Climate Action
Against Disinformation

GENERATING A(I) CRISIS: The impact of “generative AI” and machine learning systems on corporate accountability and power system decarbonisation

Summary

- **The Public Needs Transparency:** The contribution of existing machine learning systems to current power demand, and projections of future power demand from these systems are both highly uncertain.
- **Big Tech is Growing, Not Shrinking, Power Demand:** Corporate disclosures reveal extremely rapid power demand growth from large tech companies. As a consequence, data centre growth is likely to compete for resources with broader societal trends such as electrification and increased energy access.
- **AI Isn't A Climate Solution:** Some of the narratives emerging around data centre growth and machine learning resemble greenwashing and include false solutions and exaggerated benefits.
- **Big Tech Is Sacrificing Climate Goals for AI Growth:** Major tech companies are actively departing from their climate targets as a consequence of pursuing growth in machine learning applications

Introduction

The climate crisis is a challenge of reducing fossil fuel emissions, which means reducing fossil-fueled electricity demand as much as possible, while replacing coal and methane power plants with wind, solar and batteries.

Tech companies are promising a significant shift towards greater use of 'artificial intelligence' in their product offerings. Much of this involves generative applications such as chatbots and image creation, while other applications include face recognition, energy efficiency tools and code optimisation. A broader context shows that this technology is already having negative social impacts: hurting the communities exposed to the fossil fuel pollution that's powering the data centers that make AI possible, being used by fossil fuel industry to drill for more fossil fuels, chatbots that allegedly encourage suicide, AI-generated disinformation, and a super-charging of misogynistic and abusive synthetic sexual imagery targeting women and girls.

Axios' Scott Rosenberg claims "Artificial Intelligence" or "machine learning", so far has an unclear social benefit. Yet it has a disproportionately high impact on the power sector and related pollution. This is particularly so for 'generative' applications, such as chatbots and image generators that merely approximate what humans do with word processors or photo editing software.

The July 2024 mid-year Electricity Report update from the International Energy Agency (IEA) projects a 4% rise in power consumption in 2024, the highest since 2004. And the 2024 IEA 'World Energy Outlook' projects a rise of around 6,700 terawatt hours to 2030, with data centres driving 203 terawatt hours of growth within that amount. The same report finds that data centre growth will be on par with new growth in desalination plants producing clean drinking water, and equivalent to a full quarter of the total global demand growth from electric vehicles.

The rising and globally significant level of data centre power demand growth that's likely coming down the pipeline may end up drawing resources away from other sectors featuring growing power demand (such as electrification or increased access to electricity grids in less developed parts of the world). Therefore, increased scrutiny on the reasons for data centre growth, along with a close examination of their acute regional effects, appears justified and is what we will attempt to do in this report.

Reports are clear data centre demand is rising, and will continue to rise in the future. But the role machine learning will play will be determined by choices made by those who deploy, enable and allow it. The form it takes, the size it reaches and the effect it has on climate action all remain dependent on how its growth is politically, socially and economically regulated, or if the technology will go the way of NFTs, the Metaverse, and other now-popped bubbles.

Projected and current impacts on power demand

Much of the focus on power demand stems from "generative" applications of machine learning. An example is feeding a database of human-written text into a learning algorithm, which determines statistical relationships between the occurrence of various words, and chains of words. It can then generate a string of text based on what has been "learned" from that database. A similar process occurs for images, and the relationships between pixels and text descriptions, to produce machine-generated images such as those from 'Midjourney'.

One estimate from AI research group Hugging Face claims generative tasks such as text and image generation, and image captioning, are the most emissions intensive. The 'training' phase involves the supply and ingestion of data into a machine learning model, which for generative tools requires vast amounts of data and therefore significant energy consumption. However, the 'inference' phase, where a question asked to ChatGPT is 'answered' with reference to that training, consumes far more energy.

[Image 1 - HuggingFace Report]

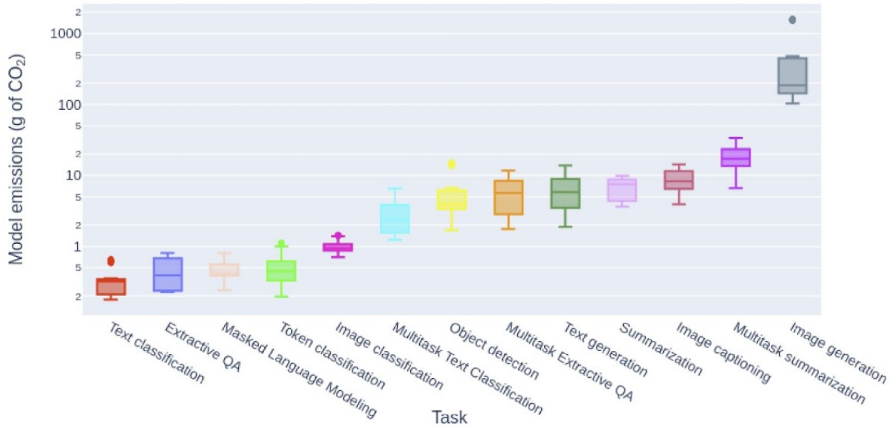


Fig. 1. The tasks examined in our study and the average quantity of carbon emissions they produced (in g of CO_2eq) for 1,000 queries. N.B. The y axis is in logarithmic scale.

Source: Luccioni et al, 2023

"We find that multi-purpose, generative architectures are orders of magnitude more expensive than task-specific systems for a variety of tasks, even when controlling for the number of model parameters"

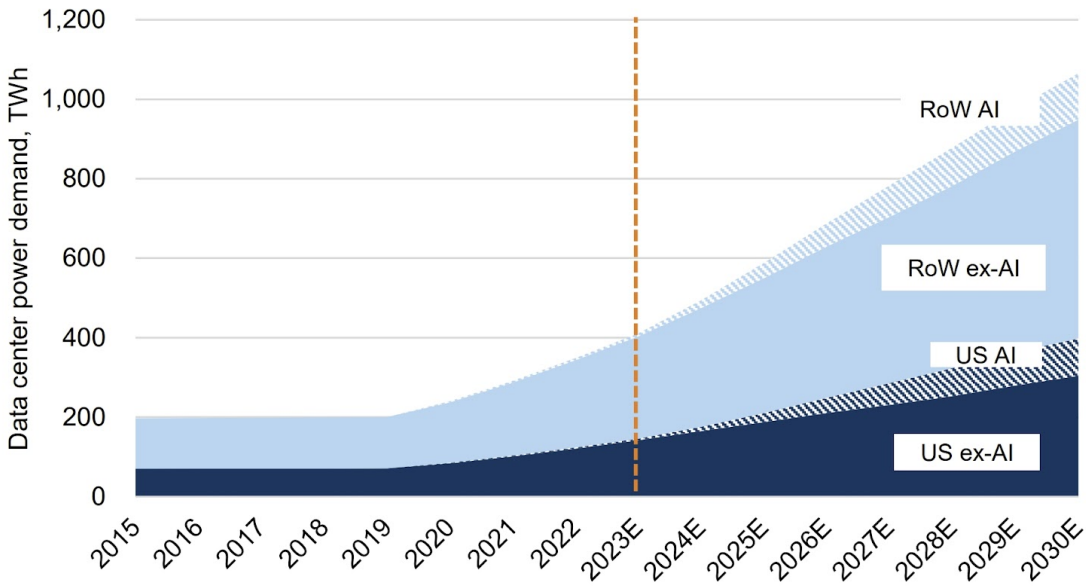
Consequently, projections of total data centre power demand growth vary significantly depending on assumptions around the training and usage of generative machine learning systems.

