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Circular business models for sustainable development

A “waste is food” restorative ecosystem

- ✓ Prof. Antonella Zucchella, Vice-Chancellor (Finance), Full Professor of Marketing and Management, Department of Economics and Management Sciences, University of Pavia, Italy
- ✓ Prof. Pietro Previtali (corresponding author), Rector’s Delegate for Human Resources management, Associate Professor of Organization and human resources management, University of Pavia, Via San Felice 7, 27100, Pavia, Italy, pietro.previtali@unipv.it, + 39 382 986424

ABSTRACT

Our aim it is to provide a better understanding of a business model based on circular principles. In particular we focus on two issues that support the development of a circular business model: i. the focal actor as orchestrator of the circular network; and, ii. the circular ecosystem encompassing suppliers, customers, research centers and public authorities, in which each actor/stakeholder plays a specific role, based on effective inter-organisational relationships.

The research method applied is an in-depth nested single case study of a circular project. Our results highlight an exemplar case of an eco-systemic business model in agriculture, involving different types of innovation and strong collaboration among network members, orchestrated by a focal firm. The abductive approach used led to the formulation of some research propositions and to the identification of some adoption factors and barriers to growth in circular business models.

Keywords: circular business model; circular economy; eco-system; upcycling, sustainable development, stakeholder engagement.

Introduction

The preservation of the planet's natural resources, and possibly their restoration, represent a major challenge for the future of humanity. Sustainable development is now at the core of policy making agendas in a number of countries and – increasingly - of business strategy and entrepreneurship (Shrivastava, 1995; Dyllick and Hockerts, 2002; Albino et al., 2009). The debate around circular economy can contribute substantially to addressing these issues and to providing novel answers to a major problem for humanity. In this debate a number of questions need to be tackled. First, “Despite the concept's importance for academia, policymakers, and companies, the conceptual relationship between the Circular Economy and sustainability is not clear” (Geissdoerfer et al., 2017, p.757). Second, these Authors, in outlining differences and similarities between the two concepts highlight, among others, two key factors for both sustainability and circularity, which require further investigation: the central role of both private business, due to its resources and capabilities, and of business model innovation. In this study we specifically address these two dimensions, in order to understand the factors for potential success and barriers to the growth and adoption of circular practices. In talking about circular business models Linder and Williander (2017, p.182) state that *“still we are not seeing widespread adoption in industry”*. According to these Authors there is some reluctance to implementing new/innovative business models based on circular principles, as they are perceived by the entrepreneur as highly uncertain and risky..

This paper addresses the trade-off between the increasing role of the sustainability agenda in business and the still insufficient adoption of circular business models by firms. The circular business model emerges from our study as an eco-systemic one, thus linking the business model literature with the industrial ecology stream. We devote special attention to two aspects, which are considered a gap in studies: the role of the orchestrator (Zaoual and Lecoq, 2018) and the nature of the relationships between partners in the eco-system (Boons et al., 2013). Our case analysis also permits us to highlight the (unstudied) dimensions of the scalability and replicability of circular business models (Schaltegger, 2016), as elements supporting the growth and adoption of circular practices.

The focus of our study is a circular business model in agriculture, analysed through an in-depth nested case study, within an abductive research design. We believe that business model innovations in agriculture are compelling: the primary sector is a key player in the preservation and enhancement of natural capital, though it has not yet gained the same attention in the circular economy literature as other economic sectors. We are also aware of the limitations of this choice, and we agree with Moreno et al. (2016) that there is no “ideal” or “best” business model with which to fully address circularity principles across all sectors and firms. Our paper is relevant for management practice as it outlines a business model that adheres to circularity principles and makes them compatible with profit. Further,

this contribution is also relevant for policymaking as the increasing attention towards the circular economy shown by policymakers in different regions calls for a dialogue between firms and institutions: both need to co-evolve in the direction of circularity (Vermeulen, 2015).

Business models, ecosystems and innovation in the circular economy

Circular economy is a term coined in the 1990s (Pearce and Turner, 1990) and, since then, it has received increasing attention. However, some key concepts that feed the circular economy concept existed before then: concepts such as ‘lifecycle assessment‘ and ‘cradle-to-cradle‘ date back to the 1970s. Notwithstanding this earlier interest in matters concerning the sustainability of the current economic model and the development of approaches aimed at “closing their loop” in the use of increasingly scarce resources, circular economy, and related issues, have really only gained momentum in the last thirty years. Different conceptualisations have accompanied the growth of the circular economy concept and have provided tools and approaches from different perspectives: the circular economy has thus evolved progressively into “a social construct which grew out of the sediment layered by many different concepts” (Ciraig 2015). This recent and tumultuous evolution has made the distinction between circularity and sustainability increasingly unclear: “While the terms Circular Economy and sustainability are increasingly gaining traction with academia, industry, and policymakers, the similarities and differences between both concepts remain ambiguous.” (Geissdoerfer et al., 2017, p. 756). As a result of their literature analysis, the Authors point out similarities and differences and provide a definition of circular economy “ as a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling” (ibid, p.777). This paper acknowledges this definition, which enables the issue of the circular economy and its business models to be positioned as a specific field, with solutions aimed at “closing the loop of resources”, inside the broader sustainability agenda. In this field, much remains to be studied regarding how firms can address the circularity principles, including, the focus of our research, - which innovative business models can be implemented (Stewart and Niero, 2018) and which implementation and growth barriers firms need to address (Hazen et al., 2017).

Circular business models: a concise state of the art

The business model’s key role is to incorporate the circular economy principles into a design or re-design of business activities and partnerships, and to create a cost and revenues structure, which is compatible both with sustainability and with profitability. The Ellen MacArthur Foundation and —

more recently — Accenture have also outlined ideal-typical business models for the circular economy (Accenture, 2014); they report five business models, which can characterize firms in the circular economy: circular supplies, resource recovery, product life extension, sharing platform and product as a service. Bocken et al. (2016) identify four business models for slow and two business models for closed resource loops, and provide a conceptual overview of the possible design strategies for a circular economy. It is particularly the latter model (closed loops) that most closely interprets the concept of circular economy adopted in this study. Tse and Esposito (2016) too identify a set of business models which embrace, in a broader sense, the principles of the circular economy: closed-loop recycling, renting instead of selling goods, and, lastly, extending and broadening the use of products through “remanufacturing”.

