

Sustainable Development

Empowering AI Leadership



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Introduction

Artificial Intelligence (AI) has proven to be a transformative technology that is helping optimize a wide range of operations in numerous sectors. Companies have used AI to re-engineer processes in nearly every business and government function – sales & marketing, customer service, manufacturing, R&D, IT, human resources, and finance to name just a few. Companies are using AI to augment their workforce with “cobots”, to hyper-personalize customer engagement, and ultimately to create better products. With such unprecedented prevalence and wide-ranging impact, it is imperative to ask how does AI affect the environment? Can AI be the catalyst that will break a link that was previously required for all past industrial revolutions to succeed—the link between economic growth and environmental degradation? AI can help provide breakthroughs in water and energy conservation, but AI comes with its own carbon footprint. AI can improve numerous impacts of society but can also reaffirm biased or unjust social status-quos.

Companies are using AI to:

- **Reduce their carbon footprint.** A 2019 study jointly developed by Microsoft and PwC forecasted that responsible use of AI can lead to a 4% (2.4 giga tons) drop in worldwide Green House Gas (GHG) emissions by 2030. To tackle climate change, companies are already using AI to reduce carbon footprint. AI can help companies optimize their energy intake and thereby reduce their carbon footprint. AI is already being used to optimize carrier routes, predict and forecast supply/demand, predict and forecast maintenance, and manage autonomous transportation. All these optimizations will directly and indirectly lead to reductions in carbon footprints.
- **Optimize the use of natural resources.** AI is helping companies predict output green energy (e.g., solar, wind, and hydro-based energy) and thus ensuring minimal waste of these natural resources. AI also helps conserve water usage in residential, manufacturing, and agricultural areas. Predictive algorithms have helped develop

new agricultural processes like precision farming, where the exact amount of water required is used and only ripe crops are picked. Algorithms also assist in farm-land planning and monitoring the health of plantation and livestock. AI also helps in developing efficient power generation schemes and setups for power generators and power consumers alike.

- **Optimize the usage of AI to reduce AI's own carbon footprint.** Although AI offers dramatic process improvements, helps create innovative new processes, and is the main catalyst in disrupting some sectors, it does not come without costs. A 2019 study developed by the University of Massachusetts Amherst concluded that training a common large AI model would have 300 times the carbon footprint of flying from San Francisco to New York. Companies are offsetting this carbon footprint by utilizing green renewable energy to power their AI models. Companies are also beginning to include carbon footprint in their cost/benefit analyses for deploying AI selectively and responsibly.

While it is recognized that the term sustainability encompasses broader governance and social aspects, the focus of this module is solely on environmental effects. Governance and social benefits and costs are covered in various other modules included in the toolkit. Environmentally, AI can transform and optimize numerous current practices to reduce carbon footprints. However, AI can also contribute to the increased emissions if not used responsibly. It falls under the board's oversight to ensure management is performing its role well. Boards should ensure that AI is being applied to tasks that matter most and should drive offsetting AI's carbon emissions by ensuring the responsible use of AI.



Examples

Google (Reducing Carbon Footprint)

Google uses AI to optimize the energy consumption of its data centres. Using machine learning technology developed by DeepMind, Google was able to optimize the energy use of its data centres by 35%. Knowing that AI running on its data centres is a major contributor to energy consumption, Google also committed to power its data centres by renewable energy and has been a zero net carbon emissions company since 2017.

Salo (Conservation of Natural Resources)

Salo has teamed up with Vibrant Planet and Planet Labs to build the California Forest Observatory. The core of the platform is an AI engine that leverages LIDAR and satellite data to provide a tree-level view of forest structure and fuel loads that scales statewide. It will integrate data on wind and weather, soil and vegetation moisture & population and infrastructure. Combined, these data can capture the complex drivers of wildfire risk, and will be integrated with contemporary wildfire models to provide a real-time, dynamic map of wildfire risk—one that can support both restoration planning and active fire operations.

Responsibilities

While the G20/OECD Principles of Corporate Governance do not specify sustainability in their list of responsibilities, boards cannot carry out their oversight duties without considering how their companies use and manage technology as well as their management's major technology plans, investments and partnerships.

Many responsibilities that apply to other modules pertain to sustainability:

- **To act in good faith**, with due diligence and care, boards should be fully informed about plans for applying AI in strategy, AI's alignment with core values and ethical standards, the risks associated with AI strategy, and regulations affecting the use of AI. Directors should have access to accurate, relevant and timely information.
- **To oversee corporate strategy, major plans of actions, risk management, and budgets and business plans**, boards should review and guide management's vision, goals, actions and expenditures for AI, its support for innovation and the use of new AI resources, management's awareness and plans for legal and environmental compliance and ameliorating AI risk, and competitors' use and plans for AI.
- **To oversee corporate performance, expenditures and acquisitions**, boards should review and guide AI's alignment with strategy, shareholder values, ethics, performance and risk indicators including ESG indicators, implementation of AI plans, the effectiveness of AI to accelerate processes and improve productivity, major investments in AI systems and talent, and acquisitions.

To carry out these responsibilities, boards should also review and guide these sustainability-specific concerns:

Act in good faith, with due diligence and care.

Directors should:

- Be fully informed about their company's and competitors' use of AI to create a sustainable environment
- Learn about the environmental implications of implementing AI
- Be fully informed about the adoption of AI in their environment and the demands and expectations important partners will place on their company

Oversee corporate strategy, major plans of action, risk management and budgets and business plans.

