



QNDCC 2023 White Paper

AI Solutions to Combat Climate Change

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AI Solutions to Combat Climate Change

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Earthna is a facilitator of sustainability efforts and action in Qatar and other hot and arid countries, focusing on sustainability frameworks, circular economies, energy transition, climate change, biodiversity and ecosystems, cities and the built environment, and education, ethics, and faith. By bringing together technical experts, academia, government and non-government organizations, businesses and civil society, Earthna fosters collaboration, innovation, and positive change.

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Executive Summary

Drawn from Qatar National Dialogue on Climate Change (QNDDCC) held in October of 2023, this paper's findings and analysis synthesize insights from the panel session "Artificial Intelligence (AI) Solutions to Combat Climate Change" and supplementary research. The paper highlights the significant role AI plays in addressing the urgent and complex challenge of climate change, presenting findings and recommendations essential for enhancing Qatar's national sustainability goals and fostering local and regional initiatives.

AI has emerged as a pivotal technology in combating climate change. Its potential to process vast data sets, make accurate predictions, and optimize resource utilization offers a promising solution to the environmental challenges posed by climate change. Qatar's initial adoption of a national AI strategy, crafted in collaboration with the Qatar Computing Research Institute (QCRI) as part of Hamad Bin Khalifa University (HBKU), signifies a crucial and positive step toward recognizing AI's instrumental role in steering the nation toward a more sustainable future. However, it is acknowledged that much more is required to fully realize the potential and impact of AI in addressing the complexities of climate change.

International climate agreements, such as the Paris Agreement and the United Nations Educational, Scientific and Cultural Organization's (UNESCO) Recommendation on the Ethics of AI, show the importance of aligning technological advancements with global environmental responsibilities. These agreements emphasize the need for ethical and responsible AI deployment to address climate change, highlighting AI's significant role in fostering sustainability.

Industries worldwide are leveraging AI across sectors like academia, transportation, waste management, and energy, manifesting a notable shift toward environmentally conscious practices. However, challenges in implementing AI solutions persist, from vague policy frameworks to public resistance to change, demanding collaborative, innovative, and tailored approaches for successful integration.

This comprehensive research analysis offers a strategic framework to overcome these challenges. It emphasizes the significance of robust policy structures, the accessibility of diverse AI solutions, public awareness, and a significant investment in infrastructure. The collaboration of government, academia, and the private sector is pivotal to driving innovation and establishing clearer guidelines for the strategic integration of AI in mitigating the impact of climate change. Furthermore, the paper acknowledges the importance of the United Nations (UN) led AI Advisory Body, industry initiatives, and country-specific efforts, such as Qatar's strategy to decarbonize the oil and gas sector. It acknowledges the global trend where AI technology is recognized as one of the innovative approaches to combat climate change, emphasizing its versatile and impactful role in addressing multifaceted environmental challenges across countries and industries.

The paper acknowledges key contributors, speakers, and those who compiled and researched the findings. The active involvement of various stakeholders, government bodies, and industry leaders has significantly contributed to this critical discourse.

Scope and Methodology

The scope of this research analysis covers the topics discussed in the Panel Session "Artificial Intelligence Solutions to Combat Climate Change" on the second day of the QNDDCC, in addition to supplementary research to substantiate the session's key findings and produce optimally relevant recommendations. The findings can be utilized to enhance Qatar's national sustainability goals and develop relevant local and regional

sustainability initiatives. The methodology followed for data collection includes preliminary academic research, on-site session note-taking, and post-session supplementary research and benchmarking. Based on these detailed insights, this White Paper provides a set of general and Qatar-specific recommendations to support the implementation of AI solutions to address climate change.