Recently, some literature reviews have aimed at systematising the still relatively young and fragmented field of circular business models.. Lewandowski (2016) refers to the business model canvas features as designed by Osterwader and Pigneur (2013) and argues that their application in the circular economy requires some degree of adaptation. The Author also highlights the need to understand better the adoption factors of circular business models.

The literature briefly mentioned above is mainly characterised by a taxonomic and descriptive intent. It extends the idea of circular business models to a broader set of cases, beyond the “close the loop” concept, and mainly has the manufacturing and service industries in mind. Beyond taxonomies, there is a growing need to identify the issues that need to be tackled for a deeper understanding of the factors involved in the adoption of circular and sustainable practices (Evans et al., 2017). The latter Authors also argue: “The lack of case studies makes it challenging for firms to understand how to innovate their business models, identify and design alternatives, then assess and select the most adequate one.” (ibid, p.598).

Furthermore, though it seems implicit that most of these circular business models cannot be designed and operated as “stand alone” models, the literature on circular business models mainly focuses on the single firm and on the idea - borrowed from the traditional business model literature - that the boundaries of the business model coincide with the boundaries of the firm (Teece, 2010). The existence of a “value network” is acknowledged by some, but it usually remains in the background and not at the core of the model itself. On the other hand, the literature on innovation management, and notably on open innovation, suggests that when companies face the uncertainties and opportunities of novel environments and challenging tasks, they need to rely on a system of partnerships and collaborations and develop open business models (Chesbrough, 2006). This is further confirmed by the discussion of the industrial symbiosis stream, in the following section.

We thus advance the hypothesis that the collaborations among different actors and innovations are two intertwined key factors that need to be better explored in order to identify the drivers of successful business models in the circular economy too.

We also agree with Evans et al. (2017) that in-depth case studies are needed, as well as a better understanding - through empirical evidence - of the barriers to growth and the adoption of circular practices.

Industrial ecology and circular business models

The issue of collaborations among different actors, which we deem fundamental in circular business models, is at the heart of the industrial ecology literature, which supports the creation of industrial eco-systems, in which local organisations form industrial symbioses (Korhonen, 2005). According to Chertow and Park (2016, p. 107) “industrial symbiosis construed as networks of organizations cooperatively sharing wastes has created irresistible imagery and high hopes for a time when virtually all water, energy, and materials will be used more than once, and not to do so will have become societally unacceptable”.

The industrial symbiosis approach engages traditionally separate industries and actors in a collective approach, involving physical exchange of resources and/or by-products, while leveraging on the synergistic possibilities offered by geographic proximity (Chertow, 2000, Wolf et al., 2007). A concrete realisation of this concept are the so-called eco-industrial parks. A circular business model can assume traits similar to those of an eco-industrial park, involving both firms co-located in a defined area and partners that are not contiguous.

The industrial ecology and the related industrial symbiosis conceptualisations are certainly coherent with the circular economy principles. At the same time, these approaches do not investigate the business implications in depth (Etzion, 2007; Wassmer, Paquin, & Sharma, 2014). Walls and Paquin (2015, p.33) make the following observation about industrial symbiosis (IS) “The IS literature is still fragmented theoretically and has developed separately from corporate environmental strategy where the focus is mostly on intra- rather than interfirm action (...). Given its potential to inform environmental strategy and organisational theory, it is a good time to consider the IS literature from an organisational angle and set an agenda for future research.” In addition to the fore mentioned gap in understanding the firm-level and organisational aspects of IS, there is a related gap in discussing the adoption/growth factors and the cost-revenue structure (business model) of industrial symbiosis. We can thus conclude that while the previously mentioned literature on circular business models does not fully consider the fact they are fundamentally “collaborative” models encompassing different

actors, the industrial ecology and IS literatures focus on the collaborative dimension, but neglect the strategic and organisational dimension, as well as the role of the focal firm.

The relationship between industrial eco-systems and circular business models requires a deeper understanding: while the eco-system provides a “stakeholders’ architecture”, a system of actors and their relationships, the circular business model (which has mostly been conceived at the single firm level), can encompass this system of actors and provide the “operational and economic architecture” to make the eco-system viable and sustainable also from the financial point of view (Low & Ng, 2018). This gap in studies has recently been confirmed by Zaoual and Lecoq (2018, p.134): “the implementation of industrial ecology at the inter-organisational level remains complicated. The mere processes of implementation remain understudied”. As stated by Mathews et al. (2018, p. 175) “in the case of the move toward circular economy (CE), the existence and identification of complementarities between firms is the starting point for moves toward CE relations that close industrial loops.” These studies result in a strong need to understand the role of “matchmakers who act as network orchestrators to facilitate new forms of inter-organisational cooperation”.

Consequently, our contribution addresses a gap in studies which concerns the poor understanding of some of the key implementation factors of circular business models, especially in regards to the role of the orchestrator and to the complex relationships between the various actors involved in the circular eco-system. Matching the stakeholders’ architecture (network, ecosystem) with the operational and economic one (business model) and understanding how the system is orchestrated, how value is created and how the system can grow and expand, are all relevant and still little explored areas of investigation.

We also address a gap in studies regarding the application of circular business models and industrial symbiosis to agriculture: the prevailing attention to the “industrial” context has overshadowed the key role of the primary sector in driving innovation and change in circular practices (Ju and Xiang, 2011; Alfaro and Miller, 2014).

Research design and methodology

The questions we address in this paper suggest an exploratory research approach based on case study evidence. We use the mechanism of abductive inferences, which is pertinent to our research (Gary 2010) as it is an appropriate method for making sense of new (or unknown) situations, through ‘*an inference*’ from observed facts” (Richardson and Kramer, 2006 p.499). This method has been employed in sustainability studies (Stubbs and Cocklin, 2008) to uncover new forms of organisation and sustainable business models in particular. Unlike induction, abduction accepts existing theory, which may improve the theoretical strength of case analyses. In our case, we build on the previously

discussed literature regarding circular business models and industrial ecology, with the aim of integrating and complementing these streams, as well as advancing knowledge, through an in-depth analysis of an “exemplar” case study.

