Enablers of Managerial Practices for Circular Business Model Design: An Empirical Investigation of an Agro-Energy Company in a Rural Area

Pasquale Del Vecchio, Andrea Urbinati, and Julian Kirchherr

***Abstract*—The concept of circular economy (CE) has gained prominence in management research as a new industrial approach that society, companies, and policymakers should follow in aiming to manage for sustainability issues. The adoption of CE principles has highlighted particular managerial practices that companies can implement in their business models. However, existing research still falls short of describing in sufficient detail the enablers of these practices for a circular business model design. This issue, especially in rural areas, is particularly interesting for the agri-food sector, which is characterized by enormous sustainability challenges, including food production and waste, packaging, transportation, consumer habits and behavior, and energy production and consumption. This article takes stock of this gap through an analysis of the enablers of managerial practices in Fiusis, a company operating in the agro-energy sector of a rural area, which has designed a circular business model and was recognized as "the best business model in the rural area" by the European Commission in 2019. The case highlights the importance of a suitable political and institutional environment beneficial to the starting-up and development of the business, and the importance of collaborating within the community of stakeholders for the creation of a new culture of sustainability.**

***Index Terms*—Agro-energy, circular business models, circular economy (CE), enablers, managerial practices, rural area, sustainability.**

I. Introduction

THE circular economy (CE) concept is widely considered as an innovative industrial paradigm that aims to substitute the traditional linear "take, make, dispose" model. CE's aim is to transform goods that are at the end of their service life into resources for others, closing loops in industrial ecosystems for effective consumption and utilization of resources, and minimizing waste, while also reducing overall resource consumption [1], [2]. Underlying the CE is the need for companies to radically change their business models and strategic positioning toward a more sustainable approach to doing business, creating value, and satisfying customers' needs [3]–[5].

The new field of circular business models studies businesses on their journey toward CE. This field has proliferated in recent years [6], [7]; it aims to further delve into the managerial practices that companies can implement in their business model to transform their linear business into a circular one [8]–[10]. Managerial practices represent the way top management, usually in charge of defining and modifying company strategy over time, and can make the transition to a new, (more) circular business model [11]. In the case of CE adoption in business models, for example, managerial practices can be related to the way companies use energy, materials, and resources, as well as to how they reduce the environmental impacts of their activities [12], [13].

While many studies have been published on circular business models in recent years [14]–[16], more theoretical and empirical effort is needed, in particular, to analyze the enablers of managerial practices for a circular business model design [17]–[20]. We understand enablers as those factors that enable and encourage the implementation of CE-driven managerial practices in companies' business models [21]–[23]. Some contributions in the direction of enablers for CE adoption in companies have been offered by the study on the coffee value chain [24], where enablers have been identified in values, technologies, and governmental policies. In the same direction, Rizos *et al.* [25] recognized corporate environmental culture, networking, financial attractiveness, recognition, and government support as those enabling factors in designing a circular business model. The topic of enablers has been accompanied in more recent literature by investigation of the barriers to CE adoption in companies, understood as those factors that obstruct companies in designing a circular business model [14]–[16], [26].

The analysis of circular business models' enablers is particularly interesting to address in the field of energy production and consumption in the agri-food sector [27]. Studying the agri-food sector is particularly relevant, given its enormous sustainability and CE challenges, including food production and waste, food packaging, transportation, consumer habits and behavior, and energy production and consumption [28]. So far, the study of

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Pasquale Del Vecchio is with the Department of Management, Finance and Technology, LUM University, 70010 Bari, Italy (e-mail: delvecchio@lum.it).

Andrea Urbinati is with the School of Industrial Engineering, LIUC Università Cattaneo, 21053 Castellanza, Italy (e-mail: aurbinati@liuc.it).

Julian Kirchherr is with the Innovation Studies Group, Copernicus Institute of Sustainable Development, Utrecht University, 3584 Utrecht, The Netherlands (e-mail: julian_kirchherr@mckinsey.com).

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the agri-food industry in the process of sustainable growth due to CE has focused on the use of biological resources for creating value-added products and their sustainable usage [29]. The transition of the agri-food industry toward a circular configuration can be achieved by using technological know-how and business practices that enable reuse of agricultural waste, by-products, and coproducts [30]. The relevance of the transition toward the CE is due to the complexity characterizing the sector in terms of the large and differentiated nature of production, the challenges of deterioration and shelf-life, the impact of weather and geographical condition, the need to guarantee safety and quality for the consumer, and the commoditization of production [31]. The focus on the agri-food industry is also relevant, given this industry is typically located in rural areas, which have rarely been studied in the CE literature (cf. [32]). Within the debate on sustainability of the agri-food supply chains and the sustainable development of rural areas, the production and consumption of energy is a topic of growing relevance. Starting from its primary theorization by Best [33], the concept of agro-energy has especially demonstrated to be a valid approach supporting the agri-food industry to have a positive impact on the environment, and it is promising mainly for rural areas where there is intensive use of agriculture and a major availability of agricultural resources [34], [35]. The effectiveness of a circular transition in the context of rural areas in conjunction with energy supply is influenced by a complex set of features and requires the adoption of a systemic approach able to leverage collaborations within supply chains, institutions, and stakeholders [36], [37].

Accordingly, one research avenue lies in studying the research stream of circular business models in the agri-food industry of a rural area, with particular attention paid to the agro-energy perspective in order to better understand the enablers that allow companies in such a context to adopt CE principles in their business model [38]. Accordingly, our research is aimed at producing one of the very first case studies on circular business model enablers in the agro-energy sector of a rural area, and addresses the following research questions: *What are the enablers of managerial practices for CE adoption in the business models of companies operating in the agro-energy sector of a rural area? How do these enablers support these companies in designing a circular business model?*.

To address these research questions, we leverage a single case study analysis of Fiusis, an innovative Italian company operating in the field of energy production for the agri-food supply chain. The company is located in a small Apulian town in the south of Italy. Due to the use of feedstock resulting exclusively from agrarian pruning and plantation removal and to the sustainable supply chain based on woody biomass, the company received a European Commission award in 2019 as "the best business model in a rural area." Therefore, Fiusis represents an exemplary case study for the intended scope of the current research.

From a theoretical perspective, the article advances existing theory in the field of circular business models, taking stock of enablers that allow companies to implement managerial practices in their business model for CE adoption, especially for those operating in the agro-energy sector of rural areas. From a managerial perspective, the article provides a comprehensive set of enablers, managerial practices, and CE outcomes that give practitioners and executives suggestions on how to accelerate the transition of companies in rural areas of the agro-energy sector toward the CE.