Directors should know:

- Whether management is developing strategies that take advantage of the new capabilities AI can bring to reduce carbon footprint and optimize the use of finite natural resources
- Whether investments in AI for sustainability target important business outcomes and not only improvements with little impact on the Corporate Social Responsibility (CSR) bottom line
- How the enterprise's acquisitions and partnerships affect its ability to use AI to advance its strategy, and whether they introduce new risks
- Whether processes using AI have identified bias and other ethical risks when AI is applied to sustainability use cases, and whether the plans of action include measures to address them

Oversee corporate performance, expenditures and acquisitions.

Directors should know:

- What progress the company is making in applying AI to sustainability use cases that differentiate their company from competitors
- Whether management is building the resources needed to implement and operate AI-enabled sustainability change
- Whether, and how, AI should be factored into performance objectives for management
- Whether sustainability key performance indicators (KPIs) and key risk indicators (KRIs) are aligned to the AI-enabled strategy
- How sustainability innovation using AI is being encouraged across the organization

- Whether the data used to train and operate AI systems is being properly managed
- How internal control processes are reported to the board (pp. 58/66, principle D7)
- How to monitor and manage potential conflicts of interest of management, board members and shareholders, including misuse of corporate assets and abuse in related party transactions (pp. 57/66, principle D6)

The analysis in this section is based on general principles of corporate governance, including the G20/OECD Principles of Corporate Governance, 2015. It does not constitute legal advice and is not intended to address the specific legal requirements of any jurisdiction or regulatory regime. Boards are encouraged to consult with their legal advisers in determining how best to apply the principles discussed in this module to their company.





Oversight

This section includes three tools to help directors oversee management as it uses AI responsibly to sustain the environment.

The **knowledge management tool** helps board members assess whether they possess, or have access to, the knowledge required to independently judge management's actions on using AI to sustain the environment.

View the Knowledge Assessment tool in Appendix 1.

The **performance review tool** consists of questions boards can ask management about their knowledge of AI and sustainability, and the progress and performance of their actions. It offers the SCEPTIC framework to help directors assess the answers they receive.

View the Performance Review tool in Appendix 2.

The **guidance tool** offers possible suggestions for further action in an "If, then" format.

View the Guidance tool in Appendix 3.

Agenda

The following suggestions can help the individual who prepares the board discussion and sets the agenda on sustainability through AI.

Before leading the first meeting:

- **Prepare yourself:** Become familiar with AI, what it can do today to support sustainability, and what it will be able to do in the future as the field advances. Separate the hype from reality by looking at the research and the sources behind the claims, and the issues that complicate the implementation of the technology. The resources section provides readings about AI and sustainability. Speak to senior IT, security and public affairs executives about any ethics issues on their minds.
- **Gauge board member interest in AI and sustainability:** Speak to other board members. Learn what importance they place on AI and the concerns they have about planned AI investments and partnerships. Identify the board members who are most interested in moving forward with new AI investments, and those who have concerns or lack interest.
- **Set goals:** Think ahead about the desired outcomes from the board discussion.

Set the initial agenda. Create a strategy for promoting the use of AI to improve sustainability efforts.

Agenda items may include:

- **Presentation:** Arrange for a briefing on how AI is being used to improve the organization's sustainability efforts. The presentation can include examples from competitors and potential use cases uncovered by researchers. It should also include cost savings and other quantified benefits when possible. The presentation should also introduce major risks and responsibilities that the company will have to manage, and the requirements that must be met to run AI, such as the data for training AI systems.
 - **Discussion:** Identify and prioritize relevant sustainability areas for pilots, based on: high potential reduction in carbon footprint; high potential optimization in natural resource usage; availability of data; ability to implement and scale up if successful.
 - **Delegate:** Decide which members of the executive team will be responsible for selecting and running the pilots as well as deciding what support is needed (e.g., technology, development platforms, innovation sandboxes etc.).
 - **Engage:** Decide how the board will stay current with developments in sustainability innovation.
- Set follow-up agenda items. These can include:**
- **Sustainability Awareness & Culture:** Discuss how the company is developing a culture that supports a sustainable business model. This conversation can include current and future key performance indicators, sustainable practices assessments, and rewarding pioneering sustainability initiatives.
 - **Renewable Energy:** Discuss how the company is prioritizing the utilization of clean energy sources and how is it investing in renewable energy R&D.
 - **Renewable Energy:** Discuss how the company is prioritizing the utilization of clean energy sources and how is it investing in renewable energy R&D.
 - **GHG standards:** understanding which GHG Protocol (Corporate, Value Chain, or Product) standard can best support the organization's missions and goals for measuring and reporting emissions. Mapping and monitoring environmental impacts across value chain, understanding which processes are (or can be) supported by data and AI.

Resources

Reports: SDGs for Boards

- United Nations, “Sustainable Development Goals Knowledge Platform”.
- United Nations, “SDG Compass Guide”.
- PwC, “Navigating the SDGs: a business guide to engaging with the UN Global Goals”.

Reports: AI and Sustainable Development

- World Economic Forum, “Unlocking Technology for the Global Goals”, 2020.
- World Economic Forum, “Harnessing AI for the Earth”, 2018.
- World Economic Forum, “The New Physics of Financial Services – How artificial intelligence is transforming the financial ecosystem”, 2018.
- PwC, “How AI can enable a sustainable future”.
- Michael Chui, James Manyika et al., “Notes from the AI Frontier: Applications and Value of Deep Learning”, McKinsey Global Institute, 2018.
- Michael Chui, Martin Harrysson, James Manyika et al., “Applying Artificial Intelligence for Social Good”, McKinsey, November 2018.
- Landing AI, “AI Transformation Playbook”.
- Accenture, “AI Explained – A Guide for Executives”.
- McKinsey, “An Executives’ Guide to AI”.
- Deloitte, “State of AI in the Enterprise, 2nd edition”.

