

8th International Electric Vehicle Conference (EVC 2023)

HOW CAN SUSTAINABLE BUSINESS MODELS AND INNOVATIVE VALUE CHAINS ACCELERATE THE TRANSFORMATION OF ELECTRIC VEHICLES?

Rudolf Schnee^a, Nathalie Kroichvili^a, Daniela Chrenko^a, Reiner Kriesten^{b*}^a*FEMTO-ST Institute, Univ. Bourgogne Franche-Comté, UTBM, CNRS, Belfort, France*^b*Institute for Energy Efficient Mobility, University of Applied Science Karlsruhe, Germany*

Abstract

Limited resources, climate change and urban mobility lead to a changed mobility behavior in population. Automobile manufacturers are responding to these new challenges by developing electric vehicles that have already reached a high technical level. Ever higher ranges and high reliability show that electric vehicles are comparable to vehicles with internal combustion engines. Nevertheless, manufacturers are failing in selling these vehicles in sufficient numbers without substantial subsidies from local states. Therefore, companies are forced to reconsider and develop their business models because existing business model approaches do not sufficiently cover the requirements for the business of electromobility. Sustainable business models are a promising solution, as they consider economic aspects as well as elements of environmental friendliness and social aspects and are therefore a good basis for electromobility. For a successful sustainable business model for electromobility also a comprehensive ecosystem with all necessary stakeholders of the various stages of the value chains is needed and forms the basis for a newly designed framework. However, the framework can not only be used for business models for electric vehicles but can also be used for other components of electromobility which has been examined in a case study with charging stations to illustrate the applicability.

© 2023 The Authors. Published by ELSEVIER B.V.

This is an open access article under the CC BY-NC-ND license (<https://creativecommons.org/licenses/by-nc-nd/4.0>)

Peer-review under responsibility of the scientific committee of the 8th International Electric Vehicle Conference

Keywords: Electric vehicle; sustainable business models; e-mobility; business model innovation

* Corresponding Tel.: +33 (0) 3 84 58 30 00; fax: +33 (0) 3 84 58 30 30.

E-mail address: rudolf.schnee@utbm.fr

1. Introduction

The demand for individual mobility without burdening the environment and socially disadvantaging work has grown rapidly in recent years and places high expectations for research, development, and production. Customer surveys show that interest in electric vehicles has increased considerably in the last few years (Cordera et al., 2019). Additionally, the development of electric vehicles has now reached a status where they are on a level with vehicles with internal combustion engines (ICE) in terms of range and daily usability. Also, the number of charging stations is increasing constantly, so that the fear from customers that they will break down with an electric vehicle becomes less. Although the conditions for the transformation of electric mobility are strong, car manufacturers can only sell their electric vehicles with high subsidies from governments and their profit margin are low or mostly negative (Baik et al., 2019). Since government subsidies can only guarantee a boost and it is not possible to plan how long they will be paid, it is necessary to increase the returns on electric vehicles.

A promising approach is innovations in business models because electric vehicles are offered with the same business model as ICE vehicles (Winton, 2019) which have been developed and optimized over decades, but the basic elements have remained almost unchanged (Baik et al., 2019). Merely additional vehicle-related services, such as financing, leasing, or the aftersales business, have been included in the entrepreneurial activities and the business models. Although many companies have recognized that business model innovations (BMI) are an essential element of economic success, the necessary changes are not taking place even changes in products, framework conditions and market circumstances (Puls, 2021). The previously successful business models should also be used for electromobility to avoid risks. But electromobility has not only an impact on business models, also the value chain must be reviewed and adapted. Due to changes in many components (powertrain and their necessary elements are replaced by an electric motor and a traction battery), existing suppliers must be reviewed and, if necessary, new ones found (Clausen et al., 2022). But the changes go far beyond that. Electromobility creates new dependencies that do not currently exist. Electric vehicles cannot be sold unless the public charging infrastructure is expanded and comes close to today's filling stations in terms of handling and duration of loading. Also, the generation of electricity is an important factor in environmental protection and requires a transformation from fossil fuels to green electricity.

