is a prerequisite for SMEs to incorporate green activities. The cost-related challenges are presented in figure 4.9.

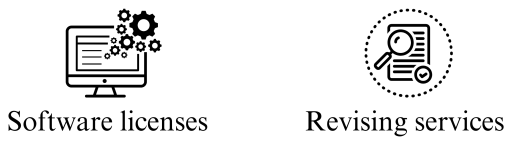

Figure 4.9: SMEs' cost-related challenges according to secondary stakeholders

Cost-related challenges included the expense of software licences, partly needed to

comply with environmental reporting standards. Complying with reporting standards could also result in high costs for SMEs in terms of revising services. CSR Västsverige argued how competitiveness among auditing companies and the limited supply risks driving prices up as demand increases.

The time-related challenges are presented in figure 4.10.

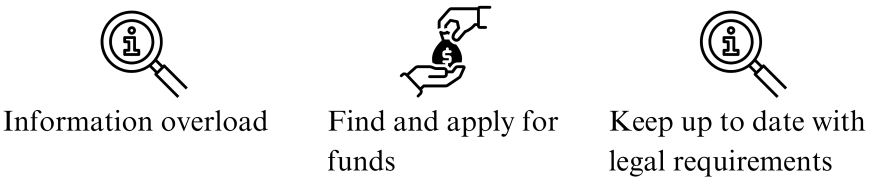

Figure 4.10: SMEs' time-related challenges according to secondary stakeholders

Like the primary stakeholders, the secondary stakeholders also identified information overload and identification and application of funds as a time-related challenges. Time was also a significant constraint in keeping up to date with legal requirements.

4.3.4 Secondary stakeholders' perception of SMEs' needs and offers of support

The secondary stakeholders agreed with the primary stakeholders on three areas where SMEs needed support, presented in figure 4.11.

Figure 4.11: SMEs' need for support according to secondary stakeholders

SMEs needed tailored advice and examples of successful environmental transitions. However, regional organisations were constrained by their obligation to remain general and objective, preventing them from offering tailored support. BRG highlighted the importance of supporting SMEs with examples of environmental efforts, emphasising that making a difference for the environment does not require them to change the world or keep track of all legal changes.

SMEs also needed to network and collaborate with other supply chain actors to understand their part in the environmental transition. RISE argued against suboptimisation thinking, emphasising that SMEs must consider the broader impact on the entire supply chain, rather than solely focusing on their own objectives. Avoiding to take responsibility can lead them to relying solely on sustainability efforts by

other supply chain actors for their survival.

Similar to the primary stakeholders, support provided by the secondary stakeholders highly depended on the SMEs' interests and learning needs. Examples of support is listed in table 4.4).

SMEs' needs	**Organisation**	**Support**
Tailored support	**Johanneberg Science Park**	Outreach activities
	RISE	Tailored support to SMEs, free of charge
Showcase success	**BRG**	"Reuser of the Year" award
	CSR Västsverige	Sharing of best practices
Supply chain collaboration	**CSR Västsverige**	Networking platform
	Energikontor Väst	Networking platform
	RISE	Networking platform

Table 4.4: The secondary stakeholders perception of SMEs' needs and what support they offered

5
Analysis

This chapter presents the analysis of the study's results by answering the research questions. The first research question aimed to explain SMEs' implementation of LCT, the second to define SMEs learning process and the third to understand how SMEs can advance their learning process.

5.1 How do SMEs adopt life cycle thinking in their operations?

SMEs in the the renewable energy sector adopted LCT through greening activities requiring three levels of competence and investments in time and money. They showed different ambition levels which depended on certain characteristics.

5.1.1 Three levels of greening activities

SMEs in the energy sector performed greening activities on three levels. The main difference between the activities was the required degree of competence and investments in time and money.

First-level activities were examples of easily achievable improvements such as energy efficiency and recycling which were the minimum efforts to meet legal environmental requirements. These activities were closely connected to scope 1 and 2 emissions in the GHG protocol (WRI & WBCSD, 2011), meaning they did not require a holistic perspective and thus no LCT (Nilsson-Lindén et al., 2021). Nonetheless, these activities were important steps in the development process of LCT.

Second- and third-level activities, such as collaboration in the supply chain or environmental reporting, required an understanding of the organisation's position in the supply chain and were therefore categorised as LCT activities.

5.1.2 SMEs ambition of LCT

The case study uncovered a correlation between internal ambition and the adoption of LCT. A variation of the SMEs was observed. SMEs at the lower end of the scale engaged in only 20 percent of identified greening activities, while those at the higher end performed between 60 to 80 percent, despite the high investments required.