Other Reports

- Global Reporting Initiative, “GRI’s Contribution to Sustainable Development”.
- John Fullerton, Capital Institute, “Regenerative Capitalism - How universal principles and patterns will shape our new economy”, 2015.
- PwC, “The Low Carbon Economy Index 2019: Tracking the progress G20 countries have made to decarbonise their economies”, 2019.

Books

- Ajay Agrawal, Avi Goldfarb & Joshua Gans, “Prediction Machines: The Simple Economics of Artificial Intelligence”, Harvard Business Review Press, 2018.
- Paul Hawken, “Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming”, New York: Penguin Books, 2017.
- H. James Wilson and Paul R. Daugherty, “Human + Machine – Reimagining Work in the Age of AI”, Harvard Business Review Press, 2018.
- Max Tegmark, “Life 3.0: Being Human in the Age of Artificial Intelligence”, Random House Publishing Group, 2017.
- Anastassia Lauterbach and Andrea Bonime-Blanc, “The Artificial Intelligence Imperative: A Practical Roadmap for Business”, Praeger, 2018.
- Kai-fu Lee, “AI Superpowers: China, Silicon Valley, and the New World Order”, Houghton Mifflin Co, 2018.

Articles

- John Elkington, “25 Years Ago I Coined the Phrase “Triple Bottom Line.” Here’s Why It’s Time to Rethink It”, Harvard Business Review, June 25 2018.
- J. Jay, S. Gonzalez, M. Swibel, “Sustainability-Oriented Innovation: A Bridge to Breakthroughs”, MIT Sloan Review, November 10 2015.
- Sam Ransbotham, David Kiron et al., “Reshaping Business with Artificial Intelligence: Closing the Gap Between Ambition and Action”, MIT Sloan Management Review in collaboration with Boston Consulting Group, 2017.
- Gartner, “Lessons from AI Pioneers”, 9 February 2018.
- Thomas H. Davenport and Rajeev Ronanki, “Artificial Intelligence for the Real World”, Harvard Business Review, 2018.
- Jacques Bughin, James Manyika, “Your AI Efforts Won’t Succeed Unless They Benefit Employees”, Harvard Business Review, July 2019.

Research centres

- Center for the Governance of AI, Future of Humanity Institute and the University of Oxford.
- Ethics and Governance of Artificial Intelligence Initiative, Berkman Klein Center for Internet & Society at Harvard University and the MIT Media Lab.

Executive education programmes

- IESE, “Artificial Intelligence for Executives”, Barcelona, Spain.
- University of California, Berkeley, “Artificial Intelligence Unlocked”, Berkeley, California.
- Harvard Business School, “Competing on Business Analytics and Big Data”.
- National University of Singapore, “Leading with Big Data Analytics & Machine Learning”.
- Stanford Graduate School of Business, “Big Data, Strategic Decisions: Analysis to Action”.

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Appendix 1: Knowledge assessment tool

This tool can be used by individual directors or as a board exercise. When asking the following questions, consider whether the board:

- Possesses the knowledge needed for independent judgement about AI and AI-related issues.
- Has access to this knowledge from inside the company, from other sources or through free access to experts.

The tool also suggests related modules for additional analysis.

External environment	Area of knowledge	Board knowledge (more than sufficient, sufficient, insufficient)	Access to knowledge by board (more than sufficient, sufficient, insufficient)	Related modules
How AI is changing sustainability in our industry and markets				
Climate Change ¹	<p>Clean power</p> <ul style="list-style-type: none"> • Optimised energy system forecasting. • Smart grids for electrical use. • Optimised decentralised & peer-to-peer renewable energy systems. <p>Smart cities and homes</p> <ul style="list-style-type: none"> • Smart traffic lights & parking systems for urban mobility management. • Optimised sustainable building design. • Energy-efficient building management systems. • Analytics & automation for smart urban planning. <p>Sustainable land-use</p> <ul style="list-style-type: none"> • Early crop yield prediction. • Precision agriculture & nutrition. • Monitoring health & well-being in livestock farming. <p>Sustainable production and consumption</p> <ul style="list-style-type: none"> • Supply chain monitoring and transparency. • Active optimization of industrial machinery & manufacturing. • Digital twins for lifespan performance optimization • Smart recycling programs. • Integrated municipal & industrial waste management. <p>Smart transport systems</p> <ul style="list-style-type: none"> • On-demand shared transport mobility. • AI-enabled electric cars. • Autonomous vehicles for efficient transport. • Optimised traffic flows. 			<ul style="list-style-type: none"> • Operations • Technology • Ethics • Risk
Biodiversity and conservation ¹	<p>Habitat protection and restoration</p> <ul style="list-style-type: none"> • Precision monitoring of ecosystems. • Bird habitat and migration pattern prediction. • Simulation of animal and habitat interaction. • Habitat loss detection and monitoring. • Micro drones for pollination. • Optimised breeding of plants. <p>Realising natural capital</p> <ul style="list-style-type: none"> • Register & trading of biological & biomimetic assets. • Plant species identification. • Machine-automated land-use detection linked to ecosystem payments. <p>Invasive species and disease control</p> <ul style="list-style-type: none"> • Machine-automated biodiversity analysis. • Smart mosquito traps. • Plant disease identification & detection. 			<ul style="list-style-type: none"> • Operations • Technology • Ethics • Risk

