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# Sustainable business model archetypes for the electric vehicle battery second use industry: Towards a conceptual framework

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ABSTRACT

This paper explores sustainable business models (SBMs) evolution for the rapidly developing battery second use (B2U) market within the emerging electric vehicle (EV) industry. Previous work identified that SBMs and EV B2U are emerging as major research streams but there is paucity among literature to deliver an overarching framework or a holistic view between these fields and highlight fresh areas for future research. We adopted an inductive multiple-case study approach to unearth new knowledge by comprehending how B2U stakeholders undertake their sustainability-related business activities. These are not only focused on economic profitability but more importantly address wider social and environmental stakeholder value as part of prospective SBMs. The SBM archetypes were adopted as the major lens for our data analysis to study multiple cases of B2U stakeholder roles and comprehend further the scope and ultimate purpose of their operations. Major results indicate that the SBM archetypes as major sustainable innovation strategies have the potential to create a new conception of business models for sustainability in the EV B2U market. In turn, this creates and drives shared sustainable value for multiple stakeholders through cross-sectoral collaborations as part of ntire new and more SBMs. Finally, this study proposes the conceptual sustainable innovation business model (SIBM) framework for the EV B2U industry that includes such shared sustainable value creations which in turn drives forward business performance and sustainability at the same time, eventually creating the business case for sustainability within the EV industry.



## 1. Introduction

The sustainable innovation of electric vehicles (EVs) represents a promising alternative to address ongoing dependency on finite fossil fuels and associated serious societal concerns on climate change. Despite policy support from various governments, a mass-market uptake of EVs is still impeded, principally due to high costs of installed lithium-ion battery packs (LIBs), which represent the single largest cost item in the vehicle (IEA, 2019; Reinhardt et al., 2016). This is why the automotive industry urgently desires substantially reduced battery pack costs for EVs to become cost competitive to conventional gasoline cars (Reinhardt et al., 2019a). Among other promising mobility innovations, reusing retired EV batteries through the concept of Battery Second Use (B2U) has emerged. B2U significantly reduces resource cycles by increasing total LIB service life in less demanding applications in the stationary energy storage market (e.g. renewable energy integration), which in turn helps to build smart grid technologies and contribute towards a renewable energy infrastructure (Podias et al., 2018; Neubauer and Pesaran, 2011; Cready et al., 2003). With prospective EV market share, there will be millions of battery packs returned from their 1st in-vehicle life. Simultaneously, there is a trend towards renewable energy production, highlighting the growing necessity to establish suitable electrical storage capacities. Still, there seems to be a frustrating paradox. Integrating vast amounts of renewables is still interfered by the shortage of effective

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large-scale energy storage systems even though the concept of B2U could promote to unlock hidden value and utilities (Casals et al., 2019; Heymans et al., 2014).

A variety of EV companies have started initiating B2U pilot projects in collaboration with e.g. experts on the energy markets, recyclers and energy storage service & system providers to comprehend economic feasibilities and development of viable innovative business models. These reported B2U projects offer evidence that innovative multi-stakeholder cross-sectoral relationships between previously isolated industries are forming (Reinhardt et al., 2019b). These projects primarily serve to comprehend possible viable innovative business models, in fact some projects have already move to the commercial scale (Jiao and Evans, 2018). However, to date very few authors have examined the EV B2U market from a sustainable business model perspective. Recently, a comprehensive review article found that B2U can solve ongoing unsustainable practices in the EV industry, which in turn will lead to a faster EV market penetration and improvements of overall sustainability performance through increased and more sustainable business model (SBMs) perspectives (Reinhardt et al., 2019b). Yet, it remains to be unearthed how B2U stakeholders can innovate their novel product life extending strategies, which are in line with the principles of the circular economy, into innovative business models that contribute towards sustainability.

Relatedly, the concept of the circular economy has been identified as a "…popular approach to create sustainable business" (Tunn et al., 2018, p324). But there exists criticism that the circular economy is a rather wide and undefined research field because there are merely 'collection of vague and separate ideas' but no singular definition of the term has been reached (Korhonen et al., 2018). In fact, it was found that even though the concept of the circular economy prioritises environmental sustainability and the economic systems, the social dimensions are usually absent (Geissdoerfer et al., 2017; Murray et al., 2017; Sauvé et al., 2016). The emerging research field of sustainable business models (SBMs) seem to be able to overcome these concerns and to be a useful framework to create 'systems change' towards sustainability in organisations (Bocken et al., 2015). In this regard, the research focus among academics and business practitioners has been on the emerging major research field of sustainable business models (SBMs), which aim to systematically integrate sustainability into business (Bocken et al., 2014). SBMs have been defined as "… business models that incorporate pro-active multi-stakeholder management, the creation of monetary and non-monetary value for a broad range of stakeholders, and hold a long-term perspective (Geissdoerfer et al., 2018, p403). But, there is still a lot of work required to develop and adapt the occurrence of SBMs in practice (Tukker, 2015). Further, Evans et al. (2017) states that there is a paucity of empirical research on business model innovation (BMI) towards more SBMs as the lack of theoretical research is reflected in the scarce number of case studies and empirical analysis in the field.

This study aims to fill this knowledge gap in examining the necessity and contribution of developing a sustainable business model (SBM) for the rapidly developing battery second use (B2U) market within the emerging electric vehicle (EV) industry. We intend to gain knowledge through understanding how the electric vehicle (EV) industry and its underlying B2U market along with its evolving stakeholders. We investigate their business-related activities that are not only focused on economic profitability but also address wider social and environmental stakeholder value as part of SBM perspectives. These two streams are rapidly evolving, and its interconnection is still not extensively disinterred.

