materials proceedings

Proceeding Paper

Relating Industrial Symbiosis and Sustainable Development Goals †

Juan Henriques [1,*], João Azevedo [1], Marco Estrela [2] and Rui Dias [1]

[1] Low Carbon & Resource Efficiency, R&Di, Instituto de Soldadura e Qualidade, 4415-491 Grijó, Portugal; jdazevedo@isq.pt (J.A.); radias@isq.pt (R.D.)
[2] Low Carbon & Resource Efficiency, R&Di, Instituto de Soldadura e Qualidade, Taguspark, 2740-120 Oeiras, Portugal; maestrela@isq.pt
* Correspondence: jdhenriques@isq.pt
† Presented at International Conference on Raw Materials and Circular Economy, Athens, Greece, 5–9 September 2021.

Abstract: Circular Economy (CE) has grown prominence over the last two decades as a concept that presents solutions to some of the world's most transversal sustainable development challenges and consequently its various business models such as Industrial Symbiosis (IS) have been identified as important tools for Sustainable Development (SD). Several authors have created a solid base to understand how CE contributes to SDGs achievement, nevertheless, there is a limited number of contributions in understanding how IS will contribute to achieving the SDGs. This paper aims to advance in the understanding of IS implementation within the scope of the achievement of SDGs, with a special focus on identifying which is the relevance of the IS to achieve the SDGs and which are the critical areas of contribution. To accomplish this objective, a research methodology integrated with a literature review and matching exercise was performed. The results of this study suggest that the extended IS implementation might collaborate with the achievement of 8 SDGs and 22 targets.

Keywords: Industrial Symbiosis; Sustainable Development Goals; sustainable development

check for updates

Citation: Henriques, J.; Azevedo, J.; Estrela, M.; Dias, R. Relating Industrial Symbiosis and Sustainable Development Goals. *Mater. Proc.* **2021**, *5*, 111. https://doi.org/10.3390/materproc2021005111

Academic Editor: Evangelos Tzamos

Published: 8 February 2022

1. Introduction

Commonly associated with Industrial Ecology (IE), Industrial Symbiosis is a strategy for promoting a circular economy since it mimics nature's natural system in an industrial environment [1]. Through the implementation of this circular business model "industrial ecosystems" are created, in which elements or industrial actors can share wastes, by-products, residues, energy, water, expertise, equipment, and materials with one another, allowing resources and materials to be used productively for longer [2].

The companies that develop these exchanges or synergies usually achieve economic, environmental, and social advantages [3,4]. In practical terms, the firms might benefit from reduced operational costs [5], fiscal benefits [6,7], new jobs [8], and emissions reduction [9]. The benefits generated by the extended practice of this circular business model have led several authors to suggest that industrial symbiosis is a sustainable business model [10,11] since many of these benefits are associated with the triple button of sustainability.

Lüdeke-Freund [10] suggest that sustainable business models are models that "create competitive advantage through superior customer value and contribute to a sustainable development of the company and society". In this sense, for a business model to be considered sustainable, it must promote a significant proposition, including positive effects for the society and the environment in addition to the economic value for the companies [12].

In 2012, the OECD considers IS as an innovative business model, since this business presents a value proposition in economic, social/culture and environmental pillars [13]. The European Commission has also referred in various studies that the extended IS implementation will be essential to boost resource use and production efficiency [14]. Moreover, dedicated specific programs for research and innovation have appeared on this subject, for instance, the SPIRE programme [15]. From a strategic perspective, the European Resource Efficiency Flagship suggests that IS's potential role in boosting efficient and sustainable production is further supported and its benefits are clearly recognized and highlighted [16]. From an academic perspective M. Yang et al. [17], also point out that industrial symbiosis is a business model with higher sustainability attributes. Bocken et al. [11] in their work identified that industrial symbiosis is framed as a sustainable business model of the "create value from waste" archetype [11].

