AI, EMISSIONS AND ENERGY – THE IMPACT OF AI IN A WARMING WORLD

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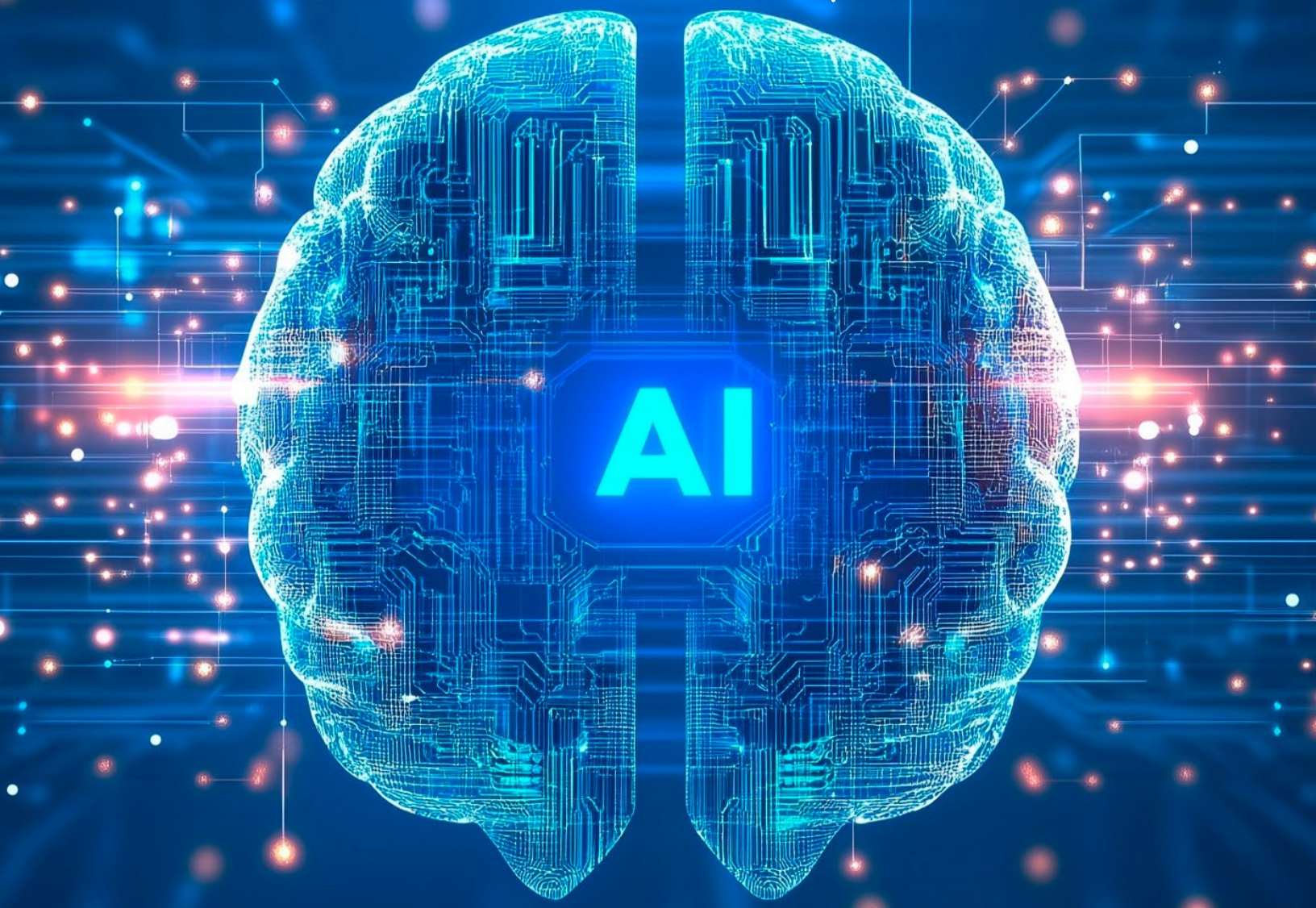


KEY TAKEAWAYS

Increasing use of AI tools is driving energy demand in this sector up, due to the high energy intensity of AI's backend processes.

