sustainability

Editorial

Bioeconomy of Sustainability: Drivers, Opportunities and Policy Implications

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Sustainability is characterized by a growing trend in the number of papers published in the last years, for an increasing impact factor and because today a large number of experts and researchers dealing with this issue have published in this journal. The challenges of sustainability are increasingly complex, the time to pose solutions is reduced, and nobody today has a clear understanding of the scale of the problem. COP26 showed that not all countries are willing to support the transition with strong imbalances in terms of sustainable development, pollutant emissions, economic production factors, efficiency and social impacts. Consequently, it is very difficult to identify a point of equilibrium. In particular, it was highlighted that there is a need for a sustainable hand in which the shared value is distributed among all stakeholders [1]. However, the question is how can this distribution of value take place? The literature highlights the strategic role of a multi-disciplinary approach, in which the research question is clarified and a robust methodology is used to propose results capable of resolving present and future needs [2–5]. This editorial, using a practical example, aims to provide some food for thought. In aligning with the increasing trend and needs (Figure 1), a new section of this journal, Bioeconomy of Sustainability, is timely and strategic to provide possible solutions to real-world problems.

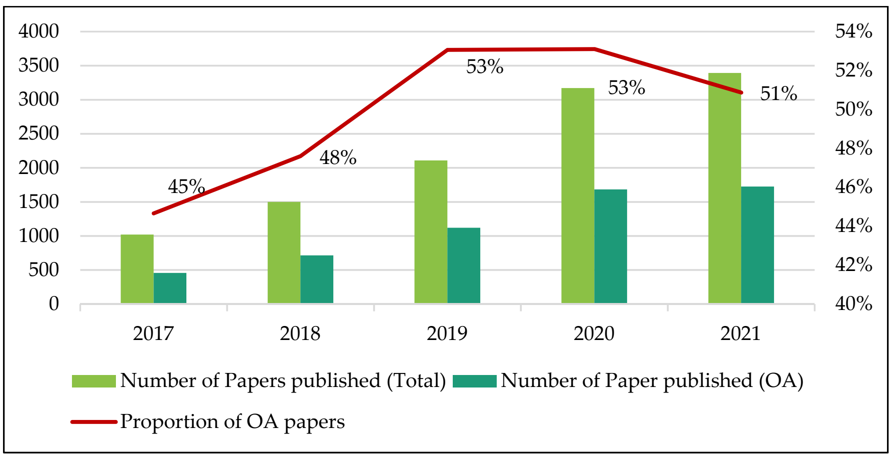

Figure 1. Trend of published articles in the subject area of bioeconomy. Source: Web of Science

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Citation: D'Adamo, I.; Gastaldi, M.; Morone, P.; Rosa, P.; Sassanelli, C.; Settembre-Blundo, D.; Shen, Y. Bioeconomy of Sustainability: Drivers, Opportunities and Policy Implications. *Sustainability* **2022**, *14*, 200. https://doi.org/10.3390/su14010200

Received: 22 December 2021
Accepted: 23 December 2021
Published: 25 December 2021

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(accessed on 27 October 2021). Note: Conducted Keyword Research in WoS: Topic (bioeconomy or "bio-based product*" or "circular econom?" or "green econom?") in research areas of Environmental Sciences Ecology or Engineering or Science Technology Other Topics or Business Economics or Energy Fuels or Biotechnology Applied Microbiology or Agriculture or Public Administration or Operations Research Management Science or Food Science Technology or Forestry or Social Sciences Other Topics or Construction Building Technology or Water Resources or Geography or Education Educational Research or Government Law or Development Studies or Plant Sciences or Public Environmental Occupational Health or Urban Studies or International Relations or Architecture or Sociology or Marine Freshwater Biology or Transportation or Biodiversity Conservation or Geochemistry Geophysics or Arts Humanities Other Topics or Fisheries or Remote Sensing or Life Sciences Biomedicine Other Topics or Anthropology; Time frame: last five years 2017–2021; Total N = 11,194; OA N = 5699. OA = Open Access.

