

Green Business Models: definitions, types, and life cycle analysis

MARYNA Z. SOLESVIK, MIRIELLE TORGERSEN, GUNNAR ANDERSSON,
PER VALTER

Abstract

Sustainability issues and green business thinking are steadily becoming more important in the strategies and daily life of small and large firms alike. In this study, we wish to contribute to an emerging field of research, namely green business models. More specifically, we have aimed to empirically test the efficiency of green business model implementation. Several aspects of green business modelling were considered. First, we have specified the definition of a green business model and shown the difference between green business models and several other types of sustainable business models. Second, using the multiple case study method, we explored green business model implementation by means of empirical data from five Norwegian SMEs. The firms that adopted green business models reduced their use of raw materials in favour of recycled materials, improved efficiency, increased the life cycle, reduced transportation length, and adopted other related measures. The results of the study demonstrated the importance of life cycle analysis (LCA) and life cycle thinking when companies select and implement green business models in their firms. The utilisation of LCA allows companies to avoid greenwashing and implement green business models more effectively. Thus, firms both achieve environmental goals and reduce economic costs.

Key words

Green business model, life cycle analysis (LCA), green business, definitions, case study

DOI: 10.23762/FSO_VOL10_NO4_10

Maryna Z. Solesvik¹
e-mail: mzs@hvl.no

Mirielle Torgersen^{1,2}
e-mail: mirielle.torgersen@hiof.no

Gunnar Andersson¹
e-mail: gunnar.andersson@hiof.no

Per Valter^{1,2}
e-mail: per.valter@hiof.no

¹Østfold University College, Norway

²Aarhus University, Herning, Denmark

Introduction

Green business is an increasingly popular concept that is attracting the attention of scholars and practitioners. The sceptical rhetoric of scholars in the 1990s, who

did not believe in the viability of more environmentally friendly business models (Newton and Harte, 1997), has given way to a more optimistic worldview of modern

academics (Trapp and Kanbach, 2021; Yi, 2014). Green business ideas are rooted in the concept of sustainability (Bruntland, 1987) that introduced environmental concerns into political debates, business life, and attracted significant attention from scholars (Alvarez-Risco et al., 2021). Since the publication of the Bruntland report, the number of publications related to sustainable and green business models has grown exponentially (Løkke et al., 2020). Policymakers stress the importance of green business and suggest that “green growth means fostering economic growth and development, while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies. To do this, it must catalyse investment and innovation which will underpin sustained growth and give rise to new economic opportunities for all in inclusive ways” (OECD, 2019: 4). The success of some industries in implementing green technologies and the introduction of green business models also motivates scholars to analyse the best practices of green leaders and find patterns of successful actions to best spread green business models to other industries as well.

The analysis of existing literature on green business models (GBM) shows that there is growing interest among scholars and practitioners in the field (Trapp and Kanbach, 2021). Though the number of publications is growing, there are still gaps in the knowledge related to green business models. Previous studies focused not only on green business models but on several types of so-called ecosystem business models (Westerlund et al., 2014). They sometimes use the notion of different ecosystem models interchangeably. This phenomenon has both positives and negatives. On the one hand, it allows one to gain insights from related research areas (Trapp and Kanbach, 2021); on the other hand, it blurs the focus on purely green business models and leads to more generic studies.

Our study was driven by two research questions:

RQ1. What are the differences between green business models and other types of ecosystem business models?

RQ2. How can an LCA-based approach be used to analyse and improve the performance of green business models?

The goal of the paper is to add to green business model research and to demonstrate how LCA methodology can be used to analyse existing green business models. This study makes several important contributions to the knowledge base. First, we distinguished green business models from other types of ecosystem business models. We summarised different ecosystem business models and showed the difference between them and GBMs. Second, we utilised an LCA-based approach to map green business models of Norwegian SMEs that have started to implement GBMs in their firms. The analysis can be useful for the revision and further development of green business models following a holistic approach to the whole life cycle.

The study will be interesting to policymakers, practitioners and scholars who seek to better understand the nuances of ecosystem business models, adopt green business models, or support the further implementation of green business models at the regional and national levels.

The paper is structured as follows. In the next section, we explain definitions related to green business models. Section three provides insights from the literature on the main concepts related to green business models and LCA. Furthermore, we introduce the research methodology. In the subsequent sections, we present and discuss the results of a case study analysis. The paper finishes with conclusions, avenues for further research, the limitations of the study and implications for theory and practice.

1. Definitions

1.1. Definitions of green business models

The discussion of business models has its roots in the 1990s and became part of the business lexicon during the dot-com era (Lindgren et al., 2010). There are numerous definitions of a business model, of which perhaps the simplest is that a “business model is a statement of how a firm will make money and sustain its profit stream over time” (Stewart and Zhao, 2000, 290). More sophisticated definitions suggest that a business model “... describes the design or architecture of the value creation, delivery, and capture mechanisms [a firm] employs. The essence of a business model is in defining how the enterprise delivers value to customers, entices customers to pay for value, and converts those payments to profit (Teece, 2010, 172)”.

Green business models are considered an intersection of two research areas, i.e. environmental sustainability and business models (Abuzeinab et al., 2014b). There is still no consensus in relation to the definition of a “green business model”. We have summarised the existing definitions of a GBM in Table 1. The definition offered by Trapp and Kanbach (2021) is used in our study as it reflects the improvement of the environmental performance throughout the value chain and suits the holistic view of the effect of the green business and life cycle assessment.

Green business model literature (Abuzeinab and Arif, 2014; Abuzeinab et al., 2017; Trapp and Kanbach, 2021) widely utilises components of GBM offered by Sommer (2012), e.g. (1) green value proposition, (2) target group, (3) key activities, (4) key resources, and (5) financial logic.

Table 1. Green business model definitions

Source	Definitions
Sommer, 2012, 106	“a business model that represents a significant improvement (discontinuous leap) in overall environmental performance relating to its entire value chain system vis-à-vis that of conventional business models (i.e. the reference case). This improvement is directly attributable to the business model through the alternative design and configuration of business model elements”.
Abuzeinab et al., 2014	“A business model is considered to be green when a business changes part(s) of its business model and thereby both captures economic value and provides environmental improvement”.
Al-Saleh and Mahroum, 2015, 263	“Green business models may be broadly defined as business plans which support the diffusion of products and services that offer an economically-viable environmental benefit”.
Trapp and Kanbach, 2021, 4	“GBM aims at creating value through offering high value products and services, while reducing costs and concurrently reducing harmful environmental impact”.