Therefore, the questions are how automotive companies can adapt their existing business models by BMI so they can make profit with a sustainable business model for electromobility (SBMEM) for their electric vehicles (EV) and are independent from state subsidies? Also, how should the value chain can be adapted so that further sales of additional products and services are possible? The aim of this paper is to contribute to narrow these knowledge gaps and to develop a framework that will provide further insights into research on SBMEM. It will additionally expand research into sustainable business models by analysing the elements and revising their structure. The result is a framework with new elements that have to be reached by business models at stake to be sustainable in the field of electromobility.

2. Methodology

The research is based on an integrative literature research in different steps and follows the recommendations of Creswell (Creswell, 2009) and Easterby-Smith (Easterby-Smith et al., 2018). A search of peer-reviewed literature is conducted, with the search strings "sustainable business model", "framework" and "electromobility" in the expressions "e-mobility" and "electric mobility". The different search strings for electromobility are chosen because no uniform term has been established in literature yet. Scopus and google scholar were used as a database and the topics article, title, abstract and keywords. The search is limited to the years between 2010 and 2021, since the research area has gained importance in recent years. In the next step, the titles and reference sections of the 241 articles were read and 56 articles are not pursued further as they are not related to the research objective. The remaining 185 article were analysed by reading the abstract and classified into different topics according to their content and objective. Therefore another 149 articles were dropped.

3. Theoretical Background

Although business models is a much-used term in economics, there is no uniform definition in science (Chesbrough & Rosenbloom, 2002; Magretta, 2002) even technological and changes in environment of the companies forces to adaption and further development. Electromobility and the wishes of customers for more environmental and social consideration have resulted in the development of sustainable business models.

3.1. Business models and business model innovation

For Chesbrough and Rosenbloom (2002), business models are catalyst and enabler that makes technology attractive to customers. It gives companies a structure to meet the customers' needs (Amit & Zott, 2012; Teece, 2010) so they are willing to pay a price for it (Magretta, 2002). Richardson (2008) classified business models in three main elements: a) value proposition, b) value creation and delivery and c) value capture. With value proposition, the company achieves a competitive advantage in offering products or services to the customer (Amit & Zott, 2012). Value creation and delivery integrates the value chain and the network of other firms that take part to the value creation (Rasmussen, 2007) and value capture refers to the way a firm gets revenue and makes money (Magretta, 2002). A well-known tool for creating a business model is the business model canvas from Osterwalder et al. (Osterwalder et al., 2005), which is "a popular and widely adopted tool for supporting business model innovation" (Joyce & Paquin, 2016). It describes the business model in a systemic perspective and has four pillars with nine building blocks.

Companies are in a permanent state of transition due to technological developments, changes in general conditions such as laws and regulations, or changes in customer requirements. This leads to a permanent adaptation of corporate functions and especially business models, even if they are successful. Failure to adapt can result in customer requirements no longer being met or in value chains no longer corresponding to the changed requirements. Inadequate business models can lead to companies no longer operating successfully in the market. Under these premises, business model innovation is defined as follows: BMI is an enabler of creating and capturing value under the assumption of changing components of the existing business model ((Amit & Zott, 2001; Chesbrough, 2010; Demil & Lecocq, 2010; Teece, 2010).

3.2 Sustainable Business Models

Sustainable business models have been an emerging research area among scientists in the last years and the number of publications is steadily increasing (Shakeel et al., 2020). The aim of the first concepts was to transform companies to a more sustainable economic system and to develop their organization (Stubbs & Cocklin, 2008; Wells, 2013). Sustainable business models become a competitive advantage and enable new technologies to successfully place themselves on the market (Schaltegger et al., 2012; Yang et al., 2017). "A business model for sustainability helps describing, analyzing, managing, and communicating (i) a company's sustainable value proposition to its customers, and all other stakeholders, (ii) how it creates and delivers this value, (iii) and how it captures economic value while maintaining or regenerating natural, social, and economic capital beyond its organizational boundaries" (Schaltegger et al., 2016). Based on the principals of the triple bottom line, sustainable business models should lead to the goals of environmental friendliness, social justice and successful economy being treated equally (Elkington, 1998). Therefore, with sustainable business models companies can satisfy the needs and wishes of customers and are able to generate profit. Closely linked to the business models are the value chains.

