UiA University of Agder

Environmental Product Declaration as a Mobilizer to Achieve Competitive Advantages

An assessment of REC Solar's low-emission silicon according to the VRIO framework

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This Master's Thesis is carried out as a part of the education at the University of Agder and is therefore approved as a part of this education. However, this does not imply that the University answers for the methods that are used or the conclusions that are drawn.

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Summary

Global climate challenges have led to a significant increase in renewable energy production. Currently, energy generated from the sun is the fastest-growing energy source globally. Solar panels based on silicon make it possible to transform solar energy into electrical energy. However, the extraction of silicon is highly energy-intensive, hence potentially contributing to significant pollutant emissions. On the other hand, a Norwegian silicon producer, REC Solar, has chosen to utilize a more expensive technology, resulting in lower polluting emissions.

Environmental Product Declarations (EPD) are used to document and promote the environmental effects of a specific product developed according to international standards and Life Cycle Analysis. The EPD is founded on Product Category Rules (PCR) to create a basis for comparison regarding environmental properties for products with equal satisfactory qualities. Thus, EPDs can contribute to more sustainable procurement. The harmonization of PCRs and the prevalence of EPDs have been proven to be most significant in the construction industry. Therefore, an empirical study has been conducted within this industry.

The thesis aims to investigate EPD's active role in a competitive market and how it can contribute to REC Solars' utilization of low-emission silicon. A quantitative study has been conducted to retrieve experiences from EPD-owners in the Norwegian construction industry. In addition, a qualitative study has been conducted to analyze how contractors evaluate EPDs in procurement processes. Finally, the empirical results are structured in a theoretical resource management framework to assess the EPD's ability to mobilize low-emission silicon and achieve a lasting competitive advantage.

The research results show that EPD can mobilize low-emission silicon as a resource. However, the perceived value of low-emission silicon is currently not adequate for buyers to prioritize lower emissions above price. The study promotes that an increased number and more explicit incentive systems are needed for the environmental properties of products to have a greater impact on procurement decisions. Hence, appropriate the potential value and achieve lasting competitive advantage.

Sammendrag

Dagens globale utfordringer knyttet til klima og miljø, har ført til en økt produksjon av fornybar energi. For tiden er energi generert fra solen den raskest voksende energikilden globalt. Solcellepaneler basert på silisium gjør det mulig å transformere solenergi til elektrisk energi. Utvinning av silisium er imidlertid svært energikrevende, og kan derfor bidra til betydelige forurensende utslipp. Den norske silisiumprodusenten, REC Solar, har valgt å bruke en mer kostbar teknologi, som resulterer i lavere forurensende utslipp.

Environmental Product Declarations (EPD) brukes til å dokumentere og fremme miljøeffektene av et spesifikt produkt i henhold til internasjonale standarder og livssyklusanalyse. EPDer bygger på Product Category Rules (PCR) for å skape et sammenligningsgrunnlag for miljøegenskaper til produkter med tilfredsstillende like kvaliteter. Dermed kan EPDer være et nyttig verktøy for å bidra til mer bærekraftige anskaffelser. Byggebransjen er den bransjen som har vist seg å ha kommet lengst med tanke på harmoniseringen av PCRer og utbredelsen av EPDer.

Studien tar sikte på å undersøke EPDs aktive rolle i et konkurransepreget marked og hvordan den har potensiale til å bidra til økt konkurransekraft for REC Solars' lavutslippssilisium. Det er gjennomført en kvantitativ studie for å hente erfaringer fra EPD-eiere i norsk byggenæring. I tillegg er det gjennomført en kvalitativ studie for å analysere hvordan entreprenører vurderer EPDer i anskaffelsesprosesser. Til slutt er de empiriske resultatene strukturert i et teoretisk ressursstyringsrammeverk for å vurdere EPDs mulighet til å mobilisere lav-utslippssilisium og oppnå varig konkurransefortrinn.

Forskningsresultatene viser at EPD kan mobilisere lavutslippssilisium som en ressurs. Imidlertid er den opplevde verdien av lavutslippssilisium foreløpig ikke tilstrekkelig for at kjøpere skal prioritere lavere utslipp over pris. Studien fremmer at det trengs økt grad og mer eksplisitte insentivsystemer for at produkters miljøegenskaper skal ha større innvirkning på anskaffelsesbeslutninger. Derav appropriere den potensielle verdien og skape langsiktige konkurransefortrinn.

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The thesis will present an empirical study on the utilization of environmental product declarations (EPD) in the Norwegian Construction Industry and reveal whether it can be a mobilizer to achieve competitive advantages for low-emission silicon producers. Motivation for conducting this study stems from a solid commitment to sustainability and a great interest in corporate strategy.

We would like to present our gratitude to Ph.D. student Benedikte Wrålsen at UiA, who, during this project, has supervised and provided academic and methodological input to the study. Thanks to Trude Nysæter and REC Solar for good communication and cooperation. We would also like to thank representatives from BDO Norge, GCE Node, Norsk Hydro ASA, and EPD Norge for their professional input and fruitful discussions.

Finally, we would like to thank the informants from the surveyed contractor companies, as well as all EPD owners who have answered our quantitative survey. You have all helped shed light on the current status of the utilization of environmental declarations in the construction industry.

We look forward to bringing the experiences from the master's program and this thesis to contribute to a more sustainable world.

Vilde Lundh Andresen & Hans Fredrik Guddal Zimmer
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List of Abbreviations

B2B Business-to-Business

CO2 Carbon Dioxide

EPD Environmental Product Declaration

ESG Environmental, Social and Governance

EU European Union

IPCC Intergovernmental Panel on Climate Change

ISO International Organization for Standardization

LCA Life Cycle Assessment

PCR Product Category Rules

PV Photovoltaics

RBV Resource-Based View

SBD Sustainable Business Development

TEK Building Technical Regulations

1 Introduction

Intergovernmental Panel on Climate Change (IPCC) documented in their main report from 2014 that the amount of emissions from human-made greenhouse gases has never been higher and that it directly affects global warming and climate change (Miljødirektoratet, 2019). The Paris Agreement was launched in 2015 to respond to global warming potential and climate change challenges. The Paris Agreement applies to all countries in the world. One of the essential pillars of this agreement is that the temperature should not increase by more than 2℃, compared to pre-industrial levels, before the end of the century. Still, all the included countries are expected to do what they can to ensure that the temperature increase is limited to 1.5℃(Arnslett, 2015; FN-Sambandet, 2020).

European Union (EU), through The European Green Deal, is aiming to become the first climate-neutral continent by 2050 and plans to reduce greenhouse gas emissions by at least 55% within 2030 compared to 1990 emission levels (European Comission, n.d.-a, n.d.-b). Norway has committed itself to reduce its emissions by 40%(Den Norske Regjeringen, 2021). Nevertheless, IPCC latest report from 2021 shows that greenhouse gases in the atmosphere continue to increase. According to the report, 1.5℃, will be reached within 20 years with the current emission rate(Miljødirektoratet, 2021a, 2021b).

International Energy Agency (2019) states that the construction industry accounts for almost 40% of total global emissions. Norwegian Construction Industry contributes with 14.7 million tonnes of Carbon Dioxide (CO2) equivalents annually. 50% of the total emissions from the Norwegian Construction Industry occur during the production and transport of materials to the building(Direktoratet for Byggekvalitet, n.d.).

Increased awareness among stakeholders has led to sustainability and, in particular, the environmental aspects, gaining a greater focus in companies' strategic management (Manzini et al., 2006; Skaar & Fet, 2012). From a business perspective, developments related to regulations and increased awareness regarding environmental impacts can lead to opportunities and potential competitive advantages for companies that focus on the environment through a sustainable business strategy

(Innovasjon Norge, 2021; Whelan & Kronthal-Sacco, 2019). As a result, a need has emerged to document the climate impacts of a product or service in an objectively quantified and comparable manner (Del Borghi, 2013; Ibáñez-Forés et al., 2016).

EPD documents the environmental effect of a specific product, based on international standards and Life Cycle Assessment (LCA)(EPD Norge, n.d.). To be able to compare the environmental effect of different products within the same category, calculation rules, defined as Product Category Rules (PCR), has to be followed(EPD Norge, n.d.). Previous research has addressed findings related to Environmental Product Declaration (EPD) as a communication tool, its challenges, increased prevalence as well as the drivers for developing EPDs(Del Borghi, 2013; Galindro et al., 2020; Ibáñez-Forés et al., 2016; Manzini et al., 2006). No discovered research has studied whether EPD can increase environmentally conscious companies' profits. For companies to use resources developing EPDs, it will be a great advantage if it can contribute to increased competitiveness. Potentially it can affect other companies to work towards more sustainable deliveries, creating ecological benefits.

The Norwegian silicon producer REC Solar struggles to compete against Chinese producers due to production scale, national regulations, and lower wages. However, due to the production process and energy mix, the emissions related to Norwegian production are significantly lower. REC Solar has chosen to develop EPDs to document their product's environmental impact and wants to explore if the EPDs can be a mobilizer to achieve competitive advantages..

1.1 The Objectives of this Study

This master's thesis aims to investigate how EPDs can mobilize REC Solar's low-emission silicon in order to achieve lasting competitive advantages from a theoretical point of view. In addition, the thesis will strive to uncover how EPDs influences procurement decisions in the Norwegian construction industry and, with the help of the empirical findings, try to forecast EPDs' future significance for REC Solar.

REC Solar developed a PCR that acknowledges PV-Panels as a building material and is among the first to develop EPD for silicon products as a building material. Due to this, it has not been possible to create a study with enough respondents from silicon manufacturers and buyers to provide reliability for the thesis. Since the EPDs are intended for solar panels used in the construction industry, the empirical study in the thesis was carried out together with manufacturers and buyers of other products in the construction industry. The empirical studies aim to investigate how EPD affects procurement decisions in practice and the experienced challenges. Furthermore, the empirical findings will be assessed against the theoretical principles and framework. The research questions of this thesis:

- **RQ1:** *How can REC Solar's development of EPDs contribute to the utilization of their low-emission silicon as a resource to achieve lasting competitiveness, according to the VRIO framework?*
- **RQ2:** *To what extent does the content of an EPD influence procurement decisions in the Norwegian Construction Industry?*
- **RQ3:** *What are the current challenges for low-emission producers with higher-priced products, utilizing EPD to reach improved competitiveness?*

RQ1 will be answered according to a literature review primarily related to resource management and the VRIO framework. The literature review will help form a theoretical basis for the thesis and define the concept of lasting competitiveness and is further used to discuss RQ3. An empirical study with quantitative and qualitative data has been carried out with respectively manufacturers and contractors in the Norwegian construction industry, answering RQ2. The empirical findings from the industry will further create the basis for the discussion of the chosen theory

regarding VRIO in RQ1. RQ3 will be answered based on a literature review related to incentives combined with the empirical findings and is discussed according to the literature used to answer RQ1.

1.2 Structure of this Study

The thesis is divided into seven chapters, starting with an introduction that addresses the thesis's background and purpose. Furthermore, chapter two will address some basic foundations related to the Norwegian Construction Industry, Solar Energy, and REC Solar. In addition, the chapter will enlighten previous research related to drivers for environmental declarations and environmental certificates and declarations as a possible method to promote resources to stakeholders. As illustrated in fig. 1, RQ1 will be answered by reviewing literature related to recourse management, presented in chapter three, and EPD as a potential contributor to increasing the company's sustainability and competitiveness. Chapter four will contain the methodological provisions used to perform the study. RQ2 will be based on the empirical findings from chapter five, and RQ3 will be answered by connecting the same empirical findings with theories regarding incentives for sustainable business development. Finally, a conclusion of the research issues will be presented.

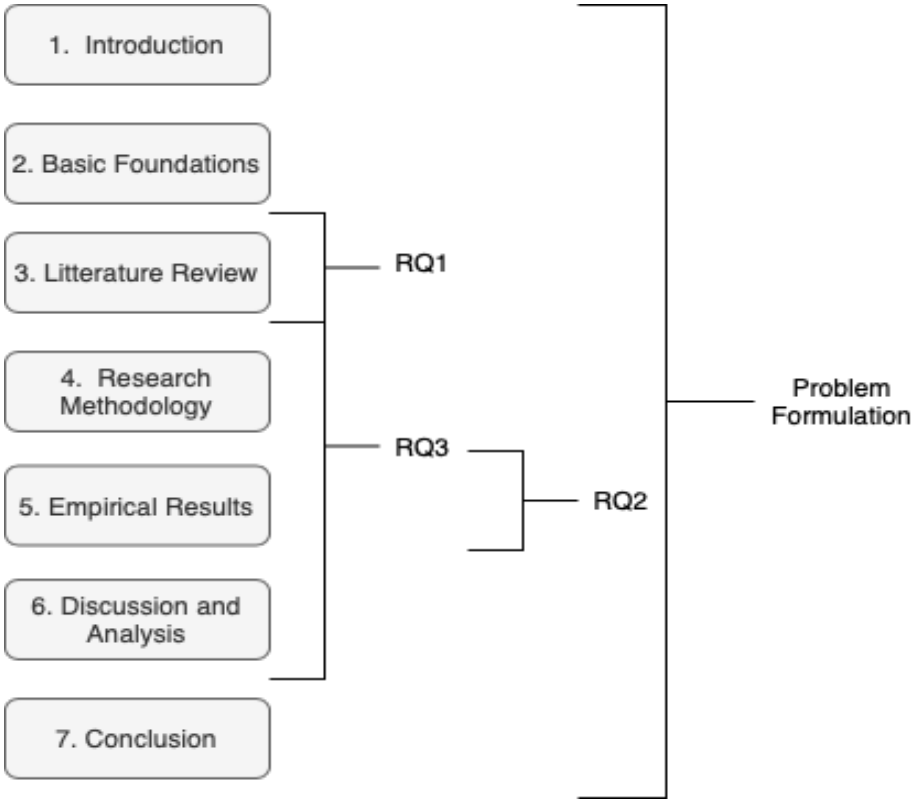


Figure 1: The thesis' structure.

2 Basic foundations

This chapter will briefly introduce the Norwegian construction industry, Environmental Declarations, solar energy, and REC Solar to facilitate an understanding of the thesis context.

2.1 The Norwegian Construction Industry

The construction industry is responsible for a large share of Norway's total emissions(Direktoratet for Byggekvalitet, n.d.). The emissions from the Norwegian Construction Industry are distributed in Scope 1, 2, and 3, where Scope 1 includes emissions related to a company's direct emissions, stationary combustion, mobile combustion, fugitive emissions, and process emissions. Scope 2 contains the indirect emissions from energy use, and Scope 3 addresses the upstream activities such as purchased materials, goods, and services, in addition to distribution and transport of the mentioned(Plan A, 2020). 50% of the total emissions from the Norwegian Construction Industry occur during the production and transport of materials to the building(Direktoratet for Byggekvalitet, n.d.). According to Direktoratet for Byggekvalitet (n.d.), it is possible to reduce emissions by 40-50% if stricter requirements are set for the use of low-emission materials and an emission-free construction site.

To a large extent, the construction industry consists of project-based value deliveries. According to Andersen (2018), a project can be considered a temporary organization, consisting of a self-composed project team set up to do a specific task at a specific time to reach a desired state. The roles in a project composition in the construction industry often include a project owner, a contractor, suppliers of materials and services, and consulting-services. The structure of the hierarchy in construction projects is shown in fig. 2.

The project owner essentially decides the future desired condition by setting the goals and framework for the project and being responsible for the value collection at the end of the project. In construction projects, this role belongs to the construction client. In the project's execution phase, the contractor has the leading role. The contractor's primary focus is on satisfying the expectations set by the client.

The contractor's roles are also procuring materials and hiring service providers to reach the future desired condition(Andersen, 2018). Law of Plans and Buildings and Technical Construction Regulations are supposed to regulate the Norwegian Construction Industry on behalf of the Norwegian Government (Direktoratet for Byggekvalitet, 2017).

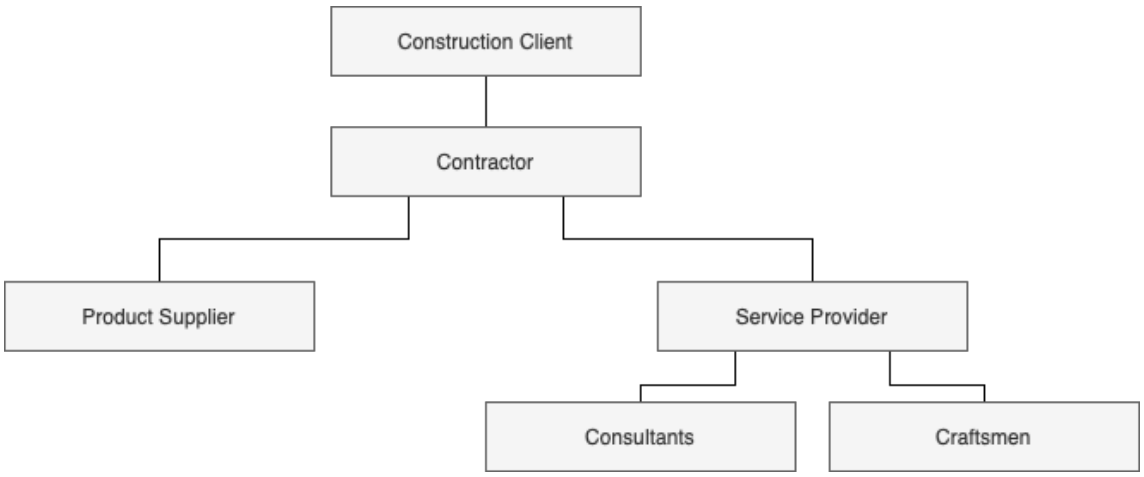


Figure 2: The distribution of roles in construction projects.

2.2 Solar Energy

Due to the challenges and future goals presented in section 1, the world's electricity generated by renewable sources has escalated over the last decade(IEA, 2021). With an annual increase of 14.1% energy production in 2018-2019, solar energy is the fuel that has the greatest production growth globally(IEA, 2021). Solar energy is a collective term that includes multiple technologies and forms of exploiting the energy from the sun and is estimated as the renewable energy source with the most significant potential (Andreani et al., 2019). This thesis will be limited to the segment where solar energy generates electricity by utilizing photovoltaic conversion technology in solar cells.

Although solar energy produces clean and renewable energy, the production of silicon used in Photovoltaics (PV) panels is profoundly energy-consuming. In order to extract silicon from quartz, which is the most common method of silicon production, temperatures up to 2000°C are required. Different processes and fuels are used to achieve such great temperatures. Nevertheless, it will, in any case, require large amounts of energy. Therefore, the energy mix in the individual country and

the preferred production method will have a significant role in the calculations of associated emissions.

According to Statista (2022), in 2021, Norway was the world's fourth-largest producer of silicon. Only China, Russia, and Brazil produced more silicon than Norway globally. On the other hand, China had a production that could correspond to 4.5 times Norway, Russia, and Brazil's total produced amount(Statista, 2022).

2.3 REC Solar

REC Solar is a solar energy company founded in 1996, producing low carbon footprint solar panels (REC Solar, n.d.). Its headquarter is found in Norway, with operational headquarters in Singapore. In 2013, Renewable Energy Corporation (REC) ASA was divided into the two solar energy condensed companies: REC Solar and REC Silicon and became what is known as REC Solar today. The factory that holds the technology discussed in the thesis is placed at Hærøya in Kristiansand, Norway.

Starting with hand-washing their own produced wafer in 1996, REC Solar is now a part of Reliance Industries Ltd. and produces over 43 million panels, according to numbers from late 2021(REC Solar, n.d.). Although REC Solar also produces solar panels, this thesis is limited to focusing on their processing of silicon used in the panels. As mentioned in section 2.2 the preferred production method plays a substantial role when calculating the emissions associated with the processing of silicon. Indifference to the majority of silicon producers, Nysæter (2022) states through personal communication that REC Solar uses a technology, simply explained, that the quartz does not need to be converted to a gaseous form in order to compose silicon. The respective form of processing requires greater financial initiative but is, on the other hand, less energy-intensive. Additionally, the production takes place in Norway, where the energy mix is based on clean, renewable energy.