AI Solutions to Combat Climate Change

Climate change stands as one of the most pressing global challenges, threatening ecosystems, communities, and economies worldwide. The rapid increase in average global temperatures, sea level rise, and extreme weather events are clear indicators of this phenomenon's severe impact. Such environmental shifts necessitate innovative, urgent solutions. Simultaneously, the emergence of AI as a transformative technology presents a promising path to addressing these environmental challenges. The capacity of AI to analyze extensive datasets, generate accurate predictions, and enhance resource utilization provides a promising outlook in the fight against climate change. This alignment between the problem and the potential solutions using AI underscores the technology's growing significance in the environmental landscape. The recent adoption of a national AI strategy in Qatar, developed by QCRI, signifies a significant leap in recognizing the critical role of AI in achieving national objectives.¹ While this marks progress, there is room for further enhancement to ensure the strategy's continued relevance in securing the economics and strategic future of Qatar, aligning with the country's broader vision for sustainable comprehensive development.

The UN-led AI Advisory Body and its focus on leveraging machine learning to address common global challenges

¹ HBKU, "Minister of Transport and Communications Announces Qatar's National Artificial Intelligence Strategy Developed by HBKU's Qatar Computing Research Institute," October 29, 2019. <https://www.hbku.edu.qa/en/news/qitcom-qcri-hbku>.

² UN, "Explainer: How AI Helps Combat Climate Change," November 3, 2023. <https://news.un.org/en/story/2023/11/1143187>.

International Climate Agreements and AI

Addressing the intersection of international climate agreements and the pivotal role of AI in combating climate change, both the Paris Agreement and the United Nations Educational, Scientific and Cultural Organization's (UNESCO) Recommendation on the Ethics of AI, highlights the necessity to align technological advancements with global environmental responsibilities. The Paris Agreement, a pivotal international treaty under the United Nations Framework Convention on Climate Change (UNFCCC), aims to combat climate change by limiting global warming. While it doesn't explicitly address AI, Article 10 acknowledges the critical role of technology in combating climate change. It emphasizes the necessity for technology development and transfer to reduce greenhouse gas emissions and enhance resilience.³ This recognition indicates the importance of technological advancements, including AI, in achieving the Agreement's goals.

UNESCO's Recommendation sets out essential principles for the ethical growth of AI. This agreement outlines crucial values for responsible AI development and sets the initial global standard for AI ethics, empowering individual states to enforce these standards.

³ United Nations Framework Convention on Climate Change, "Paris Agreement," https://unfccc.int/sites/default/files/english_paris_agreement.pdf.

⁴ Ad Hoc Expert Group (AHEG), "Draft of the Recommendation on the Ethics of artificial Intelligence," UNESCO, <https://unesdoc.unesco.org/ark:/48223/pf0000373434>. UNESCO, 2020. <https://unesdoc.unesco.org/ark:/48223/pf0000373434>.

⁵ Ibid.

The agreement strongly emphasizes the need for efficient data, energy, and resource practices in AI development to enhance its role in addressing climate change and environmental concerns.⁴ It urges the alignment of AI development with established international laws and standards focused on environmental protection and sustainable development. The recommendation specifically encourages the integration of AI in disaster risk resilience, environmental monitoring, and the promotion of sustainable consumption and production.⁵ This aligns AI initiatives with broader environmental and sustainability objectives such as the UN SDGs, emphasizing the significant role AI can play in realizing these global goals.

The parallel focus of these international agreements on AI's ethical growth and its integration within the framework of climate change combat demonstrates a crucial alliance between technological advancements and global environmental responsibilities. Both the Paris Agreement and UNESCO's Recommendation highlight the necessity to align AI development with sustainable practices, emphasizing its pivotal role in addressing climate change and promoting responsible and ethical AI.