The most commonly cited recent projection of power demand from machine learning stems from the International Energy Agency's (IEA) 2024 'Electricity' report, which projects that in the coming years, power demand from dedicated machine learning data centres will grow substantially relative to its low base in 2022.

The chips used to process machine learning data are manufactured largely by technology firm NVIDIA, and the IEA uses projections of sales of their chips to suggest dedicated machine learning power demand will be 10x greater in 2026 than in 2023.

An April 2024 Goldman Sachs report projects global and US data centre power demand increases due specifically to machine learning (and excluding crypto). In their projections, data centres move from 1-2% of global power demand to 3-4%, and up to 8% of US power demand. This is equivalent to around one third of the total power demand of residential power consumption. Goldman Sach's estimates are above the IEA, and above SchneiderElectric's projections.

Exhibit 7: After being flat for 2015-19, we have seen data center power demand accelerate in 2021-23 and expect a 160% increase through the rest of the decade
Global data center electricity consumption, TWh; includes AI and excludes cryptocurrency



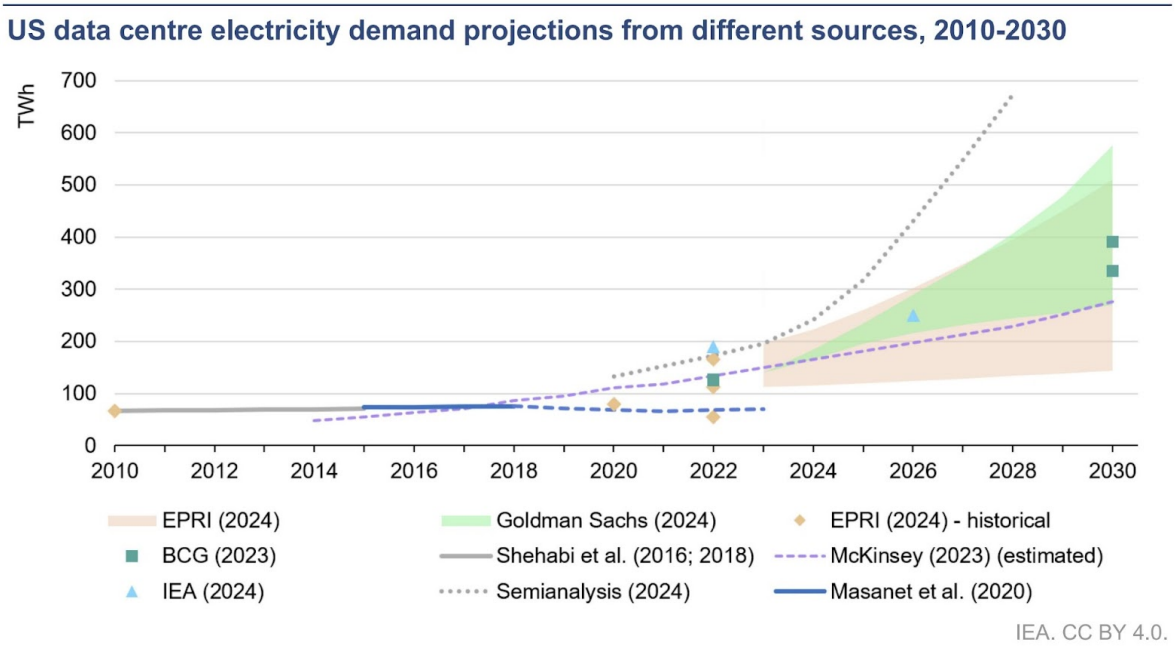
Source: Masanet et al. (2020), Cisco, IEA, Goldman Sachs Global Investment Research

Cryptocurrency climate and energy expert Alex de Vries recently published an estimate of projected power demand from machine learning, claiming that in the worst case scenario "Google's AI alone could consume as much electricity as a country such as Ireland (29.3 TWh per year)", but that a more realistic outcome is a global demand of around 5 to 8 TWh per year. His report concluded by stating that "It would be advisable for developers not only to focus on optimising AI, but also to critically consider the necessity of using AI in the first place".

A recent Goldman Sachs report illustrates how questions around the profitability and usefulness of machine learning tools will impact eventual real power demand.

According to Jim Covello from Goldman Sachs"The more time that passes without significant AI applications, the more challenging the AI story will become. And my guess is that if important use cases don't start to become more apparent in the next 12-18 months, investor enthusiasm may begin to fade". They estimate around $1 trillion to be spent over the next several years on infrastructure for machine learning, but do not identify any clear business case for profitable usage.

The July 2024 IEA Electricity Report update illustrates the yawning range of uncertainty in this space thanks to varied assumptions regarding machine learning growth:



Potentially biassed demand projections

Several large tech companies have announced deals with existing or planned nuclear power projects, justified on the grounds of rapid electricity demand growth. This meets the need of existing and emergent nuclear power operators seeking investment, and the needs of large tech companies with rising demand and increasing scrutiny.

Some examples of deals announced:

- The restart of the Three Mile Island nuclear power station (shut down in 2019), after a deal with Microsoft
- Google signing power purchase deals with several proposed, experimental 'small modular reactors'
- Oracle planning to also use 'small modular reactors' for data centres

- Meta, Facebook's parent company, requesting proposals for nuclear power generation to supply its data centres

While the level of promised ambition from companies does remain high, others have used the potential growth of AI to assert a fatalistic attitude towards climate goals. According to reports, Google's former CEO Erich Schmidt declared during an AI summit that "we're not going to hit the climate goals anyway because we're not organized to do it." Notorious fossil fuel industry commentator Mark Mills has repeated a similar line, declaring the achievement of climate goals impossible due to projected power draw from these tools (the use of projections to justify new fossil infrastructure is discussed below).

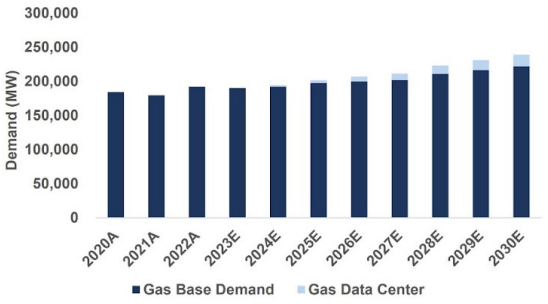
Others highlight the incentive for utilities to overestimate future demand projections, with the goal of maximising profit earned through new infrastructure buildout charged to customers. This is not without precedent - in a piece entitled "Dig more coal: the PCs are coming", published in 1999 in Forbes Magazine, fossil fuel advocate Mark Mills claimed that "while many environmentalists want to substantially reduce coal use in making electricity, there is no chance of meeting future economically-driven and Internet-accelerated electric demand without retaining and expanding the coal component".

The risks to power sector decarbonisation

A recent example of rapid power demand growth is the ongoing growth of Bitcoin mining (a digital currency), in which an ever-larger array of servers are dedicated to guessing number combinations to generate new 'bitcoin'. This requires vast amounts of energy. It has resulted in coal fired power stations being kept open (or even restarted) or new gas-fired power stations being built, demonstrating how quickly demand from new technology, or even the expectation of it, can drive fossil fuel emission increases. Despite a significant drop in Google search interest for Bitcoin relative to 2021, the Cambridge Bitcoin Electricity Consumption Index shows how power demand for this process has reached record highs in 2024.

