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How can innovation be made sustainable?

Technological innovations are important tools for greater levels of sustainability, but they are not sufficient.

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- Sustainable development requires innovations.
- Not every innovation is sustainable. To stimulate sustainable innovation, a framework based on the polluter-pays principle is required. Such framework conditions are a key component of the social market economy.
- In the global competition between economic and political systems, sustainable innovations can offer a competitive advantage. In this context, instruments such as Co2 pricing must be thought of in global terms.
- Innovations encompass more than technology. It is also important to look at new organisational structures and new business models. This will also trigger behavioural changes among people

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Sustainability through innovation?

Many climate activists and their supporters in the political sphere are skeptical with regard to the emphasis on innovation as a path towards achieving greater levels of sustainability. They argue that such an approach distracts from the necessity for change and achieving a "turnaround" in people's behaviour, and suggests that an easy solution is possible. Above all, in their opinion, sustainability cannot be achieved with "new technology", and climate change, in particular, cannot be stopped. They ultimately believe that there is no way around sacrificing general economic well-being.

However, this perspective actually closes the pathway to greater levels of sustainability, as it is based on a narrow concept of innovation. Innovations are not simply new technologies which continue with existing approaches to living and working based on a linear trajectory. On the contrary, social and technological innovations offer the potential for both living and doing business differently. Wind turbines and photovoltaic technology, for example, are now mainstays of the energy transition, as they enable the use of other resources. Ultimately, lower emissions can also be achieved if resources are used more efficiently and cycles are closed.

The coronavirus pandemic has shown us that we need technological and social innovations to sustain our traditional approaches to living and working, and that renunciation alone cannot be considered a viable solution. Although mobility was restricted, supply chains were interrupted and entire production facilities and plants were temporarily shut down in the spring of 2020, the reduced CO2 emissions as a result of the aforementioned circumstances only amounted to roughly four to seven percent in global terms[1]. It is also the case, however, that not every innovation automatically leads to greater levels of sustainability. Rather, the question is: How should we encourage those innovations that promote sustainable development?

Sustainability not only includes ecology; it also takes the economy into account. Market-based instruments are therefore necessary in order to trigger an internalisation of the external, ecological costs.

Therefore, innovation and sustainability are two sides of the same coin: One of the key concerns of any society is to be "future-proof". At every level of politics, there is an ongoing debate over which decisions need to be made today in order to maintain what has been achieved so far – and to initiate the required developments accordingly.

In the light of the coronavirus pandemic, but with the increasingly evident challenge posed by climate change in particular, this understanding of the future has rightly taken on a new dimension, in terms of which the concept of sustainability is the defining one. Even if different paths for achieving greater sustainability are currently being discussed, there is no doubt that the need for innovation has become even more urgent. Pace and dynamism are needed, as the acceleration of climate change means that quick action is required.

What is innovation?

In general terms, "innovation" is used to describe the need for development that is faster, more dynamic, potentially more technology-focussed, but above all, economic. If we take a closer look at the concept of innovation, the first thing that comes to mind are the different levels at which an innovation is used. In the narrower sense, innovation is conceived as a process that must be crucially distinguished from invention. While the latter addresses the actual creation of something new, i.e. the original idea that underlies technological progress, which is often associated with the term innovation, the former actually refers to the implementation of an invention – which does not necessarily have to be technological – and its utilisation for society. Therefore, it is not (just) about the idea, but about its implementation. In everyday language, the term frequently infers diffusion, which is located at the other end of the time sequence and refers to the further dissemination in society.

In economic science, which is where the term originally stems from, innovation highlights the journey from invention to market. Subsequently, in a broader sense, the invention becomes an innovation provided it is of use to people. This clearly means: Innovation is not a value in itself, but is meaningful, worthy of supporting and worthy of encouraging when it generates benefits. Conversely, this also encompasses the understanding that outdated technologies and processes will be terminated or no longer used. Differing concepts and views on this topic are included under the overarching term "exnovation".[2] Innovation is consistently characterised by the element of discontinuity, and in the most extreme case, even by disruption, which was raised by Josef A. Schumpeter in his famous quote of "creative destruction".[3] Schumpeter was generally drawing reference to a new combination of production factors which were heralded by a dynamic entrepreneur.

It is precisely the broader understanding of innovation described above, which encompasses the idea, its implementation and, in part, its dissemination, that is the key, and provides the basis for the relationship between the focus on innovation and sustainability in this discussion. It is not the invention (of photovoltaics, the "new food" or the method of taxonomy) per se that creates the benefits, but its implementation by people. Therefore, of the phases described, at least in the narrower sense, innovation is of crucial importance to the concept of sustainability. This can be the development of a marketable product capable for being manufactured in the quantity required, as well as social consent, which is negotiated and finds expression through constitutional and democratic processes.