1. Bioeconomy

The European Commission [6] defined the bioeconomy as an economy that uses renewable biological resources from the land and sea (e.g., animals, crops, fish, forests and microorganisms) to produce energy, food and materials. The bioeconomy involves several sectors: agriculture, forestry, fishing and aquaculture, manufacture of food, beverages and tobacco, manufacture of bio-based textiles, manufacture of wood products and furniture, manufacture of paper, manufacture of bio-based chemicals, pharmaceuticals, plastics and rubber, manufacture of liquid biofuels and production of bioelectricity.

The literature on the concept of the bioeconomy has evolved and has been grouped under three main perspectives: (i) the biotechnology vision; (ii) the bioresource vision and (iii) the bioecology vision [7]. The bioeconomy is able to move toward sustainability when certain conditions are met: (i) sustainability of the resource base; (ii) sustainability of processes and products; and (iii) circular processes of material flows [8]. All of this also requires consumer acceptance of bio-based products, and the impact of green premium and the role of sustainability certification must be evaluated [9,10]. These aspects, however, concern different sectors, as they are fundamental to look at sustainability as an enabling factor for success in the market, as a source of competitive advantage [11]. In this context, the substitution of non-renewables with biological resources, the cascading use of biomass and minimization of biowaste are virtuous examples of a circular bioeconomy [12], which is capable of playing a key role in achieving the Sustainable Development Goals (SDGs) [13].

2. Biomethane

Energy recovery from residues and waste, which can close the material and energy cycle, is a model of circular economy [14]. The biogas–biomethane chain is very promising in the direction of sustainability [15,16]. The International Energy Agency points out that biogas is a mixture of methane, CO_2 and other gases produced by anaerobic digestion of organic matter in an oxygen-free environment, while biomethane is an almost pure source of methane produced either by biogas upgrading or by gasification of solid biomass followed by methanation [17]. The literature highlights that biomethane production and use can provide new opportunities for society on multiple levels [18,19]. However, some issues related to its deployment are associated with the lack of public acceptance of biogas–biomethane plants and the inadequacy of some regulations [20].

It is produced from a number of different substrates (e.g., crop residues, animal manure, organic fraction of municipal solid waste, wastewater sludge) and can be distributed into the natural gas grid or used as a vehicle fuel or converted to cogeneration units [17]. Biomethane is widespread in Europe, but its potential is still largely unexploited [21]. At the same time, the contribution it can make globally needs to be assessed [22]. It is worth highlighting its environmental benefits both in the recovery of the organic fraction of municipal solid waste (ofmsw) [23] and by-products (e.g., animal manures, agricultural wastes and other wastes from the agro-industry) [24].

3. Profitability of Biomethane Plants

Incentive policies encourage the development of biomethane facilities. A recent study applied to the municipality of Rome identified a potential production of biomethane equal to 37.6 million m^3—driving from the ofmsw (26.3 m^3) and from by-products (11.3 m^3) [25]. The analysis showed that the profitability was more significant when considering large plants (500 m^3/h for both substrates—maximum scenario) compared to smaller plants (200 m^3/h and 350 m^3/h for the ofmsw and by-products, respectively—minimum scenario) in which, nonetheless, the minimum profitability condition was fulfilled (i.e., net present value greater than zero).

However, it should be pointed out that after a period of significant slowdown due to the COVID-19 pandemic, production activities have resumed leading to a rapid increase in demand for raw materials. Similarly, there was an increase in demand for methane, which led to a gradual depletion of European stocks due to the reduced availability associated with the strategy adopted by Russia [26]. This has led to the maintenance of high prices and a long-term project of energy dependence. The price of methane at the distributor has risen considerably doubling in a relatively short period of time from 1 EUR/kg to 2 EUR/kg.

In [25], two business scenarios were analyzed: "biomethane producer", in which a biomethane selling price (virtual trading point) of 0.25 EUR/m^3 was considered, and "biomethane producer and distributor" where the biomethane selling price (filling station net of taxes and excise duties) was 0.529 EUR/m^3. Evaluating the above-mentioned doubling of the price of methane, we replicated the analysis conducted in [25], considering three alternative scenarios in which the base price is increased by 50%, 100% and 150% (see Figures 2 and 3).