Advocates of the technology say AI can actually be leveraged to reduce global emissions, as well as transform how energy is produced and managed, thereby softening its impact on the planet.

In 2022, OpenAI released a revolutionary 'chatbot' called ChatGPT, capable of understanding and responding to all manner of questions — from run-of-the-mill search engine enquiries to complex artistic and creative asks — with remarkable precision and humanoid intelligence. Such was the intrigue and perceived utility of this tool that within two months of its release, 100 million people were actively using it, with one commentator comparing the potential impact of the underlying technology to that of the discovery of fire.[1]

[1]https://e360.yale.edu/features/artificial-intelligence-climate-energy-emissions

The technology in question — artificial intelligence, or AI — has in recent years seen explosive growth in its popularity, as an object of genuine fascination and subject of equally genuine concern. Much of that concern has centred on legislative and ethical issues associated with AI use, but at the midpoint of an important decade for climate action, the energy impact of the technology is also attracting attention. Increasing use of AI tools is driving energy demand in this sector up. However, advocates of the technology say AI can actually be leveraged to reduce global emissions, as well as transform how energy is produced and managed, thereby softening its impact on the planet.

So, just how power-hungry is AI, and can it really help clean up its own — and by extension, our collective — carbon footprint?

UNDERSTANDING AI

Artificial Intelligence refers generally to the ability of computer systems to simulate human intelligence. AI systems are "endowed with the intellectual processes characteristic of humans, such as the ability to reason, discover meaning, generalise, or learn from past experience."[2]

[2]https://www.britannica.com/technology/artificial-intelligence/Methods-and-goals-in-AI

Most internet users and smartphone-owners will have had interaction with AI on some level through search engines and digital assistants. The technology has also been integrated into online shopping experiences, entertainment and gaming apps, office software, the banking and transportation sectors, among many others, and its list of possible applications is growing fast.

TODAY, THE FOCUS IS ON BUILDING AND REFINING GENERATIVE AI TOOLS, WHICH ARE DIFFERENT FROM OTHER FORMS OF AI TECHNOLOGY IN THAT THEY CAN ACTUALLY CREATE CONTENT, RATHER THAN JUST REPLICATE PATTERNS AND ANALYSE DATA.

Generative AI tools can create works of art, write poems and computer code, and even enhance or extrapolate medical scans to show how a disease might progress in a patient.[3] To the excitement of some and alarm of others, AI is also enabling the creation of more advanced robots, able to perform like humans (or even better) in different contexts.

POWERING AI

The development of AI technology involves teaching computers to think like humans, which requires training of AI models using large data sets. It is estimated that training ChatGPT's precursor model required around 45 terabytes of text data, comparable to the volume of text found in one million feet of bookshelf space.[4]

Data centres consume large amounts of energy

Both the training and use of AI tools require energy. According to IBM, "energy is needed both to build and train AI models and then to power the complex math that a model completes each time it is asked for information or to generate content."[5]

TRAINING THE MODEL BEHIND CHATGPT IS ESTIMATED TO HAVE USED AROUND 65,000 MEGAWATT HOURS (MWH) OF ELECTRICITY, ROUGHLY EQUIVALENT TO THE ANNUAL POWER CONSUMPTION OF 6,500 HOMES IN THE US.[6]

USING AI ALSO EXACTS A HIGH ENERGY COST. COMPLETION OF ONE AI-POWERED QUERY — SUCH AS A CHATGPT ENQUIRY – REQUIRES ABOUT **10 TIMES THE ENERGY** OF A TYPICAL GOOGLE SEARCH.[7]

This energy is actually consumed by the data centres housing the massive computer systems that do the backend work, enabling Alexa to tell you that joke, or Copilot to summarise that report. Based on surging demand for AI integration, the IEA projects that by 2026, the share of global electricity that powers data centres will double.[8] These data centres (which also support cryptocurrency mining and other commercial activities) consumed an estimated 460 terawatt-hours (TWh) in 2022, and could cross 1,000 TWh — roughly the the annual electricity consumption of Japan – in 2026.[9]

