PLATTFORM INDUSTRIE 4.0

Discussion Paper

Industrie 4.0 and Sustainability

Ten ways how digital business models foster sustainability in Industrie 4.0

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The "Digital Business Models" working group of Germany's Multistakeholder Plattform Industrie 4.0 presents ten propositions as to how digital business models foster sustainability in Industrie 4.0.

German industry bears a particular responsibility in the ongoing transition to an economy that is ecologically and socially sustainable. New approaches and opportunities for putting sustainability into action are emerging with advances in digitalization and increased networking of industrial value creation as the core of Industrie 4.0. This discussion paper discusses how digital business models can increase sustainability in Industrie 4.0. Sustainability is a driver of structural change: A sustainability transformation of today's business models is needed in parallel with the digital transformation in order to create new, future-ready models.

The ten theses at a glance

1 De-materialization through digitalization reduces resource consumption.

2 Resource efficiency is an important start – but sustainable business models are the future.

3 Information visibility becomes a core value proposition of sustainable business models.

4 Sustainable digital business models balance profit maximization with social responsibility.

5 Sustainability requires and enables new input and output measurements of industrial value creation.

6 Service-based business model patterns provide a basis for a circular economy.

7 Digital marketplaces are becoming enablers of sustainability.

8 Open partnership models drive the circular economy.

9 Managing the rebound effect offers new opportunities for business model innovation.

10 The right policy framework paves the way towards a sustainability transformation.

While the challenges posed by the COVID-19 pandemic are still in the headlines, a renewed and growing awareness of climate change and its consequences is also emerging. Interventions in biodiversity and disruption to ecosystems have far-reaching consequences for our prosperity and quality of life. Unlike climate change, a pandemic occurs suddenly. It has a similar impact around the world and makes clear that action is necessary. Climate change on the other hand is more gradual and sometimes manifests itself differently**. Nevertheless, it is undisputable and requires us to act now**. Given its economic importance and role model function for other sectors, German industry bears a particular responsibility in this regard.

New approaches and opportunities for putting sustainability into action are emerging with advances in digitalization and increased networking of industrial value creation as the core of Industrie 4.0. The earlier input paper "*Sustainable production: Actively shaping the ecological transformation with Industrie 4.0*" illustrated the enormous potential in this area, based on 60 company examples.[1] The present discussion paper takes up these considerations and discusses **the opportunities of digital business models to increase sustainability in the industrial sector.**[2] The focus on business models is coupled with the strategic importance of sustainability in many companies: According to a recent survey of 4,000 executives worldwide, 43% of companies have a Chief Sustainability Officer.[3] This means that sustainability has shifted from being solely the concern of the CSR department to the core of strategy.

Our reasoning in this paper builds on two initial propositions:

I) Digitalization is a key enabler of sustainability in industry: "The green and digital transformations go hand in hand" (Ursula von der Leyen, December 2020).[4] The digital transformation of industrial production and new value networks can make energy and resource consumption more efficient over the entire product life cycle. According to conservative estimates, the potential for savings in energy consumption in the already highly efficient German industry is 8%.[5] However, energy and resource efficiency alone do not go far enough to achieve the goal of a sustainable economy.

(II) Digital business models can resolve the contradiction that exists between sustainability as an attractive value proposition and as a cost factor. New business models are the key to unlock the potential of digitalization for a sustainable industrial future. These models either place sustainability at the core of the value proposition or derive it from the value creation structure. In no case does sustainability lead to less value creation. In fact, sustainability can create new values – even if the measure of growth differs.

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1 See BMWi, 2020. Nachhaltige Produktion https://www.plattform-i40.de/IP/Redaktion/DE/Downloads/Publikation/Nachhaltige-Produktion.html

2 See also BMWi, 2020. Discussion paper "Corona and the Consequences", https://www.plattform-i40.de/IP/Redaktion/DE/Downloads/Publikation/Corona_Thesen.html.