The SMEs that performed LCT activities showed a high ambition and shared six characteristics:

- Larger company size
- Environmental management
- Preparation for CSRD demands
- Sense of responsibility towards maintaining a green supply chain
- Realising competitive advantage
- Pressure from customers

SMEs engaged in activities requiring high competence had integrated environmental issues into their management by appointing an environmental coordinator and, in some cases, forming an assisting team involving their employees. This indicated a high in-house competence to perform LCT activities and could also explain the deprioritisation of participating in educational events. Already possessing in-house competence reduces the need for external education.

In addition, SMEs with high LCT had also realised how environmental efforts could result in competitive advantage, thus focusing on the long-term profitability. They also understood the necessity of close collaboration with upstream and downstream actors to enhance both environmental and economic performance.

Among SMEs across industries, primary and secondary stakeholders perceived a range of LCT adoption. Some SMEs lacked sustainability understanding, while others engaged in LCT activities like environmental reporting. This view aligns with the case study findings. Interest and regional organisations noted that SMEs with sustainable business models often had strong LCT ambitions. Although all SMEs in the case study offered sustainable solutions, their LCT adoption varied, indicating that a sustainable model does not always imply a higher LCT.

5.2 What are the steps of SMEs' learning process of LCT?

To develop LCT, SMEs must undergo a learning process defined by four components: creating internal ambition, targeting easily achievable improvements, supply chain collaboration, and adopting standards and frameworks (figure 5.1). This is not a step-by-step model, as all components can be undertaken simultaneously or be combined in different ways. The more components undertaken, the further along the learning process has an organisation come.

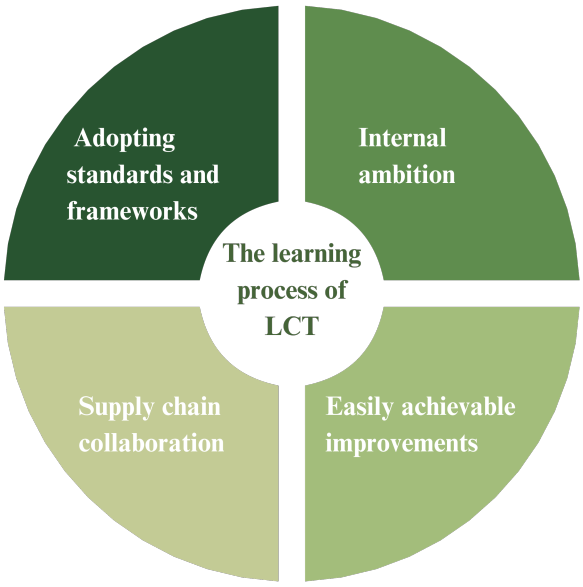

Figure 5.1: The four components of the LCT learning process

5.2.1 Internal ambition

A key condition to learning is internal ambition. The SMEs in the case study demonstrating high LCT also showed a strong internal ambition. Enhancing internal ambition is influenced by the following three factors:

1. Fundamental knowledge
2. Committed individuals
3. Overconfidence

The first factor describes how SMEs need a baseline level of knowledge to recognise their knowledge gaps and identify what they need to learn. Without this fundamental knowledge, they cannot be aware of opportunities to increase their knowledge.

The second factor is to empower individuals within organisations who are willing to make environmental change, also known as change agents. Both literature and case study findings indicate that having environmental enthusiasts is crucial in exerting internal pressure to drive change. By involving them in the decision-making, the internal ambition can be sustained in the organisation (Petts et al., 1998). In addition, they can act to make sense of the change process (van der Heijden et al., 2012) which can be important in decreasing information overload.

Chief Sustainability Officers (CSOs) was shown to be instrumental in managing environmental activities. SMEs with environmental coordinators had higher LCT than those without one. CSOs have the ability to push the organisation towards concrete

actions by their authority, expertise and ambition (Miller & Serafeim, 2014). Having a CSO can also free up time for other organisational roles to focus on their respective activities, which solves many of the SMEs time-related challenges. On the other hand, hiring a CSO is expensive but should be viewed as a long-term investment to gain competitive advantage.

The third factor that can enhance internal ambition is the effect of overconfidence, described as a cognitive bias in the Dunning-Kruger effect (Wang et al., 2023). SMEs with high confidence may invest in greening activities as they see no obstacles. One SME in the case study showed these tendencies. They were confident in their ability to start reporting in line with the CSRD, despite not fully understanding what it would entail. This overconfidence may increase their ambition to start reporting. However, organisations can underestimate operational risks which may lead them to avoid necessary investments in CSRD reporting.