The article is organized as follows. After the Introduction, Section II presents the conceptual framing of the study, i.e., a review of the existing research at the intersection between CE, circular business models, and the agro-energy sector. Section III then explains the methodology we used for the research, while Section IV describes the main results deriving from the empirical analysis. Finally, Section V discusses the theoretical and managerial implications of the research, and Section VI summarizes our findings, including the main limitations of the article and avenues for future research.

II. Conceptual Development

A. Enablers of Managerial Practices for Circular Business Models

CE is an innovative industrial approach that has gained importance over the last few decades, as the traditional "take, make, dispose," linear economic model, has become unable to manage the demand and supply balance in the consumption of natural resources [39]. According to Mathews *et al.* [40], the CE can be defined as a closed-loop system, characterized by 1) the reduction of the consumption of nonrenewable sources and nonenvironmentally friendly raw materials; 2) the reuse of products and services that have been specially designed to be reused; and 3) the recycling of waste products into new resources for further use and consumption in the same or other supply chains.

From a micro-level perspective, the CE requires companies to reflect on changing their traditional business model into a new, circular, one, by significantly rethinking the anatomy of their business model, as well as their supply chain and supply chain collaborations, and strategic positioning [15], [41], [42]. Thus, companies should redefine the mechanisms of value creation, transfer, and capture while adopting CE principles [8], [43]. Several contributions addressing this strategic managerial view of CE have proliferated in the last few years and have mostly investigated the managerial practices that companies could implement at the business model level for the adoption of CE [44], [45]. Managerial practices represent the actions that top managers implement to operationalize the company's strategy [46]. Among the managerial practices for value creation, some relevant ones are represented by modularization, standardization, design for product disassembly, design for product recycling, and the use of resources and materials which are natural, recyclable, durable, and easy-to-separate [47]. In addition, as far as value transfer is concerned, companies may leverage particular practices to share and promote their circular value proposition, such as the direct involvement of clients and customers in their activities, or extensive communication through different channels, such as in-store advertising, website, and sales personnel [6], [48]. Again, relevant practices that could be adopted by companies for value capture, i.e., for gathering the value generated and converting it into revenue streams, cost savings, and value preservation, are

represented both by pay-as-a-service mechanisms [12], [49], and take-back systems or product-service systems [50].

While analyzing the managerial practices for a circular business model design, existing research has also paid attention to the factors that can enable and encourage the implementation of these practices for CE adoption in companies' business models [22], [23], [51]. Several enablers that seem particularly promising have been identified in the existing research, such as supply chain interactions [52], with an entire scholarly subfield of circular supply chain studies having emerged in recent years[1] (cf. [4], [53]), sustainable value creation [54], (green) technological innovations [55], values and culture, governmental policies [24], [56], and servitization and platformization [57], [58], i.e., how firms can organize social and economic interactions through online platforms to achieve greater "circularity," for example, through dedicated sharing platforms [59]. Such enablers can support the design of circular business models in terms of, for example, supply chain contracts for reverse logistics and closed-loop supply chains [60], [61], industrial symbiosis [62], design for disassembly and recyclability [63], [64], green product design and environmental innovation [65], and innovation ecosystems [66].

A summary of relevant enablers of managerial practices for a circular business model design is provided in Table I. We reiterate that enablers may be understood as the contextual factors driving circular business model design, while managerial practices represent the conscious actions that a company may implement to adopt CE principles in its business model; accordingly, enablers may trigger managerial practices. Furthermore, the implementation of managerial practices for a circular business model design leads to the achievement of CE outcomes, intended as particular results or performances satisfying CE principles that the company obtains thanks to this implementation.

Despite the interesting research in this field of study [17]–[19], [51], only limited progress has so far been made regarding the enablers of managerial practices for CE adoption in the business models of companies for operating in the agro-energy sector, and especially in the context of rural areas. In particular, existing research still falls short of providing a systemic view of these enablers and of detailing how these enablers can support companies in designing a circular business model, and especially in rural areas (Lahane *et al.*, 2020).

B. Agri-Food and Agro-Energy Sectors, the Rural areas, and the Role of Circular Business Models

In the agri-food sector, circular business models can play an important role, both for policymakers and companies, in supporting the former to develop new sustainable strategies and the latter to conduct their business responsibly [68], [69]. The relevance of the agri-food industry to the debate on sustainable growth and CE has been recently highlighted by several studies in terms of the contribution to the preservation and enhancement of natural capital [69]–[71].

[1]This CE sub-field studies incentives for supply chain collaborations, the typical barriers faced, as well as systemic impacts of circular supply chains, including the modeling of end-state circular supply chains.

The transition of the agri-food sector toward the paradigm of the CE has been enhanced by the wider adoption of advanced technologies, customer-centric strategic approaches, as well as by the need to make supply chains sustainable [72]. Furthermore, CE is recognized as a concrete opportunity for addressing the patterns of sustainable development in rural areas as well as for the harmonization and the reduction of the development gaps between urban and rural areas [32], [73]. Furthermore, as argued by Jurgilevich *et al.* [74], the food sector is characterized by an increased demand for food due to population growth, the inefficient use of food resources and food distribution, and high levels of wasted food. Approximately 30%–50% of food required for human consumption is lost as waste across the different phases of the food supply chain, i.e., production, consumption, waste, and surplus management [75], [76]. It is estimated that on average, 65 kg of food are wasted per person per year, broken down as 25% in vegetables, 24% in cereals, and 12% in fruit [77]. Especially in the agri-food sector, the main issues to be solved are related to reducing food waste and emissions in food production, including greenhouse gas emissions, the recycling of food packaging materials and plastic, and cascading the use of food products, including the use of fertilizing products, using them as inputs of new products [78], [79]. In addition, the modern European agricultural sector chain generates about 700 million tonnes of agri-food waste each year, compared to the 1.3 billion tonnes of waste annually [30].