In this sense, if Industrial Symbiosis is a sustainable business model, it should have a relevant contribution to the achievement of SDGs. Several authors have created a solid base to understand how CE contributes to SDGs [18]. Nevertheless, in the case of IS there is a limited number of contributions in understanding how IS will collaborate to achieve the SDGs. The aim of this study is to contribute to the understanding of IS implementation within the scope of the achievement of SDGs. For this purpose two research questions were defined: What is the relevance and IS contribution for the achievement of SDGs? and, what are the critical areas of IS contribution within the scope of SDGs?

2. Sustainable Development, SDGs and Industrial Symbiosis

The United Nations Member States approved the Sustainable Development Goals (SDGs) in 2015, as a universal call to eradicate poverty, safeguard the environment, and ensure peace and prosperity for all by 2030 [19]. In general, the SDGs promote human dignity and prosperity while safeguarding the earth's vital biophysical processes and ecosystem services.The SDGs in a broader perspective recognizes that resolving poverty and inequality requires measures that support long-term economic growth, peace, and justice, but also address basic social needs (for instance education, health, and job opportunities), while simultaneously addressing climate change issues and improving environmental protection [20].

Diverse studies have been developed from the perspective of relating the role of industrial symbiosis, SDGs, and sustainable development [18,21,22]. Perhaps one of the most relevant contributions on this topic is a part of the work promoted by Schroeder et al. [18]. Within the context of SDGs achievement, this study recognised a group of potential IS contributions.The authors suggest a clear link between IS implementation and potential contribution for the SDG 3 (Good health and well-being) in target 3.9, SDG 6 (Clean water and sanitation) in target 6.3, SDG 8 (Decent work and economic growth) in target 8.2, SDG 9 (Industry, innovation, and infrastructure) in target 9.4, and SDG 12 (Responsible production and consumption) in target 12.4. With a different approach Cecchin et al. [23], developed a study focused in contextualize the Circular Economy and Industrial Symbiosis, through the lens of the current debate on Sustainable Development, highlighting the potential contributions of Industrial Symbiosis and Circular Economy to the path towards a more sustainable society. The authors suggest that the implementation of industrial symbiosis has an important contribution in promoting sustainable development, namely through the promotion of resource efficiency models in industries that generate a reduction in operational costs, increase competitiveness and generate social benefits [23].

Another relevant contribution to this topic was made by Li Shi [21], which promotes a theoretical assessment of the contribution of Industrial Symbiosis and Clean Energy. From an applied perspective, Roetman within the scope of the European FISSAC Project [24], developed a study that suggests that symbiotic initiatives will have relevance in SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG 8 (Decent Work and Economic Growth), SDG 12 (Responsible Consumption and Production), and SDG 15 (Life on Land). This study also suggests that Industrial Symbiosis might be relevant for SDG 16 (Peace, justice, and strong institutions) and SDG 17 (Partnerships for the goals).

In general terms, most of these studies indicate that the IS has an important contribution to the achievement of SDG 6, 7, 8, 12, and 15.

3. Research Methodology

This research is based on dedicated review literature and matching exercise with the main objective of identifying references and cases that would allow us to bridge the IS implementation and the SDGs achievement.

An analytical technique consisting of the following steps was used to process the information:

3.1. Step 1: Gathering Information and Literature Review

The primary source of information for the characterization was grounded on scientific peer-reviewed articles which were identified through a search in the database of Science Direct, Scopus, Google Scholar, Web of Science, and internet search engine machine. In this search, the main keyword "Industrial Symbiosis" was used in combination with other keywords/terms to conduct this search in the databases. This search led to the identification of a group of peer-reviewed articles. Nonetheless, other references such as grey literature, and non-scientific publications were also considered. Figure 1 presents the keywords and the logic followed in this procedure.

Search logic and Set of keywords

1) Industrial Symbiosis + SDG Number
2) Industrial Symbiosis + SDG Name
3) Industrial Symbiosis + Target achievement
4) Industrial Symbiosis + Associated indicator

Figure 1. Logic and Set of keywords used in the research.

