S&P Global Sustainable1 Investor Client Council H1 2025

- **Session 1: The Multidimensional Energy Transition: Balancing Risks and Opportunities**
- **Session 2: Navigating the Energy Surge: AI, Datacenters and the Path to Net-Zero**

Council Meeting Agenda

13.30 - 14.00: Registration & Networking

14.00 – 14.05: Welcoming Remarks

14.05 – 14.15: Guidelines & Introductions

14.15 – 15.30: Topic 1 - The Multidimensional Energy Transition: Balancing Risks and Opportunities

15.30 – 15.45: Break

15.45 – 16.55: Topic 2 - Navigating the Energy Surge: AI, Datacenters and the Path to Net-Zero

16.55 – 17.00: Concluding Remarks

17.00 – 18.00: Networking Reception

Permitted	Not Permitted
Discuss public or non-commercial matters: • **market trends;** • **perspectives on ESG regulation;** • **industry studies** • **best practices** • **high-level product development evolution thought processes and concepts** **S&P Product launches or expansions, including standardized models and analytics, to the extent presented by S&P Global Sustainable in connection with the Investor Council**	Discuss **non-public**: Pricing/commercial policy Marketing efforts Specific or granular cost information Particular customers or vendors No discussion on specificities of scores or methodologies except to the extent already publicly disclosed
Set an agenda for each meeting and review with Legal if any questions.	Discuss specifics of how market trends affect each company or examples of customers Discuss product pipeline ideas, methodology changes, specific business strategies, specific intended developments, trade secrets, or know-how
Raise any concerns about discussion topics at a meeting. If discussions continue, leave the meeting and ensure that your departure is recorded in writing. Report any concerns to Legal.	Allow any departures or deviations from the stated agenda. Allow analytical employees to attend without appropriate legal and compliance review and approval
Remember all written communications (including emails and notebooks) may be disclosable to a regulatory or legal authority (including without limitation a competition authority). **Ensure the legitimate professional objective behind discussions is clear in any written communications.**	Apply different standards of behaviour to information sharing in a less formal or social setting.
Ensure discussions are accurately recorded.	Use language which could be misinterpreted. Use language that is factually incorrect

The Multidimensional Energy Transition: Balancing Risks and Opportunities

Cleantech[1] and T&D investment primed to overtake traditional fuels in OECD and China as other countries prioritize access and affordability

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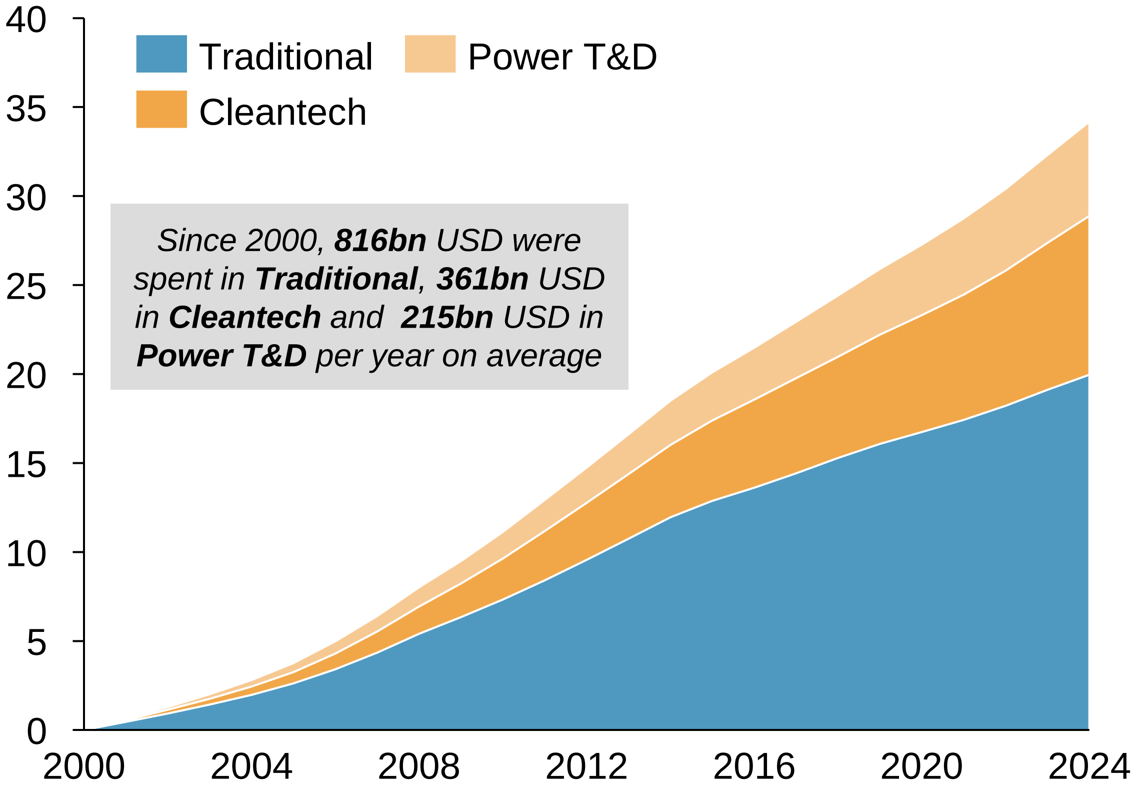
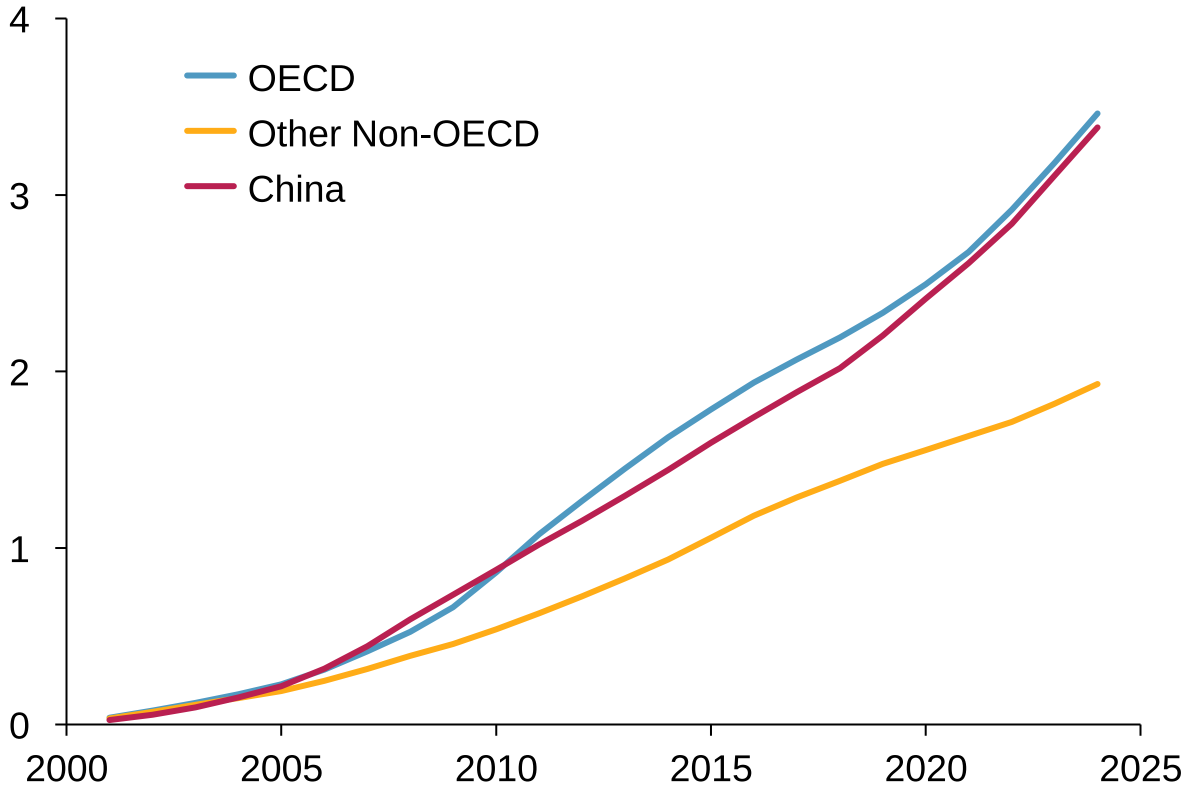
Global Cumulative Capex by Investment Type
Trillions USD



Annual Cleantech CAPEX Investment
Real 2022 Trillions USD



1. Cleantech includes power capacity from various sources, including nuclear, solar, wind, hydro, battery storage, geothermal, hydrogen generation, as well as carbon capture and storage, and direct air capture
Notes: Electrons include Hydro, Nuclear and Renewables. Molecules include Oil, Gas, Coal, Modern Biomass and Others.
Source: S&P Global Commodity Insights.

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Emerging Market Developing Economies' Access to Capital

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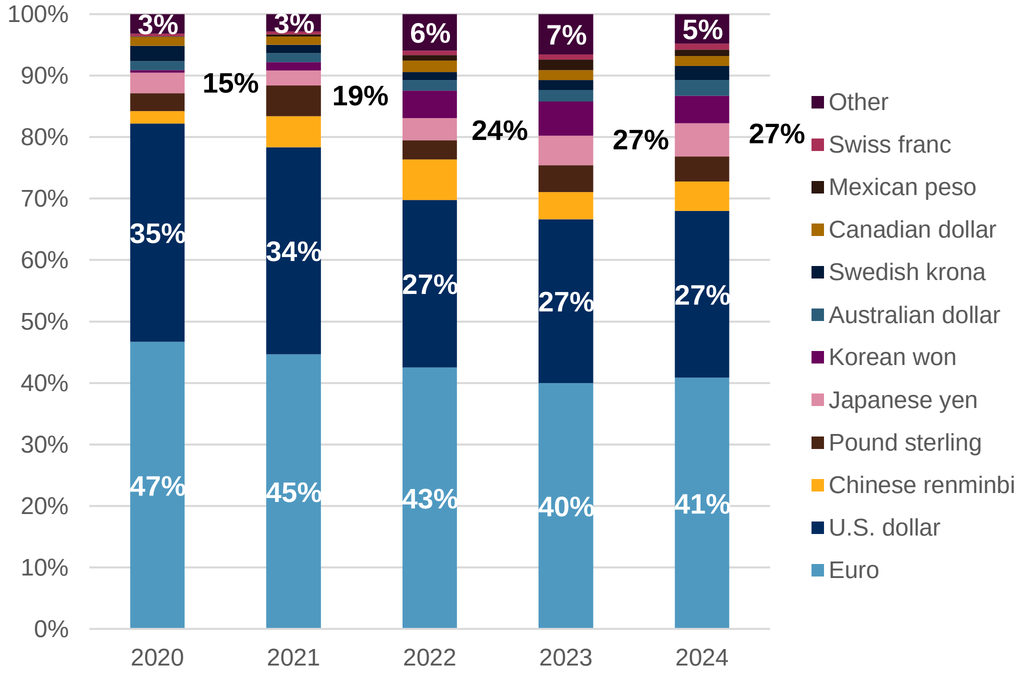
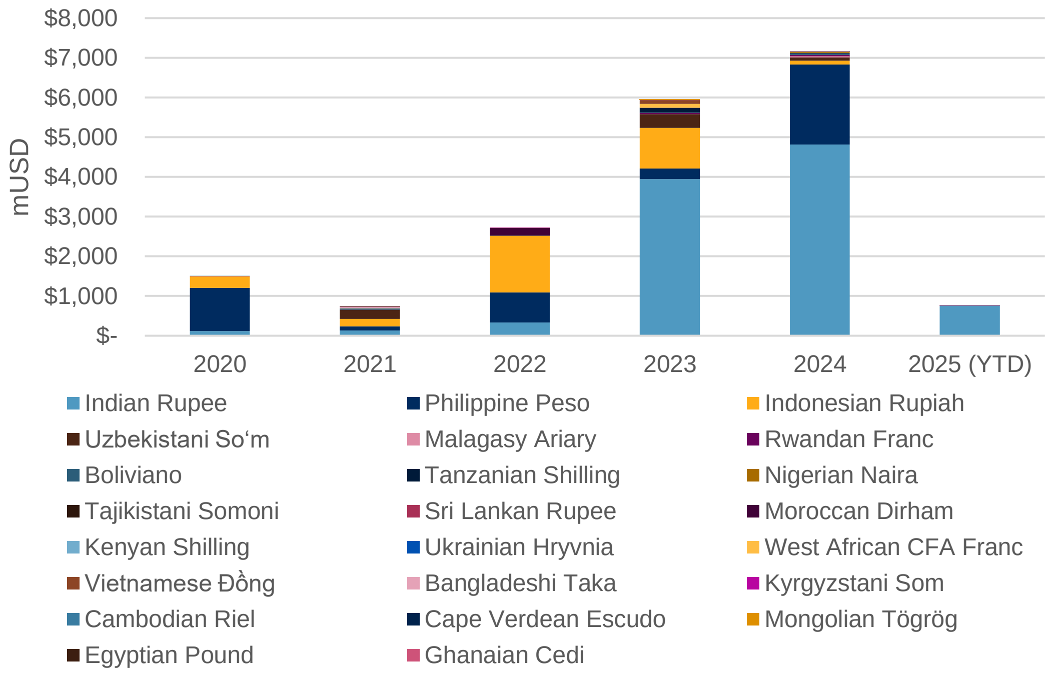
What work is needed to help EMDEs access capital for the energy transition?