In recent years REC Solar replaced its production method from primary extraction and processing to a production method based on silicon recycling. The new production method utilizes chips resulting from cutting silicon, also called kerf, to produce new silicon. Previously, the kerf was only treated as a waste product and was not

used further. Approximately 30 % of the finished silicon is turned into kerf when cutting wafers, which has previously resulted in significant losses for producers.

2.4 Environmental Product Declarations

The International Organization for Standardization (ISO) has developed standards for environmental labeling and declarations to communicate environmental impact. The standards are based on ISO group standard 14020 for environmental impact communication (Ibáñez-Forés et al., 2016; Manzini et al., 2006). ISO standard 14020 states that environmental labeling and declarations have to be accurate and verifiable, the obtained data has to include the whole life cycle of a product, as well as the methodology and procedures performed must be transparent and repeatable(Manzini et al., 2006). Furthermore, ISO has chosen to divide the various communication standards into Type I (ISO 14024), Type II (14021), and Type III (ISO 14025) (Fet et al., 2009; Ibáñez-Forés et al., 2016; Manzini et al., 2006).

Type I (ISO 14024) refers to environmental labeling verified by a credited third party. These labels intend to communicate a product's main environmental criteria and functional features. The most documented benefit of the Type I documentation is the European harmonization of these certifications(Manzini et al., 2006). However, Ibáñez-Forés et al. (2016) states that previous research has shown that consumers find Eco-labels insufficient in providing understandable information.

Type II (ISO 14021) addresses self-declared environmental claims. These claims do not have to be verified by a third party, but still, they need to provide transparent information to ensure the user that the information is accurate and deceptive. Since these claims are self-declared, it is almost impossible to compare satisfactorily similar products from other companies, which means that they often provide unmanageable information to the consumer(Manzini et al., 2006).

Type III (ISO 14025) refers to Environmental Product Declarations (EPD), which is a tool used to communicate, objectively, the environmental performance of a product investigated through a conducted Life Cycle Assessment (LCA), according to ISO 14040 and 14044 (Del Borghi, 2013; Fet et al., 2009; Manzini et al., 2006). LCA methodology is developed in order to assess products, products, systems, or

services' environmental impact from "Cradle to grave"(Del Borghi, 2013; Fet et al., 2009; Galindro et al., 2020). The EPD is based on a set of rules called Product Category Rules (PCR), which defines criteria for certain products which fulfill the same function. PCR intends to assess products with similar properties within the same product group fairly. PCR often includes modeling of the LCA-system, which data to use, and which environmental indicators should be included(Del Borghi, 2013; Fet et al., 2009; Minkov et al., 2015). The primary purpose of an EPD is to provide verifiable and measurable information related to environmental impact, which can create a basis for comparison between products that have satisfactorily similar attributes(Del Borghi, 2013; Manzini et al., 2006). In this way, EPD has the potential to encourage the demand for products and services, which causes less environmental stress(Manzini et al., 2006). Further on, EPDs can be used for internal purposes, to get an overview of a company's product impact, and thus have the opportunity to improve internal processes(Skaar & Fet, 2012).

Ibáñez-Forés et al. (2016) documents the number of EPDs produced from 1999 to 2014, showing a considerable increase from 2010. At the same time, Toniolo et al. (2019) is reporting an increase of 2934 companies developing EPDs from 2014 to 2016. While the industry containing most EPDs is the construction industry. Further on, Toniolo et al. (2019) documents that only 5% of the EPDs belong to countries outside Europe and that most EPDs are either French or German, followed by Norway with an amount of 320 company-provided EPDs(Toniolo et al., 2019).

According to Galindro et al. (2020) 76% of their survey participants use LCA and EPD information in order to answer customer demands, for marketing purposes, and in environmental management systems. On the other hand Ibáñez-Forés et al. (2016) survey, the respondents said that they mainly developed EPD due to its ability to communicate objective information and to improve corporate identity. Less than 25% of the sample had developed EPD to expand markets or increase sales. The same report states that the most common adverse experiences related to EPD are; customers having too little knowledge regarding the subject(Galindro et al., 2020), lack of harmonization in PCRs, it is resource-intensive to conduct an LCA(Ibáñez-Forés et al., 2016). Fet et al. (2009) supports that the resources required to prepare EPD can be challenging for smaller companies, and as Manzini

et al. (2006) suggests, EPDs have a low attractiveness when the costs exceed the benefits. Del Borghi (2013), Minkov et al. (2015), and Toniolo et al. (2019) amplifies the argument of lack in PCR harmonization, which as Del Borghi (2013) suggests, can be a trade barrier for companies due to the familiarization being too demanding for manufacturers. However, the organization Global Environmental Declarations Network (GEDnet) has developed a global search archive of PCRs as a measure to increase harmonization(Del Borghi, 2013). Del Borghi (2013), Minkov et al. (2015), and Toniolo et al. (2019) argues that the construction industry has come the furthest to applying EPDs. Which is a result of Green Public Procurement (GPP) criteria considering EPD as proof that the supplies correspond to required environmental characteristics and national regulations; as well as in some contexts, EPDs can contribute points in some rating systems of the building sector(Toniolo et al., 2019). The implementation of guidelines from standard ISO 21930 and EN 15804, which address the core of PCR for European EPDs of construction products, has contributed to the harmonization of PCR in the construction industry(Del Borghi, 2013; Minkov et al., 2015)

3 Theoretical Foundations

In this chapter, the study's included theories will be presented. This chapter forms the basis for answering RQ1 and RQ3. The study's theories will include a perspective related to sustainable strategy development and incentives for sustainable development, focusing mainly on the resource management framework VRIO.

3.1 Resource Management and Sustained Competitive Advantage

Resource management aims to chart resources in the organization and evaluate their opportunities to be a basis for a temporary or lasting competitive advantage. Resource management is a broad term and includes allocating, leveling, and forecasting resource usage. However, in this thesis, the focal point will be how to achieve a sustained competitive advantage using existing resources. In Jay Barden's article named Firm Resources and Sustained Competitive Advantage, earlier studies on how to achieve such an advantage are viewed and discussed. The paper concludes with features that need to be found in the resources owned by the organizations. The set of features forms the basis of the framework known as VRIO, which is further explained in section 3.1.2.

3.1.1 Resource-Based View

One of the most dominant schools within business strategies is Resource-Based View (RBV). RBV focuses on internal development and resource utilization through innovation, creativity, value chain, knowledge, and dynamic capabilities to create lasting competitive advantages(Campbell et al., 2011). The resource-based view addresses a resource approach that includes tangible and intangible assets. With inspiration from a variety of authors, J. Barney (1991) defines firm resources in his research as *"all assets, capabilities, organizational processes, firm attributes, information, knowledge, etc. controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness."* Multiple authors have given their contribution to a definition of the term *firm resources*. However, the essence of the term includes assets and strengths controlled by the organization, which it can use to formulate and implement its strategy.

Together with the controlled assets of the organization, the RBV also focuses on how to benefit fully from the resources in control using capabilities (Kraaijenbrink et al., 2010). Capabilities are a subset of intangible and tangible assets, enabling the organization to align and implement owned resources with their strategy. However, it is not the capabilities themselves that provide value but rather reinforce utilization of the primary resource (J. B. Barney & Hesterly, 2015). Henceforward, both primary resources and capabilities will be encapsulated and referred to as the term resources.

Two of the most prevalent resources in an organization are physical and financial assets. They are often accessible and straightforward to measure and are therefore comprehensible resources for the organization (Bjørnenak, 2019). Still, the resources can be divided into two additional classifications, known as human and organizational resources.

Financial assets that come from all sources related to the organization and their aim to conceive and implement strategies are what form the **financial resources**, including money from retained earnings, banks, bondholders, entrepreneurs, and equity holders. Financial resources also consist of other historical investments and their profits (J. B. Barney & Hesterly, 2015).

The **physical resources** is all the technological assets that are physically present in the organization. An organization's facilities and equipment are common physical resources. Nevertheless, it is worth noting that examples such as access to raw materials and geographical location also fall into this category of resources. Geographical location is a type of physical resource because the location can lead to higher returns. For instance, if their offices or boutique is at a practical or tailored location that correlates with the vision of the organization (J. B. Barney & Hesterly, 2015).

Using the humans in the organization and utilizing their strengths, including their intelligence, experience, training, and relationships, defines the **human resources** of an organization(Wright et al., 1994). Human resources are single attributes that help create organizational value with their own individual importance. When assembling the single human resources in a group and conceiving a structure and dynamic, **organizational resources** are formed(J. B. Barney & Hesterly, 2015).

Organizational resources include both formal and informal structures within the organization, which affect their functionality(Wright et al., 1994). Aspects as culture, relationships and reputation, procedures and reporting systems, controlling-, planning- and coordinating systems are some examples of what includes in this type of resources(Morris et al., 2006).

According to Campbell et al. (2011), the intangible assets, like human and organizational resources, contribute to the most important advantages. these assets are often more difficult for competitors to copy and thus has the potential to generate long-term and sustainable benefits. This will be further discussed in light of the theoretical framework VRIO in section 3.1.2.

3.1.2 VRIO

When analyzing an organization and its utilization of resources, it may be advantageous to base it on the VRIO framework, also known as SVIMA in Norwegian. The framework is based on the resource-based view, presented in section 3.1.1, where the letters represent different aspects of achieving and keeping a lasting competitive advantage, also known as sustainable competitive advantage, by using resources the organization possesses. J. B. Barney and Hesterly (2015) forms all of the letters as specific questions the organization must ask themselves concerning their controlled resources to ascertain the competitive capability of the assets.

The first letter in the framework represents ***Valuable*** which questions the value of the resource(J. Barney, 1991). The organization needs to answer the question of their resources, enabling them to take advantage of an opportunity or counter a threat that affects them externally. The resource is valuable if the question can be confirmed and thus weighs as a strength for the organization. Conversely, is the resource considered a weakness if the question is not verified. However, the resource is not valuable independently from the market. Accordingly, the resource can be regarded as a strength in one explicit market but a weakness in a different market (J. B. Barney & Hesterly, 2015).

Possessing valuable resources is important for an organization and is a source of achieving competitive advantage(J. Barney, 1991). Nevertheless, if numerous other organizations in the same market control the equal type of resource, it will dubiously

lead to a competitive advantage. Therefore is the next feature in the framework ***Rare***, which questions the rarity of the resource in competitive organizations (J. B. Barney & Hesterly, 2015).

If the resource is rare and valuable, the organization holds a temporary competitive advantage. Nevertheless, if competitors have the convenience of obtaining or generating their own assets with equivalent rare and valuable qualities, competitiveness will not last. Therefore, the organization that holds the resource needs to ask themselves if their asset is inimitable and the extent to which it is imitable(J. B. Barney & Hesterly, 2015). ***Inimitable*** is the penultimate letter of the framework and is the last letter that sets direct indications for the asset in the framework. Presuming that an organization holds assets that conduce to temporary competitive advantage, it is essential that their competitors that do not possess equivalent resources have a cost disadvantage when obtaining or generating them(J. B. Barney & Hesterly, 2015).

Finally, the last letter symbolizes ***Organized*** which asks how the organization organizes itself and fully exploits the potential of a resource. In the Norwegian version of VRIO - SVIMA, organized is divided into two parts and specified as mobilized and appropriated (Bjørnenak, 2019). Although the resources and its capabilities fulfill the four mentioned features of VRIO, it does not automatically give the organization financial assets. In order to transform the controlled resources into financial values, the organization needs to align its product market strategy so that it can make optimal and intensive use of the resource. If the organization that possesses the resource does not have a market strategy that facilitates intensive utilization of the resource, the resource is not ***mobilized*** (Jakobsen & Lien, 2001; Lien & Jakobsen, 2015).

Generated financial values from resources are not equivalent to high revenues for the organization. It is essential to collect and preserve the created value so the organization can manage them as desired. If the organizations manage to mobilize and obtain the generated value, one can say that the resource is ***appropriated*** (Jakobsen & Lien, 2001; Lien & Jakobsen, 2015). Lien and Jakobsen (2015) claims that one of the most common reasons why the organization is unable to obtain the generated value, or appropriate the resource, is due to challenges related to price.

The message of the two theories is identical; however, a subjective observation is that defining organized as mobilized and appropriated gives a more precise clarification of the theory. The use of this terminology will also be beneficial in this thesis; thus, these will be used in parallel with Organized.

When utilizing VRIO as a framework, or an analyzing method, an essential part is not to appraise the different aspects as separate assessment criteria but as a coherent framework where the requirements are based on each other. Fulfilling the framework's parts alone will not provide a lasting competitive advantage as the competitiveness varies with how many and to what extent one meets the elements of the framework, as illustrated in fig. 3.

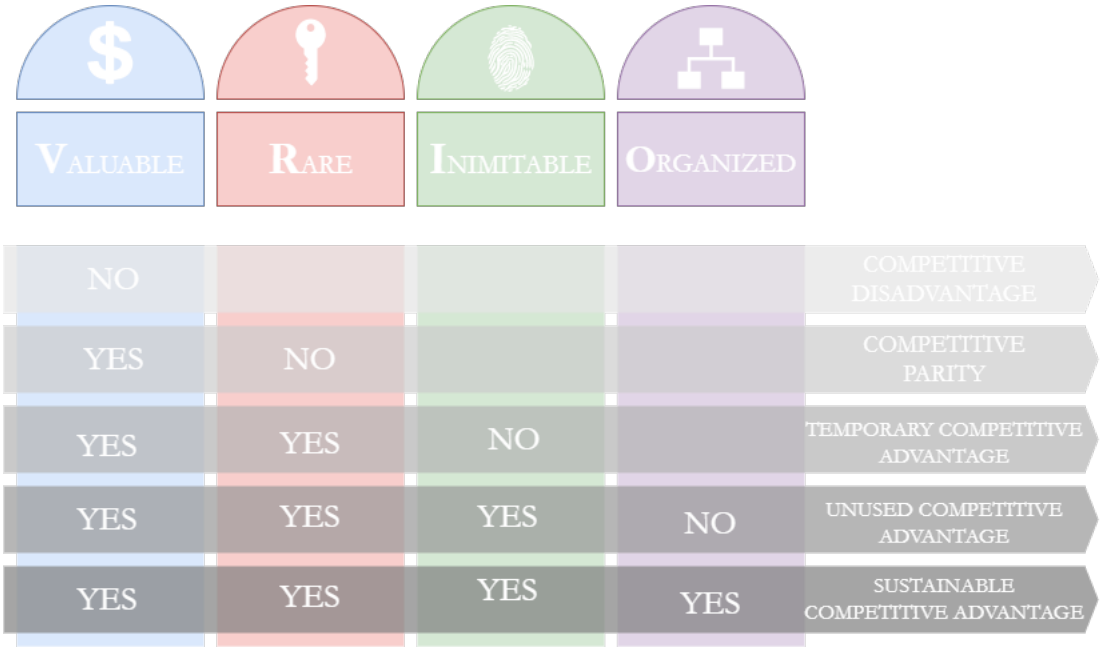


Figure 3: Illustration of the VRIO framework

3.2 Corporate Strategy

> "*Strategic thinking is about combining strategic knowledge, context and organizational awareness to shape, reshape, and redefine business boundaries, direction and resources in order to gain a competitive advantage, be it short, medium or longer term.*" -Campbell et al. (2011, p. 22)

Overall, Organizations exist to serve a particular purpose and achieve related objectives, influenced by the organization's stakeholders. Strategies can be seen as a tool to determine the organization's long-term goals and purposes, including plans, policies, and actions on how to reach them(Campbell et al., 2011).

Business strategy can be divided into four steps repeated in an iterative process. The first part consists of a strategic analysis that addresses internal and external research to map the organization's strengths, weaknesses, opportunities, and threats (SWOT). The analysis can be used to create or capture value in the market. The second part consists of developing the business strategy, generating, evaluating, and finally selecting the strategy that enables future long-term competitive advantages. Step three is the strategic implementation and management, focusing on imprinting the strategy in every operational process, from management to cultural development. Finally, lessons are learned from the process and transformed into future analyses to repeat the process(Campbell et al., 2011).

Strategy management can be distinguished between planned versus incremental controversy and competitive positioning versus resource-based strategy. A planned approach considers the preparation and implementation of strategic management as a rational, systematic process that aligns business objectives and the control mechanism to ensure that they are achieved. This method of thinking strategy was prevalent in the 1970s. Still, as societal and market changes are increasingly volatile, the technique has been criticized for not facilitating a more flexible approach to seizing opportunities. The incremental strategy perspective will change incrementally over time to adapt to ever-changing circumstances. Strategies are developed through interaction between stakeholders, the business, and its environment. However, it can be demanding to set more significant long-term goals, and because of this, it is challenging to measure performance(Campbell et al., 2011).

A competitive position can be seen as an "outside-in" approach. Where one focuses on establishing positions by outcompeting rivals in the same market. In this context, Micheal Porter's five forces analyze a market's attractiveness. Moreover, the further focus is to ensure that all parts of the business' value chain contribute to value creation to the extent that it has the opportunity to outperform its competitors either by price or product differentiation(Campbell et al., 2011).

A resource-based view, further documented in section 3.1.1 can be seen as an "inside-out" approach. The greater focus relies on how the company can create competitive advantages internally, often through a combination of core competence and resources, knowledge, and technology that differentiate the company from its competitors in the eyes of the customer. This approach supports organizational learning, knowledge management, and collaborative business networks as potential competitive advantages(Campbell et al., 2011).

According to Hallahan et al. (2007), strategic communication emphasizes the strategic application of communication and how an organization functions as a social actor to advance its mission. Merriam-Webster defines communication as "a process by which information is exchanged between individuals through a common system of symbols, signs, or behavior".Frandsen and Johansen (2007) states that communication is primarily understood as a process where the sender and recipient together create meaning. The purpose of marketing communications is "to create awareness and promote sales of products and services. Also, to attract and retain users and customers, including intermediaries in distribution channels."-(Hallahan et al., 2007, p. 2) Business-to-Business (B2B) marketing, also called industrial marketing, can be seen as the practice of companies marketing products or services to other companies in order to promote their products and inherent feature to gain market advantages(Hall, 2017).

3.3 Business Incentives for Sustainability

A paradigm transformation is currently occurring in the world economy and economic thinking (Fatemi & Fooladi, 2013). The financial approach and way of thinking are changing; where previously there was a considerable high focus on short-term profit and maximizing shareholders' earnings, there is now a shifting focus towards value creation through long-term approaches (Fatemi & Fooladi, 2013; Schoenmaker, 2018; Schoenmaker & Schramade, 2018). Sustainable finance has a central role in the transition as it illuminates the risks and opportunities associated with environmental, social, and governance(Environmental, Social and Governance (ESG)) questions and how it affects possible investments and lending.

3.3.1 Sustainable Business Development

Driven by an increasing degree of environmental laws and regulations related to pollution prevention and waste minimization, environmental management emerged in the 1970s. Still, at this point, changes were often made unwillingly, and companies strived to minimize the regulation's impacts on their business operations. However, many companies started focusing on external drivers and internal capabilities to stay abreast with the mandates like reducing air emissions, managing hazardous waste, and preventing accidents. In recent years, there has also been a growing awareness of companies' environmental impact and social responsibility from customers and stakeholders, which no longer only demands companies to produce satisfactory products but also take social responsibility. In order to answer these demands from governments, stakeholders, and customers, organizations are making a significant investment in order to improve their operations, processes, and practices to minimize their environmental impact(Rainey, 2010).

> "*Sustainable Business Development moves corporations away from responding solely to the dictates of governments and markets and toward preemptive strategies developed by leadership. The focus is on the future, on creating opportunities.*" -Rainey (2010, p. 24)

Sustainable Business Development (SBD) calls for a change from responsive strategic management in order to instead enhance business value and create new opportuni-

ties. Enabling this transformation demands a thorough understanding of current and future expectations, the company's internal and external dimensions, in addition to a strategic perspective on how to exceed these expectations. That way, businesses can differentiate their business, products, and reputation(Rainey, 2010). SBD tends to focus on three main dimensions: Social, economic, and environmental aspects and involves implementing business strategies, innovations, and initiatives to contribute to a more sustainable world(Rainey, 2010).