Analysis of the results shows that at a 50% increase in the biomethane sales price, there is an increase in NPV of 7434–8890 EUR/(m^3/h) in the biomethane producer scenario and 15,786–18,003 EUR/(m^3/h) in the biomethane producer and distributor scenario. However, these higher economic returns to investors come at the expense of consumers. Is this sustainable? As it seems, an increase in the NPV of a firm might not be economically sustainable if the burden of such an increase is unevenly distributed among stakeholders—in this case, consumers would suffer a welfare reduction being forced to bear higher prices despite opting for an energy source (gas) less impactful than other sources such as oil and coal.

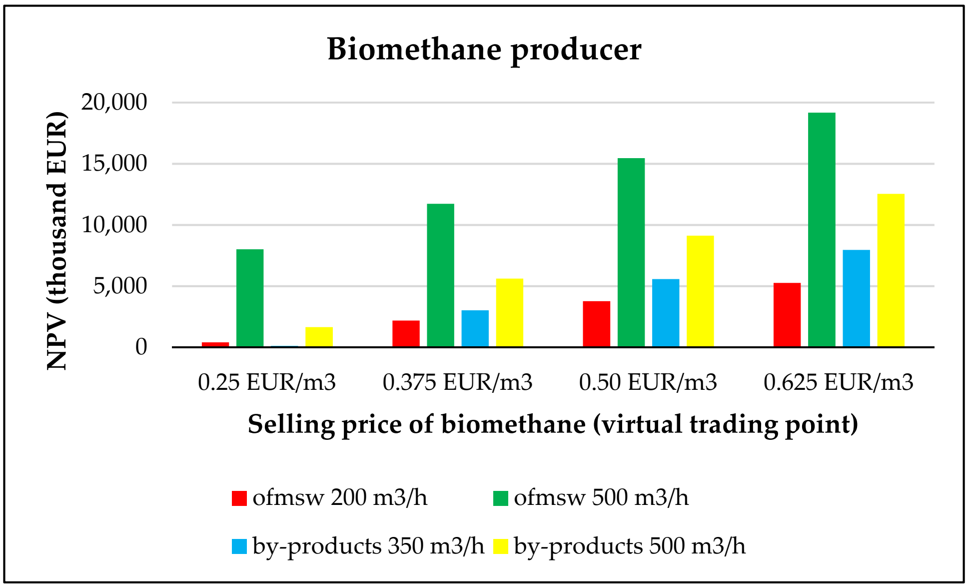

Figure 2. Profitability of biomethane plants (business model: biomethane producer).

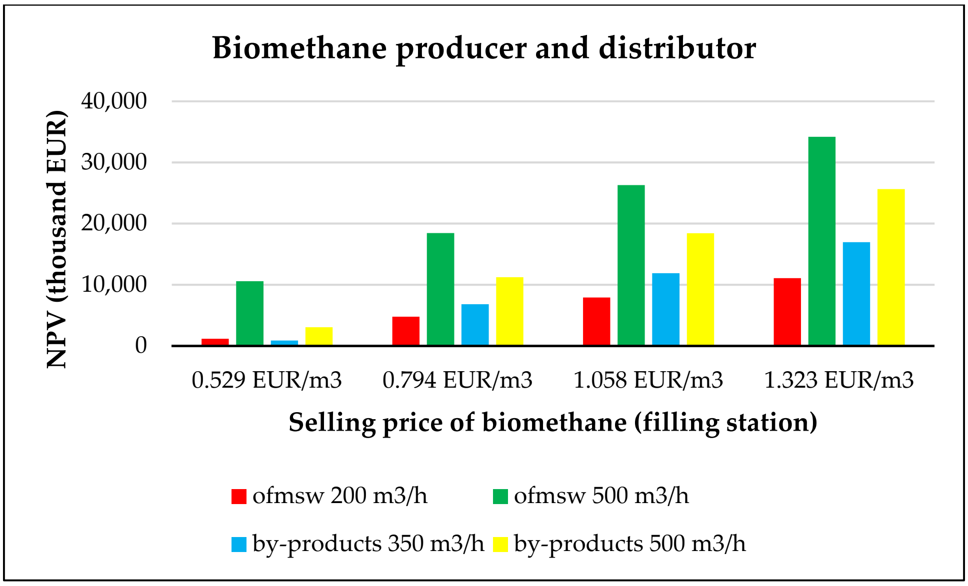

Figure 3. Profitability of biomethane plants (business model: biomethane producer and distributor).

