How aligned are AI portfolios with net-zero pathways?

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STOXX

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As spending on artificial intelligence (AI) continues to boom, investors have turned their attention to the energy use this technology will require.

Generative AI and cryptocurrencies may more than double data centers' consumption of electricity – from 460 terawatt-hours (TWh) in 2022 to over 1,000 TWh in 2026, according to the International Energy Agency (IEA).[1] This would represent approximately 3% of global electricity demand, up from 1.7% currently.

This means the climate implications of AI-exposed portfolios have never been more relevant. As more investors allocate capital to AI-focused ETFs and funds, a better understanding of carbon footprints and emissions trajectories for firms like server-farm operators and chipmakers is required. Are they aligned with aspirations for a world free of net carbon emissions by the middle of this century?

This report seeks to answer that question. STOXX currently has five thematic indices targeting AI segments. By applying ISS ESG's Scenario Alignment assessment to the STOXX® Global Artificial Intelligence index (STOXX Global AI), we aim to determine how closely it would align with the IEA's 'Net Zero Emissions by 2050' scenario ("IEA NZ 2050")[2]. The IEA scenario aims for net zero carbon emissions by 2050 to keep global warming at 1.5°C below pre-industrial levels. We also examine the STOXX Global AI index's sectors responsible for the highest share of projected emissions.

A team of ISS ESG experts recently conducted a similar analysis[3] on the 'Magnificent 7' tech stocks in the US, which have extensive reported carbon data. They found that most of these companies are aligned with Net Zero, but warned that very "recent reported emissions have departed from expected trajectories, and progress against targets may demand more aggressive mitigation measures in the next few years."

There are two important caveats that put this analysis in context. First, many companies in the AI space – as in most industries – don't disclose carbon emissions or targets. Secondly, the sector is in flux, and rapidly evolving energy technologies could dramatically change power consumption trends. As the IEA said in its World Energy Outlook 2024 report, "a sharp rise in electricity consumption by data centers looks inevitable, but the relatively early stage of this new phase of growth and sparse data availability mean that any projections are bound to be tentative."[4]

The AI index

The STOXX Global AI index consists of 80 stocks from 14 ICB Subsectors. Its methodology selects companies with relatively large revenues from business lines associated with the following four sub-themes:

- AI applications
- Big data
- Semiconductors/chips
- Cloud computing

Index constituents range from mega-caps such as Meta Platforms, NVIDIA and Alphabet to niche players.

It's worth noting that the STOXX Global AI index's methodology does not take climate considerations into account.

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[1] IEA, 'Electricity 2024,' January 2024.

[2] The IEA's "Net Zero Emissions by 2050" (NZE) scenario aims for net-zero carbon emissions by 2050, essentially meaning the carbon emissions budget for 2050 in this scenario would be zero, requiring a complete transition to clean energy sources and significant reductions in emissions across all sectors by then. Through the modeling of 1.5°C consistent pathways, the IPCC's 2018 Special Report on 1.5°C showed that achieving this goal with a limited or no overshoot would require global CO_2 emissions to reach net-zero by 2050.

[3] ISS ESG, "Actionable Insights, Top ESG Themes in 2025," January 2025.

[4] IEA, "World Energy Outlook 2024."

Projected pathways

Like the broader market, the STOXX Global AI index falls short of the IEA NZ 2050 scenario by some distance. Figure 1 shows that cumulative target projected emissions (in green) are more than double the allowable budget under IEA NZ 2050 (in navy blue), also calculated on a cumulative basis. In our theoretical AI Index portfolio with a value of USD 100 million, there are 1.84 million tons of carbon dioxide equivalent (tCO_2e) projected vs. approximately 760,000 tCO_2e budgeted. The 'Distance to NZ' (grey bar) represents the amount of work still to be done by AI Index constituents.