The empirical research employs a nested case study method, which is based on observing different units within one complex organisation or network (Gibbert *et al.*, 2008). In order to identify cases of potential interest from this viewpoint, we tried to map companies that had been reported as pursuing circularity principles. To do this, we combined different data sources: search engines; companies cited in reports and publications; companies which had received awards for their circular economy implementation; and, companies that emerged from press releases through the LexisNexis data base. We restricted our search to fifteen potential cases and in the end we chose one – Acqua & Sole (A&S) - because it encompassed the various dimensions we needed to analyse and they were available for multiple in-depth interviews, and willing to provide access to all their partners. The latter is a fundamental requisite for developing a nested case study approach.

A&S is the orchestrator of a network of private and public actors; all involved in realising a highly innovative project of waste recycling and upcycling in agriculture. It shows the traits of an “exemplar” case (Flyvberg, 2006) and permits us to outline the traits of a novel strategic and organisational closed-loop model.

The data collection involved 21 in-depth interviews: four with the A&S top management team and seventeen with people from other members of their network (including farmers, local institutions, utilities, etc.). The interview outcomes were triangulated, and also took into account other data sources, when available: company reports and web sites, press releases, and archival materials.

Each interview lasted between 60 and 90 minutes. Open-ended questions were used throughout the interviews. In particular, we first investigated the technological and innovative dimensions by asking about the technology the business model depends on and the competing technologies. Then we asked questions about the business model structure, its costs and revenues structure, the nature of relationships among partners, the specific role of each partner, the role of the orchestrator, the main coordination mechanisms used to manage the network, and the governance structure. We also asked the interviewees about the direct and indirect economic impacts of this business model, the direct and indirect environmental impacts in terms of resources, materials, energy, water, biodiversity, emissions, and waste, as well as about the social impacts.

The key data on A&S and its network is shown in Table 1.

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As already mentioned, at the heart of this circular project there is a radical innovation in waste treatment, patented worldwide by A&S after years of research and development. The implementation of this innovation required establishing a network, which involved both local communities and public actors, research centers and private companies (supermarkets, utilities). We categorised the role of the different actors, by applying the framework suggested by Jay and Gerand (2015). First we identified the “private-problem holders”: one large private utility, who deals with waste management (need for innovations in waste treatment), two large retailers (supermarkets chains with expired food to manage) and five farmers (need for fertilizer). Second, we identified the “public-problem holders”: the mayors of three municipalities (need to manage local waste and to preserve the environment) and the managers of three local public utilities. Third, we identified the “innovation champion”, in our case the founders of A&S, the Natta family. Initially, they started the research and development of their novel technology through collaboration with research centres and universities. Then –after patenting it- they founded A&S, whose role is as the orchestrator of the project and the network. Fourth, we identified the “knowledge-holders”. In our case we interviewed two academics and one researcher at the Italian National Agency for new technologies, energy and sustainable economic development, who provided their expertise in waste management, biochemistry and organic farming. Finally, we identified the “infrastructure holders”. Since in our case the financial issue was not critical, we interviewed the entities who provide the necessary regulatory framework to support the establishment and adoption of the new solution. As sometimes occurs, also in our case, the role of enabler overlaps that of the problem holder, so we interviewed the mayors of the municipalities where Acqua & Sole manages its operations.

The A&S case/1: a story of innovation

Modern agriculture predominantly applies the “take, use and throw away” principles of the linear economy. This process needs a constant input of raw materials, resources derived from minerals, which are running out, and it produces waste and pollution. To feed a world population of almost ten billion people, agriculture should be able, in less than forty years, to double the current production of soybeans and to increase production of cereals by a third (OECD-FAO, 2015). The use of chemical fertilizers has increasingly resulted in the loss of organic matter in soil, which, in turn, leads to increasingly fragile and poor soil, erosion and desertification. Each year, worldwide, 24 billion tons of soil are lost, of which nature can only restore a hundredth part each year: what humans consume in a year is recovered in 100 years by nature (United Nations, 2007).

The A&S story began in 2007 and as described by its founder Giuseppe Natta it “starts from the failure of the linear economy”. Natta comes from an engineering background and was previously a

very successful entrepreneur in waste management. He declares that he developed this new business by building on the following premise: “Waste is an economic concept, not a physical characteristic”. Waste, to Natta, indicates a material traded at a negative price, in other words, those who supply it, and not those who receive it, have to pay for it. The A&S project was conceived from the idea of inverting the “waste dominant logic”. To the best of our knowledge, it is one of the first cases in Europe of circular economy being fully implemented in agriculture and represents, as such, an exemplar case study. It is also exemplar for its degree of innovation. A new perspective of waste in agriculture requires new technologies. In this case, it began with a disruptive technology covered by an international patent: the A&S company has designed and developed the world’s first facility for the recovery of organic substrates derived from the food-cycle and its consumption, and their re-use in agriculture for the restoration of soil fertility. The plant, with its unique technology, uses as input the ‘worthless’ output of the linear economy: domestic effluent from sewage treatment plants, municipal organic waste from recycling, food residuals and expired foods, and manure from stables. These organic resources can be used and mixed in various combinations, depending on the available inputs. Advanced recycling technology, based on life and material sciences, is the backbone of the company’s business, providing new opportunities to collect, process and re-use resources and materials. The plant has the capacity to receive 120,000 t / year of waste, which is transformed into approximately 190,000 tons of completely sanitised and deodorised organic soil. This is the product of a process of biological stabilisation at high temperature obtained from the biogas that is produced by the biological degradation of waste (figure 1).

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The heat produced by the combustion of biogas maintains the process temperature at 55°C for at least twenty days and this is what makes the A&S case different. While the reuse of sludge on plantations is a common practice in conventional agriculture it is however in itself a big environmental problem, as the sludge is still polluted with toxins (residues of medications, etc.). Likewise, the production of biogas and electricity from waste streams is also common in Europe. But these processes and technologies too cause pollution. Furthermore, widely diffused practices of organic agriculture based on industrial composting also contribute to environmental pollutants in the form of volatile organic compounds (VOCs), which are carbon-based chemicals that evaporate at room temperature and are harmful for public health. A&S’s unique system, on the other hand, eliminates pollution from the waste streams. In addition the "product" is of a decidedly higher quality than any other type of sludge used as fertiliser in agriculture: this digestate is completely odourless, sewage sludge bacteria such as

Escherichia coli, Salmonella, Shigella, and Staphylococcus are eliminated and there is also a substantial reduction in the presence of heavy metals (table 2).

