Note: The following is a redacted version of the original report published October 13, 2022 [51 pgs].

Goldman Sachs

EQUITY RESEARCH | October 13, 2022 | 5:20PM EDT

GS SUSTAIN: Green Capex: Accelerating the Energy Transition

Stimulating capital and return on capital

Increases in corporate capex and recent policy stimulus are likely to provide tailwinds for Green Capex to support Net Zero, Infrastructure and Clean Water goals, though we still see need for additional investment. This will require, in our view, the three C's: **C**ollaboration, **C**omprehensive focus and **C**orporate returns. We highlight themes to consider for key stakeholders – managements, investors and policymakers – provide a case study on reducing China's weighting towards coal in its power mix, and detail why differing strategies will be needed regionally to impact corporates and consumers. We continue to see attractive equity investment opportunities across the supply chain, including in Greenablers where investment is needed more urgently.

Brian Singer, CFA
+1(212)902-8259
brian.singer@gs.com
Goldman Sachs & Co. LLC

Trina Chen
+852-2978-2678
trina.chen@gs.com
Goldman Sachs (Asia) L.L.C.

Enrico Chinello, Ph.D.
+1(212)357-3398
enrico.chinello@gs.com
Goldman Sachs & Co. LLC

Michael Hao Wu, CFA
+1(917)343-1137
michael.h.wu@gs.com
Goldman Sachs & Co. LLC

Joy Zhang
+852-2978-6545
joy.x.zhang@gs.com
Goldman Sachs (Asia) L.L.C.

Contributing Authors

Brian Singer, CFA
+1 212 902 8259
brian.singer@gs.com
Goldman Sachs & Co. LLC

Trina Chen
+852 2978 2678
trina.chen@gs.com
Goldman Sachs (Asia) L.L.C.

Enrico Chinello, Ph.D.
+1 212 357 3398
enrico.chinello@gs.com
Goldman Sachs & Co. LLC

Michael Hao Wu, CFA
+1 917 343 1137
michael.h.wu@gs.com
Goldman Sachs & Co. LLC

Joy Zhang
+852 2978 6545
joy.x.zhang@gs.com
Goldman Sachs (Asia) L.L.C.

Derek R. Bingham
+1 415 249 7435
derek.bingham@gs.com
Goldman Sachs & Co. LLC

Evan Tylenda, CFA
+44 20 7774 1153
evan.tylenda@gs.com
Goldman Sachs International

Brendan Corbett
+1 415 249 7440
brendan.corbett@gs.com
Goldman Sachs & Co. LLC

Emma Jones
+61 2 9320 1041
emma.jones@gs.com
Goldman Sachs Australia Pty Ltd

Keebum Kim
+852 2978 6686
keebum.kim@gs.com
Goldman Sachs (Asia) L.L.C.

Madeline Meyer
+44 20 7774 4593
madeline.r.meyer@gs.com
Goldman Sachs International

Varsha Venugopal
+1 415 249 7554
varsha.venugopal@gs.com
Goldman Sachs & Co. LLC

Grace Chen
+44 20 7774 5119
grace.j.chen@gs.com
Goldman Sachs International

Rachit Aggarwal
+1 212 934 7689
rachit.aggarwal@gs.com
Goldman Sachs India SPL.

Michael Puempel, Ph.D.
+1 212 357 8483
michael.puempel@gs.com
Goldman Sachs & Co. LLC

Table of Contents

PM Summary

To stimulate greater capital towards the Energy Transition and broader sustainable development goals, we believe stakeholders such as investors, managements and policymakers should deploy the **three C's**:

- **C**ollaboration towards understanding funding capacity, thresholds and gaps.
- **C**omprehensive focus, both via deploying sufficient investment across the supply chain with an eye on critical products needed early in the supply chain and via regional-/country-focused strategies towards lowering consumer and corporate emissions with the least economic and social consequences.
- **C**orporate returns clarity via greater transparency and visibility about risk and return impact of investments in the short, medium and longer term.

Investors have rewarded companies disproportionately reinvesting in Green Capex with above-average returns, and we believe this will continue to be the case. At the same time, the level of investment needed to achieve Net Zero by 2050 and Infrastructure/Clean Water goals is insufficient, requiring greater focus on the 3 C's. In our report, we highlight where capital is needed, what investors are rewarding and strategies/vehicles to stimulate investment with a case study on China decarbonization strategies.

What's misunderstood

We see three key areas for discussion and mutual understanding among the stakeholders capable to accelerating climate transition investment: investors, corporate managements and policymakers.

1. **Not all industries have spare capacity to increase investment without taking on equity or debt, but some do.** We believe an incremental $1.8 trillion of annual investment is needed this decade vs. the 2016-20 annual average to be on track with Net Zero by 2050 goal, and we see an incremental $1.0 trillion needed to be on track for Clean Water and Infrastructure goals. Of this $2.8 trillion, we believe the private sector is on track to spend $0.9 trillion but has capacity to spend a further $0.9 trillion. This "spare capacity" is highly concentrated in oil/gas, metals/mining, software, automobiles and semiconductors. This means other sectors may need greater stimulus to ramp up investment vs. what is already on track.
2. **Just because a company has spare capacity to invest more doesn't mean the market will appreciate it — corporate returns matter.** Even among the sectors that have flexibility to accelerate Energy Transition capital, investors will likely pay close attention to the short, medium and longer-term impact to corporate-level returns in order to provide sufficient support. As such, stakeholders should be more transparent about risk/returns, project timing and constraints.
3. **Impacting consumer and corporate behavior will both be critical, with varying needs/opportunities by region.** We do not believe strategies to stimulate capital deployment should be homogeneous across regions. Companies' spare capacity for

investment is not consistent across regions. And some countries could see greater initial impact from strategies/products focused on reducing corporate emissions, while others could see greater initial impact from strategies/products focused on reducing consumer emissions.

Themes for corporates and policymakers to consider

Collaboration among companies and between companies, customers and policy-makers. We believe companies, their customers and policymakers should increase their private and public discussions on what they are each looking for to accelerate investment and how they define available capital. Rising recognition by corporates of the need for increased partnerships was one of the key takeaways from our September 2022 Global Sustainability Forum.

Comprehensive focus across the supply chain and with consideration for both consumers and corporates. We believe stakeholders should consider opportunities, risks and investment opportunities across the full supply chain of products needed for the verticals essential to achieving key sustainable goals. This includes ensuring sufficient supply of Greenablers like semiconductors, copper/aluminum, electricity transmission and cybersecurity. We also see the need and opportunity for innovation in Clean Reliable Energy (battery storage and hydrogen as examples) and advanced nuclear technologies.

Differentiated strategies for impact by country/region. We believe targeted policy initiatives and technology deployment are needed to sufficiently influence corporate and consumer behavior. This is because some countries have meaningfully greater corporate emissions intensity while others have greater implied consumer emissions intensity.

China: Facilitating smoother energy transition. To facilitate a smoother and more sustainable energy transition, China is taking a flexible approach. While long-term profile of coal demand is in a contracting trend, Chinese coal demand may stay more resilient in the medium term. China is taking steps on innovative models by leveraging existing coal-fired assets, improving deployment of renewables, and also potential developing carbon capture to help minimize the impact on current industrial capacities that may otherwise become stranded.

Themes for investors to consider

Broaden focus across the supply chain. ESG fund holdings continue to be concentrated in market-weight positions in large-cap bellwethers and overweight positions in end-of-the-supply-chain pure-play companies in verticals like solar, wind and water. We see opportunity for investors to look more broadly across the supply chain via greater quantification/confidence in impact. We believe GS SUSTAIN data offerings like forward-looking Green Capex/Green Revenue/greenhouse gas emissions estimates and our Climate Transition tool can help, with additional confidence likely as disclosure and forward estimates widens over time.

Support reinvestment opportunities that do not degrade Corporate returns. Investors have rewarded companies disproportionately reinvesting capital vs. peers as

percent of operating cash flow where corporate returns are above average. We believe this can continue.

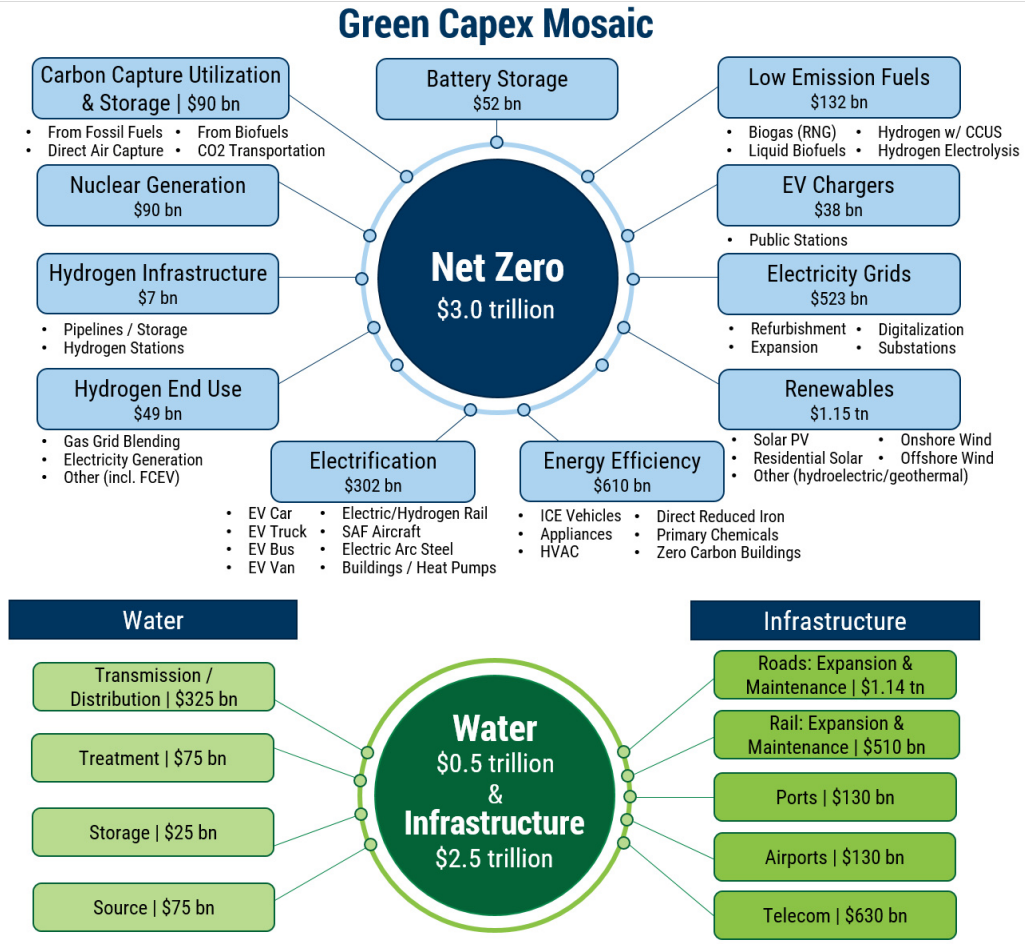
Green Capex requirements exceed current levels of investment by private sector

We believe Green Capex will be the multi-year secular theme — as focus rises to decarbonize the world and meet Clean Water and infrastructure goals — requiring $6 trillion in annual investments in the 2020s. Half of this is needed for decarbonization to be on path for Net Zero by 2050. We believe only about a third of the incremental $2.8 trillion needed to be on path to achieve these broader goals is currently on track from the private sector.