3.3.2 Incentives

Incentives are intended to make one alternative more preferable than another and therefore motivate a particular type of action. Incentives are often distinguished between internal and external incentives, of which internal incentives can be an inner satisfaction with the action, and external incentives can be some sort of rewards(Ingvild Sagberg, 2018). According to Alblas et al. (2014), external incentives can, to a large extent, promote sustainable development for manufacturers. Cerin and Karlson (2002) states that the most crucial external incentive drivers for sustainable development are government regulations, customer demands for sustainable goods and services, and pressure from environmental interest groups.

Government laws and regulations essentially have the potential to affect the industry's climate footprint. As a positive-oriented incentive, incentive schemes can be established in the form of emissions and climate impact requirements and possibly rewarding low-emission options. On the other hand, it is possible to add taxes for the options with a high climate impact. In any case, government regulations and laws have great potential to create a competitive advantage for environmentally conscious manufactures(Olubunmi et al., 2016).

The traditional balance between customer and supplier is changing rapidly due to the globalization of the economy. The information is easier to access, leading to greater transparency and consumers have more choices available. Due to this change of power relationship between buyer and seller, there has been a growing need for businesses to have a more customer-centric mindset(Teece, 2010). Customer demand affects competitiveness by prioritizing environmentally friendly products, but this will depend on the customer's perception of the product or service's value. The cus-

tomer who sets the framework for the project delivery in construction projects will be the building client. For that reason, its perception of value is of great importance for the choices made down the value chain. According to Aliakbarlou et al. (2018) value from a client perspective can be recognized as the client's perception of the delivery's worth. A client's value perception will differ from project to project according to their inherent objectives influenced by the project's stakeholders (Aliakbarlou et al., 2018).

3.3.3 BREEAM as Stimulus for EPD

Due to the raised requirements from stakeholders and consumers regarding sustainable products and services, it has become necessary for organizations to respond by some means (de Freitas Netto et al., 2020). A general understanding of organizations' environmental work is that most have some form of working method that acknowledges the environment (Sroufe & Joseph, 2007, p. 7). However, the methods span from unofficial structures to systems incorporating formal certification schemes with independent third-party verification.

The construction industry has been a pioneer in environmental documentation and certification, where several nationalities have taken part in the evolution (Cole & Jose Valdebenito, 2013). Building Research Establishment Environmental Assessment Method, more commonly known as BREEAM, is internationally the oldest environmental certification tool for buildings and is currently one of the most prominent in Europe(Cole & Jose Valdebenito, 2013). BREEAM is used to classify projects according to their environmental construction profile.

Multiple nations, including Norway, have further developed their own version of BREEAM tailored to local requirements and laws. In Norway, BREEAM-NOR is the official certification scheme regulated by Grønn Byggalianse. Early in 2022, BREEAM published an updated version of the manual, which also applies to the BREEAM-NOR scheme. The updated manual is aligned with the new initiative from the European Union - The taxonomy for sustainable activities. Additionally, one of the most noteworthy changes found in the manual is that emission reduction through material management is rewarded more significantly than in previous versions. For this thesis, the chapter on materials is particularly important as it defines its purpose

as:

> "*Recognize and encourage the use of building materials with low environmental and climate impact throughout the building's life cycle.*"
> BREEAM-NOR (2022)

In addition, one of the requirements in the manual explicitly defines that if one does not choose a material with a lower climate impact, it must be documented and justified.(BREEAM-NOR, 2022, p. 221).

Depending on an organization's status, approaching standards or certifications can, in some cases, be cost-consuming. Due to the formal certification system, it is, of which a certification according to the standard is desirable, compulsory with an independent third-party verification using an audit.

4 Research methodology

This chapter will present the research methodology used in this study. The chapter describes the study's framework, selection of theories, as well as the study's research method, and analysis of the obtained empirical data. Figure 4 illustrates the thesis' research design. An evaluation of the methodological approach will be presented in section 6.6.

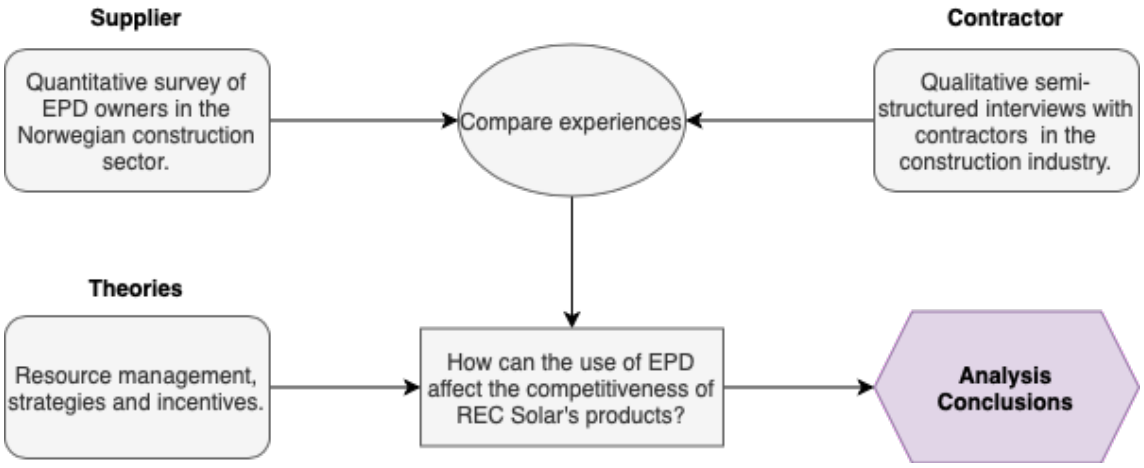


Figure 4: Methological approach.

4.1 Scope of this Study

The thesis explores the empirical experiences regarding EPDs potential to affect procurement decisions in the Norwegian construction industry. The construction industry is chosen because of the respective PCR, which REC Solar's EPD is developed upon, acknowledges PV modules as a building material. Furthermore, Minkov et al. (2015), Del Borghi (2013), and Toniolo et al. (2019) claims that the construction industry has come the furthest regarding harmonization PCRs and adopting EPDs. REC's EPDs are registered in EPD Norge's registers, therefore an exploration of the Norwegian construction industry is considered suitable.

Earlier there were no PCRs for solar panels categorized as building materials. For this reason, the empirical research will study a generalized utilization of EPDs in the Norwegian construction industry. Both manufacturers and contractors have been examined to ensure the study's validity.

The study will not address the preparation of EPDs, but rather its inherent potential in the post-preparation phase. The thesis is based on the fact that low-emission products have equal satisfactory qualities as their competitors and that the price of low-emission products is either the same or higher than the products with a more significant climate impact. EPD is one of the multiple standards to present the information assembled in an LCA analysis. However, this thesis does not consider other forms of equivalent standards. The thesis' primary focus is on values from EPDs related to CO2 emissions, despite the numerous environmental impact categories LCA assessments are able to identify. Finally, on a general basis, the content of an EPD often presents best-practice values. However, the focus of this thesis is whether the content values can create a competitive advantage. Hence the content values in themselves are neglected.

4.2 Literature Review

According to Holme and Solvang (1996), theories are more or less complex images of connections and relationships between phenomena one has developed and which one wishes to try against the concrete social situation. A literature review has been conducted to answer RQ1 and RQ3. In order to answer the research questions, it has been conducted a literature review of resource management and lasting competitive advantage to define concepts and a common framework. The literature review can argue for how certain resources and resource management can lead to a lasting competitive advantage on a general basis. Furthermore, a review of the literature related to business strategy and incentive systems is necessary to understand companies' methods and the drivers for both their reasoning for sustainable development and procurement decisions. In order to retrieve the literature, a search was conducted using the search engines Oria and Google Scholar.

4.3 Data Collection

To answer FQ2 and FQ3, the empirical data collection of this master's thesis was carried out through a survey among manufacturers and interviews with respondents from contractor companies to examine experience and coherence in the market.

When gathering the empirical data for the study, a mixed-method approach was

used, which is a form of methods triangulation. Mixed-method was chosen to cross-check that the findings from the product suppliers and contractors were consistent. Hence, achieving increased opportunities for generalized results, as well as increased contextualization and credibility(Tegan George, 2022). Quantitative and qualitative research is combined in the mixed study to contribute to a holistic assessment of EPD's function in the construction industry.

4.3.1 Quantitative Research

A quantitative survey was conducted with a descriptive design for the product suppliers. A quantitative method approach aims to collect data objectively. The essential goals of a quantitative method are to strive for generalized concepts, investigate causal relationships, or predict future results. A descriptive design is usually carried out only once with a larger population to create associations between variables and ensure a generalized connection between the variables (Johannesen et al., 2016).

Since there are limited EPDs for PV panels in Norway, it was desirable to conduct a quantitative analysis of other companies that have developed EPDs to gain their experience. A qualitative survey was conducted to examine a larger sample and promote a generalized response.

The sample in this survey was obtained by conducting a review of EPD-Norway's register of EPD registered products under the category "construction". At the time of the quantitative survey (March 2022), 1581 different construction-related products EPDs were registered within EPD-Norway's registers. Nevertheless, many of the registered EPDs have the same EPD owner.

In order to comply with GDPR rules and ensure anonymity, the quantitative survey was designed and distributed through the digital tool SurveyXact. It was distributed on 22.02.2022 and was closed on 21.03.2022, which is a total of 28 active days. The survey consisted of 17 questions with different types of questionnaire data. The set was divided into multiple-choice answers, single answers, and assessment scales, also known as a Likert-Type Item (Robinson & Leonard, 2018). The survey first addresses the product's context before investigating the surveyed samples' experiences related to EPD's impacts on the competitive situation for their products

in tender rounds. Finally, it was investigated what measures can be taken to optimize the effect of EPD in the construction industry. The entire questionnaire can be reviewed in appendix A.

4.3.2 Qualitative Research

Qualitative interviews were conducted with some of Norway's largest construction companies. According to Johannesen et al. (2016) qualitative research is used to the extent that one wants to create a deeper understanding of *why* something happens through causal relationships. The qualitative method is used to gather in-depth insights into a problem or understand concepts, opinions, or experiences by collecting and analyzing non-numerical data(Pritha Bhandari, 2022). The interviews were intended to map the utilization and evaluation of EPDs among contractors to investigate EPD's effects on procurement decisions.

In order to process personal data such as email addresses and transcribe and record the interviews, an application was submitted to the "Norwegian Center for Research Data" (NSD). The authors received guidance and help to complete information leaflets for the respondents, which addressed the purpose of the study and the data processing. According to their titles and company names, some respondents could be easily identified. Because of this, the authors avoided using the respondents' titles.

The sample intended to contain of purchasing managers from larger contractor organizations in the Norwegian construction industry. It was envisioned that the larger companies have broader knowledge about EPDs and that purchasing managers have the most competence related to procurements. The contact information was obtained through Internet searches and stored in Microsoft's cloud-based services following the clarifications from NSD. In the invitation, there was an opening to forward the interview request to other potential candidates in the company with a more excellent knowledge related to EPDs, which led to all respondents being affiliated with the sustainability departments of the examined companies. The sample consisted of employees with titles such as environmental advisors, environmental managers, and environmental and sustainability leaders. The sample of the qualitative interviews are listed in table 1.

Table 1: The respondent companies from the qualitative survey

Company	Date	Time
Statsbygg	06.04.2022	00.45.41
NCC	08.04.2022	00.41.35
Forsvarsbygg	22.04.2022	00.36.03
Bundebygg	25.04.2022	00.28.40
Veidekke	09.05.2022	00.37.47

Interviews were conducted to investigate the empirical experiences with the mentioned sample. Prior to the interview, an interview guide had been prepared and described in appendix B. However, it was nevertheless facilitated for openness through a loose structure and can be characterized as a semi-structured interview, according to Johannesen et al. (2016).

The conduct of the interview was digital through the software application Microsoft Teams. Both authors were present at all interviews. The roles during the interview were distributed by one having the primary responsibility for leading the interview, while the other was responsible for asking follow-up questions to the representative to create a deeper understanding of the respondent's answers and context.

The documentation regarding company information was gathered through the company's websites. The documentation of the interviews was carried out by conducting recordings of the interview in either audio or video format. This data was then transcribed and processed to ensure that the respondents' responses were not affected by interpretations.

4.4 Data Analysis

An analysis of the empirical data was carried out to draw parallels to the thesis's studied phenomenon. The analysis is based on individual analysis of both the quantitative survey and the qualitative interviews conducted to answer the research questions.

4.4.1 Quantitative Research

When analyzing the information gathered from the quantitative survey, the integrated analysis system in SurveyXact was utilized. Data regarding the questions was then further processed in Microsoft Excel. The total response results are presented with *completion rate* (CR) and *response rate* (RR) in section 5.1. CR and RR have also been calculated for all the multiple-choice questions individually and can be found in appendix A.

The completion rate definition is intuitively and represents the share of respondents who have completed the survey based on those who have entered the survey. In many cases, this is a measure that reflects the quality of the procedure and data collection. Sources like Robinson and Leonard (2018) have the exact definition for CR and RR. However, in this thesis, the two are treated as individual definitions. RR is, in this thesis, the share rate of respondents who entered the survey based on total distributed mails with the invitation to take part in the survey.

The analysis of response numbers shows that the number of respondents decreases when the questions regarding the organization's strategy. A possible reason for the dropout rate to these questions may be that the recipients of the survey were EPD owners and not a strategical manager, sustainable manager, or other corresponding employees (Haraldsen, 1999; Robinson & Leonard, 2018).

That respondents have answered "I do not know" may, according to (Robinson & Leonard, 2018) have several meanings. If the question is of a sensitive character, the respondents may choose to answer it due to privacy concerns. Because of the respective questions' nature, in this case, there is a greater possibility that the respondents genuinely do not know and, in some cases, do not bother to make the necessary effort to find the answer (Fowler Jr, 2014).

$$\text{Completion rate} = \frac{\text{respondents completed the survey}}{\text{total respondents entered the survey}}$$

$$\text{Response rate} = \frac{\text{total respondents entered the survey}}{\text{total distributed invitations}}$$

When calculating the response rate for each individual question, the counter *total respondents entered the survey* is replaced with *number of respondents* on that

specific question, due to a lack of information regarding respondents who have entered each individual question.

4.4.2 Qualitative Research

In order to analyze the data from the qualitative interviews, the software program NVIVO was used. NVIVO was used to structure the data and to find patterns more comprehensively. The analysis was carried out by studying the case respondents independently. The authors used the transcripts and sorted the information into the following nodes for analysis; Utilization, Collection and Analyze Method, Challenges, and Future Expectations. The challenges found in the interviews were cross-analyzed and mapped for each company against relevant challenges that emerged from the quantitative analysis of EPD owners.

5 Results

In this section, the complete collection of results will be presented in the manner that will be most advantageous in trying to answer the research question. Unprocessed data will be attached in the appendix A.

5.1 Quantitative Survey - Suppliers

Emails to the EPD owners registered under building and construction were found on EPD Norge's website. All statistics regarding responses to the survey are presented in table 2, and detailed statistics for each question are attached in the Appendix.

Table 2: Response statistics on the survey

	Percent	Respondents
Distributed (Only Entered the suvey)	14,6 %	15
Partially Completed	10,7 %	11
Completed	74,8 %	77
Total	100 %	103

Total distributed surveys	-	270
Total number of respondents entered the survey	-	103
Total number of completed surveys	-	77

Completion rate (CR)	74,8 %	-
Response rates (RR)	38,1 %	-

5.1.1 Organization Information

All of the respondents who participated in the survey answered that they represented the general industry or the construction industry. Based on 88 respondents, the most significant proportion of companies supply finished concrete and concrete products with 25% of the total. The response rate also shows an even representation of small and medium-sized businesses(SMB) together with large businesses, whereby the Norwegian Accounting Act defines the difference. However, there is a marginal predominance of SMB's with a share of 54%. With a share of 41%, the majority of

the respondents answered that the geographically defined market their organization mainly supplies to is Norway. However, 50% of the remaining share is almost equally distributed on to the markets: Scandinavia (17%), Europe (16%) and Global (16%), with the rest in Others (9%).

5.1.2 Organizations Empirical Findings and Observations

When asking the respondents what the main reasons for developing EPD for their organization's product were, the majority emphasized *requirements from customers* and the *combativeness in tender rounds*, presented in fig. 5. Dividing the answers based on the sectors and size of the organization, one can find the same trends with some variations. Separating the answers by *Small or medium-sized businesses* from *Large businesses*, it is noteworthy that as many as 56% of the large businesses have answered *To map the company's environmental impact*, compared to only 43% of the small or medium-sized businesses, which results in a difference of 13%. However, regardless of size and sector, the answer *legal requirements* is undoubtedly the one that has the least impact according to the respondents.

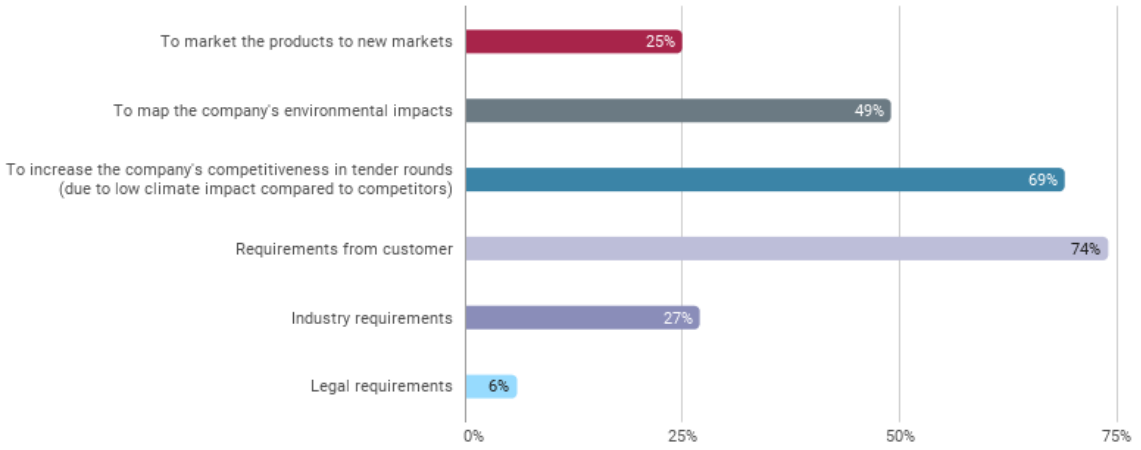


Figure 5: Organizations main reasons for developing EPD, all respondents

According to the question *to what extent has EPD benefited your business?* has the majority of the respondents experienced that EPD has contributed with *some* or *large extend*, ref. fig. 6. By dividing the answers based on the size of the organization, one can see by the fig. 7 that large businesses encounter greater benefits associated with EPD compared to small and medium-sized businesses.