Therefore, technology is not the only factor. Of course, an impressive number of technological inventions are disseminated during a process of innovation, which thereby underpin sustainability. The range of possible and necessary innovations extends far beyond the technological sphere, though. In this respect, social and economic developments are also relevant, in terms of "an innovation of an object or a social mode of action" (Gabler Wirtschaftslexikon). Innovations can therefore also be organisational, relate to an area of business, or be institutional or social[4] in their nature.

Accordingly, an excessively narrow understanding of sustainability through innovation is also misleading: Technological progress alone is unable to "fix things" and therefore spare us of the need to change our behavior. On the contrary, innovation invariably means new forms of behaviour, but not in the sense of renunciation and asceticism. Not "less", but "different".

Innovation in competition

Conversely, of course, innovation is not just about sustainability. Firstly, the role of innovation in the interests of achieving prosperity and growth should be emphasized, as was the focus of Schumpeter. Another key element is the question of how the largest possible amount of knowledge and experience can be integrated into this process and rendered usable. Finally, there is the challenge of how to manage the implementation of innovations in such a way that they lead to the greatest social benefit. In this respect, Friedrich A. von Hayek emphasized the role of the market in the "accumulation of knowledge" and as a "process of discovery". This is an essential element in determining the right framework conditions for achieving sustainability through innovation.

In addition to the direct impact on economic performance, in terms of geopolitical competition, the innovative strength of the various national economies also plays a role. The systemic rivalry that has become increasingly evident again in recent years – primarily between the liberal and market-oriented democracies of the West and the autocratic system of China and other countries – ultimately constitutes competition for innovation. The fact, for example, that countries with a limited capacity for innovation and which largely gain their resources from selling raw materials, invariably fall behind in the longer run as illustrated by the Russian war in Ukraine confirms the importance of innovation.

At the same time, innovations do not take place in "a vacuum": Even before the invention, for example, values and consumer habits influence what inventors consider possible and appropriate. If there is an idea, it must be compatible with the social needs and contexts. Historical research has identified several examples of supposedly technologically superior inventions that failed due to path dependencies. This means that innovations are successful if they tie in with existing structures. This is clear, for example, in the QWERTY keyboard that is widespread in English-speaking countries. The letters were originally arranged so that the levers in the typewriters, which were still common at the time, would not interlock. With the introduction of computers, this technical requirement disappeared, but the QWERTY keyboard remained intact, since users had become accustomed to the layout and this keyboard layout remained the standard for training typists. Alternatives, which may be superior as they place a more even load on the fingers, have as yet failed to make headway.

According to Christensen two forms of innovation can be distinguished between: On the one hand, there are "sustaining", or incremental innovations, i.e., the step-by-step improvement of products and practices. On the other hand, there are radical innovations. These differ considerably from existing products and initially fulfil completely different needs from

commonplace products. However, when these needs become widespread, the disruptive innovations scale out of the previous niche, i.e. they suddenly achieve high volumes and a wide degree of distribution – and change entire markets.[5] A typical example of this is the digital camera, which has largely pushed conventional analogue cameras aside, causing manufacturers such as KODAK to disappear.

As the research into what is referred to as national systems of innovation[6] shows, there tends to be a correlation between the structures in different countries and the types of innovations that they bring forth, as innovators, who are usually entrepreneurs, are (initially) embedded within different national and supranational structures. These structures differ from each other significantly, also in cultural terms. In this respect, political systems and patterns of legitimation, legal systems and the associated patent rights, property rights, taxes and levies are national or European responsibilities, as is the provision of funding for the areas of science, research and infrastructure. In addition to these, there are cultural factors such as the willingness to take risks, and how to deal with people who fail with their invention. It is in this area in particular that a recalibration is called for in Germany and Europe.

Another concept for the analysis of the framework conditions for innovation, with a greater focus on regional conditions, is the concept of innovation ecosystems.[7] In this respect, the factors taken into account are the availability of skilled workers, the importance of research and development institutions (universities, research-based companies, institutes), the existence of infrastructure (energy, transport, communication), the possibilities for productive networking (subsystems, actors), the existence of innovative business enterprises, an active state sector, a sufficient number of founders with a willingness to take risks and the corresponding mindset, access to capital, and access to markets.