Source: own elaboration

1.2. Green business models vs other types of environmentally friendly business models

There are several business models closely related to green ones. Though they are all related to novel business models aimed at enhancing the sustainability of enterprises, there are certain differences among these models, and they reflect different

concepts. In Table 2, we have summarised the commonalities and differences of business models. Other types of environmentally friendly business models include the sustainable lean-green business model, the greentech business model, the circular business model, renewable energy business models, and the triple bottom line (3BL) business model.

Sustainable business models include three dimensions, i.e. environmental, social and economic (Prause, 2015). Some authors call sustainable business models triple bottom line business models (Khan et al., 2021), because the triple bottom line is the main theory of sustainability, and those triple bottoms are environmental, social, and economic pillars. Notably, all three vectors of sustainability are equally important. Sustainable development is similarly important for large and small firms (Šebestová and Sroka, 2020). Generally, environmental dimension is important in all the business models mentioned above. Furthermore, the social dimension of entrepreneurial activities (Shpak et al., 2017) contributes to the sustainable development of firms. Some studies imply that sustainability and corporate social responsibility (Sroka and Szántó, 2018) are related concepts, and they are often used as synonyms (van Marrewijk, 2003).

Circular business models are steadily being implemented more widely in European countries (Shpak et al., 2021). Circular business models imply the utilisation of previously utilised raw materials, i.e. the recycling of older materials in new production. The concept of the circular economy is a spin-off of the sustainability concept (Lewandowski, 2016).

Renewable energy business models are a special group of environmental business models in which renewable sources of energy (i.e. solar, wind, tidal, wave, hydropower, biofuel, etc.) are used in value creation. There are two types of renewable energy business models, namely customer-side renewable energy business models and utility-side renewable energy business models (Richter, 2012). In the first type of renewable energy business model, the renewable energy sources are situated on the customer's property. In the second, the energy sources are of larger scale and include large wind farms or large photovoltaic projects (Nimmons and Taylor, 2008; Scolaro and Kittner, 2022).

Other green business model spin-offs include the lean and green business model and greentech business models (Table 2). Notably, some authors use the terms 'green business models' and 'greentech business models' interchangeably (Trapp and Kanbach, 2021). Green business models reflect environmental aspects of business model innovation. Thus, it is advisable to use the term 'green business model' specifically when one researches a business or transforms it into a more environmentally friendly one.

Table 2. Green business models vs other types of environmentally friendly business models

Type	Definitions
Lean and green business model	<p>"The lean and green [business models] defined as new business models strategies implementations can be seen as new opportunities for business environment improvement. Lean and green strategies are often seen as compatible initiatives because of their joint focus on waste reduction, efficient use of resources and focus on satisfying customer needs" (Duarte and Cruz-Machado, 2013, 751-752).</p> <p>"The main objective of this paper is to propose a Lean and Green Business Model (L&GBM) where the environmental aspect of sustainability is added to the pure lean thinking concept in order to create a way of thinking that contributes to, and balances, the three sustainability dimensions of people, profit and planet (Elkington, 1997)".</p>

Type	Definitions
Greentech BM	"...an integrative approach that combines two well-established concepts in the academic literature for categorisation of greentech business models, specifically business model archetype and technological entrepreneurship activities" (Trapp and Kanbach, 2021, 5).
Sustainable BM	A sustainable business model is one "that creates competitive advantage through superior customer value and contributes to the sustainable development of the company and society" (Rantala et al., 2018: 48).
Triple bottom line (3BL) BM	3BL is defined as "strategic, transparent integration and achievement of an organisation's social, environmental, and economic goals for improving the performance of the individual company" (Schulz and Flanigal, 2016, 451).
Circular BM	"a business model in which the conceptual logic for value creation is based on utilising the economic value retained in products after use in the production of new offerings" (Linder and Williander, 2017, 183). "A circular value chain business model (or green business model) is one in which all intermediary outputs that have no further use in the value creating activities of the firms are monetised in the form of either cost reductions or revenue streams" (Roos, 2014, 257).
Renewable energy business models	A business model related to the utilisation of "solar photovoltaic, solar thermal, wind, tide, wave ocean solid and liquid biofuel, biogas, geothermal, renewable municipality waste and hydro-electricity" (Engelken et al., 2016).

Source: own elaboration

2. Insights from green business model literature

2.1 Motive for implementing GBM

The biggest motive for adopting green business models is the influence of public policies encouraging firms to "go green" and do business in a manner that protects the environment and reduces dangerous gas emissions (Fitzpatrick, 2019). Government support, on the one hand, provides subsidies and green mandates that makes it cheaper for companies to switch to using renewable sources of energy and implement greener solutions that otherwise would be too costly to businesses. On the other hand, the consciousness of entrepreneurs and business owners towards using new green business models has increased as a result of popular public debates encouraging businesses to "go green" (Nasser, 2021). Empirical data confirms that environmental benefits increase motivation to adopt a green business model (Nair and Paulose, 2014).

Furthermore, the gradual development of novel green technologies not only brings reputational benefits (FORA, 2010) to companies that adopt them, but also allows them to cut costs compared to using the existing alternative. For example, *MS Ampere*, the first all-electrical ferry in the world, built in Norway in 2015, was expensive and not especially beneficial to the shipping company (Sjötun, 2019). However, its development was beneficial to the entire ferry industry in Norway and globally, since subsequent models of ferries (which were modified and improved based on knowledge gained from the use of *MS Ampere*) were significantly less expensive and more powerful. Many shipping companies gradually implemented this alternative energy-based model into their businesses and achieved significant reductions in terms of cost and pollution. By the end of 2021, 60 fully electrical ferries already operated in Norwegian waters (Sæther and Moe, 2021).

Other benefits that green business models bring and thus positively influence companies' motivation to adopt them are related to value creation, i.e. enhanced performance, better design, lower price, value for money, using the result of the function rather than product, and newness of the eco-friendly product (Beltramello et al., 2013; Osterwalder et al., 2010).

2.2 Barriers to GBM implementation

Earlier studies have explored the barriers to the development and implementation of green business models (Abuzeinab et al., 2017). A study on the experiences of Scandinavian companies divided said barriers into contextual/institutional ones (i.e. regulatory constraints, deficiency of initial funding, low demand from customers for green products (Beltramello et al., 2013), and a shortage of infrastructure and efficient technology) and organisational ones (i.e. the incompatibility of the new green business with the existing business models, a lack of a sustainability mindset, and an absence of successful cases related to green business model adoption (FORA, 2012), lack of financial resources, deficiency of knowledge and human resources, and shortage of intellectual property rights (Beltramello et al., 2013)). Furthermore, a qualitative study based on interviews with managers of construction companies in the UK revealed five groups of barriers: (1) government barriers, (2) financial barriers, (3) sector constraints, (4) company barriers, and (5) low demand (Abuzeinab et al., 2017). Importantly, scholars detected a co-dependency between these barriers (Abuzeinab et al., 2017). For example, financial barriers were correlated with belonging to the construction sector.