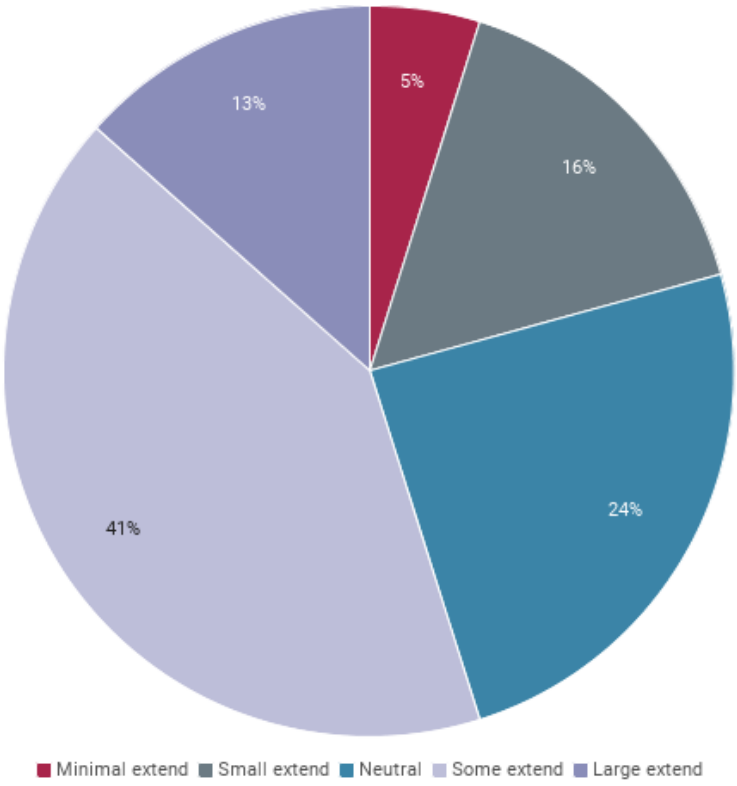
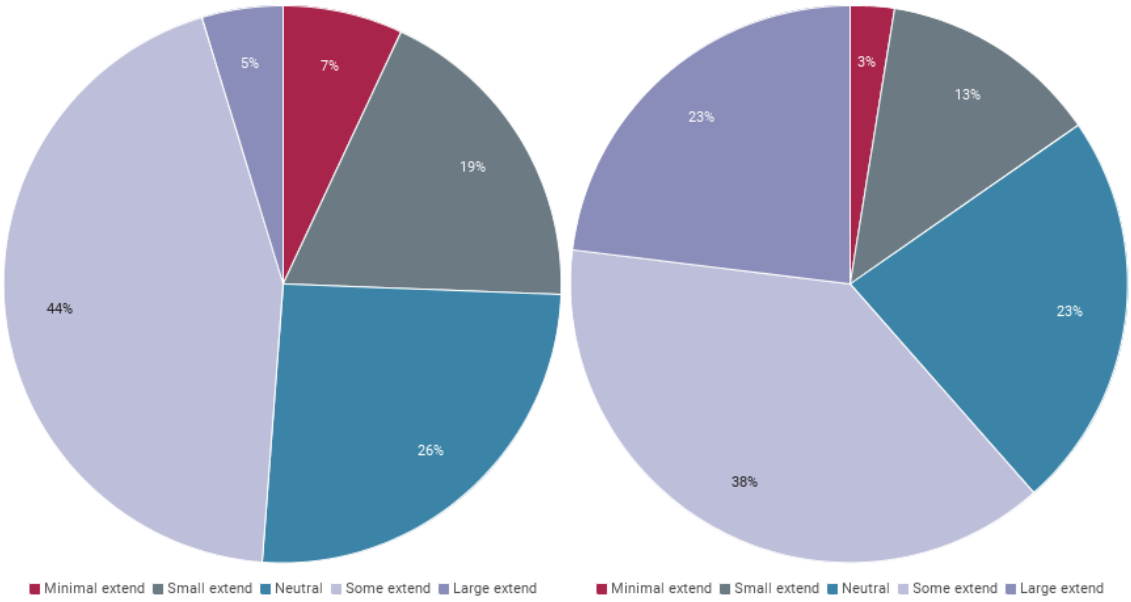


Figure 6: The extend of how much EPD has benefited the business, all respondents



(a) Small and medium-sized businesses (b) Large businesses

Figure 7: The extend of how much EPD has benefited the business

Although many stated that they experience benefits of EPDs, there are also some expenses and work associated with developing a specific product. When asking to what extent the benefits have outweighed the resource use, the survey shows that a larger share of respondents answered *Minimal*, *small* or *neutral extend*, presented by fig. 8. As in the previous question, the large companies experience greater benefits from the development and use of EPD, ref. fig. 9.

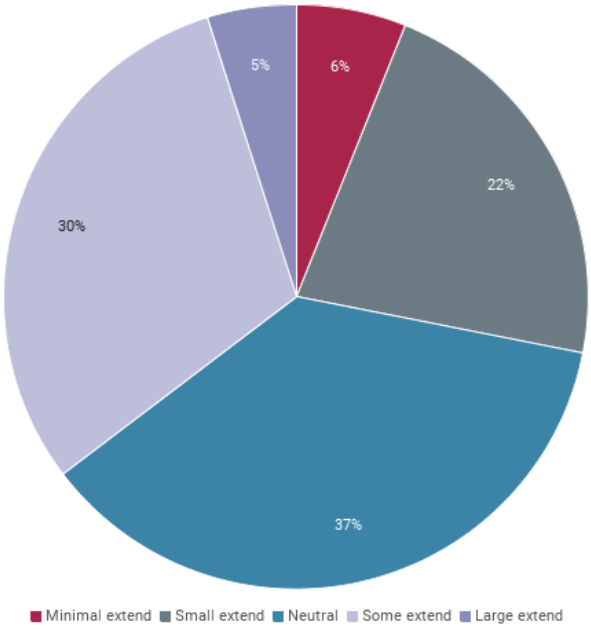
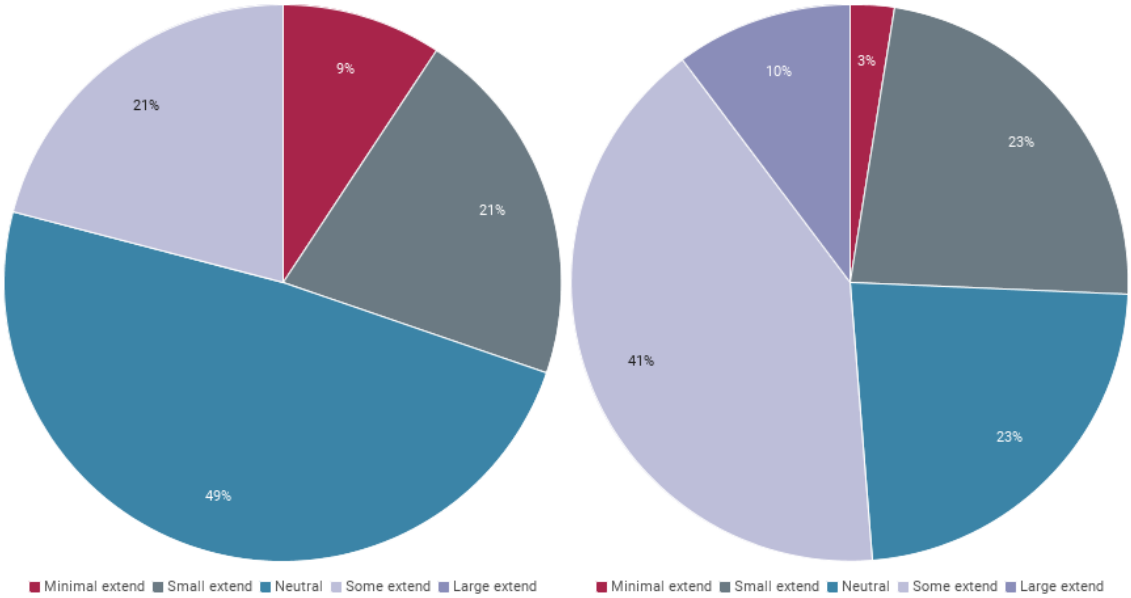


Figure 8: Benefits of the EPD versus resources used to develop an EPD



(a) Small and medium-sized businesses (b) Large businesses

Figure 9: Benefits of the EPD versus resources used to develop an EPD

In order to concretize the benefits associated with EPD, nuanced questions related to tender rounds have been asked. As presented in fig. 10, answered 42% of the participants that their EPD has contributed to increased participation in tender rounds. With a total of 64% answering *some* or *large extend* on increased participation due to EPD, shown in fig. 11.

Since the number of *I don't know* answers is as high as 32%, is there a possibility of biased answers in the question regarding participation in tender rounds due to EPD. It was specified in the question that if the respondents answered *No* on the previous question, they should choose *Neutral* on the respective question. However, in an attempt to remove biased answers, the fig. 11 is only based on the participants who answered *Yes* in fig. 10. The same applies to the following questions in the same genre.

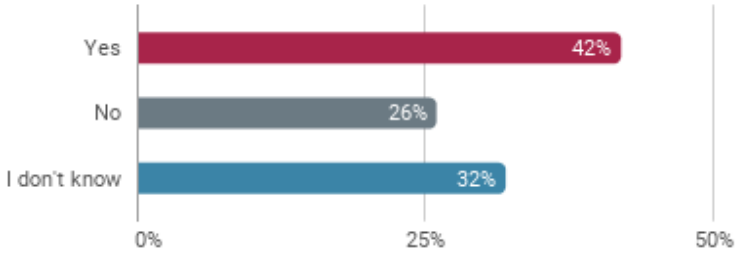


Figure 10: Participation in tender rounds due to EPD

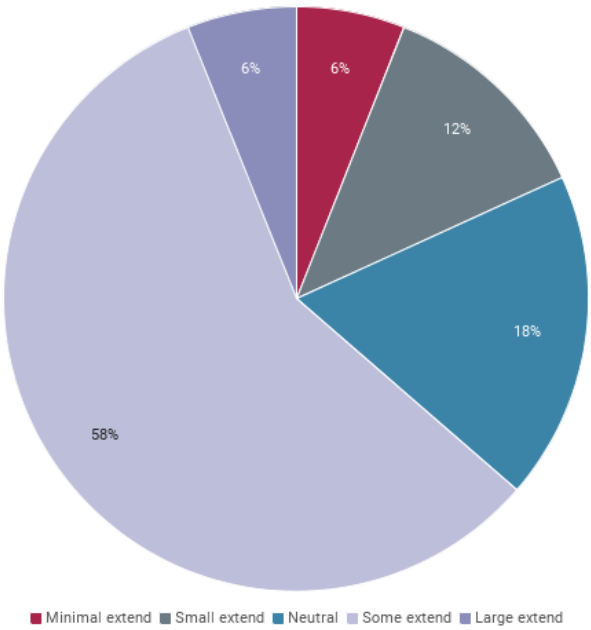


Figure 11: The extend of increased participation in tender rounds due to EPD

Additionally, 40% answered that the use of EPD has helped their organization win an increased number of tenders. Whereas 72% of those who have answered *yes* also say it has helped with *some extend*. Both the shares are presented in fig. 12 and fig. 13.

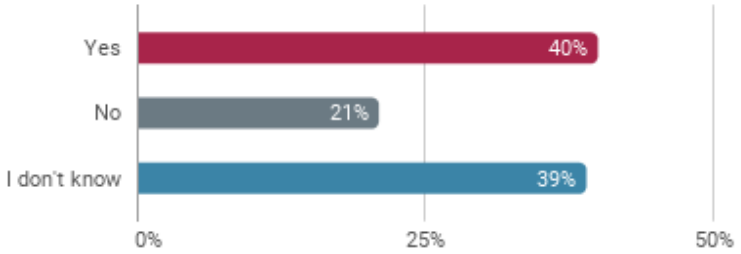


Figure 12: Organizations winning tenders due to their EPD

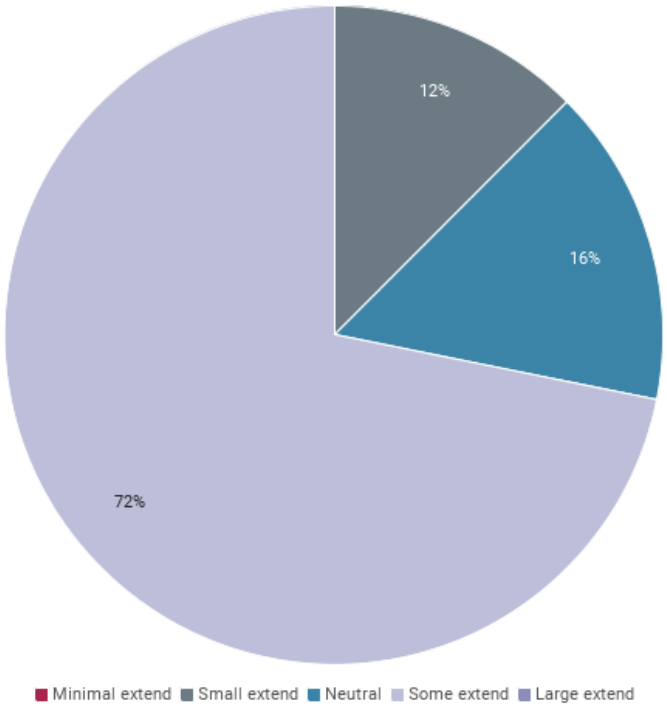


Figure 13: Extend of winning tenders due to EPD

The difference between being allowed to participate in a tender round and winning a tender is essential. Some buyers only require companies to have EPD available for their product, but no requirements or assessments of the contained values. However, as seen in fig. 14, 35% of the respondents claim that their values in the EPD have contributed to an increased number of winning tenders. 68% of the share also answers that their EPD values have increased their extent of winning tenders by some extent.

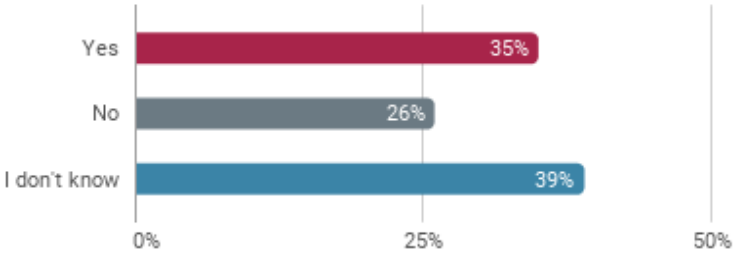


Figure 14: Increased tender wins due to the values in the EPD

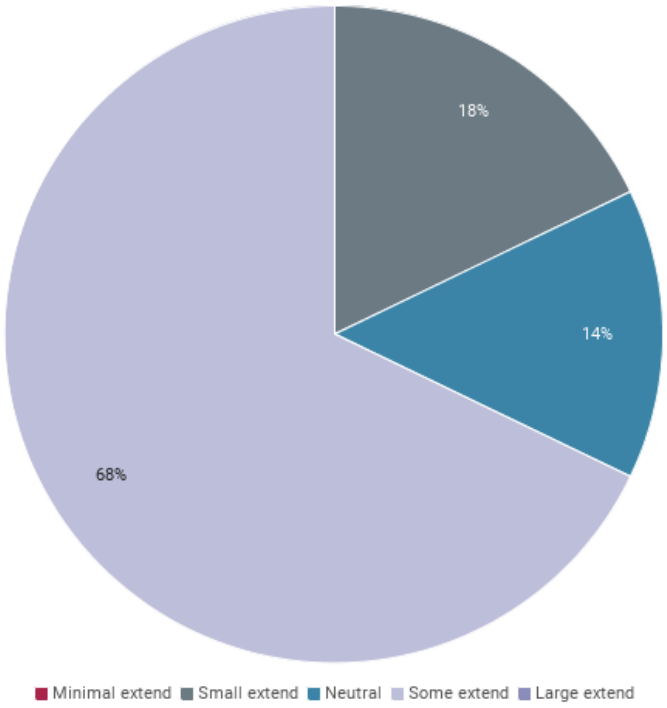


Figure 15: Extend of increased winning tenders due to EPD values

5.1.3 Challenges

According to the survey among EPD owners, the biggest challenges that affect EPDs as a mobilizer for increased competitiveness are; Price trumps climate impact, as well as there are too few EPDs, it is too expensive to develop, and there is a lack of regulations, standardization, competence, and seamlessness.

5.2 Interviews - Contractors

This part of the results will address the empirical findings regarding the utilization, collection and analysis, challenges and future expectations regarding EPDs in the Norwegian construction industry. All the questions in the interview are presented in appendix B. The interviews will be presented chronologically, where each subsection will introduce the examined companies.

5.2.1 Statsbygg

The Norwegian Directorate of Public Construction and Property (Statsbygg) is a governmental actor, which is both a client and a property manager within the Norwegian construction industry. Statsbygg is responsible for the development of new buildings, but also maintenance and operations manager for already existing buildings. At any given time, Statsbygg has over 100 ongoing projects which they characterize as some of the country's largest and most complex construction projects(Statsbygg, n.d.). Statsbygg claims that they work for good quality and a healthy economy at the same time as reducing climate emissions. Statsbygg will "use its position to cultivate a more climate-friendly, digital and serious construction industry"(Statsbygg, n.d.).

Utilization When asked whether Statsbygg makes demands on EPDs from suppliers, the Environmental Advisor in Statsbygg answers:

> "*It is not the case that there must be EPDs on absolutely everything that is delivered to Statsbygg. It is in these areas that there are requirements that the products must be of a certain quality or that there must be a certain level in terms of emissions or other environmental criteria, where we require that there must be an approved third-party verified EPD.*"

Furthermore, the environmental adviser at Statsbygg explains that almost all projects they are involved in have some form of environmental requirement that makes EPD a suitable source of documentation. Many projects have different requirements for reducing greenhouse gas emissions. In these cases, comprehensive greenhouse gas calculations are carried out in accordance with Standard NS3720, which is further compared with a reference building which is based on typical materials and which

meets the minimum requirement in accordance to the TEK-17 standard.

Collection and analysis method In a typical procurement process at Statsbygg, purchasing managers will be sent environmental follow-up plans. Furthermore, the purchasing managers will ask for prices for the products, and since Statsbygg is a public actor, they must collect prices from at least three different suppliers. If the environmental follow-up plan states that the product must have an EPD, this will then be forwarded to a consulting engineer in the field of environment and sustainability to investigate its validity.

When Statsbygg's representatives are asked whether the content of the EPD will affect the procurement's choice, Statsbygg answers that it depends on the situation. They do not have a system that rewards environmentally friendly products, but in simple procurements it happens that the products, or services with the lowest climate impact, are some times given priority over price.

Challenges When asked what their biggest challenges are in relation to the EPD, one of the interviewee answer the following:

> "*I find that some of the biggest challenges are that many people do not understand how they use it or read it. And in several contexts, documentation is provided that is not valid EPDs.*"

The other interviewee supplies:

> "*...As a public actor, we have many rules related to how we make purchases. We can not make demands that are at the expense of not having enough providers. We can not give anyone a monopoly situation. So we can not set requirements for an EPD or an ambitious emission level for a procurement where there is only one provider. An example of this is solar cells, where there have not been proper EPDs until recently, and there are not enough manufacturers that we can necessarily set a requirement to have an EPD or require the solar panels to be produced with a lower footprint.*"

Future expectations For the future, Statsbygg representatives claim that they believe future regulations will require additional requirements for calculation and documentation of greenhouse gas emissions, which will make EPDs relevant. Furthermore, they explain that they want environmental documentation to be as mandatory as product performance specifications.

5.2.2 NCC

NCC is a Nordic building and construction company, which develops commercial properties, and builds homes, offices, industrial buildings, public buildings and infrastructure and operates in Norway, Sweden, Finland and Denmark. According to their own website, NCC is concerned with improving construction methods and collaboration processes, reducing energy consumption and becoming more sustainable(NCC, n.d.).

Utilization When the representative from NCC is asked if there are any guidelines in relation to the environmental declaration from suppliers, the representative answers the following:

> "*...almost all of the major builders want BREEAM certification, so we are projecting more BREEAM certified buildings, and then we need EPDs.*"

Furthermore, the interviewee explains that they also have internal goals at corporate level which are about reducing the use of emissions from materials such as asphalt, concrete and steel and in order to be able to measure this reduction, obtaining EPDs is important. When the environmental manager in NCC is asked to what extent the content of EPDs will influence product selection, the answer is:

> "*It has a lot to do with the price. If two products are equal in price, then it is a "No-brainer" to take the one that is most environmentally friendly. And if there is a big price difference, then an assessment is needed. For example, how much should we use this material, and is the client willing to bear the extra cost.*"

Collection and analysis method The processing of the information in EPDs will thus depend on what it is to be used for. If it is to be used in a greenhouse

gas account, then the EPD values will be entered in the Software program OneClick LCA[1] to contribute total greenhouse gas accounts. Other times it is only a requirement for EPD, and in those cases it is only stored, while in some cases it is used to compare the environmental impact of products.There is no system that rewards suppliers who offer products with a lower environmental impact than others. The assessments of procurement's are carried out by the project team in collaboration with the client.

