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Towards including social sustainability in green and sustainable chemistry

Lotte Asveld

Green and sustainable chemistry holds the promise of realising a sustainable society by providing environmentally friendly production processes. However until now the focus has been very much on reducing waste and hazards, while there is also a need to consider the broader societal impact of chemical innovations. This article presents three additional principles to guide those in green chemistry towards including social sustainability in innovation trajectories.

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A societal call upon the field of green and societal chemistry

Green and sustainable chemistry holds the promise of realising a sustainable society by providing environmentally friendly production processes [1]. As stipulated by the 12 principles, key components of green and sustainably chemistry are the reduction of waste, the minimisation of the use of hazardous substances and processes and efficient use of resources [2].

However, increasingly societal actors and consumers of green and sustainable chemistry expect more than the elimination of hazards and waste. This can, for instance, be witnessed by recent criticism voiced towards producers in the area of industrial biotechnology, one of the major contributors of green and sustainable chemistry. The main criticism was that the concept of sustainability underlying the 'green and sustainable' product was too narrow [3]. In the following section, I will explicate the controversy in more detail.

These controversies emerge against the background of a broader societal call for a move towards 'Responsible Innovation' (RI) [4]. This term has gained traction within the European Union as is reflected in the prominence of the term in the Horizon 2020 calls. Responsible Innovation urges those who develop new technologies to move beyond the elimination of possible negative consequences, towards actively seeking to contribute to solving societal challenges [5,6]. These developments are specifically relevant to green and sustainable chemistry. If actors in this field want to ensure their efforts continue to be recognised as green and sustainable in a broad sense, they need to consider the following three extra principles in addition to the 12:

13. Ensure that the benefits associated with a chemical production process are distributed fairly and equitably throughout the entire value chain
14. Wherever possible, the design of chemical production process should take into account the values and interests of a wide range of stakeholders
15. Products of green and sustainable chemistry should contribute to at least one of the Sustainable Development Goals of the United Nations.

I will discuss these suggestions for additional principles in turn.

Fair and equitable benefit sharing (principle 13)

When Ecover, a Belgian company producing sustainable cleaning products, announced a change to one of the ingredients in its basic cleaning formula, it suddenly found itself under attack from a coalition of environmental organisations whose members used to be among Ecover's most loyal customers, with the international ETC Group prominent among them. The new ingredient which invoked all this criticism was vegetable oil produced from genetically engineered algae that feed on sugar [7]. This sugar was in this case derived from Brazilian sugar cane but could also be derived from other sugar sources such as beets or lignin sources.

As far as Ecover was concerned, this ingredient did not fundamentally differ from anything it had used before. In their detergents, Ecover had used enzymes produced by genetically modified bacteria for years, as most companies in this area do, and had hardly received any criticism for it. In the eyes of its critics, however, the oil produced by engineered algae does represent something fundamentally different. To these critics, the engineered algae symbolise a sociotechnological system that is inherently unsustainable because it reinforces existing economic inequalities. This technology leads to a concentration of power and knowledge in the hands of those who control the technology, say the critics. It leaves those with no access to the technology without any benefits, because they become suppliers of sugars for an industrial process instead of producing high-value products (such as vegetable oils) themselves. It would have been better, so the critics say, if Ecover would have used vegetable oils directly from the source, such as coconut oils from smallholders from the Philippines, instead of investing in a high tech technological platform that mainly serves the interests of a specific company. The controversy led Ecover to stop using the alga-produced oil [7].

For a long time, questions about the fair sharing of cost and benefits appeared to remain limited to agricultural genetic technologies and biofuels, but as evident in the aforementioned case, also other applications of green and sustainable chemistry are confronted with such concerns. Concerns about the (unfair) socioeconomic effects of biofuels have been well articulated [10], for instance, in the food vs fuel debate and as concerns about land grabbing [11]. In recent years, questions relating to economic justice have also been voiced for other biobased products such as for biosynthetic vanillin and artemisinin [8] and biosynthetic menthol [9]. Critics of biosynthetic vanillin claimed, for instance, that this product was undermining the livelihood of people in vulnerable economic positions who are producing natural vanilla from orchids.