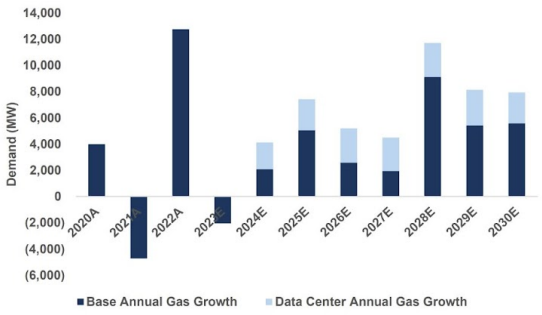
An April 2024 Goldman Sachs research report lays out projections of a substantial volume of new gas-fired power generation along with new pipeline capacity being deployed to meet the new demand specifically from machine learning applications in data centre power demand. Their projections suggest only 40% of the new demand will be met by new clean sources:

Exhibit 36: We expect data center power demand to result in a ~10% increase in the amount of gas consumed in the power market vs. today
Gas demand for power generation base plus data center power demand (2020-2030E)



Source: Goldman Sachs Global Investment Research

Exhibit 37: We expect natural gas for power demand to grow ~3% annually, of which, data centers make up a meaningful portion of that growth (~40%)
Gas demand growth - base vs data centers (2020-2030E)

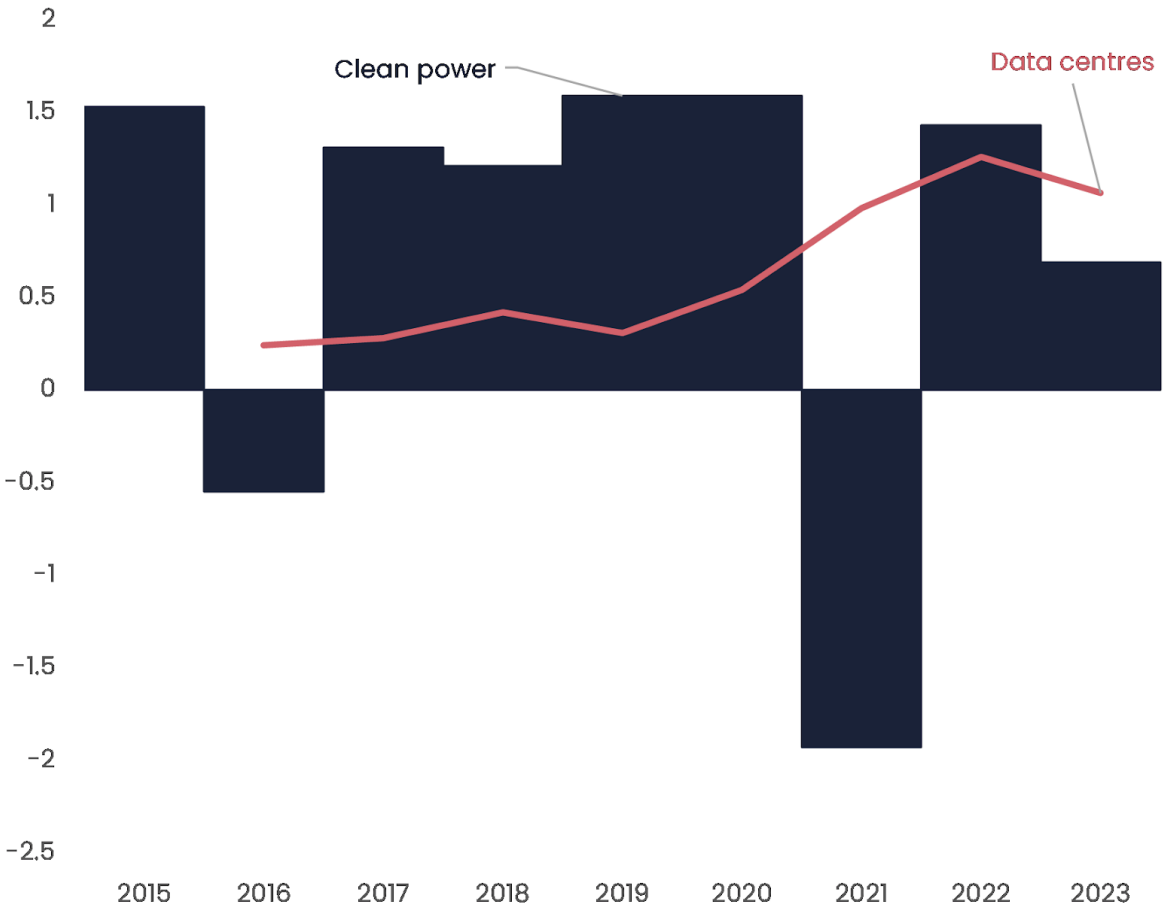


Source: Goldman Sachs Global Investment Research

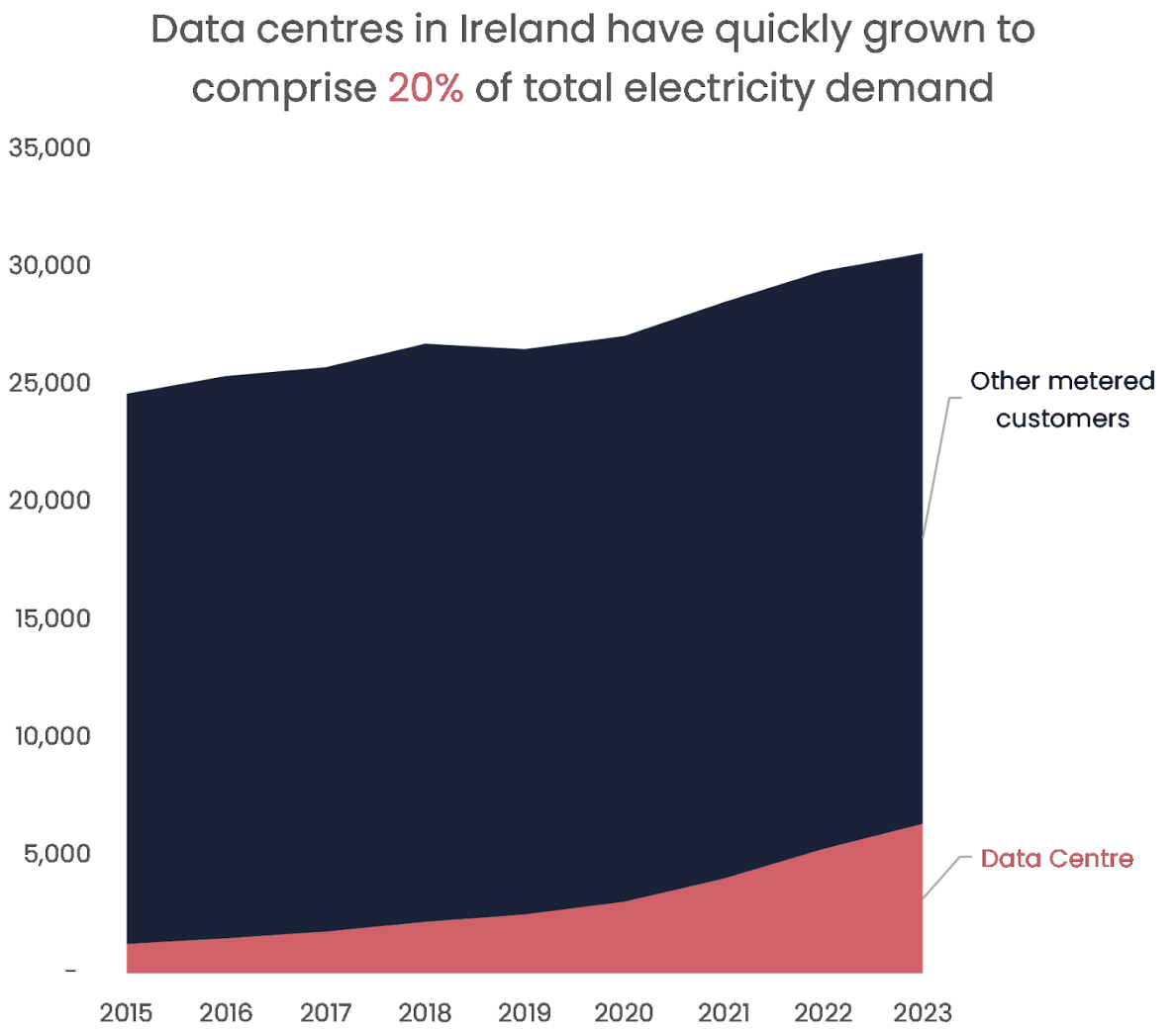
In Ireland, there have been 20 recent requests from data centres to connect directly into the fossil gas grid. The country has already seen significant growth in data centre power consumption, resulting in a rise in power demand. While much of that rise has been met with clean power and additional imports, it means emissions have not fallen significantly in Ireland's power sector between 2019 and 2024.