## 2. Towards new and more sustainable business models

The concept of 'business models' gained popularity in the 1990s and is a complex research field whereby key strategy-oriented literature perceive a business model as a holistic description on 'how a firm does business' by creating and capturing value within a value network (Chesbrough, 2010; Zott and Amit, 2008; Teece, 2010; Richardson, 2008; Johnson et al., 2008; Osterwalder et al., 2005; Osterwalder and Pigneur, 2002; Chesbrough and Rosenbloom, 2002). The central element of any business model is the value propositions as customers do not only need to comprehend a company's offering but also its value proposition and how it differentiates to competing offerings (Chesbrough, 2010; Zott and Amit, 2008). Richardson (2008) introduced a widely accepted business model framework, including the value proposition (product/service offering and target customer segments and differentiation strategies), value creation and delivery (key activities, resources & capabilities, position in the value network etc.) and value capture (revenue model and cost structure). Business models are defined by Teece (2010) as "… the design or architecture of the value creation, delivery and capture mechanisms employed" (p.179). This study perceives business models by its three interrelated value elements (Fig. 1). These are the value proposition (product/service offering and target customer segments and differentiation strategies), value creation and delivery (key activities, resources & capabilities, position in the value network) and value capture (revenue model and cost structure) (Richardson, 2008).

Business model innovation (BMI) is about organisations identifying new value propositions (and how to create, delivery and capture it) and has been widely acknowledged as the key to unlock the creation of sustainable business(Boons and Lüdeke-Freund, 2013). Accomplishing sustainability in business has become a central research area because companies are the productive resources of the global economy and without their backing, functional sustainable development cannot be realised. Subsequently and in order to respond to these persistent challenges, the United Nations (UN) have introduced the 2030 Agenda for Sustainable Development including its 17 Sustainable Development Goals (SDGs) and 169 targets to eliminate poverty and achieve global sustainable development by 2030 (United Nations Secretariat, 2018). According to the World Economic Fourm (2019) there has never been "…a more pressing need for a collaborative and multi-stakeholder approach to shared global problems" (World Economic Forum, 2019, p5).

Considering the triple bottom line, the most known approach to advance sustainability integration into business practices, the emerging major research field of SBMs appear to offer a comprehensive solution as they incorporate the concept by acknowledging the environment and society as part of a wider stakeholder network (Bocken et al., 2014; Elkington, 1997). A SBM is defined as a business model for sustainability that "…helps describing, analysing, 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, p3). Relatedly, at the core of any SBM is the sustainable value proposition (SVP) that has been defined as the "… promise on the economic, environmental and social benefits that a firm's offering delivers to customers and society at large, considering both short-term profits and long-term sustainability" (Patala et al., 2016, p144). Baldassarre et al. (2017) introduced the SVP framework that is the result of a given sustainability problem, the resulting stakeholder network and developed product/service in the network that addresses this problem (Baldassarre et al., 2017).

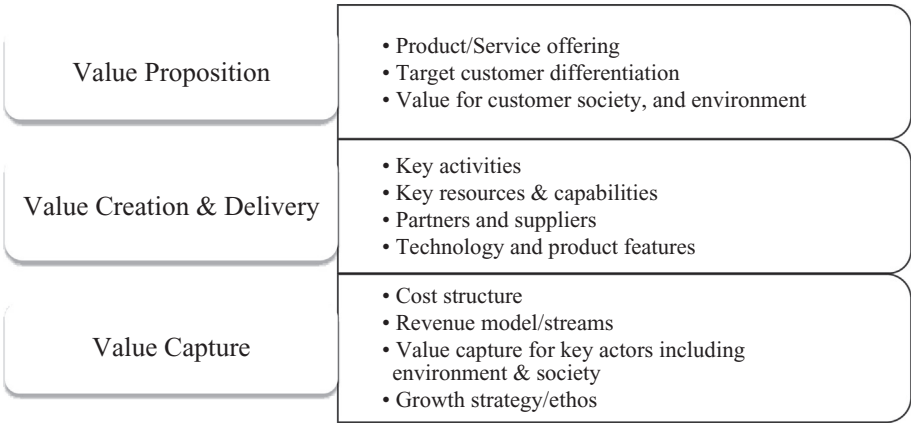


**Fig. 1.** Business model framework synthesis (adapted from Bocken et al., 2014; Richardson, 2008; Osterwalder et al., 2005 )

However, existing available academic literature remains conceptual on SBM practical tool and framework development such as the value mapping tool (Bocken et al., 2013), sustainable value analysis tool (Yang et al., 2017, 2014, 2013), the flourishing canvas (Upward and Jones, 2016) and the triple layered business model canvas (Joyce and Paquin, 2016). These approaches and practical tools are rare among presently available research, yet they have been found to only focus on distinct phases of the innovation process (Geissdoerfer et al., 2016).