Higher income countries' currencies still dominate sustainable bond markets



Source: Environmental Finance, S&P Ratings

But lower income countries' local currency issuance is growing

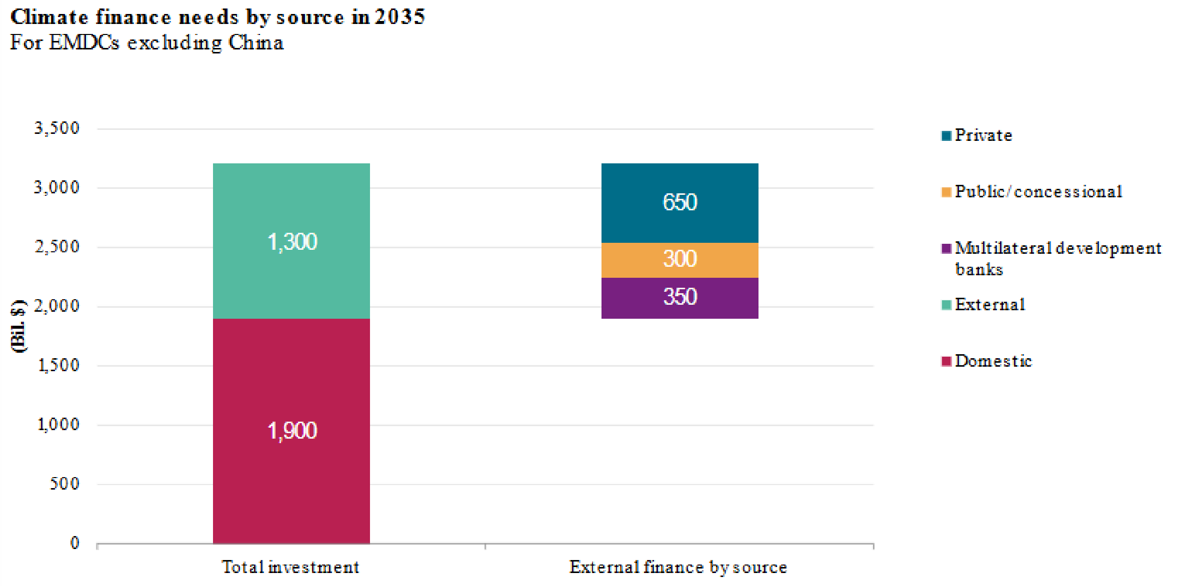


Source: Environmental Finance, S&P Ratings

COP29's Climate finance goal leaves more work for the private sector

Bridging the gap by turning investment needs into investment opportunities

Climate Finance Needs by Source in 2035



Data compiled Nov. 26, 2024. Split of external (non-domestic) finance based on splits quoted for 2030 in HLEG report.
EMDCs--Emerging markets and developing countries. Source--HLEG (High Level Expert Group on Climate Finance); S&P Global Ratings.

Source: S&P Ratings Sustainability Insights: Five Takeaways From COP29: Finance Remains A Thorny Issue | S&P Global Ratings (spglobal.com)

- Estimated $3.2 trillion per annum needed by 2035 for EMDCs excluding China with $1.3 trillion coming from outside domestic capital markets.
- The agreed $300 billion per annum from developed countries & MDBs is insufficient compared to previously estimated sourcing, hence more is left for the private sector to pick up.
- Energy transition in EMDCs requires rapidly scaling energy capacity (e.g., Vietnam needs to double its capacity by 2030 and increase by 6-fold by 2050 from 2022 levels to maintain its high GDP growth rates, currently 6-7% annually).
- De-risking projects and matching assets to liabilities (in size, currency, investment mandates etc.) remain challenges to scale.

Innovation, experience and new technologies continue to drive down the cost of clean energy technologies

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Historic capex	Solar PV	Energy storage	Onshore wind	Offshore wind	Electrolysis[4]	Carbon capture and storage
Capex change 2010-20	-80%	-80%	-35%	-30%	N/A	N/A
Capex change 2020-24	-35%	-25%[1]	-10%	-10%	+91%[2]	+7 – +15%[3]

Capex drivers through 2030

	Solar PV	Energy storage	Onshore wind	Offshore wind	Electrolysis	Carbon capture and storage
Downward drivers	Mass production and oversupply; cell technology transition (n-type, TOPCon); higher module efficiency	Mass production and oversupply); higher energy density; non-lithium technology gains traction	Modularization, model rationalization, growing share of Chinese turbine suppliers, *higher capacity factors*	Larger turbines; modularity; *higher capacity factors*	Increasing project size; standardisation; *improved efficiency*	CCUS Hubs; technological innovation; *process optimisation*
Upward drivers	Soft costs (labour and permitting); local manufacturing; tariffs	Soft costs; automotive demand; material bottlenecks; tariffs	Growing development costs access to land, increasing local content requirements	Soft costs; finance costs; infrastructure (ports); tariffs; *wake effects*	Finance; project complexity; material bottlenecks; alternative chemistries	Finance; project complexity; permitting delays
Expected change 2025-30	-25%	-20%	-10%	+15%	-14%	+2 – +22%

Data compiled: January 2025

Capex figures reflect global weighted averages. Elements in *Italics refer to factors that impact levelized cost.*

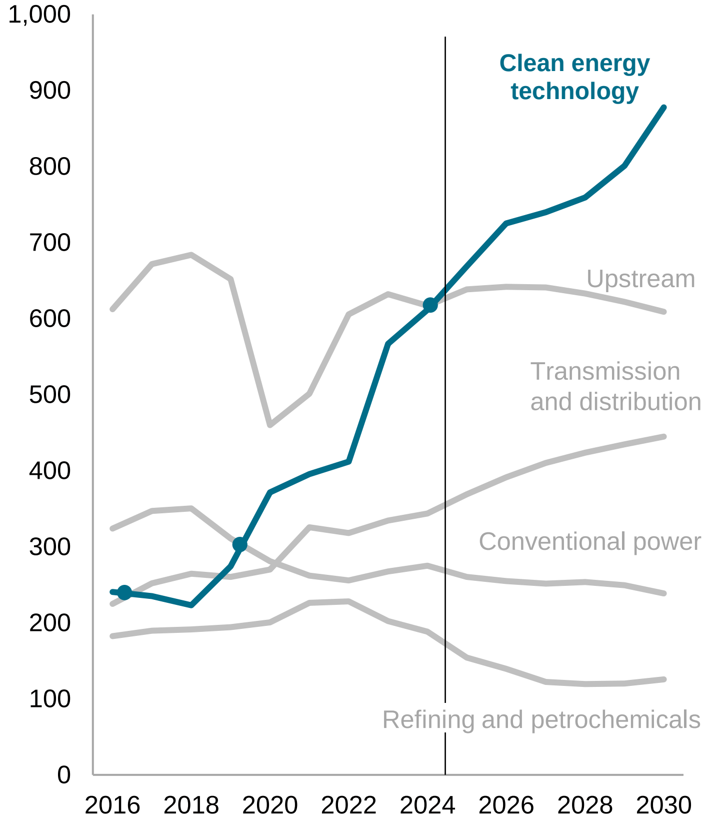
Notes: [1]For a 4-hour energy storage system (LFP module). This number does not reflect the increase in average durations for energy storage systems globally. [2]Electrolysis cost reflect alkaline electrolysis outside Mainland China. Size increases from 10MW in 2020 to 100MW with 20MW modules in 2023 and 500MW with 100MW modules by 2030. [3]Capex change include a range of different CCS configurations for different sectors, the reduction in capex was driven by optimization of capture technology for low CO_2 concentration applications, on the other hand sectors with high CO_2 concentration applications like natural gas processing and ethanol saw an increase of capex of 40%.

Clean technology—led by solar PV— is edging out upstream spend on capex.

Nearly 5 TW of additional cleantech capacity will come online by 2030

Clean energy tech spend surges ahead

Energy supply-side spending, US$ billion (real 2023)

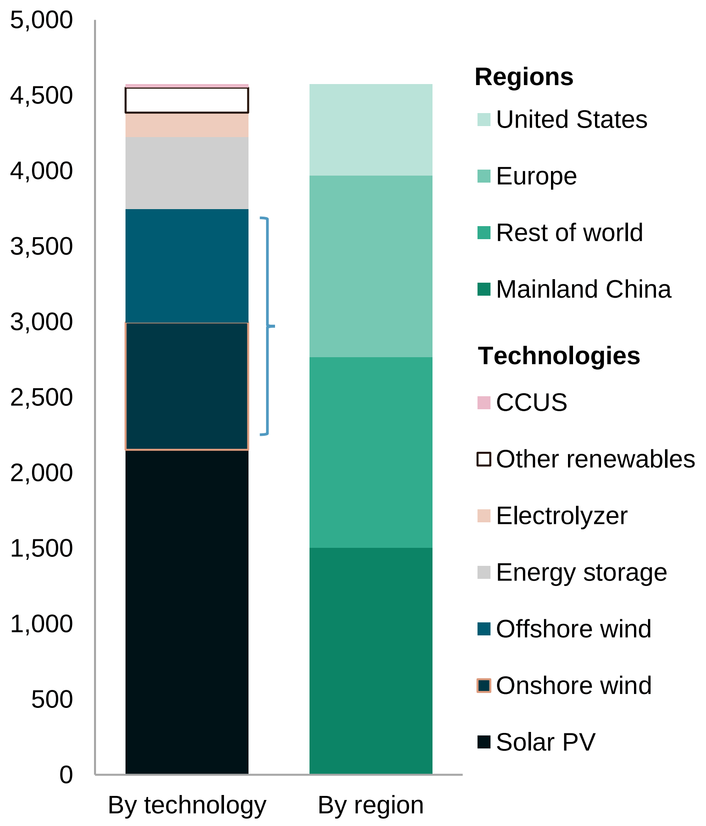


Data as of Nov, 27. 2024.

Source: S&P Global Commodity Insights.

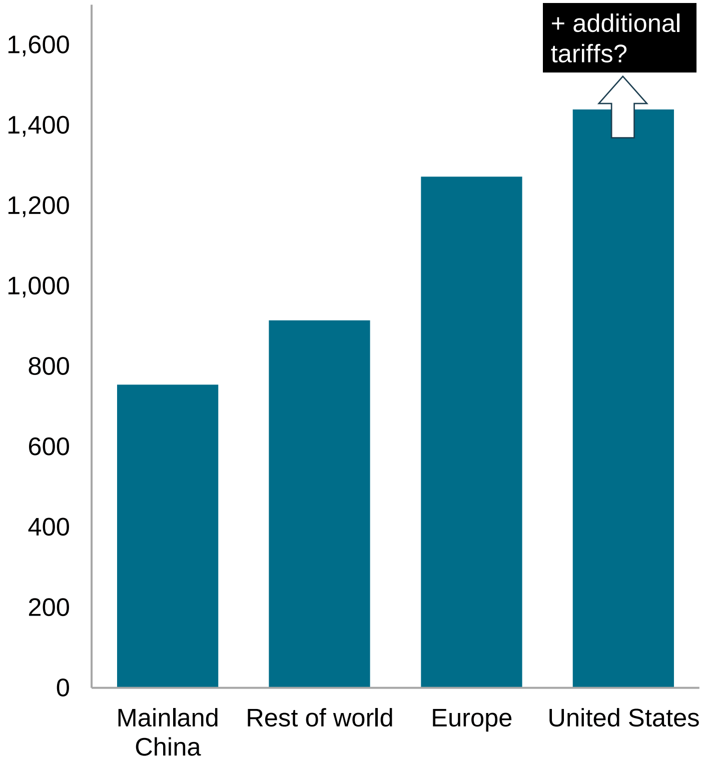
China and solar lead the dance

Cleantech spending, US$ billion (real 2023), 2025–30



More spark for your spend

Average cleantech cost, US$ million/GW, 2025–30



Includes investment in non-hydro renewable power generation, energy storage and electrolysis. CCUS spending is not included.