3 Source: Accenture CXO Survey 2021.

4 Source: European Commission, 2020. https://ec. europa.eu/germany/news/20201201-von-der-leyen-digital-gipfel_de.

5 Source: Digitalisierung als Enabler für Ressourceneffizienz in Unternehmen, Institut der deutschen Wirtschaft, 2021, https://www.iwkoeln.de/ fileadmin/user_upload/Studien/Gutachten/PDF/ 2021/Ressourceneffizienz_4.0_Hauptbericht_final.pdf.

Drawing on these two premises, the "Digital Business Models" working group of Plattform Industrie 4.0 has formulated ten propositions on the role played by digital business models in a sustainable economy (Figure 1). These propositions are intended to provide inspiration impetus to companies and policymakers exploring the opportunities offered by digital business models for a sustainable industry.

Our focus is on the opportunities provided by new business models. We do not consider concerns about bans and regulations on existing (outdated) business models. This is because we believe that sustainability is a driver of structural change: Today's business models must undergo a sustainability transformation in parallel with the digital transformation in order to become new, future-ready models.

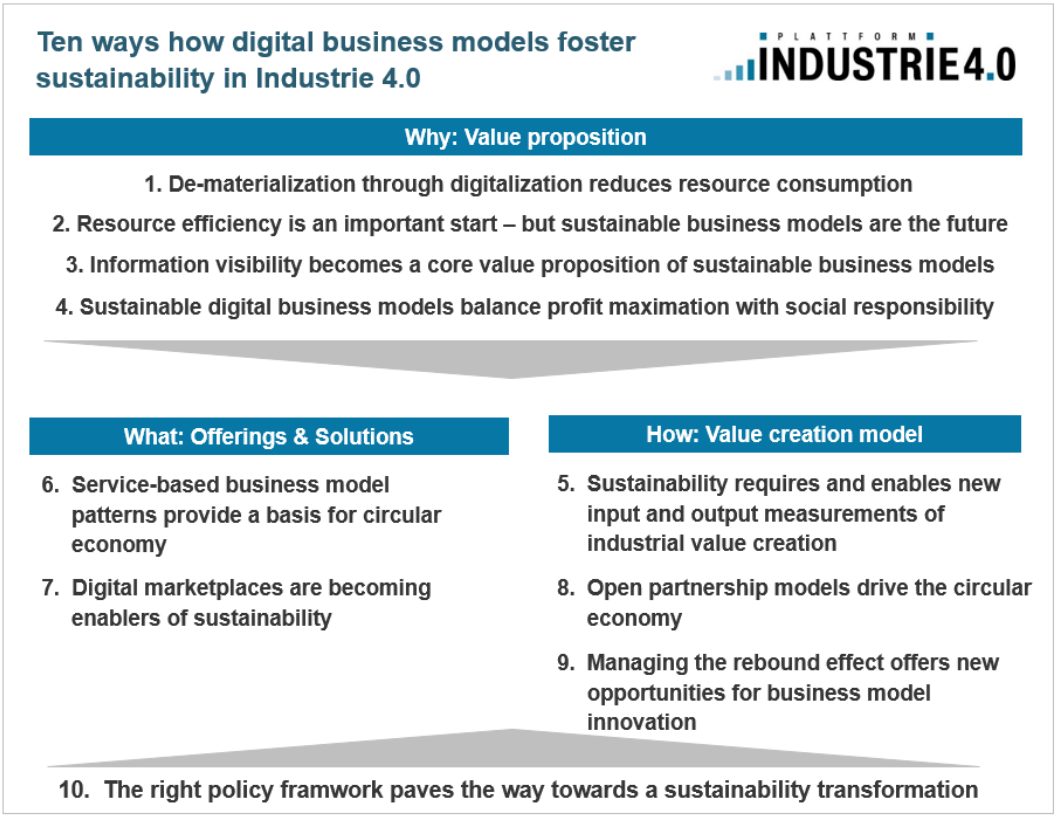

Figure 1: Ten ways how digital business models act as driver for sustainability

In this discussion paper, the working group focuses on **ecological sustainability**. We are therefore primarily concerned with the natural environment and the conservation of natural resources and ecosystems. However, ecological sustainability cannot be achieved without social and economic sustainability. Our awareness of these close interdependencies is also emphasised in the 2030 Vision[6] published by Plattform Industrie 4.0.