We see need for $1.8 trillion of annual incremental decarbonization investment in the 2020s and $1.0 trillion for infrastructure/water. As we detailed in our Green Capex: Making Infrastructure Happen report, Green Capex toward Net Zero, Infrastructure and Clean Water needs to increase to $6 tn annually in the 2020s to achieve Net Zero and other Sustainable Development Goals (SDGs) and has been about $3.2 trillion annually within 2016-2020. This represents a $2.8 trillion incremental annual investment on average this decade vs the 2016-20 average. The incremental contribution for decarbonization is $1.8 trillion of the $2.8 trillion.

Incremental Green Capex will be needed from a combination of governments, private companies and public companies, and will involve, in our view, an all-in approach across multiple sectors that will be critical or needed (see Exhibit 1)**.** With continued inflationary pressures, we see potential upside risk to the $6.0 trillion annually that is required for this decade. At the same time, the potential for greater deployment of solutions could increase the pace of innovation in areas like hydrogen, battery storage and energy efficiency.

Exhibit 1: The Net Zero, Infrastructure and Clean Water mosaic
Critical technologies/focus areas and annual investment in the 2020s to achieve Net Zero, Infrastructure and Clean Water needs



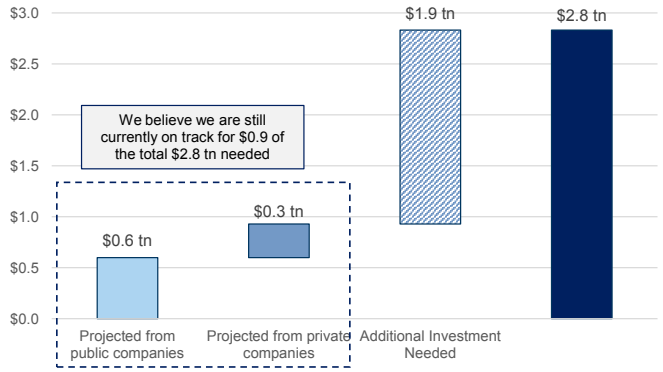
Source: IEA, McKinsey, OECD, Company data, Goldman Sachs Global Investment Research

What's needed this decade vs. What's on track

We believe the private sector is on track for $0.9 tn of the incremental $2.8 trillion Green Capex needed annually in the 2020s. Please see Exhibit 2 for more details. As detailed in our latest Green Capex report published June 13, we believe the private sector is currently on track to invest $0.9 tn more annually on average vs. 2016-2020 as a result of:

- $0.6 tn from publicly traded companies, applying consensus expectations for capex + R&D growth in 2022E/2023E and a 3.5% CAGR to overall Capex + R&D post-2023, together with a 1.5% annual Green Capex mix shift — consistent with our November 2021 ESG of the Future report;
- $0.3 tn from Green Capex-related private capital raised (Renewable Energy, Clean Tech, Environmental Services, Utilities, Water funds), assuming a 50%/50% equity/debt split and a 20% CAGR to total capital raised in the 2020s.

Exhibit 2: We believe the private sector is on track for $0.9 tn of the incremental $2.8 tn Green Capex needed annually in the 2020s; this implies the need for $1.9 trillion of additional investment to meet decarbonization, clean water and infrastructure goal pathways
Components of incremental annual investment needed this decade to meet Net Zero, infrastructure and clean water goals, $ trillion



Source: IEA, OECD, McKinsey & Company, FactSet, Preqin, Goldman Sachs Global Investment Research

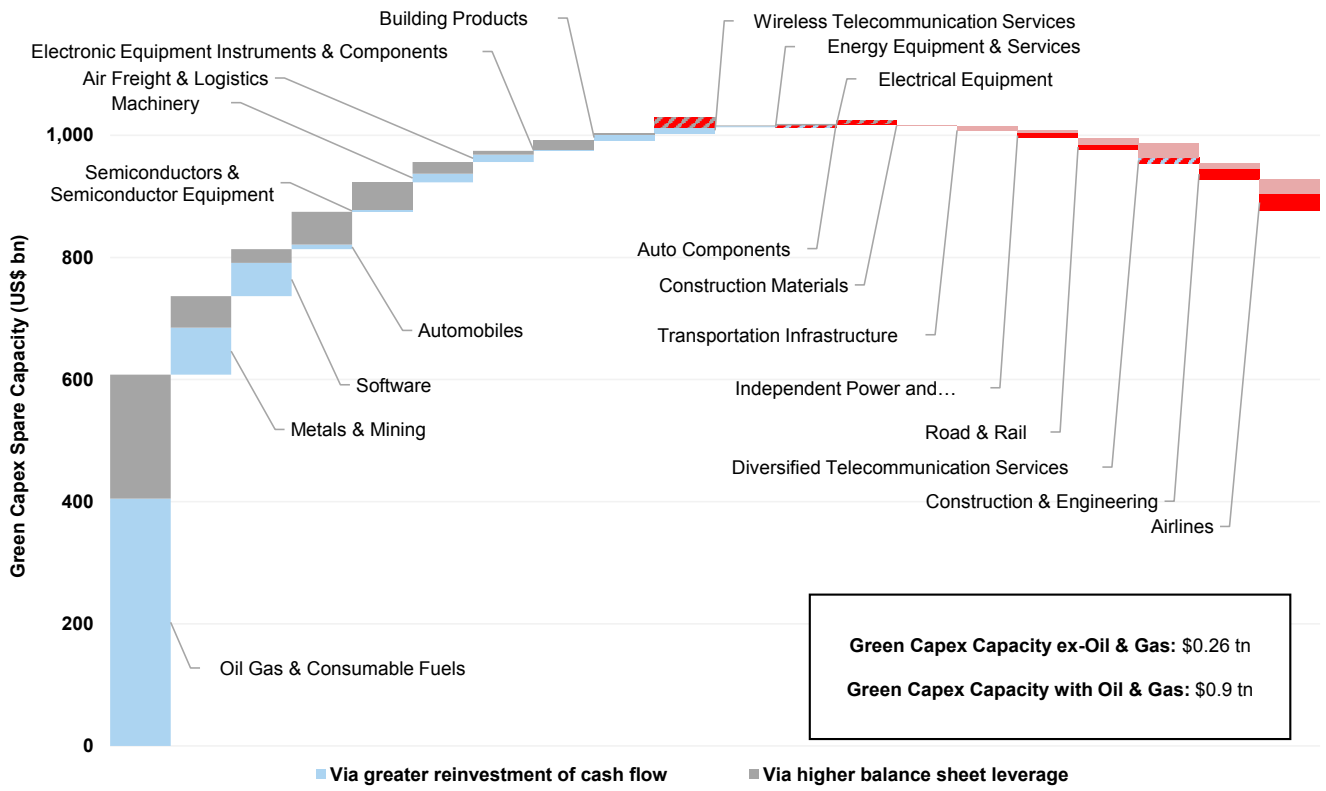
Public companies can invest meaningfully more, but spare capacity is highly concentrated

One of the critical areas for discussion and mutual understanding among policy-makers, investors and managements is over how much capacity public companies have to invest more. As we highlight, the "spare capacity" is ample — $0.9 trillion per year without stretching balance sheets or eliminating return of capital to shareholders. However, not every company and every sector has flexibility to invest more, as the spare capacity for additional investment is highly concentrated in a handful of sectors. Even if companies allocate spare capacity to Green Capex, additional investment will be needed to fill the remaining gap — by governments and individuals or by companies via equity issuance/increased leverage.

We see $0.9 tn in spare capacity from publicly traded companies annually (revised down slightly vs. prior estimates on lower operating cash flow and slightly higher leverage), if reinvestment rates of cash flows into capex + R&D and leverage were to return to the historical levels between 2000 and mid-2010s. As we have highlighted, the reinvestment rate of operating cash flow back into capex and R&D was 60%-70% in the early 2000s through 2012, but in the past decade the reinvestment rate has decreased to near 50%. This opens up meaningful opportunity for publicly-traded companies to invest more without taking on new debt, new equity and/or stretching balance sheets.

But not all sectors contribute equally — spare capacity is highly concentrated and has become more concentrated with commodity inflation. While spare capacity is generally concentrated in five sectors (oil/gas, metals/mining, software, automobiles and semiconductors), the oil/gas sector represents the biggest share as a result of the recent spike in prices and management focus on return of capital — see our latest Green Capex report for more details.