Cost reductions and technology advances have made renewables ‘competitive’ with fossil fuel power, though intermittency will require huge transmission and battery storage investment

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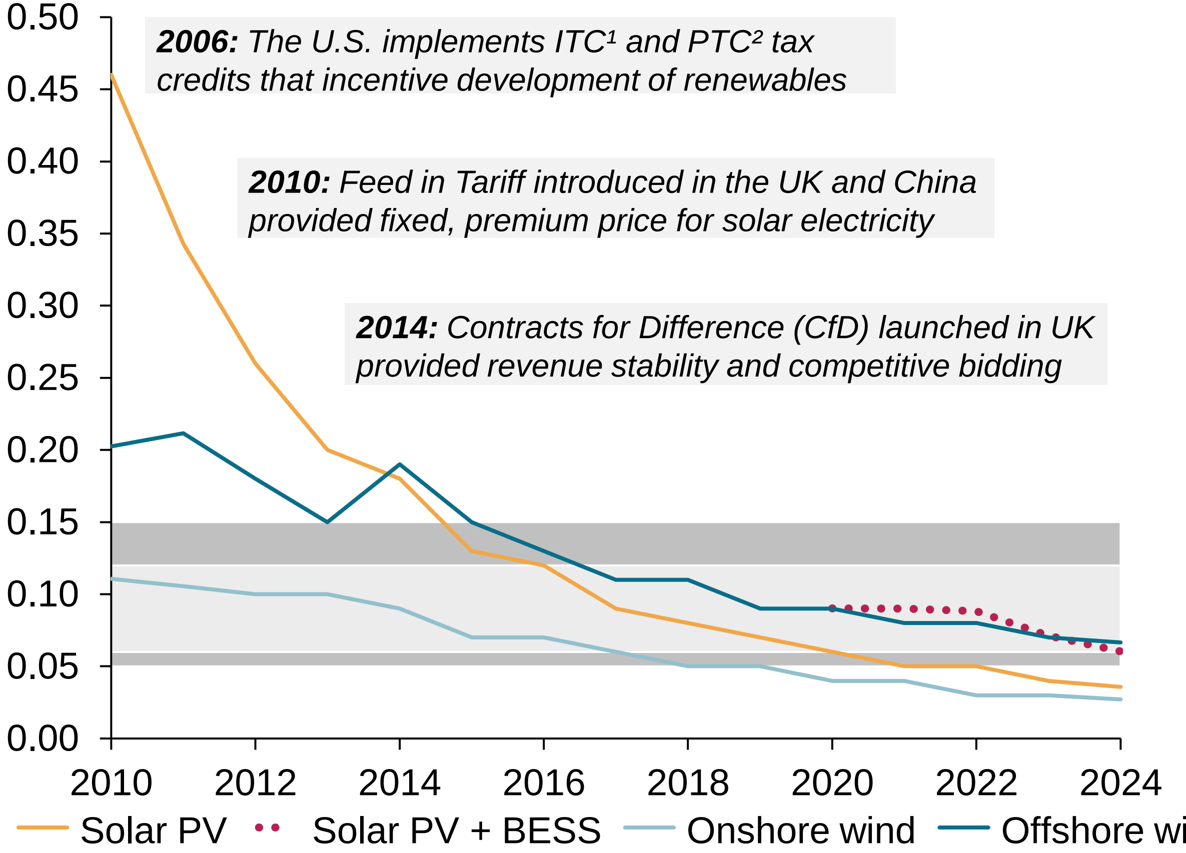
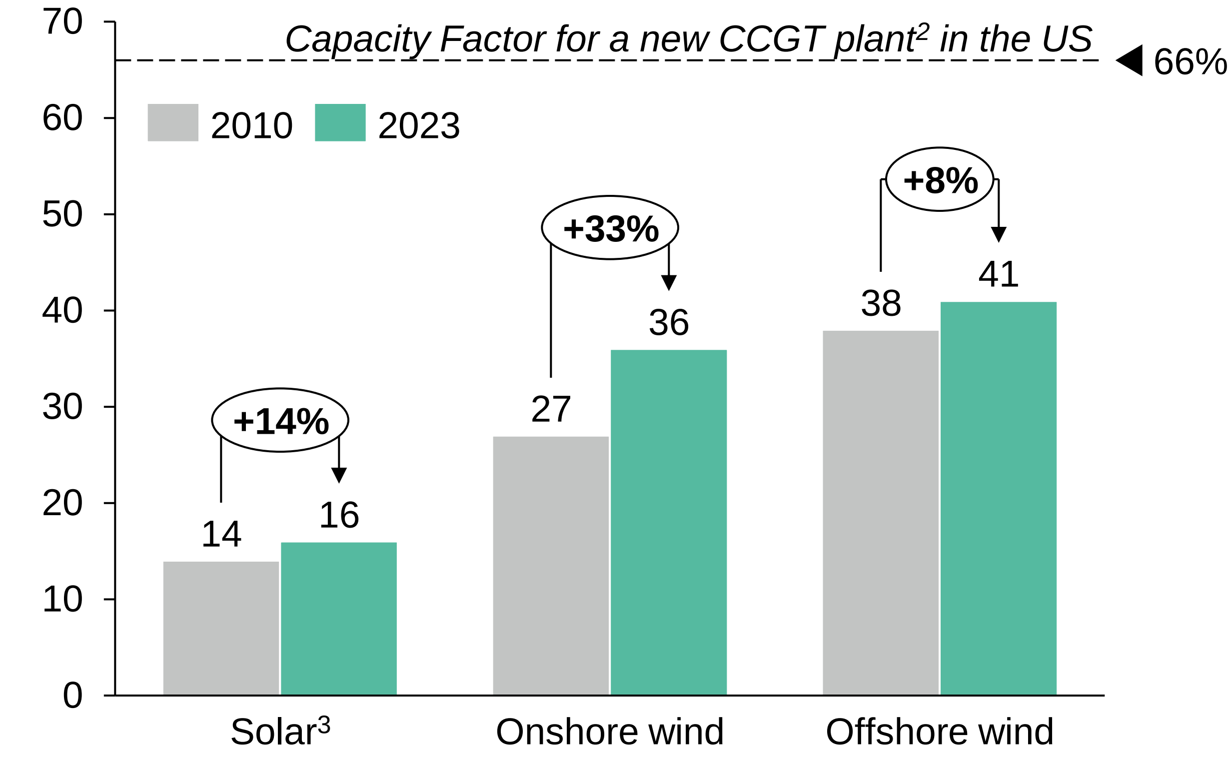
Global Weighted Average Renewable LCOE vs. CCGT and Coal, 2010-2024 2022 $/kilowatt-hour (kWh)



Global Weighted Average Renewable Energy Capacity Factor, 2010-2024, %



Data compiled September 2024

1. ITC: Investment Tax Credit. 2. PTC: Production Tax Credit

2. Combined Cycle Gas Turbine (CCGT) plant Capacity Factor as per US Energy Information Administration (EIA) - https://www.eia.gov/todayinenergy/detail.php?id=61444

LCOE – Levelized Cost of Electricity, which represents the average net present total cost of operation for a power plant over its operation lifetime; BESS – Battery Energy Storage System; CCGT – Combined Cycle Gas Turbine

LCOE data shown represents weighted averages from 23,372 renewable energy projects (2706 GW) across different global regions with China, US and India contributing 44%, 11% and 7% respectively.

These calculations are based on country and technology specific project costs as well as weighted average cost of capital assumptions collated in the IRENA Renewable Cost Database 2023

3. Capacity factor for a Solar PV+BESS plant is typically 1%-5% higher than that of standalone solar PV plant alone depending on energy storage duration, project location and other project specific characteristics

Sources: S&P Global Commodity Insights, IRENA.

The result is a global divide in terms of the pace and trajectory of the ongoing transition

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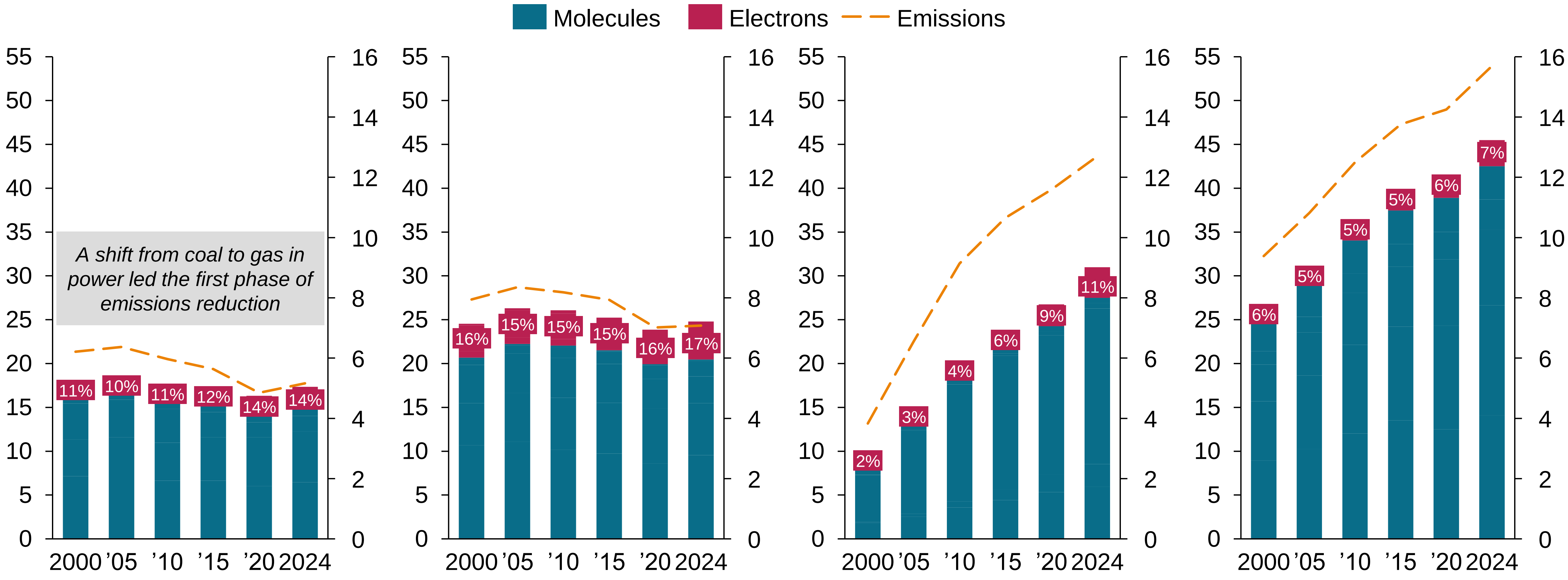
US
Primary Energy Demand
Bboe (left) and BtCO2e (right)

OECD (Ex US)
Primary Energy Demand
Bboe (left) and BtCO2e (right)

China
Primary Energy Demand
Bboe (left) and BtCO2e (right)

Non-OECD (ex China)
Primary Energy Demand
Bboe (left) and BtCO2e (right)



Bboe: Billion Barrels of Oil Equivalent; BtCO2e: Billion Tons of Carbon Dioxide Equivalent.
Source: S&P Global Commodity Insights; IEA.