Challenges Furthermore, NCC's representative explains that the biggest challenges associated with the use of EPD at NCC are the lack of knowledge on how to use them as a tool. Additionally, it is explained that at times there are differences in the information in the EPD which make the basis of comparison difficult to carry out. This is partly due to the fact that some EPDs do not cover the same life cycle categories, some only have "Cradle to Gate", while others have "Cradle to Grave". At the same time as there should be more regulations and requirements from the national level, as the use of EPDs is largely promoted by private sector initiatives.

Future expectations In order to increase the use and usefulness of EPDs, NCC mentions further governmental regulations, and that the taxonomy will be able to increase the use of EPD, as greenhouse gas accounting is part of it.

5.2.3 Forsvarsbygg

Forsvarsbygg is under the command of the Norwegian Ministry of Defense. Forsvarsbygg builds, develops and operates properties for the defense sector(Forsvarsbygg, n.d.-b). In accordance with Forsvarsbygg's environmental strategy, the most important thing is mentioned to support the Armed Forces' fighting power and, together with the Armed Forces, contribute to a sustainable society through good environmental management and a focus on long-term solutions. Forsvarsbygg's sustainability strategy is to reduce their climate footprint, executed by setting requirements for the suppliers of goods and services, as well as emphasizing circular solutions(Forsvarsbygg, n.d.-a).

[1]One Click LCA is a software for life cycle analysis (LCA) in construction projects(LCA, n.d.)

Utilization Forsvarsbygg has internally developed environmental follow-up plans that confirm that they will collect EPDs on the materials; concrete, steel and insulation. The reason for this is that it is the materials that have the greatest impact on the overall climate accounts. Furthermore, the representative from Forsvarsbygg is concerned that much of their business takes place in northern Norway, which means that they are focusing on the overall picture and have to work in a different ways than the more central located companies. In addition, they are a public actor which means that they can not create monopoly situations.

Collection and analysis method The environmental follow-up plan is attached to each investment project, stating the requirements and to reach them. In practice it is the project manager, together with the contract consultant, whom is responsible for ensuring that the requirements are fulfilled.

Challenges Forsvarsbygg's representative points out that Statsbygg largely controls the information in One Click LCA. In addition, they want the EPDs to be digitized to a greater extent so that they can be used directly in BIM models, to increase seamlessness.

Future expectations The representative from Forsvarsbygg believes in particular that the consultation in "climate-based energy requirements" within TEK17, could increase the importance of greenhouse gas accounts, thus benefits of EPDs.

> "*There is a new technical, regulatory change, that was announced last year called climate-based energy requirements. It is still out for consultation because there were almost 100 hearing statements. In connection with the building application process, the intention is that one must have a greenhouse gas emission account on the building for material use. Now it has been signaled that this will be launched this summer. So it will change the preconditions, I think, for how to operate in the industry.*"

5.2.4 Bundebygg

Bundebygg is a contractor, part of the Bundegruppen, which develops and builds residential and commercial buildings in Oslo and the surrounding area. Part of

Bundebygg's sustainability strategy is to be climate neutral through initiatives to the UN "Climate Neutral Now" which addresses a three-step model where emissions are mapped, attempts are made to reduce, otherwise residual emissions are compensated by purchasing EU / UN approved climate quotas(Bundebygg, n.d.).

Utilization Bundebygg claims that it is largely the client who controls the degree of focus on EPDs. The representative from Bundebygg says there are two different types of builders, those who develop to sell and those who develop to operate. Those who develop to sell want to make the most profit possible and for that reason, only focuses on achieving the requirements in TEK17. Furthermore, Bundebygg says that this means that they also have to focus on prices, as they lose tenders if they do not have the same prerequisites as their competitors. The developer who develops for operation has a greater life cycle focus and often wants to develop BREEAM certified buildings, where collection of EPDs is required.

Collection and analysis method In BREAEM certified buildings, climate accounts are performed and assessed on a five to ten different alternatives for the materials that are most used based on the availability of EPDs, as in BREEAM there is a requirement for a 20-40% reduction compared to reference buildings. Bundebygg will assess which materials to focus on in order to have the shortest path to the goal. The collection and assessment of EPDs are carried out by the purchasing department and representatives from the sustainability department.

Challenges Bundebygg believes that the challenges have previously been that there are not enough EPDs in the industry. Now they believe that the problem lies in the fact that there are no regulations from the government that can change the focus of the client towards a more sustainable oriented focus.

> "*..the industry says that the authorities are not very challenging, the industry wants more challenges and more demands from the authorities. The industry believes they are ready to meet the demands that may come.*"

Furthermore, the interviewee points out that it would be appropriate to present a simplified presentation of the characterization of the content of the EPD and

highlights ECOproduct[2] as a solution.

Future Expectations Bundebygg states that having a lower climate impact than its competitors is a competitive advantage and will be strengthened in the future. Furthermore, Bundebygg mentions the potential regulation of "climate-based energy requirements", the taxonomy, and the development of new BREEAM versions as drivers for sustainable procurements; hence EPDs will potentially be a helpful tool.

5.2.5 Veidekke

Veidekke is Scandinavia's largest contractor, building bridges, roads, tunnels, and buildings. Veidekke aims to be climate neutral by 2045 by reducing emissions and contributing to a reduction in climate footprint from their suppliers and their customers. One of Veidekke's measures is to use sustainable materials such as solid wood and low-carbon concrete(Veidekke, n.d.).

Utilization Veidekke's utilization of EPDs is most often project-based, following the client's objectives. In those cases where one is to build BREAM certified buildings, where a climate account is required, or achieve a certain reduction of climate impact according to a reference value, then EPD is used. Apart from this, Veidekke does not have any internal guidelines stating that they must collect the EPD. The EPDs are also most often used and assessed for the materials with the highest contribution to the overall climate accounts.

Collection and analysis method The representative from Veidekke explains that they do not have a centralized purchasing function, which means that within the project, it is often the project manager's job to delegate the purchases. During the conclusion of large contracts, the purchasing function is usually accompanied by environmental advisers who make the decisions. As a retrieval tool, "One Click LCA" is used in the retrieval of PDF EPD files.

Challenges The representative from Veidekke mainly believes that their perceived challenges related to the EPD are related to seamlessness. Although several are

[2]ECOproduct is a service provided by Grønn Byggallianse og Byggtjeneste that assesses the building product's environmental properties, based on EPD, according to six aspects, each of which is given a grade(Byggtjeneste, n.d.)

working to remedy this problem, they believe that the weakness is that it is still not easy enough to apply EPDs to their internal systems. Furthermore, Veidekke mentions the need for more EPDs, as there are still products and product categories where there are no EPDs.

Future Expectations Veidekke is committed to reducing emissions from scopes 1, 2, and 3 by 50% by 2030, and EPD can thus be a helpful tool for achieving this goal. The representative explains that they are actively working to develop a framework for decision-making when it comes to sustainable procurement and raising the skills of their employees, especially in the purchasing function. Veidekke is confident that environmental documentation and evaluation will become even more critical in the imminent future.

5.3 Summary - Research Results

Table 3 presents the results that form the basis for the discussion in section 6 and the analysis and the recommendations in section 7. The challenges that affect EPDs as a mobilizer for increased competitiveness are categorized in table 4.

Table 3: The main findings from the empirical study.

Quantitative Survey - Suppliers	**Interviews - Contractors**
• 54% claims EPDs have been beneficial in *some* or *large extend*.	• No system that rewards low-emission procurement.
• *Large businesses* have experienced significantly greater benefits due to EPD, compared to *small* and *medium-sized businesses*	• Focuses on the total climate accounts.
• 64% claims EPDs has increased participation in tender rounds with *some* or *large extend*.	• Collection and evaluation of EPD is context-based.
• 42% claims EPD has increased participation in tender rounds.	• Price prioritized over climate impact.
• 35% claims, EPD values contributed tender victory.	• EPD, an important tool in the future.

In the quantitative survey, 54% of the sample answered that EPDs have been beneficial to the company to a certain extent or a large extent, and 5% answered that there had been minimal benefits related to the development of EPD. 64% have answered that the EPD has contributed to a certain or large degree of increased participation in tender rounds. In comparison, 68% claim that, to a certain extent, they emerge victorious from tender rounds due to their values in the EPD related to climate impact.

The qualitative analysis has highlighted that it depends on the situation to what extent EPDs are obtained and evaluated. The main focus is on the total greenhouse gas emissions, and for that reason, there is a focus on the most significant emissions contributors. In addition to the mentioned contributors, the price will largely be prioritized over climate impact. The evaluation of EPDs is carried out differently in all companies, but the common denominator is that no one has specific systems that reward low-emission products. All companies believe that EPDs can be essential tools to meet future requirements for greenhouse gas calculation and reduction.

Table 4: Experienced challenges related to Environmental Product Declaration as a mobilizer to achieve competitive advantages for low-emission producers.

Challenge/Company	**Statsbygg**	**NCC**	**Forsvarsbygg**	**Bundebygg**	**Veidekke**	**EPD Owners**
Price trumps climate impact		X		X		X
Major contributors focus		X	X	X	X	
Too few EPDs	X				X	X
Too expensive to develop						X
Lack of regulations		X		X		X
Lack of standardization		X				X
Lack of competence	X	X				X
Lack of seamlessness			X	X	X	X

6 Discussions and analysis

In this chapter, the literature review will be systematically discussed and used to analyze the empirical findings. The discussion based on the literature review establishes a foundation for answering RQ1. Furthermore, to answer RQ2, the uncovered experiences discovered in the empirical findings will be discussed. Additionally, will the discussion regarding the literature contribute to the interpretation of the empirical findings and answer RQ3. The chapter also addresses a discussion related to the thesis limitations.

6.1 REC Solar's Strategic Rationale for Developing EPDs

As seen in the results, presented by Figure 5, several companies choose to develop EPDs to amplify their competitive position in the market as a result of increased awareness of environmental impact among customers. Strategies are about combining business contextual awareness with the ability and willingness to adapt to it(Campbell et al., 2011). For this reason, it can be argued that developing an EPD is a strategic choice for REC Solar.

According to Campbell et al. (2011), an essential part of the preparation of strategies is based on an evaluation of the company's strengths, weaknesses, opportunities, and threats (SWOT). In REC Solar's situation, it is reasonable to think that their company's production costs are their *weakness* and that their low emission production process is their *strength*. The *opportunities* lies in the increased focus on environmental and sustainability aspects. By developing EPDs for their products, the strengths will be communicated and promoted to potential customers. Nevertheless, the *threat* in this context is that the market decides to what extent climate impact will trump the appreciation of low price.

REC Solar's production process can be aligned with the resource-based approach where corporations work from "inside and out" by focusing on and developing internal processes to stand out from their competitors by utilizing a differentiated competence, knowledge, or technology supported by organizational learning. In this context, REC Solar's silicon is acknowledged as their resource, which will be further discussed in section 6.2. The purpose of EPDs is to present verifiable and measurable

information related to the climate impact of a product or service and create a basis for comparison based on climate impact for two products with similar satisfactory attributes (Del Borghi, 2013; Manzini et al., 2006). In this context, EPDs will act as a B2B marketing tool, as EPDs enable companies that produce products with a lower climate impact than their competitors to communicate the inherent advantages of their products(Hall, 2017). Nevertheless, Frandsen and Johansen (2007) states that communication takes place through the sender and receiver together, creating a common meaning. If the recipient is unable to transform the information as intended, then a common understanding will not be achieved.

The development of further regulations and industry requirements in the industry will, as mentioned in section 5.2.3, increase the importance of mapping a company's climate impact. In such an assessment process, previous research has shown that EPD has the ability to contribute insights related to climate impacts and can therefore be used as a basis for sustainable procurements. Therefore, REC Solar's strategic reasoning for developing and implementing EPDs can be defended as part of their sustainable business development. They are focusing on creating new opportunities by not only reacting to a current market situation but by trying to predict a future situation, thus being ahead of its competitors(Rainey, 2010).

6.2 Resource Utilization of Low-Emission Silicon

According to the VRIO framework presented in section 3.1.2, the resource in the organization needs to fulfill the features of valuable, rare, inimitable and organized in order to achieve lasting competitive advantage. Numbers presented in section 2.2 show that solar energy is highly necessary and needed in order to satisfy the growing energy demands sustainably. Silicon will therefore be a valuable resource in the future, with the provision that the development related to solar energy continues. Although not all of the needed energy will necessarily be supplied through solar panels, the need for silicon in the applicable panels will be present due to its ability to generate electricity. On the other hand, as mentioned in section 2.2 is silicon often extracted from quartz, which is the second most widespread mineral in the earth's crust (Raade, n.d.). Therefore, the raw material is not particularly rare or arduous to obtain, but transforming the quartz into silicon is a complex process.

Processing the raw material to the finest silicon that has the ability to convert solar energy to electrical energy requires intelligent people with proper knowledge of the right technology.

Discussing the first two features of the VRIO framework, it is evident that silicon as a resource alone is only enough to achieve competitive parity. Capabilities within the organization are therefore essential when striving for lasting competitive advantage. As presented in section 3.1.1, capabilities are not the source of value, yet they facilitate and strengthen the organization's utilization of the primary resource. The technology used in the processing of silicon can be perceived as such capabilities and attributes properties to the resource, which in turn can be utilized by the company. The low-emission technology and silicon can also be seen as a cohesive resource, where the resource, in this case, can be referred to as low-emission silicon. Using a technology that generates less polluting emissions causes the resource to differentiate itself from competitors. Because most silicon producers use technology with a high level of emissions related to production, the resource of the low-emission producer will be more valuable and rare. One of the drivers for increasing the share of energy production from solar energy is its property as a renewable energy source, where it will be part of the solution towards a more sustainable future. The value will thus increase as it, through a reduction of emissions in the production, will have another property that meets the driver. In addition to the valuable feature, the resource may be considered rare. As mentioned, the most common way of processing silicon is highly energy demanding. Using an alternative technology that requires less energy and thus lower emissions compared to the standards makes the resource capabilities rare. Additionally, the silicon producer, REC Solar, is located in Norway, where the energy mix is based on almost 100% electrical energy from renewable sources. Therefore, the energy mix will contribute to a decrease in the total polluting emissions and amplify the value and rarity.

As presented in section 3.1.2, if an organization holds a resource that is valuable and rare, it holds a temporary competitive advantage. Nevertheless, the competitive advantage will not last if competitors can obtain equivalent resources with corresponding characteristics. Although processing silicon is complex, it is possible to obtain the technology. It is also possible for existing silicon producers to reorganize

their production methods to meet the emission level of direct production. The reorganization will, in most cases, give the organization a cost disadvantage in some form, but the significance of the disadvantage may vary. The cost can be a disadvantage at the moment of investment but then turn into a long-term benefit. Thus, the extent to which the resource is imitable can be discussed. However, organizations placed in Norway, or countries with equivalent energy mix, will have the advantage that their main energy supply has low emission levels compared to the rest of the world. Changing the energy supply of an entire country or a larger geographic area is more ambitious. It may be challenging for competitors to align with such producers' total emissions related to production. Because of this, the resource can be considered inimitable according to the theory described in section 3.1.2.

According to the theory, it is not adequate that the resource is valuable, rare, and inimitable to reach a lasting competitive advantage. Fulfilling these three features only corresponds to a competitive advantage. Using EPD as a tool to communicate the environmental properties of a resource such as silicon helps the consumer identify the explicit value of pollution emissions related to the production. Regardless of the organization's market strategy, an EPD can mobilize the resource due to the explicit evidence of less emissions, thus confirming the value.

6.3 Empirical Verification of VRIO

Results from the quantitative research, presented in fig. 12, display that 40% of the respondents have won a tender because of their EPD, which demonstrates that using an EPD together with a product mobilizes their resources. The survey results also reveal that 35% of the respondents have an EPD where the stated values have helped their organization win an increased number of tenders, as illustrated in fig. 14. The replies from the qualitative study also confirm that EPD can mobilize the resource as several contractors require EPDs from their suppliers. Additionally, in some procurement processes, the contractors claim they base their material selection on the emission values documented in the EPD.

Although using EPD as documentation for a resource shows transparency regarding product emission and enables differentiation between products based on emission

levels, the perceived value of the resource must be aligned with the price of the product. As mentioned in section 3.1.2, price is the main challenge when trying to appropriate the resource, which is also confirmed through the qualitative part of the research. The lower-prized product is often chosen if the material with the lowest emission rates is more expensive than the competitors' products unless there are specified claims from their clients. The NCC representative stated the following: "It has a lot to do with the price. If two products are equal in price, it is a "no-brainer" to choose the most environmentally sustainable." All interviewees use systems to respond to environmental issues internally in the organization. Still, none have established systems to determine the break-even point between cost and emissions for the material procurement in a project, which is a paradox as the construction industry is mainly project-based.

Theory from the VRIO framework clarifies some of the challenges that are to be found in the empirical findings. Pricing of the product is a problem where, according to the empirical evidence, buyers generally do not want to pay significantly more for a product with a higher environmental impact. Adjusting the price or increasing the resource's value is needed to appropriate the resource. In this case, the production process is more costly than the traditional production method, and it will not be applicable to reduce the price. Therefore, assessing the product's value will possibly be more relevant. Although silicon produced with low-emission technology, as discussed earlier, has a potential value in being more environmentally sustainable, it does not necessarily mean that potential buyers appreciate the value. As mentioned in theory chapter section 3.3.2, it is argued that value in this context can be seen as the client's(buyers) perception of the delivery's worth. At this point, the product's value does not meet the buyer's willingness to pay, even if the potential value indicates so.

The representative from Bundebygg stated that it is possible to distinguish between two types of clients; The clients who build for further operations and those who build to sell. In most cases where the client builds for sale, the perceptions of monetary gains and cost-reduction are the most critical factors in value creation. In these situations, construction clients only aim to fulfill the minimum requirements

declared by TEK17[3], which further creates consequences for environmental impacts as a basis for competition.

Mobilizing and actualizing the product's potential value is essential if buyers are going to prioritize environmental attributes over costs. Possible measures, which are also indicated by the empirical findings, are regulations and incentive systems. As mentioned by Bundebygg in the interview, the industry desires more challenges and more demands from the authorities. At this point, there are hardly any regulations regarding sustainable material procurements.

As Fatemi and Fooladi (2013) and Schoenmaker (2018) explains, presented in section 3.3, the economic thinking and financial approach in change. Value creation through long-term thinking and approaches is essential in working towards a sustainable future. It is shown in the empirical findings that the organizations are not going to prioritize higher-priced materials unless there is a potential to acquire other perceived values. Some organizations choose materials with fewer emissions despite being more expensive if the customer explicitly specifies it. Both NCC and Bundebygg indicate that such specified claims from the clients may be because they aim to construct a building according to certifications schemes like BREEAM.

The new BREEAM manual, discussed in section 3.3.3, emphasizes materials as a generator for emission reduction. Therefore, projects that prioritize low-emission materials get more points awarded on the way to certification compared to earlier BREEAM versions. EPD is actively requested as a document to fulfill the multiple requirements in the manual. However, minimal organizations use BREEAM or other certification schemes without achieving any value or gain from using it. It is therefore essential to have incentive systems that support the certifications and the choice of more sustainable materials, which is further discussed in section 6.5.

[3]Building Technical Regulations (TEK) describes the minimum number of properties a building must have in order to be built in Norway. The main rule is that TEK applies to all new buildings and upgrades that require approval of the Norwegian plan and the building authority(Direktoratet for Byggekvalitet, 2017)

6.4 Empirically Grounded Challenges for EPD as a Mobilizer

Although the most significant weaknesses for low-emission silicon to achieve lasting competitive advantage are associated with the perceived value of the resource to appropriate the potential value, there are some challenges directly related to the use of EPD, which limits the optimal mobilization of the resource. The empirical findings show tendencies of challenges related to EPD and its ability to mobilize materials as a resource in an organization. In addition, it shows these empirical findings on how contractors handle the EPDs and how the choice of method affects the actual value of the materials.