Industries Leveraging AI for Climate Change

In today's evolving landscape, industries worldwide are leveraging the potential of AI to drive innovative and impactful solutions to combat climate change. At an international level, countries are integrating AI technology to combat climate change. The United States, for instance, leverages AI for climate modeling, allowing for a more comprehensive understanding of extreme weather events.⁶ This emphasizes the pivotal role of AI in analyzing vast datasets to model climate patterns effectively, providing crucial insights into the dynamics and potential impacts of extreme weather events. This deeper understanding is instrumental in formulating adaptive strategies, enhancing preparedness, and developing resilient infrastructure to mitigate the adverse effects of climate change. Similarly, the strategic embrace of AI in India's disaster management highlights the adaptability of technology in forecasting and addressing natural calamities.⁷ This proactive approach, supported by predictive analytics and machine learning, signifies

an efficient strategy to mitigate climate-induced disasters. Similarly, European countries like Albania and Bosnia and Herzegovina incorporating AI in agricultural adaptation further emphasize the versatility of AI in addressing diverse climate-related challenges.⁸ This strategic integration of AI in agriculture enables these nations to enhance resource efficiency, optimize crop yields, and implement adaptive measures to cope with evolving climatic conditions. By leveraging AI's capabilities, these countries are not only increasing their agriculture resilience but also contributing to sustainable food production practices amid changing climate patterns. Globally, a noticeable trend has emerged among leaders in both public and private sectors, indicating a rising endorsement of employing AI to address climate change. This signifies a shift towards acknowledging the potential of AI technologies in addressing environmental challenges and the evolving stance underscores a broader commitment to innovation and collaboration in the fight against climate change.

Moreover, at the regional level, Qatar's Ministry of Environment and Climate Change launched the Qatar National Environment and Climate Change Strategy which covers 5 areas of climate change: greenhouse gas emissions, air quality, biodiversity, water, circular economy, waste management, and land use. The National Environment and Climate Change Strategy aims to reduce GHG emissions by 25%, establish 30 air quality monitoring stations and increase the number of reserves concerning biodiversity by 2030.⁹ To achieve these goals Qatar is exploring the use of AI, aiming to achieve net-zero emissions.¹⁰ This strategic utilization aligns with global sustainability goals, highlighting the potential of AI in driving environmental responsibility at a national level.

At an industry level, academia is using the transformative application of AI in processing extensive datasets, particularly satellite imagery, which marks a significant advancement in climate pattern modeling and predictive analysis. The integration of AI has revolutionized the depth of understanding of climate change dynamics, enabling the development of more precise and effective mitigation strategies.¹¹ This technological leap not only enhances the accuracy of environmental studies but also yields tangible outcomes by providing unprecedented insights and precise predictive capabilities that were previously unattainable. This innovation brings forth promising prospects for tackling climate change through more data-informed and precise methodologies, further contributing to sustainable solutions.

Within the transportation industry, the integration of AI to optimize flight routes and advance electric vehicle (EV) performance underlines a substantial shift toward eco-friendly operations. The reduction of the aviation sector's global warming impact by 35% highlights the transformative capacity of AI in a high-polluting sector.¹² This approach accelerates battery development, enhances performance, and facilitates the exploration of more sustainable battery chemistries. The incorporation of AI in predicting material performance stands as a distinctive feature, streamlining the testing process, efficiency, and sustainable battery innovations for greener operations.

The introduction of AI-driven robots in the recycling industry illustrates not just an efficiency upgrade but a significant environmental impact. Recycling robots utilizing AI work faster and more efficiently in collecting recycled materials compared to humans. This showcases how AI technology optimizes recycling processes and significantly reduces greenhouse gas (GHG) emissions. Companies such as AMP Robotics utilize AI technology