Against this background, Yip and Bocken (2018) identify SBMs as a type of 'sustainable innovation' as both concepts achieve a balance of "…competing and complementary interests of key stakeholders' segments, and contextually business sustainability should manifest as economic viability and contribute to both societal and environmental sustainability" (p151). We consider this notion of thinking as extremely important since there exists no clear consensus on defining the term 'sustainable innovation', further complicated due to the complexities around the terms 'sustainability' and 'sustainable development'. According to Arthur D. Little (2005) 'sustainability-driven innovation' is "…the creation of new market space, products and services or processes driven by social, environmental or sustainability issues" (p3). Building on the concept of business models and definition of eco-innovation set out in the review by Carrillo-hermosilla and Könnölä (2010), Boons et al. (2013) deliver a concise definition of sustainable innovation stating, "'innovation that improves sustainability performance', where such performance includes ecological, economic, and social criteria'" (p3). Thus, we follow the argument from Yip and Bocken (2018) with the belief that the major emerging research field around SBMs highlights that any present or future innovation must include all sustainability dimensions. In any other case, it could be claimed that this is unethical and unmoral considering the pressing needs for firms to achieve functional corporate sustainable development to tackle the ongoing global climate crisis.

### 2.1. A focus on the sustainable business model archetypes

The literature on SBMs further describes sub-categories, subtypes and generic strategies such as product service systems or base of the pyramid, which were examined in an extensive review by Bocken et al. (2014) and synthesized as the so-called 'sustainable business model archetypes' to develop a unifying research agenda. The emergence of the sustainable business model (SBM) archetypes or sometimes referred to as the SBM generic strategies, deliver a concise and unifying research agenda on types of major sustainable innovations that in turn leads to more SBMs (Bocken et al., 2014). The SBM archetypes present major orientations of diffusion of new and clean technologies, social innovations and organisational solutions that could contribute to building up the business model for sustainability while providing managers and practitioners with useful examples; hence Bocken et al. (2014) argues that "to tackle the pressing challenges of a sustainable future, innovations need to introduce change at the core of the business model to tackle unsustainability at its source rather than as an add-on to counteract negative outcomes of business" (p44).

Recently, the archetypes have been further developed by Bocken et al. (2016) and Lüdeke-Freund et al. (2016) to include nine archetypes distributed to environmental, social and economic categories as the major innovation types derived from the concepts of sustainable development and the TBL approach (Table 1) (Ritala et al., 2018; Elkington, 1997). The archetypes are of immense value since they represent typical examples of solutions that contribute to establish SBMs in theory and practice. Ritala et al. (2018) emphasizes on the importance of the SBM archetypes stating, "…we expect this taxonomy to cover the most common instances of sustainable business activities, and therefore, it is an applicable tool to understand how sustainable business models are actually adopted" (p219). However, despite their momentous potential with emerging innovative solutions as it might be the case with EV B2U, and a noticeable call for action to tackle pressing issues such as pollution and resource scarcity, these generic SBM strategies have not been accepted by industries (Despeisse et al., 2017). Finally, we would like to highlight that this study does not refer to cultural or decision making archetypes but rather fundamental business models for companies. These categorizations are primordial and essential business models. They are the starting position that allows for later more complex business behaviour to emerge following the original formulation and thus this will be another contribution of this study.

## 3. Methods

This is a seminal exploratory research based on sporadic previous relevant studies. Due to this fact we aim to she fresh light by synthesizing the most important elements from previous studies and collecting relevant primary data on them to record the present status and outline hidden gems in the process of sustainable business models on innovations. As a result of the lack of empirical research on sustainable business model (SBM) occurrence in the electric vehicle (EV) battery second use (B2U) industry, a qualitative and exploratory research approach was adopted (Eisenhardt, 1989). As this research focuses on an area of knowledge where little is

**Table 1**
**Overview of the sustainable business model archetypes** (based on Bocken et al., 2014; Lüdeke-Freund et al., 2016; Ritala et al., 2018).

| | Environmental | | | Social | | | Economic | | |
|---|---|---|---|---|---|---|---|---|---|
| Archetypes | Maximise material & energy efficiency (1) | Closing resource loops (2) | Substitute with renewables and natural processes (3) | Deliver functionality, not ownership (4) | Adopt a steward-ship role (5) | Encourage sufficiency (6) | Repurpose for society/ environment (7) | Inclusive value creation (8) | Develop sustainable scale up solutions (9) |
| Definition | Do more with fewer resources Generate less waste, emissions, and pollution | Reuse materials and products. Turn waste into feedstocks for other products/ processes | Use of non-finite materials and energy sources. | Provide services that satisfy users' needs without their having to own physical products | Proactively engage with all stakeholders to ensure their long- term health and well-being | Solutions that actively seek to reduce end-user consumption | Seek to create positive value for all stakeholders, in particular society and environment | Sharing resources, knowledge, ownership, and wealth creation, inclusive value generation | Delivering sustainable solutions at a large scale to maximise benefits for society and the environment |
| Examples | Low-carbon manufacturing Lean manufacturing Additive manufacturing Low-carbon solutions Dematerialisation Increased functionality | Circular economy and closed loop Cradle-2-Cradle Industrial symbiosis Reuse, recycle, remanufacture Take-back management | Move from non-renewable to renewable energy sources Solar and wind power-based innovation Zero-emissions initiative Slow manufacturing | Product-oriented PSS-maintenance, extended warranty Use-oriented PSS-rental, lease, shared Result-oriented PSS-pay per use | Biodiversity protection Consumer care – promote consumer health and well-being Ethical trade (fair trade) Choice editing by retailers Radical transparency about environmental/ societal impacts | Consumer education, communications and awareness Demand management Slow fashion Product longevity Premium branding/limited availability Frugal business | Not for profit Hybrid business, social enterprise (for profit) Alternative ownership; cooperative, mutual, collectives Social and biodiversity regeneration initiatives | Collaborative approaches (sourcing, production, lobbying) Peer-to-peer sharing Inclusive innovation Base of pyramid (BoP) solutions | Incubators and entrepreneur-support models Open innovation (platforms) Patient/slow capital Impact investing/ capital Crowdsourcing/ funding Peer-to-peer lending |

understood, an analytic inductive theory development approach with the help of semi-structured case study interviews was adopted (Fig. 2) (Saunders, 2017).