3.3 Value Chains in Automotive Industry

Value chains describe the process of all manufacturing and marketing levels of companies for a product and was developed by the US economist Michael Porter (Porter, 1985). He describes value chains as a collection of activities by which a product is designed, manufactured, distributed, delivered, and serviced. Historically, companies in the transportation sector have predominantly worked with linear value chains networks (Sturgeon et al., 2008). In automotive industry sources the integrator parts from various upstream suppliers and produces a vehicle. The vehicle is sold to customers worldwide either directly or via dealer. The automotive industry is one of the most

global industries in the world. Products are developed, produced and sold on all continents and it is dominated by a small number of companies (Felice et al., 2013, pp. 1–30). The manufacturing of the products requires a high degree of work sharing, with each participant fulfilling a defined role. The value chain is divided into a value-added chain of suppliers. This is differentiated in the ranking of suppliers according to the complexity of the goods produced. Tier 1 suppliers have a high level of integration expertise, while suppliers at the tier 2 level are often technology leaders in their specialty area. Tier-3 suppliers are process or cost leaders. The other tier-X suppliers produce single parts in decreasing complexity (Karaer et al., 2020) (Figure 1).

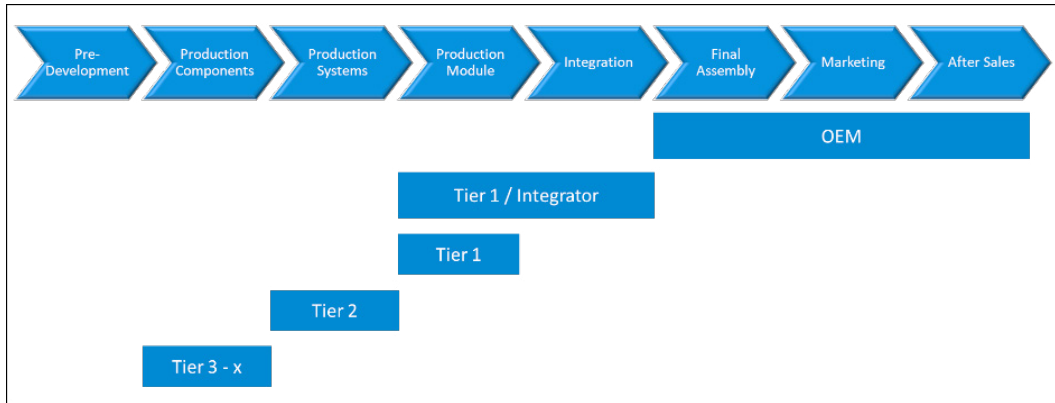


Fig. 1: Value chain and value creation level (Koch, 2006)

4. Results

The result of the paper is the creation of a conceptual framework for SBMEM (Figure 2). Through its redesign in the arrangement of elements and the ecosystem to be built, it supports and promotes the transformation of electromobility by satisfying customers' needs while enabling companies to generate profit. Unlike frameworks of conventional business models, where the components of value proposition, value creation and delivery, and value capture are equally lined up, SBMEM adds the elements of environment, social aspects, and an additional economic component that are transversal to the conventional business models. To ensure supply and delivery, the traditional value chains are broken down and transformed into an ecosystem. This ecosystem can act on several levels and is therefore not on the same level as the existing or redesigned components. It can be seen that the environmental and social elements must be added, as the shift to electromobility is intended to protect the environment and promote social justice. The framework enables companies to meet the environmental and social requirements of their customers, as well as the potential to generate profits with products and services, considering the changing value chains.