5.2.2 Targeting easily achievable improvements

Targeting easily achievable improvements is a way for SMEs to start their learning. These activities give immediate feedback on the environmental and economic impact and do not require high investments or competence. Case study findings showed that environmental improvements must generate profit for SMEs, either short-term or long-term. All SMEs in the case study had started with short-term activities, such as recycling or energy efficiency. However, the SMEs with high LCT had also realised competitive advantages, thus understanding the long-term economic benefits.

5.2.3 Supply chain collaboration

To advance the greening process, the literature emphasises the importance of close collaboration among supply chain actors (Rao, 2006). This collaboration could involve activities such as raising awareness and assisting suppliers in developing their own environmental agendas. According to the findings of the case study, it could also involve networking or collaboration projects with upstream or downstream actors. All but one SME participated in collaborative projects.

Closer collaboration allows more experienced companies to share their knowledge and best practices, reducing the risk of SMEs making the same mistakes. It can also enhance double-loop learning by providing new insights and time for reflection on operational activities. Additionally, such collaboration can lead to competitive advantages, which is important for improving profitability (Chin et al., 2015).

5.2.4 Adopting standards and frameworks

Adopting an EMS can provide SMEs with a structured framework to manage environmental issues (Darnall et al., 2008). The case study highlights how SMEs with higher internal ambition are more likely to follow standard methodologies to gather environmental product data, certification, or reporting. Standardised methodologies

to calculate the environmental performance of products are needed as it would reduce SMEs' administrative burden and free up time for other activities that improve learning.

Standardised eco-certifications and reporting frameworks are essential to prevent SMEs from losing business opportunities due to non-compliance with various standards. A standard method would improve consistency in SMEs' learning and application of environmental practices. The case study revealed that SMEs view standardised methodologies primarily as a way to reduce administrative burden rather than enhance comparability, suggesting that reducing work overload is more important to them than making informed product choices.

5.3 How can SMEs advance their learning process?

Three ways for SMEs to advance their learning process is to incorporate strategic work, adopt triple loop learning and be offered the right support from stakeholders.

5.3.1 Incorporate strategic work

In all steps of SMEs' learning process of LCT, a successful change management is important. To manage sustainable-related change, literature and findings from the case study suggest that sustainability must be integrated into the organisation's strategy. This is essential to succeed with the economic, societal and environmental pillars of sustainability and thus cover the condition that the greening process must be profitable (Miller & Serafeim, 2014). To act more strategically, leaders can create business models, systems and procedures, such as EMSs, that aim to tackle societal and environmental issues while also maximising long-term profitability.

5.3.2 Adopt a triple loop learning mindset

To advance their LCT learning, SMEs could also adopt a triple loop learning mindset, which will help them identify and challenge outdated or counterproductive practises (Snell & Chak, 1998). The case study revealed that SMEs with high LCT showed triple loop learning in efforts such as collaboration projects with actors in the end of life stage to learn more about waste management, instead of only reporting numbers they do not fully understand, and questioning systems by requesting standardised methods.

5.3.3 The role of stakeholders

Based on the case study and literature, it was identified that both internal stakeholders (management and employees) and external stakeholders (regulators, customers, suppliers, investors, public organisations, and NGOs) play crucial roles in pressuring

SMEs to advance their LCT (Galpin & Hebard, 2019). The primary and secondary stakeholders of the case study are examples of public organisations and NGOs. Except for putting pressure, the external stakeholders can also provide SMEs with support. Eight key support needs for SMEs were identified from the case study, summarised in table 5.1.

Needs	**Suggested by**	**Support offered**
Supply chain collaboration	SMEs, primary and secondary stakeholders	X
Tailored advice	Primary and secondary stakeholders	X
Showcase success	Primary and secondary stakeholders	X
Standardised methods to reduce time to comply with various software tools and certification standards	Primary stakeholders and SMEs	
Easy access to information	Primary stakeholders	X
Free educational and networking events to increase participation	SMEs	X
Information on news such as legal requirements emails, newsletters, webinars and fairs	SMEs	X
Increased access to funds	SMEs	X

Table 5.1: SMEs' needs and support offered

The perception of SMEs' needs differed between the SMEs and their stakeholders, although primary and secondary stakeholders shared similar views among themselves. The need for support in supply chain collaboration was the only area where both SMEs and stakeholders agreed. These differing perceptions may stem from the diverse industries some organisations represented, which may not align with the renewable energy sector. It might also be due to SMEs not fully disclosing their needs, while stakeholders possess a broader perspective, but on the other hand, lack the detailed insight that SMEs possess. Nevertheless, these complementary perceptions bring an indication of what support the stakeholders should continue, stop or start doing to assisting SMEs in advancing their learning and adoption of LCT.