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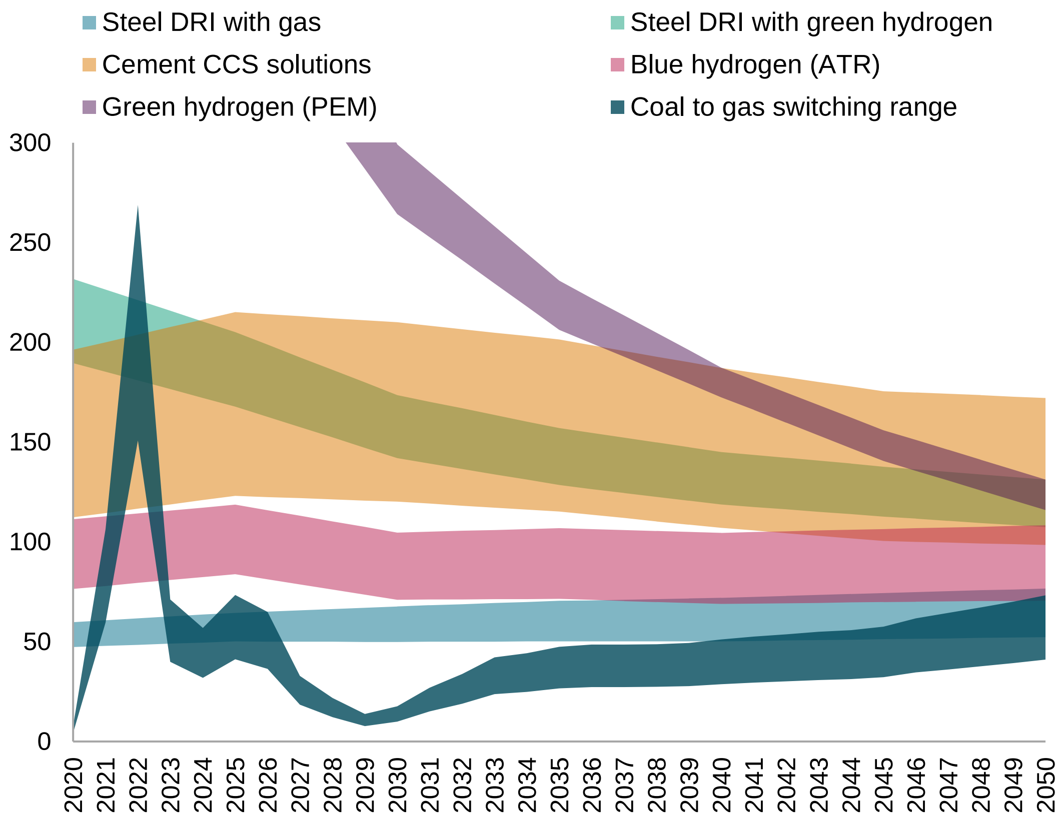
Beyond power, high carbon prices are needed to trigger industrial sector abatement: EU examples

Abatement costs in steel, cement and hydrogen are far higher than options in the power sector

Abatement costs in steel, cement and hydrogen production (real 2023 €/tCO_2e)



- Power sector has been leading the charge in decarbonization in the EU, driven by significant renewable energy additions and coal phaseouts across Europe.
- Emissions abatement in industrial sectors (such as production of cement, steel, hydrogen) would need to ramp up to ensure continue reductions through 2040 and 2050. While the abatement costs drop over time given expected improvement in technology and learning-by-doing, they are still significantly higher than those in power (i.e. coal to gas switching). Most industrial abatement options fall within the €100-€200/t range.
- Should the carbon market be the primary catalyst of investment in industrial decarbonization, we would require a carbon market price far exceeding current and historical levels.

Data compiled September 2024.
DRI = direct reduced iron; PEM = proton exchange membrane; ATR = autothermal reforming; tCO_2e = metric tons of CO_2 equivalent.
Coal-to-gas switching range is computed with coal efficiencies ranging from 36% to 45% higher heating value (HHV) and gas efficiencies ranging from 45% to 54% HHV.
Source: S&P Global Commodity Insights.

Our long-term outlooks show a wide divergence in energy and climate outcomes

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S&P Global Commodity Insights Energy and Climate Scenarios: Key metrics

	Global GDP (CAGR 2023–50)	**2050 TPED** (change vs 2023)	**2050 Fossil fuel % of TPED**	**GHG emissions** (change vs. 2023)	**Global temperature** (change by 2100)
Inflections (base case)	2.5%	+13%	59%	-24%	2.4°C
Green Rules	2.6%	-3%	41%	-56%	1.8°C
Discord	2.0%	+10%	68%	-9%	3.1°C

Data compiled July 2024.

CAGR = compound annual growth rate; TPED = total primary energy demand.

Commodity Insights considers a country or region to have effectively reached “net-zero” emissions once GHG emissions have fallen to less than 1% of their 2023 level and remain at that level over the course of a year.

Source: S&P Global Commodity Insights.

The size of the prize is tremendous as cleantech and T&D lead the way, but investments in traditional energies continue to be significant

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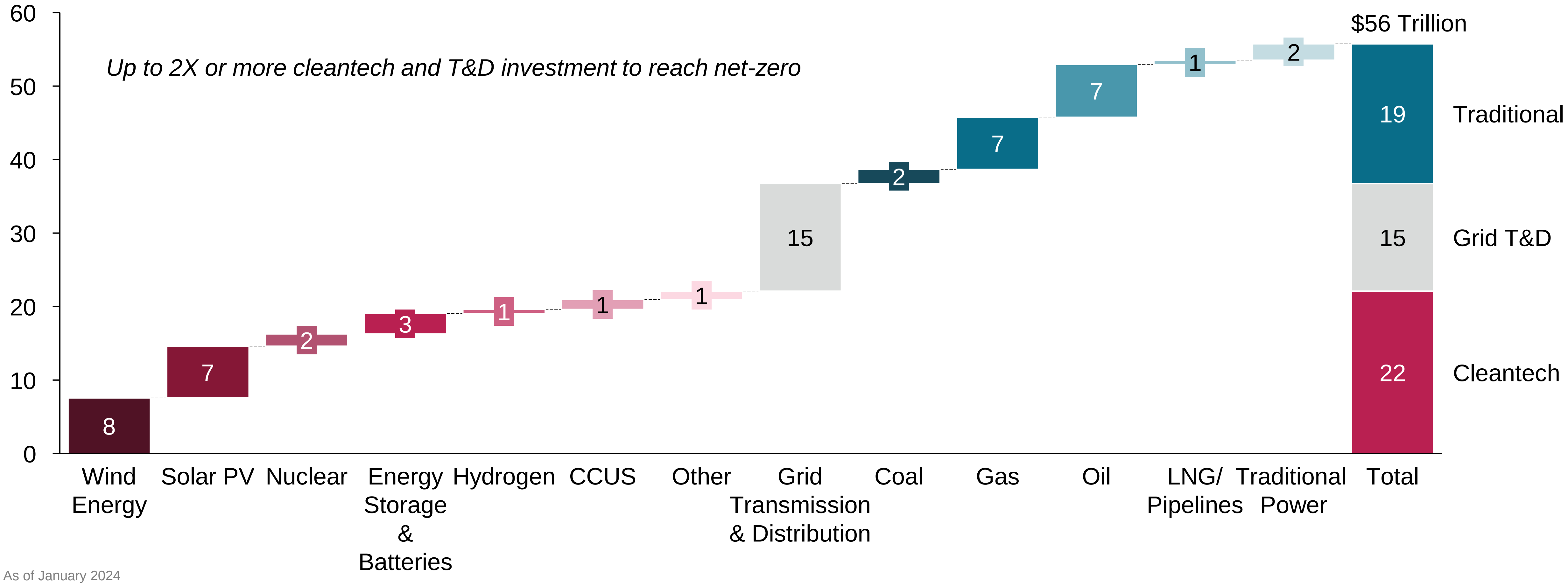
Key Technology Cumulative Investment Required as per Inflections (2023-2050)
Real 2022 US$ Trillion



As of January 2024
Source: S&P Global Commodity Insights..

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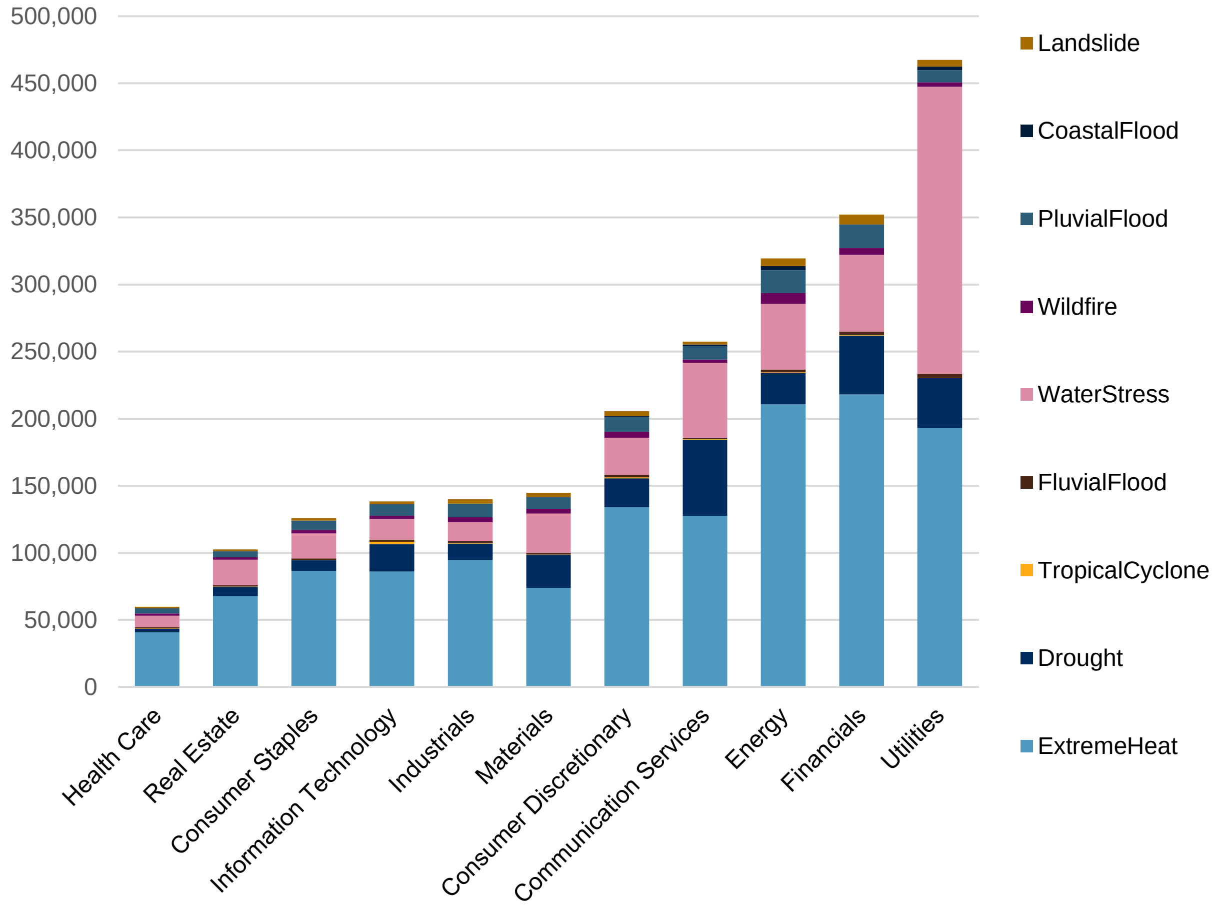
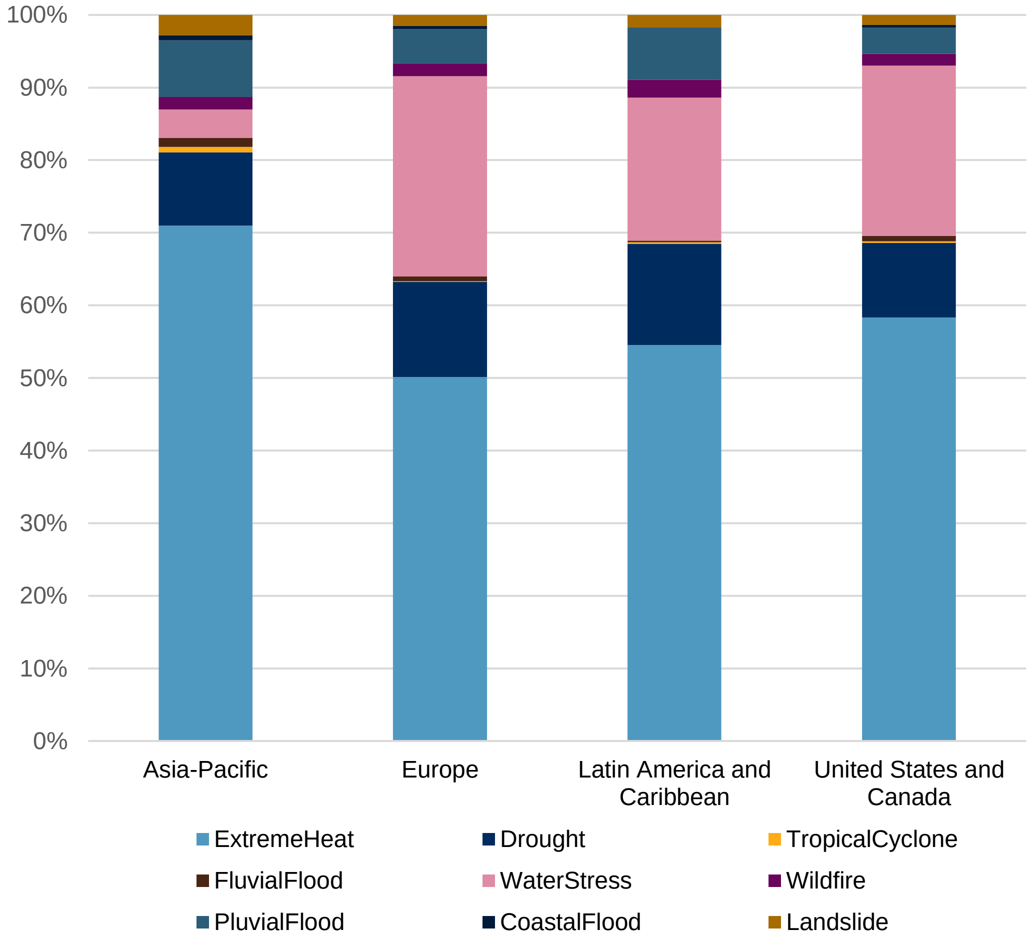
Extreme heat and water stress drive largest financial impacts across sectors and geographies under a medium-high scenario

