Lernende Systeme

GERMANY'S PLATFORM FOR ARTIFICIAL INTELLIGENCE

With Artificial Intelligence to sustainable business models

White Paper

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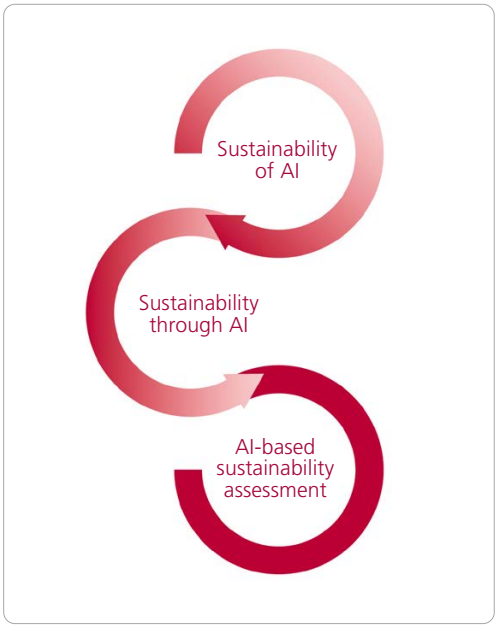
Executive Summary

Emissions reduction, resource conservation and efficiency gains – Artificial Intelligence (AI) offers many potentials for developing sustainable business models and optimizing existing processes. Like the digital transformation, climate change is one of the most formative changes in our society and at the same time one of the greatest challenges of the 21st century. Both changes are already triggering profound transformation processes in various areas of society. AI is considered a key technology in the context of sustainability: AI can contribute to increase the efficiency of existing processes, to implementing innovative, data-driven, and platform-based business models, to reducing our energy and resource consumption, and to developing sustainable products, services and mobility concepts. At the same time, the high energy consumption associated with the use of AI technologies must be carefully weighed up and be reduced or compensated in the long term to avoid rebound effects.

Experts from the working group Business Model Innovations of Plattform Lernende Systeme have investigated the significance of AI technologies for sustainable business models and the potential of AI-based business process optimization for greater sustainability along three dimensions:



Sustainability of AI: The high energy consumption of AI contrasts efficiency gains. The potential of AI technologies can only be fully exploited if costs, effort, and benefits are carefully weighed against the background of the lowest possible consumption of resources. On the one hand, new methods of learning, the reuse of models and more efficient hardware can reduce the required energy. On the other hand, the waste heat from data centers can be used to reduce energy consumption in other areas (e.g. for heating buildings, cooling systems).

Sustainability through AI: Addressing climate change requires reducing emissions, which necessitates changes in mobility, agriculture, energy, and circular economy, among others, while also requiring adaptation to the impacts of climate change and planning for resilience and disaster management based on an understanding of the climate and extreme events. From startups to mid-sized companies to large corporations, companies are key drivers in the development of AI applications, with many now bringing AI-based solutions to market that help reduce environmental impacts, make systems and processes more resource efficient, and improve systems understanding of the environment and climate. At the same time, there are also many application-oriented research projects at universities to make processes or business models „greener" with the help of AI.

Sustainability with AI: Artificial Intelligence can also be used to monitor and evaluate the sustainability of companies and to link investment in companies to specific sustainability criteria. There are also promising projects and approaches in nature conservation and environmental monitoring that use AI methods to monitor and evaluate sustainability commitments.

Importance of AI for sustainable development

Sustainable development meets the needs of the present without risking that future generations will not be able to meet their own needs. Building on this concept, the global community committed to 17 global goals (UN Sustainable Development Goals) for sustainable development in 2015 under the umbrella of the United Nations with the 2030 Agenda. The guiding principle of the 2030 Agenda is to enable people around the world to live in dignity while preserving the natural foundations of life in the long term. This includes economic, ecological and social aspects. At the same time, the 2030 Agenda emphasizes the shared responsibility of all actors from politics, business, science, civil society – and every individual. This vision has been translated into Sustainable Development Goals (SDGs) that aim to achieve, among other things, a world without poverty and hunger, affordable and clean energy, sustainable consumption and climate protection.

Numerous application examples already demonstrate that AI has great potential to help us achieve economic, social, and environmental sustainability goals and AI can therefore have a predominantly positive impact on the UN Sustainable Development Goals. Thus, AI is also expected to impact global productivity, equal opportunity and inclusion, the ecological environment, and several other areas in both the short and long term, if these positive examples can be translated into broad applications and societal acceptance. In this regard, the use of AI can improve people's well-being in many ways, such as by increasing the productivity of services in the areas of food, health, water, education, and energy – which directly contribute to the achievement of the SDGs. AI also has the potential to better educate and train people to adequately perform their tasks and activities. Artificial Intelligence therefore plays an important role not only in achieving the environmental goals, but also in achieving all other SDGs in development, consumption, and production. The key positive AI impact potentials of how AI technologies can optimize the sustainability of existing business models and enable new ones can be summarized under the following categories:

Dimensions for positive impact potentials of AI for more sustainability (business models or business process optimization)

At the same time, it must be considered that the use of AI solutions is not per se economically, ecologically, and socially sustainable. The use of AI technologies must always be weighed against the background of the high energy and resource consumption, the potential savings and the differences between the training and deployment phases of an AI system. A further challenge is posed by the rebound effects of new AI solutions, which can develop if, for example, the broader application of AI technologies or efficiency improvements (e.g. mobility) result in higher energy consumption overall. If rebound effects are considered early in the planning of new AI applications, there are also opportunities to exploit the full potential of AI for resource conservation. For example, when introducing new AI applications, measures to educate users (including nudging, if necessary) and to point out environmentally friendly alternatives could mitigate rebound effects, for example, by leading to more energy-efficient and/or sufficiency-oriented use. In the area of mobility, for example, new AI-based business models can also lead to more resource-efficient sharing models, as well as to easier multimodal mobility and more flexible public transport.

Solutions for more resource-efficient AI technologies

For the objective evaluation and regulation of AI-related resource consumption, there are several approaches and technological solutions that can already or in the future help to better evaluate, research, and reduce the energy and resource consumption and thus the environmental footprint of deployed AI technologies. These approaches include the following:

- **Sufficiency principle:** AI is not an end in itself – regarding sustainable development, it is important to strive for the lowest possible consumption of raw materials and energy and thus to specifically consider the question of which use of technology makes sense for dealing with a specific problem, taking sustainability objectives into account. Overall, a decision for sustainable development may also mean not using AI or energy-saving alternatives at all.

- **Hardware efficiency:** Improvements in hardware efficiency are a keyway to mitigate the increase in energy consumption that can be attributed to the training of larger models and the widespread adoption of AI.

- **Extending life cycles and circular value chains:** A possible further solution approach for reduced resource consumption is to extend the life cycles of the devices as well as a circular value chain that is as residue-free as possible.

- **Creating sustainable awareness:** To reduce rebound effects as much as possible, awareness should be created among AI developers about the emissions of AI training use over the entire development cycle and innovative ways of reducing them should be developed.

- **Energy-efficient infrastructure, switching to renewable energy, and intelligent recycling of waste heat:** Data center operators should develop

innovative concepts to reduce their carbon footprint by investing in energy-efficient infrastructure, switching to renewable energy, recycling waste heat, and other solution concepts.

- **Reinvestment of saved resources in sustainable processes:** Any rebound effects must also be considered in the efficiency gains enabled by AI in the industrial context. The key here is that companies should continue to invest the resources saved in environmental technologies and processes to achieve positive ecological effects. It would not be in the spirit of sustainability to reinvest saved resources to further increase the value added.

- **Efficiency instead of expansion – reduction of the absolute energy and resource consumption:** Sustainable AI treats resource efficiency as the primary evaluation criterion and promotes transparency and reuse of existing solutions by making training data and models widely available.

- **Sustainability by Design:** Sustainability in AI research is influenced by many factors – the greatest effect can only be achieved if sustainability is always considered from the beginning, for example, by offering datasets in different sizes or using only data that demonstrably contribute to system performance. In addition, for some AI applications, it can make sense to use pre-trained models. Another possibility is the combination of semantic methods or digital twins and the teaching of AI models.

- **Federated learning and reuse of model calculations:** Reuse is obviously sustainable – and possible in the field of machine learning. However, once trained, models reflect the underlying systematics of the training data. If the application domain changes, for example if the model no longer fits the data with which it was trained, the divergence between the data predicted by the model and the actual (source) data becomes so large that the model can no longer be used meaningfully. To transfer models within an application domain to related tasks, so-called transfer learning can be used. When transferring from the source to the target domain, the transfer learning algorithm requires only a fraction of the data that was necessary for the initial training. This makes large models applicable even if the user does not have a large data set or the computational resources for training.

Possible design options

AI can make a significant contribution to greater ecological, economic, and social sustainability for our society. Nevertheless, the high energy requirements of AI and the possible rebound effects of AI technologies must always be considered and be critically reflected upon as to whether AI must be part of the solution to a problem or whether there are alternative, lower-energy solutions. In addition, innovative solutions and research are needed to make AI technologies inherently more sustainable. Targeted research and investment in AI

applications can help ensure that AI technologies lead to greater sustainability in all three dimensions and that their potential can thus be fully exploited. Business, science, and politics can work together to improve the framework conditions to promote the sustainability of and through AI:

Technological measures

- Smart solutions for CO_2 reduction
- Promote sustainable technological innovations
- Create awareness of AI-related rebound effects & energy consumption
- Further research: Training effort of ML models and their use; create data base

Regulatory approaches

- Sustainability label (Sustainable AI) for energy efficient AI applications
- Tracking of resources used for products/services
- Standardization & data exchange

Standardization & interoperability of collected data

- Data exchange between companies
- Standardized determination of corporate emissions
- Interdisciplinary and cross-industry cooperation

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