More sustainable and innovative practices are therefore needed to reduce the millions of tonnes of agri-food waste each year and to reach more sustainable food, and agri-food, supply chains. For example, circular business models in the agri-food sector could mean reducing the amount of wasted food, as well as increasing the reuse of food, nutrient recycling, and utilization of by-products and waste [74]. The agri-food industry would thus be more likely to become more resource-efficient with positive implications for the entire sector [80]. In a recent article on CE in agricultural waste, Donner *et al.* [81] identified a critical set of success and risk factors that may support the design of circular business models for companies in the agri-food industry. These factors consist of technology and logistics, economic, financial, marketing, and organizational setting, institutional and legal frameworks, and environmental, social, and cultural features. Despite the growing interest of researchers and practitioners in the implications and meaning of the CE in the agri-food industry and agriculture, the debate on this topic is, however, still fragmented and not solidly established [29]. All these factors assume a more critical configuration in the context of rural areas, where the primary sector plays a more critical role in terms of employment, infrastructure, market sophistication, and research orientation [32], [73]. It is in this perspective that a circular configuration of the agri-food industry is particularly relevant, since, in this context, the adoption of CE is associated with a process of 1) optimization of economic growth, 2) reduction in the use of natural resources and of environmental impact, and 3) transformation of supply chains and economic systems [82].

According to Nicolosi *et al.* [32], in the context of a rural area, a CE configuration of the agri-food industry represents a lever for creating new sources of revenue and employability, for spreading

TABLE I
SUMMARY OF RELEVANT ENABLERS OF MANAGERIAL PRACTICES FOR CIRCULAR BUSINESS MODEL DESIGN (INCLUDING THE ENABLED MANAGERIAL PRACTICES AND THE CE OUTCOMES)

Enablers	Managerial practices	Circular economy outcomes	References
Supply (chain) interactions	Development of structured contractual systems with supply chain actors	Improvement of companies' reverse logistics systems and enhancement of closed-loop supply chains	Albino et al., 2016 Govindan et al., 2015 Savaskan et al., 2004
(Green) technological innovation	Implementation of environmentally friendly technologies, such as environmental management, water-related adaptation, and climate change mitigation technologies	Better usage and allocation of natural resources, and improvement of companies' utilization efficiency of raw materials and energy	Wang et al., 2019 Dangelico, 2016 Diaz-Rainey & Ashton, 2015 Yabar et al., 2012
Sustainable value creation	Implementation of Design for X approaches, such as Design for assembly, disassembly, reuse, remanufacture, and recyclability	Shift towards green product design and environmental innovation, i.e., reducing pollution and conserving energy in core business activities	Sassanelli et al., 2020 Li et al., 2019 Baumann et al., 2002 Boothroyd, 1994 Kuo et al., 2001
Servitization & Platformization	Implementation of product-service systems or digital platforms for extensive collaboration and interaction	Development of new mechanisms for managing customer buying habits and behavior, such as pay-per-use and pay-per-performance (less-careful use of products when compared to ownership); and enhancement of industrial symbiosis phenomena	Ciulli et al., 2020 Konietzko et al., 2020 Fraccascia, 2020 Kerdlap et al., 2019 Tukker, 2015
Values & Culture	Formulation and establishment of circular-oriented policies and objectives, training of internal resources and creation of awareness about the need for product design practices among all the actors of the supply chain, through leveraging the commitment of top management	Development of a shared mental image or a strategic vision that all stakeholders strive to achieve	Rizos et al., 2016 Gorissen et al., 2016 Urbinati et al., 2017 van Keulen & Kirchherr, 2021
Governmental policies	Purchases of work, goods, or services by public authorities that seek to contribute to circular business model design (public procurement) and allocate financial resources for companies' transition to circular economy	Stimulating and creating demand for goods that contribute to the circular economy, supporting material circles and business models, reinforcement of the collaboration with supply chain stakeholders, leading to reductions in raw material utilization and waste generation, and to developing more environmentally friendly technologies	Alhola et al., 2019 Brammer & Walker, 2011 Ellen MacArthur Foundation, 2015 Kiiver and Kodym, 2014 Su et al., 2013 Witjes & Lozano, 2016 van Keulen & Kirchherr, 2021

innovative ideas and practices, and for discovering the value of local resources by nurturing the social capital and by building a sustainable local community. In addition, the effectiveness of CE adoption is largely dependent on several features, including cross-sectorial dependencies and intersections, the institutions, and the larger community of stakeholders populating the area [36]. It is in this context that the agro-energy arises as a promising perspective for supporting the transition of the agri-food industry toward a CE configuration and for achieving objectives of sustainable development in the rural areas [34], [35]. Indeed,

TABLE II
PHASES AND DECISIONS FOR CONDUCTING THE SINGLE CASE STUDY METHODOLOGY

Phases of the case study	Key decisions
Identification of the research goals	*"What are the enablers of managerial practices for CE adoption in the business models of companies operating in the agro-energy sector of a rural area?"* *"How do these enablers support these companies in designing a circular business model?"*
Selection of the Case	Criteria for case selection: - adoption of a circular business model - high degree of innovation in the agro-energy industry of a rural area, e.g., recognized by awards in the field of circular economy - consolidated presence on web and social media
Identification of case study's boundaries	Holistic view of the phenomenon in terms of sustainable value creation and circular business model in the agro-energy sector
Selection of Data Sources	- Interview protocol composed of open-ended questions and addressed to: a) Company's founder and Chief Executive Officer (CEO), b) Purchasing Manager, c) Head of the energy production plant - In-depth analysis of the website, and official accounts on social networks (such as Facebook and LinkedIn) - In-depth analysis of interviews, press releases, videos, official documents made available by the company
Analysis of Data	Triangulation of data, by combining evidence resulting from the web-based desk analysis, official reports published by the European Commission and information collected from the interview

pivotal agro-energy projects have been successfully promoted into different areas of the planet [83], [84], mostly supporting the agri-food industry in better energy production and consumption.

III. METHODOLOGY

A. Using a Single Case Study Methodology

The article adopts the methodology of a single case study as a suitable investigative methodological approach for the analysis of a contemporary phenomenon in its natural setting [85], [86] by leveraging on the collection of data from various types of multiple sources [87]. Consistent with the qualitative research approach described by Strauss and Corbin [88] and Yin [85], [86], case study methodology has been preferred, since the boundaries between the phenomenon and the context are not clear [89], [90]. Aiming to understand a phenomenon in its whole articulation through the observation of variables and their interacting relationships [91], the case study becomes very useful when it is not easy to separate the object of the observation from its context [92]; its usefulness is confirmed when the study requires the observation of social phenomena and their interpretation by researchers [93]. In addition, as highlighted by Bressanelli *et al.* [94], the exploratory nature of the research, as well as the need to explore meanings and dynamics associated with the CE in the context of the agro-energy sector (as in this research), is consistent with a single case study. The choice of using this methodology is also supported by the need to have a full understanding of a phenomenon that is characterized by a complex articulation and within its environmental setting [95], [96]. Moreover, the single case study has been largely adopted in several recent studies on CE, demonstrating its relevance and usefulness in this field of study [97]–[100]. Finally, although Kirchherr and van Santen [20] have criticized the CE research community for its reliance on single case studies due to the external validity challenges, we very much believe that, given the scarcity of knowledge on the topic, this single case study is needed to provide the basis for medium-N and large-N research on circular business model enablers in the field of energy production and consumption in the agri-food sector of a rural area [101].