3.2. Step 2: Screening of Data

The second step was to perform a data screening that was achieved through a thematic/content analysis of papers to identify the relevant references. In this phase, the articles initially selected pass through a critically reading process. The references related to IS and its contribution to SDGs achievement were selected, and the non-relevant articles were discarded.

3.3. Step 3: Matching Exercise

The methodology described by Schroeder et al. [18], is used in this study's matching exercise. However, in our study it was applied exclusively within the scope of the IS and their contribution for SDGs, while Schroeder has a broader perspective to the whole concept of CE and all its models. In practical terms, this exercise allows to identify the relationship between IS implementation and SDG targets, showing that IS implementation will potentially contribute to the achievement of a large number of SDG targets. For the matching exercise, the same start-stop rule proposed by Schroeder et al. [18] was also considered: the start rule was to identify an SDG target to which the IS practice could offer a contribution, regardless of the contribution level; the searching stops once the contribution was identified. This characterization was then performed throughout all 169 targets aiming to allocate the specific IS practices and literature references to the individual targets. After the SDG practices were allocated, the type and level of the contribution that IS implementation could potentially have to the SDGs was assessed.

The level of contribution in this study is obtained through a relationship assessment, by means of a simple relationship assessment grid consisting of four categories: Weak or no link (0); Direct/strong contribution of IS for the SDG (1); Indirect contribution; (2) and Progress on IS practices supports the uptake of the target (3) [18].

4. Results

For the purpose of visualizing the results, the SDGs, targets, and IS contribution levels are represented on a matrix basis. This heat diagram allows the visualization of the SDGs targets by IS contribution relevance. On this matter, the dark green displays the target where IS has the greatest contribution in its achievement ranging in colour degraded until light green, which represents those with the lowest contribution. Also, the yellow represents those targets where IS has no contribution in their achievement. The heat diagram for the matching exercise and target identification is shown in Figure 2.

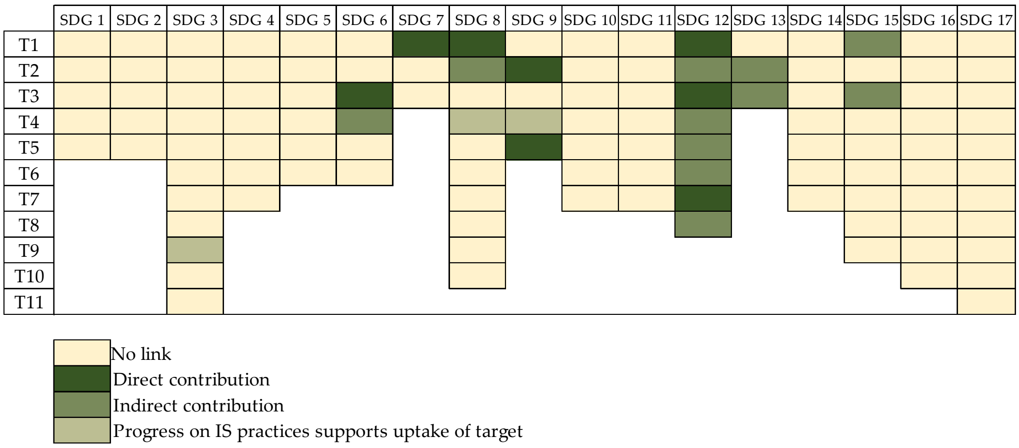

Figure 2. Heat diagram for the matching exercise and target identification.

Concerning the IS contribution in an individual perspective of SDGs, our study identified that the extended Industrial Symbiosis implementation (Implementation across industrial sectors in a national or regional perspective) might contribute to the achievement of the scope of 8 SDGs. In SDG 3 (Good health and well-being), where IS will have an achieving target contribution through target 3.9, by the means of reducing the emissions of GHG [25] and water pollution [26,27].

In SDG 6 (Clean water and sanitation), IS will play a relevant role since the eco-industrial park perspective promotes the efficient use of water resources. Several eco-industrial parks have symbiosis-based models to optimize the wastewater treatment system in industrial parks [28].