External environment	Area of knowledge	Board knowledge (more than sufficient, sufficient, insufficient)	Access to knowledge by board (more than sufficient, sufficient, insufficient)	Related modules
How AI is changing sustainability in our industry and markets				
Biodiversity and conservation ¹	<p>Pollution Control</p> <ul style="list-style-type: none"> • Pollutant dispersal prediction and tracking. • Analysis of urban runoff quality issues. <p>Sustainable Trade</p> <ul style="list-style-type: none"> • Food value chain optimization. • Supply-chain monitoring & origin tracking. • Detection of unauthorised animal capture and trade. • Poacher route prediction and high risk animal tracking. 			<ul style="list-style-type: none"> • Operations • Technology • Ethics • Risk
Healthy oceans ¹	<p>Fishing sustainably</p> <ul style="list-style-type: none"> • Overfishing prevention and control. • Insights for fishermen. • Aquaculture monitoring. • Monitoring & detection of illegal fishing activities. • Optimising patrol schedules. <p>Impact from climate change (including acidification)</p> <ul style="list-style-type: none"> • Real-time monitoring of ocean temperature and pH. • Phytoplankton distribution detection and prediction. • Monitoring of ocean currents. • Monitoring of coral reef ecosystems. <p>Protecting species</p> <ul style="list-style-type: none"> • Monitoring location and quantities of ocean species. • Predicting the spread of invasive species. • Monitoring & prevention of illegal trafficking of marine wildlife. • Drones & AI to analyse whale health. <p>Protecting habitats</p> <ul style="list-style-type: none"> • Monitoring marine habitats for change (e.g. marine dead zones). • Habitat conservation assessments. • Coral reef mapping. • Autonomous vehicle deep sea assessments. <p>Preventing pollution</p> <ul style="list-style-type: none"> • Marine litter prediction. • Robotic fish to fight pollution. • Real-time monitoring of pollution levels. 			<ul style="list-style-type: none"> • Operations • Technology • Ethics • Risk
Water security ¹	<p>Water supply</p> <ul style="list-style-type: none"> • Water supply monitoring and management. • Water quality simulation & data alerts. <p>Drought planning</p> <ul style="list-style-type: none"> • Drought prediction. • Simulations of drought planning. • Drought impact assessments. <p>Adequate sanitation</p> <ul style="list-style-type: none"> • Drones and AI for real-time monitoring of river quality. • Ensuring adequate sanitation of water reserves. • Real-time monitoring and management of household water supply. <p>Water efficiency</p> <ul style="list-style-type: none"> • Residential water use monitoring and management. • Optimisation of industrial water use. • Predictive maintenance of water plants. • Early warning system for water infrastructure. • Smart meters in homes. <p>Catchment control</p> <ul style="list-style-type: none"> • Harmful algal blooms detection and monitoring. • Streamflow forecasting. • Automated flood centered infrastructure. 			<ul style="list-style-type: none"> • Operations • Technology • Ethics • Risk

External environment	Area of knowledge	Board knowledge (more than sufficient, sufficient, insufficient)	Access to knowledge by board (more than sufficient, sufficient, insufficient)	Related modules
How AI is changing sustainability in our industry and markets				
Clean air ¹	<p>Monitoring and prevention</p> <ul style="list-style-type: none"> • Real-time air pollution monitoring and simulations <p>Filtering and capture</p> <ul style="list-style-type: none"> • Optimised sensor-based air purifying systems • Carbon capture, sequestration and use <p>Clean fuels</p> <ul style="list-style-type: none"> • Advanced battery and fuel-cell design • Advanced battery components • Pollution forecasting for transport management <p>Early warning</p> <ul style="list-style-type: none"> • Air quality alerts • 2-10 day pollution level forecasting 			<ul style="list-style-type: none"> • Operations • Technology • Ethics • Risk
Weather and disaster resilience ¹	<p>Prediction and forecasting</p> <ul style="list-style-type: none"> • Extreme weather event modelling and prediction • Weather-forecast-informed flight paths • Climate informatics for enhanced climate modelling <p>Resilience planning</p> <ul style="list-style-type: none"> • Impact & risk mitigation analytics • Emergency risk communication • Real-time disaster risk mapping • Real-time disaster response coordination <p>Financial instruments</p> <ul style="list-style-type: none"> • Rapid, multi-source risk analysis • Analytics for financial parametric risk instruments • Analytics for claims analysis <p>Resilient infrastructure</p> <ul style="list-style-type: none"> • Automated mitigation of flood risk • Building-specific earthquake damage prediction • Disaster-ready urban infrastructure and buildings <p>Early warning systems</p> <ul style="list-style-type: none"> • Natural catastrophe early warning • Real-time enabled communication of natural disasters • Social media enabled disaster response 			<ul style="list-style-type: none"> • Operations • Technology • Ethics • Risk
Global commitments to the 17 Sustainable Development Goals (SDGs)	<p>Opportunities for AI to accelerate the achievement of the SDGs:</p> <ul style="list-style-type: none"> • In value chain productivity evaluation and enhancement • To accelerate research and development • To solve previously unsolvable business problems • Create entirely new business capabilities 			<ul style="list-style-type: none"> • Ethics • Risk • Governance • Operations
Emergence of Environment, Social, Governance (ESG) standards	<ul style="list-style-type: none"> • A framework focusing investors and financial analysts on Environmental, Social and Governance factors. • Investors may avoid companies that pose a financial risk due to their environmental or other practices. • Brokerage firms and mutual funds are offering ETFs and other financial products that support ESG standards. 			<ul style="list-style-type: none"> • Ethics • Risk • Governance • Operations • Customer
Internet of things	Mass data gathering in a sensor-driven world.			<ul style="list-style-type: none"> • Ethics • Governance • Responsibility • Technology