Exhibit 3: We see $0.9 trillion of spare capacity for additional investment by public companies without the need for equity/debt financing, but the spare capacity is highly concentrated in 4-5 sectors
Green Capex spare capacity from key relevant sectors needed for Net Zero, Infrastructure and Clean Water goals



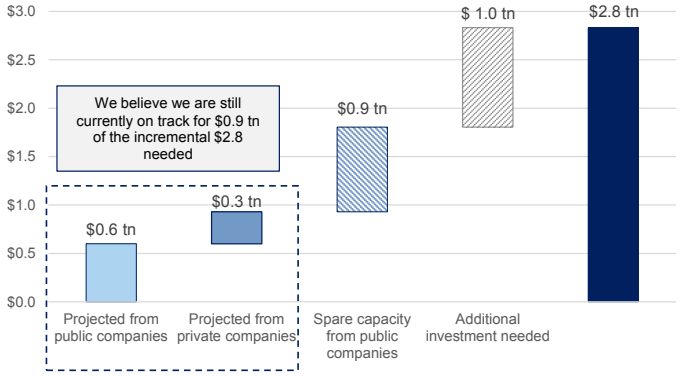
Spare Green Capex capacity considers potential for shift in reinvestment and tolerance for leverage. Reinvestment capacity is based on incremental capex/R&D capacity to achieve a 70% 2022E reinvestment rate of cash flow. Leverage capacity is based on incremental spending per year over remainder of decade based on difference between 2022E net debt/EBITDA and 1.5x. Diversified Telecom Services has positive excess capacity from reinvestment that gets cancelled out by leverage impact.

Source: Goldman Sachs Global Investment Research

Even if corporates used their full spare capacity and spent $0.9 trillion more per year, we would still need $1.0 trillion per year of additional annual investment to meet Net Zero, Clean Water and Infrastructure goals from governments and individuals. We believe government direct investment and individuals' investment will be important and a potential driver for some of the gap. Governments and individuals are implied historically to represent a high percentage of overall capital formation vs. corporate capex + R&D. We expect $0.4 tn of investment by individuals to support development of residential solar, electric vehicles and energy efficient appliances.

Exhibit 4: If public companies were to allocate the full $0.9 trillion of spare capacity to Green Capex, we would still need an additional $1.0 trillion of investment from governments, individuals or other stakeholders

Components of incremental annual investment needed this decade to meet Net Zero, infrastructure and clean water goals, $ trillion



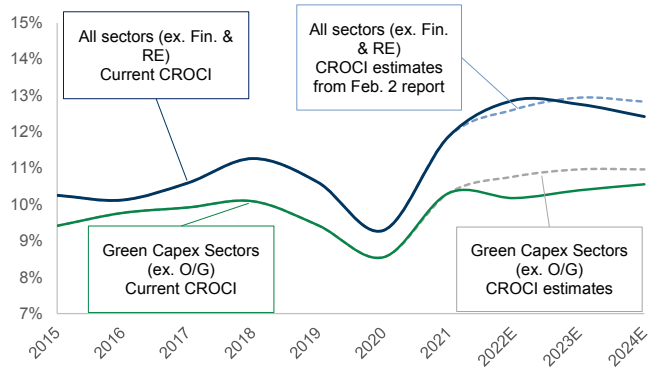
Source: IEA, OECD, McKinsey & Company, FactSet, Preqin, Goldman Sachs Global Investment Research

Corporate returns, not just capital availability, critical for increased investment

A second critical area for discussion and mutual understanding among policy-makers/investors/managements is regarding how financial markets will view increased Green investment. We believe markets will consider the implications for corporate-level returns — return on capital employed, return on equity, cash return on cash invested, etc. — when determining their level of support. As such, simply having spare capacity for additional investment is not a guarantee for financial market support. Many sectors important for decarbonization have above-average corporate returns. However, there are multiple sectors that have below-average corporate returns, where some combination of higher prices, lower costs or policy support may be needed.

Even with market volatility, we continue to see favorable momentum for corporate returns broadly which could represent a tailwind for increased investment. Our analyst forecasts imply corporate returns — we consider cash return on cash invested (CROCI) are expected to improve for the majority (14 in 2023E and 17 in 2024E) of Green Capex-critical sectors. An improving outlook for corporate returns should be supportive for increased Green Capex, assuming that managements can demonstrate that such initiatives are either not deteriorating corporate returns or are leading to an improvement in medium-term or longer-term. We note that only a handful of sectors with above-average cash return on cash invested are reinvesting more than 60% of cash flows into capex + R&D in 2022E (Exhibit 6).

Exhibit 5: Our analyst forecasts imply declining public company corporate returns in 2023E/2024E but rising corporate returns for sectors critical in the Green Capex supply chain
Weighted Average CROCI, all sectors. Comparison of current values (as of Sept. 23) vs. as published in our June 13 Green Capex note; Green Capex sectors exclude Oil & Gas



Source: Goldman Sachs Global Investment Research

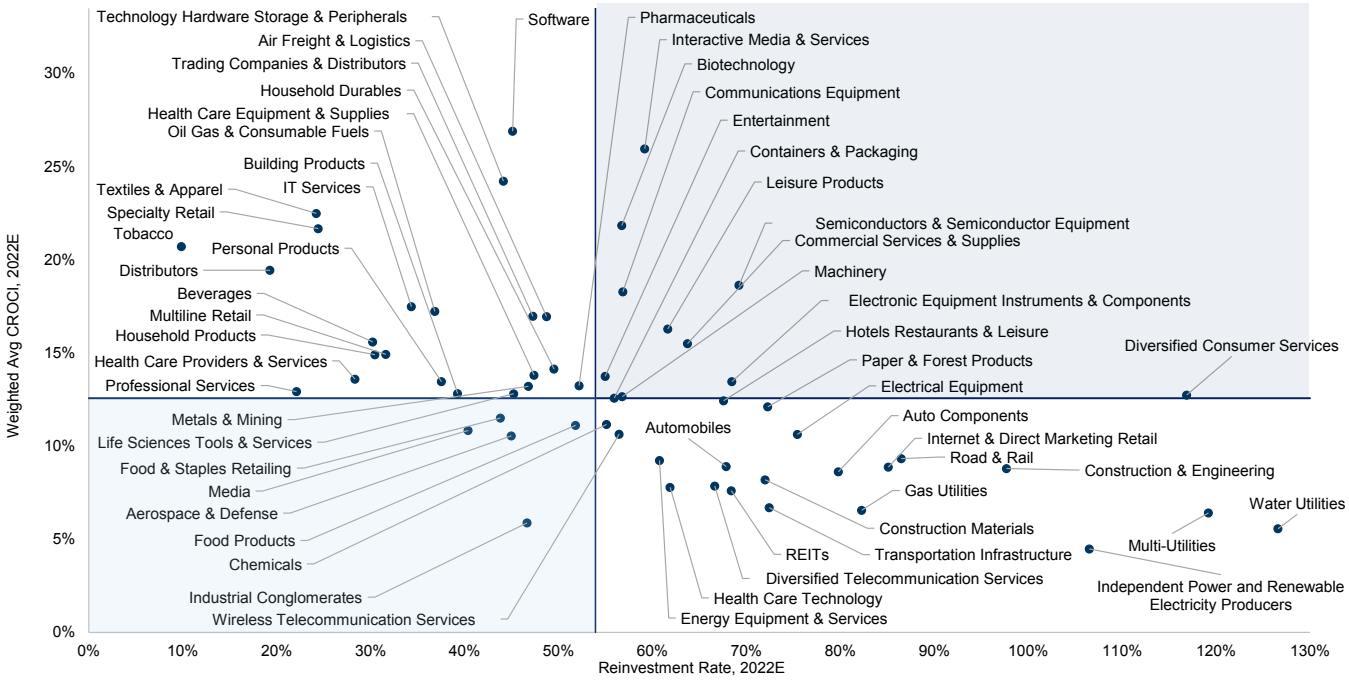
However, many important sectors for Green Capex have average or below-average corporate returns. We continue to expect the debate on whether focus on Impact should lower the acceptable threshold is likely to continue. We believe that confidence in project returns — both absolute and their momentum — and in measures that would

increase cash flow to accommodate Green investments — will be critical to overcome the possible initial skepticism from managements and investors towards deploying larger Green Capex.

Three catalysts that could stimulate greater investment with market support. While there has been much focus on falling cost of capital and the implications of greater access to capital, given inflationary pressures and market volatility we believe investors will likely focus more on corporate returns. At the same time, we believe there will be tolerance for considering corporate returns impact over a medium-term time horizon as long as managements can demonstrate pathway and visibility. For companies or sectors that are not projected to deliver attractive corporate returns, we believe one of three catalysts is needed to boost market confidence:

- **Higher product prices.** As shown in Exhibit 7, a 1% increase in corporate returns — if achieved via top-line growth and assuming no changes in cost structure — would require a 1%-4% increase in pricing. The ability for customers/consumers to tolerate potential price increases may continue to provide competition between Environmental and Social goals.
- **Lower costs (Innovation).** As has been seen across multiple sectors from semiconductors to shale to solar, greater investment in innovation can ultimately lead to cost reductions. The levelized cost of energy for renewable power has decreased by more than 70% since 2008, and the overall cost curve of carbon abatement — detailed in our Global Energy team's Carbonomics reports — has also decreased due to innovation and scale.
- **Policy support.** Governments are likely to play a critical role in supporting Green Capex with multiple mechanisms in addition to their role in providing the necessary regulatory clarity to stimulate additional engagement in Green Capex from public and private companies. Among policy measures, we note the recent Inflation Reduction Act in the US, Infrastructure Bill in the US, China's 14th 5-year plan and EU's Green Deal as supportive of Green Capex initiatives. In Europe, we note the recent REPowerEU initiative should generate additional support to Green Capex.

