

THE ROLE OF AI IN SUSTAINABILITY: BOON OR BANE?

Whitepaper
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IN 1987, THE UNITED NATIONS BRUNDTLAND

Commission defined sustainability as “meeting the needs of the present without compromising the ability of future generations to meet their own needs.” Since then, with the increasing threats posed by climate change, along with burgeoning population growth and the emergence of resource-intensive technologies, it has become one of the most important topics to guarantee the survival of the human race.

In parallel, the ever-evolving innovations pushed by human ingenuity have given rise to artificial intelligence (AI), which is creating massive paradigm shifts across industries with implications for businesses, economies, and societies worldwide.

It is here, at the juncture of sustainability and AI, that an important discussion emerges: when it comes to sustainability, is AI boon or bane? And what factors do corporates and governments need to consider when it comes to effectively managing the two?

THE UPSIDE

The rise of artificial intelligence has been marked by complexity and controversy, but its potential role in the global campaign for sustainability is great. Two of the areas in which AI could be a catalyst for positive change are the corporate and government domains, as organizations strive to build sustainability into their operations and limit their carbon footprint. Here, Arthur D. Little (ADL) has formulated three perspectives on how artificial intelligence can support

sustainability efforts across sectors, focusing on the ability of AI to:

1. **Enhance:** Make current operations and business models more sustainable.
2. **Transform:** Support the fundamental transformation of business models with the goals of reducing environmental impact, enhancing profitability and future-proofing business.
3. **Adapt:** Help businesses and governments adapt and prepare for the inevitable effects of climate change and natural disasters.

ENHANCE – BOOSTING THE SUSTAINABILITY OF CURRENT BUSINESS MODELS

One of the advantages of artificial intelligence is its ability to make an impact with minimal disruption. AI can add a layer of solutions onto existing assets and business models to deliver enhanced sustainability. In many cases, solutions can be implemented rapidly – or even immediately – without affecting the smooth running of business operations.

One such example relates to energy efficiency. AI can help enhance the energy efficiency of existing assets by optimizing operations, maintenance and performance. For instance, it can help to improve the predictive capabilities of solar resources to optimize or maximize clean energy generation. It can also support domestic, commercial and industrial AI-based energy management systems that reduce energy consumption and costs for consumers. →

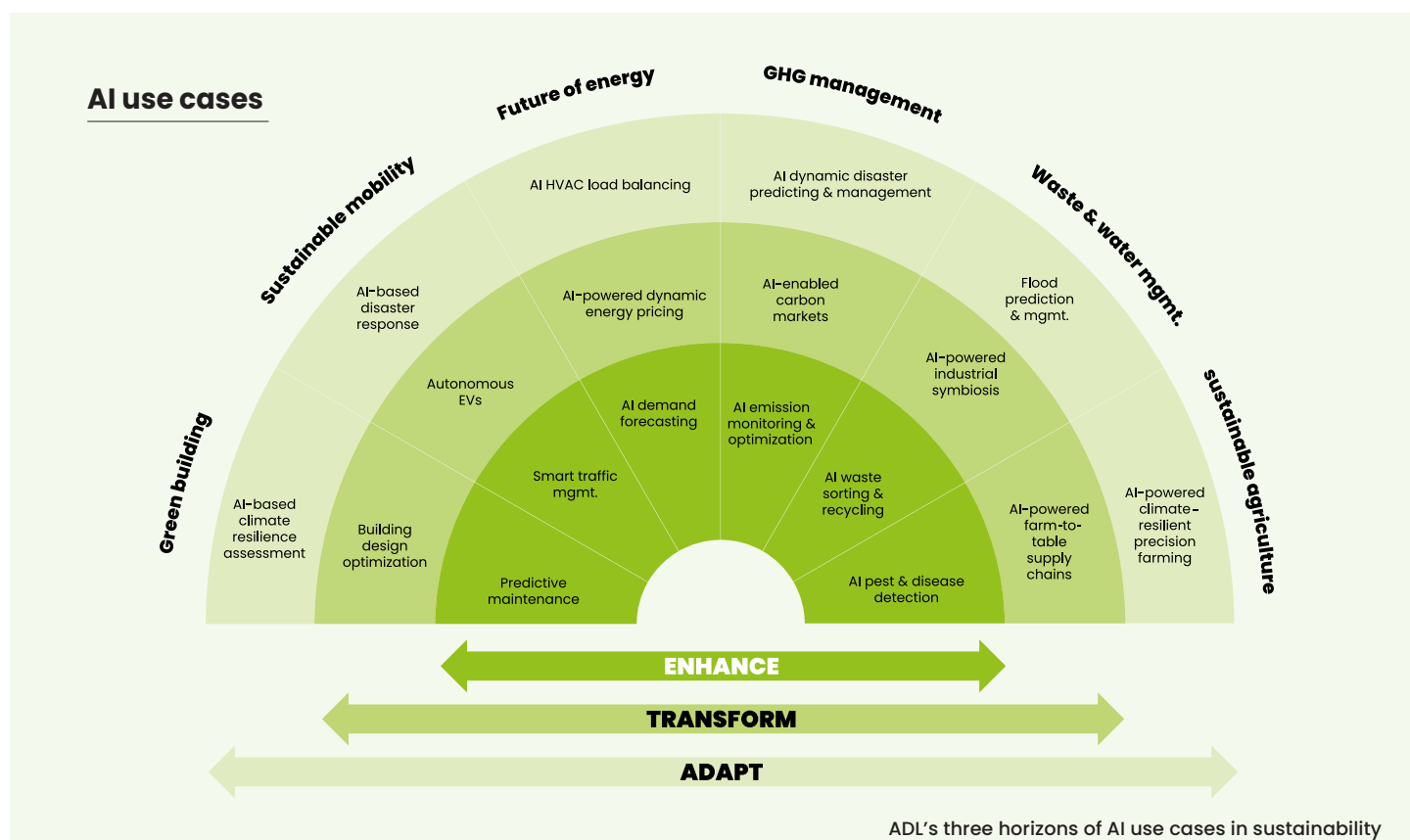
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→ These applications of AI can help reduce greenhouse gas (GHG) emissions, save resources, improve productivity, and benefit both grid stability and security of supply.