### 3.1. Data collection and sampling

This study first briefly reviews relevant literature on the developing research field of SBMs with the SBM archetypes emerging as a useful and key lens for data analysis of our case samples. Data were collected from peer-reviewed literature on SBMs through searching the academic databases of Web of Science and Scopus with a combination of the keywords of "sustainable business model" and "business models for sustainability". Subsequently, we applied previously identified inclusion and exclusion criteria to the literature set (Table 2).

In the second stage, fourteen semi-structured interviews were carried out with stakeholders in the emerging EV B2U industry to identify their current practices, views and experiences. The application of the multiple-case study research strategy fits particularly well for this study to comprehend the activities taking place in the context of the different stakeholders involved and business models deployed. Further, multiple-case study research, where the focus is within and across cases, underlies the logic of replication and has been found to be superior to single case study approaches as the evidence from the multiple cases is considered more compelling and overall study is regarded as more robust (Yin, 1994).

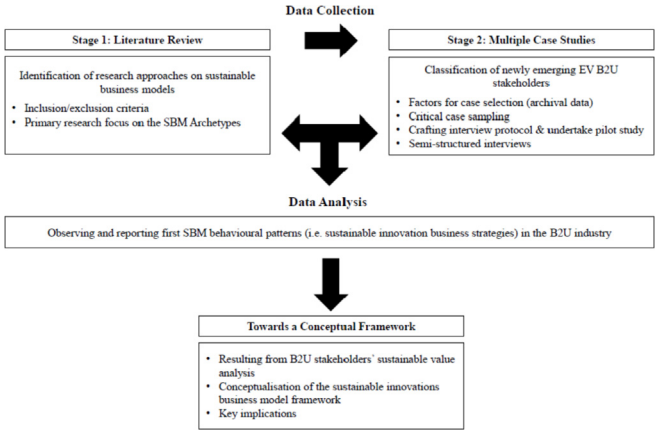


**Fig. 2.** Research approach.

As the B2U market is still in its very early stages, it is difficult to estimate and identify the exact number of emerging stakeholders over short amount of time. Therefore, we searched available archival data (e.g. company releases, news bulletins and press releases), which were all screened under the inclusion criteria of relating to the emerging B2U market and correlated innovative stakeholder activities (Yin, 2011). As a result of the diversity of the emerging innovative B2U market along the difficulty of classifying all participating stakeholders, this study applies the purposeful sampling technique of critical cases that ' … involves identifying criteria in advance that distinguish cases from others that make up the majority of a population and using those criteria to select cases'(Lee and Saunders, 2017, p. 85). This type of sampling is especially suitable if a small number of cases can be sampled whereby the focus is on comprehending what and why is happening in each critical case (Struwig and Stead, 2001). This permits to develop logical generalizations from collected rich evidence of the selected in-depth case study data that can also apply to other cases because if it is true in this case, it is likely to be true for all other cases (Patton, 2002). The criteria selected for this study include those stakeholders (*i.e.* companies) that are participating in the evolving B2U industry through adapting (innovative) business models. As the majority of stakeholder engagement in the nascent B2U industry is classified through pilot projects with only a few projects having moved to early commercialisation stages, both have been considered for this study. Given the problem of dearth of data in determining all participating stakeholders in this innovative and

**Table 2**
Inclusion and exclusion criteria of literature search.

| Included | Excluded |
|---|---|
| Studies with a primary research focus on sustainable business models, sustainable business model innovation and sustainable business model archetypes | Studies with a distinct focus on sub-categories, sub-fields etc of sustainable business models such as circular business models, circular business model innovation, circular economy, eco-innovation, resource efficiency, sustainable resource management, sustainable consumption and production (etc.) |
| Type of study: peer reviewed journal articles, conference papers and book chapters | Type of study: non-peer reviewed journal articles, theses/dissertations and reports |

disrupting industry, we have decided to further include EV B2U research experts in your sample to expand the perspective on the topic. The rigorous scientific method of data triangulation was applied for this study through multiple data collection sources, tackling single sources bias and thus leading to an improved research credibility and dependability (Seale, 1999). Furthermore, a comprehensive state-of-the art study on the concept of B2U from Martinez-Laserna et al. (2018) underlined that "…additionally, it needs to be pointed out that, to date, automotive OEMs or ESS integrators were barely involved in battery second use research publications" (p.713). Hence, we attempt to deliver such novel perspectives on the B2U industry through synthesizing results from the previously isolated automotive and energy markets, which are now entering into business agreements.

This study was conducted between September 2018–March 2019. Most interviews were conducted with managers and chief executive officers (CEOs) and lasted between 60 and 120 min (min). The interview started with an introduction to the interviewer, brief contextual research background, previous research results on the topic and objectives of this research study. During the interview questions were asked and discussed that related to the rapidly developing EV market, the emerging topic of B2U and its correlation to the EV sector, the company's involvement in B2U projects and innovative sustainable business model perspectives for B2U.Table 3.

### 3.2. Data analysis

Since the interviews were the primary technique of the data collection, it was important to be aware of the kind of the data analysis in the earlier stages, where the unit of analysis is the business model and sustainability-related business strategies of our case samples. All interviews were recorded and transcribed and relied on the strong operational method of qualitative thematic analysis, a process of identifying themes or patterns within collected data (Braun and Clarke, 2006; Lee and Saunders, 2017).