The Benchmark projection (dark blue bar) assumes that issuers' emissions will follow the industry's evolution under a neutral scenario.
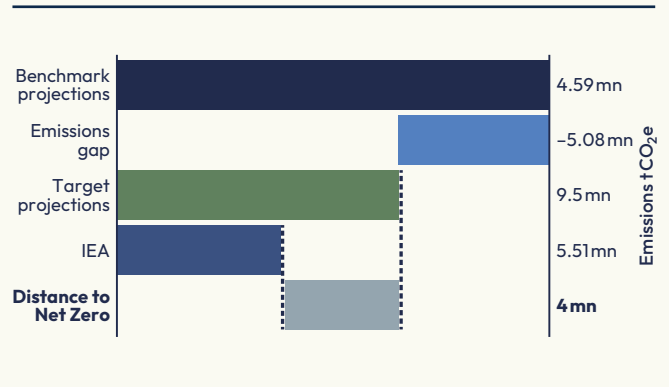
Figure 1: STOXX Global AI portfolio's cumulative projected emissions to 2050 and carbon budget (Scope 1–3 in tCO_2e)

Benchmark projections	2.03 mn
Emissions gap	–0.19 mn
Target projections	1.84 mn
IEA	0.76 mn
Distance to Net Zero	1.09 mn
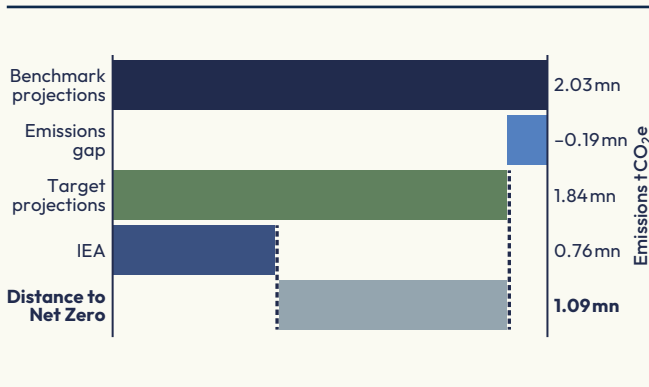
Source: ISS ESG. Data as of December 31, 2024. Corresponds to a portfolio worth USD 100 million. The chart analyzes the ambition of the portfolio target emissions projections, which include GHG reduction targets of its constituents, when compared to the selected net-zero carbon budget. Figures include total cumulative Scope 1–3 emissions between 2020 and 2050. The 'Emissions gap' bar shows the emissions that could be mitigated if companies met their disclosed targets. A positive 'Distance to Net Zero' means that the target ambition falls short of being aligned with net zero. A negative 'Distance to Net Zero' means that the portfolio can be considered as aligned, conditional on targets being fully achieved by 2050.

A similar analysis of the STOXX® World AC index shows that this broad benchmark also has a significant emissions-alignment gap, though it's closer to alignment with IEA NZ 2050 than the Global AI index (Figure 2).

Figure 2: STOXX World AC portfolio's cumulative projected emissions to 2050 and carbon budget (Scope 1–3 in tCO_2e)

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Benchmark projections	4.59 mn
Emissions gap	–5.08 mn
Target projections	9.5 mn
IEA	5.51 mn
Distance to Net Zero	4 mn

Source: ISS ESG. Data as of December 31, 2024. Corresponds to a portfolio worth USD 100 million.

Projected emissions are those that have yet to be observed by companies but are estimated through various analytical lenses. As of March 2024, ISS ESG leverages three methodologies to project emissions:

- **Historical –** Assumes that the historical rate of emissions evolution will carry on in perpetuity for the issuer. This is done for Scope 1–3 emissions separately.

- **Benchmark –** Assumes that issuers' emissions will follow the industry's evolution under a neutral scenario that is based on the current commitment of governments, and not any commitments or ambition which have yet to materialize in actual policies.

- **Target –** Assumes that issuers' emissions will reach their disclosed target.

The difference between the AI index and the broader market can also be seen in the following two charts of their 30-year emissions pathways. The grey area represents each portfolio's projected target emissions overshoot of the IEA NZ 2050 scenario. In both cases, projected emissions fall far more slowly than budgeted carbon – but the AI index makes less progress.