A recent report confirms that all new clean energy in Ireland in 2023 served new data centre growth, with none left over for any other industry. Ireland data centre power consumption expert Dr Hannah Daly reports that data centres have been driven to apply for fossil gas connections due to a moratorium on new power grid connections around Dublin.

Data centre power consumption grew faster than clean power in Ireland, between 2022 and 2023



Year on year change in terawatt hours. Ember GER 2024 + Ireland CSO



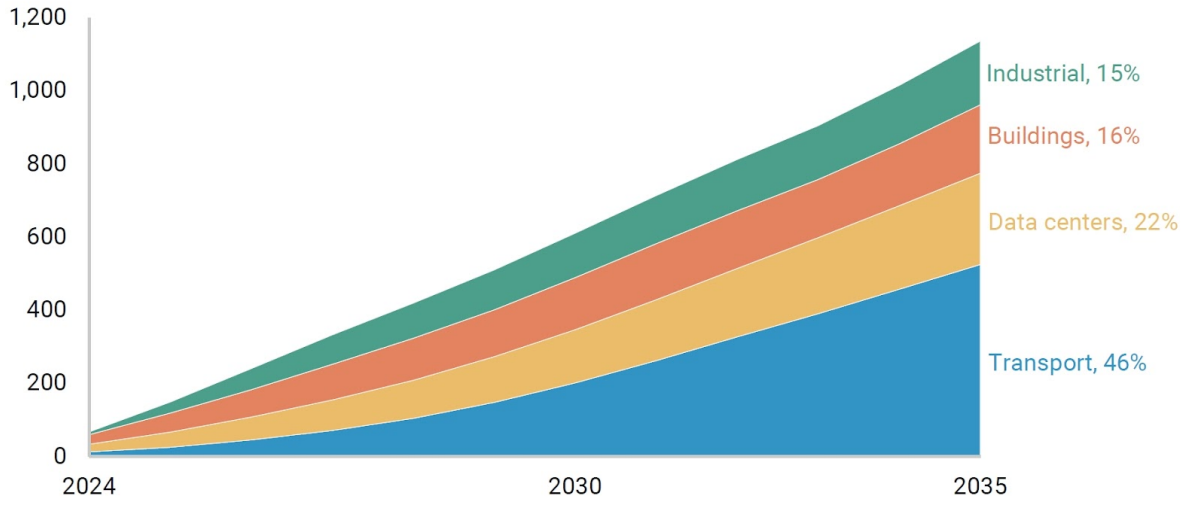
Total Ireland electricity consumption by type, CSO 2024, gigawatt hours

As reported recently in Bloomberg, rising power demand linked to data centres has likely contributed to the delayed closure of fossil-fuelled power stations. This illustrates a much deeper system-level effect of rising power demand, beyond any immediate, short-term actions taken by companies causing this rise in power demand.

A July 2024 analysis by the Rhodium group claims that nearly one fifth of projected power sector demand growth in the US will come from data centres, and that a rise in this data centre demand paired with a slowdown in clean energy growth due to development issues results in significantly higher power sector emissions (noting that a rise in transport

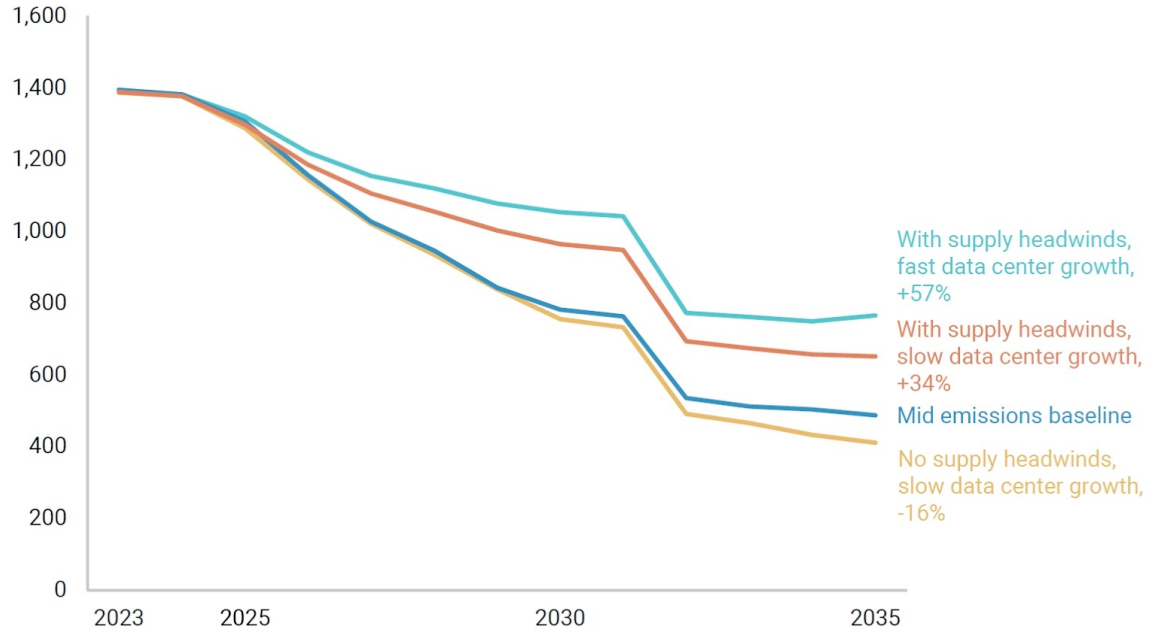
electricity demand results in a reduction in total country greenhouse gas emissions due to the electrification of combustion engine vehicles):

FIGURE 13
Sources of electricity demand growth from 2023 levels in the mid emissions scenario
Billion kilowatt hours



Source: Rhodium Group

FIGURE 16
Power sector emissions in the mid emissions baseline and with sensitivities
Million metric tons of CO_2-e, percent change from baseline



Source: Rhodium Group

Consuming and competing for clean resources

Large companies such as Microsoft, Google and Amazon promise to effectively operate their data centres on clean power resources (this is explored further in the corporate accountability section). This mostly does not involve the literal connection of clean power resources directly to data centres; rather it involves the establishment of purchasing deals where a power generator promises to match its output to demand.

In addition to the Ireland example shown earlier in this report, a recent Bloomberg article analyses the growth of data centres relative to new renewable energy supply, finding that many regions will see demand growth that far outstrips the growth rate of wind and solar. The consequence, if new renewable supply is less than new demand, is that the remaining demand is met by existing power generators, which can include fossil gas power stations. A recent report published by S&P Global claims 60% of new data centre demand will be met by additional fossil gas power stations, resulting in between 48 to 60

million tonnes of carbon dioxide equivalent in the year 2030 (nearly double current data centre emissions).