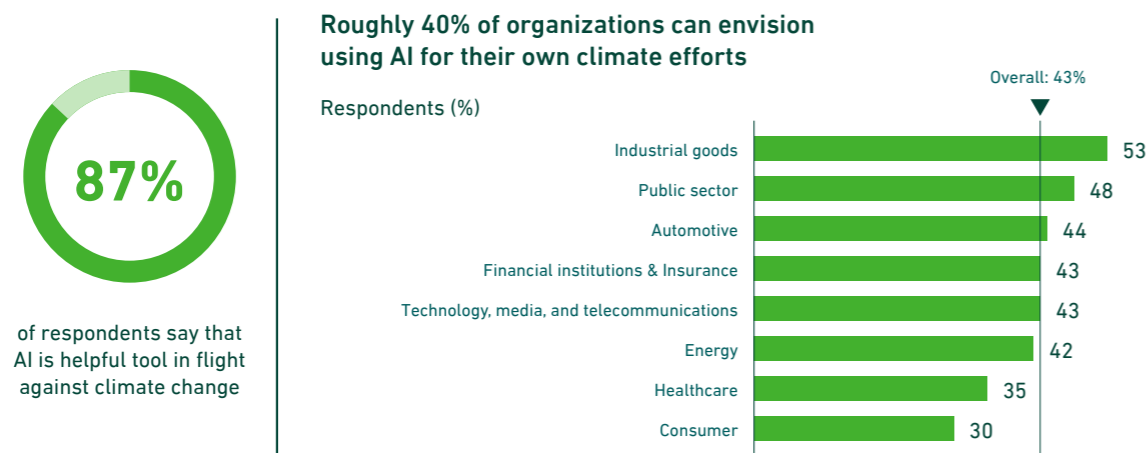
Industries Leveraging AI for Climate Change

that helps prevent nearly 1.8 million metric tons of GHG emissions, equivalent to removing approximately 375,000 cars from the road.¹³ This innovation emphasizes AI's tangible effect in reducing environmental footprints and revolutionizing waste management. Similar to the recycling industry, the environmental service companies' integration of AI solutions offers a systemic approach to reducing carbon emissions and optimizing energy consumption. Veolia, a French water, energy, and waste recycling management company, is utilizing AI to avoid 15 million metric tons of CO2 in emissions by 2023.¹⁴ The strategic application of AI within Veolia's framework includes monitoring and optimizing water consumption, managing water networks, enhancing waste sorting and recycling processes, and detecting and anticipating infrastructure events and anomalies.¹⁵ Additionally, Veolia's employment of AI extends to innovative tools like the Bob unit in France, analyzing industrial machine vibrations for improved anomaly detection, and robots used in sorting centers.¹⁶ These advanced AI-driven solutions highlight Veolia's commitment to sustainable practices and environmental stewardship.

Sheikha Athba Al-Thani, Head of Sustainable Development and Chief Business Officer at Qatari Diar Vinci Construction (QDVC), a Qatari construction company, highlighted the significance of AI in optimizing data-driven practices within the construction and infrastructure sectors. This emphasis reflects a clear acknowledgment of AI's capacity to enhance resource efficiency in these critical domains. It emphasizes the importance of ethical and sustainable AI utilization, aligning with the need for responsible environmental practices in these critical sectors. The significance of AI in construction extends beyond QDVC. AI in construction contributes to optimizing equipment usage, accelerating education and on-the-job training, enhancing site safety, and increasing sustainability. It plays a crucial role in reducing waste, accurately forecasting material needs, and positively impacting the workflow, highlighting the transformative potential of AI in reshaping the construction industry.¹⁷

The oil and gas (O&G) industry in Qatar holds a crucial place in the nation's economy, but its emissions pose a challenge to the country's commitment to reducing GHG emissions. The National Climate Change Action Plan (NCCAP) signals the country's intention to decarbonize, acknowledging that shifting solely to low-carbon energy won't sufficiently reduce emissions. The industry is making significant investments, including \$200 million towards emission reduction technologies.¹⁸ AI and machine learning have become essential tools in these efforts, aiding in identifying emission sources, conserving

Public-and Private-Sector Leaders Who Oversee Climate and AI Topics Support Using AI to Flight Climate Change



⁶ United Nations, "Climate Adaptation," https://www.un.org/en/climatechange/climate-adaptation?gclid=Cj0KCQiAjMKqBhCgARIsAPDgWlwEls5meTNoIKs48Cul6fy9wpY2U5wr7TixRVNu0umDXnKQ847sSHMaAjwhEALw_wcB

⁷ Ibid.