On the latter, AI has for instance the ability to enhance the accuracy of energy infrastructure. It can give operations engineers a whole-grid view, allowing them to plan more efficiently and offer customers a much more reliable supply. AI tools also enable energy asset managers to predict, inspect, and repair system failures, resulting in both productivity and safety gains.

While commercial rollout of AI-powered solutions is still at the nascent stage, real-world examples are emerging that demonstrate the power of artificial intelligence in generating incremental changes or improvements within existing business models.

A prime example is Google. The global tech giant has reduced the energy consumption of its data centers by up to 40% using computational models known as deep neural networks to predict power usage and adjust the cooling systems accordingly. And smart thermostat company Nest uses AI to learn the preferences and habits of its users and adjust temperatures accordingly,¹ saving customers up to 15% on heating and cooling costs, and reducing environmental impact.²

Meanwhile, the IBM Watson system helps farmers to increase their crop yields and reduce water consumption by using AI-based weather forecasting, soil analysis and crop monitoring.³ As of 2024, IBM, in partnership with India's Ministry of Agriculture and Farmers Welfare, deployed this solution successfully on a pilot basis for the Kharif crop season in three districts – Bhopal, Rajkot and Nanded – and has now expanded it to ten districts.

The same toolkit has also been deployed in partnership with Karnataka Agricultural Prices Commission to predict the prices and production patterns of tomatoes and maize in the state.

These are but a few examples of the growing use cases for AI and generative AI across a broad spectrum of industries and applications.

TRANSFORM – SUPPORTING BUSINESS MODEL TRANSFORMATION

Used effectively, AI can enable new ways of delivering value and creating impact to radically change existing business models and reduce their environmental footprint – all while increasing profitability and competitiveness.

To maximize the sustainability gains while enhancing their value proposition, companies across sectors can explore the possibility of incubating new business models with AI at their core. In the case of healthcare, a medical facility serving a larger number of patients could utilize AI-based algorithms to diagnose, monitor and recommend interventions remotely. This would reduce physical infrastructure requirements, travel and waste, all of which have a detrimental impact on the planet and its resources.

In addition to reducing resource consumption, AI can also support the growth of the circular economy through business models that reuse, recycle and regenerate materials using AI-based platforms, sensors and analytics. Similarly, AI can support a sharing economy model that can optimize the utilization and allocation of assets and services using AI-based matching, pricing and rating systems.

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These applications of AI can help decouple economic growth from environmental degradation, create new sources of revenue and value, and enhance customer satisfaction and loyalty – as companies such as Babylon Health and Uber are beginning to demonstrate.

Digital healthcare company Babylon Health uses AI to provide accessible and affordable healthcare services to millions of people around the world using chatbots, video consultations and health monitoring devices.⁴ Meanwhile, Uber harnesses AI to match drivers and riders in an effort to optimize routes and prices, which in turn reduces traffic congestion and pollution.⁵ According to ADL analysis, by optimizing just 1% of its route lengths, Uber can avoid roughly 169 million tons of emissions. By conservative estimates, that is almost double the carbon footprint of the AI use case itself.