Further, the analysis was primarily based on the criteria and categories developed from our literature review on sustainable business models (SBMs), in particular the deriving importance of the SBM archetypes. Thus, we mainly integrated knowledge from the previously discussed SBM archetypes as a lens for qualitative data content analysis to classify B2U stakeholder sustainable business innovation related activities into a suitable and comprehensive set of SBM B2U archetypes and resulting sustainable value analysis. We used the most recently updated SBM archetypes (Table 1) to investigate and structure current and prospective (sustainable business models) in our case samples. Consequently, we first highlight the importance and definitions of SBM Archetypes, present their occurrence in relation to our case samples, discuss implications and finally present our key contribution, conceptualising a sustainable innovation business model (SIBM) framework for the B2U industry.

## 4. Results

This section presents the identification of the SBM archetypes for the B2U stakeholder case samples and their associated B2U industry sustainability-related business activities and resulting value analysis (Table 4 – 7).

### 4.1. Case 1: EV manufacturers

Following interviews within Case 1, a combination of SBM archetypes occurrence has been identified (Table 4). It was further confirmed that B2U is a dominant cost-effective solution that could lead to additional revenue generation for EV manufacturers (Jiao and Evans, 2016). Thus, EV companies would be able to lower their vehicle prices, making this innovative technology more competitive and attractive towards the global mass market.

The resulting and new value proposition is thus mainly centred on slowing and closing resource loops – archetype (2) – as previously considered EV waste batteries are reused in less demanding applications in the energy storage market. This directly leads to the identification of archetype (1) as the engagement in B2U activities

**Table 3**
Battery second use stakeholder cases.

| Case | Stakeholder Role | Position of interviewee | Location | Length and type of interview |
|---|---|---|---|---|
| 1 | EV manufacturer | Manager | France | About 60 min on the phone |
| 1 | EV manufacturer | Manager | Germany | About 45 min on the phone |
| 1 | EV manufacturer | Manager | South Korea | About 90 min on the phone |
| 1 | EV manufacturer | Manager | Spain | About 60 min on the phone |
| 2 | Energy storage/B2U service & system provider | CEO | United Kingdom | About 60 min on the phone |
| 2 | Energy storage/B2U service & system provider | Manager | USA | About 60 min on the phone |
| 2 | Energy storage/B2U service provider | Manager | Spain | About 45 min on the phone |
| 2 | Energy storage/B2U service provider | CEO & Founder | United Kingdom | About 90 min on the phone |
| 3 | Battery Lifecycle Management | CEO & Founder | Australia | About 90 min on the phone |
| 4 | Battery recycler | Manager | Germany | About 45 min on the phone |
| 4 | Battery recycler | Manager | Belgium | About 30 min on the phone |
| 5 | B2U Expert (Research) | Manager | Spain | About 120 min in-person interview |
| 5 | B2U Expert (Research) | Post Doc Researcher | Spain | About 90 min in-person interview |
| 5 | B2U Expert (Analyst) | Research Analyst | United Kingdom | About 60 min on the phone |

**Table 4**
Identified SBM archetype(s) Case 1.

| SBM archetype | Value proposition | Value creation & delivery | Value capture |
|---|---|---|---|
| Maximise materials & energy efficiency (1) | Fewer use of resources, generate less waste and emissions than product/services that deliver same functionality | Activities and partnerships to reduce resource use with a focus on product and manufacturing process innovations, new partnerships and value network reconfigurations | Environmental value: Substantially reduced costs through optimised resource use<br>Positive impact on environment and society through minimised environmental footprint |
| Closing resource loops (2) | Previously thought waste is eliminated and reused in a new application through life-cycle based approach | Activities and partnerships to eliminate life cycle waste<br>Close material loops<br>New partnerships, potentially across industries (e.g. with recycling companies) | Reduced costs through reuse/second use<br>Positive impact on environment and society through minimised environmental footprint & extended producer responsibility |
| Deliver functionality, not ownership (4) | Services that satisfy customer's need without the need to physically own product as part of B2U ESS (pay per use/rental/lease/buy) | Delivery through product/service offerings that require significant changes to the firm<br>New partnerships to deliver holistic solutions | Social value: support sustainability-related behaviour among customers and suppliers<br>Decrease necessity to own physical good<br>Market expansion: more consumers likely to pay for the service |
| Inclusive value creation (8) | Innovative collaborative cross-sectoral multi-stakeholder platform (B2U industry) | Sharing resources, knowledge, ownership, and distributed wealth creation. Inclusive value generation | Economic value:<br>Major new business opportunities<br>Leverage resources, time and talents |

has the positive impact of eliminating previously perceive waste that is no reused in new applications. In addition, archetype (4) has been identified as it is based on the literature of product service systems (PSS), which in essence is about shifting from offering products towards pure service driven business models (Tukker and Tischner, 2006). Considering that some of the interviewed EV companies are already offering battery leasing agreements to their customers, highlights the incremental shift to such business models.

As EV companies are the physical owners of the battery packs, the value creation & delivery is focused on activities and new partnerships and value network configurations. This has been confirmed in the set of multiple interviews since all of the interviewed EV companies are engaging in cross-industry multi-stakeholder partnerships to evaluate the full value of second life batteries. The value capture is centred on less resource use and thus aims at positive impacts on society and the environment. Therefore, the combination of identified SBM archetypes delivers a variety of positive impacts on this new and more sustainable business model, which are cost savings through enhanced efficiency and improved resource use, previously considered waste is turned into new value and thus new avenues of revenue streams and the potential to trigger an industry wide change for industrial sustainability.