Some of these characteristics rely on an open society. For example, the spirit of entrepreneurship is pretty much inconceivable under the framework conditions of arbitrariness, and in the absence of legal certainty, new business start-ups seem pretty unlikely. With regard to other aspects, however, autocracies can certainly keep up or are even a step ahead, in terms of having an active state sector, for instance. However, this raises the question of the extent to which it is possible for the state sector to identify solutions before all of the many entrepreneurs and market participants are able to. Despite this, the state has often played an essential role in the past, not least as a contracting entity for the uses of innovations.[8] Following Walter Eucken's thesis of the "interdependence of orders", which is closely linked to the concept of the social market economy[9], however, the working hypothesis continues to apply that only the environment of an open society is able to provide a good breeding ground for innovations. The reason for this is, not least, the fact that innovations are more than technology – after all, hardly any innovation exists in a "purely technological form". In authoritarian systems, both institutional and social innovations are arbitrary, and to a certain extent excluded from existing in the first place. Democracy and a market economy in terms of the framework of values and structures described here best fit within a comprehensive concept of innovation.

The impact of innovations on economic growth and systemic rivalry – as well as the existence of innovation ecosystems and the design of the national system of innovation – are also closely related to the dimension of sustainability. Not all innovations are sustainable, and from the perspective of sustainability, some should be rejected. It is often the case that one and the same innovation encourages growth, the competitiveness of an economy and its sustainability balance. Increasingly, sustainability itself is also becoming a criterion in the system competition (for further information on sustainability and international trade, see the following Monitor).

The same framework conditions prepare the ground for a wide variety of innovations, regardless of whether they are driven primarily by sustainability, competition or growth-related factors. At the same time, advanced economies with strong research capabilities have the task of developing technologies for the entire world, which will then drive sustainable development everywhere and have a corresponding impact. Although the CO2 emissions of Germany may be small compared with those of China or the USA, solutions discovered in Germany can nevertheless help to reduce emissions in China, the USA and other countries.

Innovation and sustainability – framework conditions according to the polluter pays principle

The "sustainable transformation" of the economy and society is a Herculean task. To halt the rapidly advancing climate change and mitigate its consequences in particular, extensive changes are necessary. To achieve this, innovations, in the sense described above as fundamentally new products and behaviours, are essential, and both incremental and disruptive innovations will have to take place. The origins of the term in economic science point to another aspect of this behavioural change It is not forced, but it is induced by incentives.

In a social market economy, prices that reflect the scarcity of goods are the central steering instrument. The scarcity principle also includes the damage caused or the sacrifice that the use of these goods impose on society.[10] In other words: Prices must also reflect the social costs. This, of course, includes intangible costs, such as a decrease in overall quality of life because of environmental pollution.

Economic science describes this with the concept of the internalisation of external effects, which is a key component of the social market economy. This would establish what is known as the true cost of the price. For innovations in a market-based system, this means the following: If innovations that achieve sustainability are to be encouraged, a framework is necessary that generally operates according to the polluter-pays principle. For this purpose, there are the two options for levies and allowances, with allowance-based emissions trading systems proving to be superior in most cases and being increasingly applied, such as those in the framework of the *European Union Emissions Trading Scheme* (EU-ETS).[11]

In general, alongside the possibility of encouraging behaviour through costs and prices, another approach is the use of official prohibitions or requirements. These simply exclude specific products and processes that fail to fulfil the goal of sustainability, compel others, or, at least, set absolute limits for certain processes.

A problem in this respect is the rigidity of such rules: They provide no incentive to reduce environmental damage or emissions beyond the prescribed limits, through innovation, for example. Moreover, official restrictions can only be based on the current state of the art. Innovations that are not (yet) known cannot be considered. To be efficient, a regulator would have to incorporate all the knowledge that has been accumulated to date and all that will exist in the future – an impossible task. The regulator would also need to anticipate the various ways in which people respond to official requirements and prohibitions. This is also rather unlikely, not to say almost impossible.

However, official restrictions are not just inferior to levies or certificate solutions in terms of their innovative efficiency, but also in terms of their ecological efficiency:[12] For example, if they are not linked to absolute maximum limits but to base units (for example, the consumption of petrol per kilometre), as the rates of use rise, emissions can increase without infringing the rules. The

benefit of fuel consumption limits for vehicles (per kilometre) is lost, for example, if more cars are driven overall. Certificates, in turn, offer the highest degree of "ecological accuracy", as their scope can be adjusted precisely to the absorption capacity of the ecosystem in question. In the case of CO2 emissions, this would be required at the global level. Moreover, the issuance of certificates can also reward the new creation of what are known as "sinks" – and therefore, of innovations that increase the absorption capacity of an ecosystem.