Another example is the SYMBA project. This EU-funded initiative involves five EU countries (Italy, Spain, Belgium, The Netherlands and Germany) and a consortium of leading organizations (Novamont, Climate-KIC, CIRCE, Centexbel, AIMPLAS, ICLEI Europe, Bio-Based Europe Pilot Plant and Cetaqua) and aims to develop a user-friendly and accessible AI database that will propose regional Industrial Symbiosis (IS) innovative processes to create value chains with no waste, ensure more local supply chains, a better distribution of economic and social benefits among stakeholders, and an increase in the economic value of final products.⁶ Such initiatives also show the positive impact of collaborations between the private, public and non-profit sectors in implementing AI use cases.

ADAPT – PREPARING BUSINESSES AND GOVERNMENTS FOR CLIMATE CHANGE AND NATURAL DISASTERS

In addition to supporting the continuous sustainability efforts of business and governments, AI can help

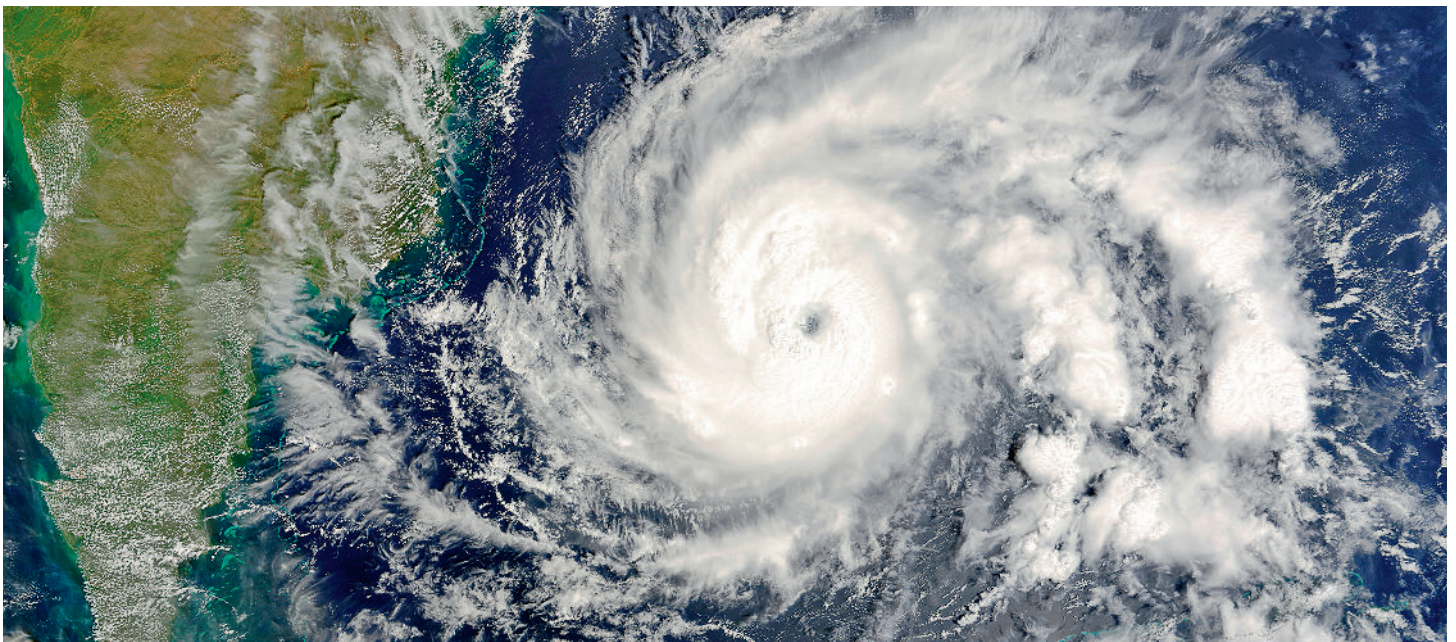
organizations to manage the risks and challenges posed by the changing climate and the increasing frequency and intensity of natural disasters.

For instance, AI-based simulation, design and testing can assist in uncovering more heat-resistant materials for a wide range of applications, while sensors, models, and alerts based on AI can help monitor and predict the occurrence and impact of natural disasters. Furthermore, AI-based platforms, drones and robots can be instrumental as organizations strive to coordinate and optimize their response and recovery efforts.

These applications of AI can help reduce the vulnerability and exposure of businesses and governments to climate change and natural disasters, enhance their resilience and adaptation capacity, and mitigate human and economic losses.