Taking an even more holistic view of the entire ecosystem of activities associated with the technology, all AI-related electricity consumption is estimated to grow by as much as 50% annually from 2023 to 2030.[10]

[3]https://www.coursera.org/articles/generative-ai-applications
[4]https://www.mckinsey.com/featured-insights/mckinsey-explainers/what-is-generative-ai
[5]https://www.ibm.com/think/insights/future-ai-energy-efficiency#:~:text=up%20with%20customers.-,AI%20energy%20use%20creates%20a%20challenge,information%20or%20to%20generate%20content
[6]https://www.weforum.org/stories/2024/07/generative-ai-energy-emissions/
[7]https://www.weforum.org/stories/2025/01/energy-ai-net-zero/
[8]https://www.iea.org/reports/electricity-2024/executive-summary
[9]Ibid
[10]https://www.weforum.org/stories/2025/01/ai-energy-dilemma-challenges-opportunities-and-path-forward/

This growth in energy use is attended by an increase in emissions. Microsoft, which is investing heavily in generative AI, recently announced a 30% increase in its CO_2 emissions since 2020, due to data centre expansion.[11] Meanwhile, Google revealed an almost 50% uptick in its 2023 emissions compared to 2019, largely due to the energy demand tied to data centres.[12]

LEVERAGING AI

These numbers notwithstanding, AI-based tools can actually be leveraged to support climate action — an argument which favours their continued development.

In a 2023 report, Google and Boston Consulting Group (BCG) shared that AI has the potential to help mitigate 5-10% of global greenhouse gas (GHG) emissions by 2030 — the equivalent of the total annual emissions of the European Union.[13]

Achieving this result comes down to how AI is ultimately applied. Google's joint report with BCG highlighted that AI's strengths in curating information, enhancing prediction, and guiding optimisation can support advancements in three crucial areas.

Mitigation: Helping with both the reduction and removal of emissions—and with the underlying measurement needed to size the challenge and track progress

Adaptation and resilience: Aiding countries, regions, cities, citizens, and businesses in forecasting climate related hazards, developing plans to address them, and responding in real time to crises

Foundational capabilities: Enabling climate-related modelling, research into climate economics, new approaches to climate education and supporting breakthroughs in fundamental research.

(Source: Accelerating Climate Action with AI, Boston Consulting Group/Google, 2023[14])

Essentially, with the help of AI tools, stakeholders in the climate fight will be able to process, analyse and extrapolate data more efficiently and effectively, in applications that seek to track and reduce emissions, forecast climate change impacts and model solutions.

As an illustration of its utility in this regard, AI was utilised in a Google project to analyse atmospheric data, in order to determine which flight paths pilots could follow to leave the fewest contrails — the white lines that sometimes appear behind airplanes in the sky. Since contrails account for more than a third of commercial aviation's contribution to global warming, if the results of that one project were applied across the industry, it would save more CO_2 equivalent than what was generated by AI in 2020 alone.[15]

Energy sector applications

AI can similarly be applied within the energy sector to help reduce emissions.

In 2024, the US Department of Energy published a report outlining how AI can accelerate the development of a 100% clean electricity system, through:

Improving grid planning: Utilising climate data sets with advanced generative machine learning to accommodate renewables, which tend to be more variable energy sources.

Enhancing grid resilience: AI's ability to rapidly process massive amounts of data and detect subtle patterns can assist grid operators in diagnosing and responding to (or avoiding) disruptions in electricity delivery.

Discovering new materials: Quickly identifying new materials for clean energy technologies, such as for batteries requiring less lithium, novel solar-active materials, or improved catalysts to increase hydrogen production.