External environment	Area of knowledge	Board knowledge (more than sufficient, sufficient, insufficient)	Access to knowledge by board (more than sufficient, sufficient, insufficient)	Related modules
How AI is changing sustainability in our industry and markets				
Reporting impact and performance + metrics	Sustainability and impact reporting initiatives: <ul style="list-style-type: none"> • GRI • Carbon Disclosure Project (CDP) • IRIS+ • Impact Management Project (IMP) • SDG Compass 			<ul style="list-style-type: none"> • Ethics • Audit
Ethical, legal and other AI responsibilities	The rapid expansion of AI is already outpacing the development and deployment of legal and regulatory frameworks and the mechanisms that are designed to govern it.			<ul style="list-style-type: none"> • Ethics • Risk
Digitization of Education	<p>Massive Open Online Courses (MOOCs)</p> <ul style="list-style-type: none"> • edX • KhanAcademy <p>AI can be used to transform the structure of formal and information education, placing AI in the role of the teacher on the internet.</p> <p>As machines carry out an ever-growing number of routine tasks, learning that stimulates conceptual and creative capacities appears increasingly relevant. This could imply an education system shifting from a focus on mathematics and reading to a different set of personal and intellectual skills that facilitate working in tandem with intelligent machines (Brinolfsson & McAfee, 2014).</p> <p>“The global education system is still based on the assumption that people are indispensable ... It is essential to be able to adapt to changes in society and the environment, and that we must develop an education that supports that” (Teramachi, 2018, para. 7)</p> <p>Young children interact with AI through educational software like Leapfrog, use of smartphones, and reactive virtual assistants: Siri, Alexa, Ok Google, etc. Students are not utilizing libraries to find information when they have that capability at their fingertips.</p> <p>Management education must keep pace with the emerging AI revolution.</p>			<ul style="list-style-type: none"> • Ethics • Audit • Cybersecurity
Other questions	<p>Variance in national AI policies. There are significant disparities among countries in their readiness for the AI revolution, and hence their capacity to capture the potential benefits.</p> <p>Rate of tech obsolescence.</p> <p>Leapfrog strategies. Developing countries need systematic assistance and sustained development aid to strengthen their education systems, business enterprises and governance to be able to leapfrog into the green technologies and new energy future promised by AI.</p> <p>Greening of IT Vs. Greening through IT.</p> <p>Jevons paradox.</p> <p>Environmental costs of AI?</p> <p>Life cycle assessments.</p> <p>Sustainability-oriented innovation (SOI).</p> <p>Sustainability Indexes (e.g. Dow Jones Sustainability Index (DJSI)).</p> <p>Furthering the understanding of climate change, and modelling of its possible impact.</p>			

External environment	Area of knowledge	Board knowledge (more than sufficient, sufficient, insufficient)	Access to knowledge by board (more than sufficient, sufficient, insufficient)	Related modules
Competitors', customers' and partners' use of AI in Sustainability				
Competitors	<p>How traditional competitors compare on:</p> <ul style="list-style-type: none"> • Use of AI to improve on their GHG emissions and transform processes . • Instituting new low-carbon operating models using AI-enabled productivity enhancing processes. • Investments in AI ecosystem development. • Innovation programmes and incentives for sustainability-orientated innovation. • Vendors and partners engaged, and results obtained. • AI talent. • Intellectual property (patents, unique data etc.) • Results of benchmark comparisons against competitors. 			<ul style="list-style-type: none"> • Competitive • Customer • People and culture • Risk • Technology
Partners	<p>Whether partners follow responsible AI practices.</p> <p>Our partners' readiness to share data and use shared AI learnings for the collective.</p> <p>Open-source software and data community:</p> <ul style="list-style-type: none"> • Open source algorithms and machine learning standards • Accelerating the democratization of AI <p>AI implementation as a third-party service. Adopting data science and artificial intelligence by expressing business needs into technical solutions.</p> <p>AI-enabled sharing and circular economies.</p> <p>Emergence of satellite imagery and data analytics as a service.</p> <p>Global Reporting Initiative (GRI) helps companies find the value in sustainability reporting.</p>			<ul style="list-style-type: none"> • Competitive • Risk

Internal response	Area of knowledge	Board knowledge (more than sufficient, sufficient, insufficient)	Access to knowledge by board (more than sufficient, sufficient, insufficient)	Related modules
Coordination of AI-enabled sustainability initiatives				
Identification of new transformation and improvement opportunities	<p>Sustainability-Orientated Innovation (SOI): <i>Deliberate changes to products, processes, services, organizations or wider systems to deliver environmental and social as well as economic value.</i></p> <p>How management is targeting AI to support sustainability driven business models for a better world.</p> <p>What management is learning from other companies' sustainable development strategies? Does AI have a role? Why or why not?</p> <p>Whether management is focused on growth or just cost reduction.</p> <p>How management uses AI to find new opportunities and balances trade-offs.</p> <p>How management judges initiatives' value, risks, compliance with core mission and values, and the responsibilities and legal requirements to be met.</p> <p>The prize of aligning business strategies with AI and sustainable development.</p> <p>How much will be doing nothing cost?</p> <p>Risks and responsibilities of committing to SDGs.</p> <p>Whether establishing a task force or committee will help the board review the company's AI activities.</p> <p>Benefits of providing an educational programme on AI to board members (either internally or externally).</p>			<ul style="list-style-type: none"> • Governance • Ethics • Risk • Technology • Brand and strategy • Competitive • People and culture • Operations