6.4.1 Too Few EPDs

The empirical research in this study, supported by previous research in section 2.4, points to a significant increase in the number of EPDs. However, there are still product categories where there are an insufficient number of EPDs. For the public contractors, this creates problems because they cannot give anybody a monopoly situation. This means that they can not set requirements for EPDs in their procurement falsifications if less than three suppliers can offer this information. This will directly impact REC Solar, as there, at this moment, are no other suppliers who have developed EPDs for their product.

The manufacturers may not want to develop EPDs because it is resource-intensive and expensive to develop EPDs. Previous research refers to the fact that this applies especially to the smaller companies, where the in-house competence is insufficient(Fet et al., 2009; Ibáñez-Forés et al., 2016). For this reason, in most cases, there will be a need for external expertise to carry out the life cycle calculations. Moreover, as Manzini et al. (2006) claimed, the development of EPDs will have little attractiveness for the manufacturer if the cost exceeds the positive effects.

6.4.2 The Focus on the Major Contributors

When developing new buildings, it is common to use a reference building, which covers the minimum requirements of TEK17, as a comparison basis for the design of the new building. In these cases, greenhouse gas accounting is used to ensure that the

requirements defined by the client are fulfilled. Emission requirements and reference values are often determined for materials such as concrete, steel, and insulation through internal environmental follow-up plans. The determination is defended by these materials having the highest emissions and are used in a significant quantity and will therefore significantly impact the overall greenhouse gas accounts. However, it is essential to mention that if the material satisfies the determined reference values, the most affordable alternative will be chosen in the vast majority of procurements.

It is mainly understandable that the purchasing organizations focus on the main drivers of environmental impacts, as they have the most significant influence on the overall accounts. Nevertheless, manufacturers who supply other products and work to minimize their environmental impact are not rewarded.

Several informants claimed that it is relatively common to use standard values or table values of emissions for materials without accompanying EPDs. Since there are only a few EPDs for silicon and solar cells, it will be natural to use generated values. If the table values are significantly higher than the actual value, it will negatively impact the overall greenhouse gas accounts and further on the material assessment. Since solar cells are not a necessary material in a building, these generated values may be neglected in procurement decisions to keep the overall accounts within the reference values.

6.4.3 Lack of competence in the industry

Suppliers and contractors respectively claim and confess that the general competence regarding EPDs and their utilization of it is insufficient. As mentioned in section 4.3.2, this study initially aimed to address the purchasing managers' experiences related to the utilization of EPDs. However, it turned out that the experience and knowledge were low among buyers, leading to the interviews being conducted with employees within the companies' environmental departments. Several of the studied contractor companies admit that the competence regarding EPDs is low among the procurement division, which resulted in the assessments of EPDs often being forwarded to environmental advisers or others with the needed competence. This will, therefore, affect the resource's mobilization as it creates additional work for the environmental department and potentially disrupts the procurement process.

6.5 Incentives for Sustainable Procurement

The finding, presented in table 4 illustrated that the current regulations do not stimulate the incentives to engage in sustainable business development. Current policies require environmental documentation to be collected and controlled - they do not create incentives to base procurement evaluations on environmental impact. This directly impacts the utilization of environmentally sustainable products through EPD as a competitive advantage. Eventually, according to this thesis's empirical findings, it will indirectly affect eco-efficiency, as today's main focus in the Norwegian Construction Industry is profit maximization.

Direktoratet for Byggekvalitet (n.d.) states that 50% of all emissions in the construction industry occur from the production and transport of materials to the construction site, which in itself is a significant part when the construction industry globally, accounts for 40% of the total emissions in the world. If it is desirable to reduce the climate impact from material procurement, then there is a need for further incentives to make sounder decisions.

Figure 2, shows the structure of the construction industry. This figure can also be understood as a value chain to a large extent, where all the components are intended to contribute through value creation to reach the client's specific objectives. According to Cerin and Karlson (2002) laws and regulations, customer demand and the influence of environmental interest groups contribute to the most important incentives to reduce climate impact. Their impact on the value chain is highlighted in fig. 16. The figure illustrates how the construction client's stakeholders influence its value proposition to build sustainably, which will create ripple effects down the value chain, as all the components of the value chain work towards the targets defined by the construction client.

The mentioned challenges in table 4 can be significantly minimized by using the right incentives. To a large extent, laws will have the most excellent effect on creating incentives for a more sustainable industry because they must be complied with regardless. Nevertheless, other opportunities exist to develop incentives to contribute to sustainability beyond laws. As listed in table 4, one of the challenges for more sustainable procurement in the industry is the focus on supplier costs. With

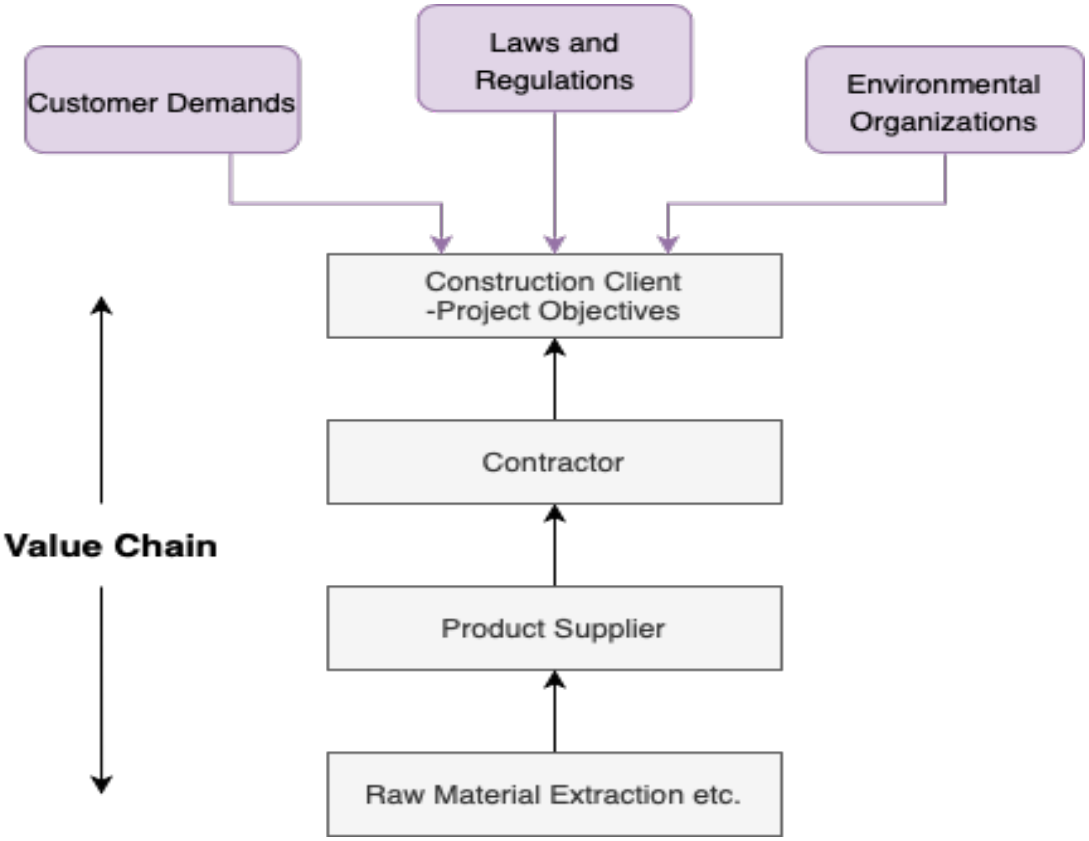


Figure 16: An elaboration of incentives' impact on the value chain in the construction industry

regulations from authorities that financially reward construction clients who build with low climate impact or penalize those clients with high climate impact, it will be possible to create incentives to build more sustainably, which will eventually lead to more sustainable material procurements. Customer demand will also affect these challenges; if all customers demand the product with the most negligible climate impact, it is a driver for a "green competition". Further, it would potentially affect the issue according to too few EPDs. More corporations will notice the possibility of profitability by developing EPDs and becoming more sustainable to create a competitive advantage. Hence, benefits will exceed the costs (Manzini et al., 2006). Ultimately, the construction client's value perception will contribute to greater competition among the contractors' procurement's manufacturers, as the clients define the project's framework and requirements.

6.6 Limitations of Empirical Study

The framework of this project was established in the spring of 2021. For this reason, the stated emission values for REC Solar are potentially somewhat lower than they will be after the energy exchange with Europe through the Acer agreement. This thesis has not assessed how this agreement will affect Norway's energy mix.

As earlier presented, the developed PCRs for solar panels, referred to in this thesis, are intended for use in the building and construction industry. There are, at this point, a limited number of EPDs for processed silicon and in the solar industry in general. In addition, it was early in the research discovered that the use of EPD is somewhat reserved for the building and construction industry. Therefore, it has been necessary to equate the panels with building materials. Equating them makes it somewhat challenging to include and evaluate probably the most positive feature of the panels, which is to generate electricity. The empirical study in this thesis focuses on materials in general and if buyers evaluate the EPD's content. In order to limit the scope of the thesis and answer the research questions, it has been necessary only to study the emission characteristics of various materials and how it affects the customer. Then analyze the findings and transfer the accumulated knowledge to solar panels as a material. Therefore, it has not been considered what ripple effects the energy generation will entail. Using solar panels in buildings will function as a material described in the thesis and supply the organization with electricity that can provide cost benefits in the long run and a decreased need for energy supplementation. Similar assessments have not been directly included in the considerations but should be considered in further research.

The interviews prove that the utilization of EPDs is primarily project-dependent. For this reason, all respondents used EPDs in the projects where there were fundamental requirements for environmental documentation or emission reduction targets. Nevertheless, some of the companies had stricter internal requirements than others. The evaluation process turned out to be different in all contexts. Some had prepared role distributions, while others did not have such direct distributions. However, the common denominator was that none used a decision-making system. There was a large consensus among the companies regarding the challenges and future prospects.

Several companies in the industry have been investigated to retrieve the experiences related to the studied phenomenon. However, an advantageous measure of this study would be to interview a broader span of organizations in the qualitative part. The selection has been centralized around large firms with significant quantities of resources. Such large organizations are often leading within sustainability and innovation. Although they have relevant knowledge, which can be the standard in the future, they may not represent how the majority operates at this point. However, they accompany and influence the path toward long-term value creation. Hence, the results gathered in the thesis may be somehow affected by this, and the information regarding the organization's environmental work gathered from the interview may be perceived as more developed than reality dictates.

In the quantitative survey of EPD owners, a significant portion of respondents chose "I do not know" as their answer, which can indicate an issue with the given questions. The accumulated experience related to business management throughout this research indicates that most EPD owners do not have sufficient knowledge related to the organization's sales process. Hence, the specified population will not be optimally representative of this question(Robinson & Leonard, 2018). In addition, it would possibly have been more advantageous if the alternatives in the Likert-Type Item-questions, like fig. 13, had been specified more clearly with explicit examples of what they represent. If the research period had lasted over a more extended period, it would have been advantageous to conduct a pilot study with a limited number of respondents. In retrospect, it would have been appropriate to program the survey so that those who answered “no” or “I do not know” did not receive follow-up questions.

The responses from the quantitative results show that several companies have achieved positive results in tender rounds related to the development of EPD. The qualitative results show that EPDs are most often utilized for procurements related to the materials with the most significant climate impact. This may be because the contractors, to a large extent, demand EPDs for the mentioned materials, causing the manufacturers of these materials to have good experiences with EPDs. This response might have been different if the study had disregarded the suppliers of the mentioned materials.

Furthermore, the empirical study is based on a general collection of information on low-emission products that provides competitive advantages. It is somewhat impossible to answer whether there are equal prerequisites for low-emission-produced silicon based on the study. However, the study indicates specific trends, making it possible to draw parallels to solar cells as a building material.

The selected literature related to VRIO and Resource Management has the potential to be relevant for manufacturers offering products to the Norwegian construction industry using a similar energy mix and a production with lower emissions than their competitors. The study's empirical data are related to generalized experiences and may be relevant to the same materials. However, low-emission concrete, steel, and insulation manufacturers may experience several benefits.

7 Conclusions

The research shows that utilizing EPD can help REC Solar mobilize low-emission silicon as a resource. According to the VRIO framework, REC Solar and its low-emission silicon have a potential for competitive advantage. However, the empirical findings show that the conditions are not facilitated to achieve lasting competitive advantage. In general, the content of the EPD influences the buyer's choice primarily if the price of two competing products is equal. The perceived value of the low-emission products is currently not adequate for the buyer to prioritize low emissions above price.

As the product price and the perceived value are incompatible, the silicon resource is not considered appropriated according to the theory. The value of the low-emission silicon is, at this point, only a potential value. To appropriate the value, the organizations rely on an increased number and more explicit incentive systems, like industrial and governmental regulations. Incentives that generate higher value for sustainable products and services should provoke organizations that make sustainable and environmentally sustainable choices to gain financial profits. Thus may, the total value of the low-emission silicon be sufficient to achieve a lasting competitive advantage. However, at this point, the low-emission silicon resource does not fulfill all of the requirements in the framework, and therefore, does not holds a lasting competitive advantage.

Overall, an EPD highlights the properties of low-emission silicon as being more environmentally sustainable and makes it easier for the resource to be discovered and utilized by environmentally conscious companies that choose materials based on emission values. According to the selected theoretical framework in this thesis, an EPD may affect REC Solars' competitiveness by mobilizing and facilitating the appropriation of their low-emission silicon.

7.1 Recommendations

As material procurement accounts for a large part of the emissions from the Norwegian construction industry, there is great potential in this part of the value chain to reduce the climate impact contribution. For this to be possible, policymakers must establish stricter laws and regulations to support sustainable procurement. Furthermore, incentives must be generated to promote sustainable solutions. The responsibility lies with politicians, industry leaders, and contractors to create these incentives by rewarding low emission products and demand a more sustainable focus from the construction client.

The contractors are responsible for ensuring that the evaluation of their procurements is executed in the best sustainable way, which requires that they acquire sufficient competence related to environmental declarations. Furthermore, it is recommended to establish systems that can objectively assess environmental impact according to the price.

Producers have a responsibility to provide accurate information and collaborate with subcontractors to develop EPDs that address the entire life cycle of their products. From an industrial perspective, it is appropriate that there are several EPDs. For this reason, minority companies should receive support to develop EPDs.

Finally, it is recommended to improve the digital solutions, to simplify the acquisition and use of EPDs in BIM modeling tools to ensure seamlessness. In addition, the harmonization of declaration standards and PCRs must be further improved.

7.2 Further Research

Society is constantly changing, leading to developments in value perception. The thesis findings have confirmed that climate impact documentation will be necessary for the years ahead. For this reason, it may be beneficial to continue to monitor the situation in the construction industry.

As mentioned in section 4.1, the thesis is based on the Norwegian market. Norway is not REC Solar's primary market, and the results may differ in other countries or markets. However, there is reason to believe that there will be some similarities in different markets. Further research related to the global market will therefore be beneficial.

It may also be advantageous to study how the use of environmental declarations can be increased. Moreover, what specific incentives are needed to support increased competitiveness for low-emission materials in the Norwegian construction industry.

Furthermore, it may be valuable to investigate how to increase the seamlessness in the use of declarations and whether consideration should be given to simplifying the information or possibly increasing the perceived understanding of the documentation.

It is worth to highlight the importance of more industries applying environmental declarations to map and minimize their climate impact. For further research, it may be important to study how EPDs can be used in other industries as a tool to reach sustainability.

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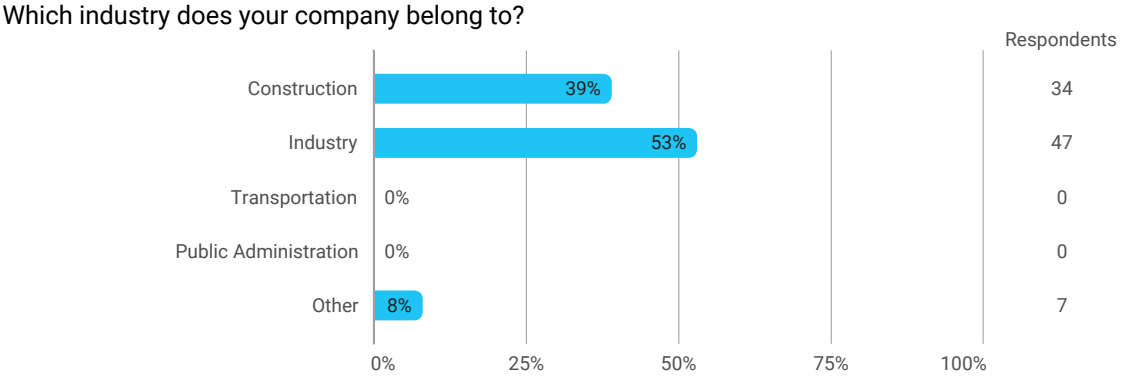
Appendix

A Survey

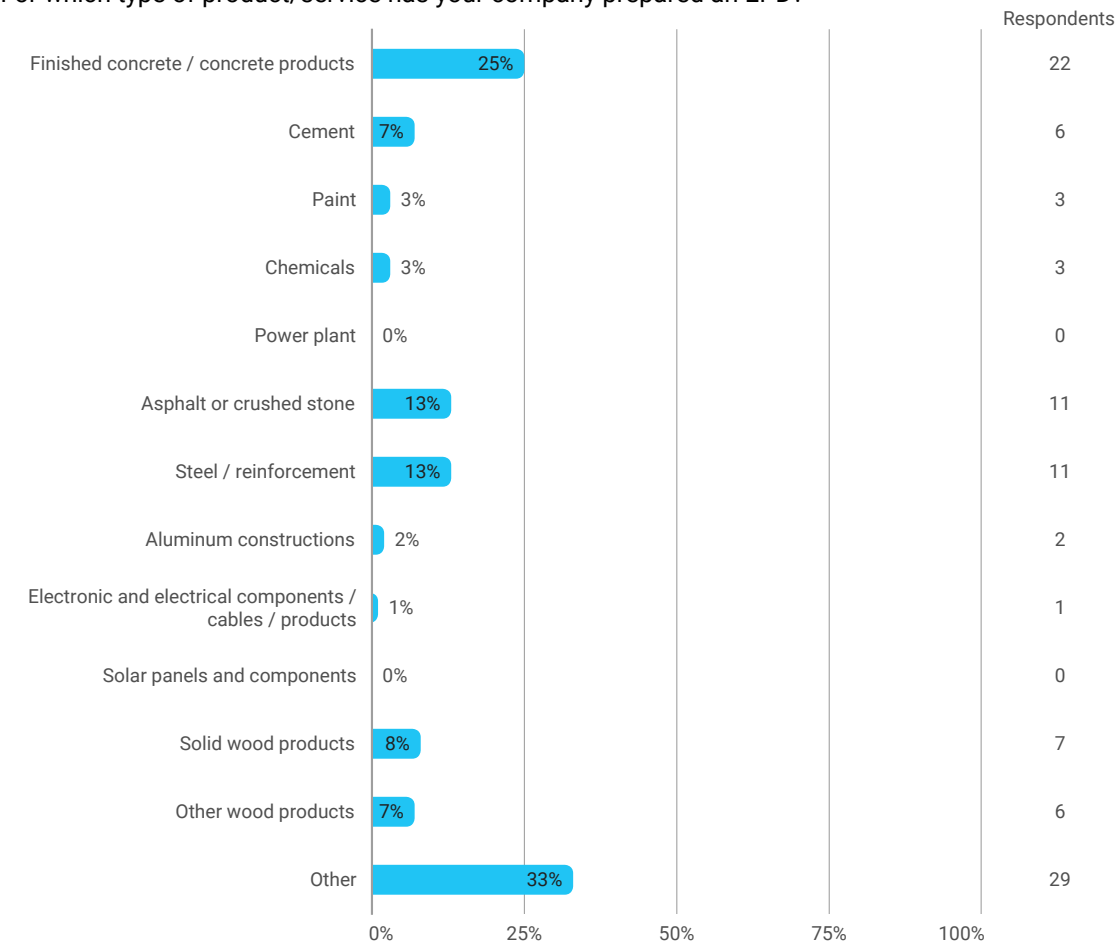
Which industry does your company belong to?