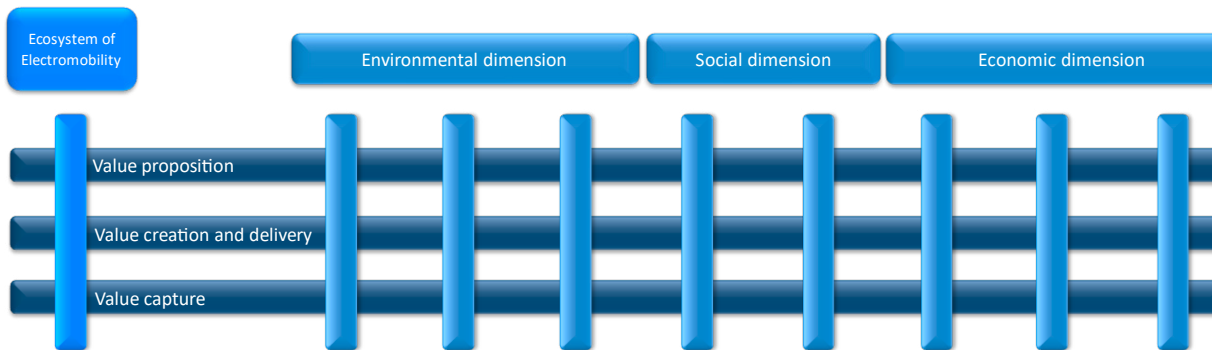


Fig. 2: Synthetic view of the framework of SBMEM

5. Discussions

Conventional business models arrange the elements of value proposition, value creation and delivery in an equal structure and do not consider social concerns or the environment. Sustainable business models add the components of environmental friendliness and social justice without changing the relationship between the components. As a result, the individual components are in direct competition with each other. The SBMEM as a conceptual framework mitigates these conflicts by setting the environmental, social, and economic dimensions in a transversal relationship based on their impact on the classic elements of the business model. This provides customers and companies with a system to find a satisfactory compromise between economic, environmental, and social aspects. This can be seen by an example: The value proposition of a customer to save the environment can be satisfied by selling an electric vehicle which is produced with social arrangements. For the company it could have the consequence at the economic dimension that they can sell more electric vehicles like Tesla. Tesla could increase their profit by using a more distinctive ecosystem instead of producing a lot of elements of themselves. So, for every element of the framework, positive and approaches that can be improved can be analysed and optimized.

Another new aspect of SBMEM is the importance of an ecosystem for electromobility, which forms the basis for the transformation to electromobility and is thus a complementary element. Linear or combined value chains are broken up and transferred into an ecosystem. In this approach, the dependencies of the individual stakeholders can be better resolved and supports the overall success of electromobility. Although this further increases the dependencies between the participants in the supply chain, it leads to a necessary community of purpose. The failure of individual participants can lead to a complete breakdown of the entire chain, as it is very difficult to replace them with another component. This can be seen, for example, in the dependence of electric vehicles on charging stations or the need to generate green energy for charging means of transport in an environmentally friendly way. A lack or even elimination of charging stations makes the sale of electric vehicles almost impossible. The SBMEM extends existing approaches by integrating the business model into the ecosystem and includes the need for value proposition and customer motivation. For the success of the electromobility ecosystem, it is necessary that information is shared between the participants about their own business models. This exchange of information requires a relationship of trust between the companies in the ecosystem, which can grow over time and be confirmed by economic success. It therefore makes sense to invest in the development of an ecosystem and integrate the relevant participants as early as the development and marketing of electromobility.

The developed framework for SBMEM helps to fill gaps in research on sustainable business models and shows entrepreneurs and managers how SBMEM can help to drive the transformation to electric mobility. The framework can help managers develop new business models or review existing ones to identify and address potential deficiencies.