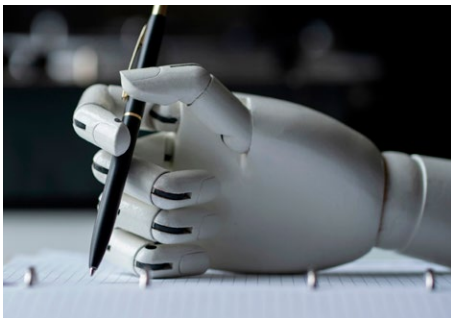
(Source: https://www.energy.gov/policy/articles/how-ai-can-help-clean-energy-meet-growing-electricity-demand)

IN PLACES WHERE RENEWABLE ENERGY IS ALREADY INTEGRATED, AI CAN HELP OPTIMISE ENERGY PRODUCTION AND CONSUMPTION.

Since renewable power is not constant, there can be overproduction of electricity during peak times and underproduction during lulls, which can lead to wasteful energy consumption and grid instability. AI can help improve energy management by analysing datasets — from weather patterns to energy consumption trends — to give better insights into when and how energy should be used for maximum efficiency.[16] Such insights can enable users to schedule work and other tasks so as to only use energy when electricity from renewable energy sources is available.

[11]https://www.weforum.org/stories/2024/07/generative-ai-energy-emissions/
[12]Ibid [13]https://blog.google/outreach-initiatives/sustainability/report-ai-sustainability-google-cop28/
[14]https://web-assets.bcg.com/72/cf/b609ac3d4ac6829bae6fa88b8329/bcg-accelerating-climate-action-with-ai-nov-2023-rev.pdf
[15]https://e360.yale.edu/features/artificial-intelligence-climate-energy-emissions
[16]https://www.weforum.org/stories/2024/07/generative-ai-energy-emissions/

AI can also generate energy efficiency gains. Integration of AI tools and equipment can help optimise the performance of heating and air conditioning in buildings, for example, or inform predictive maintenance programmes.[17]



In the oil and gas sector
Applications abound for AI in the oil and gas sector as well:

It is **boosting the efficiency of exploration** and enhancing sustainability in managing hugely complex oil and gas development projects.

It is **facilitating predictive maintenance of operating assets** such as platforms, pipelines, and processing plants to avoid downtime and enhance safety.

Using data from sensors and from on-site, aerial, and satellite cameras, AI can identify vulnerabilities and/or leaks (eg. methane releases) enabling more timely responses.

Use of 'digital twins' with integrated AI is making asset integrity management far easier, which supports emission reduction efforts.

On the commercial side, AI can **improve demand forecasting and manage price fluctuations** to maximise revenue, assist with regulatory compliance processes, and drive supply-chain efficiencies.

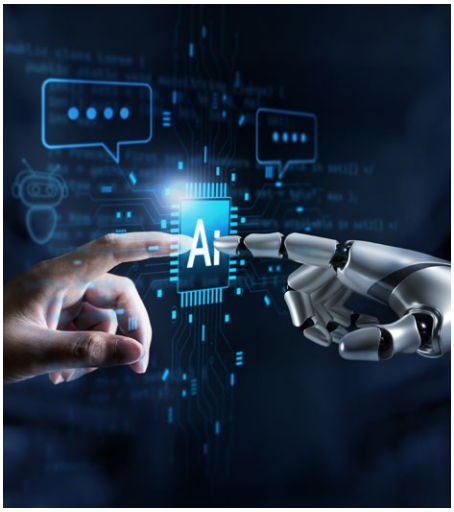
(Source: https://www.dnv.com/article/ai-spells-opportunity-and-manageable-risk-for-the-oil-and-gas-industry/)

Key areas to monitor concerning AI's energy impact, 2024-2025 outlook
Image: AIGA, AI Energy Impact Initiative, World Economic Forum

Improving the efficiency of oil and gas operations translates to enhanced value creation and, in many cases, reduced emissions.

THE FUTURE OF AI

The story of AI is still being written. As the above graphic illustrates, there are several areas of action that will ultimately determine the net impact of this technology. Importantly, human intelligence is not obsolete just yet — there is ongoing research and development to refine the technology, both to reduce its carbon footprint (through, for example, more Earth-friendly data centres) and strengthen its capacity to help us solve the most difficult climate challenges. While time alone will tell how far we can take this



revolutionary technology within the constraints of a warming world, there is no doubt that the future is being shaped by the meeting of minds, of man and machine. ■

[17]Ibid