Which industry does your company belong to? - Other

- Windows production
- quarry
- Bergverk
- Producer of construction materials
- Extraction raw materials
- Bygg og Anlegg og Betongproduksjon
- Produksjon og transport av ferdigbetong

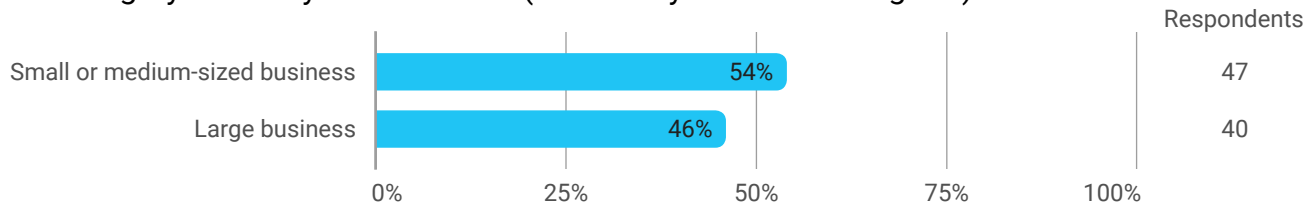
For which type of product/service has your company prepared an EPD?



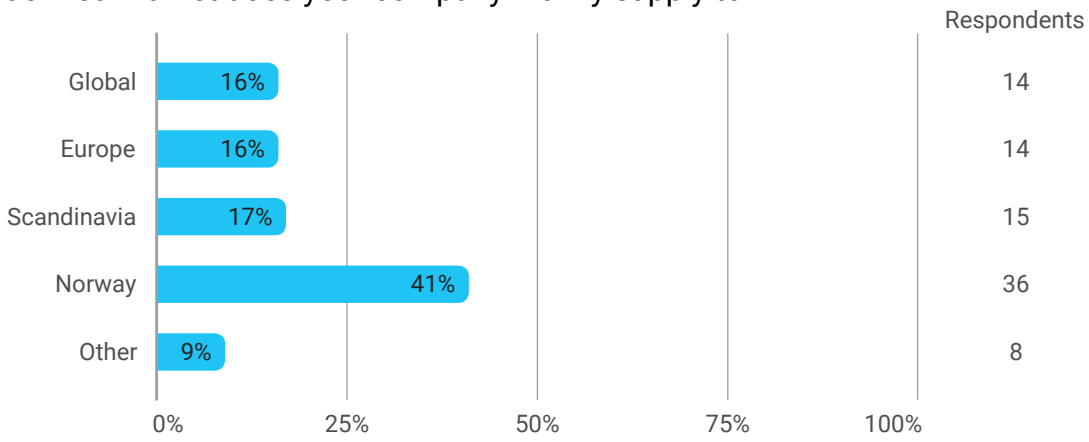
For which type of product/service has your company prepared an EPD? - Other

- Rock security
- Vapor barriere
- Insulation, EPS,XPS
- Interior glass partitions
- non metallic non corroding reinforcement
- Sportsflooring
- Concrete
- Production of cladding panels
- Tilslag og tørrmørtel
- Pipes and fittings
- Tactile indicators
- Windows
- valvolame
- Valves
- Mineral Wool (Insulation)
- Aluminium semi products (slabs, Extrusion Ingot, Primary Foundry Alloys, Wire rod
- EPS (expandable polystyrene).
- Insulated panels
- Granite
- Aggregates
- Plastic film product
- both blocks and lightweight aggregate
- Insulation
- Primary Aluminium Foundry Alloys
- Aluminium materials (before processig to constructions)
- Betong
- GRP pipes
- Asfalt takmembraner, vindsperrer
- Aggregates.

What size category defines your business? (Defined by the Accounting Act)



Which geographically defined market does your company mainly supply to?

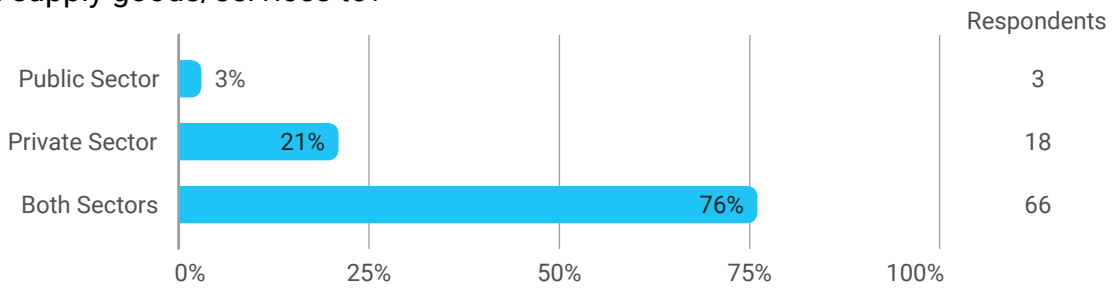


Which geographically defined market does your company mainly supply to? - Other

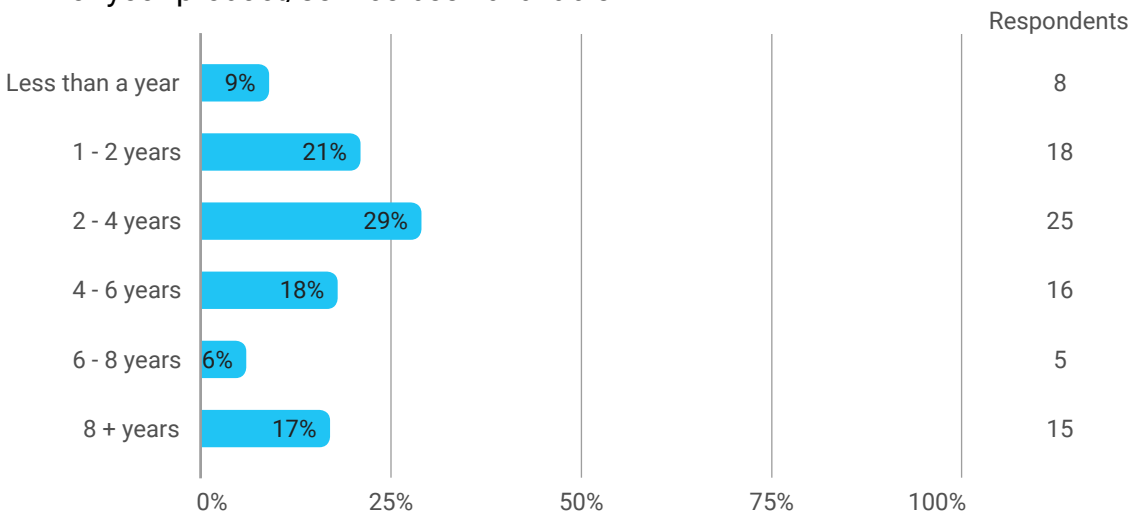
- Denmark
- Iceland, Faroe Islands
- Sweden

- Sweden
- Iceland
- Sweden
- Møre og Romsdal
- Lokalt

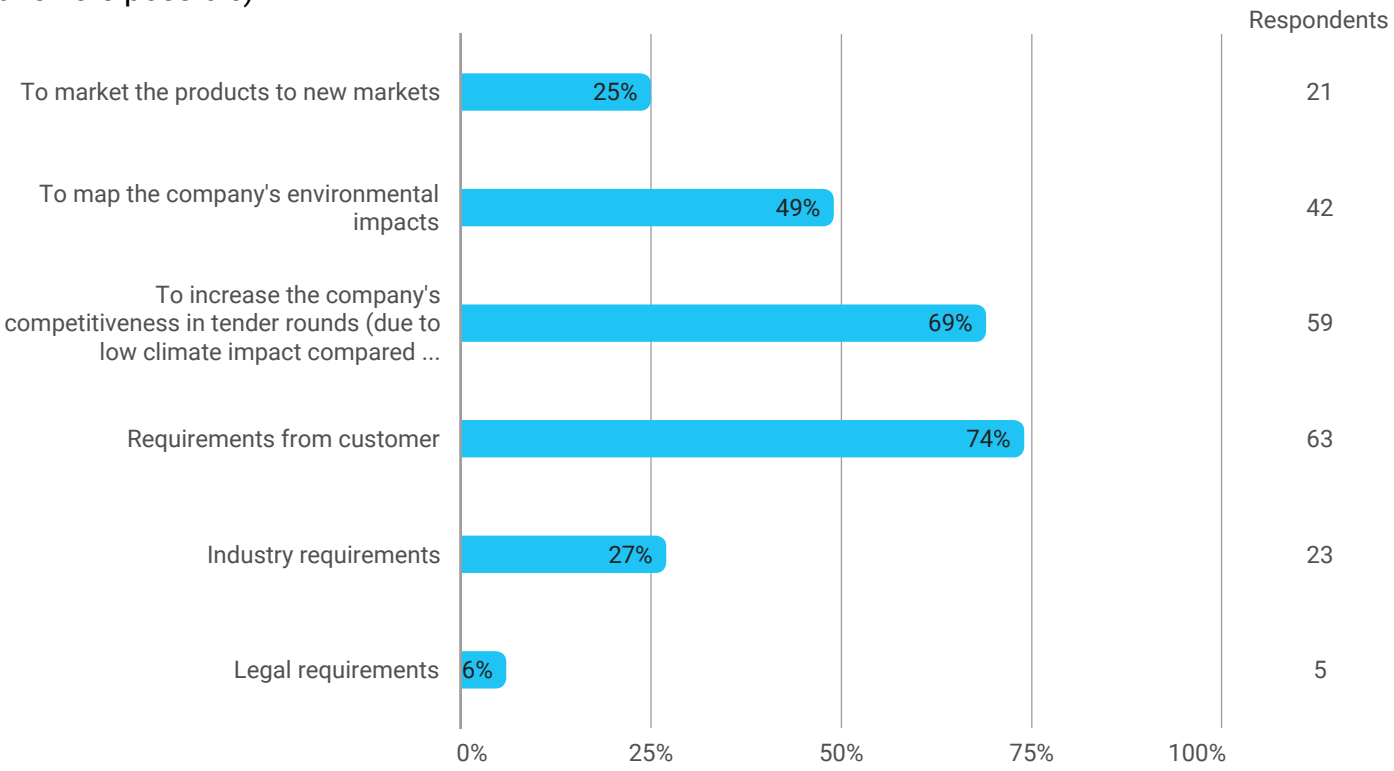
Which sector do you supply goods/services to?



How long has the EPD for your product/service been available?



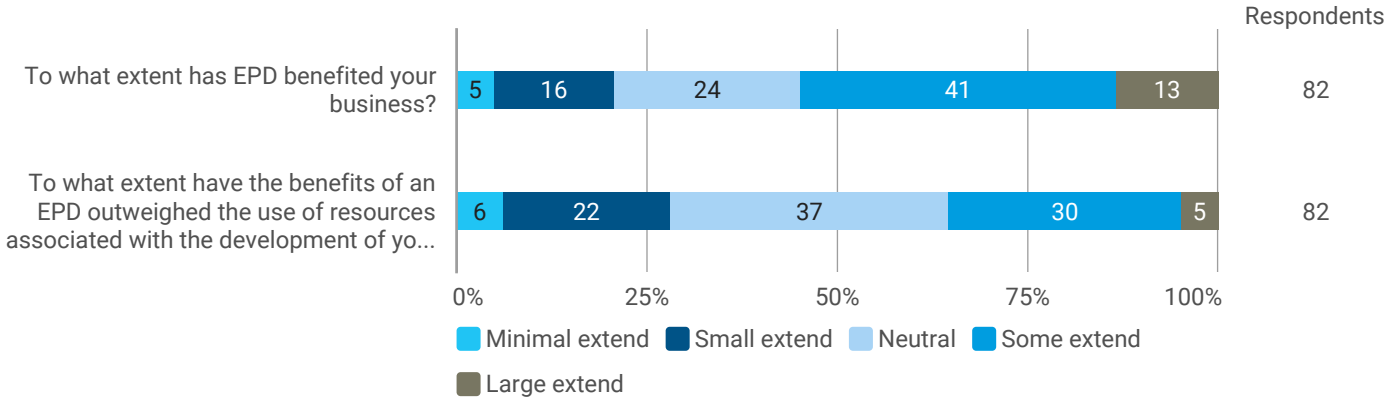
What were the main reasons for developing EPD for your company's product/service? (Multiple answers possible)



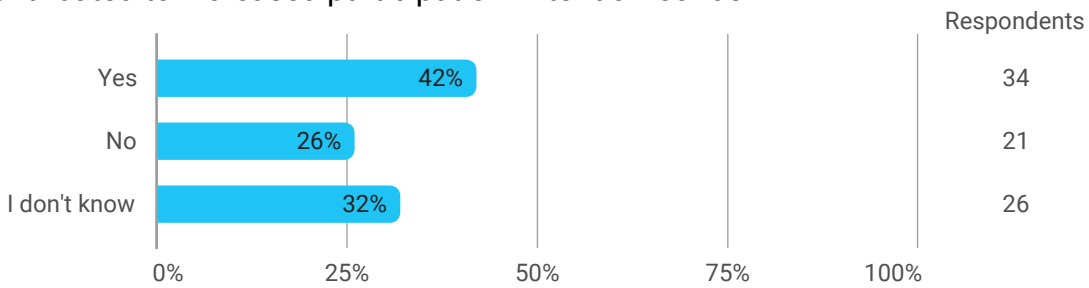
Other reasons? (If no - type No)

- No
- No
- No
- No
- No
- En del av bedriftens bærekraftarbeid
- En del av bedriftens bærekraftarbeid
- no
- No
- New Climate declaration
- No
- No
- No
- To increase competitiveness
- No
- no
- No
- No
- No
- no
- No
- No
- No
- no
- x
- Også krav fra kunde
- NO
- no
- no
- No
- The environmental strategy for the company
- No
- no
- no
- No
- no
- No
- No
- Because the company is sincerely dedicated in a continous aim in improving its impact on the envioronment.
- No
- No
- No
- No
- NO
- No
- To certify our products CO2 footprint by a 3rd party
- nei
- No
- no
- No
- No
- No
- No
- No
- no
- no

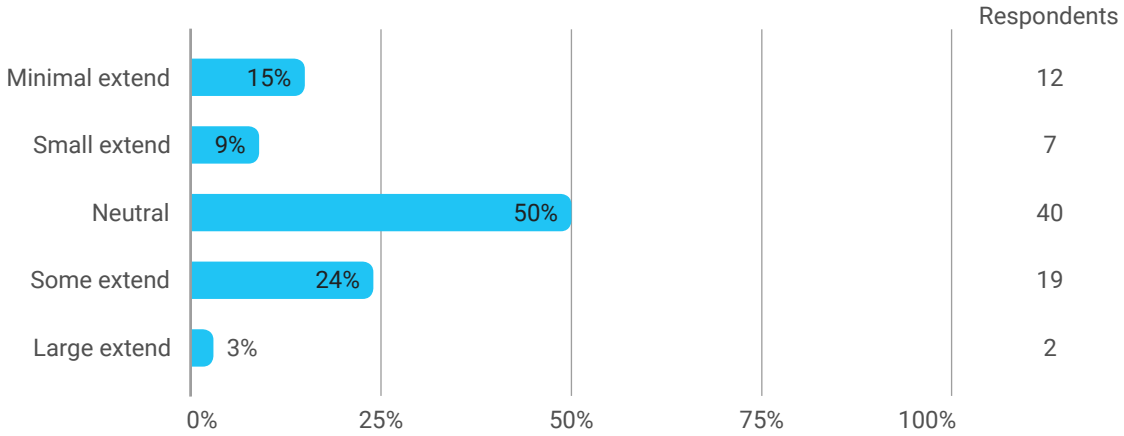
- No
- no
- No
- no
- no
- No
- NO
- competitors had EPDs..
- No
- No
- no
- no
- no
- no
- Requirements from customer
- Nei
- No
- No
- No
- no
- To set a new standard among suppliers of sustainable materials
- Nei
- To be prepared for legislation change
- Nei
- No
- No
- No



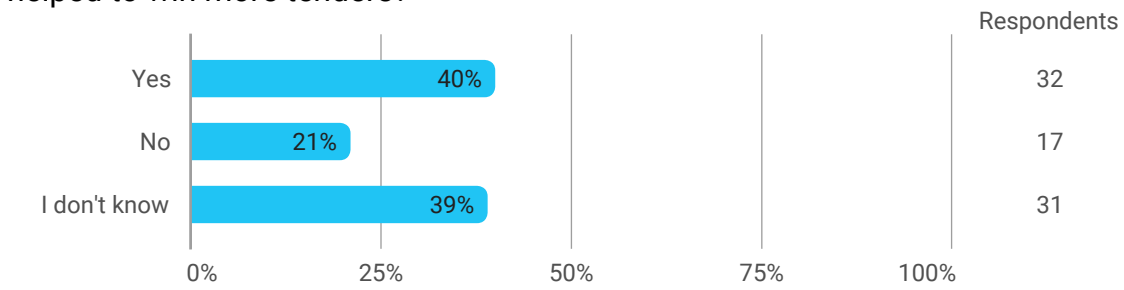
Has the use of EPD contributed to increased participation in tender rounds?



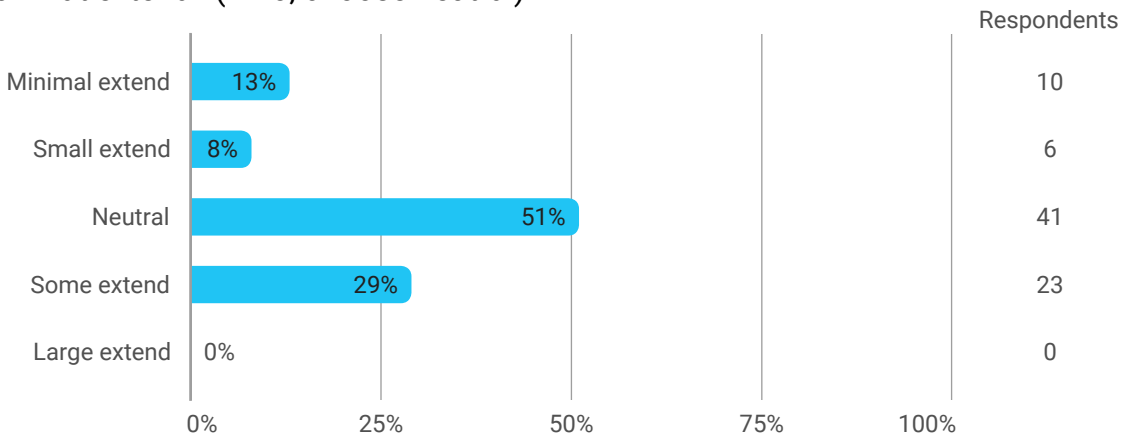
If answered yes - To what extend? (If no, choose neutral)



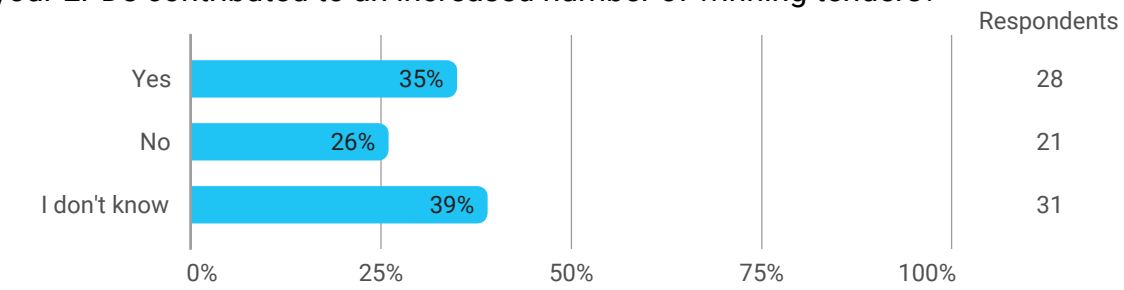
Has the use of EPD helped to win more tenders?