In developing our case study, we referred, in particular, to the typical phases of this methodological approach with the key decisions synthetized in the following Table II [85].

B. Research Context

The empirical context of the research has been identified in Fiusis, an innovative small Italian company operating in the agro-energy sector and located in Calimera, a small Apulian town, in the South of Italy, with a turnover of around €2 million. The company has 6 permanent employees operating

in the energy production plant, and 10 permanent and 5 seasonal employees in pruning, harvesting, and transporting. The company has created a small-scale power plant (1 MWe) for producing electricity exclusively from olive tree pruning. The plant consumes between 24 and 28 tons of pruning daily. This range is due to the moisture content. The process of electricity production has made it possible to avoid CO_2 emissions for an estimated value of 5359 tCO_2(eq) per year, with an electricity efficiency range of 24%–25%. This estimation is based on measurements and forecasts realized by the company assuming the regular and full operation of the plant. The performances associated with the plant are continuously monitored by the company, as well as by public entities and agencies. Thanks to using exclusively this feedstock gained from agrarian pruning and plantation removal, and to the sustainable supply chain based on woody biomass, Fiusis has been recognized as an exemplary case of a sustainable and circular business model, and in 2019 was recognized as "the best business model in the rural area" by the European Commission. The company has recently made further investment by installing a plant to produce bio-pellet. Due to its success, Fiusis can also be identified as an "extreme case," i.e., one that stands out as being effective, a front runner, and successful [102]. Indeed, Fiusis is a critical and extreme case [86], [87] of an innovative company that rose to the opportunity of designing a circular business model in attempting to close the loop in the agro-energy sector of a rural area. By selecting an extreme case, we can better understand the characteristics of Fiusis' business model and spillover into the rural area. As Pettigrew [103] and Petruzzelli and Savino [104] observed, given the limited number of cases that can usually be studied, it makes sense to choose extreme cases and polar types in which the process of interest may be clearly recognized. Finally, we adopted an inductive and open-ended research approach, identifying themes from the data through several iterations with the existing literature.

The company operates in a geographical area with a recognized vocation for agriculture and mainly for olive production. The area is characterized by the presence of very small agriculture farms, managed directly by the owners with limited volumes of production and based on traditional agricultural practices, such as pruning and harvesting by hand, and management of the production phases with low automation. During recent years, the area has been affected by the spread of the Xylella fastidiosa disease, a decline syndrome in olive trees caused by a bacterium [105], originally detected in olives on the Ionian coast of Salento, which has caused a desertification of a large part of the olive groves. This phenomenon has made a huge quantity of wood and olive tree prunings available. By benefiting from programs of public funds for the installation of new industrial plants and thanks to the national laws on the introduction of the energy produced into the national distribution grid, Fiusis works in a supply chain made up of a widely distributed base of suppliers (mainly for the wood, but also producers of tools, plants, and oil) and two main customers, who are Fiusis itself, with the two plants for the production of energy and bio-pellet, and the national energy grid.

C. Data Collection and Analysis

Data collection and analysis were carried out using multiple data sources and ensuring triangulation of information [87]. The combination of different investigative techniques was used to reduce the bias of a single observation and to enhance data credibility [106]. Data collection was carried out by integrating primary and secondary sources. Regarding the first, several formal, face-to-face, interviews, and follow-ups were conducted with the founder and CEO of Fiusis, the Purchasing Manager, and the Head of the energy production plant, amounting to over 15 h of interviews. The direct, face-to-face meetings were preceded by a contact request aimed at clarifying the research goals and illustrating the structure of the interview protocol that was composed of open-ended questions, organized around thematic topics related to the company overview, and its business model and supply chain collaborations. The interview protocol is shown in Table AI of the Appendix. Together with formal interviews with the key respondents, informal interactions with other company employees and stakeholders who were present during the company visit were conducted. Both the interviews and informal meetings were useful to identify elements of the company business model, and mostly the set of enablers that have allowed the company to adopt the CE in its business model.

All the information gathered was integrated with data resulting from secondary sources and specifically the company's website and accounts on social networks, interviews, and press releases available online, financial reports, and official documents related to the business competition in which the company received an award from the European Commission. We stopped interviewing, meeting people, and scrutinizing secondary sources when the possibility for us to obtain additional new information was exhausted (thematic saturation), and further coding was no longer feasible [107].

As far as data analysis is concerned, an inductive, iterative, process was implemented [88], [89]. To ensure a wide understanding of the multifaceted dimensions of the observed phenomenon, as also required in a case study analysis, the convergence of observations with the entire research team's contribution was guaranteed. Data were preliminarily prepared before the analysis. This required an activity of categorization, reduction, and contextualization of data collected from secondary sources. As for the analysis of data resulting from the interviews, a preliminary definition of a descriptive code was made from results of the theoretical background. Accordingly, data reduction and organization of thematic categories were implemented to prepare the first version of findings, which was discussed by the researchers in order to achieve the full interpretation, to identify specific features of the Fiusis business model and of the enablers of CE-driven managerial practices for its design [108]. As suggested by Tellis [108], each author independently reviewed the transcript of the interviews conducted with key informants and the key information resulting from secondary data. The triangulation of these data aimed to verify their coherence and solve ambiguous information. Consequently, an activity of integration of the analysis conducted by the authors was undertaken to achieve a common