To overcome financial barriers, managers use a variety of financial resources. Different green business models have different sources of funding, i.e. in-house resources, national and regional government grants and loans, supportive customers, venture capital

and angel investors, private equity, and bank loans (Beltramello et al., 2013). Without a doubt, many green businesses would not survive without government funding in the form of grants (Krämer and Herrndorf, 2012). A significant number of green businesses are built around radical innovations that are rather novel for firms and somewhat risky, even for large enterprises (Solesvik and Gulbrandsen, 2013).

Barriers related to a shortage of knowledge and skills to implement green business models are overcome in practice with the help of mainly in-house resources and training, interfirm collaboration, engaging experts, cooperation with universities and recruitment from higher educational institutions, international cooperation, contracting and recruiting, as well as mergers and acquisitions (Beltramello et al., 2013), and even cooperation with competitors (Cygler et al., 2018).

2.3 Types of green business models

There are several classifications and taxonomies of green business models offered in previous research depending on theoretical lenses that were utilised for the exploration of green business models. Sommer (2012) offered a taxonomy of green business models consisting of three types measured in terms of the degree of radical innovation of its environmental impact: Type 1 – incremental improvement (non-green business models), Type 2 – discontinuous improvement (GBM), Type 3 – strong sustainability (GBM).

Furthermore, Henriksen et al. (2012) divided green business models into incentive models and life-cycle models. The incentive models contain sales and service systems, for example water saving, energy saving, material saving, and other functional areas. The life-cycle models range from “cradle to cradle, take back management, green supply chain management, and industrial symbiosis” (Henriksen et al., 2012: 8).

Using four green business dimensions (i.e. maximise energy efficiency, maximise material efficiency, close resource loops, and substitute with renewables and natural processes), and insights from technological opportunities (new technology, enhanced technology, existing technology), Trapp and Kanbach (2021) offered 12 greentech business archetypes: Energy Efficinnovator, Efficiency Energiser, Energy Efficreator, Material Efficinnovator, Efficiency Materialenhancer, Material Efficreator, Recyclinnovator, Recyclenhancer, Green Technolooper, Greenew Substituter, Greenhanced Substituter, and Greentech Substituter.

The analysis of 55 cases of green business models from 14 OECD countries showed that existing business models can be grouped into: (1) greener products/process-based business models; (2) waste regeneration systems; (3) alternative energy-based systems; (4) efficiency optimisation by ICT; (5) functional sales and management services models; (6) innovative financing schemes; (7) new sustainable mobility systems; (8) industrial symbiosis; (9) green neighbourhoods and cities (Beltramello et al., 2013).

Some researchers suggest that business models can be physical, digital, and virtual (Lindgren, 2020). Moreover, enterprises can adopt both single business models and multi business models that are united into business model ecosystems (Lindgren, 2020). In addition, some firms prefer a combination of green and traditional business models; thus, *hybrid* business models are used (Agrawal and Bellos, 2017; Trapp and Kanbach, 2021).

2.4 LCA-based framework

It is not always easy to measure the outcomes of green business model implementation (Westerlund, 2013). The measures have simply not yet been sufficiently elaborated upon, and the return on investment in green business models might be long-term and difficult to capture since many other factors might influence a firm's performance.

It is suggested that management should just measure everything and start somewhere to map the outcomes of green business model implementation (Westerlund, 2013).

Recent studies have shown the trend towards greenwashing business models where no real total environmental effect is observed. In some cases, environmental effects are moved geographically, i.e. more environmental friendliness in some regions but heavier environmental pollution in other regions. For example, the wider use of electrical cars produces less CO₂ in developed countries, but leads to more severe environmental pollution at the initial stage of lithium extraction, the use of child labour in Africa and significant pollution during the utilisation of old electrical batteries in developing countries. Life cycle thinking helps to distinguish degrees of green business model utilisation and select truly green business model ideas for further funding and practical implementation. The importance of following a green business approach at all stages of the business cycle is stressed in green business literature. "Green business model innovation is when a business changes part(s) of its business model and thereby both captures economic value and reduces the ecological footprint in a life-cycle perspective" (Abuzeinab and Arif, 2014a: 4).

The LCA-based approach is not new. The first attempts to estimate the environmental impact from the raw material extraction phase to the utilisation of end products or recycling were made in the 1960s but did not receive a great deal of attention until the 1980s. Nowadays, procedures are more standardised, such as the ISO 14040 and 14044 series (International Organization for Standardization, 2006). The International Organization for Standardization (ISO) defined LCA as "a technique for assessing the environmental aspects and potential impacts associated with a product by: (a) compiling an inventory of relevant inputs and outputs of a product system, (b) evaluating

the potential environmental impacts associated with those inputs and outputs, (c) interpreting the results of the inventory analysis and impact assessment phases in relation to the objectives of the study” (International Organization for Standardization, 2006). Different environmental impacts are usually measured, i.e. CO₂ emissions, weakening of the ozone shield, the acidification of environment, fresh water pollution, and others.

The LCA-based approach is a reliable managerial tool for making decisions. In the context of green business modelling, LCA allows one to make decisions related to the costs and benefits of adoption and/or revision of existing business models considering the total effect of novel changes. Interestingly, Mieras (2015) suggests taking into consideration not only economic indicators (e.g. financial results, financial risk, or productivity resources) but also ecological (e.g. environment, waste, and climate change) and social (e.g. social cohesion, autonomy, trust) indicators. Mieras (2015) adapted the triple bottom line approach

to the life cycle-based framework. Generally, the LCA-based approach is applied widely to estimate the environmental impact of a firm’s activities and products throughout the entire production life cycle (Buxel et al., 2015). There are, of course, some barriers to the correct analysis, since, for example, the impact of some raw materials is difficult for a company to estimate, especially an SME. LCA is used to estimate value creation potential in different areas, e.g. strategy elaboration, R&D processes, choice of suppliers, sales and promotion, and training personnel (Buxel et al., 2015).

Løkke et al. (2020) offered a seven-parameter model for the evaluation of green business models using the LCA approach (Table 3). The LCA approach has been developed significantly during the last 20 years and has overcome previous drawbacks (Ayres, 2005). Furthermore, we will demonstrate how we used the abovementioned seven-parameter model to estimate the green business models used by the companies which were the subjects of the case study.