Notably, even though Google claims it is buying enough clean energy to match its total electricity consumption, the accounting rules for emissions under the GHG Protocol stipulate this must be sourced from the same region - where there is a surplus in the US, and insufficient clean power in Asia. Consequently, and confusingly, Google claims "100% renewable energy" but still reports substantial emissions for its power consumption, even when accounting for its certificate purchases.

Data centre growth in the dirtiest grid regions in the world

The 2024 "Data Centre Index", published by analytics firm DCByte, claims that the largest region in the world for newly operating and planned data centre growth rates is the Asia-Pacific (APAC) region. The group projects the Americas to remain the highest for data centre capacity in absolute terms, but APAC to experience the strongest relative growth.

Bloomberg recently explored the example of Malaysia, quoting one data centre developer who projects it becoming 'the next Virginia'. Bloomberg claims that "most of Malaysia's data centre capacity is not in use yet, but factoring in everything under construction, the amount of electricity used just by data centres would exceed the country's total renewable output in 2022".

High levels of data centre development in grid regions that rely heavily on fossil fuels and feature lower levels of planned clean energy growth (relative to Europe and the Americas), as grids in the APAC region tend to, will likely lead to the incentivisation of higher output from existing fossil fuel plants.

False solutions and fantasy tech creates further risk

Several unlikely solutions have been suggested to meet the high projected future demand. OpenAI's CEO Sam Altman is a backer of nuclear fusion startup Helion, and former Microsoft CEO Bill Gates has invested in various fusion energy projects. Altman is also a backer of Oklo, a company promising 'small modular reactors'. Despite Oklo not operating any real power stations today, they are already entering into power purchasing deals with data centre operators.

However, according to this Washington Post article, these plans are already falling through:

"[Salt Lake City] was supposed to be a "breakthrough" technology launchpad, with utility PacifiCorp declaring it would aim to replace coal infrastructure with next-generation small nuclear plants built by a company that Gates chairs. But that plan was put on the shelf when PacifiCorp announced in April that it will prolong coal burning, citing regulatory developments that make it viable"

Several studies examine how false promises of climate action deter material investments in mitigation, a phenomenon described by academics as 'mitigation deterrence'. This report contends that highly improbable 'moonshot' promises deter investment in cheap, feasible renewable energy deployment to meet new demand. Consequently, when these technologies fail to manifest, the default consequence will be more fossil fuel generation.

ML advocates have also leant on more traditional 'false solutions' such as CCS. OpenAI's former chief scientist Ilya Sutskever said:

"Here's how to solve climate change. You need a very large amount of carbon capture. You need the energy for the carbon capture. You need the technology to build it. And you need to build a lot of it"

Generative tools turbocharge climate disinformation

A recent report by Climate Action Against Disinformation highlights the very high likelihood that machine learning tools are already causing direct informational impacts to worsen fossil fuel reliance and delay climate action.

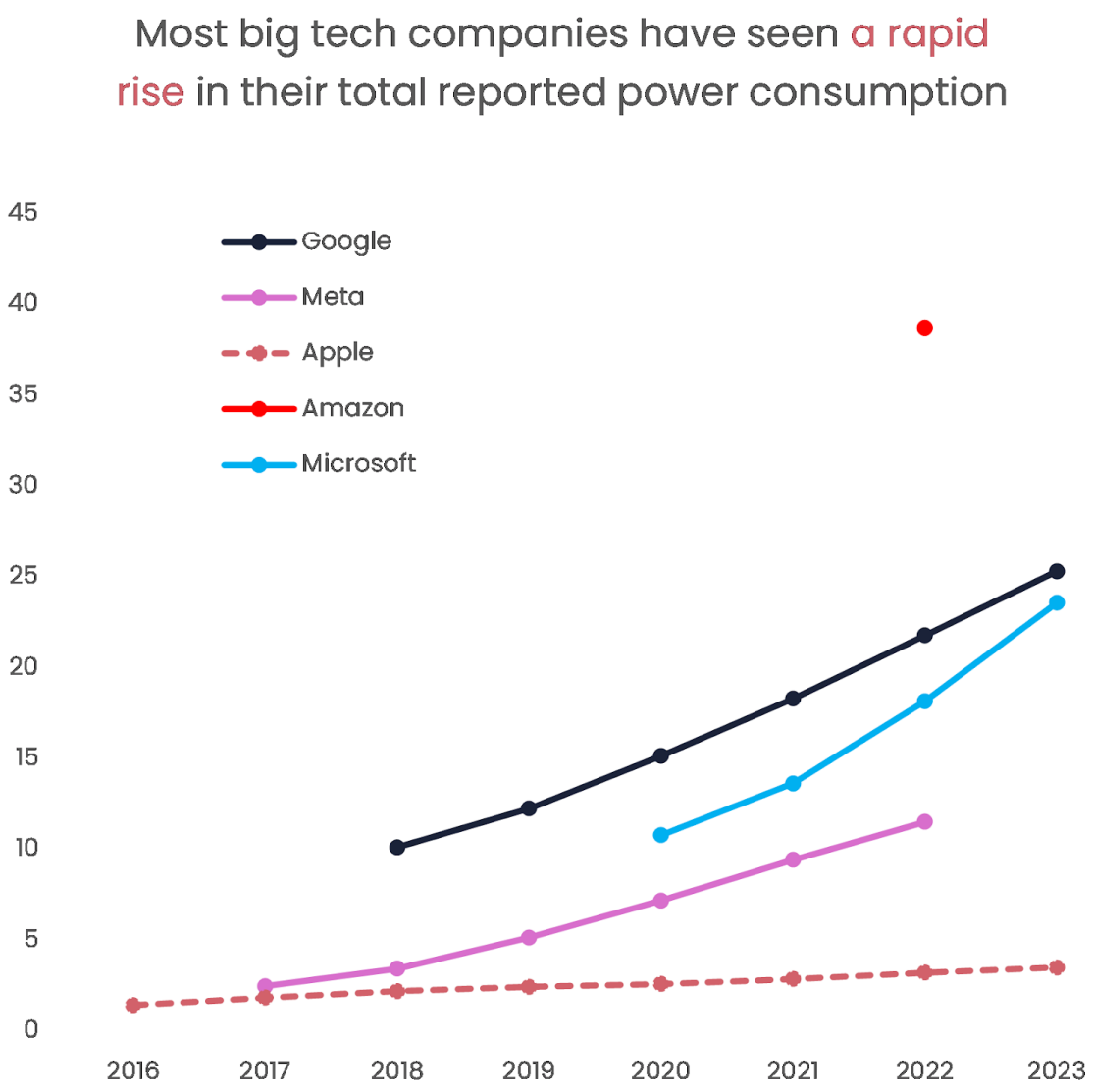
"AI models will allow climate disinformation professionals and the fossil fuel industry to build on their decades of disinformation campaigns. More recent attempts, such as falsely blaming wind power as a cause of whale deaths in New Jersey or power outages in Texas, have already been effective. AI will only continue this trend as more tailored content is produced and AI algorithms amplify it"

Recently, in Australia, an anti-wind farm group used a machine learning tool to generate a fake scientific paper to share within a Facebook group. Images have also been generated but these tend to be less focused on disinformation and more around evocative imagery that triggers emotions to bypass intellect.