Concerning SDG 7 (Affordable and clean energy), IS will have a specific contribution through target 7.3 (double the global rate of improvement in energy efficiency), since the energy-based industrial symbiosis perspective is recognized as an effective strategy to reduce the use of traditional fuels in energy production. For instance, in the Chinese iron and steel sector, energy consumption could be reduced up to 6% due to energy-based IS synergies of the total energy consumption [29]. Some authors support that IS plays an important role in increasing the renewals energies in the energy mix (eco-industrial parks) [30].

In SDG 8 (Decent work and economic growth), the contribution of IS is represented in target 8.1 (per capita economic growth), target 8.2 (Annual growth rate of real GDP per capita/per employed), and target 8.4 (Material footprint per capita). In this SDG, the studies directed to a regional level have helped to verify the connection between industrial symbiosis and the scope of this goal. For instance, the study promoted by Johnsen et al. [8] addressing the IS implementation in the Nordic countries has shown the importance of this business model for green growth in this region. Another important contribution in this matter was a study performed in the regions of Andalusia and Extremadura in Spain [31]. In this study, the eco innovation and extended implementation of innovative business models, such as IS, have contributed to place those regions in the top of the European rankings. In particular, by the impacts in some economic performance indicators such as Material productivity (GDP/Domestic Material Consumption), Water productivity (GDP/Water Footprint), and Energy productivity (GDP/gross inland energy consumption), which have been considerably improved.

For SDG 9 (Industry, Innovation, and Infrastructure), IS has a contribution through target 9.2 (Promote inclusive and sustainable industrialization), target 9.4 (upgrade infrastructure and retrofit industries to make them sustainable) and, target 9.5 (Enhance scientific research). Promoting inclusive and sustainable industrialization (target 9.2) has demonstrated the potential of IS in creating new businesses and jobs [8]. Upgrade infrastructure (target 9.4) to implement industrial symbiosis can benefit all parties involved and contribute significantly to sustainable growth and greenhouse gas reduction (GHG), especially in energy-intensive sectors such as the cement sector [32]. Regarding the enhanced scientific research (target 9.5), several studies point out that in order to achieve an effective implementation of the industrial symbiosis it is fundamental to promote research in industry, designed to solve real-world problems and generate insights with direct high utility for business practices [33].

The SDG 12 (Responsible consumption and production) is the SDG with the highest representation in the context of industrial symbiosis, as IS will have a direct and indirect contribution to the 8 targets of this SDG. In particular, a direct contribution of IS for the target 12.1 (Programmes on Sustainable Consumption and Production Patterns [8]), target 12.3 (halve per capita global food waste at the retail and consumer levels [25]) and target 12.7 (Promote public procurement practice [34]). For the rest of the targets, there is an indirect contribution.

In SDG 13 (Climate Action), IS plays an important role in the achievement of target 13.3 (integrate climate change measures into national policies, strategies, and planning) because national/supranational plans and strategies in the last 10 years have been established, by policies of national and European institutions that effectively promote sustainable growth and IS implementation. At the European level, the Action Plan for the Circular Economy [35] and the European Green Deal [36] are two examples in this context. Another critical aspect of contribution is associated with target 13.3 (Improve education, awareness-raising, and human and institutional capacity on climate change mitigation), IS will help to reach this target, even, it is very focused on institutional education perspective (Increase awareness in businesses) [37,38].

Lastly, in SDG 15 (Life on land), in which the IS extended implementation will contribute in the achievement of two targets related to the restoration and sustainable use of terrestrial and combat desertification (Targets 15.1 and 15.2) since the long-term implementation of this business model reduces the pressure on ecosystems by the means of reduction of resources consumption (virgin raw materials, water, and energy) [5,26].

Regarding SDG 1, 2, 4, 5, 10, 11, 14, 16, and 17 no published data were found that validated the relationship between the IS implementation and the achievement of those goals. From the 164 targets proposed by the UN in the SDGs, our study suggests that there is some type of contribution in the achievement of 22 targets. For most of these targets there is an indirect contribution. Also, there are a total of 8 targets where the IS implementation will have a direct contribution. Lastly, with a lower representation, 5 targets were identified in which the Industrial Symbiosis will tangentially contribute to their achievement.