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Finally, the plant itself does not produce any waste; on the contrary, the process of biological degradation also produces 4,000 tons of ammonium sulphate, which can be used as liquid fertiliser, and an annual energy surplus of over 12,000 MWh (Figure 2). As such, it realizes a model of circular economy in the strictest sense by closing the loop of resources. Additionally, as we'll comment on later, it has enabled the revitalisation of a previously damaged natural system.

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The A&S case/2: understanding the aim and role of the orchestrator

A key factor in implementing the circular business model is the presence of a matchmaker who acts as network orchestrator, in our case A&S. The driving force behind A&S is the idea of implementing a circular business model that has its roots in agriculture, through a simple but innovative concept, which is to “return to the soil what has been taken out”. This process builds on a traditional agricultural practice that, in recent years, had been abandoned in favor of the increased use of mineral fertilisers. At the same time, the orchestrator promotes radical innovations, which make this practice even more compatible with the natural environment and potentially scalable and transferable. This process is defined by Mr. Natta as “the production of quality fertilizers”. If properly managed, waste can be transformed from being a cost and an environmental problem to an economic advantage and environmental improvement by reducing pollution caused by nitrates and phosphates.

The vision of the founder, Mr. Natta, and the philosophy underlying A&S is “neo-rurality”, which means the development of rural areas where agricultural production is integrated with services production, the shared use of farmland and buildings, with the objective of increasing, often dramatically, the landscape quality, its biodiversity and the total value of production. This requires that innovation at A&S goes far beyond the technological dimension (waste treatment), but also encompasses new concepts like neo-rurality, which are shared with the entire eco-system, and engage all the actors.

A&S is located in an area of 1300 hectares, which over the years, has been “re-naturalised” (restituted to nature) and cultivated in an environmentally friendly way. For example, ducks have replaced insecticides, use of fungicides has been reduced, and natural soil improvers produced in the plant have always been used. In twenty years, around its seven farms, 107 hectares of wetland, 78 hectares

of forest, 65 hectares of timber reforestation, 50 hectares of meadow and 110 hectares of hedges and trees have been created. In doing this, an ancient ecosystem has been restored to the Lombard community, creating a biodiversity record: the ecosystem as it was in the year 1000, that is a millennium ago. Natural soil fertility has increased and emissions of greenhouse gases and nitrates have been substantially reduced. In the same twenty-year period, bird species have increased by 170% (80 to 202), dragonfly species by 146% (13 to 30), butterfly species by 105% (21 to 36), and mammal species by 81% (16 to 28). Soil fertility has increased by 71% (from 7 to 12 C.E.C. meq / 100g.).

A&S's vision was to create a network inspired by a natural ecosystem, and make it compatible with economic return through an effective circular business model. The orchestrator had to disrupt the mental schemes deeply rooted in many actors of the ecosystem, who consider waste as a residual material. Here what emerges as particularly relevant is the role of individuals, particularly the founder Mr. Natta and his family members. In disrupting long held beliefs and agricultural practices, the individual level is a critical one and transformational leadership can make the difference in managing relationships with a disperse number of farmers and small municipalities.

The neo-rural philosophy represents a vision of the orchestrator, which is now shared throughout the eco-system of actors. The orchestrator shows that waste can turn "from necessity to richness", in keeping with the vision of the Natta family that "agriculture and environment are synergistic, and the former cannot live without the latter". Finally, all this generates trust between the various actors and enhances their commitment and their involvement over time.

The system of actors and the circular business model

The "A&S model of business cannot work as a stand-alone company", its CEO comments: the firm is, in fact, at the heart of an ecosystem. This network involves firms and partners –consisting of the following actors: the farms– using the digestate – located within a 5km radius of the plant and involving about fifty farmers; the municipalities and utility companies, which deal with water purification and the collection and disposal of waste; the supermarkets; and, the universities and research centers that collaborate with A&S (innovation champion and orchestrator) and provide advanced knowledge and a continual improvement process (figure 3).

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In this network, each player is vital to completing the range of services and closing the loop in the circular system. A&S is an independent legal entity but its model of business could not operate

without being part of a network embedded in a local territory where agriculture, environment, people's wellbeing and public services are deeply intertwined. It acquires physical resources, in this case "waste", which it transforms back into "organic matter". Everything previously considered as waste is revived for other uses, effectively eliminating not only the waste itself but the concept of 'waste' altogether. In this way the circle closes: it returns to the environment, to the territory, to the community, what was previously removed. It thus restores fertility, through organic matter, to the soil, on which 99.7% of what we eat depends. In the words of the founder, "The recovery of nutrient elements is, without any doubt, the greatest net wealth that can be created for a region". A&S sells a service to its 'suppliers', for a fee, and offers a product to its 'customers/partners', for free, simultaneously providing a service to the whole community in terms of sustainability and well-being. Waste disposal today has a cost both for businesses and for public administrations, A&S is able to charge much lower rates than any other disposal technique or facility, given that their plant facility needs no energy or any other human resources or techniques apart from the natural process of biodegradation in order to function. A&S's source of income is derived from the acquisition of the input - organic matter. Farmers have an annual economic benefit of over €2 million arising from the non-purchase of mineral fertilisers based on potassium, phosphorus and nitrogen. In the words of one farmer, "thanks to A&S's innovation I don't buy mineral fertilisers anymore, which means a total saving of €10,000 each year (€400 per hectare). For a small farmer like me this is a big saving". In addition, as described above, the 'product' is of a decidedly higher quality than any other type of sludge used as fertiliser in agriculture. A large state-owned company in the water purification business that manages about 350,000 tons of waste a year and supplies this to A&S, has estimated its savings to be up to €4 million a year for the elimination of sewage sludge, compared to the traditional process of waste incineration. A&S provides a service, which is strategic to the community and to the territory; also through the significant savings in energy and greenhouse gas emissions due to the lack of production and transportation of mineral fertilisers (the reduction in emissions exceeds 5,000 t of CO₂ per year).