The impact on corporate climate action

Overview and key issues

Large technology companies investing in machine learning have reported significant increases in their electricity consumption. They disclose power consumption (but not the proportion of this that relates to the usage of generative machine learning in particular):



Annual power consumption, terawatt hours, various company sustainability reports

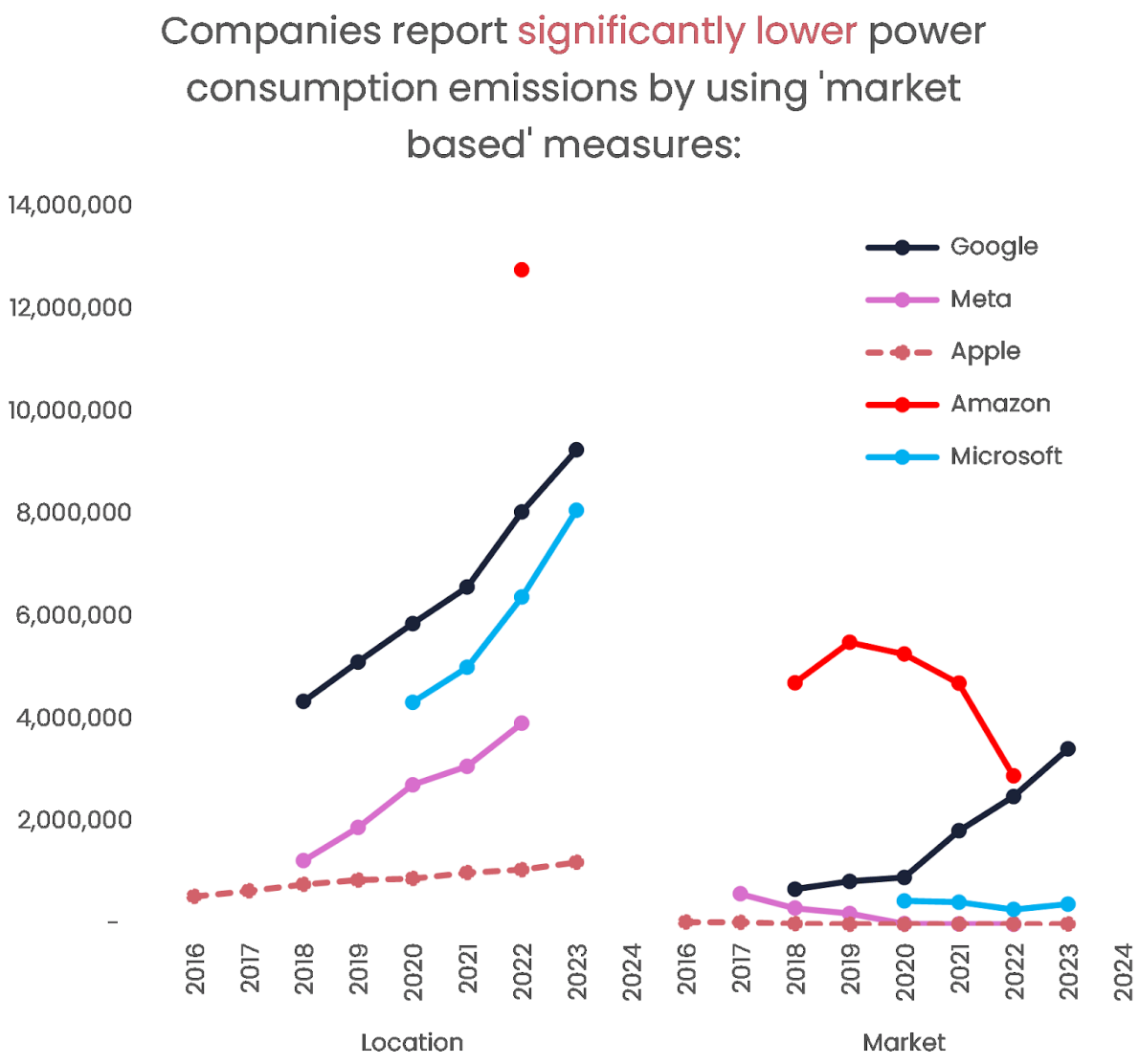
Sources: latest climate reports; Google (2024), Meta (2024), Apple (2024), Amazon CDP response (2024), Microsoft (2024)

Companies are required under the GHG Protocol emissions reporting scheme to assign an emissions value to this power consumption. The standard method for this is taking the grid emissions intensity at the time the power was consumed, known as "location based".

An alternative method - known as "market based" accounting - applies a reduction in emissions based on various types of contractual arrangements or certificates. This could involve a company buying 'renewable energy certificates' which are created when a wind

or solar farm generates one megawatt hour of electrical energy. Or they can involve a detailed contractual power supply agreement between the company and a renewable energy provider.

Though companies are technically required to report both "location based" (the grid-based method) and "market based" (reduced using contracts), they tend to interpret this guidance loosely and highlight and centralise the latter, hereby improving the story of their climate progress:



Annual scope 2 emissions, tonnes of carbon dioxide equivalent, various company sustainability reports

Sources: latest climate reports; Google (2024), Meta (2024), Apple (2024 and auditor reviews), Amazon CDP response (2024), Microsoft (2024)

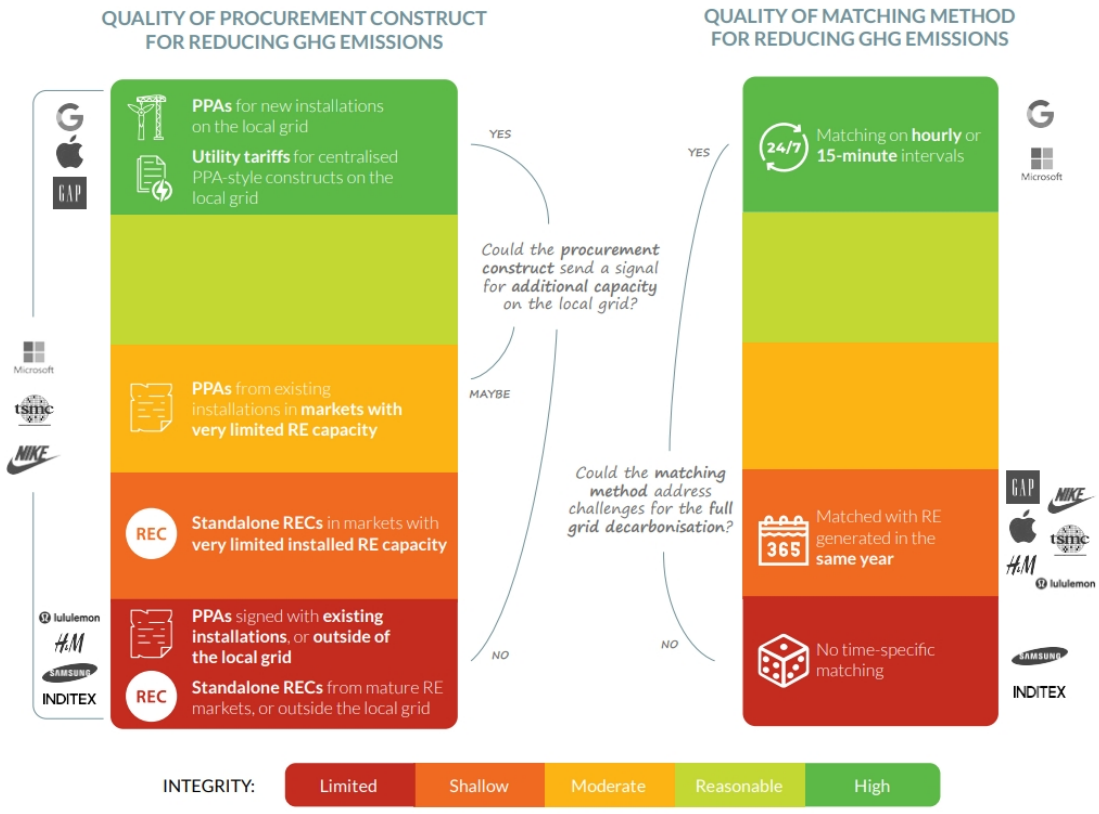
A 2024 report by the NewClimate Institute, "Navigating the nuances of corporate renewable electricity procurement: Spotlight on fashion and tech", claims corporations generate this alternative "market based" view of their emissions using contracts or certificates that may not be truly reducing emissions. It explains that "renewable energy certificates" (also known as "guarantees of origin" or GOs) may be generated many years in the past, traded through intermediaries and relate to grid regions distant from the final purchase point. Renewable procurement of this kind is significantly less likely to directly incentivise new renewable energy, claims the NewClimate Institute report.