Table 3. Parameters of the holistic framework for the evaluation of systemic impacts of intended activities

A	Life cycle thinking	Risk of the burden shifting between LC phases and risk of shifting impacts geographically
B	Use of LCA	Risk of disproportional assessment of impacts from different LC phases and lacking the assessment of selected impact categories
C	LCA methodology	The risks inherent in including no LCA or only parts of one are the sum of the below risks
D	Adequately holistic	Risk of greenwashing from a focus on misleading parameters
E	Substitution	Risk of supporting the development of products or services which are worse than what is on the market today
F	Alternative scenarios	Risk of supporting the development of products or services which are worse than what would otherwise come on the market in the future
G	Quantification	Risk of either completely lacking or of ‘misvaluing’ environmental impacts in relation to each other

Seven parameters (A–G) and related risks in greenwashing, if the parameter has not been taken into consideration when designing the business model.

Source: Løkke et al. (2020)

3. Methodology

3.1. Description of the methodology

A multiple case studies approach (Yin, 2018) is used to explore green business models in small and medium-sized enterprises (SMEs). Multiple case studies may be seen as an extension of experience (Stake, 2000, p. 449) for understanding complex, situated, and contemporary phenomena such as green business models. We employ this methodological approach and design in several cases to make generalisations based on the comparative analysis of data (Yin, 1981).

3.2. Selection of cases

The SMEs which were the subjects of the case study are part of the Greenbizz project, funded by the Interreg Øresund-Kattegat-Skagerrak programme. The project is a collaboration between Aarhus University in Denmark, Halmstad University in Sweden, and Østfold University College in Norway. It aims to help a total of 60 start-ups and SMEs reduce their energy consumption by 10-15% and/or convert to more renewable energy (green energy) and thus decrease their CO₂ emissions. To accomplish this, researchers in the Greenbizz

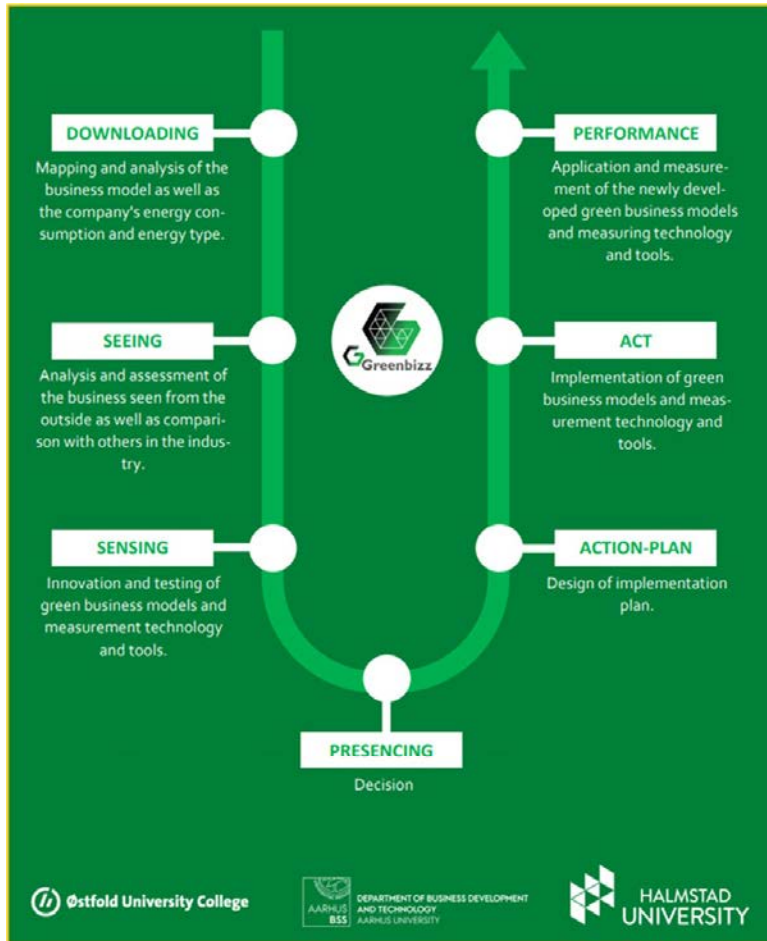
project analyse, develop and document firms' transformation to green business models in collaboration with the SMEs and start-ups. This includes mapping green business model parameters, resources and materials, energy, renewable (green) energy, waste, environment, and profit from green business models and measurement technologies.

3.3. Data collection and analysis

The study applies the holistic impact framework to the assessment of the environmental sustainability of business models (Løkke et al., 2020). This framework is based on seven parameters when designing the business model: life cycle thinking, the use of LCA, LCA methodology, being adequately holistic, substitution, alternative scenarios, and quantification (Table 3).

The five firms (Table 4) were selected from the 20 Norwegian partners in the Greenbizz project. Data was collected using observations and interviews during the period from August 2021 to February 2022. The Greenbizz process framework shown in Figure 1 was used as the overall process framework by which to conduct the empirical investigations.

Figure 1. Greenbizz process framework



Source: <https://www.greenbizz.eu/project/>

The first interviews with the companies were focused on the downloading and seeing phases. The interview guide is semi-structured and was divided according to the abovementioned two phases. The downloading phase was structured around the Bee Star model (Valter et al., 2018) and questions were formulated within each of the seven dimensions: value proposition, customer and user, value chain functions, competence, network, value formula, and relations. In the seeing phase, we focused on the ecosystem of the business model and the upstream and downstream

impact of waste and material flow, as well as sustainability effects. The next stages included sensing, where we evaluated all the possible interventions and selected the ones that were passed onto the action-plan phase. In the action-plan phase, we made detailed plans of who, what and when the task required to implement the chosen intervention; thereafter we executed the action-plan in the act phase; and finally, in the performance phase, we measured the performance of the interventions to verify that we had achieved the goals envisioned in the sensing phase.

Table 4. Description of firms included in the case study
(size, number of employees, industrial affiliation, turnover)

No	Company name	Industry	Year of foundation	Number of employees	Turnover in 2021, NOK
1	Smartpanel AS	Wood-based panels	2018	52	165 mln
2	Re:Inventar AS	Reuse furniture and interior	2021	2	1.3 mln
3	Norbygg	General contractor	1979	19	216 mln
4	Tronrud Engineering Moss AS	Sheet metal fabrication	1987	81	152 mln
5	Nen-Produkter AS	Juice production	1985	23	139 mln

Source: www.proff.no

4. Results and discussion

One of the most effective approaches to measuring the effect of green business model implementation is life cycle analysis (Løkke et al., 2020). We used this approach to analyse the empirical data from the firms which were the subjects of the case study, which are briefly described in Table 4. The main characteristics of the firms are also presented. We described the green business model elements of each company in Table 5. Furthermore, following the LCA framework of mapping the green business models (Table 3), we analysed the green business models of these firms. The results are summarised in Table 5. As we see from Table 5, a number of green elements were introduced by companies. The majority of companies have reduced their raw material use, and have also started to use recycled materials, increased efficiency, lengthened the life cycle and reduced transportation length. This is in line with the results of previous studies (Henriksen et al., 2012; Pampanelli et al., 2015).