Total Annual Cost of Climate Hazard Exposure in 2050s - SSP2-4.5 ($M)

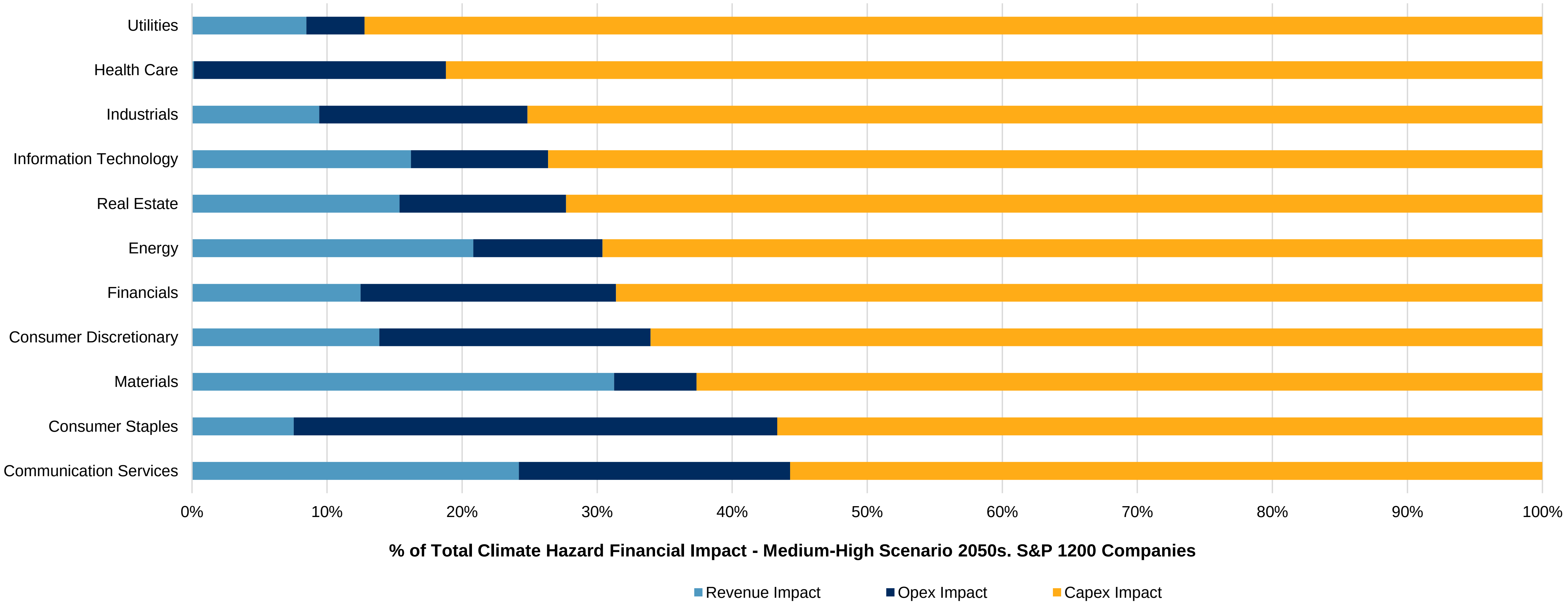


Climate Hazard Exposure Contribution to Financial Impact SSP2-4.5 2050s (%)



Source: S&P Global 2024

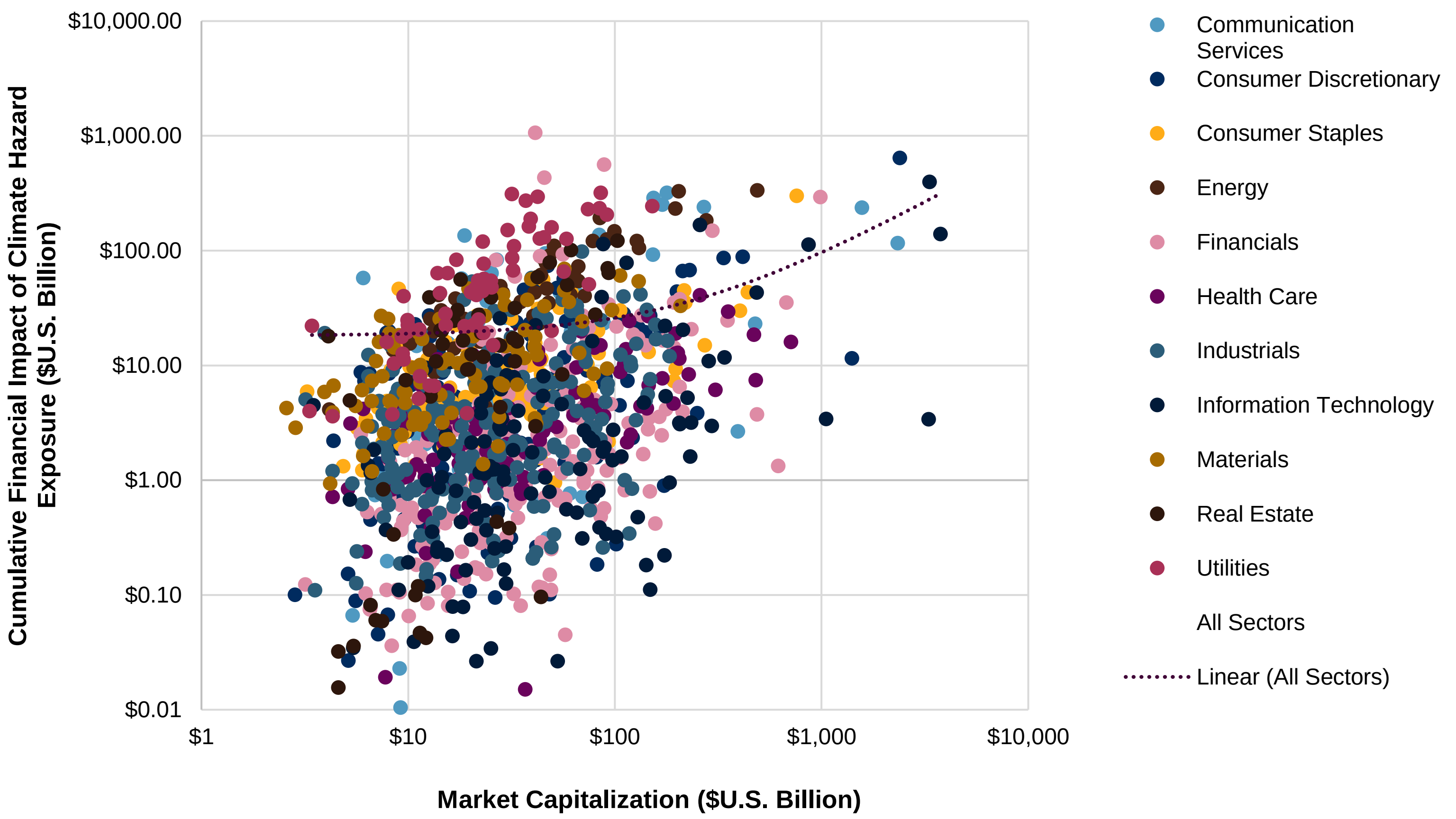
Impacts on corporate capital expenditure are the largest driver of financial impact from physical climate hazards for all sectors



Source: S&P Global 2024

Climate Hazard Financial Impact Tends to Correlate with Size

The absolute magnitude of climate physical hazard costs is broadly correlated with company size, but this is not strictly true for all companies.



Source: S&P Global 2024

Credibility and Integrity in Transition Finance

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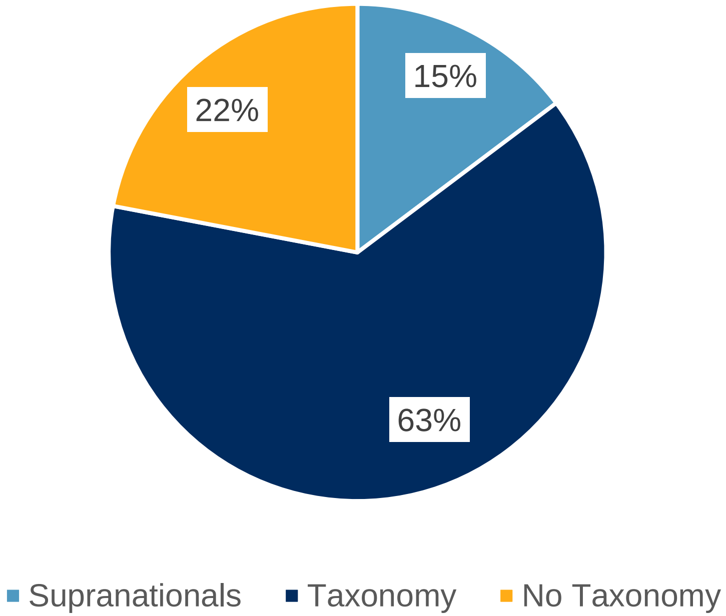
What more guidance is needed to help define and scale transition finance?

Most Outstanding Sustainable Debt is in Jurisdictions with Taxonomies



Source: S&P Ratings, Efdata.org. Data compiled April 3, 2025. Proportion of outstanding bonds maturing in 2030 or beyond according to Environmental Finance data and list of available planned, in development or existing taxonomies tracked by S&P Ratings

Taxonomy proliferation: APAC brings in Transition

Current taxonomies	Transition activities*	Sector coverage 1	2	3	4	5	6	7	8	9	10
ASEAN Taxonomy (2024)	✓	●	●	●	●	●	●		●	●	●
Australian Taxonomy (2025)	✓	●	●		●		●	●		●	
China's Green Bond Endorsed Projects Catalogue (2021)		●	●		●		●			●	●
Singapore-Asia Taxonomy (2023)	✓	●	●	●	●	●	●			●	●
Hong Kong Taxonomy (2024)			●		●					●	●
Indonesian Taxonomy (2024)	✓	●		●	●		●	●			●
Korean Green Taxonomy (2021)		●	●	●	●		●		●	●	●
Multi-Jurisdiction Common Ground Taxonomy (2024)	✓	●	●		●		●			●	●

*These taxonomies provide specific classification for transition activities on a pathway to green or includes specific provisions for activities not necessarily considered "green" but aligned with a transition agenda. Sectors Coverage (from left to right) 1. Agriculture, Forestry, & Fishing, 2. Construction & Real Estate, 3. Carbon Capture, Storage and Utilisation, 4. Energy, 5. Information & Communication, 6. Manufacturing, 7. Mining, 8. Professional, Scientific & Technical, 9 . Transportation, 10. Water Supply, Sewage and Waste Management. Source: Asian Development Bank (ADB)

Source: S&P Ratings, 2025, Sustainable Bond Outlook 2025: Asia-Pacific Issuance Could Hit Record High

Building Capacity in The Market

The Role of S&P Global Ratings

- Our **Climate Finance Website** provides free research, easy-access rating transparency, sustainable finance frameworks, and perspectives on market innovations and novel transactions (including blended finance).
- We have set up a **dedicated task force** on the Climate & SDG Financing gap topic to engage with market stakeholders and contribute to working groups.
- We have also changed our organization to be able to rate in a timelier way innovative transactions, including in the blended finance space.