"Power purchase agreements", or PPAs, are more likely to directly incentivise new renewable energy, but can also apply to pre-existing projects. However, in all cases, the renewable energy generation procured may have been generated at a time or place separate from when and where the demand occurred.

As an example: a data centre drawing power today, based in Norway, may source its renewables (through RECs or a PPA) from a solar farm in the US, which generated electricity yesterday but not today. This is a weak claim to emissions reductions. The same data centre based in Norway sourcing its renewables from a wind turbine in Norway generating today - at the same time and in the same place as the data centre draws power - has far higher integrity.

The NewClimate Institute's analysis claims many companies additionally fail to disclose enough information to allow third parties to scrutinise how they are formulating their green claims.

Figure S 1: Diverse landscape of renewable electricity procurement constructs and matching methods



Source: Authors' own elaboration. The categorisation of procurement constructs is for illustrative purposes only; the integrity of any given procurement construct depends on the specific conditions of that construct and may differ from the indication given by the graphic. The placement of company logos indicates the main approaches implemented by those companies according to the interpretation of the authors. See the Methodology in the Annex for further differentiation between other procurement constructs.

"The real GHG emission reduction impact of companies' renewable electricity claims is often far less than implied. Current best practices lead to modest impacts, while weaker approaches may have very little impact at all"

NewClimate Institute, 2024, Special analysis of renewable procurement

TECH AND ELECTRONICS

OWN OPERATIONS RENEWABLE ELECTRICITY STRATEGY

		TRANSPARENCY	INTEGRITY	
Google	24/7 carbon-free energy by 2030	Reasonable	Reasonable	p. 36
Apple	Maintain current 100% renewable electricity claim (annually matched)	Reasonable	Moderate	p. 34
Microsoft	24/7 carbon-free energy by 2030	Reasonable	Moderate	p. 39
tsmc	100% renewable electricity (annually matched) by 2040	Moderate	Shallow	p. 43
Samsung	100% renewable electricity (annually matched) by 2050	Moderate	Limited	p. 41

The second key issue relates to 'scope 3' emissions: where a company either purchases products or sells products that their emissions impact outside the direct operational control of that company.

A key example is, for instance, the steel and cement purchased by a company to construct a data centre, or the power consumption of a gaming console after it is sold by a company. While this is acknowledged by companies operating, building and leasing data centres, there is significantly less transparency and disclosure of these emissions. A related issue is the emissions footprint of manufacturing the chips and other hardware infrastructure required for machine learning applications.

These two key issues - power consumption emissions and 'scope 3' emissions - are explored for several companies below.

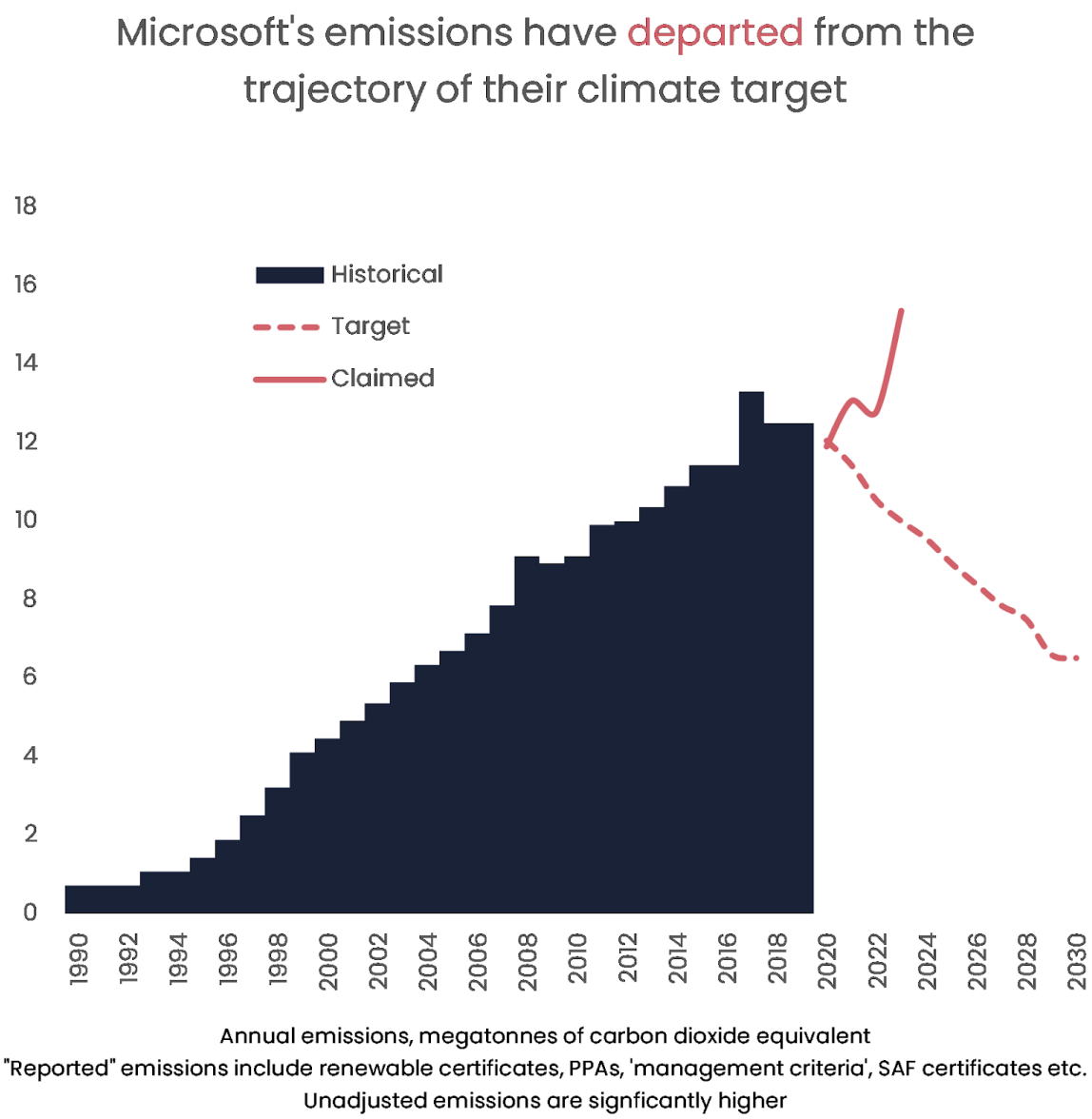
Microsoft

In the short term, machine learning has been problematic for Microsoft's green goals. Brad Smith, Microsoft's outspoken president, once called its carbon ambitions a "moonshot". In May, stretching that metaphor to a breaking point, he admitted that "the moon has moved", due to the new conditions of Microsoft seeking investment in machine learning.

It is unclear from disclosed data what proportion of Microsoft's rise in power demand - and subsequent rise in greenhouse gas emissions - relates to new machine learning processes, as opposed to the growth of pre-existing business areas.