⁸ Ibid.

⁹ Qatar News Agency, "Environment Minister: National Environment and Climate Change Strategy a Main Pillar of Qatar National Vision 2030," October 28, 2021. <https://www.qna.org.qa/en/News-Area/News/2021-10/28/0043-environment-minister-national-environment-and-climate-change-strategy-a-main-pillar-of-qatar-national-vision-2030>

¹⁰ Qatar Tribune, "Is AI a Viable Tool to Help Reduce Carbon and Cost for Qatar?," April 22, 2021. <https://www.qatar-tribune.com/article/211597/BUSINESS/Is-AI-a-viable-tool-to-help-reduce-carbon-and-cost-for-Qatar>.

¹¹ Chasan, "Some Experts See AI as a Tool against Climate Change. Others Say Its Own Carbon Footprint Could Be a Problem," CBS News, August 28, 2023. <https://www.cbsnews.com/news/artificial-intelligence-carbon-footprint-climate-change/>.

¹² Ibid.

energy, and improving overall energy efficiency. AI's role in managing complex issues like methane emissions underscores its importance in the industry's decarbonization efforts. These technologies enable the creation of reliable GHG emission baselines and aid in driving emission reduction projects that align with Qatar's climate objectives, significantly shaping the industry's emission reduction strategies. This local initiative within the oil and gas industry exemplifies a strategic utilization of AI for climate action, echoing a broader global trend where AI technologies are spearheading diverse efforts to combat climate change across countries. Furthermore, the integration of AI in the O&G industry contributes to bridging the industry's performance gap. AI-driven data analytics systems and tools are crucial in overcoming operational complexities, yielding substantial returns, and reducing ecological impact.¹⁹ It also plays a vital role in decreasing freshwater usage, improving water recycling efforts,

reducing methane leaks, and streamlining processes, ultimately enhancing sustainability.²⁰ The industry's adoption of renewable energy and exploration of biofuels further exemplify its transformative journey toward a more sustainable and environmentally responsible future.

The trends in AI solutions for combating climate change are remarkably diverse and comprehensive. This technological expertise provides a substantial advantage in understanding the unpredictable nuances of climate change. Furthermore, AI's role in optimizing energy usage is crucial. By making industries more efficient and fostering the creation of eco-friendly infrastructure, AI contributes to significantly reducing carbon footprints. This multifaceted approach is vital in the race to combat climate change, facilitating more sustainable and environmentally conscious practices within various sectors.