The relationships among actors in this complex network are a core issue of our case study and are further discussed in the next section.

We also asked the focal firm about the growth potential of their model, which is now entering – following the experimentation stage- into a stage of scaling up. The proximity to a large metropolitan area is key to the further growth of the circular business model. The center of Milan is, in fact, only 18km from the plant and the A&S system provides a clean, green and fully-circular lung for one of the most polluted regions in Europe. Besides this, A&S can contribute dramatically to the waste management issues of metropolitan areas. The company is working on a partnership with the large

utilities in Milan for the disposal of municipal waste and sewage sludge. Already, as things stand today, the plant would be able to dispose of half of all the sludge and waste produced in Milan. Simply doubling capacity would close the circle for the entire metropolitan area. A&S's business model thus shows a good potential for scalability, but also for replicability, both in the proximate areas and in other regions. The company is already planning to set up similar facilities in other Italian regions. The current ecosystem, according to their plans, could evolve into a broader industry-level solution. This would mean transforming the business model from a product-based one to a platform upon which an entire industry can transform itself through the streamlined adoption of circular business models. CEO Francesco Natta declares: "We do not intend to stop here..."

Finally, our interviews outline the relevance of some adoption factors and barriers for innovative business models in the circular economy. The regulatory framework in some cases favors linear economy businesses and this means that circular enterprises struggle to emerge. In starting-up, A&S had to face two main obstacles. The first was the bureaucratic red tape that delayed the opening of the plant and the lack of a specific regulatory framework for this kind of activity. The company was required to get their project through seven separate different service boards (all committees with relevant public actors) in the space of four years; a timespan that would have caused problems for businesses that had to take out loans to start-up.. The second issue is a potential threat and derives from the fact that the company's input is wastewater and waste. These materials are often the object of legal controversies with the interests of criminal organisations at their core. There is a risk that illegal forms of economy may provide competition to A&S by charging lower disposal fees than those of A&S. Notwithstanding the above-mentioned challenges and threats, the A&S project is still growing. It could be argued that most firms would have found these barriers to entry very difficult to overcome without the determination to succeed and the capacity to self-finance the project: this poses questions about how to support potentially innovative projects in the circular economy when these conditions are not in place.

Discussion

The circular business model emerges from our case study as one that makes profit compatible with the future of the planet. Our exemplar case study uncovers a model, which developed from agriculture and addresses the issues of both waste recycling/upcycling and natural capital restoration, and encompasses different industries right up to the end consumers. The case shows that realising a model that closes the loop of resources (according to the definition of circular economy that we embraced) can provide a valuable contribution to the sustainability agenda. The exemplar model contains the key building blocks of a successful system in the circular economy: relevant innovations are involved,

in products, processes and in the business model, a range of differentiated actors –not only co-located- are engaged, and an orchestrator plays a key role in pursuing and sharing a vision and materialising it into an eco-systemic business model.

The role of the orchestrator

The role of the network orchestrator is crucial to the processes of implementation and engagement in realising a circular business model. Its aim is to manage the complementarities (Mathews, 2018) between all the companies and institutions involved in the ecosystem. We departed from the (few) extant studies (Paquin and Howard-Greville, 2012; Zaoual and Lecoq, 2018) on this subject. In our case the orchestrator is not a third-party matchmaker. Instead, it is a company that also plays the role of innovation champion and that is deeply embedded in the network. In addition, it is not a large firm, as in some literature, but coordinates small and large organizations very effectively. Its leadership builds on the transformational leadership of the founders (Bass and Avolio, 1994) and on the innovativeness and learning advantage of a disruptive technology (Garcia-Morales et al, 2008).

The transformational leadership is strengthened by the history of the Natta family as leading innovators. Giuseppe Natta's father was Giulio Natta – a chemical engineer who discovered polypropylene in the fifties and won the Nobel Prize for chemistry in 1963. His grandfather was also an inventor, who devised a way of squeezing silkworms to make fishing lines, which he sold all over Europe in the 19th Century.

We could thus highlight in our case – beyond the firm/organisational and the network level of analysis - an individual level, which has so far received little attention in circular business models and in industrial symbiosis literature: “individual-level theories are not prominent in the IS literature” (Walls and Paquin, 2015, p. 45). Our case highlights the central role of championing, as represented by key individuals with the competencies, resources, ability and power to bring an eco-system together, by sharing a new concept (Chertow & Ehrenfeld, 2012) and a vision behind the circular business model (Baas & Huisinigh, 2008; Hewes & Lyons, 2008; Mirata, 2004).

A second element in our case is the innovative technology, which requires an innovative and eco-systemic business model. The orchestrator facilitates relations and forms of cooperation; it detects and manages interdependencies among the various actors through governance and collaboration systems, implementing continuous flows and the exchange of resources and services. Not always are these opportunities for collaboration evident, and often they are not spontaneous. Hence, the network orchestrator must bring people together; share a vision and the opportunities for a win-win strategy, thereby reducing the significant lack of trust and communication. The latter typically drive entrepreneurs' behaviors at the early stages of a collaboration process, especially in small companies

with – such in our case – no previous experience of working together. The orchestrator has to generate trust, communication and commitment between all the actors of the network. The smaller partners of the ecosystem, like the farmers in our case, benefit from access to sources and new methods of doing business. They can achieve a critical mass through the network and, together, be part of a new model of circular agriculture, while at the same time improving the natural environment and its biodiversity. The orchestrator has disrupted logics and cognitive frameworks embedded in the linear economy, by introducing the novel concept of neo-rurality, with the final aim of changing the mindsets regarding waste and how to respond to environmental challenges. Finally, the orchestrator needs to activate and subsequently maintain the new business model, to establish agreements, legal contracts, and develop formal and informal governance structures.

This discussion leads to our first research proposition:

Proposition 1: The network orchestrator is crucial for the processes of engaging actors in the implementation of circular business models, which are characterised by disruptive innovations and multiple and diverse partners. The role relies on sharing a common vision and building trust, on the commitment of resources, both tangible and intangible, and on the transformational leadership of its key decision makers. The understanding of the development and growth of innovative circular business models should be approached by complementing an individual level of analysis with an organisational and network one.