A similar example can be found in sustainable mobility. Here, governments are pushing car makers in electrifying their portfolios in order to enable a green transition in the mobility sector. However, the cost of this transition is largely put on the shoulders of customers that, on the one hand, are encouraged to change their old vehicles and, on the other hand, are required to pay higher prices (compared with internal combustion vehicles) to buy a hybrid/electric car.

Looking at the same problems from a different angle, we could evaluate the Discounted Do Nothing Cost (DDNC). With reference to the mentioned study on Rome municipality [25] the delay of 1 year in the realization of biomethane plants involved an economic loss ranging from EUR 370 thousand to 2.9 million. For example, the DDNC 1 year is 6 kEUR and 20 kEUR for the 350 m^3/h by-products plant and 200 m^3/h for the ofmsw, respectively [25].

The objective of the Italian government is to inject 2.3 billion m^3 of biomethane into the gas network by 2026, plus 1.1 billion m^3 in transport within the Next Generation EU. The National Federation of Methane Distributors and Transporters (Federmetano) highlights the potential production of 8 billion m^3 by 2030. Let us assume that we want to estimate the DDNC 1 year associated with the production of 3.4 billion m^3. We consider both business scenarios (biomethane producer and biomethane producer and distributor) and for each the use of plant sizes corresponding to the two minimum and maximum scenarios. In addition, we estimate a potential distribution of substrates between the ofmsw and by-products, where the first substrates can vary in total weight from 10% to 30%, while the second substrates from 90% to 70% in the three scenarios examined—Figure 4.

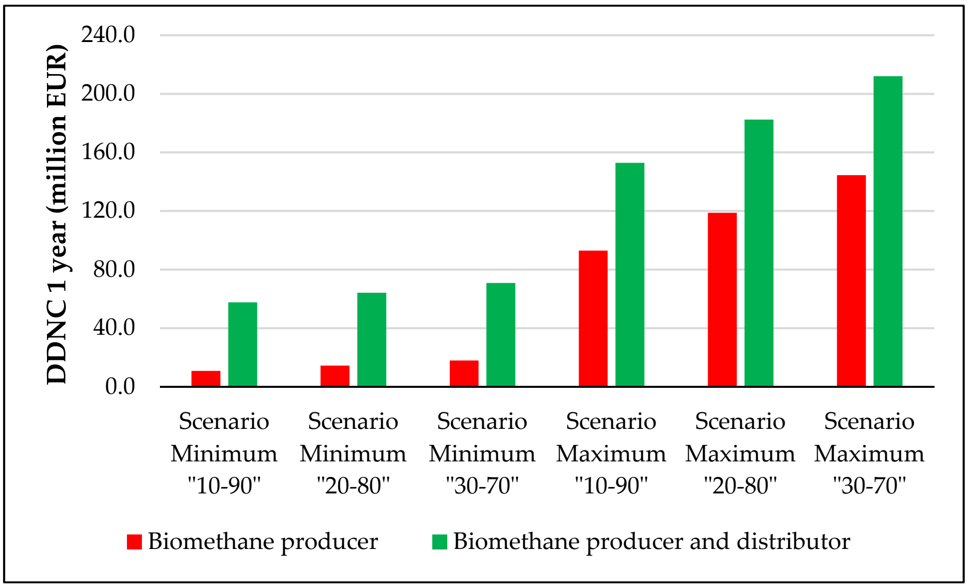

Figure 4. DDNC 1 year associated with the production of 3.4 billion m^3 of biomethane.