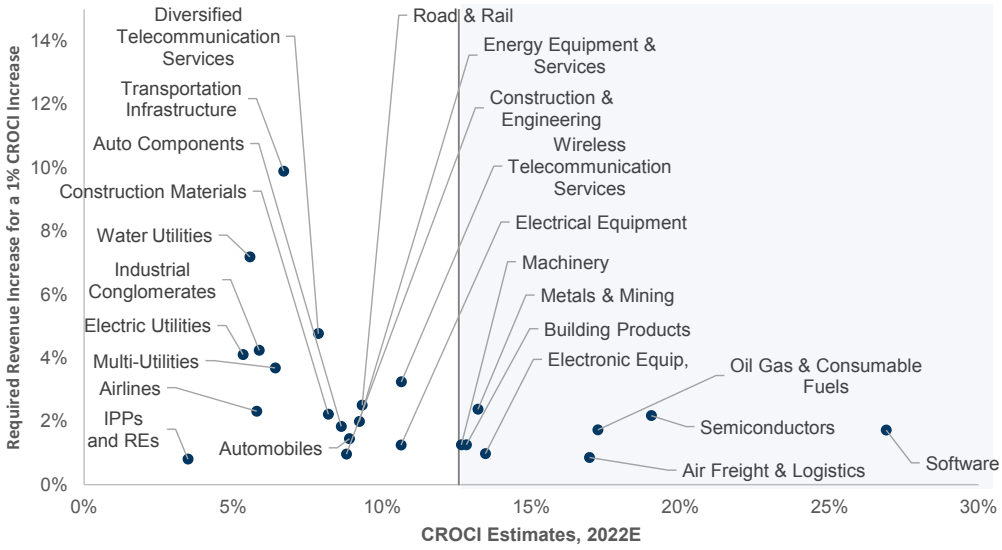
Exhibit 6: There is opportunity for greater reinvestment by sectors with above-average corporate returns in the top half of the exhibit ...
Reinvestment rate vs. cash return on cash invested weighted average by sector for companies covered by GS Research, 2022E



*We view Real Estate cash return on cash invested as less comparable than other sectors

Source: FactSet, Goldman Sachs Global Investment Research

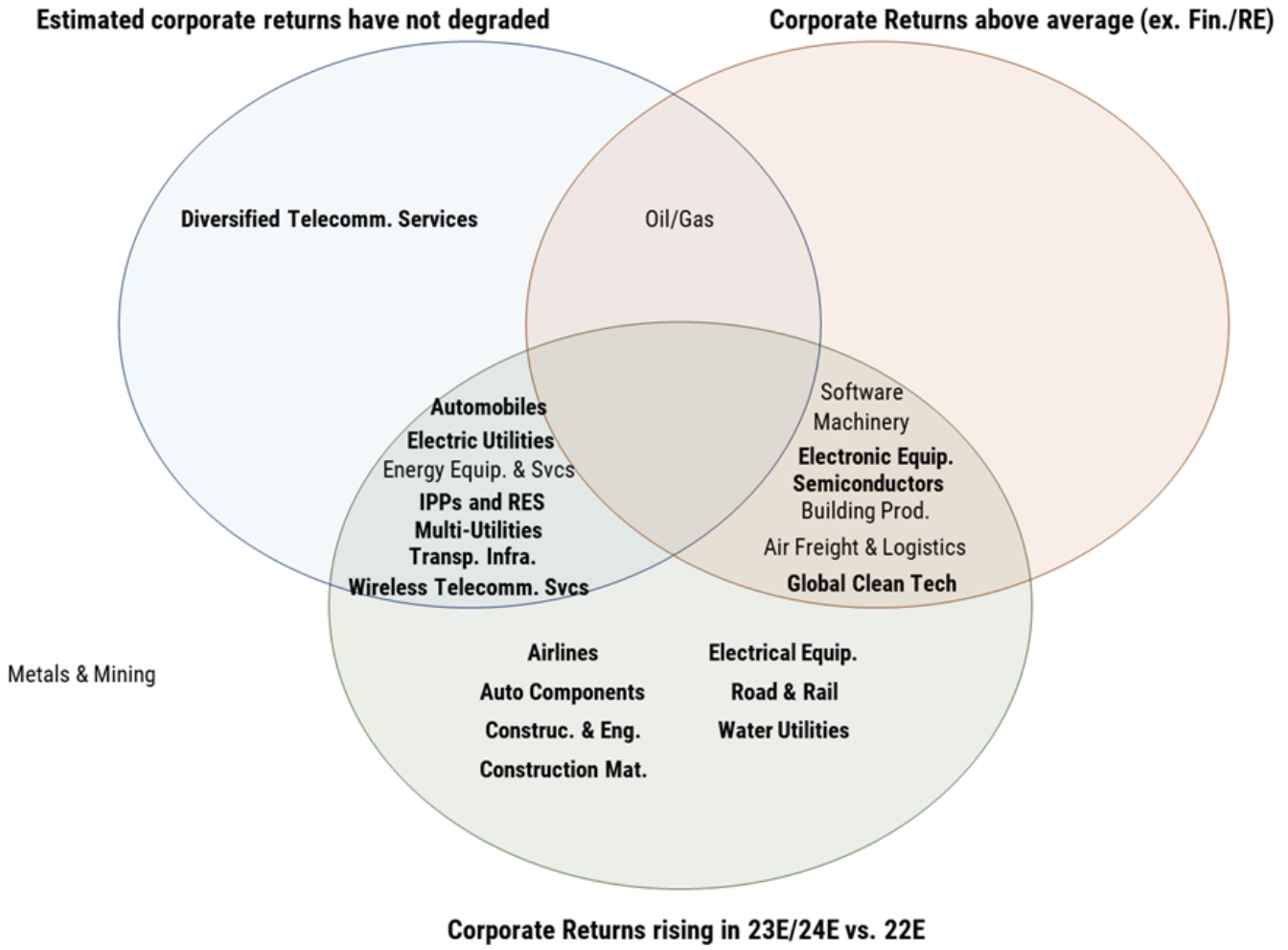
Exhibit 7: ... While unregulated sectors with below-average corporate returns on the left half of the exhibit may need higher product prices, lower costs or policy support to receive market support for increased investment
Implied revenue increase (assuming no change in costs) required for a 1% increase in CROCI, '22E / '23E average, select sectors



Vertical line represents the 2022E weighted average CROCI for all sectors

Source: Goldman Sachs Global Investment Research

Exhibit 8: We believe investors will look to sectors that over time have some combination of resilient, high and or rising corporate returns
Overview of sectors for which (1) corporate returns analyst estimates have not degraded vs. our Feb. 2 report, (2) estimated corporate returns in 2022E-23E are above average (ex. Financials and Real Estate) and (3) corporate returns are forecast to rise in 2023E or 2024E vs. 2022E. Bolded sectors have above-average — ex. Financials & Real Estate — reinvestment rate (refers to 2022E-23E average)



Corporate returns are considered not degraded if current estimates are higher than or within 0.2% of prior estimates. Calculations refer to the sector 22E/23E average CROCI.

Source: Goldman Sachs Global Investment Research

Why different strategies are needed by country/region to drive impact

We believe investors, policy-makers and managements should not view impact homogeneously when considering strategy or product deployment. Some countries could benefit more from decarbonization efforts initially focused on corporates, while others could benefit more initially from solutions that can lower consumer emissions. As such, policies and policy-committed capital should be targeted at the region or country level to influence the greatest level of behavioral change from consumers/corporates and investment in decarbonization solutions. Our analysis suggests greater policy support is needed in APAC, greater investor/corporate engagement is needed in Americas/EMEA, consumer-based decarbonization solutions can be initially impactful deployed in the US/Japan/Australia, and corporate-focused solutions can be initially impactful in India/South Africa/Saudi Arabia.

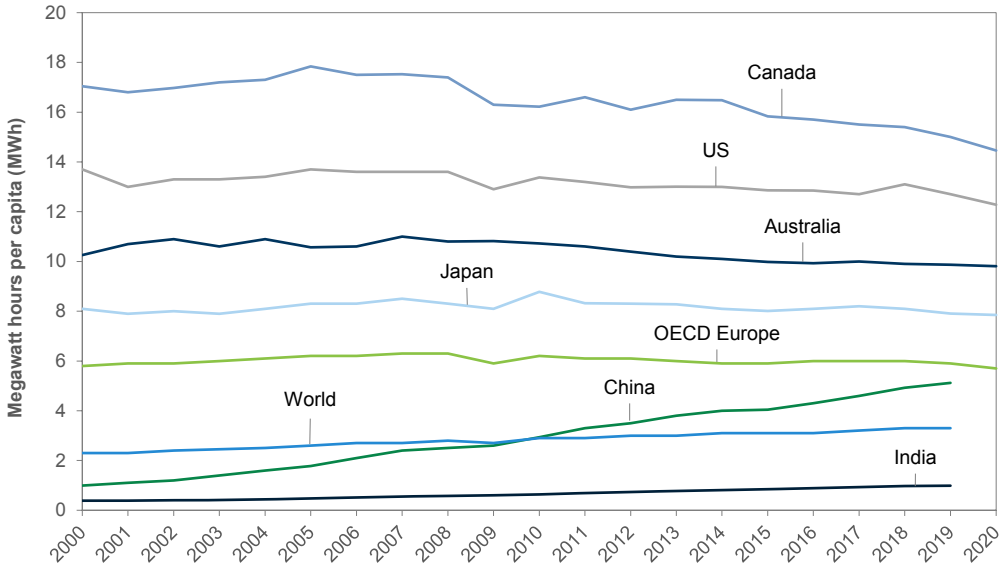
Focus solutions initially on consumers in some countries, corporates in others

We believe an all-in approach embracing consumer- and corporate-level emissions will be needed to achieve Decarbonization goals. There is rising recognition that policymakers and investors have focused decarbonization efforts more towards lowering supply of high-emitting products than lowering demand. This has helped contribute to the inflationary environment in commodities, even before the Russia-Ukraine war exacerbated supply disruptions. As we have noted, reported Scope 1 emissions from publicly traded corporates across sectors in our 7,000+ company GS SUSTAIN database only adds up to about 18% of global emissions. As such, solutions that that can change consumer behavior, government emissions and can be deployed by private companies are extraordinarily important. The relatively low direct emissions footprint by corporates is an argument used to promote wider disclosure of Scope 3 emissions which considers consumers. But beyond accounting, driving impact will require greater thoughtfulness on where to deploy consumer-based solutions/pressure and where to focus on corporate emissions. Our analysis suggests this focus should vary by country, depending on whether the major emissions driver is skewed towards consumer vs. corporate emissions. More details can be found in our ESG of the Future report on corporate greenhouse gas emissions.