Source: S&P Ratings; https://www.spglobal.com/ratings/en/research-insights/special-reports/climate-finance

Council Meeting Agenda

15.30 – 15.45: Break

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Navigating the Energy Surge: AI, Datacenters and the Path to Net-Zero

Outlooks for data center power demand: Differences across scenarios show that power systems are a key constraint to data center growth

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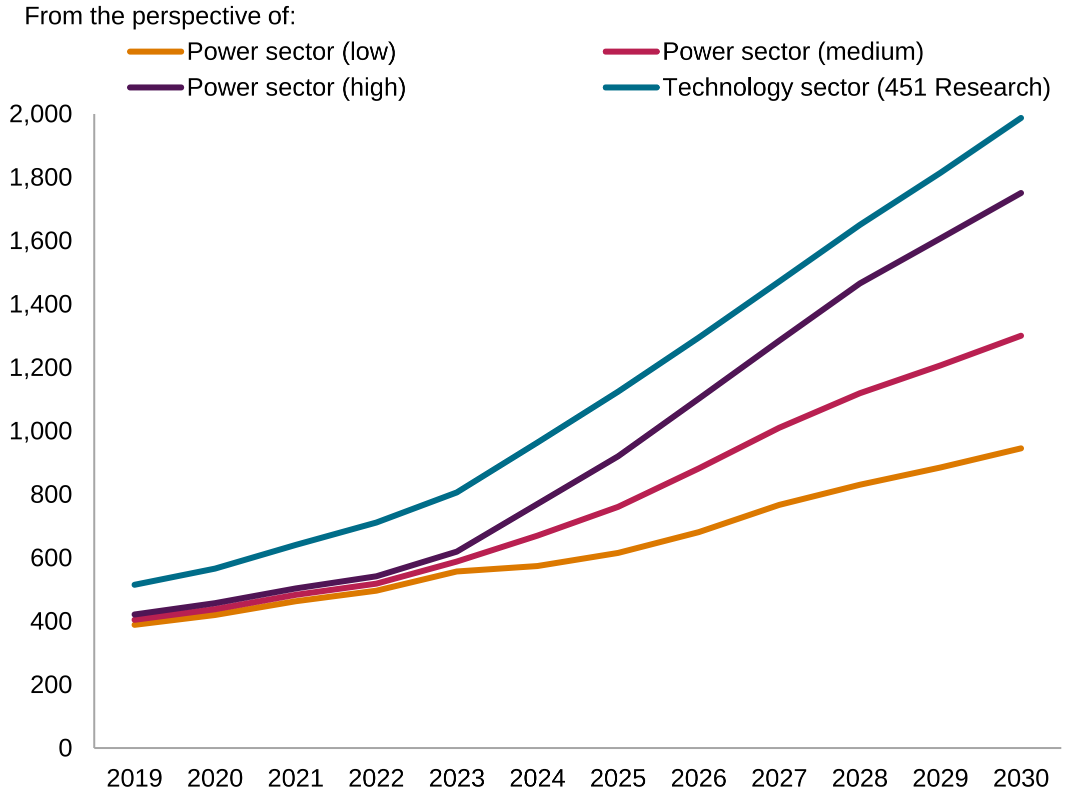
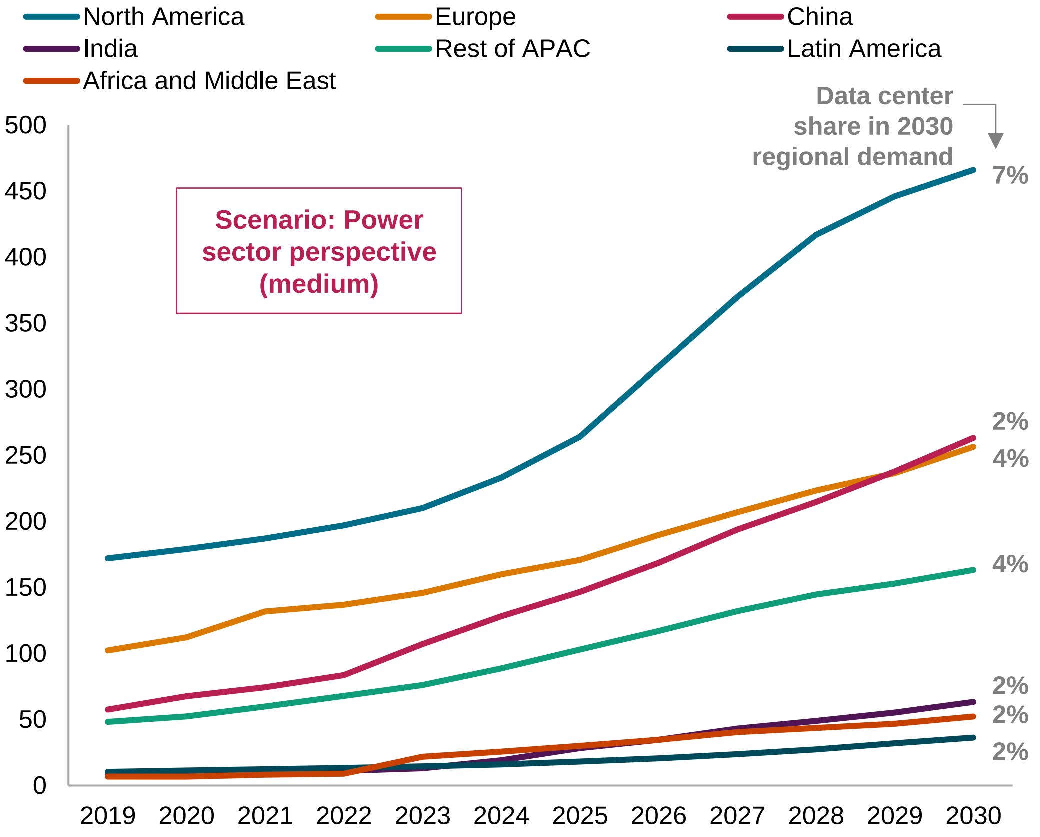
Global data center power demand, by scenario (TWh)



Global data center power demand, by region (TWh)



As of September 2024.

Note: The outlook "Technology sector perspective (451 Research)" is calculated to 2029; the value for 2030 is extrapolated.

Note: Variations in the historical levels of data center power demand stem from substantial variations in the data across the limited sources of information available. For example, the International Energy Agency says "studies for the European Union show that the share of data centres' consumption in total electricity demand in 2022 could range between 1.8% to 3.5%. In the United States, estimates range between 1.3% to 4.5% in 2022, and in China it can range from 1.9% to 2.9% [...]. In some individual countries, the range of uncertainty is even greater." (https://www.iea.org/reports/electricity-mid-year-update-july-2024) In our research, estimates of historical data center demand could vary by a third or more for North America, China, India, Latin America, and Africa and the Middle East. Differences are likely due to the inclusion versus exclusion of cryptocurrency mining and/or enterprise data centers (i.e., data centers owned by organizations whose primary business is not data center leasing services), differences in assumed data center utilization and efficiency rates, and a broader lack of reporting to official institutions.

Source: S&P Global Commodity Insights, S&P Global Market Intelligence.

The wish lists from datacenters and the power sector are not always aligned

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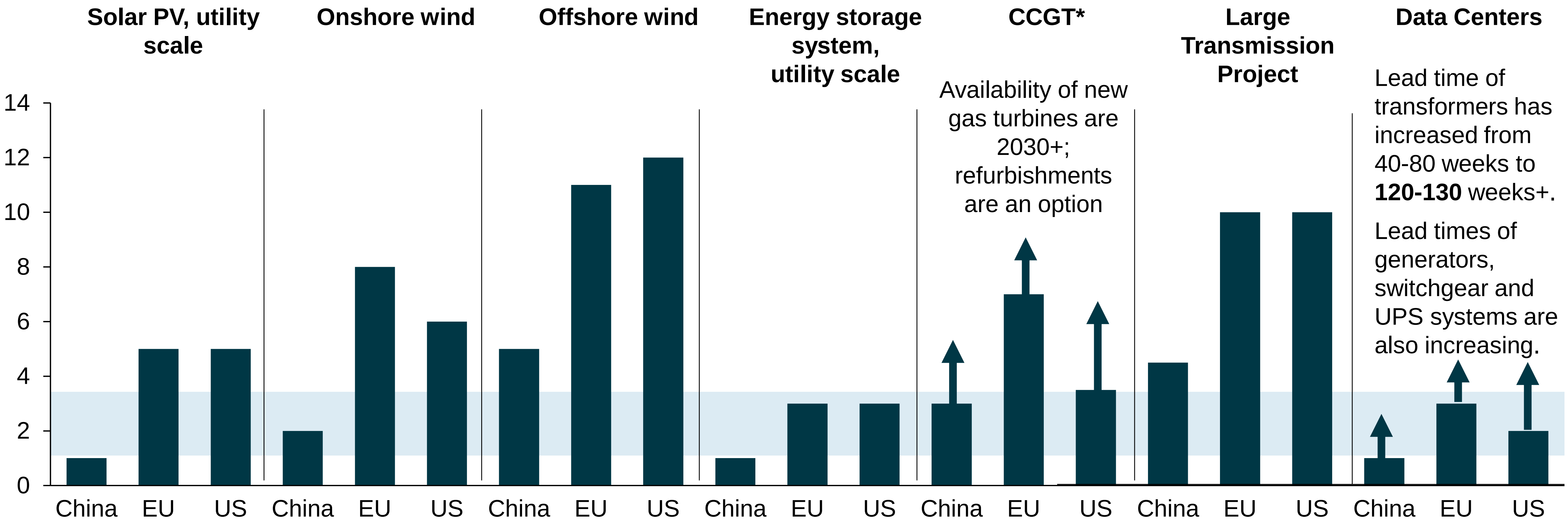
	Data centers	Power sector
Location	➢ Want to be close to their customer base and to data infrastructure – typically large cities with high concentration of power demand	➢ Locating demand close to supply limits impact of grid constraints and lowers overall system costs
Low carbon supply	➢ Want certified (ideally 24/7) low carbon power to fulfill their sustainability targets	➢ Low carbon sources (e.g. offshore wind and nuclear) are often located some distance away from demand centers. Renewable generation is highly variable
Operating profile	➢ Want reliable 24/7 baseload power for their operations	➢ Increasingly values (and is willing to pay for) flexibility of grid offtakes, either through actual demand turndown or through on-site storage / generation
Delivery timelines	➢ Relatively short time to market, of 2–3 years ➢ Long-term demand trends are uncertain, hinged on the growth in AI usage vs efficiency gains	➢ New power projects, esp. low carbon baseload ones like nuclear or BECCS, take at least 5 years; upgrades to grid infrastructure can take 10+ years ➢ Values long term certainty on demand to support investment decisions

Time to market for data centers is faster than power projects, increasingly requiring creative solutions to source power

Indicative time to market for renewables and data center projects

Time to Market | Data Center Build Time

Years



Development timelines consider project planning (early design prior to seeking approvals by relevant authorities), permitting, pre-build (e.g., finalizing financing, gathering contractors, site preparation), and build phases (project under construction or in testing phase). Timelines vary significantly around these averages, depending on local regulations, site characteristics (local opposition, grid connection issues) and technical characteristics (e.g., length of transmission lines). * For mainland China, we assume a greenfield gas-fired plant; for Europe and the US, we assume a brownfield combined cycle gas turbine.
Source: S&P Global

That said, Data Centers have a higher willingness to pay a premium for low carbon base load power compared with other industries