TABLE III
ENABLERS, MANAGERIAL PRACTICES, AND CE OUTCOMES OF FIUSIS' CIRCULAR BUSINESS MODEL

Enablers	Managerial practices	Circular economy outcomes
National and supranational laws for green energy production	Fiusis has implemented a production plant to produce biomass-based energy according to the national and supranational laws related to the green energy and CO_2 reduction	Image of a green and sustainable company with a high commitment to the local community
Public funds for the installation of new industrial plants	Fiusis has accessed public programs supporting the development of new industrial plants	Lower direct investment by the company, fiscal benefits, and advantageous conditions for loans
Waste management and energy efficiency	Fiusis uses prunings as raw material and the energy produced from the energy production plant also for self-feeding, and attempts to use the ashes resulting from the production of bio-pellet for fertilizing fields	Value creation in coherence with the principles of circular economy and according to a strategic model that works towards closing the loop and reintroducing equilibrium in the local ecosystem
Supply contracts with local farmers	Fiusis has developed a structured contractual system to obtain the raw material for producing energy. The recent introduction of the Ligna NewCo has allowed it to structure the network of suppliers	A well-established network of suppliers that guarantees the raw materials by avoiding the problems of storage and management of the inbound flows of pruning.
Supply contracts with the national energy system	Fiusis introduces into the national distribution grid the energy exceeding the needs of the energy production plant	Certainty of the outbound flows with fixed economic conditions and access to a relatively protected market
Business expansion and technological innovation	Fiusis continues to look for new entrepreneurial opportunities. Several innovations have been introduced during the last few years, as initiatives to improve the competitiveness of the company's core business, as in the case of Ligna, or to promote a diversification strategy, as realized with the new plant for producing the bio-pellet	Competitiveness and growth, higher employment rate, and higher value creation process

understanding of the case and assure its full comprehension. As suggested by Weber [109], a coding process was adopted for the content analysis together with the identification of the most useful information for an effective understanding of the case.

Finally, as suggested by Eisenhardt [87], a further series of iterations between empirical data and literature review analysis was conducted to identify the enablers of managerial practices for the circular business model design of Fiusis, as well as to better identify the theoretical foundations and implications of the research. The findings developed from the empirical analysis of the case were discussed with the key informants for their final approval.

IV. FINDINGS

A. Circular Business Model of Fiusis

Fiusis is an innovative company operating in the field of energy production from olive tree pruning and plantation removal. The company was set up in 2010 by Marcello Piccinni, the founder and CEO. Fiusis works on a volume of 8000 t/y and the coverage of an area of 10 kms. Fiusis is in a rural area, traditionally dedicated to agriculture and characterized by the limited specialization of the tertiary sector and the presence of urban areas of small dimensions. As highlighted during the interviews, the volume of energy produced can satisfy the nightly need of electricity of the small town of Calimera. As

the founder and CEO of the company declared, *In the start-up phase, the company benefited from the supporting policies that the Italian government adopted for the producers of renewable energy from biomass. In addition to this, Fiusis signed a 15-year contract with the grid operator with a subsidized feed-in tariff. The profitability of the business model is assured only if the biomass is sourced locally, within 70 kms of radius from the power plant, i.e., within the so-called short supply chain*. The innovativeness of the Fiusis business model is clearly linked to the area. As highlighted during the interviews with the founder and CEO, while the production of biomass energy was already widespread in the north of Italy and in other European countries, areas characterized by high levels of development, in the context of the province of Lecce, it represents a meaningful innovation.

As for the plant-based exclusively on olive tree pruning, the company initially worked to ensure the procurement of this raw material. Despite its abundance in the area, the number of farmers initially collaborating with Fiusis was very limited (only 12 in 2010). As the Purchasing Manager said: *The initial distrust was due to the novelty within consolidated agricultural practices. Over time, the number of companies that started collaborating with Fiusis increased, and in 2016 there were more than 1200 farmers collecting pruning for Fiusis. This number has further increased in recent years*.

The area is characterized by very small and fragmented farms with limited portions of fields. Currently, more than 60% of the local farms in the area collaborate with Fiusis. In collecting pruning for Fiusis, farmers have the benefit of cleaned fields. This also allows them to reduce the costs of cleaning and to considerably reduce the environmental pollution due to burning. In recent years, the area has been affected by the emergence of Xylella, which has impacted the overall landscape and has enhanced the quantity of wood and pruning of olive trees available in the area. Despite this, the interviews with the company's founder and CEO led us to understand that the biggest challenge was convincing local farmers to abandon their well-established habits of burning branches in their fields. For this, several meetings, either with single local farmers, or consortia, were promoted to illustrate some scenarios of collaboration and mutual benefits.

Logistics and collection activities are also very critical in the Fiusis supply chain. After a first phase in which Fiusis collaborated with external contractors for the collection and harvesting of pruning, in 2014, Fiusis created a "NewCo" (named Ligna). According to the founder and CEO of the company, *The new company oversees all the feedstock-collecting activity, and it is equipped with machinery for chipping, harvesting, and delivering residual wood feedstock to the energy production plant*. The activities of Ligna aim to perform a new strategy of logistics' management and consist of services of messaging and geolocalizations that are useful for the coordination of the supply chain; they have a positive impact on the network of suppliers in terms of better organization of their single supplies, cultural spillovers, and cultural catching up. As highlighted during the interviews, the creation of Ligna allowed the company to optimize the operational processes. Through Ligna, the company collects the farmers' requests by registering all the data necessary for both the traceability of the pruning and the effectiveness of the logistics. As the Head of the energy production plant said, *The establishment of Ligna has assured that within the plant we have all the necessary resources and support for a more effective operation of the plant itself*.

Moreover, as far as the new plant for producing bio-pellet is concerned, Fiusis still leverages on the local farmers and uses only olive wood. In addition, the new plant is powered by the energy made by the Fiusis energy plant, and its product is made without the typical use of chemicals used for producing pellets. Furthermore, the ash resulting from the production of bio-pellet is purposed as fertilizer for the olive groves.

As synthetized in Fig. 1, the history of Fiusis started with the commitment of a first nucleus of relevant stakeholders who made it possible to implement the actions undertaken by the company in its development. Fundamental to the starting-up phase was the agreement made with the grid network. However, the necessary authorizations made available by the Regional Agency for the Environment, as well as the grants provided for the installation and setting up of the energy production plant were also essential to the company's inception. As the company grew, other relevant milestones were identified for enhancing its circular business model: 1) the creation of the Ligna NewCo that made the company independent from external contractors for logistics, 2) the meaningful number of suppliers obtained in 2016 (more than 1200 local farmers), 3) the award achieved in 2019 from the European Commissions, together with the installation and setting up of the new plant for bio-pellet and, finally, 4) the presence of a more consolidated organization of the supply chain stakeholders and the large number of new projects of agro-energy and sustainable agriculture available in the company's portfolio.