These concerns continue to have a major impact on the sector. As a response to such concerns related to biofuels, at present, there is a growing attention to include the social aspects of sustainability in the assessment of biofuels [12]. This can, for instance, be done through so-called social LCAs (life cycle assessment), even though social aspects are more difficult to quantify and measure than economic and environmental impacts [13] and the methods need further development [14]. Issues included in a social LCA are, for instance, working conditions, gender equality, energy security and fair property rights [15]. The application of social LCAs could provide a model for also ensuring the fair and equitable development of other (biobased) products of green and sustainable chemistry [16]. Arguably, higher biobased chemistry products require less biomass, but similar issues can be expected as with biofuels, because the same kind of feedstocks are involved and both product classes are same drive towards sustainability.

It is clear that addressing the social aspects of sustainability is needed for a field that considers itself green and sustainable, as the issues of equity and justice are gaining importance in the societal understanding of sustainability [17]. Hence, my proposal to add principle 13: Ensure that the benefits associated with a chemical production process are distributed fairly and equitable throughout the entire value chain.

Including a wide range of stakeholders (principle 14)

My main point in this article is that society expects more from green and sustainable chemistry than safety and waste reduction. A way to deal with this request is to apply the approach of value sensitive design (VSD). VSD is a method for doing Responsible Innovation, which was mentioned previously. VSD proposes to base design choices upon a wide range of values, including safety, but also equality, justice, and sustainability in a broad sense [18].

The main similarity between VSD and the 12 principles approach is the focus on design as a way to ensure societally desirable goals such as safety [19]. Anastas and Eghbali [20] state " …. the most important aspect of Green Chemistry is the concept of design." As they go on to explicate, green (and sustainable) chemistry is a conscious effort to realise effective and economic chemistry while reducing hazards, using the 12 principles as a guiding framework [20].

The main difference between the 12 principles and VSD (and RI in general) are the additional values that VSD expects to be relevant as complementary to (environmental) safety and efficiency. These values can be identified through the explicit inclusion of a broad range of stakeholders as essential sources of meaningful values for innovations [21]. VSD assumes the value of safety as a prominent goal for societally robust design, but it stipulates that other values should also be included [22]. This will not only make the technology more societally acceptable and inclusive but also make it more effective in achieving a product that is considered to be safe by a wide range of people. The acceptability of a specific risk associated with a technology is for many people closely intertwined with other ethical issues [23]. If these other issues are not addressed, concerns over safety will remain prevalent. In the case of GM (genetically modified) crops, for instance, many people who are concerned about the risks associated with such plants are also concerned about the ecological costs of having large scale monocultures which are enabled by GMOs (genetically modified organisms) [24].

What values are relevant for the societal and ethical acceptability of specific technology needs to be established through interaction with stakeholders and cannot be determined solely by engineers or other product developers [25], especially in the field of sustainability [26]. For example, Parada et al. [27], a group of embedded social scientist in an industrial biotechnology department, have shown that in assessing the sustainability of biorefineries, many approaches start from pre-identified indicators and metrics, leading to very uniform approaches that ignore the actual societal context in which the biorefinery is built. Instead, Parada et al. [28] develop an approach in which they take sustainability as a leading value, which they contextualise by actively inviting perspectives from relevant stakeholders. These stakeholders include representatives from local governments, companies and academics. In this way, they are able to translate the value of sustainability into actual design requirements suited to the specific social context. One of the main values that emerged from the case on which this approach was built, was fair and equitable benefit sharing and a fair distribution of responsibilities as complementary to the economic and ecological aspects of sustainability [28] Such fair and equitable benefit and risk sharing could translate to contracting practices in which those supplying the biomass receive a fair price for their products or become co-owner of the biorefinery.