5. Results Discussion

Regarding the first question, which concerns the relevance of IS for the achievement of SDGs, our study suggests that IS does not fully cover all aspects of SDGs and sustainable development. Nevertheless, the extended implementation of this business model, (Implementation across industrial sectors in a national or regional perspective), has a significant degree of relevance for a considerable group of SDGs and indirectly helps to reach various targets.

Concerning the second research question, critical areas of IS contribution, our study suggests that IS will have an important contribution to the economic and environmental pillars of SD. Nevertheless, according to our analysis IS still lack of assessed impact on the social pillar, having slight or no direct contribution in fundamental aspects such as good health and well-being, no poverty, and zero hunger. Most of the contributions of IS are focused on the economic and environmental pillars, there is an extensive theoretical and practical background where various cases have allowed a quantitative characterization of IS contribution, most of them in a regional or local perspective. In concerning the economic pillar, it is inferred that IS has an important participation in aspects related to Green growth, promotion of sustainable production, and consumption. Regarding the environmental pillar, most of the benefits and contributions are associated with the reduction of emissions, increase of the resources efficiency (virgin raw materials, water, and energy), and reduction of carbon and material footprint.

Comparing this research to other approaches, there is a group of SDGs that have been suggested as relevant in other studies and have also been identified in this work, reinforcing the importance of the practice of IS on those SDGs.Namely, SDG 6 (Clean water and sanitation), SDG 9 (Industry, Innovation, and Infrastructure) and, SDG 12 (Responsible consumption and production). Nevertheless, there are also some important differences with previous studies, for instance, Schroeder et al. [18] suggest that the contribution of symbiosis is focused on the SDGs 3, 6, 8, 9,and 12. Our analysis shows that there are also important contributions in SDG 7, 13, and 15, as presented in the results section. The study proposed by Roetman in the FISSAC Project [24], suggests that IS implementation might be relevant to SDG 16 (Peace, justice, and strong institutions) and SDG 17 (Partnerships for the goals). However, within the scope and the analysed criteria of our study, there were no identified references, evidence or cases that support this statement.

6. Conclusions

This study has systematically reviewed the contribution of Industrial Symbiosis in the achievement of SDGs through a literature review and an applied matching exercise. The main outputs of this study are a detailed analysis of the IS contribution and the critical areas of IS contribution in SDGs achievement. The results of this study suggest that the extended IS implementation might contribute to the achievement of 8 SDGs and 22 targets. In general terms, our analysis suggests that the extended IS implementation has a direct contribution to achieve the SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, innovation, and infrastructure) SDG 12 (Responsible Consumption, and Production). On the other hand, IS will also have an indirect contribution to SDG 3 (Good health and well-being), SDG 13 (Climate action), and SDG 15 (Life on Land).

The present study presents an empirical approach based on research methods such as literature review, therefore the corresponding contribution proposed can be considered as a theoretical contribution. A potential area for future developments and studies would be associated with the validation with quantitative data in order to strengthen the actual results and its outcomes.

Funding: This work was supported by the European Union's Horizon 2020 research and innovation programme through the TRUST project (grant agreement No 810764).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

References

1. Chertow, M.R. Industrial symbiosis: Literature and taxonomy. *Annu. Rev. Energy Environ.* **2000**, *25*, 313–337. [CrossRef]
2. CEN-CENELEC Management Centre. *CEN-CENELEC Industrial Symbiosis: Core Elements and Implementation Approaches*; CEN-CENELEC Management Centre: Brussels, Belgium, 2018.