B. Fiusis' Supply Chain Collaborations

The anatomy of Fiusis business model represents a clear example of the CE principles put into practice, where the mechanisms of value creation, transfer, and capture characterizing the business model join the particular synergies that the company has designed with its supply chain and the local stakeholders. From the analysis of Fiusis' business model, it emerges how collaborations along the supply chain play a pivotal role in facilitating interorganizational cooperation between the company and each stakeholder. The design of Fiusis' circular business model has indeed implied the design of a collaboration network with some key actors operating in the same supply chain of Fiusis. Fiusis' supply chain collaborations are shown in Fig. 2.

The award received from the European Commission was due in particular to several aspects of "circularity" belonging to the key collaborations with the supply chain stakeholders and, most importantly, for the profile of the rural area where these collaborations take place.

Indeed, although the profile of a rural area is associated with the fragmentation and small size of farms, traditional and consolidated practices, and limited collaborations, Fiusis has been able to create a sustainable network of collaborations around its business model with several typologies of stakeholders, such as: 1) the local farmers, who provide pruning from their fields, 2) the "NewCo" business Ligna, 3) the national energy system, which acquires the energy produced, and 4) the local community.

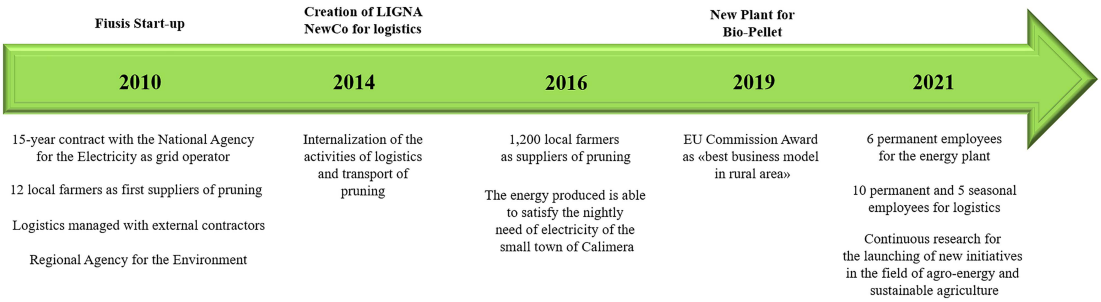

Fig. 1. Timeline of Fiusis' main facts.

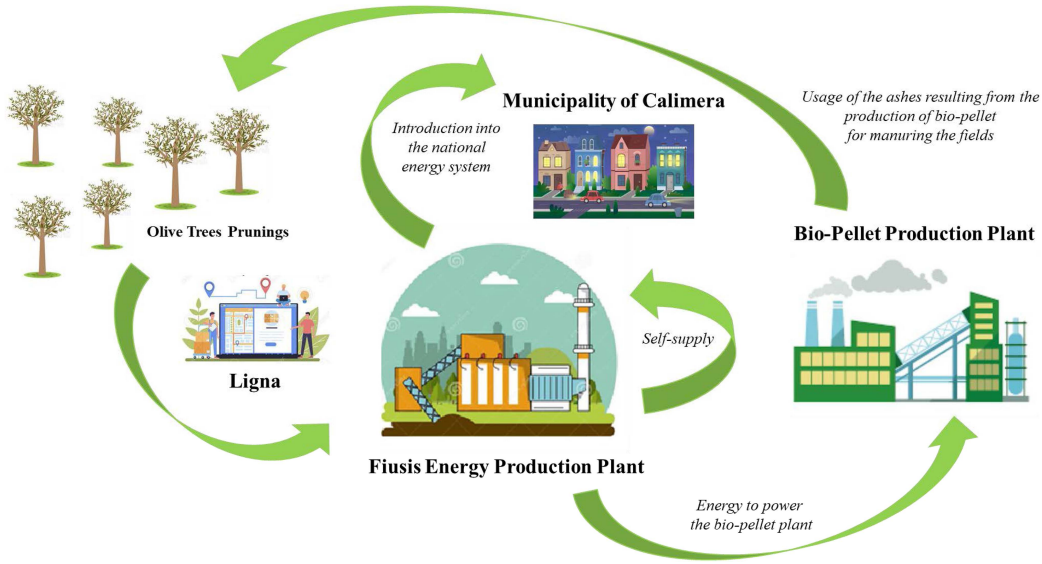

Fig. 2. Fiusis' supply chain collaborations.

It is the synergic collaboration with all these typologies of stakeholders in the Fiusis supply chain that allows the company to effectively implement its circular business model.

Fiusis creates value for each of its stakeholders while respecting the environment and impacting positively on the wellbeing of the area since it proposes more sustainable alternatives to the traditional burning practiced by local farmers in the management of their seasonal activities. Benefits for farmers are identifiable in terms of cost reduction and traced management of their pruning and plantation removal, but also in terms of a culture of more sophisticated management of their farms based on more structured practices not based on tradition. In addition, the growing number of farmers collecting for Fiusis highlights an awareness of the opportunity offered in the improvement of the traditional activities of cleaning and burning of the fields and the creation of forms of networking and collaboration among local farmers.

As for the company, its owners, and employees, the main benefits are identifiable in the capture of tangible value in terms of reduction of environmental impact and emissions of CO_2, revenues, and job opportunities, as well as in the transfer of intangible value in terms of reputation improvement and recognition at local, national, and international level. As the Head of the energy production plant said, *The energy exceeding the needs of the plant is fed into the national grid managed by ENEL, the Italian National Entity for Electricity, and it is able to cover the nightly need of energy of the small town of Calimera. In addition, by avoiding the traditional agricultural practices related to the burning of pruning in the fields, Fiusis increments the quantity of green energy available in the national system*. Again, the usage of the surplus of energy produced to cover the needs of the small town of Calimera clearly has a positive impact in terms of brand loyalty and reputation.

As for the customers and local community, the former have the possibility to purchase energy, electricity, or bio-pellet, with a feeling of citizenship inspired by the principles of sustainability and CE, while the latter can benefit from the reduction of burning in the fields, as well as from the green process of production implemented by Fiusis for both the energy and bio-pellet; both of these plants have a positive impact on pollution and on the quality of the air in the area and more.