[6] Plattform Industrie 4.0, 2019. Position Paper 2030 Vision for Industrie 4.0, https://www.plattform-i40.de/IP/Redaktion/EN/Downloads/Publikation/Positionspapier%20Leitbild%20(EN).html.

Thesis 1: De-materialization through digitalization reduces resource consumption.

A key aspect of digitalization is the focus on added value and the partial or full replacement of dispensable physical components with software and information. This leads to a **natural overlap of efficiency and resource conservation**, an achievement made possible for the first time on a larger scale with digitalization.

For example, **remote services** using augmented reality technology reduce travel expenses for maintenance and service, since technicians no longer need to be on site or at least far less often. Similar effects can be observed with digital trainings and meetings. **Smart, adaptable products** enable user-oriented, individual product design through software and digital services instead of complex, multi-variant hardware. **Digital twins** represent real products and act as replacements in development, training and sales. A "**sustainability twin**" is a digital model that is networked with the real product and provides information about performance, repair requirements and possibilities for more efficient use. This type of model continuously improves operation and adapts the product to the performance level that is actually required. It also provides an essential stimulus for more sustainable development of the next product generation.

Thesis 2: Resource efficiency is an important start – but sustainable business models are the future.

Reducing the consumption of resources and implementing climate-neutral digitized production are just the beginning. On their own these measures will not bring about radically new business models that generate prosperity in tandem with resource recovery, not just growth with less resource consumption.

Carbon-neutral production and a transition from energy management to resource efficiency are accepted goals today for many companies. In the area of IT, targeted data processing as a guiding principle is replacing an ever-growing demand for more computing capacity. Trading emission certificates can promote more environmentally friendly production. **However, these measures, while important, often reinforce existing business models** and can support sustainability narratives or "greenwashing".

Instead, a **dual paradigm shift** is required: Digitization and sustainability must move into the **center of the value proposition**. Sustainability must be generated from the value creation structure itself. An example for the former are digital platforms for second-hand goods, an example for the latter "as-a-service" models, where value creation shifts from the production of a good to its use.

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Thesis 3: Information capability becomes a core value proposition of sustainable business models.

Better information capability is a key component of digitalization. In Industrie 4.0, **cross-company data spaces** contribute to this capability. Sustainable business models use these data spaces and offer transparent information as part of their value proposition. In this way, they **foster organizational decision making** for more sustainable value creation.

Data spaces contain information that was not previously collected (or at least not systematically). They link traditional "data silos", even across company boundaries. New findings emerge, supported by artificial intelligence and machine learning. Differences in levels of information are reduced. Greater information capability (in real time, complete, distributed) makes processes more efficient and avoids waste, for example by deploying more temporally accurate procurement and a production process that only generates what is actually used by the market in a specific location for a particular purpose. Improved information capability also makes it easier to comply legal reporting requirements of supply chains and allows users to manage their own economic activity sustainably. **Transparent information is becoming a differentiator**.

Thesis 4: Sustainable digital business models balance profit maximization with social responsibility.

Communicating a firm's distinctiveness to the relevant stakeholders is a core principle of value creation. **Sustainable digital business models increase the company's value by assuming social responsibility** and communicating this as the company's purpose[7].

Traditionally, a company's shareholder value is driven by its profit. Profit is the goal communicated to shareholders and financial markets. However nowadays many investment firms' investments are guided not only by the (expected) financial success of a company, but also by its contribution to sustainability. Likewise, customers demand sustainable products, production chains and supply chains.

Sustainability as a communicated company purpose is also gaining traction in human resource management. Social responsibility plays an increasingly important role in the search for talent, alongside salary and work-life balance. The active contribution of employers to a worthwhile future is now more than ever the focus of attention.

Sustainable digital business models incorporate this ambition in their value proposition. In this way, they differentiate themselves from the competition and increase their corporate value. Digitalization can be used to demonstrate and communicate the value proposition.