A real-world example of how AI can help businesses and governments to adapt and prepare for the inevitable effects of climate change and natural disasters can be drawn from MIT, where researchers are using AI to design new materials that can withstand extreme temperatures and pressures.⁷ In further examples, IBM and The Weather Company are using AI to improve weather forecasts and alerts, using data from millions of sensors, satellites and models,⁸ while the UN leverages AI to support disaster relief operations, including damage assessment, aid delivery and locating survivors.⁹

Google's Tree Canopy project is another live example of how AI can help adapt humanity to climate risk. It uses AI and aerial images to help cities measure their current tree cover and plan better urban forestry initiatives to avoid "heat islands," which are urban areas that get hotter because of man-made structures that trap and release heat. Austin, Texas has already used this project to plant more trees in heat-vulnerable areas of the city and place bus shelters to provide shade. According to Google, Tree Canopy has grown from 14 cities at launch





→ to almost 350 cities worldwide — including Atlanta, Baltimore, Buenos Aires, Lisbon, Mexico City, Paris, Sydney and Toronto. This project is part of a bigger network of partnerships with local governments and international organizations, and involves collaborations with the World Resource Institute, American Forests Organization and Resilient Cities Catalyst.¹⁰

Whatever the AI application, the timeline for preparedness and adaptation to take root has a long-term horizon. However, it is important for organizations to set the wheels in motion and take a proactive approach to developing and implementing the relevant AI capabilities.

THE FLIP SIDE OF THE COIN

From helping organizations prepare for climate change to supporting business model transformation, AI can be a catalyst for sustainability in various ways. However, it is not a panacea – in fact, it has costs and implications of its own. As the applications of AI continue to grow, artificial intelligence is likely to pose new ethical, legal, and social challenges relating to privacy, security and accountability, among many other areas. But it is on the environmental front that the impact is most pronounced.

Notably, AI consumes significant energy and water resources, which contribute to GHG emissions and water scarcity. Homing in on the environmental impact of large language models (LLMs), an article co-written by ADL's Greg Smith, Michael Bateman, Remy Gillet and Eystein Thanisch¹¹ estimates the cost to train the model behind the original ChatGPT at approximately 1,287,000 kilowatt-hours, or 552 metric tons of CO₂e. According to the authors, this best-case estimate equates to the emissions of two or three full Boeing 767s flying round-trip from New York City to San Francisco. The costs do not end there; the impact of using the model on a daily

basis is likely ten times greater, not accounting for the billions of liters of water required to cool data centers each day.

Meanwhile, governance is an area plagued with potential pitfalls, with AI programs capable of making significant errors. In industries such as nuclear power or aviation where mistakes can be fatal, this is particularly worrisome, but even where there is no risk to life, AI mistakes can introduce bias into business, lead to data breaches and damage public trust.

The concerns over AI are both real and valid. However, in some situations there is a risk of exaggerating the drawbacks. As the abovementioned article from ADL points out, the largest LLMs are often used for relatively trivial interactions that could at times be handled by a much smaller model or even a search engine. Commands such as “write a short poem in the style of Shakespeare” are a sign of frivolous consumption when it comes to generative AI, with little scope for risk or harm. By contrast, the benefits outweigh the costs by orders of magnitude for most AI sustainability applications. Here, Uber serves as a good example, with the benefits of AI almost double the costs to the ridesharing giant.

CONCLUSION

In a context of climate change, depleting natural resources and growing populations, the pursuit of sustainability in all its forms has never been more urgent. Indeed, the future of livelihoods and life on Earth depend on it. Human behavior will be a determining factor in the campaign to sustain ecosystems – both ecological and economic – but so too will technology. Today's world is increasingly dependent on advanced tech, and embracing AI is becoming less of a choice and more of a necessity for organizations across sectors.

On the macro level, the benefits created by AI could be manifold. As explored above, in the quest for →

→ sustainability, artificial intelligence has the potential to enhance current operations and business models, support business model transformation, and help both organizations and nations to adapt to the challenges of climate change and natural disaster. But this potential comes with a caveat: AI is not a silver bullet for sustainability, and the related technology and its use cases come with their own risks that must be considered with care.

To reap the sustainability rewards of AI while minimizing the risks, governments and corporate entities must keep their eyes fixed firmly on the “enhance, transform and adapt” horizons to stay abreast of the megatrends. Balancing AI and sustainability will not be easy – it will require different degrees of investment, different operating model setups, and a high degree of adaptability – but in the final analysis, the reward will undoubtedly be worth the cost. ■

SOURCES

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