The companies clearly demonstrated LCA thinking. First, some companies turned waste to resources, e.g. waste veneer is used to now to produce briquettes for heating (Company 1). In a similar vein, waste panels are used for packaging (Company 1)

and steel is used in recycling (Company 5). Reduced raw material use is also an important element in the green business models implemented by the majority of firms, as is the design to reduce material use in products (Company 4), the design of inventory for reuse, repair, refurbish, remanufacture, repurpose (Company 2), recycling of excess paint from production (Company 1), and standardisation of packaging (Company 5). The experiences of other companies also show a reduction in raw material use as a further result of green business model implementation (Ferroq et al., 2016).

It is also important to note that some companies combined green elements in business models and other effective strategies such as lean manufacturing (Company 4) and the just-in-time approach (Company 3). Company 5 also reported that they improved efficiency through high flexibility and reduced change over time in production. This finding is also in line with prior research (Ferroq et al., 2016; Perboli & Rosano, 2019).

Notably, companies do not simply try to cut costs and substitute more durable and quality elements with cheaper ones. This was a trend in recent years when companies tried to make manufacturing cheaper and used lower-quality components in production. The quality of the final products and

their lifetime thus became much shorter. In some of the companies studied, the opposite trend is visible, i.e. the use of better and more sustainable materials by Companies 2 (using quality and sustainable materials with a long lifetime) and 4 (design for increased lifetime in products). The result of such an approach is that the lifetime of the end products is longer.

Companies adopted different elements and strategies to implement green business

models. The choice of green elements depends on the industry in which companies operate, the size of the companies, their attitude to sustainability, and the knowledge base acquired through participation in the Greenbizz project. Companies indicated that the role of universities in green business innovation development and support is significant. This finding is in line with the results of earlier studies (García-Machado et al., 2021).

Table 5. Evaluation of business models

No	Description of the firm	Business model	The green element	A)	B)	C)	D)	E)	F)	G)
1	Smartpanel AS	Using huntonit core in building panel production (from MDF)	Reduced carbon footprint (measured using LCA)	x			x	x		
		High flexibility and reduced change over time in production	Increased efficiency	x						
		Using production waste (veneer) for producing briquettes	Turning waste to resources	x						
		Recycling of excess paint from production	Reduced raw material use	x						
		Using waste (panels) for packaging	Reduced raw material use	x						
2	Re:Inventar AS	Reuse, repair, refurbish, remanufacture, repurpose disposed inventory	Reduced raw material use					x		
		Using local suppliers and partners where possible	Reduced transport	x						
		Using quality materials with a long lifetime	Increased product life					x		
		Using sustainable materials with a long lifetime	Increased product life					x		
		Design inventory for reuse, repair, refurbish, remanufacture, repurpose	Reduced raw material use						x	
		<i>Repair, refurbish and remanufacture</i> inventory as an alternative for virgin products	Reduced raw material use						x	
		<i>Repurpose</i> inventory as an alternative for virgin products	Reduced raw material use						x	
		<i>Reuse</i> of inventory as an alternative for virgin products	Reduced raw material use						x	
3	Norbygg AS	Construction rehabilitation as an alternative to building new buildings what?	Increased product life						x	

No	Description of the firm	Business model	The green element	A)	B)	C)	D)	E)	F)	G)
		Ordering the exact amount of materials needed in the construction project to reduce waste and surplus materials on the construction site	Reduced raw material use						x	
		Using local suppliers and partners where possible	Reduced transport	x						
4	Tronrud engineering Moss AS	Lean production system and flow reducing waste	Increased efficiency					x		
		Design for reduced material use in products (dimensions)	Reduced raw material use						x	
		Design for minimum waste (stamping)	Reduced raw material use						x	
		Design for increased lifetime in products	Increased product life							x
		Waste steel sold for recycling	Recycling material	x						
		Heat recovery in furnaces	Reducing energy use		x					
		Raw material (steel) recyclable	Recycling	x						
5	Nen-Produkter AS	High flexibility and reduced change over time in production	Increased efficiency						x	
		Standardising packaging across products	Reduced raw material use and increased efficiency							
		Recyclable packaging	Recycling material	x						

Source: Løkke et al. (2020) and own data from case studies

Conclusions and implications

Novel contribution

This study makes several important contributions to the knowledge base. First, it clarified the importance of the distinction between green business models and other types of environmentally friendly business models more specifically. The study of green business models is a separate and interesting direction for research and requires further attention from scholars. Second, we have applied an LCA-based approach and empirically confirmed the importance of the holistic view on the green shift and green business model implementation. We have tested and extended the utilisation of the LCA approach based on a sample of innovative Norwegian SMEs. The study confirmed

the importance of the systematic approach to the estimation of the effectiveness of green measures, and the importance of avoiding greenwashing during the development and implementation of green business model innovations.

Managerial implications

The study has a number of implications for practitioners willing to implement green business models in their enterprises. First, we have explained the difference between green business models and other sustainable business models. The main feature of green business models is that they underline the improvement of the environmental component of business activities and cost reduction. The definition of green business models given by Trapp and Kanbach (2021)

is, in our opinion, the most elegant and best reflects what the majority of business owners and managers aim to achieve, namely environmental improvements and cost efficiency.

Further, we have demonstrated the green elements which managers of SMEs have implemented in their business models. We have utilised life cycle analysis to explore the measures taken by the firms which were the subjects of the case study and analyse them from the point of view of the holistic life cycle. This approach may be useful for managers of SMEs who can benefit from these ideas and understand how to evaluate the implementation of and improvement to green business models. Thus, the use of the LCA approach improves the performance of business models. This finding is in line with the results of previous studies (Scheepens et al., 2016; Testa et al., 2016).

Implications for policymakers

Understanding the environmental improvements related to the whole life cycle is equally important for policymakers. Our study demonstrates the importance of considering the effect of environmental benefits at all stages of product development and utilisation. Unfortunately, some policymakers do not completely understand the importance of the LCA approach, and sometimes projects more related to “greenwashing” (Ramus and Montinel, 2005) gain public support rather than real environmentally friendly ideas. It is equally important that policymakers take the economic component and cost considerations into account when selecting and supporting projects aimed at funding green business models.