The circular business model as an ecosystem

In our case we can observe an eco-system working for circularity, in which different layers and outcomes of innovation – not only technological - contribute to the creation and capture of value. More specifically, the case cannot be described as a stand-alone circular business model, but can only be understood as an ecosystem.

In the descriptive section of this case study we adopted Jay and Gerrand's (2015) framework to categorise the different players of the eco-system and to understand better their role regarding the innovation introduced. In discussing the relationships among the actors we now refer to three elements, following Mülling Neutzling et al. (2018): resource investment, collaboration and governance. The first element, resource investment, can be based both on tangible and intangible assets. The first step made by A&S was an investment of approximately €30 million, of which only €1.5 million was subsidised by public funds, to build the plant. The initial commitment of A&S generated trust in the network members. The relationships among farmers, utilities and A&S imply the exchange of physical resources, and in particular waste as input and digestate as the output of the

process. But the consideration of resources goes beyond the physical and monetary aspects. It implies also an investment in terms of intangible resources, such as knowledge.

Our interviews with the farmers highlight an even more important outcome from their being partners of the A&S business model: they report that their crops (mostly rice and wheat) are improving substantially, thanks to stronger plants that are more resistant to viruses, infections and pathogens. “We have cultivated our land for decades without fully realising the damage to the soil and to the environment. We are now aware of what it means to preserve and revitalise natural capital and, at the same time, use advanced technologies. A farm today requires both a return to the original marriage with nature and, going forward a marriage with innovation.” The farmers feel they could never have faced the challenges posed by the transition to a new agriculture if they had not started networking with innovative companies.

The second and related element is collaboration, from communication to information sharing, from specific relationships to social norms sharing and social ties. Companies and institutions involved in the network are different and heterogeneous, with firm-specific needs and interests that sometimes are even contrasting. Collaboration happens primarily through sharing A&S’s vision and the neo-rurality concept, then through getting engaged in the business model. This element is well highlighted in the interviews with the mayors of two municipalities involved in the area where A&S operates. All of them pointed out the relevance of this core company in improving and preserving the rural landscape, providing a benefit for all citizens, not just farmers. The mayors agree in their vision of becoming “a possible centerpiece of an innovative experiment of the circular economy”. One mayor declares that the “public and private sectors need to work together to realise circularity principles. The idea that public institutions and private firms have divergent targets belongs to the past: we are all together challenged by the survival of our environment.” “Municipalities have, for decades, operated in waste management through their utility companies, through consortia or by delegating the service to private firms. The issue of waste management has already been a field for coordinating public interest and private firms. Now we have to make the jump to a higher level, with technological innovations and broader networks”. This opinion is supported by another mayor, who adds: “The problem is how to make this cooperation happen, what are the rules of the game and how is the value created going to be shared. I think that A&S has been very good at striking the right balance, in finding an optimal equilibrium between the firm’s survival and natural capital enhancement, and involving all the different players, with their complementary visions, resources and capabilities.” In other cases, the collaboration is based on specific partnership and joint programs. For a large state-owned company in water purification the partnership with A&S represents in the words of its CEO “a window of opportunity on new and potentially disruptive technologies for waste management. In

fact, established larger companies need time to adapt and evolve in new directions, like the circular economy. At the same time, they can speed their transition through partnerships with smaller niche players and networks”. A similar consideration holds for the large retailers (supermarkets) that supply A&S with food items that have passed their expiry date: “food waste is a major issue for developed economies: we are looking for innovative partnerships to tackle this problem and to develop joint projects”.

Finally, the third element is governance, from formal control, command structures and legal contracts to informal mechanisms based on trust, communication and cultural socialisation. In our case, we found both. The ecosystem applies formal mechanisms and legal contracts to manage the input process, and informal mechanisms based on trust to manage the output process. The relationships with the suppliers (livestock farms, utilities) are based on formal agreements and legal contracts that define prices, methods, quantities and quality of the waste. By contrast, since fertiliser derived from the appropriate treatment of the ‘waste’ is given free to farmers, A&S doesn’t require any contracts with the farmers, just a form of collaboration based on information sharing and especially on trust and communication. In the words of one farmer “they don’t ask me for anything, just to coordinate our times and methods of planting and cultivation.” Finally, the ecosystem also implies the mechanism of cultural socialisation. A mayor outlined that the implementation of the circular economy in their territories has a value “not only in terms of productivity in agriculture, citizens’ wellbeing and natural capital enhancement. The model has also reconciled environmentally conscious local communities with farming”.

In summary, a circular business model requires a value network with a mutual adjustment based on a complex mixture of resources, collaboration forms and governance mechanisms. And the key role of the orchestrator is that of choosing and implementing the best mix of these crucial elements of network relationships, and balancing the needs of the single actor with the needs of the whole ecosystem (Rantala et al, 2018). The outcome of these dynamic and complex relationships is an “operational and economic architecture” supported by a “stakeholders’ architecture” (eco-system plus local communities and citizens) (Anbarasan and Sushil, 2018). The model is sustainable from the social, environmental and economic point of view (Adams et al., 2016; Belz and Binder, 2017).

This discussion leads to our second research proposition:

Proposition 2: A circular business model is an economic and operational architecture, encompassing the organisational boundaries of different actors (eco-system). Its scope is determined by the resources committed, both tangible and intangible, trust and knowledge flows, and the involvement

of different partners, all of which enables the loop to be closed. Both formal and informal mechanisms provide the governance architecture of the eco-system.

Scalability and replicability of the circular business model

A major issue in circular and sustainable business models is their scalability and replicability (Schaltegger et al., 2016). Scalability refers to the possibility of the model growing (Stampfl et al, 2013), while replicability refers to the possibility of transferring the original model to other contexts. A number of good practices in the circular economy remain mainly confined to a small scale and a (single) local context. This can raise risk and uncertainty, due to the inadequate scale of the operations, and limits the (especially private) funding opportunities. Thus scalability and replicability issues can represent a barrier to the adoption of circular practices and help to explain why circular business model innovation is not yet more widespread.