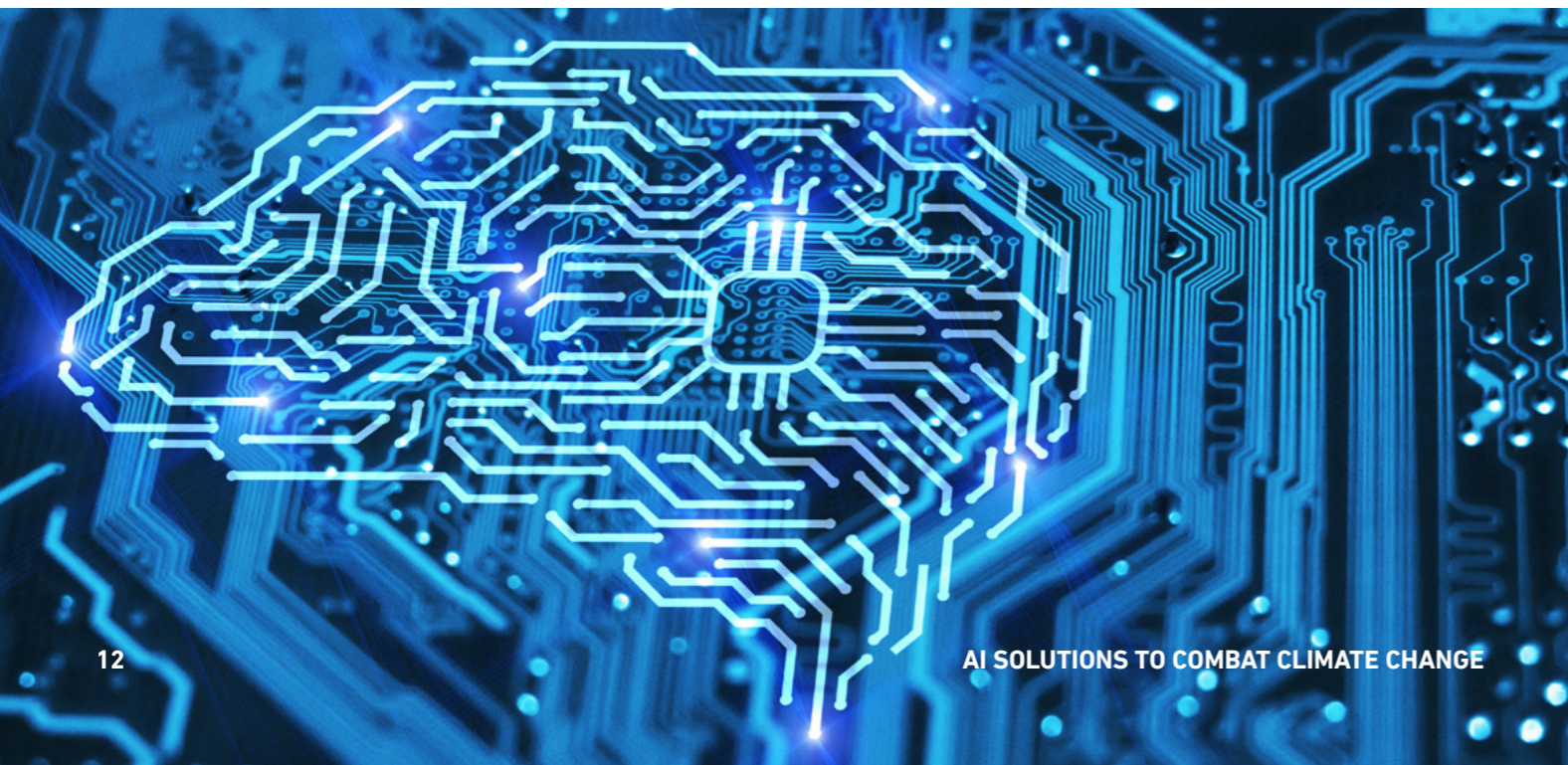
¹³ Ibid.
¹⁴ Veolia, "Artificial Intelligence Working for Our Business," <https://www.veolia.com/en/ressources/smart-city/artificial-intelligence-working-our-businesses>.
¹⁵ Ibid.
¹⁶ Ibid.
¹⁷ Meirav Oren, "4 ways AI is revolutionising the construction industry," World Economic Forum, June 21, 2023. https://www.weforum.org/agenda/2023/06/4-ways-ai-is-revolutionising-the-construction-industry/?DAG=3&gad_source=1&gclid=CjwKCAiA0syqBhBxEiwAeNx9N2tLgJZQgqBIPfahN_SRze081mkvG05Yr9ZGr1oXwFM59ZDXWcRhDRoCv4cQAvD_BwE.
¹⁸ Sachin Kumar, "AI at Forefront of Solving Emissions Challenge in Qatar," The Peninsula Qatar, December 30, 2021. <https://thepeninsulaqatar.com/article/30/12/2021/ai-at-forefront-of-solving-emissions-challenge-in-qatar>.
¹⁹ World Future Energy Summit, "8 ways the Oil and Gas Industry is making better use of sustainable technologies," <https://www.worldfutureenergysummit.com/en-gb/future-insights-blog/8-ways-the-oil-and-gas-industry-is-making-better-use-of-sustainable-technologies.html>.
²⁰ Ibid.