Higher-income countries consumer more electricity per capita than lower-income countries. Overall electricity demand on a per capita basis is greatest among developed economies, though we note that — even among developed countries — the US is meaningfully above Japan, which is meaningfully above EMEA. The global weighted average is significantly lower, as a result of many countries and populations with more limited access or affordability for electricity consumption. We believe advancement towards No Poverty Sustainable Development Goals likely means that the global average for electricity consumption per capita will be on the rise in future years. This is another reason for financial market and policymaker consideration for corporate vs. consumer emissions. For some countries like Canada, the higher electricity

consumption per capita is in part driven by severe weather — i.e., a greater number of population-weighted heating and cooling degree days. This is less applicable — based on IEA data — for the US and Japan.

Exhibit 9: Higher-income countries consume much more energy than lower-income countries on a per-capita basis
Per-capita electricity consumption by country

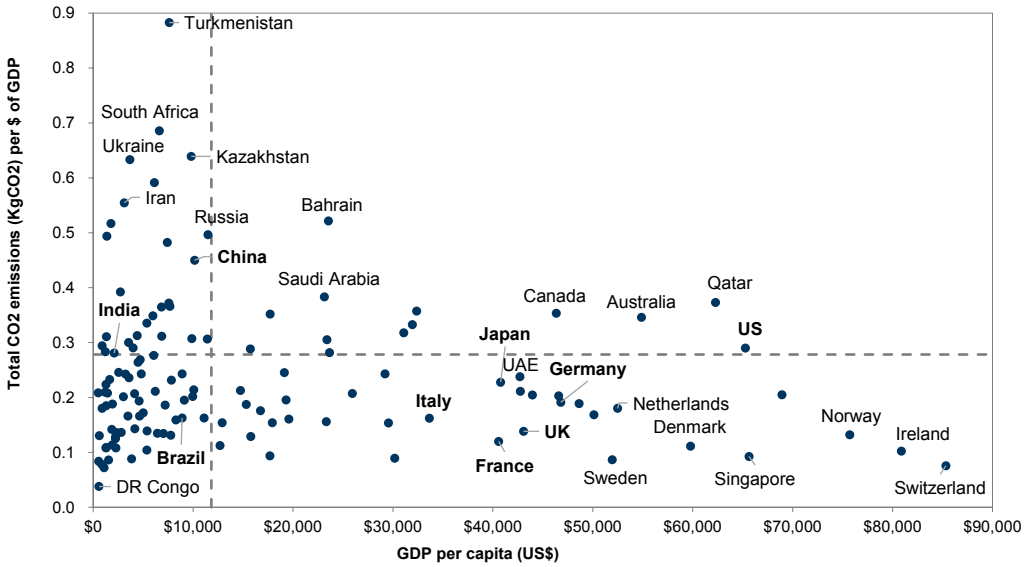


Source: IEA, Goldman Sachs Global Investment Research

However, overall emissions intensity by country does not consistently match up with electricity consumption per capita. The positioning of countries when looking at country-level emissions per dollar of GDP differ from the rankings when evaluating electricity consumption per-capita. As an example, the US and India both have similar levels of overall emissions per dollar of GDP (about the global average) even as the US has a materially higher electricity consumption per capita than India (US well above average and India below average). This is an example of why strategies for decarbonization should not necessarily be deployed homogeneously and should focus more regionally on corporates vs. consumers.

Exhibit 10: Overall country emission intensity of GDP is greatest in lower-income resource-producing countries

CO2 emissions intensity per $ of GDP and GDP per capita by country, 2019; top 10 countries based on GDP are bold

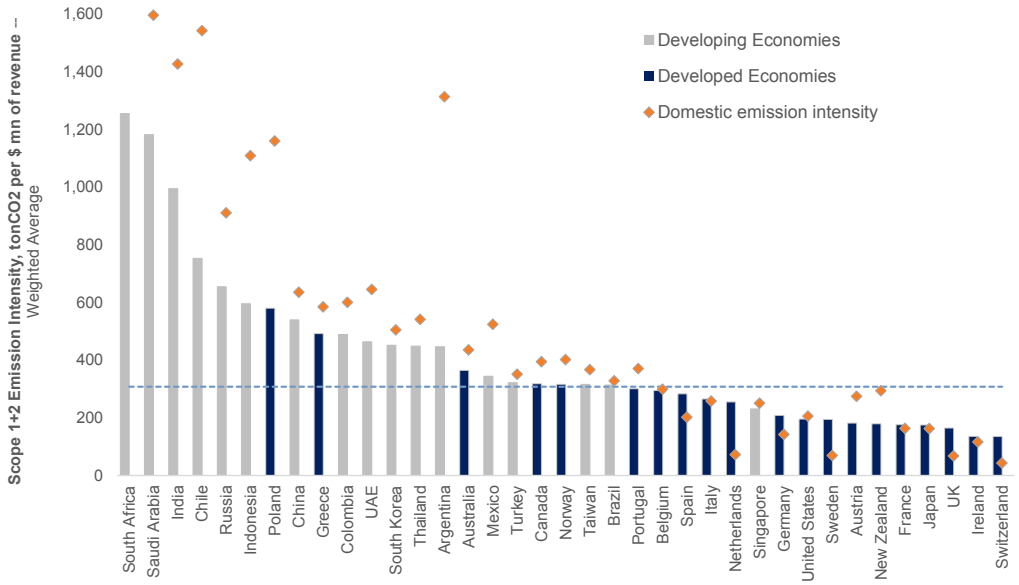


Source: World Bank, United Nations, Global Carbon Atlas, Goldman Sachs Global Investment Research

Corporate emissions intensity on a revenue basis is greatest in emerging markets or those more dominated by energy-intensive industries. Exhibit 11 shows corporate-level Scope 1 + 2 emissions per dollar of revenue by country, derived applying a company's overall emissions intensity to a country based on what percent of revenue each company sells in a given country. So if a company sells 50% of its product into country A and 50% of its product into country B, both countries would be allocated half the company's emissions and half the company's revenue towards calculating country-level corporate emissions intensity. Based on this methodology, countries such as Saudi Arabia, India and Russia have the highest corporate emissions intensities. On the other end of the spectrum, corporate emissions intensity is lowest in Western European countries (Switzerland, UK, Ireland, France among them), Japan and the US. We note that not every company discloses emissions, and our dataset looks only at emissions at disclosed publicly traded companies (with select high-emitting private companies that disclose emissions also included, primarily electric utilities in Asia and South Africa).

Exhibit 11: Emissions intensities for publicly listed corporates based on our revenue-allocation method are higher in emerging markets

Publicly traded company Scope 1+2 emissions intensities, tons of CO2 per $ of revenue allocated to country of sales, 2019. Sorted from highest (left) to lowest (right); domestic emissions intensity reflects in-country emissions intensity from companies headquartered in-country



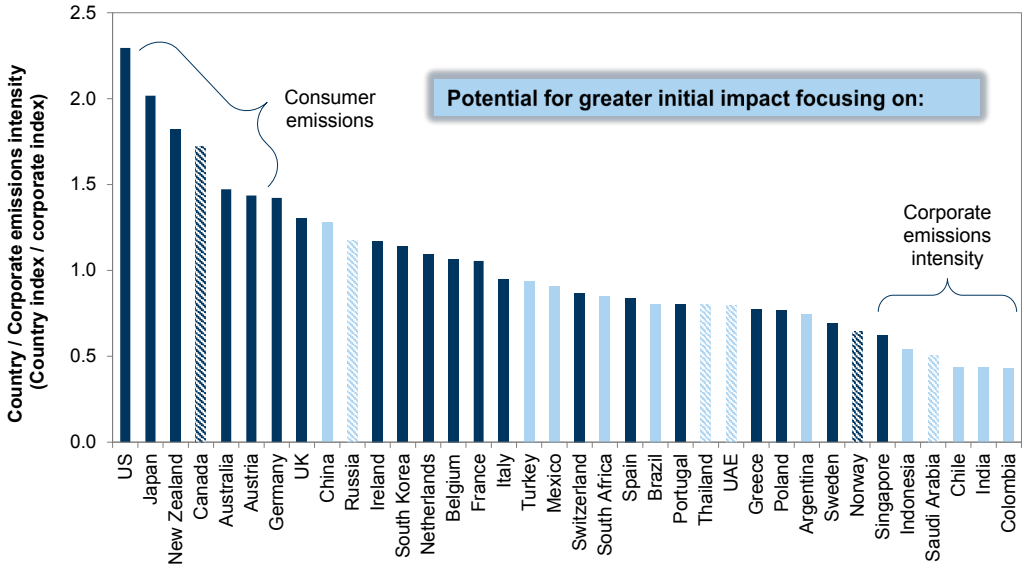
South Africa's domestic emissions intensity is implied at about 1,980 tonCO2 / $ mn

Source: Thomson Reuters, FactSet, Bloomberg, Refinitiv, United Nations, Company data, Goldman Sachs Global Investment Research

We believe this suggests the initial focus of investors and policy-makers towards decarbonization should be varied depending on the country to have the greatest impact. Our analysis suggests that there may be greater impact focusing in the United States and Japan on the consumer vs. the corporate, while there may be greater impact in India and Eastern European countries focusing more on the corporate than the consumer. In Exhibit 12 we have created a qualitative index where policy/investor focus may initially be better directed towards the corporate vs. the consumer or equally to both. We believe equity markets will put premium valuations on companies with favorable corporate returns providing energy efficiency solutions or innovation as confidence builds in impact and execution.

Exhibit 12: Our indicative index that divides country emissions intensity per $ of GDP by corporate emissions intensity per dollar of revenue suggests potential greater initial impact from focusing decarbonization efforts on consumers in the US and Japan and on corporates in India and other emerging markets

Country emissions intensity index / corporate emissions intensity index, 2019



Index values calculated by dividing a country's overall/corporate emissions intensity values by the median values of the comparison set. Dark blue bars represent developed countries, light blue bars represent developing countries, and striped bars represent countries with more than 3,500 degree days in 2019.