6. Case study charging station

Access to public charging stations is one of the main reasons for the slow transformation of electromobility. The infrastructure is lagging far behind the planned figures, so that politicians and environmentalists already see the transformation of electromobility in danger. Neither politicians, nor car manufacturers, nor even the oil companies are prepared to make the necessary investments to provide sufficient charging stations. One of the main reasons for this are the poor economic conditions. ChargePoint Holding is one of the largest independent charging station networks in Europe and America with approximately 115,000 places to charge electric vehicles (Witsch, 2020a). Corporate objective is to develop and produce charging stations and offer charging-as-a-service to customers. ChargePoint has received \$127 million through investors in mid of 2020 (Witsch, 2020b) and its forecasted revenue will be more than two billion US-Dollar in 2026. Fiscal year 2021 revenue was about \$146 million and fiscal year 2021 GAAP net loss was \$197.0 million compared to \$134.3 million in the prior year period. (McNeill, 2022). So ChargePoint has not yet managed to make profit with its charging-as-a-service business since its foundation (McNeill, 2020, 2021).

To improve the economic situation, ChargePoint could expand its existing business model and develop it into an SBMEM. To do this, it could enhance the value proposition for customers and pay more attention to the environment. Currently, there is no evidence that ChargePoint is taking environmentally friendly measures in its operations, such as avoiding the mining of raw materials by introducing second life or recycling. Furthermore, it could reduce electricity consumption by introducing new technologies. Through vehicle to grid (V2G), it is possible to reduce electricity peaks by using the traction batteries of electric vehicles as electricity storage and can therefore save electricity. Similarly, ChargePoint cannot currently guarantee completely that the electricity at the charging stations is produced in an environmentally friendly way.

The social components could also be expanded, not only by ensuring that raw materials are only sourced from suppliers who treat their employees socially, but also by improving the accessibility of their charging stations. For example, it makes sense to expand the charging stations in rural areas or in places that are accessible without barriers. In the economic sector, additional business is possible. For example, the expansion to offer charging-as-a-service in the private sector could help to advance the transformation of electromobility and generate additional sources of income.

7. Conclusion and further research

The population's desire for environmentally friendly mobility and transportation without burdening social fairness is steadily increasing, and industry and companies are satisfying these demands with new technologies and services in electromobility. However, a compromise must be found between product offering and the opportunity for companies to make profit. The result of the paper is that conventional business models are not sufficient for the transformation of electromobility and must be expanded to include environmental and social attributes. Also, the one-dimensionally structured sustainable business models lead to an equality of value proposition, value capture and delivery, value creation, environment and social aspects and can result in a conflict between the fulfilment of customer needs and the companies' goal to generate profit. So, customers can be confronted with the decision to buy environmentally friendly products at a higher price. For example, the extraction of raw materials under eco-friendly and socially fair conditions lead to higher costs for the companies and thus increase the price. As a result, companies are keeping social aspects and environmental friendliness in the form of an accounting and the goal of the companies to better protect the environment and the people is lost. Therefore, government subsidies and tax regulations are needed to provide an attractive price for customers or to force companies to bring more environmentally and socially responsible products to the market.

The SBMEM framework provides new insights for research on sustainable business models. It extends the peer elements of sustainable business models with additional building blocks that stand transversally to create a trade-off between environmental friendliness, social aspects, and economic success. It shows that the design of SBMEM has to be done at the level of the new ecosystem to be created, where individual companies cannot succeed in isolation, but ensure the satisfaction of the customer's value proposition through joint value creation and delivery and value sharing among stakeholders.

Due to the complexity of the topic, this paper cannot address the exploration of the conditions and modalities of

the transition to a sustainable business model. In addition, the conditions under which the ecosystem can fulfil its objectives more efficiently should be analysed in more detail and adjustments to the framework should be considered based on lessons learned from further case studies.