Qatar's Context: Addressing Challenges and Applicable Recommendations for AI Implementation

Addressing the complex hurdles in deploying AI solutions to tackle climate change requires a holistic approach. These challenges, though pertinent to Qatar, resonate globally. To navigate the challenges effectively, a multifaceted strategy is imperative, encompassing technological innovation, robust policy frameworks, active public participation, and synergistic collaborations among governmental bodies, academic institutions, and private

sectors. This is where forums like the Qatar National Dialogue on Climate Change prove effective in addressing these challenges and identifying appropriate solutions. The table below outlines the specific challenges encountered within the Qatari context along with corresponding recommendations to advance the integration of AI technologies in combating climate change.

	Challenges	Recommendations
Government Policy Framework	The absence or ambiguity of specific policies and frameworks that direct, incentivize, or enforce the use of AI for environmental preservation is a universal concern. A robust policy framework guiding the implementation and regulation of AI technologies in the context of climate change mitigation is often lacking on an international scale. The absence of clear guidelines can create ambiguity in adopting these technological solutions	To resolve the absence or ambiguity of policies guiding AI's role in environmental preservation, a collaborative approach involving various stakeholders—government bodies, academia, and private enterprises—is paramount. Dr. Ghanim Al-Sulaiti Director of Government Innovation at Civil Service and Government Development Bureau highlighted the significance of cooperative efforts to drive innovation. Policymakers should work hand in hand with technological innovators to establish clear guidelines and regulations, fostering the strategic integration of AI in climate change mitigation. This collaborative approach will enhance the responsiveness of policies to technological advancements and ensure sustainable application and regulation of AI technologies
Limited AI Solutions	The accessibility and diversity of available AI solutions tailored for addressing climate change concerns can pose a challenge. The availability of comprehensive tailored AI solutions to different countries and different industries can be a limiting factor when using AI as a tool to combat climate change.	To address the scarcity of AI solutions, Ms. Hayfa Al Abdallah Innovation Director at Qatar Science and Technology Park (QSTP) highlighted that entities like QSTP play a pivotal role by offering tangible support and platforms for collaboration, fostering an environment that encourages creative thinking and problem-solving. In initiatives such as the 'Meet the Expert' series, QSTP collaborates with its partner Qatar Shell Research and Technology Center, showcasing a commitment to advancing the use of AI in propelling the transition toward a low-carbon economy. The deployment of predictive AI models has enabled the monitoring of over 16,000 pieces of equipment, predicting failures and consequently, reducing costs, time, efforts, and CO2 emissions. ²³ These concrete examples highlight the effectiveness of AI initiatives supported by entities like QSTP in addressing climate change and driving innovation across diverse sectors.



Qatar's Context: Addressing Challenges and Applicable Recommendations for AI Implementation