Source: Goldman Sachs Global Investment Research

Why corporate capacity for reinvestment differs by region

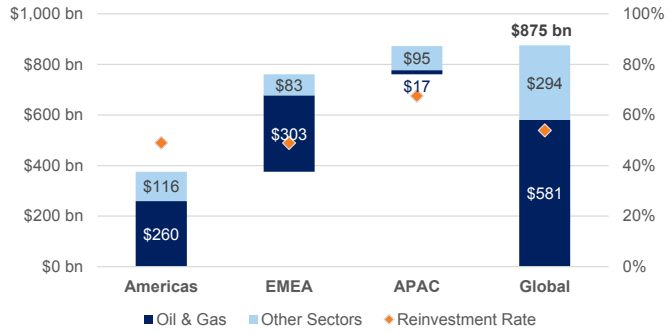
Green Capex spare capacity for public companies — potentially unlocked via higher reinvestments of cash flows into capex + R&D and higher leverage — is highly concentrated among Americas and EMEA companies. Exhibit 13 shows the annual Green Capex spare capacity — calculated under the assumptions that if reinvestment rates of operating cash flow into capex + R&D were to revert back to the historical average between 2000 and mid-2010s — is primarily concentrated among companies headquartered in the Americas and EMEA, where each region holds 43%-44% of the global total. Public companies based in Asia Pacific account for less than 15% of the total.

Spare capacity for investment from Oil/Gas — which represents the majority of overall Green Capex spare capacity — is more heavily concentrated in Americas/EMEA. As we have written in our latest Green Capex report, Green Capex spare capacity is even more concentrated vs. our prior reports among Oil & Gas publicly-traded companies: regionally, Oil & Gas represents 69%, 78% and 15% of total regional Green Capex spare capacity in Americas, EMEA and Asia Pacific, respectively.

Additionally, reinvestment rate of operating cash flow back into capex + R&D is higher in APAC. APAC companies under GS Research coverage are expected to reinvest 68% back into their business vs. 49% for companies based in the Americas/EMEA. Please see Exhibit 14 for the regional breakdown of reinvestment

rates since mid-2000s. We also note APAC companies under GS Research coverage are — on a weighted average basis — forecast to deleverage more and faster than the global/Americas/EMEA weighted average (please see Exhibit 15 for more details).

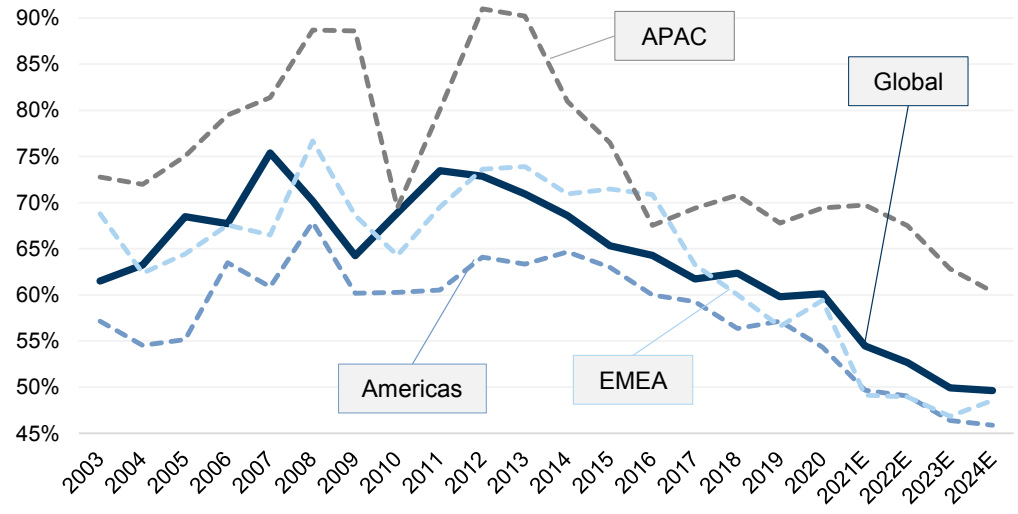
Exhibit 13: Of the $0.9 trillion in annual Green Capex spare capacity via higher reinvestment and higher leverage, public companies based in Americas and EMEA account for about $0.8 tn; APAC companies hold <15% of total global spare capacity
Regional breakdown of Green Capex spare capacity from key relevant sectors needed for Net Zero, Infrastructure and Clean Water goals, and weighted average of 2022E reinvestment rates of cash flows into capex + R&D



Spare Green Capex capacity considers potential for shift in reinvestment and tolerance for leverage. Reinvestment capacity is based on incremental capex/R&D capacity to achieve a 70% 2022E reinvestment rate of cash flow. Leverage capacity is based on incremental spending per year over remainder of decade based on difference between 2022E net debt/EBITDA and 1.5x. Diversified Telecom Services has positive excess capacity from reinvestment that gets cancelled out by leverage impact.

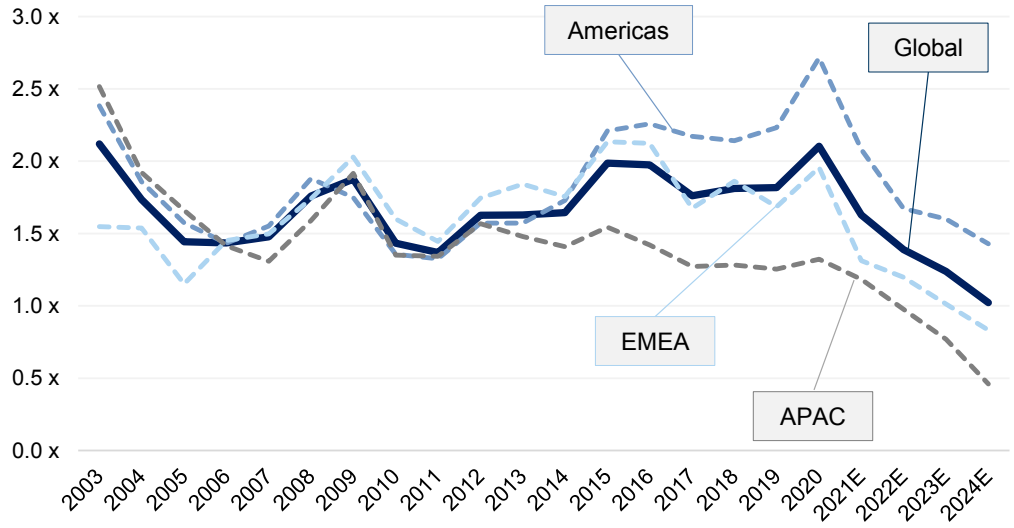
Source: Goldman Sachs Global Investment Research

Exhibit 14: Reinvestment rates of cash flows into Capex + R&D have trended downward globally and regionally since mid-2010s, though APAC public companies have been reinvesting more throughout the period and are forecast to continue to do so through 2024E
Consensus estimates for reinvestment rates of cash flows into Capex + R&D, 2003 - 2024E — excludes Financials and Real Estate — globally and by region



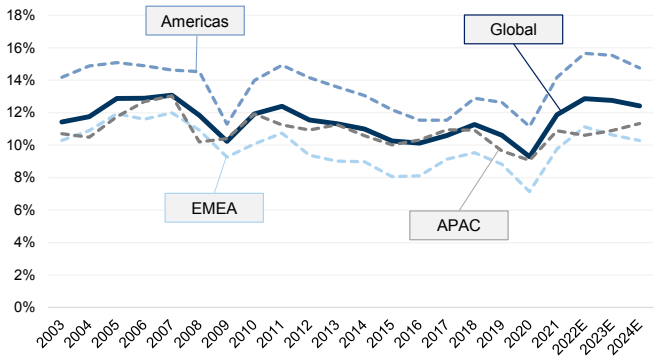
Source: FactSet, Goldman Sachs Global Investment Research

Exhibit 15: Net Debt/EBITDA ratios has been decreasing globally and are now forecast at about 1.0x in 2024E, though we note that APAC companies are characterized — on a weighted average basis — by lower leverage
Net Debt/EBITDA ratio, globally and by region



Source: FactSet, Goldman Sachs Global Investment Research

Exhibit 16: Corporate returns for Americas companies have been, and are projected to be, above the global average
Weighted average CROCI for all sectors, excluding Financials and Real Estate



Source: FactSet, Goldman Sachs Global Investment Research

Implications

Policy support needed in APAC, investor engagement needed in Americas/EMEA. We believe Asia-based companies may have relatively more limited opportunity set for increased reinvestment and as such there may be greater need for other stakeholders like policy-makers to incentivize or directly support Green Capex. As we have highlighted, we see potential for investors to consider a more engagement-oriented approach with companies that have meaningful spare capacity to help direct spare capacity towards Green Capex.

Consumer-based solutions needed in the US/Japan/Australia, corporate-focused solutions needed in India/South Africa/Saudi Arabia. As we have highlighted, we see impact opportunity for those that can provide solutions to lower consumer emissions intensity. These will particularly impactful in countries with relatively higher electricity per capita and relatively lower corporate emissions intensity like the US, Japan and Australia. Solutions that can mitigate corporate emissions can be particularly impactful in countries like India, South Africa and Saudi Arabia.

When the market should consider to support companies increasing investment

What do investors need to see to support ("CARE" for) companies' increased decarbonization investments? We believe the capability to generate favorable returns on Green Capex initiatives will be key regarding managements' decisions on how to allocate resources vs. returning capital to shareholders. In our view, investors are likely to "**CARE**" about Green Capex initiatives based on whether the company can demonstrate:

- **C**ore competencies in that area
- **A**vailable capital to deploy
- **R**eturns at the corporate level that are/remain favorable over medium term
- **E**xecution to meet goals and raise revenue contribution from Green initiatives that are material.

Our framework could serve as the lens investors could potentially use to assess where it is more favorable to allocate capital. In our view, to the extent projects do not meet the four pillars of "CARE," capital may be more efficiently deployed when returned to shareholders and then re-directed to Green initiatives.

A key area of focus — particularly for larger/diversified companies — is on Returns and Execution. For decades, investors in companies pursuing major capital projects have often been more willing to own stocks when they are in the "Harvest" phase of their investment cycle (i.e., when new projects are coming online or are sufficiently close to starting up where a shift in growth and free cash flow can be confidently forecast). Investors have been less willing to own stocks when they are in the "Investment" phase at the early stages of multiple years of less meaningful returns/FCF. We do not expect these forces to go away. For managements, boosting confidence in medium to longer-term corporate and project level returns is key. An unwillingness by managements to make investments or investors to support them because of longer-term nature could be a tactical consideration for policy stimulus.