The CE approach is identifiable in several aspects of Fiusis' operational activity. For example, its production process is based on the use of waste (the olive tree pruning and removal) as raw material. In the meantime, the exclusive usage of these resources in the energy production plant reduces the usage of fossil oil for producing electricity. By reducing the practice of open field burning of the pruning by local farmers by 70%, this process generates lower CO_2 emissions into the atmosphere as well as assures a mechanism of control of the fumes generated into the area, thanks also to the certification of the Regional Agency for

the Environment (ARPA Puglia). Considering that the energy produced can satisfy the internal demand of the plant and that the overproduced energy is fed into the national energy grid, the benefits in terms of decarbonization are high. The recent development of the bio-pellet plant highlights another dimension of the "circularity" approach characterizing the business of Fiusis. Indeed, through the usage of the auto-produced green energy, the company can almost close the loop of its production. The localization of the company in the context of a rural area as well as the contribution offered to the CE configuration of traditional and well consolidated agricultural practices enhance the innovativeness and effectiveness of the Fiusis operational model.

C. Enablers of Managerial Practices of Fiusis' Circular Business Model

The analysis of Fiusis from the perspective of the enablers of managerial practices for CE adoption in companies' business models can be summarized as Table III. This table shows the main enabling factors, the enabled managerial practices, and the CE outcomes characterizing the circular business model of the company—and consistently with the rationale followed in the theoretical background, which resulted with the building blocks depicted in Table I above.

V. Theoretical and Managerial Implications

Recognized by the European Commission as an exemplary case of circular business model in the rural area, the case of Fiusis provides interesting evidence for the theoretical premises behind this article and offers promising insights for managers and companies willing to embrace CE principles, and especially operating in the agro-energy sector of rural areas.

A. Theoretical Implications

The empirical evidence offers a contribution of contextualization to both the research field of enablers for a circular business model design [43], [51] and that of circular supply chains [4], [53], [59], [110], [111].

Within the perspective of enablers for a circular business model design, important enablers have been identified in the favorable legislation at national and at European levels, supporting the production of green energy and the process of gradual decarbonization, and in the availability of public programs for funding the installation of a new industrial plant with several fiscal advantages. This very much resonates with Hartley *et al.* [112], who also found CE policies are a core enabler for circular business model design and its subsequent implementation. This finding is also coherent with existing theory around circular business models (see, e.g., [113], [114]). In addition, important enablers have been found in the waste management and energy efficiency issues, which contributed to the design of the company's production, consumption, and distribution systems. This result fits and extends emerging contributions in the existing research, aiming to underline the relevance of process redesigning in the light of waste management and energy efficiency objectives for a circular business model design [44], [45]. These objectives have enabled the implementation of managerial practices, such as the usage of prunings as raw material or the usage of the energy produced for self-feeding, as a basis for the development of the first plant for the energy production by biomass, and especially for the installation of the new plant for the bio-pellet production. The possibility to connect the two plants represents for the company a sustainable and circular system of biological and technical loops [60], [61].

With the aim to provide a stable basis for the planning of the supply of raw material and to reduce the uncertainty of the demand for energy, this result confirms the relevance of contractual strategies in the supply chains to reinforce and accelerate the design of circular supply chains [52], [115], whereas this article, as much other research in the field, remains silent on the exact contractual setups needed for circular business model design. This result also extends the relevance of sustainability issues in the debate on sustainable and circular supply chains [15], [41], [42], especially for agro-energy companies. We confirm—as previous literature—that supply chain collaborations are a decisive factor in circular business model design. Furthermore, the article confirms the opportunities of sustainable growth that can be achieved by rural areas through the development of agro-energy projects [34], [84], and it is one of the very few CE studies out there examining a circular business model in a rural setting. Finally, as far as the enabler of business and technology innovation is concerned, findings address the theory of corporate entrepreneurship for a CE [116], as well as sustainability-based research in the domain of management engineering [117]. Indeed, both the strategy of diversification realized by Fiusis, which concerns the bio-pellet production, and the creation of the company Ligna, because of a corporate spin-off for managing the supply chain, highlight the relevance of some of the dimensions of corporate entrepreneurship [118], [119], as well as product and process innovation through the collaboration between the company and its network of stakeholders. These findings may also be connected to the emergent CE subfield of circular entrepreneurship with the studied company resembling a nature-based as well as waste-based business model (cf. [120], [121]). In addition, the establishment of a new company (i.e., Ligna) to connect the stakeholders and to contribute to the effectiveness of the supply chain is coherent with the existing contributions dealing with the role of intermediation in supply chains' articulation to promote a more CE [122]. Conceived as a business intermediary between the company and its suppliers for monitoring the traceability and energy transfer, the introduction of Ligna extends the debate into scientific research on sustainability intermediation, a stream that calls for examining the criticalities of well-functioning ecosystems of intermediaries who can broker knowledge exchange and collaboration between different actors of the supply chain [123]. In the context of agro-energy, as well as in the larger context of agri-food, the role of intermediaries assumes a meaningful value since they can allow increasing interactions and collaborations among companies that have limited size and a traditional approach.

B. Managerial Implications

Several implications arise also for practice. Managers can indeed find interesting insights from our research and

especially regarding the adoption of CE in companies' business model through dedicated enablers and managerial practices. Accordingly, the article provides a comprehensive set of enablers that can allow for the adoption of managerial practices for a circular business model design, and especially for agro-energy companies operating in rural areas. These practices span branding awareness campaigns, exploitation of public programs, the usage of production waste for fertilizing fields, exploitation of contractual systems for an effective supply, energy efficiency measures, and innovation activities. These practices do not claim to be exhaustive, but they aim to allow managers in charge of sustainability and CE initiatives of companies within which they operate to reflect on how agro-energy companies can design their business following the principles of CE and can accelerate their transition toward the CE, and especially in rural areas. The article also allows for understanding the value that agro-energy projects can offer to the sustainable development in rural areas. In this development pathway toward sustainability and CE, a great contribution can be offered by digital technologies, which although do not emerge as relevant in our case study, we are aware they could enhance the performance of the agro-energy sector [58], [59], and very likely in rural areas. The findings obtained from the empirical analysis also suggest a further implication for the development of a political agenda of regional development of the rural area. The support for the creation of CE start-ups appears mandatory and promising not only for the success of the single entrepreneurial initiative, which could also be relevant in the context of these areas, but also for the technological, managerial, and cultural spillovers that they are able to generate by reducing the existing gap between the urban and rural areas [32].

VI. Conclusion

The present article aimed to analyze the enablers of managerial practices for CE adoption in the business models of companies operating in the agro-energy sector of a rural area; an interesting research issue that has recently emerged in the existing fields of CE and circular business models. The article tackled this objective by leveraging a single case study analysis of Fiusis, a small company located in a rural area of southern Italy operating in the field of energy production from olive tree pruning and recently involved in the production of bio-pellet.