	Challenges	Recommendations
Lack of Public Awareness and Resistance to Change	Encouraging public acceptance and behavioral change remains a common obstacle across the globe. Convincing countries and companies to embrace AI-powered solutions for climate change face resistance due to entrenched habits, cultural norms, skepticism regarding effectiveness, and privacy protection.	Strategic communication is vital for initiatives focused on raising awareness and overcoming resistance to change. Collaborative efforts involving government bodies, academia, and the private sector play a key role in effective public engagement campaigns, emphasizing the benefits of adopting AI-based solutions. Government bodies contribute to this synergy by providing a robust regulatory framework and policies ensuring national alignment. Academia brings its strengths in research, innovation, and knowledge transfer, complemented by the practical applications and technological advancements offered by the private sector. This cohesive collaboration ensures a holistic approach to addressing climate change by pooling crucial resources such as funding, infrastructure, and talent
High Initial Investment and Lack of Infrastructure	Implementing AI-driven solutions to combat climate change demands substantial initial investments and extensive infrastructure development. Research from the University of California emphasized that creating computer hardware involves labor-intensive mining and raw material production, which significantly contributes to the negative environmental impact of AI. ²¹ The training process for AI models such as ChatGPT-3 consumes approximately 500 milliliters of water to generate responses for 20 to 50 inquiries. ²² In other words, this illustrates the resource implications associated with the computational power and data processing requirements of training advanced language models. Creating sustainable systems and incorporating advanced technology involves significant costs, from developing infrastructure for data collection to establishing renewable energy systems.	Dr. Abdelaziz Bouras Professor in Computer Science and Manager of Pre-Award Department at QU stated that collaboration between research institutions, such as QU, and industry players is crucial. These partnerships will support the development and optimization of sustainable infrastructure and AI technologies. By facilitating collaboration and funding joint projects, these institutions can streamline the development of AI-supported sustainable systems, infrastructure, and optimized AI technology, reducing the cost of implementation and making it more accessible.

²¹ Chasan, "Some Experts See AI as a Tool against Climate Change. Others Say Its Own Carbon Footprint Could Be a Problem," CBS News, August 28, 2023. <https://www.cbsnews.com/news/artificial-intelligence-carbon-footprint-climate-change/>.

²² Dolby, "Artificial Intelligence Can Make Companies Greener, but It Also Guzzles Energy," WSJ, September 11, 2023. <https://www.wsj.com/articles/artificial-intelligence-can-make-companies-greener-but-it-also-guzzles-energy-7c7b678>.

²³ Mourad Atriss, "QSTOP Session Explores Role of Artificial Intelligence in Powering Energy Transition," Qatar Science and Technology Park, June 11, 2023. <https://qstp.org.qa/qstp-session-explores-role-of-artificial-intelligence-in-powering-energy-transition/#:~:text=For%20example%2C%20we've%20deployed, reduction%20in%20our%20CO2%20emissions.%E2%80%9D>.

Conclusion

The challenge of climate change is urgent but also complex. However, within this complex challenge lies an opportunity for innovative solutions. AI has emerged as a guide in combating climate change. This transformative technology has the potential to address the intricate web of issues. The recent national AI strategy in Qatar indicates a growing recognition of the pivotal role that AI can play in shaping a more sustainable and resilient future. While it may not be the sole pillar, it signifies a crucial step forward, emphasizing the country's understanding of the importance of AI in steering towards a greener and more sustainable tomorrow.

The international landscape also echoes this sentiment, highlighting the intrinsic connection between AI and environmental responsibilities. Multinational agreements like the Paris Agreement and UNESCO's Recommendation on the Ethics of AI highlight the pivotal role of AI in combating climate change. These agreements emphasize the need for technological advancements to be in alignment with global environmental obligations, stressing the ethical and responsible deployment of AI in fostering sustainability. Industries worldwide are embracing AI technologies to

navigate a path toward sustainability. From academia to transportation, and waste management to water and energy sectors, AI's integration is propelling a shift toward eco-conscious practices. These transformations underscore AI's versatility and its profound impact across diverse sectors in contributing to environmental stewardship.

Yet, challenges persist in harnessing AI's full potential to combat climate change. Issues such as vague policy frameworks, limited accessibility of tailored AI solutions, public resistance to change, and the considerable investment and infrastructure needed underscore the need for strategic solutions. To overcome these hurdles, collaboration, innovation, public awareness, and a tailored approach are crucial. In the collective effort to combat climate change nations and industries align their practices to meet global environmental responsibilities. The significance of AI in driving sustainability is becoming increasingly clear. This necessitates a unified global effort, innovative strategies, and the ethical deployment of AI to pave the way for a more sustainable future.



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