Driving innovation in Clean Reliable Energy

Clean Reliable Energy likely to receive premium valuation over Clean Energy. The spike in commodity prices and disruption in Russia/Ukraine commodity supply has brought to the forefront the need not just to transition to Clean Energy but to have adequate supply of energy reliability. To simultaneously meet Environmental and Social goals, ideally the reliability should be clean and the clean should be reliable. With some country policies more focused on clean and others more focused on reliability, innovation and inventory will likely key areas of focus going forward. Specifically, we see potential greater deployment of Hydrogen, Battery Storage and Nuclear which have potential to lower both corporate and consumer emissions intensity.

Cost reductions + inflation + policy likely to spur innovation. Renewable energy sources — per our US Utilities team's estimates — are currently cost-competitive with other generation technologies on a levelized cost of electricity (LCOE) basis, driven by improvements in operational efficiencies and a reduction in the cost of capital for clean energy developments (please see our colleagues' report Carbonomics: The Clean Hydrogen Revolution for more details on those drivers). While we see potential for further innovation within solar/wind, given intermittency issues we believe there will be greater premiums attached to Clean Reliable Energy solutions if they can scale and also move down on the cost curve. Energy reliability issues (albeit temporary) over the past two years in Texas, California, China and Europe have further focused investor attention on solutions to decarbonization that do not compromise energy reliability. The focus on reliability has increased further post Russia/Ukraine conflict. We are optimistic that we could see innovation accelerate if the current price spike is prolonged — as we previously noted, the last commodity price spike in 2003-08 led to impactful innovation in shale scale.

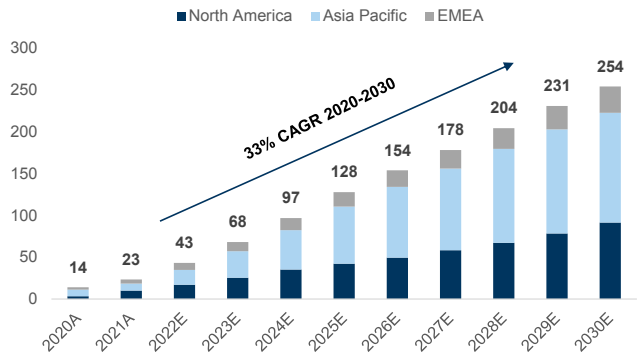
We expect Energy Reliability to be particularly in focus in Europe. As our European Utilities team recently noted, the Russia-Ukraine conflict is likely to drive an inflection point in EU's energy policy via the REPowerEU initiative. Our colleagues expect the proposals to revolve around (1) security of energy supply and (2) greater consumer protection. On the former, new policies are expected to highlight the need to degasify Europe, via acceleration of renewables developments/electrification and slower decommissioning of existing coal plants.

Hydrogen deployment likely to expand rapidly in Europe — demonstrating cost reductions and medium-term returns key. As detailed in its Carbonomics: The Clean Hydrogen Revolution report, our EU Energy team expects global hydrogen demand to grow between 2x-7x by 2050E vs. 2020, depending on the temperature rise scenario considered. Particularly on Green Hydrogen In Europe, on the back of policy support from REPowerEU, our colleagues expect 20 Mton of renewable H2 by 2030 (a notable upgrade vs. the 5.6 Mton under the "Fit for 55" initiative), or a >3.5x upward revision in the same timeframe, stemming from a combination of locally produced and imported volumes. See Exhibit 18 for more details.

Hydrogen and Battery storage have potential transformational growth in the US

due to Inflation Reduction Act tax incentives, as described in our recent report. On Hydrogen, the IRA introduces a production tax credit (PTC) for clean hydrogen of up to $3/kg of hydrogen, provided lifecycle CO2-equivalent emissions are not greater than 4 kgCO2-eq/kg of hydrogen produced, which significantly improves the economics of Green Hydrogen and, more modestly, Blue Hydrogen. As discussed in the report, potentially, the Clean Hydrogen PTC can fully bridge the gap between fossil fuel-based hydrogen production and hydrogen from renewable power. On stationary Battery Storage, in our view, the IRA is most transformational for utility-scale and residential standalone deployments, given the extension of the investment tax credit (ITC) to energy storage solutions — even when not co-located with renewable assets — with a higher amount (30% vs. 26% in 2022 and 22% in 2023, previously). Potentially, the IRA could pave the way for acceleration in residential standalone deployments due to significant improvements in project economics, and, on the utility-scale, the bill could incentivize project developers and utility companies to build storage sites alongside their wind and solar properties and receive tax credits for both.

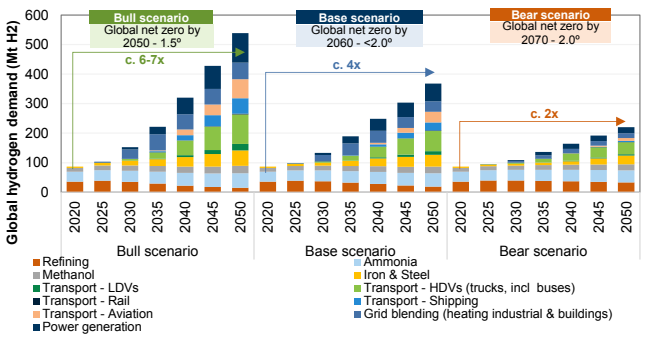
Exhibit 17: Our Clean Energy teams estimate annual battery storage installations to grow at a 33% CAGR in the 2020s, for a total cumulative installed capacity of more than 1,400 GWh by 2030
Annual battery storage installations by geographic region, in GWh



2020A from BNEF and Wood Mackenzie

Source: Goldman Sachs Global Investment Research, BNEF, Wood Mackenzie

Exhibit 18: Our Carbonomics team estimates meaningful growth in the hydrogen market, with hydrogen demand increasing at least 2-fold and up to 7x on the path to net zero
Global hydrogen demand (Mt H2) under the three GS net zero models



Source: Goldman Sachs Global Investment Research

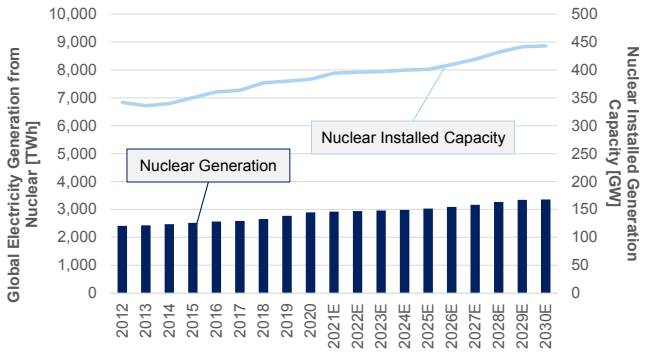
Nuclear: greater focus for energy reliability concerns, but acceleration in deployments and abatement in generation costs would be required on path to Net Zero. We believe nuclear power could potentially receive greater focus in response to energy reliability issues that affected major economies worldwide in 2021/2022, i.e., the need to ensure sufficient low-emissions baseload generation to counterbalance the intrinsic intermittent nature of renewables. This is aligned and supported by the recent inclusion of nuclear — alongside natural gas-fired power when replacing coal — into the EU Green Taxonomy, with nuclear, particularly, receiving soft pushback in a framework where governments and regulators are trying to solve for decarbonization and energy independence. We estimate nuclear generation capacity of about 450 GW in 2030, up from ~380 GW in 2020 (see Exhibit 19). In a more ambitious scenario on path to Net Zero emissions by 2050, IEA estimates call for an increase in average annual additions to 17 GW in 2021-2030 and 24 GW in 2031-2050, vs. the historical average of 7 GW in 2016-2020, globally (Exhibit 20). Our US Utilities

team estimates a levelized cost of electricity generation of c$0.68 per MWh for nuclear, above other clean energy resources such as us utility-scale PV and onshore wind, as well as natural gas combined cycle.

Looking ahead, advanced, modular nuclear reactors could result in more affordable generation cost. Advanced Small Modular Reactors (SMRs) are a focus areas for private and public R&D, as they could enable the abatement of generation costs from nuclear reactors. In fact, smaller and more modular reactors could allow better exploitation of economies of scale and design efficiencies than GW-scale reactors. These reactors are envisioned in the range within tens of MW to hundreds of MW and may employ light water (as opposed to "traditional" nuclear, which employs heavy water) or other mediums such as gases, liquid metals or molten salts as coolants (see here for an overview). Combined with the ability to possibly work at pressures and temperatures close to atmospheric levels, SMRs could result in lower LCOE and therefore unlock accelerated deployments of nuclear power plants.