Sector and regional organisations must continue to provide networks and collaboration projects for SMEs to meet with their supply chain actors. Larger supply chain actors with more resources could also initiate contact with SMEs to enhance collaboration. Projects may fail to launch if the initiator company is too small.

Stakeholders may also increase their offers of tailored advisory services by initiating contact with individual SMEs to understand SMEs' struggles and needs and to balance the information they provide. However, regional organisations face constraints in providing such tailored support, as they often must provide uniform assistance to everyone. Consequently, sector and interest organisations need to take on the responsibility of offering tailored advice to SMEs. These organisations, along with supply chain actors, must be more proactive in driving the agenda of information and knowledge, which can increase SMEs' engagement in the environmental transition.

Furthermore, talking directly to SMEs can help balance external pressure. Case study findings showed that external pressure must be balanced to push SMEs to undergo change while also allowing them to learn and experiment. Therefore, it is important that organisations continue to ask their SME members how they perceive different external pressures and then take actions such as lobbying based on this feedback.

Another action that sector, interest and regional organisations must continue is to show and award successful cases of environmental change. This is important for SMEs motivation, inspiration and knowledge about business opportunities. These organisations can also showcase own initiatives or challenges in environmental issues.

The findings of the case study show no indication of efforts in developing common standardised methods to decrease the SMEs administrative burden. SMEs were also challenged in paying for events and software. Providing easy-to-use software tools can reduce the time SMEs need to spend on learning and implementation. Such software might not require an extensive amount of functions, perhaps making it affordable for SMEs to purchase. To assist SMEs in the application and implementation process of financial funds, similar projects such as EU SME support need to be initiated.

6
Discussion

This chapter discusses the strengths and weaknesses of the study, its contributions to SMEs in the renewable energy sector and across industries, and its impact on the research field. It evaluates the literature, choice of methods, limitations, and assumptions.

6.1 Strengths and weaknesses

One key strength was the number of interviews conducted, 18 in total, providing a solid foundation for the results and analysis. Another strength was the inclusion of a wide range of stakeholders, both primary and secondary, offering a comprehensive view of external pressures and available support for SMEs, not only in the renewable energy sector but also in general. This approach also generated excitement and increased understanding among stakeholders about the challenges SMEs face and how they can provide support and solutions. Additionally, the use of a broad array of literature to support the analysis was a significant strength.

Weaknesses include assumption making and interpretation of SMEs greening activities, challenges, needs and support offered by stakeholder organisations.

6.1.1 Literature in the field

This study was built on a wide range of literature across multiple fields, including change management, learning in organisations, SMEs, green supply chain management, LCT, and the EU environmental transition. The literature provided a nuanced understanding of the subject matter and guided the analysis. However, sustainability is a constantly evolving field, including EU regulations and related literature. Therefore, the future relevance of this study remains uncertain, and the related literature should be continuously reviewed.

6.1.2 Choice of methods

The aim of the study was to explore SMEs' LCT in the renewable energy sector. Since the study did not focus on a single case company, the methods chosen needed to facilitate broad applicability. The methods used included a literature review and a case study based on interviews.

When conducting the case study, the integrity of the research was maintained by adhering to best ethical practices. The information gathered through interviews with SMEs formed the core of the study, providing valuable insights into their self-perception of LCT and related challenges. Interviews with primary and secondary stakeholders offered a broader perspective on SMEs in general, beyond the selected industry, and highlighted the support they provide. This, in combination with the SMEs' identified needs, helped to pinpoint potential gaps. However, the SMEs in the case study were only involved in the production and distribution phases of the energy value chain. Ideally, including SMEs from all phases would have provided a more comprehensive view of LCT throughout the entire value chain.

The interviews also facilitated the identification of emerging themes and insights that might not be apparent through other data collection methods. This is particularly valuable for investigating LCT, as it allows for the discovery of novel practices, innovative solutions, and unanticipated barriers that SMEs encounter. Additionally, conducting interviews can be beneficial for the interviewees themselves, as they had the opportunity to reflect on their greening process.

An improvement to the method would have been to reconnect with the SMEs after the analysis began, which could have provided clearer and more specific answers regarding their greening activities, resulting in more accurate analyses and comparisons. Another way to achieve this would have been through benchmarking, screening all SME activities via a survey or more specific interview questions. However, this approach might have compromised the semi-structured interview method, which was better suited for the broader purposes of the case study.