Acknowledgement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

- Amit, R., & Zott, C. (2001). Value creation in e-business. *Strategic Management Journal*.
<https://doi.org/10.1002/smj.187>
- Amit, R., & Zott, C. (2012). Business Model Innovation: Creating Value in Times of Change. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.1701660>
- Baik, Y., Hensley, R., Hertze, P., & Knupfer, S. (2019). Making electric vehicles profitable McKinsey Center for Future Mobility Making electric vehicles profitable. *McKinsey & Company, March*.
[https://www.mckinsey.com/~media/McKinsey/Industries/Automotive and Assembly/Our Insights/Making electric vehicles profitable/Making-electric-vehicles-profitable.pdf](https://www.mckinsey.com/~media/McKinsey/Industries/Automotive%20and%20Assembly/Our%20Insights/Making%20electric%20vehicles%20profitable/Making-electric-vehicles-profitable.pdf)
- Chesbrough, H. (2010). Business model innovation: Opportunities and barriers. *Long Range Planning*, 43(2–3), 354–363. <https://doi.org/10.1016/j.lrp.2009.07.010>
- Chesbrough, H., & Rosenbloom, R. S. (2002). The role of the business model in capturing value from innovation: Evidence from Xerox Corporation’s technology spin-off companies. *Industrial and Corporate Change*, 11(3), 529–555. <https://doi.org/10.1093/icc/11.3.529>
- Clausen, J., Grimm, A., & Pfaff, M. (2022). *Die erfolgreiche Transformation der Automobilbranche* (ISSN 2509-259, Issue 253).
- Cordera, R., Dell’Olio, L., Ibeas, A., & Ortúzar, J. de D. (2019). Demand for environmentally friendly vehicles: A review and new evidence. *International Journal of Sustainable Transportation*, 13(3), 210–223.
<https://doi.org/10.1080/15568318.2018.1459969>
- Creswell, J. W. (2009). *Research design: Qualitative, Quantitative, and Mixed Methods Approaches* (4.th). SAGE Publications. Inc. moz-extension://4fea5303-263b-4334-8536-e008f23435ba/enhanced-reader.html?openApp&pdf=http%3A%2F%2Fwww.drbramedkarcollge.ac.in%2Fsites%2Fdefault%2Ffiles%2Fresearch-design-ceil.pdf
- Demil, B., & Lecocq, X. (2010). Business model evolution: In search of dynamic consistency. *Long Range Planning*, 43(2–3), 227–246. <https://doi.org/10.1016/j.lrp.2010.02.004>
- Easterby-Smith, M., Thorpe, R., & Jackson, P. (2018). *Management and business research* (6th ed.). Sage Publications Inc.
<https://books.google.com/books?hl=de&lr=&id=97NTDwAAQBAJ&oi=fnd&pg=PP1&ots=Ilmq-VslCO&sig=FkLrIPkBMNUKqNGpQc8js43CZkU>
- Elkington, J. (1998). Partnerships from cannibals with forks: The triple bottom line of 21st-century business. *Environmental Quality Management*, 8(1), 37–51. <https://doi.org/10.1002/tqem.3310080106>
- Felice, F. De, Petrillo, A., & Monfreda, S. (2013). OPERATIONS MANAGEMENT. In M. Schiraldi (Ed.), *OPERATIONS MANAGEMENT* (pp. 1–30). InTech, Rijeka, Croatia. <https://doi.org/doi.org/10.5772/45775>
- Joyce, A., & Paquin, R. L. (2016). The triple layered business model canvas: A tool to design more sustainable business models. *Journal of Cleaner Production*, 135, 1474–1486.
<https://doi.org/10.1016/j.jclepro.2016.06.067>
- Karaer, Ö., Kraft, T., & Yalçın, P. (2020). Supplier development in a multi-tier supply chain. *IIE Transactions*, 52(4), 464–477. <https://doi.org/10.1080/24725854.2019.1659523>
- Koch, W. (2006). *Wertschöpfungstiefe von Unternehmen: Die strategische Logik der Integration*. Deutscher Universitätsverlag. <https://doi.org/10.1007/978-3-8350-9374-4>
- Magretta, J. (2002). Why business models matter. In *Harvard Business Review* (pp. 86–92).
<https://doi.org/10.1016/j.cub.2005.06.028>
- McNeill, S. (2020). *ChargePoint Annual Report 2019*.
- McNeill, S. (2021). *ChargePointFacts_September2020*. moz-extension://4fea5303-263b-4334-8536-e008f23435ba/enhanced-