Microsoft's latest sustainability report shows that both rising electricity consumption and rising emissions from data centre construction are contributing to a significant upwards trend in its total, unadjusted emissions. Coverage of that report highlighted the company's shift in the wrong direction.

In 2020, Microsoft published a sustainability report that laid out their plan over the coming decade. The graphic below compares Microsoft's greenhouse gas emissions and carbon removals to respective targets:

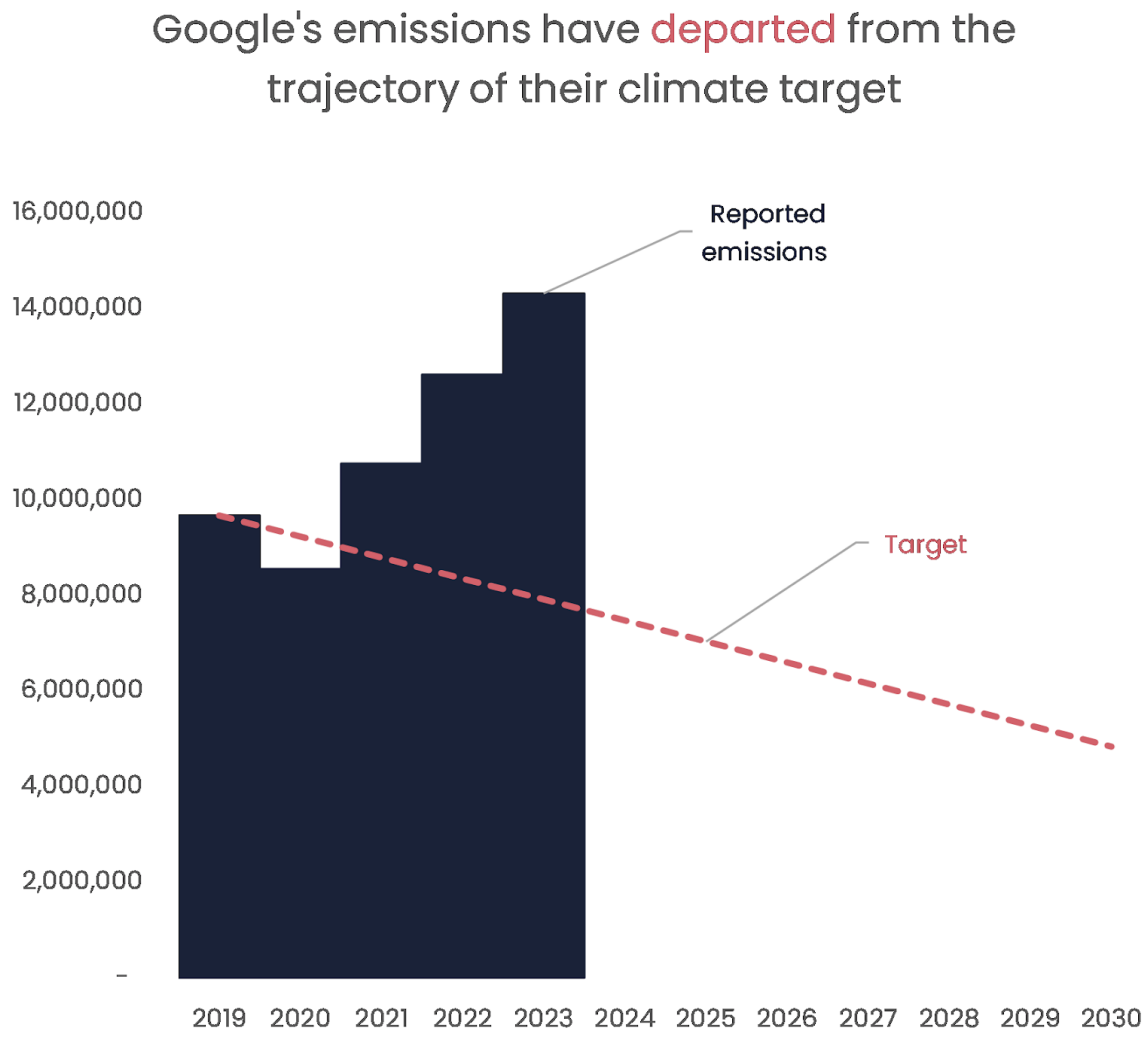


Microsoft is investing heavily in carbon removal technologies - including deals with major fossil fuel companies - and claims it will remove everything it has emitted since its inception as a company. The company has also received criticism from its former employees - including those prominent in its sustainability teams - for supplying cloud computing and AI services to oil and gas companies to help expand fossil fuel production.

Google

Google's data reporting trends also show a significant rise in power consumption, an inability to procure renewable energy contracts and certificates to fully eliminate power consumption emissions, rising intensity and a shift towards leaning on carbon removal investments to deal with emissions rather than significant reductions.

Google does not clearly report a significant rise in scope 3 emissions relating to data centre construction, is moving away from "carbon neutral" claims, and the company is pushing for closer time relationships between its clean energy procurement and its power consumption (known as '24/7 matching' or 'carbon free energy').



Annual emissions, tonnes of carbon dioxide equivalent
"Reported" emissions include renewable certificates and customised adjustments; unadjusted emissions are significantly higher

In their 2024 climate report, Google makes several relatively significant claims that their investments in "AI" are directly reducing emissions, or that they are destined to reduce emissions. For example, they claim AI-driven fuel efficient routing in Google Maps has saved approximately 2.8 megatonnes of greenhouse gases. However these systems are separate from the generative tools, such as Google's "Gemini" system, which are blamed for the rise in power consumption. They also cite AI models used for flood prediction and optimisation of traffic light timing to reduce stops (which they claim will reduce emissions at intersections by 10%).

Google repeated an unsubstantiated claim in their most recent sustainability report that "AI has the potential to help mitigate 5-10% of global greenhouse gas emissions by 2030".

Nvidia

Nvidia is a graphics processing unit manufacturer originally known for selling video cards for use in computer graphics, but more recently known as one of they key beneficiaries of the AI boom, with rapidly inflating stock price (briefly the most valuable company in the world) and a monopoly on the supply of key hardware infrastructure for machine learning.

Nvidia does disclose an estimate of the emissions impact of 'upstream' supply of the components in the chips used to manufacture its products, which comprise the bulk of the company's reported emissions. However, 'downstream' impacts - such as shipping its products and the climate impacts of their product's use - are noticeably excluded from their report.

These numbers would be extremely substantial, given the high emissions intensity. Google and Netflix do not report the emissions associated with use of their products, but Microsoft, Meta and Apple do. Nvidia has relatively low electricity consumption compared to the operators of data centres like Microsoft and Google.

Appendix: AI climate claims - key quotes

The energy efficiency and the productivity gains that we'll get from [AI]... is going to be incredible." Jensen Huang, chief executive of Nvidia, the leading AI semiconductor company, New York, September 29, 2024

"When you look at wildfire mitigation, when you look at storm impact, when you look at the things that really are going to impact every human being on this planet, that's where you see AI as a tool that literally can save lives...definitely a hero" Bobby Hollis Microsoft VP of Energy, New York, September 27, 2024

“AI can be a powerful accelerant in addressing the climate crisis.”, CEO of Microsoft Satya Nadella, Annual report 2023

“Advances in AGI research will supercharge society’s ability to tackle and manage climate change” Koray Kavukcuoglu, Google AI subsidiary DeepMind’s vice president of research, November 2021

AI has the potential to unlock insights that could help mitigate 5% to 10% of GHG emissions by 2030, Google and Boston Consulting Group, NOVEMBER 20, 2023

9 ways AI is helping tackle climate change, Feb 12, 2024, World Economic Forum link
(none of these are reducing energy use and the majority are simply documenting the effects of climate change)