6.1.3 Limitations and assumptions

Initially, the study aimed to include only regional SMEs and organisations from the Gothenburg area, where the researchers were based. However, the scope was later expanded to incorporate SMEs from both the Gothenburg and Stockholm regions for interviews. Consequently, since the stakeholder interviews were conducted first, no regional organisations from the Stockholm area were included in the research. While interviewing Stockholm-based organisations would have been valuable, time constraints limited the study's scope.

When mapping SME activities in the diagram, the researchers assumed which activities required substantial time or financial investments. Since the SMEs were not explicitly questioned about their engagement in specific activities, the researchers grouped similar activities based on the information gathered during interviews. This approach could mean that some activities were overlooked. As the diagram was used to map SMEs based on their ambition level and degree of LCT, some SMEs might have been perceived as having more ambition than they actually did. However, this grouping still provided an overview and showed how the SMEs fell under a spectrum regarding LCT and ambition.

6.1.4 Validity and reliability of data

During the study, the researchers made a concerted effort to remain objective and avoid letting their personal opinions or prejudices influence the case study and the interviews. The validity and reliability of the findings were strengthened by the large sample size of interviewees, as well as by the purposeful selection of employees within the organisations who were directly responsible for sustainability related matters. Additionally, standardised interview guides, one tailored for SMEs and another for stakeholders, were employed to ensure a consistent set of questions and procedures across all interviews, contributing to reliable and comparable data collection. Furthermore, the validity of the data was strengthened by allowing the interviewees to review and verify the results upon request. The reliability of the analysis was enhanced through independent coding and analysis of the interview data by both researchers, minimising the influence of individual biases. 2

6.1.5 Generality of the data

The scope of this research was to investigate the LCT of SMEs in the renewable energy sector, but the method employed could be applied to other supply chains. As the questions asked in the interviews were generally applicable to SMEs regardless of their specific sector this method could be applied to other industries and potentially yield similar findings. The generalised nature of the method is a strength, as SMEs frequently face comparable challenges, such as limited resources and concerns about sustainability practices.

6.2 Contributions to the research field

This research has offered valuable insights for the SMEs involved in the case study as well as for the broader field of study. This following section will explore what new contribution of knowledge this study brings, as well as results that reassures or contradicts previous studies.

6.2.1 The study's knowledge contributions that was previously lacking

One notable contribution of this research is the mapping of the learning process of LCT in SMEs and evaluating the level of LCT adoption among SMEs in the renewable energy sector. The study broke down the process of developing LCT into specific components, offering SMEs practical guidance on initiating or furthering their LCT implementation efforts. Additionally, the findings highlighted the critical role of customised support from stakeholders in enabling SMEs to successfully adopt LCT practices.

6.2.2 Results in the study that reassures or contradicts previous studies

The interview results confirm previous research findings that SMEs face significant challenges in pursuing greening initiatives due to constraints in time, finances, and relevant expertise. The data gathered through these interviews aligns with and reinforces the existing body of knowledge on the difficulties SMEs encounter when attempting to initiate a greening process. Moreover, the results strongly affirmed the importance of having dedicated and driven individuals within the SMEs who serve as change agents. These change agents play a crucial role in championing and facilitating the greening process, leading the adoption of environmental initiatives within their organisations.

7
Conclusion

The aim of this project was to study SMEs' LCT to identify key challenges in their greening process towards environmental sustainability. The research involved a case study of SMEs and their stakeholders in the renewable energy sector, investigating their greening activities, LCT adoption, and learning process. The role of primary and secondary stakeholders was examined to identify gaps between current support and SMEs' needs for advancing their learning process. The following seven key challenges, related to both cost and time, were identified:

- Affording software and revising services to provide environmental data
- Participating in educational and networking events
- Hiring a sustainability manager
- Keeping up to date with news and legal requirements
- Economic fluctuations
- Finding opportunities of collaboration with supply chain actors
- Finding and apply for support

RQ1: How do SMEs adopt life cycle thinking in their operations?
The adoption of LCT varied between the SMEs in the renewable energy sector. They showed different ambition levels and adopted greening activities requiring three levels of competence and investments in time and money.

RQ2: What are the steps of SMEs' learning process of life cycle thinking?
The learning process comprised four components: internal ambition, targeting easily achievable improvements, collaboration in the supply chain, and adopting standards and frameworks.

RQ3: How can SMEs advance their learning process?
SMEs can advance their learning through incorporate strategic work, adopt a triple loop learning mindset and by stakeholders offering the right support.

Based on this study's findings, four areas for further research are proposed:

- Conduct a case study of SMEs implementing the steps of the learning process
- Further investigate stakeholders offered support and how they can improve their offerings, including standardised systems and applicable funds
- Expand the study to include a larger and more geographically diverse sample of participants.

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