All firms participating in the Greenbizz project positively evaluated public support and knowledge exchange with Scandinavian universities that collaborate with firms within the scope of the project. The role of universities in innovative business model development is positively evaluated in our

research and previous research (García-Machado et al., 2021; Moratis et al., 2018) alike. Future studies might involve further research into collaboration between businesses, public and governmental institutions, and universities related to the promotion of green business models. Moreover, the environmental awareness of the younger generation, such as university students, should be supported by means of university study programmes and the promotion of environmental thinking. This will support the creation of businesses based on green business models in the future (Titko et al., 2022).

Limitations and implications for future research

Our research is not free of limitations. First, the research has an explorative and qualitative nature. The selection of this type of research was dictated by the research questions of our study. We wished to highlight the differences between various types of sustainable business models. Furthermore, we wanted to clarify the definition of green business models and select one that best suited modern green business research. In addition, we wished to apply a novel approach of life cycle analysis to evaluate different existing green business models. Thus, the case study approach best suited the purposes of the study. In the future, we intend to apply a quantitative approach and suggest other scholars carry out surveys related to different factors of green business model implementation.

Further, we have tested the proposed LCA methodology on only five SMEs. Further research might focus on a greater number of cases, and include not only SMEs but also large firms. An increasing number of firms are considering adopting green business models. It would be interesting to compare insights from empirical research carried out in small and large firms alike. Also, we have had limited opportunities to see the

differences in green business model implementation and LCA thinking of managers in different industries. Such a study might also result in interesting findings, since different industries have made varied progress in GBM implementation.

Second, we have based our case study research on empirical data from Norway, which with its fellow Scandinavian countries are among the leaders in the green shift and the implementation of eco-innovations. Subsequent research should focus on the context of other countries, both developed and developing.

References

- Abuzeinab, A., Arif, M. (2014a), Stakeholder engagement: a green business model indicator, *Procedia Economics and Finance*, 18, 505-512. [https://doi.org/10.1016/s2212-5671\(14\)00969-1](https://doi.org/10.1016/s2212-5671(14)00969-1)
- Abuzeinab, A., Arif, M., Thompson, W. (2014b), Green business models in the UK construction sector: Empirical study. <https://stars.library.ucf.edu/scopus2010/9186>
- Abuzeinab, A., Arif, M., Qadri, M. A. (2017), Barriers to MNEs green business models in the UK construction sector: An ISM analysis, *Journal of Cleaner Production*, 160, 27-37.
- Agrawal, V. V., Bellos, I. (2017), The potential of servicizing as a green business model, *Management Science*, 63(5), 1545-1562. <https://doi.org/10.1016/j.jclepro.2017.01.003>
- Alvarez-Risco, A., Mlodzianowska, S., Zamora-Ramos, U., Del-Aguila-Arcentales, S. (2021), Factors of green entrepreneurship intention in international business university students: The case of Peru, *Entrepreneurial Business and Economics Review*, 9(4), 85-100. <https://doi.org/10.15678/EBER.2021.090406>
- Ayres, R. U. (1995), Life cycle analysis: A critique, *Resources, Conservation and Recycling*, 14(3-4), 199-223. [https://doi.org/10.1016/0921-3449\(95\)00017-D](https://doi.org/10.1016/0921-3449(95)00017-D)
- Beltramello, A., Haie-Fayle, L., Pilat, D. (2013), Why new business models matter for green growth, *OECD Green Growth Papers*, 2013-01, OECD Publishing, Paris. <https://doi.org/10.1787/5k97gk40v3ln-en>
- Blomsma, F., Brennan, G. (2017), The emergence of circular economy: a new framing around prolonging resource productivity, *Journal of Industrial Ecology*, 21(3), 603-614. <https://doi.org/10.1111/jiec.12603>
- Brunland, G. H. (1987), *Our Common Future Report of the World Commission on Environment*. New York. <https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf>
- Buxel, H., Esenduran, G., Griffin, S. (2015), Strategic sustainability: Creating business value with life cycle analysis, *Business Horizons*, 58(1), 109-122. <https://doi.org/10.1016/j.bushor.2014.09.004>
- Cygler, J., Sroka, W., Solesvik, M., Dębkowska, K. (2018), Benefits and drawbacks of cooptation: The roles of scope and durability in cooperative relationships. *Sustainability*, 10(8), 2688. <https://doi.org/10.3390/su10082688>
- Duarte, S., Cruz-Machado, V. (2013), Lean and green: a business model framework, In *Proceedings of the Sixth International Conference on Management Science and Engineering Management* (pp. 751-759), Springer, London. DOI: https://doi.org/10.1007/978-1-4471-4600-1_64
- Fercoq, A., Lamouri, S., Carbone, V. (2016), Lean/Green integration focused on waste reduction techniques, *Journal of Cleaner Production*, 137, 567-578. <https://doi.org/10.1016/j.jclepro.2016.07.107>
- Fitzpatrick, T. J. (2019), Building a new utility business model on a weak green foundation, *The Electricity Journal*, 32(2), 27-30. <https://doi.org/10.1016/j.tej.2019.01.017>
- FORA. (2010). *Green Business Models in the Nordic Region: A Key to Promote Sustainable Growth*. Copenhagen, Denmark. http://www.motiva.fi/files/4878/Greenpaper_Green_Business_Models_in_the_Nordic_Region_A_Key_to_Promote_Sustainable_Growth.pdf