**Figures 3 and 4: Projected target emissions vs. net-zero carbon budget**
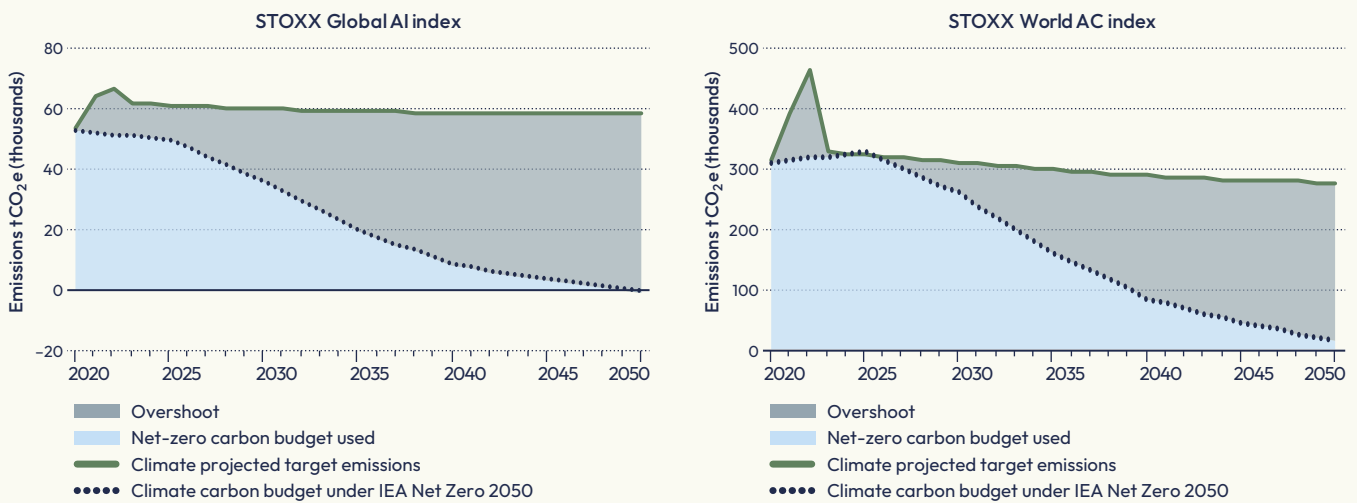
Source: ISS ESG. Includes Scope 1–3.

For clarity, alignment of projected emissions with climate scenario projections (such as those by the IEA) is a forward-looking analysis. That's inherently different to a backward-looking analysis such as those that consider emissions intensity based on historical emissions data.

For example, Figure 5 shows how, currently, a portfolio of AI-related companies has a much lower carbon intensity than a global benchmark such as the STOXX World AC – partly due to the lack of exposure to utilities, materials and energy shares.

Figure 5: Current weighted average greenhouse gas intensity
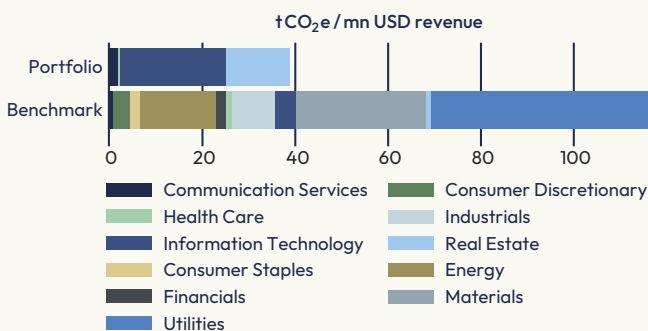
Source: ISS ESG. Portfolio is STOXX Global AI index. Benchmark is STOXX World AC index.

Current and future-oriented analyses are not unrelated, however. That's because in an ISS ESG Scenario Alignment analysis, current and historical emissions intensity

will have a bearing on the amount of future budget that an issuer will be allocated.

On a 'fair-share approach' basis, an issuer's intensity will be compared to the sector's average; companies with a lower intensity will be allocated more of the budget as a reward. Likewise, those with higher intensity than the current sector average will be allocated less budget, to reflect their need to go further than sector peers with better current emissions.

Sector analysis

So which activities are responsible for the excess projected emissions in the STOXX Global AI index? Here, we can disaggregate the carbon pathway to examine different sectors. Figure 6 shows the weight, share of projected emissions and take-up in the IEA NZ 2050 budget, as well as sector-level alignment, for the five main NACE Level 1 sectors[5] in the STOXX Global AI index.

The analysis finds that all three dominant sectors in the index by weight (Information and Communication, Manufacturing, and Real Estate) are projected to misalign with the IEA NZ 2050 scenario, based on Scope 1–3 emissions. This is true even when assuming all reported targets are accepted at face value.