[7] Aaron Hurst regards the "purpose economy" as the fourth stage of economic development, following the agrarian, industrial, and information economy (A. Hurst, The Purpose Economy, 2nd edition, Boise: Elevate Publishing 2016). See also H.G. Servatius, Nachhaltigkeitsinnovationen als Werttreiber in der Purpose Economy, Düsseldorf 2020, https://www.competivation.de/nachhaltigkeitsinnovationen-als-werttreiber-in-der-purpose-economy.

Thesis 5: Sustainability requires and enables new input and output measurements of industrial value creation.

Business models that focus on sustainable development in addition to financial success **need new criteria to measure their success**. Digitalization makes it much easier to collect, manage and identify appropriate key performance indicators.

Approaches such as the *UN Sustainable Development Goals,* the *Triple Bottom Line or ESG Reporting Frameworks* can be used as the basis of a new type of balanced scorecard to make a company's sustainability contribution visible and measurable for different stakeholder groups. The selected approach should go beyond the legally prescribed requirements. Under the German Supply Chain Act, the industrial sector is obliged to implement new legal requirements. It should be guided by these to make the required investment in order to use **new capabilities and digital solutions to create a value proposition that exceeds the legal requirements**. Digital technologies that can provide evidence of sustainability along the supply chain also enable new business models (e.g., blockchain, IoT, AI or dedicated). The proposal by the German Electro and Digital Industry Association (ZVEI) for an *"EU Digital Product Passport (DPP)"* is an example of a quantification method that seeks to balance European Union regulations and industry needs.

Thesis 6: Service-based business model patterns provide a basis for a circular economy.

Circular and service-based business model patterns[8] are often only economically viable through digitalization. In a circular economy, sustainable business models rely on such patterns, i. e. the regenerative use of products, components, and materials with the highest possible quality over several cycles. The principles of *reuse and repair* rather than recycling apply here, and *performance-based solutions* rather than purely product-based solutions.

In a traditional product-based business, the largest possible production volumes secure market share and allow for economies of scale. However, this model leads to overproduction and low-capacity utilisation and usage rates of existing goods (studies show that only 4% of car seats, 9% of train seats and a maximum of 34% of the potential of a machine tool are actually used[9]).

Service-based business models on the other hand are about maintaining a product, ensuring it is highly used and updating it. As-a-service business models thus shift the value measurement from the sale of a product to the use of a product's performance or service. This shift towards sustainable behaviour is evident in a variety of related business model

[8] Recently, collections of business model patterns have emerged that allow the construction of sustainable business models, e.g., Hansen et al., Circular business models: a typology based on actor type, circular strategy, and service degree, 4th PLATE Conference, 2021; Kortmann & Piller, Open business models and closed-loop value chains, California Management Review 58.3 (2016): 88-108; Lüdeke-Freund et al., Sustainable Business Model Design: 45 Patterns. Berlin 2021.

[9] Boos & Schuh, Die Produktionswende, Whitepaper, RWTH Aachen 2021, https://www.awk-aachen.com/wp-content/uploads/2021/05/White-Paper_Produktionswende.pdf.

patterns. It often includes sharing of capital goods (e.g., in agriculture or construction). Related patterns are refurb logistics services or repair-as-a-service providers. The business models in this case also include enablers such as intermediation platforms as well as the financing of assets.

From a general industrial perspective, any optimisation of the usage process contributes to sustainability because resources are used more efficiently. Fewer raw materials, parts and components are needed. This also affects participants in the value chain. Supply chains are converted into **service chains** focused on maintaining and optimising industrial services, with the aim of capturing a larger part of the economic value added.

Thesis 7: Digital marketplaces are becoming enablers of sustainability.

Traditional industrial value chains incentivize players to achieve cost advantages through economies of scale. Sustainable solutions often still have lower margins or fail, as their markets are too small. **New digital marketplaces and business platforms can change this situation**.[10] They bundle providers, foster visibility, and match demand requirements with supply.