The results are presented in the scenario in which the baseline price was considered (0.25 EUR/m^3 and 0.529 EUR/m^3, respectively, in the two business scenarios) and show that the delay in the construction of biomethane plants results in an economic loss calculated of 10.8–17.9 million EUR in the minimum scenario and 92.9–144.4 million EUR in the maximum scenario in the context of the biomethane producer business (red bars). Obviously, the values in the biomethane producer and distributor business are even more significant, varying from 57.6 to 212.0 million EUR (green bars).

4. Discussion and Policy Implications

Sustainability is the biggest challenge ahead of us and, like COVID-19, is changing the lifestyle of large shares of the world population. The approach might be to be short-sighted, simply looking at our current needs. However, a long-term perspective, that underlies sustainability, is not only right, but it is a duty for future generations.

The different approach of countries toward these issues leads to economic problems, as production factors are generated under different conditions and this affects efficiency and competitiveness. However, the transition process must take into account the systems that must be modified, and the same rules cannot be applied to everyone. Certainly, a greater effort is required from developed countries.

The cost of energy, which has risen dramatically in Italy, as in the rest of Europe, calls for reflection but also to outline future policies. The objective must be to use all available resources to produce clean energy. Therefore, it is necessary to realize the greatest number of renewable plants, obviously verifying the minimum condition of economic viability.

Similarly, the data proposed in this editorial pointed out that the effects of increasing the selling price of energy would be to the detriment of businesses and citizens who purchase this energy. The result is the short circuit of the economic system. The matter is highly complex, requires regulatory intervention to monitor the trend of these prices and to reduce the harmful effects. At the same time, other data highlight how many economic opportunities we are losing by not investing in renewable sources (calculated without speculative effects on selling prices). It seems to be a paradox to have available substrates, not to convert them into energy, to be energetically dependent on foreign countries and therefore to have little bargaining power to contrast price rises. A suggested solution, hence, would be to diversify the origin of energy sources (reducing geopolitical risks), producing renewable energy by identifying the critical points in the final uses and placing the transport sector at the center of a significant change. This approach requires a significant improvement also in terms of recycling technologies able to recover critical raw materials from e-wastes and obsolete vehicles (e.g., car batteries). In addition, the support of digital technologies is needed not only to enhance the product lifecycle management, with a major focus on the end-of-life stage, but also to effectively monitor and control all the types of flows circulating in the extended circular supply chain [27,28]. Indeed, data and information management increasingly play a strategic role to support the circular performance measurement assessment of companies and trigger the development of relevant KPIs able to unveil the positive externalities for today's society. Finally, it should be emphasized that energy requirements should not be at the expense of food needs [29]. The ecological transition requires a new social approach, an involvement of citizens in decision-making processes. Similarly, incentives must be provided to encourage the construction of small-scale plants, as this is essential to achieve the requirements of self-sufficiency. Similarly, incentives must be provided to encourage the implementation of small-scale plants or the construction of energy communities, as these facilities are essential to achieving self-sufficiency requirements.

Biomethane is an example of a circular bioeconomy, which requires the collaboration of citizens called to share the choices of realization of plants in their territories by choosing a criterion of size equal to the substrates actually available. Similarly, political choices cannot set electricity against methane if both are powered by renewable sources, but there is an urgent need at European level to clarify the role that nuclear and gas will play in the ecological transition. Companies are called to be inspired by the principles of shared value, and research has the task of proposing ideas, concepts and analyses. The Next Generation EU is a great opportunity for European countries to achieve sustainable goals; however, money should be spent wisely, and collaboration should prevail among the various parties within the concept of the sustainable hand.

Author Contributions: Conceptualization, I.D., M.G., P.M., C.S., P.R., D.S.-B. and Y.S.; writing—original draft preparation, I.D., M.G., P.M., C.S., P.R., D.S.-B. and Y.S.; writing—review and editing, I.D., M.G., P.M., C.S., P.R., D.S.-B. and Y.S.; supervision, I.D. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: We are very grateful to everyone involved in the process of publishing a scientific work.

Conflicts of Interest: The authors declare no conflict of interest.

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