Internal response	Area of knowledge	Board knowledge (more than sufficient, sufficient, insufficient)	Access to knowledge by board (more than sufficient, sufficient, insufficient)	Related modules
Coordination of AI-enabled sustainability initiatives				
Identification of risk	<p>Guiding AI to mitigate against risk:</p> <p>Performance risks</p> <ul style="list-style-type: none"> • Risk of errors • Risk of bias • Risk of opaqueness or “black box” risk • Risk of explainability • Risk of stability for performance <p>Security risks</p> <ul style="list-style-type: none"> • Cyber-intrusion risks • Privacy risks • Open-source software risk <p>Control risks</p> <ul style="list-style-type: none"> • Risk of AI going “rogue” • Inability to control malevolent AI <p>Ethical risks</p> <ul style="list-style-type: none"> • “Lack of values” risk • Value alignment risk • Goal alignment risk <p>Economic risks</p> <ul style="list-style-type: none"> • Job displacement risks • “Winner-takes-all” concentration of power risk • AI-based developments may not be accessible to small firms, driving the gap with respect to larger ones. • Liability risk • Reputational risk <p>Societal risks</p> <ul style="list-style-type: none"> • Risk of autonomous weapons proliferation • Risk of “intelligence divide” 			<ul style="list-style-type: none"> • Risk • Ethics • Cybersecurity • Technology
Investment in AI	<p>Expenditures in AI to support the company’s strategy.</p> <p>Expenditures in AI for process retrofit and improvements.</p> <p>Developing needed skills and retaining vital talent.</p> <p>Striking a balance between short- and long-term investment horizons with the rate of AI’s advancement.</p>			<ul style="list-style-type: none"> • Competitive • Risk • Governance • Technology
Identification of implementation requirements	<p>Responsibly operating and developing AI; recruiting and retaining AI talent; obtaining, managing and protecting data.</p> <p>Companies with AI process improvement capabilities that are potential acquisition targets.</p> <p>Action taken to ensure data quality, and that it is collected, used and stored responsibly.</p> <p>Integrating deep life-cycle analyses into our design phases.</p> <p>Renewable energy sources and providers.</p>			<ul style="list-style-type: none"> • Competitive • Brand • People and culture • Technology • Cybersecurity

References

1. Pwc, “Harnessing AI for the Earth”, 2018

Appendix 2: Performance Review Tool

This tool can be used by board directors to pose questions to management and evaluate their answers. It follows the same broad topics as the knowledge assessment tool.

Judge the answers received by management using the SCEPTIC framework.

The tool also suggests related modules for additional analysis.

The SCEPTIC framework:

Specificity: Are the answers precise and do they show depth of knowledge?

Candour: Do the answers cover up issues, exaggerate benefits or steer towards one course of action?

Evidence: Are there data, KPIs and other support to back the opinion?
Is the evidence unbiased, complete and sound?

Planning: Are answers drawn from an effective internal process?

Thoroughness: Are the answers based on a rigorous search for information from diverse sources?

Involvement: Are the answers based on real-world experience?

Consistency: Are the answers logical and free from contradictions and gaps?

	Ask management	Related modules:
AI and sustainable development		
Identification of new transformation and improvement opportunities	<p>Is management familiar with sustainability-orientated innovation (SOI) to make deliberate changes to products, processes, services, organizations or wider systems to deliver environmental and social as well as economic value?</p> <p>How are we developing a culture that simultaneously supports SOI and the responsible use of AI and data?</p> <p>How is management targeting AI to support sustainability driven business models for a better world?</p> <p>What are the most important AI opportunities we should pursue to:</p> <ul style="list-style-type: none"> • Solve environmental, social, and economic problems we were unable to solve before? • Address demands from customers, business partners and regulators? • Deal transparently and systemically with risk, uncertainty and irreversibility? • Ensure appropriate valuation, appreciation and restoration of nature? • Conserve biodiversity and ecological integrity? • Ensure inter-generational equity? • No net loss of human capital or natural capital? • Augment our workforce's skills, abilities and decision-making? <p>How do we know these are the most important opportunities?</p> <p>What is the prize of aligning business strategies with AI and sustainable development?</p> <p>How much will doing nothing cost?</p> <p>What companies should we follow for ideas on how to use AI to transform processes into cleaner/greener states?</p> <p>How are we applying the principle of continuous improvement?</p> <p>How well does management understand ecosystem thinking?</p>	<ul style="list-style-type: none"> • Governance • Risk • Technology • Operations • Competitive • Brand • Customer • People and Culture

	Ask management	Related modules:
AI and sustainable development		
Ethical, legal and other AI responsibilities	<p>How management judges initiatives' value, risks, compliance with core mission and values, and the responsibilities and legal requirements to be met?</p> <p>Have we consulted with our legal staff and unions about the impact on jobs and skills from our AI plans?</p> <p>How might new sustainability-orientated processes create conflicts with our core values and principles?</p> <p>What are the risks and responsibilities of committing to sustainability-orientated business model strategies?</p>	<ul style="list-style-type: none"> • Ethics • Risk • Governance • Audit • Cybersecurity • Operations • Technology
Other questions	<p>Who advises us on AI? Are we satisfied with the advice?</p> <p>Whether establishing an AI task force or committee will help the management review the company's AI activities?</p> <p>Whether providing an educational programme on AI and/or sustainability (either internally or externally) will help top management?</p> <p>Variance in national AI policies.</p> <p>Rate of tech obsolescence.</p> <p>Leapfrog strategies.</p> <p>Greening of IT Vs. Greening through IT.</p> <p>Renewable energy sources and providers.</p> <p>Jevons paradox.</p> <p>Furthering the understanding of climate change, and modelling of its possible impact.</p>	
Competitors', customers' and partners' use of AI and sustainable development		
Competitors	<p>How are our competitors' and other companies:</p> <ul style="list-style-type: none"> • Using AI-enabled processes and principles of sustainable development to enhance their business strategy and operating models? • Using unique intellectual property – patents, proprietary data – to capitalize on and improve their environmental and operational stewardship processes? • Managing fairness, data guardianship, explainability and other AI responsibilities? • Investing in AI-enabled sustainability driven enhancements? How does that compare with our investments? • Creating a culture that supports sustainable development? How well is it working? • Addressing the ethical issues and AI responsibilities they are encountering as they transform processes? <p>How is management learning from other companies' sustainable development strategies? Does AI have a role? Why or why not?</p> <p>What are the results of benchmark comparisons against competitors inside our industry?</p>	<ul style="list-style-type: none"> • Governance • Risk • Competitive • People and culture • Operations • Technology
Customers and business partners	<p>How are the expectations and preferences for interacting with our company changing? Can we use AI to meet those expectations?</p> <p>How are we sustaining trust with customers? With business partners?</p> <p>Are our suppliers and partners' practices for using AI responsibly consistent with ours? If not, what are we doing to reconcile them?</p> <p>What are the most promising opportunities for partnering with companies in the ecosystem?</p> <p>How 'ready' are our partners' to share data and use shared AI learnings for the collective?</p> <p>How are we leveraging AI-enabled sharing and circular economies?</p>	<ul style="list-style-type: none"> • Customer • Brand