### 4.2. Case 2: energy storage/B2U service & systems providers

With regards to Case 2, a combination of three archetypes was identified (Table 5). As the concept of B2U employs used EV batteries cost-effectively in ESS, the energy markets are highly interested in such alternative revenue streams. This results in a value proposition that is primarily focused on reducing negative impacts on environment and society – archetype (3) – through the use of increased renewable energy sources as a viable solution. From similar importance is the occurrence of archetype (4) as companies within Case 2 are the expert on the energy storage markets and are marketing B2U within ESS towards final customers (through pay per use/rental/lease/buy).

The resulting value creation & delivery is principally based around product/process innovations as it is the case with B2U. Most of the interviewed stakeholders in this sample have confirmed that such 'breakthrough innovations' avenues must be undertaken to effectively deploy second life batteries in the storage sector. New cross-industry partnerships are necessary to trigger such change and the creation of environmental and social benefits. In fact, companies within Case 2 have engaged in business model agreements with OEMs but at different scales such as standard business model (sell/buy batteries) or collaborative business models (share expertise, knowledge and resource).

Lastly, the value capture mainly refers to reducing finite resources, waste and pollution while capturing environmental value through increased renewable energy use. This in turn leads to major new business opportunities within the energy storage markets, which are predicted to grow substantially over the next few decades.

**Table 5**
Identified SBM archetype(s) Case 2.

| SBM archetype | Value proposition | Value creation & delivery | Value capture |
|---|---|---|---|
| Substitute with renewables and natural processes (3) | Use of non-finite materials and energy sources (B2U in storage systems) | Product/process innovation by introduction renewable energy sources (innovative B2U products/services)<br>New partnerships to deliver holistic solutions | Environmental value: less resource use, reduce emissions related to non-renewables (fossil fuels) |
| Deliver functionality, not ownership (4) | Services that satisfy customer's need without the need to physically own product as part of B2U ESS (pay per use/rental/lease/buy) | Delivery through product/service offerings that require significant changes to the firm<br>New partnerships to deliver holistic solutions | Social value: support sustainability-related behaviour among customers and suppliers<br>Decrease necessity to own physical good<br>Market expansion: more consumers likely to pay for the service |
| Inclusive value creation (8) | Innovative collaborative cross-sectoral multi-stakeholder platform (B2U industry) | Sharing resources, knowledge, ownership, and distributed wealth creation. Inclusive value generation | Economic value:<br>Major new business opportunities<br>Leverage resources, time and talents |

**Table 6**
Identified SBM archetype(s) Case 3.

| SBM archetype | Value proposition | Value creation & delivery | Value capture |
|---|---|---|---|
| Develop sustainable scale up solutions (9) | Unlock substantially extended lifetime and performance of EV batteries through BMS technology<br>Sustainability solution to maximise benefits for society, environment but also economy | Partnerships with potential and unusual partners (e.g. government) and other organisations crucial to scale the business | Economic value:<br>Achieve scale: from start-up to large scale project<br>Ensuring a viable fee is paid for scaling up the solution/venture<br>Potential breakthrough innovation |

### 4.3. Case 3: battery lifecycle management

For Case 3, archetype (9) has been identified (Table 6). This came as no surprise since this stakeholder is a unique battery control technology specialist start-up developing advanced solutions around lifetime-extending battery management system (BMS) technologies for EV batteries. This system reduces the upfront costs of batteries by 30% through recycling the 'best' cells within degraded EV batteries and connecting them with smart technology that extends overall lifetime and sustainability.

The resulting value proposition is focused around scaling up the company from start-up to large scale to maximise sustainable value benefits, that in turn can create an industry wide change for sustainability by e.g. creating breakthrough innovations. In fact, the stakeholder of Case 3 has been named as one of the top 15 start-ups globally, because the company demonstrated to realise capable, long-lived, and cost-effective storage in residential and commercial & industrial B2U applications. As a result, the value creation & delivery systems are focused on securing partnerships and investments, including unusual relationships with e.g. governments, to scale up the business. Last, the vale capture is around receiving viable fees (profits) for scaling up a potential breakthrough innovation in the global energy market.

### 4.4. Case 4: recyclers

In evaluating interview data from Case 4, it seems that none of the SBM archetypes can be related and identified. It appears that recyclers have no strong interest in the direct participation of an emerging B2U market but highlighted their interest for battery recycling (after 2nd or even 3rd EV battery life) to produce battery active materials. It appears that recyclers are merely 'participating' in the emerging B2U market and potential joint ventures agreements as a result of the ongoing unsustainable but economically viable battery recycling processes (value proposition). The interviews have confirmed that recyclers are not directly involved in B2U as they have no ambitions to assess batteries for functional refurbishment (i.e. second life applications). This raises the major sustainability concern to whether recyclers are actively engaging in sustainable innovation approaches at all in the B2U markets. In fact, we would argue that recycling LIBs remains immature and expensive, clearly underlining the importance of moving drastically towards integrating the concept of B2U. At this point, we argue that such business activities can be related to the entire business eco-system and conclude that there appears to be a lack of willingness towards functional corporate sustainable development in the EV sector. At this point we conclude that it is likely that other companies with newly emerging innovative SBMs will attempt to offer increased radical sustainable circular recycling solutions as part of collaborative joint ventures.