The anatomy of the Fiusis business model reveals interesting evidence for the comprehension of the relationships between enablers, managerial practices, and CE outcomes. First, the mechanisms of value creation, transfer, and capture in Fiusis are affected by the political and institutional environment, identifiable in the favorable policies that allowed for the company's start; also important were the environmental safety standards that enabled Fiusis to reduce the CO_2 emissions in the atmosphere. Second, Fiusis has implemented core activities in the direction of sustainable networking, affiliation of local farmers, traceability of their production, creation of a new culture of sustainability, and green behavior in farmers and customers, as well as in the employees' mindset. Third, through the analysis of Fiusis circular business model and its supply chain collaborations, it is possible to identify several insights in terms of redesigning of the traditional process of management of fields, change to the conception of waste usage for a new production process, and implementation of new forms of collaborations with a vast array of supply chain stakeholders. The nature of the rural area in which Fiusis has been able to design its circular business model highlights the relevance of the evidence collected and resulting from the case study analysis. Accordingly, the empirical analysis provides interesting implications for a deeper comprehension of the meaning of the enablers of circular business models and the consequences of the CE adoption realized by Fiusis, given by, and impacting a plurality of stakeholders. The analysis of the case allowed us to identify the need for a more structured strategy of digitalization that could make it possible to support the several processes undertaken for creating value in coherence with the CE principles as well as for supporting the catching up of the company's supply chain and network of collaborations. Finally, the case of Fiusis provides interesting evidence for the advancement of the academic debate in the field of CE, and especially at the intersection between circular business models, agri-food and agro-energy sectors, and development of rural areas. Specifically, the findings arising from the empirical analysis have contributed to the identification of particular enablers for implementing CE-driven managerial practices in agro-energy companies' business models in the context of rural areas by disclosing interesting speculations for the agri-food supply chains. The different nature of these enabling factors has allowed us to shed new light on the importance of adopting an ecosystem perspective in the design and implementation of a circular business model.

The article has of course some limitations that deserve further examination. First, the article does not analyze the barriers associated with the implementation of Fiusis managerial practices in its business models, but only the enablers that have pushed the company to design a circular business model. The analysis of the barriers hampering a circular business model design is an emerging topic that is worthy of further attention in future studies [51]. Another limitation is mostly related to the kind of methodology we used for conducting the empirical analysis. Indeed, the single case study methodology does not allow for cross-case comparison or statistical generalizations [108]. Therefore, other agro-energy businesses that are adopting the CE for a circular business model design could be investigated to reinforce, at the very least, the "analytical" generalization of the results obtained [124]–[126]. In addition, more key respondents could be included through additional formal meetings within the research, such as with the stakeholders populating the supply chain of the company, to deepen knowledge of the enablers and mechanisms of value creation, transfer, and capture that characterize the whole supply chain in which Fiusis operates, enhancing the view of the single company together with that of the network of several economic actors. Therefore, a more in-depth analysis of the context area would be needed to show the peculiarities of the company's circular initiatives in relation to those of the stakeholders to support the "circularity" of the agro-energy sector, the whole agri-food industry, and the overall development of the rural area to which they belong.

APPENDIX

TABLE AI
INTERVIEW PROTOCOL

Section 1 – Fiusis Company Overview	• Company history (how and why was it created?) • Mission statement • Value proposition • Ownership and management team • Future development • Any other relevant issues?
Section 2 – Fiusis Business Model	• What are the company's value drivers? • Why can Fiusis be considered a green company? • What are Fiusis' strategic assets? • Can you describe Fiusis' value chain? • Which are the main innovations introduced? • How is/are the plant/s organized? • How are the topics of waste management and energy efficiency managed by Fiusis? • Is Fiusis a circular economy company? • In which way has Fiusis implemented the circular economy? • Which managerial practices of circular economy have been implemented? • What were the enablers of Fiusis circular economy transition? • Any other relevant issues?
Section 3 – Fiusis Supply Chain Collaborations	• Who are the main stakeholders of Fiusis? • How is Fiusis involved with local stakeholders? • How does Fiusis manage its supply chain network? • Who are Fiusis' customers? • In which way has the circular economy transition of Fiusis changed the way the company interacts with its stakeholders, including customers? • Any other relevant issues?

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Pasquale Del Vecchio received the Ph.D. degree in eBusiness from the eBusiness Management Section of Scuola Superiore ISUFI, Univesity of Salento, in 2008.

He has been visiting Ph.D. at the Center for Digital Business, MIT's Sloan School of Management, Cambridge, MA, USA. He is currently a Senior Researcher in management engineering with the Department of Management, Finance and Technology, LUM University, Bari, Italy. He has been involved in research and innovation projects focused on the technological entrepreneurship for circular economy and smart destination management. He has authored or coauthored research papers published in approximately 60 publications spanning international journals, conference proceedings, and book chapters. His research interests include the issues of circular economy, data-driven business model innovation, and digital transformation.

Andrea Urbinati received the Ph.D. degree in management, economics, and industrial engineering from the School of Management of Politecnico di Milano, in 2018.

He is currently an Assistant Professor of Strategy and Business Design with the School of Industrial Engineering, LIUC Università Cattaneo, Castellanza, Italy. He has authored/coauthored more than 60 publications, as papers on international journals, book chapters, and conferences.

Dr. Urbinati is a Member of the Core Faculty and Director of the Center on Technological Innovation and Circular Economy, LIUC Business School, the School of Management, LIUC Università Cattaneo. He is an Associate Editor of the *International Journal of Innovation and Technology Management*, a Member of the Editorial Board of Sustainability, a Review Editor on the Editorial Board of Frontiers in Sustainability (specialty section on Circular Economy), and Ordinary Member of the International Society for Circular Economy.

Julian Kirchherr received the Ph.D. degree in economic geography from the School of Geography and the Environment, University of Oxford, in 2017.

He is currently a Principal Investigator with the Copernicus Institute of Sustainable Development, Utrecht University, Utrecht, The Netherlands, and an Associate Partner with McKinsey & Company. He joined Utrecht University, in 2017, as an Assistant Professor. He has authored/coauthored more than 30 peer-reviewed articles in academic journals such as Global Environmental Change, Ecological Economics, World Development, and Energy Policy including some of the most highly cited articles on circular economy out there and his work on sustainability transitions has also been featured in media outlets such as BBC, Bloomberg, and the Wall Street Journal. His research interests include sustainability transitions and the role the private sector can play in these.