	Ask management	Related modules:
AI-enabled sustainable development		
Climate Change	<p>Does our business model address:</p> <ul style="list-style-type: none"> • Clean power? • Smart cities and homes? • Sustainable land-use? • Sustainable production and consumption? • Smart transportation systems? • Preventing pollution? 	
Biodiversity and conservation	<p>Does our business model address:</p> <ul style="list-style-type: none"> • Habitat protection and restoration? • Protecting land and marine species? • The realization of natural capital? • Invasive species and disease control? • Pollution control? • Sustainable trade? 	
Healthy Oceans	<p>Does our business model address:</p> <ul style="list-style-type: none"> • Sustainable fishing? • Impact from climate change (including acification)? 	
Water Security	<p>Does our business model address:</p> <ul style="list-style-type: none"> • Water supply and efficiency? • Drought planning? • Adequate sanitation? 	
Clean air	<p>Does our business model address:</p> <ul style="list-style-type: none"> • Monitoring and prevention? • Filtering and capture? • Clean fuels? • Early warning? 	
Weather and disaster resilience	<p>Does our business model address:</p> <ul style="list-style-type: none"> • Prediction and forecasting? • Resilience planning? • Financial instruments? • Resilient infrastructure? • Early warning systems? 	
Internal response		
Investment in AI	<p>What AI investments are we making to pursue sustainability-orientated development opportunities?</p> <p>Does our software development platform have the capabilities we need to create and test AI systems? If not, what investments are we making to upgrade it? What is our plan for acquiring companies to boost our AI process capabilities?</p> <p>What investments are we making in skills and talent? Are we making them in a way that is consistent with our diversity goals?</p> <p>How is management leveraging the open-source software and data community? Open source algorithms and machine learning standards, accelerating the democratization of AI.</p> <p>Has management considered outsourcing AI implementation needs to a third-party?</p>	<ul style="list-style-type: none"> • Governance • Technology • People and culture

	Ask management	Related modules:
Internal response		
Identification of implementation requirements	<p>Are our sustainability-orientated process improvement plans consistent with our core values? Are these initiatives well aligned with our strategic priorities and business needs?</p> <p>What are the technology requirements and migration challenges that our company must meet to successfully implement AI-enabled processes for sustainability? How ready is our company to meet these challenges?</p> <p>What are the implementation and ethics requirements for successfully pursuing these opportunities – e.g. cultural changes; support and incentives for sustainability-orientated innovation; talent needs; cross-functional cooperation; obtaining, managing and protecting data?</p> <p>How will our data science and analytics teams support our AI process improvement strategies?</p> <p>What is our strategy for training and retaining our employees for the new skills, roles and jobs required for AI?</p> <p>When will the technology to create these new AI-enabled sustainability-orientated innovations be mature and scalable enough for us to use it? How did we determine that?</p>	<ul style="list-style-type: none"> • Ethics • Risk • Governance • Audit • Technology • Operations • Cybersecurity
Initiation	<p>What major AI initiatives are underway for sustainability-orientated developments? What are our plans for prototypes, initial implementations and scaling up these processes?</p> <p>What is their potential value to our business? Their brand reputation, legal and other risks? How did we evaluate this?</p> <p>How are we measuring success? What are the KPIs?</p> <p>How are we reporting on our sustainability?</p> <p>Which executives are responsible for driving the technical, process and cultural/human resource management changes?</p> <p>Who from outside our company is participating in our initiative, and what role will they play? (vendors, consultants, ecosystem partners)</p> <p>How will we move from a pilot to a full-scale system?</p> <p>What internal data will we use to train and operate the model? What data are we acquiring from outside the company? How will we ensure data quality, and collect, use and store the data responsibly?</p> <p>How are we designing for sustainability?</p> <ul style="list-style-type: none"> • Are components derived from scarce resources? • What is the content of recycled material? • What levels of waste or pollution are generated in production? • Could the production process use less energy or water? • At end of life, can product components be recycled, re-used, disassembled? • Is packaging and distribution optimised for sustainability? • Do suppliers subscribe to your sustainability principles • Is the workforce assured a safe and healthy work environment? • Are workers in the supply chain equally assured? 	<ul style="list-style-type: none"> • Brand • Risk • Audit • Operations • Technology
Progress	<p>What progress has been made to date in our major AI-enabled sustainability stewardship process transformation and improvement activities?</p> <p>How are we ensuring our employees and partners are complying with responsible AI and other ethics practices?</p> <p>How are we addressing concerns and resistance from managers and other employees?</p> <p>Is coordination across organizational silos going well? If not, how will problems be addressed?</p>	<ul style="list-style-type: none"> • Governance • Audit • Risk • People and culture