A&S's circular business model leverages at the same time, the advantages of geographic proximity, the co-location of many actors and the economies of scale related to the concentration of human activities in cities and urban environments (Chertow, 2000; Chertow, Ashton, & Espinosa, 2008; Desrochers, 2001; Desrochers & Leppala, 2010). According to our case study, this physical proximity is related to the early stages of a circular business model. During its evolution this enables new relationships to develop (Deutz & Gibbs, 2008, Gregson et al., 2012; Lombardi & Laybourn, 2012), even if this implies a change of coordination and governance mechanisms. The A&S case is particularly relevant from this point of view as it is based a few miles from Milan, the major urban and industrial area in Italy and one of the biggest metropolitan conglomerations in Europe. A&S's ambition is to become "the hub of the circular economy for the entire metropolitan area of Milan". The scalability of the circular neo-rural ecosystem dramatically improves the natural capital in its area, but also has a high potential impact on the larger metropolitan area of Milan.

The model is also conceived as a replicable one and our interviews reveal that initiatives are already been taken to apply the model in other regions.

Proposition 3: Circular business models need to be designed keeping both the scalability and replicability dimensions in minds. Both these dimensions contribute to improving economic margins, enhancing possibilities for private and public fundraising and to spreading the principles of the circular economy to a larger context.

Conclusions

Our research highlights an exemplar case of an eco-systemic and innovative business model in agriculture, which makes profit compatible with a closed-loop system. It is first framed in an

innovative vision (neo-rurality in our case) and put forward by a transformational leader (individual level of analysis), who then shares it with other partners. Second, the transformational leader creates a model of governance for the eco-system and engages different organisations in the project (organisational and inter-organisational level of analysis). Finally, an innovative and eco-systemic business model is implemented, which concretely defines the exchange relationships between actors, the costs and revenues (economic architecture), and makes profit compatible with the preservation and even restoration of the environment.

We also discussed factors that support the growth of the model via scalability and/or via replication in other contexts and we found some barriers to the adoption of fully circular and innovative models of business.

Our work has implications for managers and entrepreneurs as an exemplar case of a circular ecosystem for agriculture and waste management and its critical factors of success at the individual, organisational and network level. It also has implications for policymaking, by highlighting some barriers to adoption and growth. It is clear that institutional frameworks and financial systems need to be redesigned to support the growth of circular business models.

Finally, our work has some limitations. Our focus was a single exemplar case, which we found particularly interesting. We are aware that a number of other business models exist and are continually being developed in this “generative stage” of the circular economy. This represents the main limitation of our work. Our principle direction for future research is to map these differentiated models and to understand better which factors drive or hinder their growth and diffusion.

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Table 1 Research methodology characteristics

Actors	A&S	Farms	Municipality	Public service companies	Service company	Enea	Universities	Larger retailers
Legal entity	Limited liability company	Independent farmers	Public institution	Public utilities company	Limited liability company	Public agency	Public institution	Large corporation
Main activity	Recovery of organic substrates derived from the food-cycle	Agriculture	Italian basic administrative division	Public utility services	Waste management	Italian National Agency	Education	Retailing activity
Interviews	4	5	3	3	1	1	2	2
Interviewees	Founder CEO	Farmers	Mayors	CEO	CEO	Researcher	Researchers	Top management

Table 2 Sludge parameters and percentage of improvement in relation to the limit values defined by regional decree

Sludge parameters	Limit value defined by the regulation (regional decree n. 2031 of 1/07/2014)	% of improvement in relation to the limit values
Cadmium (cd) [mg/kgSS]	≤ 22	95,12%
Copper (Cu) [mg/kgSS]	≤ 1200	64,70%
Nickel (Ni) [mg/kgSS]	≤ 330	80,53%
Lead (Pb) [mg/kgSS]	≤ 900	92,48%
Zinc (Zn) [mg/kgSS]	≤ 3000	60,37%
Chrome (Cr tot) [mg/kgSS]	≤ 900	86,95%

Mercury (Hg) [mg/kgSS]	≤ 11	85,18%
Polycyclic aromatic hydrocarbons (IPA) [mg/kgSS]	<6	94,14%
Polychlorinated biphenyl (PCB) [mg/kgSS]	<0,8	86,36%
Polychlorinated dibenzodioxins / dibenzofurans (PCDD/F) [ng/Kg TEQ ss]	<100	88,97%
Fecal coli [MPN/gSS]	<10000	none
Salmonella [MPN/gSS]	<100	97,00%
Ethylhexyl phthalate (DEHP) [mg/kg SS]	<100	95,94%
Organic carbon (C_org) [% SS]	> 10	57,30%
Nitrogen Ntot [% SS]	> 1,0	403,48%