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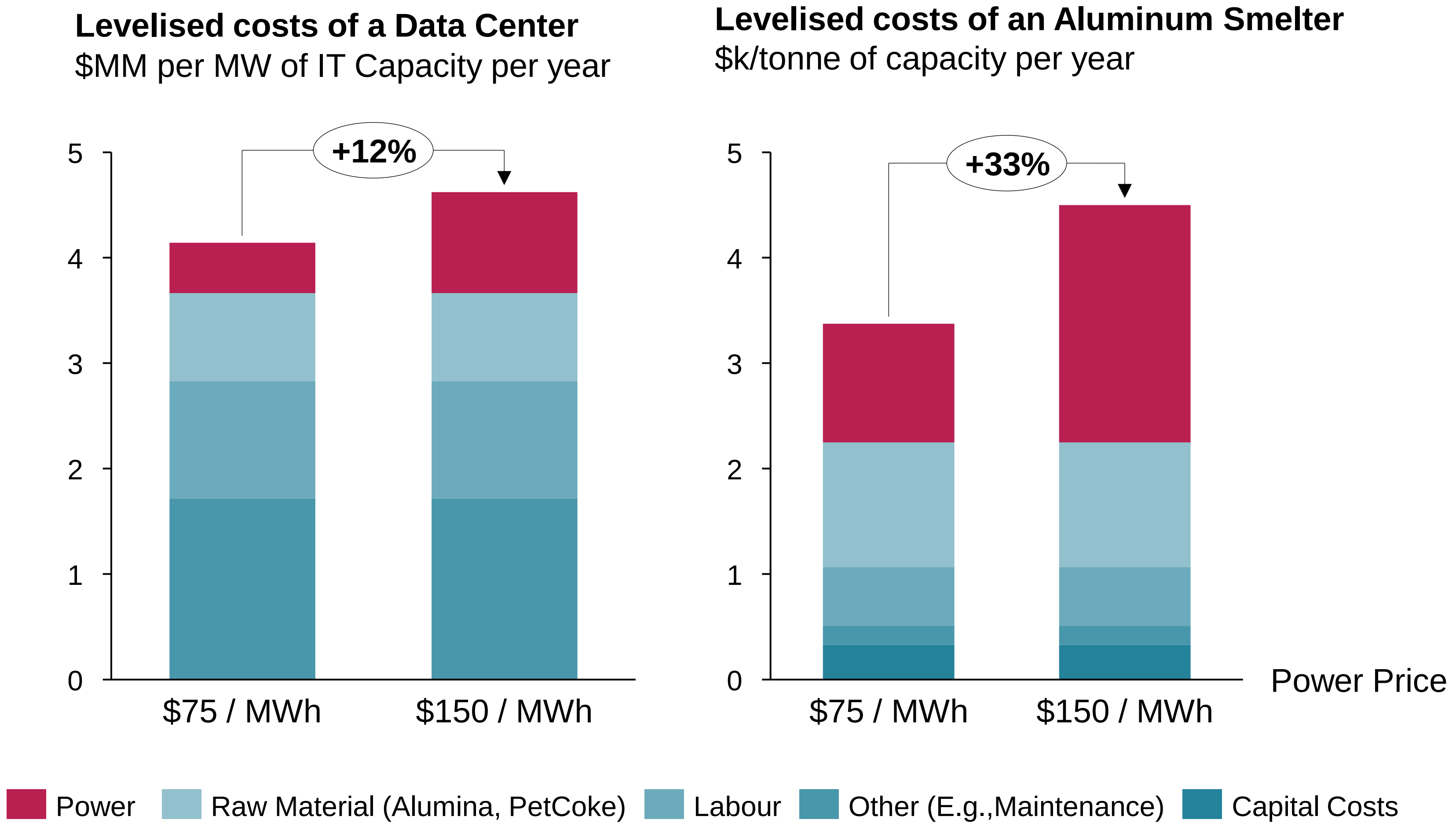
- Proportionally, a doubling of power prices impacts lifecycles costs less in Data Centers than other energy intensive industries requiring baseload power supply. This perhaps results in a higher willingness to pay by data centers for harder to finance low carbon solutions – nuclear, integrated gas with CCUS, and geothermal.
- This is evidenced by the growing momentum: ~7 GW of announcements to procure and invest in nuclear were made in 2024.

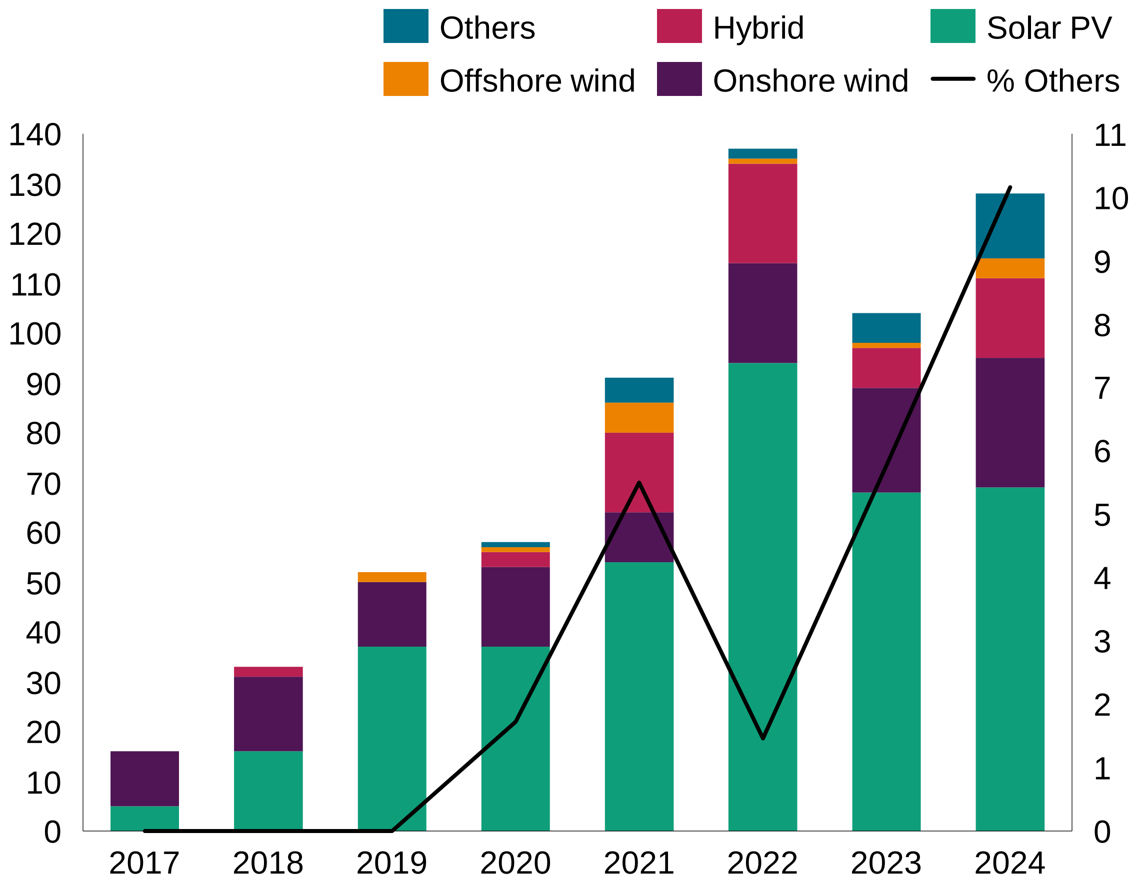


Capital Costs Assumptions: Discount Rate of 5%, Payment Period of 20 Years for Aluminium and 10 years for Data Centers. $10.5M / MW of IT Capacity including training, $4,000/tonne of aluminum capacity installed
Source: S&P Global Commodity Insights, S&P Global 451 Research

As such, while Solar and wind are the bulk of clean power procurement, nuclear, geothermal and CCUS are gaining momentum

Clean Energy Procurement (CEP) Deals in Data centers[1]

Deals / %



Note: Others include Geothermal, Hydro, Bioenergy, Nuclear, Hydrogen

1. S&P Global Commodity Insight, Corporate Renewables Contracts

2024 "Others" Deals

Nuclear

- **~7 GW of** announcements to procure and invest in nuclear made in 2024
- Microsoft: 835 MW from the Crane Clean Energy Center in Pennsylvania
- Google: 500 MW from upcoming SMRs
- Meta: intends to seek 4 GW nuclear for its datacenters
- Amazon: 960 MW in Pennsylvania; 320 MW from SMRs in Pacific West (option to increase to 960 MW); 300 MW from an SMR in Virginia

Geothermal

- **~265 MW of** deals signed to procure and invest in geothermal energy in 2024
- Meta PPA with Sage Geosystems for 150 MW
- Google partnership with Fervo Energy to supply 115 MW

CCUS

- ExxonMobil: planning **1.5 GW CCGT+CCUS** facilities in Texas *(no agreements confirmed)*
- Chevron working on proposals to develop CCUS *(no agreements or projects announced yet)*

AI is enabling investments at GW scale in hard-to-finance projects and new partnerships are emerging

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Selected examples: Hard to Finance Projects

Small Modular Reactors (SMR)

>8 GW

by 2040

of planned SMR dedicated to data center

- Modules are 15-200 MW (typically ~80 MW) and can be grouped by 3-5 in a generation unit
- Expected to become available in practice after 2030

ORACLE

Oracle is designing a >1 GW data center powered by SMR.

Geothermal

>1 GW

by 2030

of new geothermal electrical capacity dedicated to data centers

- Typically 100-200 MW generation units that must be distributed to reach GW level
- Geothermal sources can also be used for heating (offices) or for cooling (data centers).

Microsoft G42

Microsoft and G42 have signed a letter of intent to build a 1 GW data center in Kenya, powered only by geothermal. The first phase of the project is 0.1 GW.

Hydropower

up to 0.5 GW

by 2030

of new hydropower capacity dedicated to data centers

- Small hydropower
- Pumped hydropower

Iberdrola

Iberdrola is seeking to finance pumped-hydro for a data center in an electricity-for-equity deal.

Flaring

~0.05 GW

already installed

of flare-powered data centers

- Containerized data centers located on-site at rigs, wells or pipelines
- Methane from flare to produce electricity
- 200-250 kW per container
- Intended for crypto mining, moving into cloud and AI

Crusoe

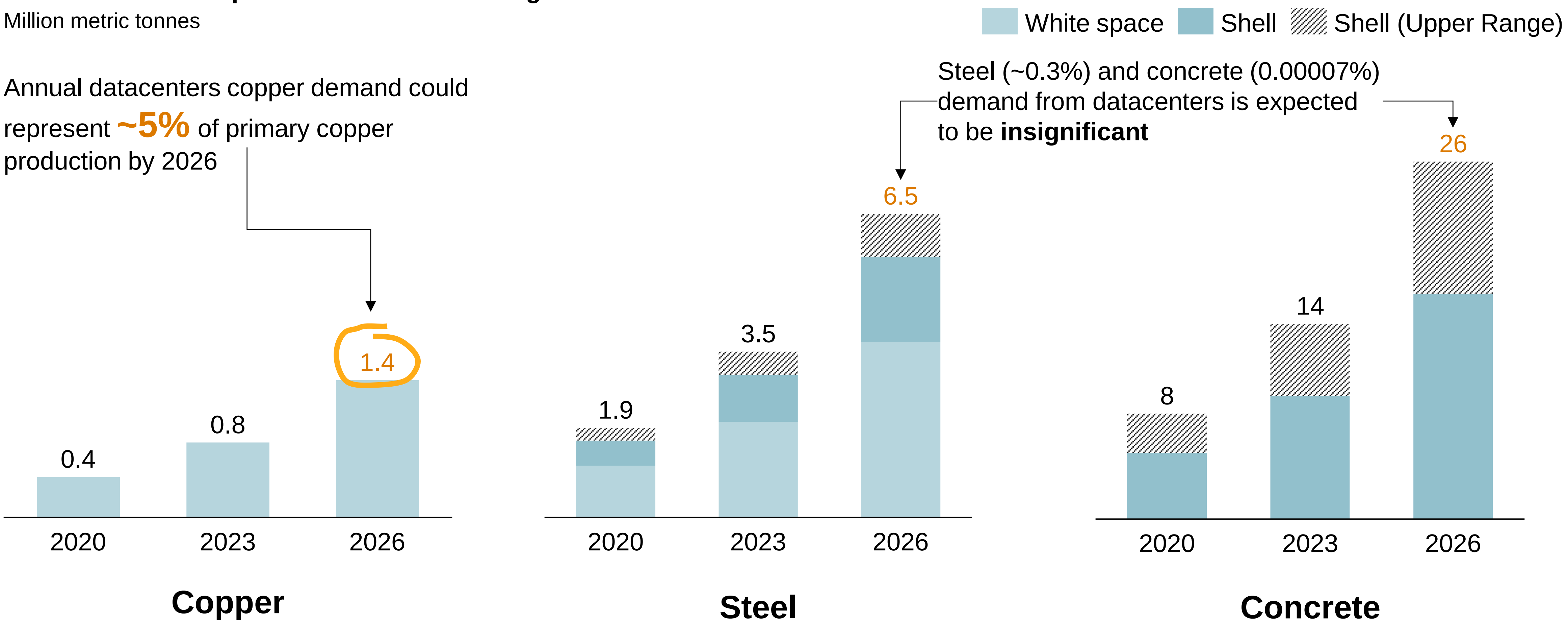
US startup Crusoe installed 125 units of micro data centers alongside pipelines in the US.