	Ask management	Related modules:
Internal response		
Evaluation	<p>Have we met our goals and KPIs? Why?</p> <p>What value have we received? Did it meet expectations? Do we have the business capabilities we expected?</p> <p>Does the new process outperform the previous process on a sustainability standpoint? By what metrics?</p> <p>Have we completely met legal and responsibility requirements? If not, how will we meet them?</p> <p>How will we sustain our success?</p> <p>Have there been any negative outcomes?</p> <p>How are they being mitigated?</p> <p>Are the outcomes accepted by the employees, customers and partners who use them?</p>	<ul style="list-style-type: none"> • Governance • Audit • People and culture
For companies affecting EU citizens	Are we compliant with GDPR?	

Appendix 3: Guidance tool

Use this tool to consider responses to the knowledge assessment and performance review tools. These suggestions are a starting point for brainstorming on responses.

If the board...	Then consider...
Needs more external information	<ul style="list-style-type: none"> • Reading and subscribing to news sources and reports on AI trends and sustainable development. • Attending professional events on AI opportunities, strategies and emerging risks. • Meeting with AI researchers, regulators, trusted advisers and sustainability experts. • Establishing an emerging technology committee to advise the board or assign a technology advisory role to an existing committee. • Reading use cases on websites of AI vendors, consultancies and start-ups. • Speaking with peers and executives on the boards of other companies in our ecosystem. • Commissioning (or discovering via conversations with start-ups) third-party perspectives.
Needs more internal information	<ul style="list-style-type: none"> • Requesting reports and updates from the executive team on AI pilots and implementations, and on programmes to create a culture for AI success. • Meeting with the executives – chief HR officer, chief information officer, chief risk officer etc. – engaged in developing a mindset for AI success in innovation, risk management and use. • Meeting with mid-level human resource managers and teams developing, implementing and using AI.
Wants management to better understand the potential ethical and legal risks of future AI applications and technologies	<p>Encouraging management to:</p> <ul style="list-style-type: none"> • Set up an independent ethics board. • Hire AI ethicists to advise them. • Ask legal counsel to report on AI's regulatory requirements and legal risks. • Engage with organizations devoted to promoting responsible AI and AI ethics. • Attend or set up a workshop exploring AI ethics issues.
Needs management to focus on strategy and business-model innovation	<p>Encouraging management to:</p> <ul style="list-style-type: none"> • Set up design thinking and ideation sessions. • Study AI strategy innovations by competitors and in industry. • Focus on developing a culture and organization that supports innovation and experimentation. • Review executive compensation.
Needs management to increase benefits from strategic AI initiatives	<p>Encouraging management to:</p> <ul style="list-style-type: none"> • Rapidly improve new AI-enabled systems and processes. • Investigate new business models. • Consider new joint ventures and partnerships.
Needs management to better understand and follow through on risk, compliance and responsibilities of AI	<p>Encouraging management to:</p> <ul style="list-style-type: none"> • Work with trusted advisers and legal experts to identify risks, relevant legal issues and ethical concerns. • Develop an AI governance framework. • Establish an ethics board. • Request regular reports on risk and responsibility assurance See also: the Ethics, AI governance and Risk modules.
Questions the value, terms and risks of a major AI contract	<ul style="list-style-type: none"> • Bringing in third parties, including attorneys and consultants, to review the contract. • Asking the chief finance officer to review and explain questionable parts of the contract. • Seeking opinions from executives who were not consulted on the deal. • Asking the chief information officer to report on the implications of the deal for the company's IT infrastructure and technology organization. • Asking executives who oversee data, legal, ethics and public affairs officers to analyse the implications of the deal.
Needs management to understand what its competitors are doing with AI technologies	<ul style="list-style-type: none"> • Hiring benchmarking services. • Encouraging management to focus on competitor analysis

If the board...	Then consider...
Needs management to improve stewardship of data	Encouraging management to: <ul style="list-style-type: none"> • Appoint a chief data officer or other executive to take responsibility for data management.
Needs management to build a more diverse and inclusive AI workforce	Encouraging management to: <ul style="list-style-type: none"> • Review and educate staff on the reasons why diversity of perspectives is essential for developing AI. • Focus on diversity at the early stage of AI team-building and recruitment. • Set up an internal audit to assess the diversity of the current workforce across the organization (departments, roles etc.) • Integrate elements of diversity, equity and inclusion into performance reviews and professional development. • Lead by example, by practising inclusion and building a diverse team of managers and advisers. • Improve training opportunities for employees to enter AI careers.
Needs more external information about AI and environmental sustainability-orientated innovation	<ul style="list-style-type: none"> • Establishing an emerging technology committee to advise the board, or assign a technology advisory role to an existing committee. • Reading and subscribing to news sources and reports on AI trends and providers. • Reading use cases on websites of AI vendors, consultancies and start-ups. • Scanning articles in trade press and journals for professionals in target processes. • Establishing an educational programme on AI for board members. • Attending events on AI and on target processes. • Meeting with venture capitalists, AI technology experts, experts on, and AI researchers at major universities. • Speaking with peers and executives on the boards of other companies in our ecosystem. • Commissioning (or discovering via conversations with start-ups) third-party perspectives.
Wants management to better align AI activities with priorities	Encouraging management to: <ul style="list-style-type: none"> • Review and reconsider KPIs and metrics, including creating new metrics. • Develop an operating model that integrates AI process changes into a new way of doing business. • Set up strategy reviews.