B2B platforms in the highly fragmented recycling market offer a good example. In the area of plastic recyclates, suppliers meet potential buyers on platforms such as *Cirplus.* The platform fulfills an aggregation function that also enables smaller market participants (e.g., SMEs) to participate in the business. For buyers, a secure and flexible supply chain is created, for suppliers of plastic recyclates a costly distribution is eliminated.

All participants benefit from increased market transparency, making recyclates a serious alternative even for traditional customers in sectors such as packaging, automotive or construction. A stable market also attracts investors, building up capacities in research and development to improve the state of the art around recyclates.

Thesis 8: Open partnership models drive the circular economy.

New partnership models are becoming the basis for competitiveness. Digitalization has already increased productivity in production by increasing efficiency. The priority now is collaborative value creation and sharing of values in cross-company and open ecosystems.

Providing evidence of a contribution to sustainability is a challenge faced by digital marketplaces and other sustainable value propositions.

This requires data not just on final products, but also on semi-finished goods, raw materials, production processes, transportation, usage, and disposal. While building a data space enabling this visibility is technically relatively easy, it is difficult to motivate all actors to share the data required – all too often, **a lack of willingness to share and use data is preventing best case scenarios.**

The reason is a traditional understanding of competitive advantage based on the notion of exclusivity. **Sustainability in industry requires a complete reversal of thinking in "lock-in effects"**, as

[10] For more details, refer to the whitepaper "Digital ecosystems in industry - typology, examples and future development", Plattform Industrie 4.0, 2021, https://www.plattform-i40.de/IP/Redaktion/DE/Downloads /publication/Digitale_Oekosysteme.html.

typical for the classical management school that still characterizes many business models. The goal is not to bind customers and their data exclusively to a company, but to share values (e.g. data) and knowledge with everyone. Corresponding governance structures are an essential component of sustainable business models – but there still is little knowledge in conventional industrial firms how to define and utilize such **governance structures fostering openness.**

Thesis 9: Managing the rebound effect offers new opportunities for business model innovation.

Digitalization promotes dematerialisation and thus reduces resource consumption. However, the infrastructure costs (data centres, cloud storage, blockchains, algorithms) must not outweigh the savings achieved. **Innovative business models must avoid this rebound effect** by aiming to conserve resources rather than consume them.

The rebound effect is "one of the most underestimated obstacles on the path to a sustainable economy."[11] Aside from the issue of digital infrastructure, the positive environmental impact of sustainable business models are mainly offset by increased use. For example, digital photos are more environmentally friendly than traditional prints. But because their users incur hardly any costs, far more photos are created and saved. Ultimately, the saved resources and energy are either partially or completely neutralised. In the worst case, consumption is even higher than before. Car-sharing platforms, for example, can result in fewer people owning their own car, but far more people using a vehicle.

From a business model perspective, managing the trade-off behind the rebound effect is a great opportunity. One example is “nudging” apps, in which customers pay to adopt certain behaviour patterns (e.g., a healthy lifestyle). An artificial scarcity of virtual goods can also give rise to new status symbols, which also consume fewer resources overall. Transferring these B2C approaches to the industrial world is a current challenge and one which offers great economic and social potential for business model innovation.

Thesis 10: The right policy framework paves the way towards a sustainability transformation.

It is the responsibility of industry to develop sustainable business models. However, it must act within the legal and regulatory framework set out by policymakers. Policymakers must therefore actively support the transition towards sustainability. Smart intervention by regulators promotes the introduction and acceptance of sustainable business models.

The right framework conditions encourage companies to make their business models more sustainable. They also pave the way for new models. For example, business models should be promoted in which value creation and resource consumption are largely decoupled (e.g., “as-a-service" models). The possibilities allowed under tax legislation

[11] Maja Göpel, Unsere Welt neu denken: Eine Einladung, Berlin: Ullstein 2020, p. 65.

can be fully leveraged to this end. Other measures can promote digitalization in order to accelerate the shift away from unsustainable business models.

Two factors are crucial for success: First, the framework conditions must give companies planning security so that they can invest in the time-consuming and costly process of developing sustainable business models. Second, the framework conditions must not stifle business model innovations by imposing overly detailed requirements. These innovations should be supported in the most open climate possible.

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