Increased datacenter installations will drive steel, copper and concrete demand growth in many states and countries

Sustainable1

Annual material requirement for datacenter growth

Million metric tonnes



Assuming a steel based facility
Source: S&P Global 451 Research, S&P Global Commodity Insights,

Partnerships are already forming to drive low carbon materials in the data center supply chain to drive reduction in Scope 3 emissions

Selected examples: green data centers strategy & approaches for Scope 3 emissions reduction

1 Using AI to formulate sustainable concrete mixes

Leveraging AI to model the formulation and testing of concrete mixes to optimize for multiple variables including lower carbon performance requirements

Meta | University of Illinois

META partnered with University of Illinois to create an open source model that generates low carbon concrete mixtures (up to 40%)

2 Investment in H2 Green Steel

H2 Green steel with 95% reduction in CO2 emissions compared with traditional steel making

CIF Climate Investment Funds | Stegra

Through CIF, Microsoft invested in a near-zero steel producer in Sweden who aims to bring 5 million tons of green steel to the market by 2030

3 Testing low carbon concrete to reduce embodied carbon

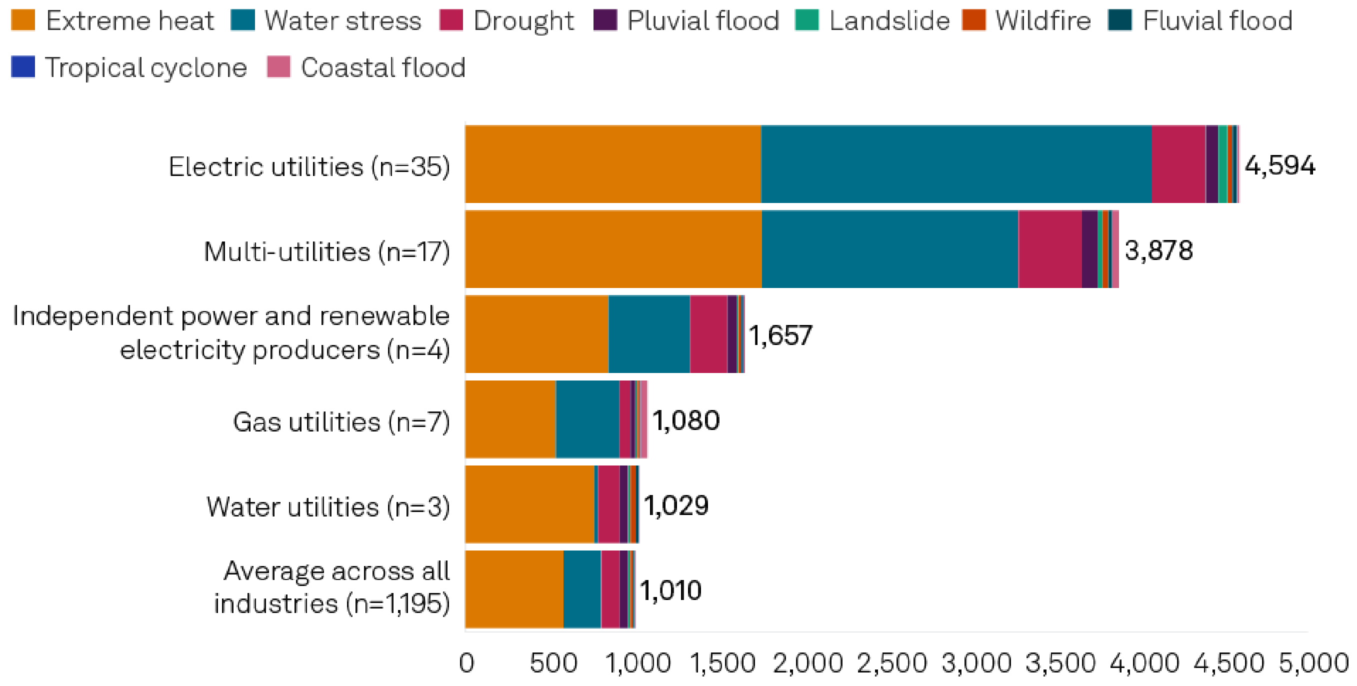
Working with data center providers to test new low carbon cement that will reduce emissions

Ozinga | aws

AWS tested cement in new data centers by Ozinga which achieved a 64% reduction in embodied carbon compared with industry average

An electric utility faces 4.6x higher projected financial impact from physical risk compared to the average across industries

Sustainable1

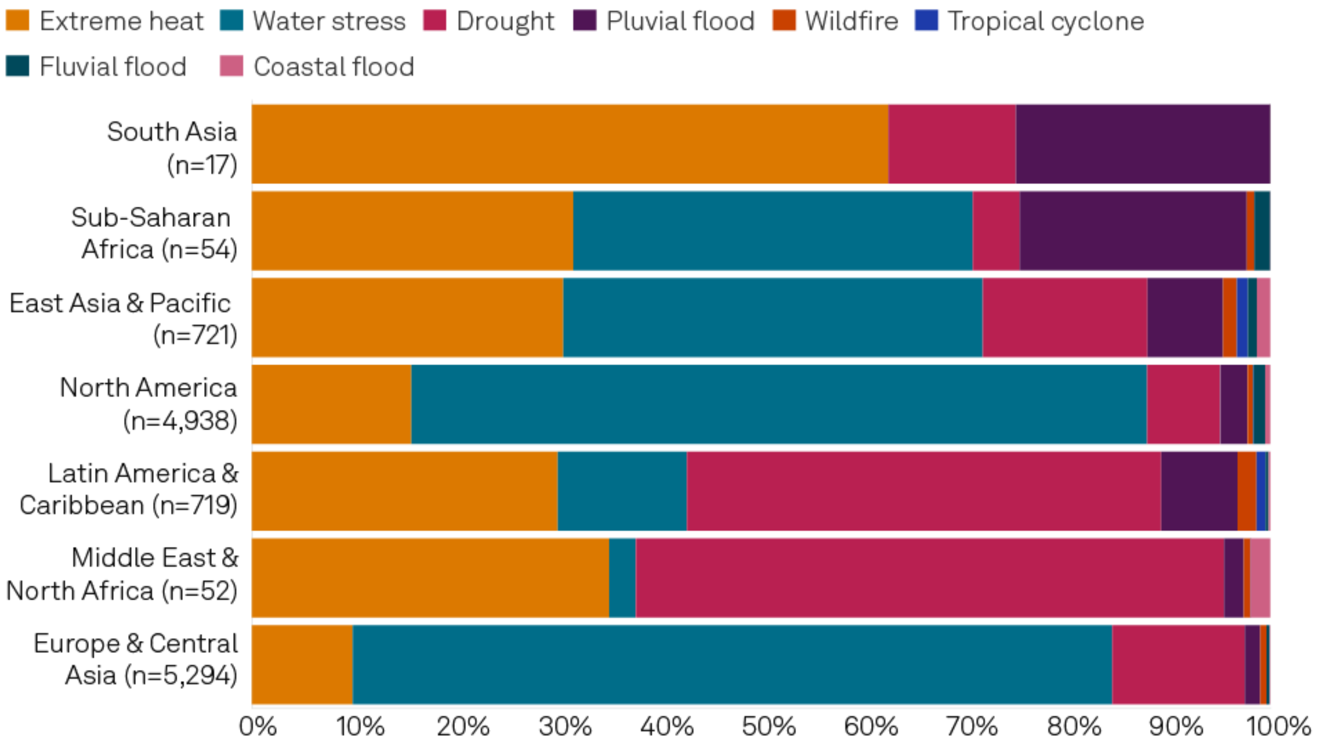


As of Feb. 24, 2025.
SSP = Shared Socioeconomic Pathway.
SSP2-4.5 is a medium climate change scenario that contemplates strong mitigation, in which total greenhouse gas emissions stabilize at current levels until 2050 and then decline to 2100. This scenario is expected to result in global average temperatures rising by 2.7 degrees C (2.1 degrees C-3.5 degrees C) by the end of the century.
No inflation assumptions are applied and results are presented in nominal 2024 prices.
Source: S&P Global Sustainable1.

Source: S&P Global 2024

The climate hazards causing projected financial impact on power plants vary by region

Sustainable1

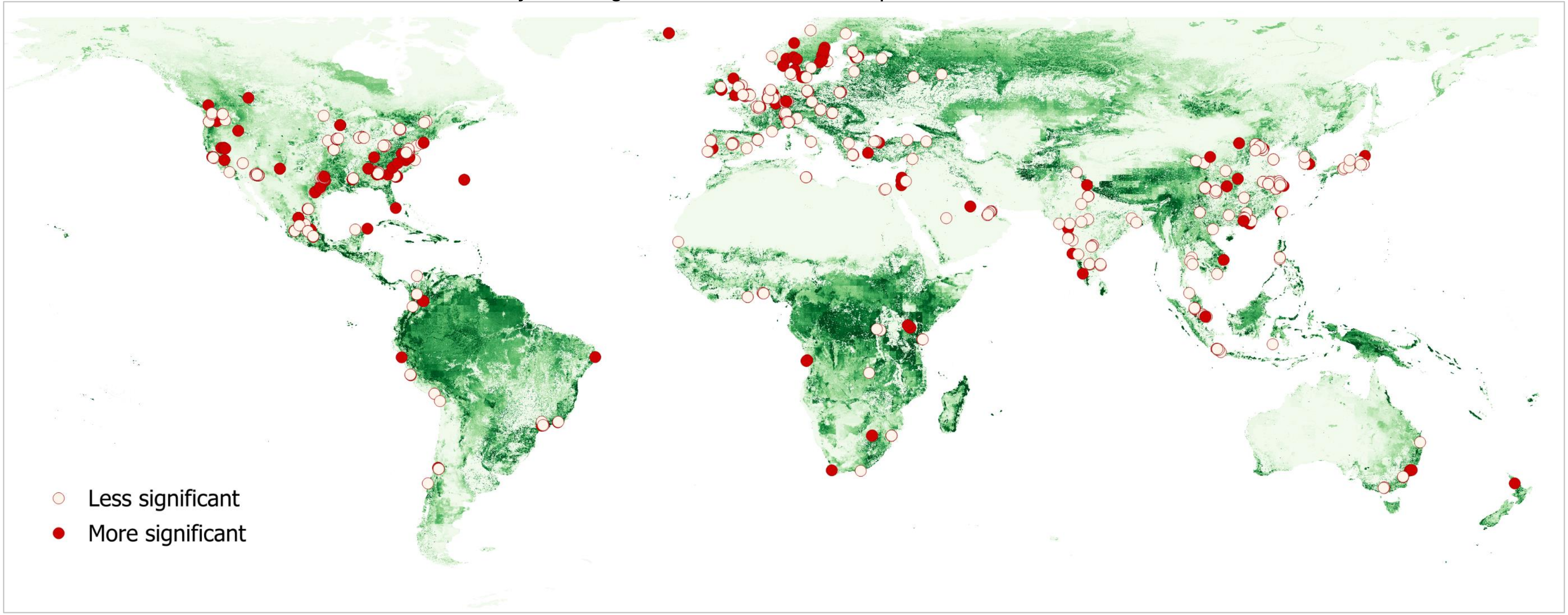


As of March 3, 2025.
SSP = Shared Socioeconomic Pathway.
SSP2-4.5 is a medium climate change scenario that contemplates strong mitigation, in which total greenhouse gas emissions stabilize at current levels until 2050 and then decline to 2100. This scenario is expected to result in global average temperatures rising by 2.7 degrees C (2.1 degrees C-3.5 degrees C) by the end of the century.
No inflation assumptions are applied and results are presented in nominal 2024 prices.
Chart reflects 11,790 power plant assets.
Source: S&P Global Sustainable1.

Source: S&P Global 2024

38% of planned data centers are in locations of high ecosystem significance (compared to 22% for existing)

Ecosystem Significance at locations of planned data centers



Council Meeting Agenda

Concluding Remarks

Sustainable1

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