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[5] The Statistical Classification of Economic Activities in the European Community, commonly referred to as NACE, is the industry standard classification system used in the European Union.

Figure 6: Sector emissions analysis (NACE Level 1) – Top 5 sectors

NACE Level 1	Weight	No. of issuers	% of index cumultative projected emissions	% of index cumultative IEA Net Zero 2050 budget	Sector-level IEA Net Zero 2050 alignment
C – Manufacturing	38.7	40	78%	85%	249%
J – Information and Communication	52.3	29	17%	9%	487%
L – Real Estate Activities	8.4	2	4%	4%	235%
Q – Human Health and Social Work Activities	0.5	1	1%	1%	315%
G – Wholesale and Retail Trade	0.1	1	0%	1%	35%

Source: ISS ESG. Includes Scope 1–3.

The data also shows that Manufacturing represents a disproportionately large share of overall projected emissions versus the Information and Communication sector. The latter accounts for less than 20% of the cumulative projected target emissions and less than 10% of the allocated carbon budget, despite accounting for over 50% of the portfolio's weighted investment.
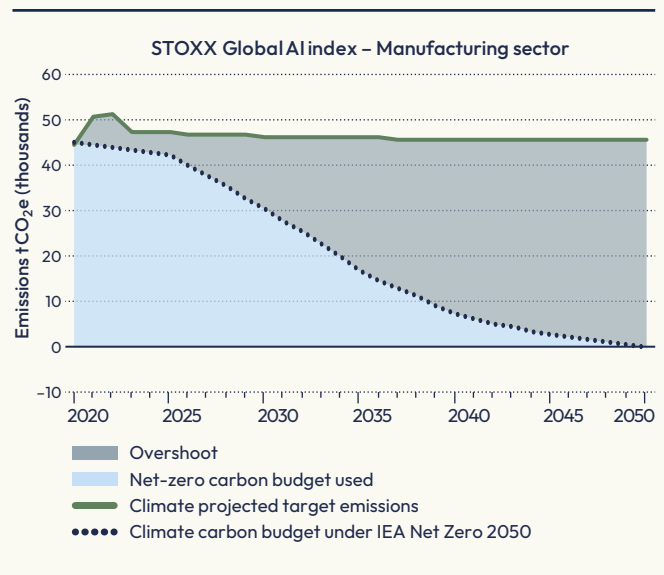
In terms of 2050 projected emissions, again based on a notional invested value of USD 100 million, the Manufacturing sector represents 78% of the STOXX Global AI index's projected target emissions by 2050.[6] This sector primarily covers semiconductor and computer production, and represents 85% of the AI index's allowable IEA NZ 2050 budget.[7] These high levels reflect the carbon 'problem' with chip-makers: according to the Boston Consulting Group, semiconductor manufacturing is responsible for as much CO_2 output as half of US households.[8]

Finally, the Manufacturing sector is misaligned with IEA NZ 2050, with projected target emissions representing nearly 250% of the allocated budget. Information and Communication is also highly misaligned with the target: projected emissions are nearly five times the allocated budget.

Manufacturing

Manufacturing is the second-largest sector in the AI index, representing almost 40% of its total weight. Within the index, aggregated Scope 1–3 emissions in the sector are up 30% over the last three years, according to ISS ESG data.

Figure 7: Projected target emissions vs. net-zero carbon budget – Manufacturing (NACE Level 1)

STOXX Global AI index – Manufacturing sector

Legend:
- Overshoot
- Net-zero carbon budget used
- Climate projected target emissions
- Climate carbon budget under IEA Net Zero 2050

Source: ISS ESG. Includes Scope 1–3.

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[6] Projected 'target' emissions accommodate reported targets at face value across the timeline.

[7] This is the allowable budget for a portfolio's projected emissions in order to be aligned with net-zero.

[8] BCG, "For Chip Makers, the Decarbonization Challenge Lies Upstream," May 16, 2023.

Information and Communication

Information and Communication (NACE Level 1), which primarily covers data hosting and processing services, and takes up almost 50% of the total weight in the STOXX Global AI index, is less relevant in terms of future emissions. Scope 1–3 aggregated emissions for the sector have tripled over the last three years.