Figure 1 The A&S's plant operations

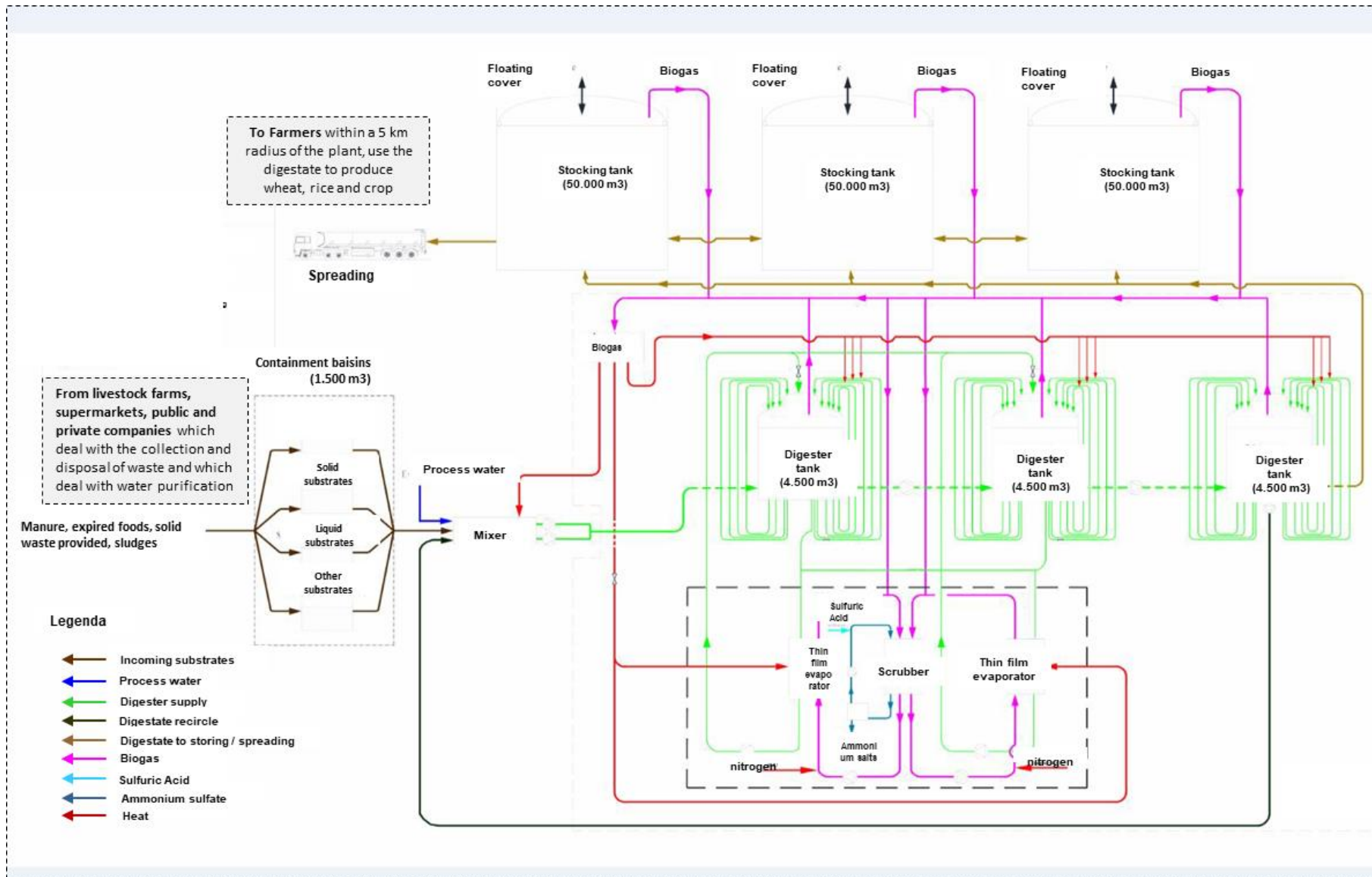


Figure 2 The process of biological degradation

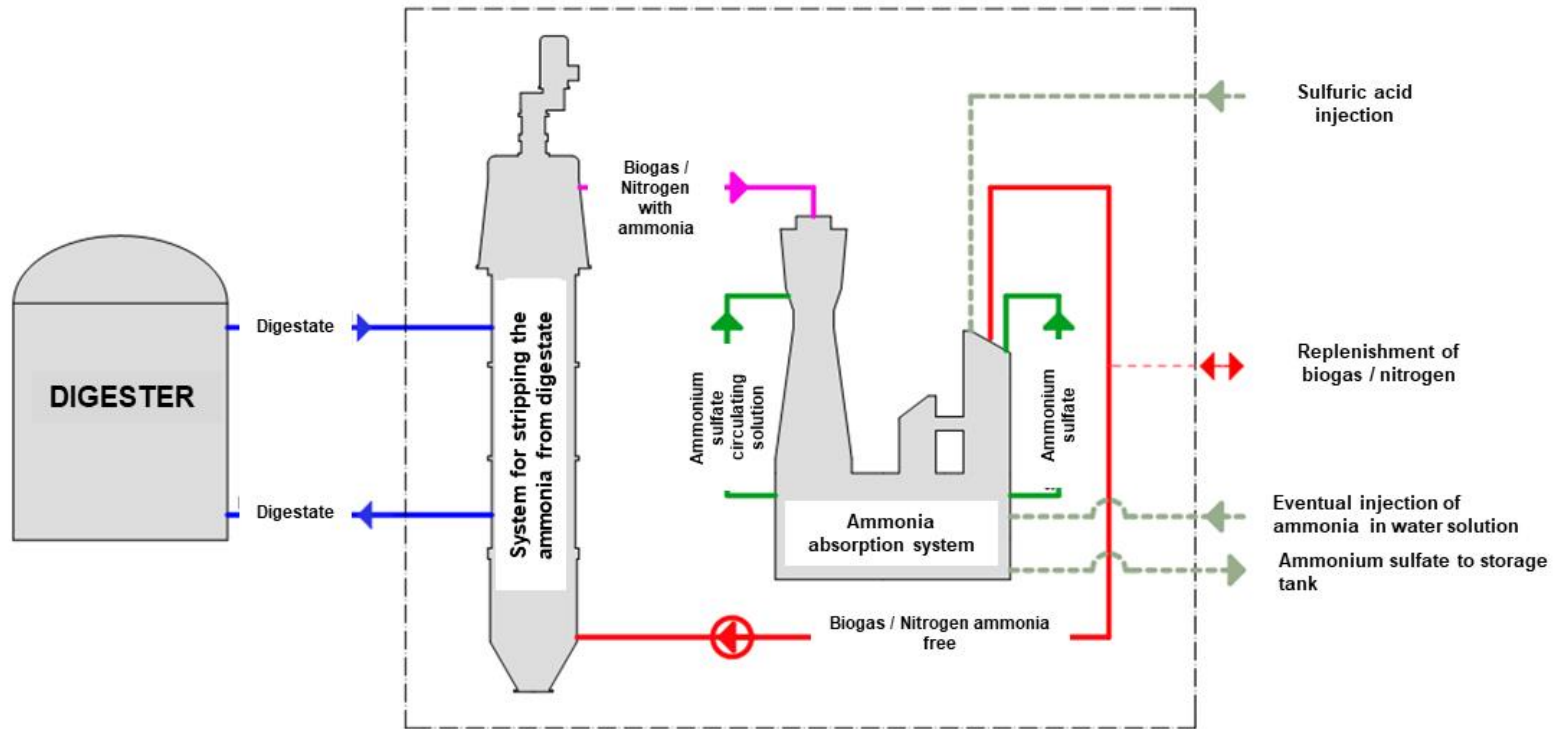


Figure 3 A&S's eco-system of actors