### 4.5. Case 5: B2U research experts

Data from Case 5 confirmed our previous notion on including B2U research experts in our sample (Table 7). The concept of B2U and its relation to SBM perspectives remain relatively unexplored in the global scientific community. Thus, there are very limited number of global B2U experts and researchers available. We feel that such experts and researchers are crucial to be included in prospective SBM modelling process since their value proposition includes benefits to all stakeholders by engaging with the 'full story' through their expertise on the concept of B2U and how it contributes to business models for the circular economy or functional corporate sustainable development. This leads to a value creation & delivery system, which includes pioneering research activities in the field through international partnerships and collaborations both, in academia and industry. The direct results are valuable implications for policy makers, practitioners and business managers. Therefore, the value capture focuses on securing increased project and research funding based on scientific contributions and relevancy for industry. This will result in positive impacts such as to achieve long-term viability of the value network (Lüdeke-Freund et al., 2016). Further, there are associated important benefits to society as innovative studies on B2U and SBMs address contemporary major concerns: move towards a sustainable transport and energy system as soon as possible.

### 4.6. Towards a conceptual framework

This is the major theoretical contribution of this article. The purpose of this paper was to examine the inevitability of developing sustainable business models (SBMs) for the rapidly developing battery second use (B2U) market within the emerging electric vehicle (EV) industry. To our great surprise we found that there is a lack of agreed concepts and frameworks that support sustainable business model innovation in the context of prospective functional corporate sustainable development.

In synthesizing and building upon previously discussed literature and key results from our case analyses, this study advances to proposes a conceptual sustainable innovations business model (SIBM) framework in order to facilitate participating B2U stakeholders to maximise shared sustainable value of degraded EV batteries through identifying major sustainable innovation strategies as part of innovative and more effective SBMs (Fig. 3). This realisation and contribution alone, offers a range of important practical advice for managers and policy makers.

Furthermore, the particular model includes major findings on the EV B2U macro environment (Reinhardt et al., 2017, 2016; Fischhaber et al., 2016), as well as the impact of the SBM archetypes (as major sustainability innovations) on the organisational level towards establishing more and new SBMs. This is from great importance since adopting SBMs requires to integrate key macro and micro levels. In comprehending SBM archetype(s) occurrence

**Table 7**
Identified SBM archetype(s) Case 5.

| SBM archetype | Value proposition | Value creation & delivery | Value capture |
|---|---|---|---|
| Adapt a steward-ship role (5) | Benefits to all stakeholders (through academia) by engaging with the 'full story' | Research activities through international partnerships & collaborations with leading experts in the field | Social value:<br>Innovative studies and resulting solutions on urgent sustainability problems<br>Increased Project Funding in the field without breaching conflict of interests |

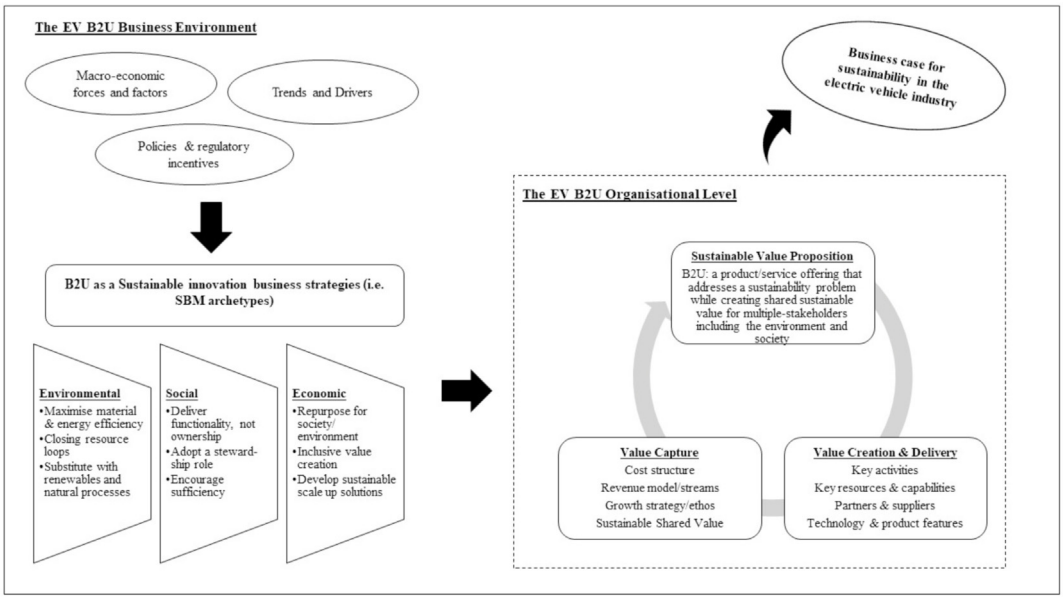


**Fig. 3. Conceptual sustainable innovation business model framework** (based on and developed from Richardson, 2008; Bocken et al., 2014, 2015, 2016; Lüdeke-Freund et al., 2016; Baldassarre et al., 2017; Ritala et al., 2018).

and impacts in our case samples, we were able to draw an innovative sustainable business model that includes sustainable value propositions (Baldassarre et al., 2017; Bocken et al., 2016). Thus, our framework informs that the SBM archetypes are a type of major sustainable innovations that drives sustainable value along the entire sustainable business model. Ultimately, this could then build the business case for sustainability within the emerging EV B2U industry. Our study attempts to deliver major implications to scholars and practitioners by opening up a major discussion on SBM adoption in practice with the help of rich in-depth interview data from EV B2U stakeholders. We invite further research, contributions and criticism on our work that we believe create a new research pathway with clear implications for the economy, environment and society. Through reporting first SBM behavioural patterns in the B2U industry, this study facilitates practitioners and managers in moving from theoretical to practical industrial sustainability as part of novel SBM approaches.