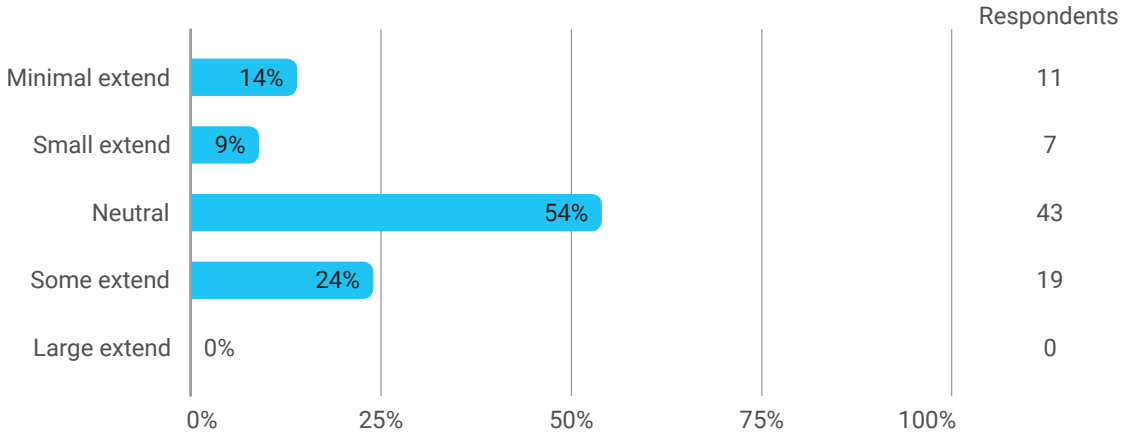
If answered yes - To what extend? (If no, choose neutral)



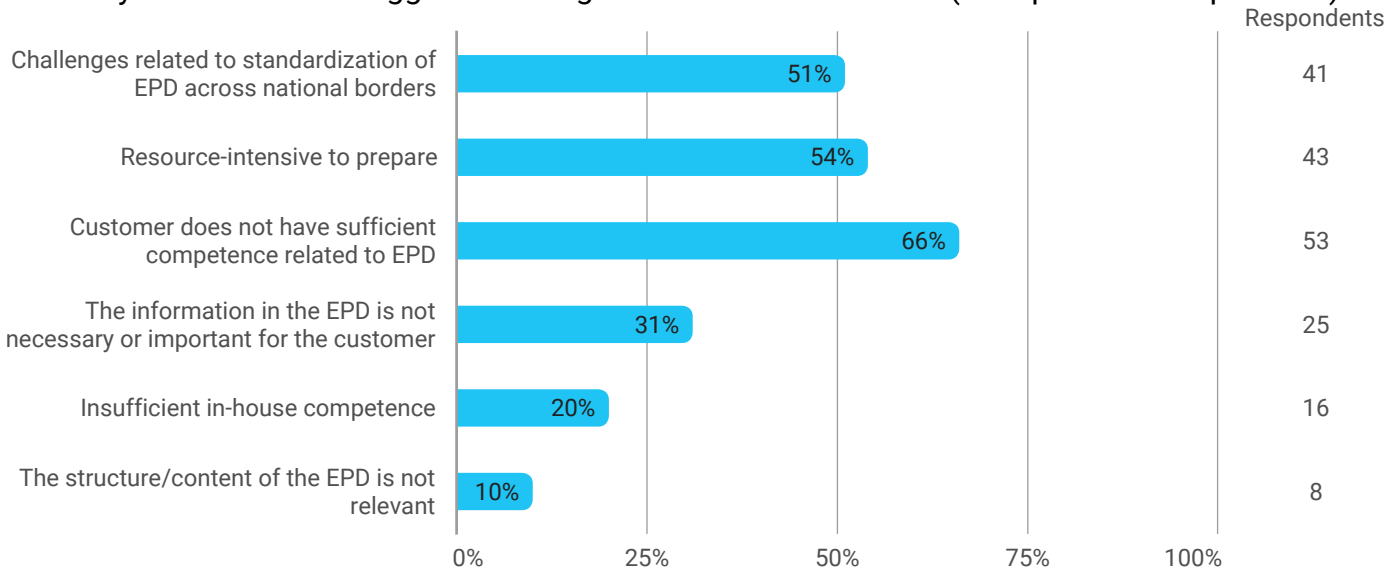
Have the values in your EPDs contributed to an increased number of winning tenders?



If answered yes - To what extend? (If no, choose neutral)



What do you think are the biggest challenges associated with EPD? (Multiple answers possible)



Other challenges? (If no - type No)

- No
- To expensive
- For noen av prosessene våre så er det et nybrotts arbeid, PCR`n er ikke tilpasset enda. Dette gjelder vasking og knusing av rene, og forurensede masser.
- PCR and calculation to individual product/size
- No
- For få tilgjengelige EPD fra stålverk
- no
- No
- Make sure that standardization is reached
- No
- Price is more important
- no
- Private contractors try to avoid the presence of EPD in specifications in order to get multiple offers to choose from
- No
- Getting EPD from sppliers
- No
- No standard on product type. e.g. some report tonnes, some m3 and some m3.
- No
- no
- no
- No
- No
- x
- Nei

- No
- no
- no
- no
- No
- NO
- no
- no
- No
- It is a form of self declaration by the manufacturer. Many of the input values are impossible for the verificator to check/verify
- There is a lot of "talk" regarding EPD in the Norwegian market, but little action. Even though there are many BREEAM-NOR prosjects and some government projects which specify materials with EPD, I experience that products without EPD are choosen if there are monetary gains.
- EPD need to be a demand from the authorities and weigh specific criterias against price.
- No
- No
- No
- NO
- The industry uses different PCR
- Difficult to read and understand the data in an EPD. EPD is based on historically data, new updates needed each time you do improvements of footprint
- nei
- No
- no
- No
- No
- No
- EPD is expensive for to companies.
- No
- no
- no
- No
- Customers seem to think that an EPD is synonymous with less environmental impact - they don't understand that it's only raw information...
- No
- no
- no
- No
- No
- difficult to compare based on different levels of Declared Unit
- No
- No
- no
- no
- Standardization / control in maket. Based on trust.
- Expensive to develop and not accurate enough (when you make Eco products based on the EPDs)..
- Customer does not have sufficient competence related to EPD
- nei
- no
- No
- No
- no
- greenwashing - epd rules are not strong enough
- Nei
- The process not transparent enough. We saw cases of EPDs from our competitors presenting unreal/misleading results
- Nei

- No
- no
- Customer choose the price before the CO2.

What measures do you think are needed for EPD to reach its potential to reduce environmental impact?

- kg Co2/ton for each material used.
- Way lower the cost.
- Sterkere krav fra myndigheter, byggherrer og kunder til leverandører.
  Kompetanse økning rundt verdiene i EPD`n ikke bare fokus på GWP.
- Standards
- a
- - Økt kunnskap om EPD, og endret fokus, hos kunder.
  - Breeam må akseptere alle moduler i en EPD.
  - Tilstrekkelig kompetanse hos de som verifiserer EPD,
  kontroll med at EPD inneholder korrekt informasjon.
  - At flere krever EPD fra sine oppdragsgivere.
- no answer
- I don't know
- Globally the UN SDGs are important and will be reflected in Regional and national legislation e.g. EU Green Deal.
- Legal requirement
- The EPD is often used to compare CO2 on a kg per kg basis of two competing materials. e.g. Steel versus Basalt Fiber Reinforcement. the wholistic approach allows the clever engineer to design out excess concrete to lower CO2 in concrete needed, steel eliminated and reinforcement from basalt added in resulting in a net reduction in costs, time and CO2 etc. so a wholistic approach is needed
- A broader awareness for the contents and general willingness to specify and in the end to follow up where EPD is actually specified. Although environment is in focus most building contractors will do what they can to choose the cheapest products as they have no personal interest in the endproduct only the most profitable "bottom-line".
- Make it easier to develop and to make it mandatory for all purchasing processes.
- You need to agree on limits for some important data
- More understandig of the customer
- There need to be a europeean og national labeling on products similar to what is applied on electronics.
- Digital EPD.
- Visualization
- GWP data
- Requirements in tenders
- Use of consequential EPD instead of attributional
- Clear regulations and equal requirements to avoid opportunities for green washing.
- Ingen kommentar
- Regulations
- Must be easier to
  make an EPD
  "read" an EPD
  compare EPD's with each other
- vet ikke
- less average numbers input, more actual
- Increased competence among purchasers
  An legal obligation to demand EPDs in public tenders
- Set EPD as an claim.
- I don't know
- Easier and cheaper to develop.
  Easier to read and intrepret the result
- ?
- An increase of specification for use of material with EPD. In Norway there should be a specification of EPD from epd-norge, due to the extra requirements. A EPD should not be considered to be a final document, it must be treated by the owner as a ongoing process to improve the impact from the manufacturer. For the market in general, there must be more awareness to the document and its reason for being.

- This is not my expertice.
- More træning for all sides (them who prepare them but also them who use them).

  Maybe a more unique way to prepare them.
- Keep it simple !
  Make comparison easy for everyone !
- -
- a requirement in the industry
- More clear and rigid rules in order to make the EPD's comparable.
  Less expensive. Many sites and products becomes a huge cost.
- Updates of data must be much easier and faster (should be done annually)
  Common standard in Europe
  Do to cost often an EPD is created for a group of products. Should be possible to substract data for a single product within the group online.
- At det blir et absolutt krav om EPD
- Higher flexibility related to change of materials and distance to the different prosjectsites.
- Mandatory demands from regulations and better knowledge within the business(specific demands on construction for durability/strength, less overengineering. Knowledge with buyers of finished office/housing projects since environmental impact does not affect price at a great rate but adds value and "goodwill")
- - Same set of rules
  - Make sure credits are not calculated many times in the value chains
  - Same rules for embodied carbon in every material
- Clearer guidelines when preparing an EPD.
- Needed international consensus of how to compare different materials in LCA analysis
- EPD must be easier and cheaper to produce. Not all companies have the resources or resources to do this.
- It must be easier to prepare and read EPD's.
- CO2 eq
  re-use
  renewable
- The customers need to not only demand an EPD but also use the data and actually compare. It needs to be driven from the purchaser of the material. Public sector is and should be fore runners.
- EPD does not take into account all of the enviromental "potental" of products.

  An example of this would be how do you quantify how resyclable a product is. At best you can make some general assumptions. For granite this is one of the key enviromental advantages. The product is ever lasting. And the product does not detorite neither visually or functionally. Yet this is almost impossible to quantify.

  The issue with EPD is simpy that it is an attempt at quantifying the real world in fairly simple terms. This is impossible. At its current state i would not trust the results of an EPD alone to give me the information i need to compare the enviromental impact of products.
- Make it even more clear on the EPD front page (or similar) that (if...) the EPD is approved and scrutinized by an international organization so that the user knows that it is comparable to other EPD:s.

  Make it compulsory in public procurement.
- Vekting av utslipp - CO2
- .
- Overview table that shows the rank of the EPD compared to same products in the same product category and maybe also top 3-5 with the best environmental impact.
- Ok for the moment
- Adoption by more countries all over the world
- .
- Force separation of biogenic carbon from GWP and allow certified energy sources (not only physical deliveries)
- Demands in Standards in Tender-fase
- ?
- make EPDs comparable within a product group
- Easier to make

- The possibility to make product spesific EPDs, the make sure theese can be attached to offers and projects.
- Do not know
- Usikker
- GWP
- It has to become mandatory for most of the products.
- ?
- The EPDs must be more standardised to be albe to compare between competitors
- Clear rules (PCR's) limitting green-washing
- Vet ikke
- EPDs should be required in all public tenders and contracts (especially in building sectors).
  They should be specific for products (no sector average or company average EPDs based on artificial or averaged formulation data).
  But in order to be as proposed above, the process (generation, publishing, etc) should be cheaper otherwise is limited to big market players only
- Økt kunnskap hos kunder. Mindre fokus på egen lønnsomhet ved å prestere på miljø, mer fokus på miljø og klima globalt
- ....
- n
- .

Do you have anything else to add to this survey? (If no - type No)

- No
- no
- Nei
- No time
- No
- Nei
- no
- no
- No
- No
- no
- No
- No
- No
- Good Luck with the project
- no
- No.
- No
- No
- No
- No
- No
- Nei
- No
- It is hard to compare EPD's from similar companies.
  There are a few guidelines but everybody can put in data, or leave out data after own interpretation. One company thinks specific data is important, the other thinks not. And then you get differences in the mentioned values and is one company "the best" because they did not mention important values, consciously or unconsciosly.
- no
- no
- No
- NO:)
- no
- NO
- No
- It may well be that my negative reaction and answers in this survey are due to my impatience. I instigated the process of the EPD within our organisation for two main reasons; it was a natural extension of the enviormental policy for Cimberio and, due to

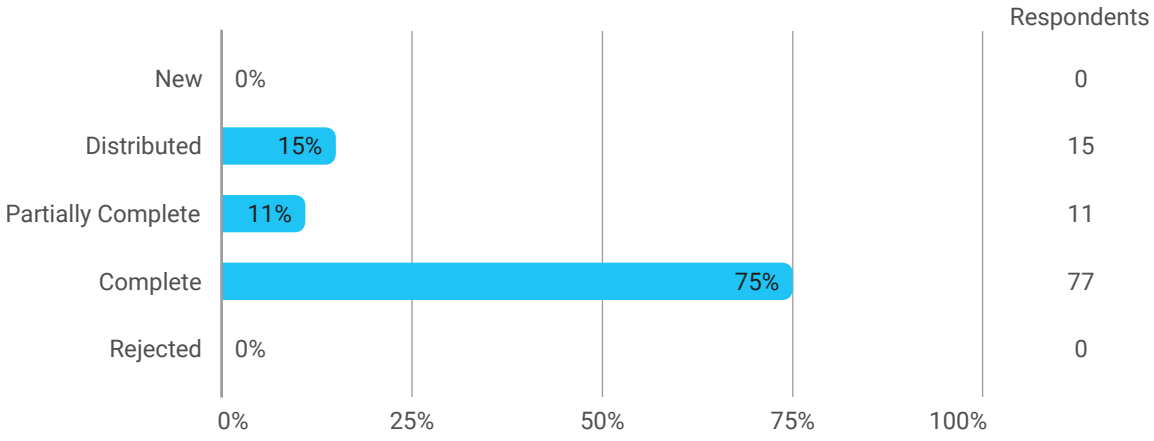
various published statements, there seemed to be a strong wish for an EPD for techincal HVAC products. So far little has changed. Is it too early, lack of awareness, "no-one" cares or just talk & more green-washing ? I add that I am happy that to learn of this Master Thesis, it will be interesting to see the result.

- How the EPD should be used by the end customer need to be very clear. It seems to be the lowest price still winning in the market.
- No
- No
- No
- no
- No.
- How to read and understand the data should be a part of the EPD (like help in Excel)
- nei
- No
- no
- No
- No
- No
- No
- It must be easier to prepare and read EPD's.
- no
- no
- No
- no
- No
- no
- no
- No
- No
- .
- No
- No
- no
- no
- no
- No
- no
- Nei
- NO
- No
- No
- no
- no
- Nei
- EPD presents plenty of various impact indicators. So far the market is only interested in carbon footprint. The number of scores presented is overwhelming.
  EPD should rather be presenting carbon footprint and some single score parameter (like Enviromental Cost Indicator - type of environmental penalty), to make it simple and understandable to all players. All other data should be available in electronic form from EPD program operators.

  We still struggle with EPD program operators not being all associated in just one association (like Eco Platform) and publishing all the data in commonly agreed form in one singe database.
- Nei
- No
- n
- no

E-mail

Overall Status



Which industry does your company belong to?

	Percent	Respondents
Total number of respondends		88
Total unanswered		15
Total number entered		103
Completion rate (CR)	85,4 %	
Response rate (RR)	32,6 %	

For which type of product/service has your company prepared an EPD?

	Percent	Respondents
Total number of respondends		88
Total unanswered		15
Total number entered		103
Completion rate (CR)	85,4 %	
Response rate (RR)	32,6 %	

What size category defines your business? (Defined by the Accounting Act)

	Percent	Respondents
Total number of respondends		87
Total unanswered		16
Total number entered		103
Completion rate (CR)	84,5 %	
Response rate (RR)	32,2 %	

Which geographically defined market does your company mainly supply to?

	Percent	Respondents
Total number of respondends		87
Total unanswered		16
Total number entered		103
Completion rate (CR)	84,5 %	
Response rate (RR)	32,2 %	

Which sector do you supply goods/services to?

	Percent	Respondents
Total number of respondends		87
Total unanswered		16
Total number entered		103
Completion rate (CR)	84,5 %	
Response rate (RR)	32,2 %	

How long has the EPD for your product/service been available?

	Percent	Respondents
Total number of respondends		87
Total unanswered		16
Total number entered		103
Completion rate (CR)	84,5 %	
Response rate (RR)	32,2 %	

What were the main reasons for developing EPD for your company's product/service? (Multiple answers possible)

	Percent	Respondents
Total number of respondends		85
Total unanswered		18
Total number entered		103
Completion rate (CR)	82,5 %	
Response rate (RR)	31,5 %	

To what extent has EPD benefited your business?

	Percent	Respondents
Total number of respondends		82
Total unanswered		21
Total number entered		103
Completion rate (CR)	79,6 %	
Response rate (RR)	30,4 %	

To what extent have the benefits of an EPD outweighed the use of resources associated with the development of your EPD?

	Percent	Respondents
Total number of respondends		82
Total unanswered		21
Total number entered		103
Completion rate (CR)	79,6 %	
Response rate (RR)	30,4 %	

Has the use of EPD contributed to increased participation in tender rounds?

	Percent	Respondents
Total number of respondends		81
Total unanswered		22
Total number entered		103
Completion rate (CR)	78,6 %	
Response rate (RR)	30,0 %	

If answered yes - To what extend? (If no, choose neutral)

	Percent	Respondents
Total number of respondends		80
Total unanswered		23
Total number entered		103
Completion rate (CR)	77,7 %	
Response rate (RR)	29,6 %	

Has the use of EPD helped to win more tenders?

	Percent	Respondents
Total number of respondends		80
Total unanswered		23
Total number entered		103
Completion rate (CR)	77,7 %	
Response rate (RR)	29,6 %	

If answered yes - To what extend? (If no, choose neutral)

	Percent	Respondents
Total number of respondends		80
Total unanswered		23
Total number entered		103
Completion rate (CR)	77,7 %	
Response rate (RR)	29,6 %	

Have the values in your EPDs contributed to an increased number of winning tenders?

	Percent	Respondents
Total number of respondends		80
Total unanswered		23
Total number entered		103
Completion rate (CR)	77,7 %	
Response rate (RR)	29,6 %	

If answered yes - To what extend? (If no, choose neutral)

	Percent	Respondents
Total number of respondends		80
Total unanswered		23
Total number entered		103
Completion rate (CR)	77,7 %	
Response rate (RR)	29,6 %	

What do you think are the biggest challenges associated with EPD? (Multiple answers possible)

	Percent	Respondents
Total number of respondends		80
Total unanswered		23
Total number entered		103
Completion rate (CR)	77,7 %	
Response rate (RR)	29,6 %	

B Interview

1. Er dere sertifisert, eller følger dere noen form miljøstyringssystem?
2. Hvilke retningslinjer har dere til miljødeklarasjon fra deres leverandører?
3. Er valget om å innhente EPD'er, eller andre miljødeklarasjoner, en del av en overordnet strategi, interne krav eller et miljøstyringssystem?
4. Hvordan behandler dere informasjonen som blir innhentet fra miljødeklarasjoner?
5. I hvilken grad vil innholdet i en EPD avgjøre om dere velger, eller velger bort, et produkt?
6. Hva anser dere som de største utfordringene knyttet til bruk av EPD ved innkjøp?
7. Er det noen reguleringer som i senere tid har ført til større føringer på anskaffelser av materialer? (f.eks.statlige krav, reguleringer, bransjekrav?)
8. Hva mener dere skal til for at miljødeklarasjoner kan påvirke deres innkjøpsvalg ytterligere?
    (a) Har dere noen tanker tilknyttet den kommende taksonomien, og om den eventuelt vil påvirke bruken av EPD på noen annen måte?

Master

UiA University of Agder