- FORA (2012), The future of eco-innovation: The role of business models in green transformation. OECD/European Commission/Nordic Innovation Joint Workshop: Copenhagen, Denmark. <https://www.oecd.org/sti/inno/49537036.pdf>
- García-Machado, J. J., Sroka, W., Nowak, M. (2021), R&D and innovation collaboration between universities and business — A PLS-SEM Model for the Spanish province of Huelva, *Administrative Sciences*, 11(3), 83. <https://doi.org/10.3390/admsci11030083>
- Henriksen, K., Bjerre, M., Bisgaard, T., Høgenhaven, C., Maria Almasi, A., Damgaard Grann, E. (2012), Green business model innovation: Empirical and literature studies, *Nordic Council of Ministers, Oslo*. <https://www.diva-portal.org/smash/get/diva2:707242/FULLTEXT01.pdf>
- International Organization for Standardization (2006), Environmental management — Life cycle assessment — Requirements and guidelines. Geneva: ISO. <https://www.iso.org/standard/38498.html>
- Khan, I. S., Ahmad, M. O., Majava, J. (2021), Industry 4.0 and sustainable development: A systematic mapping of triple bottom line, *Circular Economy and Sustainable Business Models perspectives*, *Journal of Cleaner Production*, 297, 126655. <https://doi.org/10.1016/j.jclepro.2021.126655>
- Kirchherr, J., Reike, D., Hekkert, M. (2017), Conceptualizing the circular economy: An analysis of 114 definitions, *Resources, conservation and recycling*, 127, 221-232. <https://doi.org/10.1016/j.resconrec.2017.09.005>
- Kramer A., Herrndorf M. (2019), Policy Measures to Support Inclusive and Green Business Model. Federal Ministry for Economic Cooperation and Development (BMZ), Bonn. https://pactoglobal.com.gt/wp-content/uploads/2019/10/Policy_Measures_to_Support_Innovations.pdf
- Lewandowski, M. (2016), Designing the business models for circular economy—Towards the conceptual framework, *Sustainability*, 8(1), 43. <https://doi.org/10.3390/su8010043>
- Linder, M., Williander, M. (2017), Circular business model innovation: inherent uncertainties, *Business strategy and the environment*, 26(2), 182-196. <https://doi.org/10.1002/bse.1906>
- Lindgren, P. (2020), Multi business model innovation in a world of smart cities with future wireless technologies, *Wireless Personal Communications*, 113(3), 1423-1435.
- Lindgren, P., Taran, Y., Boer, H. (2010), From single firm to network-based business model innovation, *International Journal of Entrepreneurship and Innovation Management*, 12(2), 122-137. <https://doi.org/10.1002/bse.1906>
- Lüdeke-Freund, F., Gold, S., Bocken, N. M. (2019), A review and typology of circular economy business model patterns, *Journal of Industrial Ecology*, 23(1), 36-61. <https://doi.org/10.1111/jiec.12763>
- Løkke, S., Schmidt, J. H., Lyhne, I., Kørnøv, L., Revsbeck, R. (2020), How green are supported 'green' business models? Time for the life cycle approach to enter public support programmes, *The International Journal of Life Cycle Assessment*, 25(10), 2086-2092. <https://doi.org/10.1007/s11367-020-01806-9>
- Merli, R., Preziosi, M., Acampora, A. (2018), How do scholars approach the circular economy? A systematic literature review, *Journal of Cleaner Production*, 178, 703-722. <https://doi.org/10.1016/j.jclepro.2017.12.112>
- Moratis, L., Melissen, F., Idowu, S. O. (2018), Sustainable business models, Principles, Promise, and Practice. Cham, Switzerland: Springer. <https://doi.org/10.1007/978-3-319-73503-0>
- Nair, S., Paulose, H. (2014), Emergence of green business models: The case of algae biofuel for aviation, *Energy Policy*, 65, 175-184.
- Nasser, W.H. (2021), Innovation capital, sustainable entrepreneurial orientation, and the moderating role of entrepreneurial resilience, *Entrepreneurial Business and Economics Review*, 9(3), 73-85. <https://doi.org/10.15678/EBER.2021.090305>

- Newton, T., Harte, G. (1997), Green business: technician kitsch?, *Journal of Management Studies*, 34(1), 75-98. <https://doi.org/10.1016/j.enpol.2013.10.034>
- Nimmons, J., Taylor, M. (2008), Utility solar business models, *Emerging Utility Strategies & Innovation*. Solar Electric Power Association (SEPA) Publication: Washington, DC, USA. <https://doi.org/10.13140/2.1.2273.8564>
- Nußholz, J. L. (2017), Circular business models: Defining a concept and framing an emerging research field, *Sustainability*, 9(10), 1810. <https://doi.org/10.3390/su9101810>
- Pampanelli, A. B., Found, P., Bernardes, A. M. (2015), Sustainable manufacturing: The lean and green business model. In *Sustainable Operations Management* (pp. 131-161). Springer, Cham. https://doi.org/10.1007/978-3-319-14002-5_7
- Perboli, G., Rosano, M. (2019), Parcel delivery in urban areas: Opportunities and threats for the mix of traditional and green business models, *Transportation Research Part C: Emerging Technologies*, 99, 19-36. <https://doi.org/10.1016/j.trc.2019.01.006>
- Prause, G. (2015), Sustainable business models and structures for Industry 4.0, *Journal of Security & Sustainability Issues*, 5(2), 159-169. [https://doi.org/10.9770/jssi.2015.5.2\(3\)](https://doi.org/10.9770/jssi.2015.5.2(3))
- Ramus, C. A., Montiel, I. (2005), When are corporate environmental policies a form of greenwashing? *Business & Society*, 44(4), 377-414. <https://doi.org/10.1177/0007650305278120>
- Rantala, T., Ukko, J., Saunila, M., Havukainen, J. (2018), The effect of sustainability in the adoption of technological, service, and business model innovations. *Journal of Cleaner Production*, 172, 46-55. <https://doi.org/10.1016/j.jclepro.2017.10.009>
- Richter, M. (2012), Utilities' business models for renewable energy: A review, *Renewable and Sustainable Energy Reviews*, 16(5), 2483-2493. <https://doi.org/10.1016/j.rser.2012.01.072>
- Roos, G. (2014), Business model innovation to create and capture resource value in future circular material chains, *Resources*, 3(1), 248-274. <https://doi.org/10.3390/resources3010248>
- Scolaro, M., Kittner, N. (2022), Optimizing hybrid offshore wind farms for cost-competitive hydrogen production in Germany, *International Journal of Hydrogen Energy*, 47(10), 6478-6493. <https://doi.org/10.1016/j.ijhydene.2021.12.062>
- Scheepens, A. E., Vogtländer, J. G., Brezet, J. C. (2016), Two life cycle assessment (LCA) based methods to analyse and design complex (regional) circular economy systems. Case: Making water tourism more sustainable, *Journal of Cleaner Production*, 114, 257-268. <https://doi.org/10.1016/j.jclepro.2015.05.075>
- Schulz, S. A., Flanigan, R. L. (2016), Developing competitive advantage using the triple bottom line: A conceptual framework, *Journal of Business & Industrial Marketing*, 31(4), 449-458. <https://doi.org/10.1108/JBIM-08-2014-0150>
- Šebestová, J., Sroka, W. (2020), Sustainable development goals and SMEs decisions: Czech Republic vs. Poland, *Journal of Eastern European and Central Asian Research (JEECAR)*, 7(1), 39-50. <https://doi.org/10.15549/jeeicar.v7i1.418>
- Sjötun, S. G. (2019), A ferry making waves: A demonstration project 'doing' institutional work in a greening maritime industry, *Norsk Geografisk Tidsskrift-Norwegian Journal of Geography*, 73(1), 16-28. <https://doi.org/10.1080/00291951.2018.1526208>
- Shpak, N., Melnyk, O., Horbal, N., Ruda, M., Sroka, W. (2021), Assessing the implementation of the circular economy in the EU countries, *Forum Scientiae Oeconomia*, 9(1), 25-39. https://doi.org/10.23762/FSO_VOL9_NO1_2
- Shpak, N., Satalkina, L., Sroka, W., Hittmar, S. (2017), The social direction of enterprises' innovation activity, *Polish Journal of Management Studies*, 16(1), 187-201. <https://doi.org/10.17512/pjms.2017.16.1.16>
- Šimanskienė, L., Župerkienė, E. (2014), Sustainable leadership: The new challenge for organizations, *Forum Scientiae Oeconomia*, 2(1), 81-93.
- Solesvik, M., Gulbrandsen, M. (2013), Partner selection for open innovation, *Technology Innovation Management Review*, 3(4), 6-11. <https://doi.org/10.22215/timreview/674>