### 4.7. Discussion and contributions

There is strong evidence that participating stakeholders in the emerging B2U market have started to engage in various forms of sustainable value creation activities. This has become an integral part of their innovative sustainable business processes (i.e. SBM archetypes) within the emerging B2U industry that was not up until now clearly understood and emphasized. In other words, the application of degraded EV batteries at low cost in less demanding stationary storage systems in the energy markets seems to be now a key activity that is both sustainable from multi-stakeholder perspective and profitable. Understanding and practising a particular type of SBM archetype is a key strategic element in the business model of the major competitors within the B2U industry. This was, up until now, an underlying important link in the success and sustainability of these competitors but not unearthed, conceptualised and fully explored. Further proof from our data demonstrates surprising differences in SBM archetype identification and occurrence among B2U stakeholder activities and resulting sustainable value(s). Our case samples provide key insights that there appears to be the existence of either none of the SBM archetype(s), a combination within one sustainable innovation archetype (e.g. environmental innovation) or the existence of all sustainable innovation archetypes.

Most notably, it was unearthed that EV companies and energy storage/B2U service & system providers appear to innovate at all three SBM archetype levels that are environmental, social and economic sustainable innovation business strategies. Both stakeholders have an immense interest in the success of a potential B2U market as cheap batteries are becoming available for the energy markets while EV companies can generate additional revenues that in turn could lower total vehicle prices and overall sustainability performance. Therefore, it becomes comprehensible that the archetype of 'inclusive value creation' mainly occurs within Case 1 and 2. According to Reinhardt et al. (2019b), the emerging B2U industry has the potential to disrupt and revolutionise current landscapes of the automotive and energy sectors as reusing LIB batteries through B2U embodies the most cost-effective electricity storage solution available today. On the other hand, Case 3 and Case 5 have engaged in economic and social sustainable innovations

respectively. Yet, innovating at 'merely' one major archetype still has the ability to connect positively to more SBMs and positively create synergistic value. This value is respectively disseminated to different stakeholders and has a beneficial effect to society, environment and economy. The particular realisation is further supported by Lüdeke-Freund et al. (2016) stating, "…indeed, every single archetype can contribute to sustainable development, but their potential effects will be more powerful if they are combined" (p57).

In fact, the occurrence of one or a combination of more than one archetype, still has the same effect of creating (dominant) sustainable value, that in turn leads to a new and more SBMs where sustainable value is driven along the entire model. This is confirmed by relating the observed B2U industry activities to the recently proposed sustainable value proposition (SVP) framework. The SVP framework is not only a key contribution to theorists since it is based on the key interrelated elements of shared sustainable value creation for a network of shareholders. At the same time, it provides major implications for practitioners, addressing the sustainability problem and consequently developing a product/service as a solution to a much needed sustainability equilibrium between natural resources and societal/economic prosperity (Baldassarre et al., 2017).

## 5. Conclusions, limitations and contributions

The goal of this study was to contribute to the literature on sustainable business model (SBM) perspectives for the emerging battery second use (B2U) industry within the rapidly evolving electric vehicle (EV) industry.

Major results from our case samples indicate that there is evidence that participating stakeholders in the emerging B2U market have started to engage in some form of sustainable value creation activities as part of their innovative sustainable business processes (i.e. SBM archetypes). In fact, it was unearthed that either none, singular or a combination of the SBM archetypes are occurring within EV B2U sustainability business-related activities.

Finally, and as a direct result from our analysis, we propose a conceptual framework that captures such sustainable innovation business model strategies towards achieving more sustainable business models in practice. These could ultimately result in increased industrial sustainability in the EV industry. In addition, we argue that the concept of B2U might prove itself to be an exemplary case of how SBMs can be implemented in practice through adapting the widely acknowledged but not by industry accepted SBM archetypes for analysis.

However, as a result of the explorative research context, there can be some limitations to this study that must be acknowledged. First, this study and its resulting SIBM framework have only been applied to the EV B2U industry. Furthermore, at this point it is extremely difficult to estimate the exact size and number of emerging B2U stakeholders as the industry is still emerging and hence there is the issue of limited data availability and dearth of data. The SBM archetypes have been developed with a focus on the manufacturing industry and follow up studies have adapted the archetypes to e.g. banking industry. This raises another limitation since our study is focused on the B2U industry. However, this is an innovative forming market that brings together cross-sectoral stakeholders. Thus, this limitation is up to debate to some degree since it creates the space for further research and more creative efforts to fill gaps and links between the particular approach and current practices. Future studies shall evaluate further empirical case study research that contributes to identifying SBM occurrence and adaption by specific industries.

All things considered, we believe that this is an interdisciplinary effort that will revolutionise a whole business and its practises towards a sustainable future. It was shown that the concept of B2U relates to increased cleaner production since previously considered EV waste batteries are prevented and reused in less demanding applications. Considering the prospective EV market uptake in the future, this will have substantial impact on increased resource and energy efficiency as part of more effective circular economy approaches in the global EV industry. Managerial implications reshape the way managers view strategies and tactics in this market, whereas we challenge current theoretical perspectives with fresh insights and new research streams on sustainable business model (SBM) adoption in the rapidly emerging EV B2U industry.

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## Author contribution statement

We, the authors, have decided not to submit an author contribution statement.

## Declaration of competing interestCOI

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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