3. Azevedo, J.; Ferreira, I.; Dias, R.; Ascenço, C.; Magalhães, B.; Henriques, J.; Iten, M.; Cunha, F. Industrial symbiosis implementation potential—An applied assessment tool for companies. *Sustainability* **2021**, *14*, 1420. [CrossRef]
4. Mirata, M. Experiences from early stages of a national industrial symbiosis programme in the UK: Determinants and coordination challenges. *J. Clean. Prod.* **2004**, *12*, 967–983. [CrossRef]
5. Albino, V.; Fraccascia, L.; Giannoccaro, I. Exploring the role of contracts to support the emergence of self-organized industrial symbiosis networks: An agent-based simulation study. *J. Clean. Prod.* **2016**, *112*, 4353–4366. [CrossRef]
6. Costa, I.; Massard, G.; Agarwal, A. Waste management policies for industrial symbiosis development: Case studies in European countries. *J. Clean. Prod.* **2010**, *18*, 815–822. [CrossRef]
7. Fraccascia, L.; Giannoccaro, I.; Albino, V. Efficacy of landfill tax and subsidy policies for the emergence of industrial symbiosis networks: An agent-based simulation study. *Sustainability* **2017**, *9*, 521. [CrossRef]
8. Johnsen, I.; Berlina, A.; Lindberg, G.; Mikkola, N.; Smed Olsen, L.; Teräs, J. *The Potential of IS as a Key Driver of Green Growth in Nordic Regions*; Nordregio: Stockholm, Sweden, 2015; ISBN 9789187295348.
9. Sun, L.; Li, H.; Dong, L.; Fang, K.; Ren, J.; Geng, Y.; Fujii, M.; Zhang, W.; Zhang, N.; Liu, Z. Eco-benefits assessment on urban industrial symbiosis based on material flows analysis and emergy evaluation approach: A case of Liuzhou city, China. *Resour. Conserv. Recycl.* **2016**, *119*, 78–88. [CrossRef]
10. Lüdeke-Freund, F. Towards a Conceptual Framework of Business Models for Sustainability. In Proceedings of the ERSCP-EMSU Conference 2010, Delft, The Netherlands, 25–29 October 2010.
11. Bocken, N.M.P.; Short, S.W.; Rana, P.; Evans, S. A literature and practice review to develop sustainable business model archetypes. *J. Clean. Prod.* **2014**, *65*, 42–56. [CrossRef]
12. Boons, F.; Lüdeke-Freund, F. Business models for sustainable innovation: State-of-the-art and steps towards a research agenda. *J. Clean. Prod.* **2013**, *45*, 9–19. [CrossRef]
13. Machiba, T. *The Future of Eco-Innovation: The Role of Business Models in Green Transformation*; Danish Business Authority: Copenhagen, Denmark, 2012.
14. European Commission. *Cooperation Fostering Industrial Symbiosis Market Potential, Good Practice and Policy Actions*; European Commission: Brussels, Belgium, 2018.
15. European Commission. *SPIRE Roapmap 2030*; European Commission: Brussels, Belgium, 2013.
16. European Commission. *A Resource-Efficient Europe—Flagship Initiative under the Europe 2020 Strategy*; European Commission: Brussels, Belgium, 2011.
17. Zhang, Y.; Zheng, H.; Chen, B.; Yang, N. Social network analysis and network connectedness analysis for industrial symbiotic systems: Model development and case study. *Front. Earth Sci.* **2013**, *7*, 169–181. [CrossRef]
18. Schroeder, P.; Anggraeni, K.; Weber, U. The Relevance of Circular Economy Practices to the Sustainable Development Goals. *J. Ind. Ecol.* **2019**, *23*, 77–95. [CrossRef]
19. United Nations Development Programme. What are the Sustainable Development Goals? Available online: https://www1.undp.org/content/oslo-governance-centre/en/home/sustainable-development-goals.html (accessed on 1 July 2021).
20. United Nations 17 Goals to Transform Our World. Available online: https://www.un.org/sustainabledevelopment/ (accessed on 6 July 2021).