- reader.html?openApp&pdf=https%3A%2F%2Fwww.chargepoint.com%2Ffiles%2FChargePointFacts.pdf
- McNeill, S. (2022). *ChargePoint Reports Fourth Quarter and Fiscal 2021 Financial Results*.
- Osterwalder, A., Pigneur, Y., & Tucci, C. L. (2005). Clarifying Business Models: Origins, Present, and Future of the Concept. *Communications of the Association for Information Systems*, 16. <https://doi.org/10.17705/1cais.01601>
- Porter, M. E. (1985). Creating and sustaining superior performance. *Competitive Advantage*. <https://doi.org/10.1182/blood-2005-11-4354>
- Puls, T. (2021). Strukturwandel in der Automobilindustrie-wirkt die Pandemie als Beschleuniger? In *Ifo Schnelldienst*.
- Rasmussen, B. (2007). Business Models and the Theory of the Firm. *Pharmaceutical Industry Project*, Jun, 1–11. <http://www.econlit.org/>
- Richardson, J. (2008). The business model: an integrative framework for strategy execution. *Strategic Change*, 17(5–6), 133–144. <https://doi.org/10.1002/jsc.821>
- Schaltegger, S., Hansen, E. G., & Lüdeke-Freund, F. (2016). Business Models for Sustainability: Origins, Present Research, and Future Avenues. *Organization and Environment*, 29(1), 3–10. <https://doi.org/10.1177/1086026615599806>
- Schaltegger, S., Lüdeke-Freund, F., & Hansen, E. G. (2012). Business cases for sustainability: The role of business model innovation for corporate sustainability. *International Journal of Innovation and Sustainable Development*, 6(2), 95–119. <https://doi.org/10.1504/IJISD.2012.046944>
- Shakeel, J., Mardani, A., Chofreh, A. G., Goni, F. A., & Klemeš, J. J. (2020). Anatomy of sustainable business model innovation. *Journal of Cleaner Production*, 261, 121201. <https://doi.org/10.1016/j.jclepro.2020.121201>
- Stubbs, W., & Cocklin, C. (2008). Conceptualizing a “Sustainability Business Model.” *Organization & Environment*, 21, 103–127. <https://doi.org/10.1177/1086026608318042>
- Sturgeon, T., Van Biesebroeck, J., & Gereffi, G. (2008). Value chains, networks and clusters: Reframing the global automotive industry. *Journal of Economic Geography*, 8(3), 297–321. <https://doi.org/10.1093/jeg/lbn007>
- 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>
- Wells, P. (2013). Business Models for Sustainability. In *Business Models for Sustainability*. Edward Elgar Publishing. <https://doi.org/10.4337/9781781001530>
- Winton, N. (2019). *Electric Car Sales Ambitions Dangerously Ahead Of Forecasts*. Forbes. <https://www.forbes.com/sites/neilwinton/2019/11/25/electric-car-sales-ambitions-dangerously-ahead-of-forecasts/>
- Witsch, K. (2020a). *Chargepoint-Aktie: US-Ladeanbieter plant den Börsengang*. Handelsblatt. <https://www.handelsblatt.com/unternehmen/energie/e-mobilitaet-us-ladeanbieter-chargepoint-geht-an-die-boerse/26213926.html>
- Witsch, K. (2020b). *Ladeanbieter Chargepoint sammelt 127 Millionen Dollar ein*. Handelsblatt. <https://www.handelsblatt.com/technik/thespark/e-mobilitaet-ladeanbieter-chargepoint-sammelt-127-millionen-dollar-ein/26068080.html>
- Yang, M., Evans, S., Vladimirova, D., & Rana, P. (2017). Value uncaptured perspective for sustainable business model innovation. *Journal of Cleaner Production*, 140, 1794–1804. <https://doi.org/10.1016/j.jclepro.2016.07.102>