I have claimed elsewhere that such an approach might have helped in cases such as the aforementioned Ecover case [3]. Ecover did not perform an extensive stakeholder consultation before they started using the alga-based oil. If they had, they might have found that relevant stakeholders and consumers considered economic justice and ecological stability of vital importance. Possibly Ecover could have taken additional care to ensure that the feedstocks used for algae-based oil were produced in a socially fair manner to live up to the call for a more robust and broad conceptualisation of sustainability.

Flexibility and reflection in design

A notable advantage of a VSD approach is that it allows for more flexibility than a more strict approach based on principles. A VSD approach makes clear that there may be other values at stake besides safety and efficiency, such as, good local working conditions and local energy security.

If such other values are explicated, it invites for more reflection on part of the process and product developers, than if such values are simply assumed to be supported by the dominant values of safety, efficiency, and sustainability. It seems obvious that it is usually better to use a safer solvent such as water than a toxic one. But is that all that needs to be done? Local scarcity and whose water is being taken must also be considered. The physical aspects addressed by the 12 principles are not enough. They occur within a social context. Whose water is being taken to use for the chemical process? If we use renewable feedstocks, who will produce them and what price are they being paid? Does the feedstock require local farmers to acquire new skills and machinery? And if so, who will provide them? Who profits from a chemical production process and who does not?

Explicating the various values that are relevant in the specific context of a chemical production process invites developers to actively consider the specifics of that context and to identify the most ethically and societally robust way to achieve sustainable solutions within that specific context [26,28]. Of course, this is a more time-consuming approach than following principles focussed on physical aspects and hence cannot always be taken. In addition, stakeholders may have conflicting values and interests, and it may not be clear which of these values or interests should take precedence.

However, considering the increased call for societal responsibility on the part of those who develop new technologies, those working in the field of green and sustainable chemistry should at least feel compelled to consider which specific values are relevant to the context in which the chemical production process is situated. When it is unclear which values take precedence, those developing the product can make an explicit choice for one of these values and provide a justification for that. Listening to stakeholders does not necessarily imply to unquestioningly adopt the values of those stakeholders but, rather to acknowledge, consider and weigh them to see how they might fit the intended design. Therefore, I propose to add principle number 14: Wherever possible, the design of chemical production process should take into account the values and interests of a wide range of stakeholders.

A product for whom and for what societal challenge? (Principle 15)

The 12 principles portray a strong focus on the process side of chemistry. They do not include an appeal to consider the actual products that emerge from such a process and their purpose. Put bluntly, one could develop a chemical component for the intensive animal farming—one of the main emitters of CO2—using the 12 principles and claim it as a green product. However, the societal push for a transition to a sustainable society is growing, and this urges those operating under the flag of green and sustainable chemistry to also consider the way their products are being put to use.

I do not want to claim that some industries should be barred from receiving any products derived from green and sustainable chemistry. It is possible that chemicals for intensive animal farming have an overall beneficial impact on the industry, for instance, because they make the industry require less resources or emit less pollution. However, if this only serves to increase the profitability of intensive animal farming and does nothing to contribute to sustainable consumption of food and feed, a specific responsibility for that effect also falls to the ones who produced the product in the first place. Such a product, even if it was produced by using the 12 principles, should not be considered green or sustainable.

A guideline to assess whether a product fits the portfolio of green and sustainable chemistry could be the Sustainable Development Goals of the United Nations. These have been named as the main target for any responsible innovation [29] and as a promising opportunity for industrial biotechnology [30]. Therefore, I would like to propose principle 15: Products of Green Chemistry should contribute to at least one of Sustainable Development Goals of the United Nations and contradict none of the other.

Conclusion

The missions of providing green and sustainable chemistry should be enhanced by adopting a more broad concept of sustainability that includes also the social aspects of sustainability. The uptake of such a broad concept of sustainability can be supported by adding three principles to the existing 12 that focus on the social embedding of chemical products. Social LCAs, VSD, and the Sustainable Development Goals are useable instruments to support this goal. This approach requires an ongoing dialogue with a broad range of stakeholders. This will likely increase reflexivity on part of those developing new green chemistry products, beyond a focus on safety and efficiency.

Conflict of interest statement

Nothing declared.

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** of outstanding interest

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