- Sommer, A. (2012), *Managing Green Business Model Transformations*, Springer Science & Business Media. <https://doi.org/10.1007/978-3-642-28848-7>
- Sroka, W., Szántó, R. (2018), Corporate social responsibility and business ethics in controversial sectors: Analysis of research results, *Journal of Entrepreneurship, Management and Innovation*, 14(3), 111-126, <https://doi.org/10.7341/20181435>
- Stake, R. E. (2000), Case studies, In Denzin, N. K. & Lincoln, Y.S. (Eds.), *The Sage Handbook of qualitative research* (Bd. 2nd, s. 435-436–454). Sage Publications.
- Stewart, D. W., Zhao, Q. (2000), Internet marketing, business models, and public policy, *Journal of Public Policy & Marketing*, 19(2), 287-296. <https://doi.org/10.1509/jppm.19.2.287.17125>
- Sæther, S. R., Moe, E. (2021), A green maritime shift: Lessons from the electrification of ferries in Norway. *Energy Research & Social Science*, 81, 102282. <https://doi.org/10.1016/j.erss.2021.102282>
- Teece, D. J. (2010), Business models, business strategy and innovation, *Long Range Planning*, 43(2-3), 172-194. <https://doi.org/10.1016/j.lrp.2009.07.003>
- Testa, F., Nucci, B., Tessitore, S., Iraldo, F., Daddi, T. (2016), Perceptions on LCA implementation: evidence from a survey on adopters and nonadopters in Italy, *The International Journal of Life Cycle Assessment*, 21(10), 1501-1513. <https://doi.org/10.1007/s11367-016-1106-9>
- Titko, J., Tambovcva, T., Atstaja, D., Lapinskaitė, I., Solesvik, M. Z. (2022), Attitude towards sustainable entrepreneurship among students: Testing a measurement scale, 12th International Scientific Conference “Business and Management 2022”, May 12–13, 2022, Vilnius, Lithuania (pp. 325-331), Vilnius Gediminas Technical University. <https://doi.org/10.3846/bm.2022.893>
- Trapp, C. T., Kanbach, D. K. (2021), Green entrepreneurship and business models: Deriving green technology business model archetypes, *Journal of Cleaner Production*, 126694. <https://doi.org/10.1016/j.jclepro.2021.126694>
- Valter, P., Lindgren, P., Prasad, R. (2018), Valter's seven forces; a model for analyzing the forces affecting the business model innovation process, *Nordic and Baltic Journal of Information and Communications Technologies*, 2018(1), 47-64. <https://doi.org/10.13052/nbjict1902-097X.2018.004>
- Van Marrewijk, M. (2003), Concepts and definitions of CSR and corporate sustainability: Between agency and communion, *Journal of Business Ethics*, 44(2), 95-105. <https://doi.org/10.1023/A:1023331212247>
- Westerlund, M. (2013), TIM Lecture Series–Green business models to change the world: How can entrepreneurs ride the sustainability wave?, *Technology Innovation Management Review*, 3(7). <http://doi.org/10.22215/timreview/707>
- Westerlund, M., Leminen, S., Rajahonka, M. (2014), Designing business models for the internet of things, *Technology Innovation Management Review*, 5-14. <http://doi.org/10.22215/timreview/807>
- Yi, H. (2014), Green businesses in a clean energy economy: Analyzing drivers of green business growth in US states, *Energy*, 68, 922-929. <https://doi.org/10.1016/j.energy.2014.02.044>
- Yin, R.K. (1981), The case study as a serious research strategy, *Knowledge: Creation, Diffusion, Utilization*, 3(1), 97–114. <https://doi.org/10.1177/107554708100300106>
- Yin, R. K. (2018), *Case study research and applications: Design and methods* (sixth edition). Sage.

Maryna Z. Solesvik is an Adjunct Professor of Innovation and Management at Østfold University College, Norway. She holds a PhD from the Nord University Business School, Norway. Her research interests include entrepreneurial intentions, female entrepreneurship, entrepreneurship in emerging economies, and strategic alliances. <https://orcid.org/0000-0002-6702-4643>

Mirielle Torgersen is a PhD student at Aarhus University, Denmark, and Østfold University College, Norway, in the research area of sustainable, green, and circular business model innovation. She has an MSc in Industrial Economics and Technology from Agder University, Norway, and an MSc in Logistics and Supply Chain Management from Heriot-Watt University, Edinburgh, UK. After 17 years of work experience in various positions in three large companies in Norway, she began her PhD education in 2021.

Dr. Gunnar Andersson is an associate professor of innovation at Østfold University College, Norway. He received his PhD in Industrial Economics and Technology Management from the Norwegian University of Science and Technology (NTNU) in 2011. His main research areas are sustainable innovation processes and value creation in collaboration with public and private businesses. <https://orcid.org/0000-0001-8060-7491>.

Dr. Per Valter is an Associate Professor of innovation, technology, and sustainable business development. His main research fields are innovation, sustainable business development, 6G, digitisation of business models, and entrepreneurship. Besides his role in academia, Per Valter has successfully founded several startup companies and grown them to the exit stage. Børsen awarded him the Gazelle award in 2013, 2014, 2019, and 2020 for creating and leading one of Denmark's fastest-growing companies. In addition to these business achievements, he is a Computer Science graduate. He holds an Executive MBA – Master's in Management of Technology, an MSc in Business and Management Research from Henley University of Reading, and a Ph.D. degree in Social Sciences and Business from Aarhus University. He is an experienced bachelor's and master's level teacher and supervises Ph.D. students. <https://orcid.org/0000-0002-3201-9641>.