21. Shi, L. Industrial Symbiosis: Context and Relevance to the Sustainable Development Goals (SDGs). In *Responsible Consumption and Production. Encyclopedia of the UN Sustainable Development Goals*; Springer: Cham, Switzerland, 2020; pp. 381–391.
22. Ruiz-Puente, C.; Jato-Espino, D. Systemic analysis of the contributions of co-located industrial symbiosis to achieve sustainable development in an industrial park in Northern Spain. *Sustainability* **2020**, *12*, 5802. [CrossRef]
23. Cecchin, A.; Salomone, R.; Deutz, P.; Raggi, A.; Cutaia, L. Relating Industrial Symbiosis and Circular Economy to the Sustainable Development Debate. In *Industrial Symbiosis for the Circular Economy*; Springer: Cham, Switzerland, 2020; pp. 1–25.
24. Roetman, E. A Tool to Improve and Measure the Impact of Projects. 2018. Available online: http://fissacproject.eu/wp-content/uploads/2018/05/E.Roetman_FISSACwebinar_31May.pdf (accessed on 7 July 2021).
25. Neves, A.; Godina, R.; Azevedo, S.G.; Pimentel, C.; Matias, J.C.O. The Potential of Industrial Symbiosis: Case Analysis and Main Drivers and Barriers to Its Implementation. *Sustainability* **2019**, *11*, 7095. [CrossRef]
26. Ntasiou, M.; Andreou, E. The Standard of Industrial Symbiosis. Environmental Criteria and Methodology on the Establishment and Operation of Industrial and Business Parks. *Procedia Environ. Sci.* **2017**, *38*, 744–751. [CrossRef]
27. Cui, H.; Liu, C. Applying industrial symbiosis to chemical industry: A literature review. *AIP Conf. Proc.* **2017**, *1864*, 020090.
28. Hu, W.; Tian, J.; Li, X.; Chen, L. Wastewater treatment system optimization with an industrial symbiosis model: A case study of a Chinese eco-industrial park. *J. Ind. Ecol.* **2020**, *24*, 1338–1351. [CrossRef]
29. Fraccascia, L.; Yazdanpanah, V.; van Capelleveen, G.; Yazan, D.M. Energy-based industrial symbiosis: A literature review for circular energy transition. *Environ. Dev. Sustain.* **2020**, *23*, 4791–4825. [CrossRef]
30. Butturi, M.A.; Lolli, F.; Sellitto, M.A.; Balugani, E.; Gamberini, R.; Rimini, B. Renewable energy in eco-industrial parks and urban-industrial symbiosis: A literature review and a conceptual synthesis. *Appl. Energy* **2019**, *255*, 113825. [CrossRef]
31. SYMBI Project. *Comparative Analysis Study of Regional and National Policies on Industrial Symbiosis and Circular Economy*; Interreg Europe: Lille, France, 2017.
32. Henriques, J.; Ferrão, P.; Castro, R.; Azevedo, J. Industrial Symbiosis: A Sectoral Analysis on Enablers and Barriers. *Sustainability* **2021**, *13*, 1723. [CrossRef]

33. Vladimirova, D.; Miller, K.; Evans, S. *Scaler Deliverable 2.1: Lessons Learn and Best Practices for Enhancing Industrial Symbiosis in the Process Industry*; European Commission: Brussels, Belgium, 2018.
34. European Commission. *Buying Green Handbook*; European Commission: Brussels, Belgium, 2016; ISBN 9789279568480.
35. European Commission. *Circular Economy Action Plan*; European Commission: Brussels, Belgium, 2018.
36. European Commission. *The European Green Deal*; European Commission: Brussels, Belgium, 2019; pp. 47–65.
37. Neves, A.; Godina, R.; Azevedo, S.G.; Matias, J.C.O. Current status, emerging challenges, and future prospects of industrial symbiosis in Portugal. *Sustainability* **2019**, *11*, 5497. [CrossRef]
38. Islam, K.; Islam, K.N.; Rahman, M.F. Industrial Symbiosis: A Review on Uncovering Approaches, Opportunities, Barriers and Policies. *J. Civ. Eng. Environ. Sci.* **2016**, *2*, 011–019. [CrossRef]