Figure 8: Projected target emissions vs. net-zero carbon budget – Information and Communication (NACE Level 1)

STOXX Global AI index – Information and Communication sector
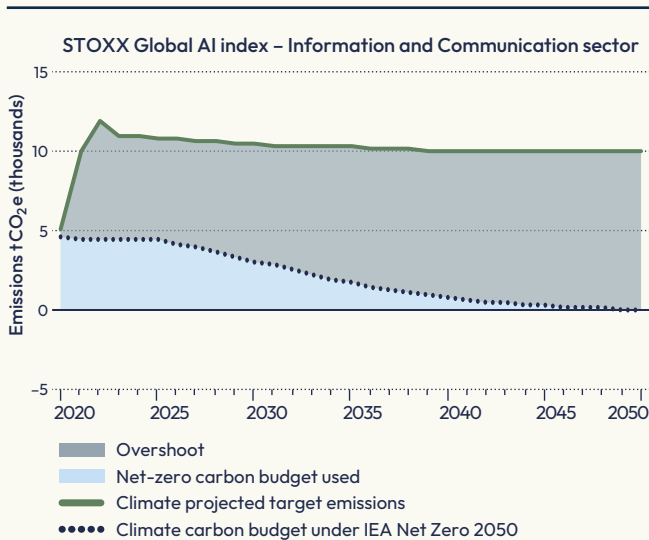
Source: ISS ESG. Includes Scope 1–3.

Subsectors

When digging deeper into the Manufacturing (NACE Level 1) sector (Figure 9), we find that Manufacture of Computers and Peripheral Equipment (NACE 26.20) on a weighted basis represents the largest subsector in terms of projected Scope 1–3 emissions. Within Information and Communication (NACE Level 1), Data Processing, Hosting and Related Activities (NACE 63.11) represents approximately 13% of projected target emissions.

Figure 9: Carbon footprint NACE Level 4 – Top 5 subsectors

NACE Level 4	Share of cumultative projected target emissions	Share of cumultative IEA Net Zero 2050 carbon budget
26.20 – Manufacture of Computers and Peripheral Equipment	40.1%	61.4%
26.11 – Manufacture of Electronic Products	34.1%	21.7%
63.11 – Data Processing, Hosting and Related Activities	12.9%	4.8%
58.29 – Other Software Publishing	3.8%	3.5%
68.20 – Renting and Operating of Own or Leased Real Estate	3.8%	4.0%

Source: ISS ESG.

Among the three main subsectors (NACE Level 4) in terms of contribution to projected emissions:

• Manufacture of Computers and Peripheral Equipment has seen emissions fall by about 30% over the last three years. The subsector takes up 160% of its IEA NZ 2050 budget.

• Emissions for Manufacture of Electronic Products (includes semiconductor chips) (NACE 26.11) tripled over the last three years. The subsector is expected to emit the equivalent of 400% of its total cumulative budget by 2050.

• Data Processing, Hosting and Related Activities saw emissions more than triple over the last three years. It is misaligned by nearly 700% of its total cumulative budget by 2050.

Effect of data modeling

As mentioned, the lack of full reporting from all companies means that a relatively high level of modeled data for carbon emissions must be used. At the Scope 1–2 level, 68% of the STOXX Global AI index's current emissions reporting is based on reported data, and the remainder is modeled projections. At the Scope 3

level (emissions that occur in the "value chain," or indirect operations such as a company's suppliers), even more modeling is required: only 58% of issuers (as measured by weight) provide reported data. This is important because Scope 3 represents approximately 90% of both 2020 emissions and 2050 projected emissions in the Global AI index.

Ways things could improve

There are possibilities that emissions could improve in coming years, underpinned by continued efficiency gains at both the hardware and software level.[9] As an example, the IEA estimates that modern AI-related computer chips use 99% less power to perform the same calculations than processors from 2008 did.[10]

Further investigation

Deeper scrutiny of AI companies' different economic activities would help paint a clearer picture of their carbon footprint pathway. This includes disaggregating within Scope 1–3, taking a closer look into the extent of reported targets and modeled data, and implementing further disaggregation at the sector and issuer levels.

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[9] IEA, "What the data centre and AI boom could mean for the energy sector," October 2024.

[10] IEA, "What the data centre and AI boom could mean for the energy sector," October 2024.

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