Despite this, it will be largely impossible to completely avoid official prohibitions and requirements, not least because they are generally far easier to implement. However, their static nature and the frequently slow pace of adaptation of the relevant legislative processes make them considerably less conducive to innovation. In contrast, levies (taxes) and certificate solutions are superior in terms of their innovation efficiency, as they generate corresponding incentives for the polluter.

Conclusion: "Guidelines" of the social market economy and acceptance

The most promising approach is therefore to create guidelines for sustainable development with the use of an appropriate tax or, even better, certificate system, within which various technological, social or other solutions (see above) remain possible. Within these limits, creative minds are able to blossom and develop innovative models independently of specific technologies. A willingness to embrace new forms of technology are the key words, at least with regard to the technological dimension of innovations. On this basis, people's distinctive creativity and talent for creating and adapting technologies is harnessed. Society is also enabled to develop local solutions according to the principle of subsidiarity. Only in this way can a development in the direction of greater sustainability become a task for society as a whole.

As the shift towards a sustainable transformation is linked to investments, it is initially crucial, regardless of the specific instrument, to configure goals which are long-term and binding – for example, to announce the number or value of emission certificates to be issued at an early stage – while ensuring that the paths and instruments remain flexible at the same time. It is equally important to maintain acceptance, as both ways of life and people's habits will be changed, and sometimes at short notice. It is therefore important to bring those stakeholders on board, who, through their consumption, have a major influence on the success of a sustainable product. Likewise, it is important to allow opportunities for participation to encourage personal responsibility, but also to include as wide a range of ideas as possible.

Innovations require an infrastructure; they need political, legal and social prerequisites. If they are to lead to greater levels of sustainability on a systematic basis, framework conditions based on the polluter-pays principle are also necessary, as is inherent in the social market economy. If we are to achieve sustainability and to avert climate change, we will not get anywhere without more, quicker and better innovations. These innovations must be encouraged and the framework conditions must be configured accordingly. Sustainability is too important to be achieved without the social market economy.

[1] Le Quere, C. et al. Temporary reduction in daily global CO2 emissions during the COVID-19 forced confinement. Nat. Clim. Change (2020).

[2] Antes, Ralf; Eisenack, Klaus; Fichter, Klaus: Wirtschaftswissenschaftliche Ansätze zur Gestaltung von Wandlungsprozessen. *Ökologisches Wirtschaften-Fachzeitschrift*, 27 (3), 2012, p. 37 et seq.

[3] Schumpeter, Joseph: *Theorie der wirtschaftlichen Entwicklung*; new edition, ed. by Jochen Röpke and Olaf Stiller, Berlin 2006 [1911].

[4] Antes, Ralf; Eisenack, Klaus; Fichter, Klaus: Wirtschaftswissenschaftliche Ansätze zur Gestaltung von Wandlungsprozessen. *Ökologisches Wirtschaften-Fachzeitschrift*, 27 (3), 2012, p. 37 et seq.

[5] Christensen, Clayton M.: The Innovator's Dilemma, Harvard Business Review Press, 1997.

[6] Ebner, Alexander: Nationale Innovationssysteme. Handbuch Innovationsforschung, Springer VS, forthcoming.

[7] Autio, Erkko; Thomas, Llewellyn: Innovation ecosystems. The Oxford Handbook of Innovation Management, 2014, p. 204–288.

[8] As regards the biggest locations for innovation of Silicon Valley and Israel, this is particularly the case for the defence industry. Here, the role played by DARPA (*Defense Advanced Research Projects Agency),* the research agency of the U.S. Department of Defense, in the emergence of the internet is frequently cited.

[9] Eucken, Walter: Grundsätze der Wirtschaftspolitik, Tübingen: J. C. B. Mohr (Paul Siebeck), p. 180 et seq.

[10] See Hartwig, Karl-Hans: Umweltökonomie, in: Bender, Dieter et al. (eds.), Vahlens Kompendium der Wirtschaftstheorie und Wirtschaftspolitik, vol. 2, 5th ed., Munich, 1992, p. 131.

[11] For an overview of current and planned emissions trading schemes, see https://icapcarbonaction.com. For an assessment of the Chinese initiative, see Hübner, Christian: Strategische Klimapolitik – Chinas Emissionshandel, Konrad Adenauer Foundation, 2021. An overview of different pricing systems is given in the analysis and arguments in "A comparison of CO2 pricing models", while the CO2 border adjustment mechanism is discussed in the paper "The Co2 border adjustment mechanism: a tax or tariff for the climate?".

[12] See Hartwig, Karl-Heinz: Umweltökonomie, in: Bender, Dieter et al. (eds.), Vahlens Kompendium der Wirtschaftstheorie und Wirtschaftspolitik, vol. 2, 5th ed., Munich, 1992, p. 123–162.

Legal notice

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