Exhibit 19: Our global power generation model through 2030E estimates c.450 GW of nuclear generation capacity by the end of the decade

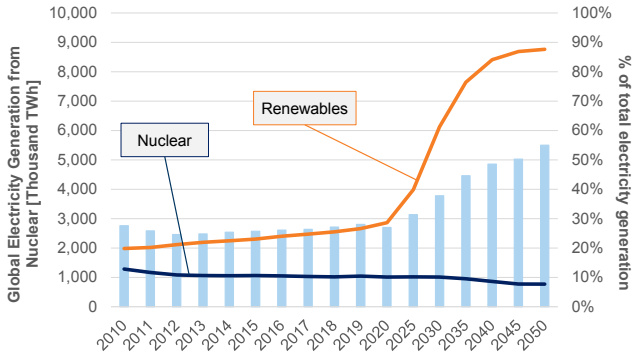
Nuclear electricity generation (vertical bars, dark blue) and nuclear installed capacity (line, light blue) — based on GS estimates



Source: Goldman Sachs Global Investment Research

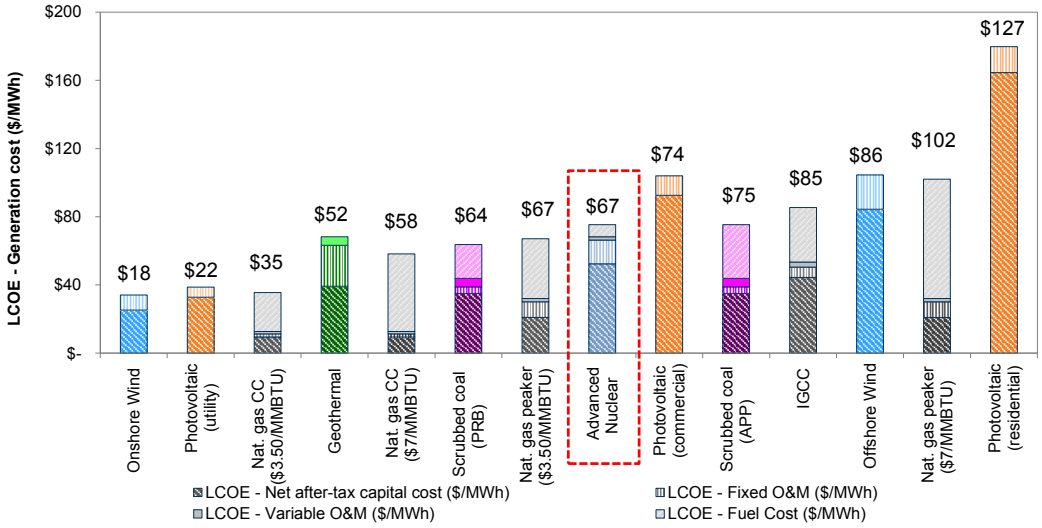
Exhibit 20: IEA estimates on path to Net Zero by 2050 call for growing electricity generation from nuclear, though accounting for a decreasing share of total electricity — dominated by fast-accelerating renewables deployments.

IEA estimates under the Net Zero by 2050 scenario for electricity generation from nuclear plants (vertical bars, in thousands TWh), % of total electricity generation from nuclear (blue line) and % of total generation from renewables (orange line)



Source: IEA, Goldman Sachs Global Investment Research

Exhibit 21: Our US Utilities team estimates the LCOE of advanced nuclear power to be significantly higher than utility-scale solar, onshore wind and NGCC
Levelized cost of electricity generation (LCOE, $/MWh)



Underlying assumptions refer to US.

Source: Goldman Sachs Global Investment Research

Exhibit 22: Innovations across multiple technologies could help lower the cost of decarbonization and introduce new climate solutions
Select focus areas for decarbonization technological innovation

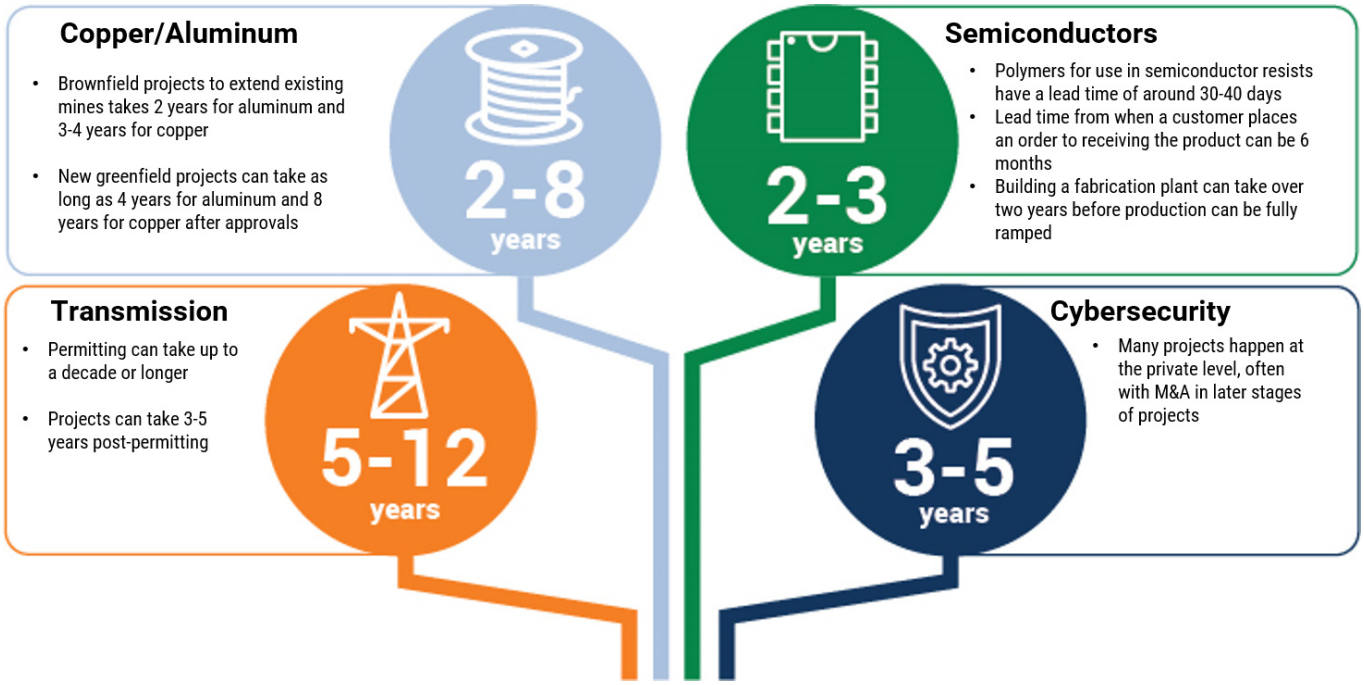
Technologies	Innovation areas	Technologies	Innovation areas
Electrification	Next gen high cell efficiency technologies	Carbon Capture	New capture technologies
	Optimization of wafer size and thickness		Optimization of input costs
	Changes in module design	Low Carbon Fuel	Localization of clean hydrogen ecosystems
Grid Transmission	Ultra-High Voltage (UHV) lines		Fuel cell vehicles
	Equipment and software upgrades		Gas-fired distributed generation
Low Carbon Production & Energy Conservation	Electrification of construction equipment		Sustainable Aviation Fuel (SAF) solutions
	EAF and hydrogen steel production	Digitalization	Cost deflations in Silicon Carbide
Battery Storage	Improvements in battery energy density	Hydrogen	Improvements in electrolyzers (performance and cost)
	Graphene based super-fast charging		Advancements in fuel cells (performance and costs)

Source: Goldman Sachs Global Investment Research, Gao Hua Securities Research

Greenablers like electricity transmission need early support

We believe ensuring adequate supply of "Greenablers" or Green Enablers — early in the supply chain materials or products needed as building blocks towards executing on decarbonization solutions — will be critical to avoid supply chain bottlenecks. While not a complete list, we have identified Copper/Aluminum, Semiconductors, Electricity Transmission and Cybersecurity as key Greenablers that warrant focus. We focus in this section on electricity transmission given that in many countries there is ample distance between where renewable capacity will be deployed and where consumption markets exist. We believe across transmission and the other Greenablers, collaboration between policymakers, corporates and investors will be key to ensure adequate permitting, market support for corporate investment, project/corporate returns and environmental footprint mitigation.

Exhibit 23: We estimate the lead time for Greenablers projects is 2-12 years, which will likely add an urgency/greater focus on investment levels for Semiconductors, Copper/Aluminum, Electricity Transmission and Cybersecurity in particular



Source: Goldman Sachs Global Investment Research

Transmission infrastructure: A key need and a key risk

Electricity Transmission is a 'Greenabler' due to its criticality in supporting expansion in renewables and electrification, but investments are needed timely to avoid reliability issues. As detailed in our Green Capex: Making Infrastructure Happen report, we believe Electricity Transmission is a key 'Greenabler' (i.e., Green Enabler) due to its pivotal role in ensuring reliability of electricity supply while more renewable assets integrate/replace traditional power plants and penetration of electrification technologies increases. The need to transport electrons to demand centers from solar/wind plants — not necessarily in their proximity, but whose positions are rather dictated by where

sun/wind are more plentiful — adds more complexity to the refurbishments vs. new build scenarios. However, electricity transmission expansions do not happen overnight, as they require rights of way, permitting approvals, and, in regulated markets like the US, approval to pass through to customer bills. **The range of lead time for these projects is 5-12 years, the longest of the four Greenablers sectors** we highlight in our Green Capex reports (with permitting/land acquisition typically covering the largest share of the timeline, sometimes proving to be an insurmountable hurdle).

IEA's estimates on path to Net Zero by 2050 call for a c.130% increase in annual average expansions/replacements in electricity networks globally in the 2020s vs. the 2016-2020 average. As detailed in the Net Zero by 2050 report, the International Energy Agency (IEA) projects about 4,400 mn kilometers of power lines will be refurbished/newly-built annually in the 2020s, on average (a c.130% increase vs. the 2016-2020 annual average, please see Exhibit 24). This is driven by about 1,600 mn km of annual refurbishments and about 2,800 mn km of annual new builds due to renewables/electrification in the 2020s, +33% and +310% vs. the 2016-2020 annual average, respectively. Beside power lines, complementary pieces of infrastructures — e.g., substations — will be critical too: based on IEA's estimates on path to Net Zero goals, the annual build-outs in substations capacity would double in the 2020s vs. the annual 2016-2020 average (Exhibit 25).

Electricity Transmission is a key focus in China's 14th 5-year plan. In China, our colleagues expect more than $0.4 trillion ($2.8 billion Rmb) in investment in the grid system over the 14th Five-year plan period with a rising focus on automating distribution coverage and intelligent dispatching (see China de-carbonization: A new eco-system of green tech for more details). Ultra-high voltage (UHV) line development was one of the new infrastructure projects introduced in 2020. In addition, as China embraces renewable energy, its power grids will need to be become digitalized to enable energy storage, demand-side management, remote controlling, and real-time demand forecasting. This is part of about $0.9 trillion of investment in the power grid we expect in China through 2060. According to the NEA, China has invested an aggregate of c. US$671 bn over the past 10 years and built 1.03 mn km in transmission infrastructure (110Kv and above) as of 2018-end, facilitating 1,900 GW in accumulated power capacity. The importance of Electricity Transmission has been reiterated more recently NDRC and NEA's Renewable Energy Development Plan for the 14th 5-year plan, where the agencies indicated the requirement of renewable energy power generation of no less than 50% for newly built power lines.

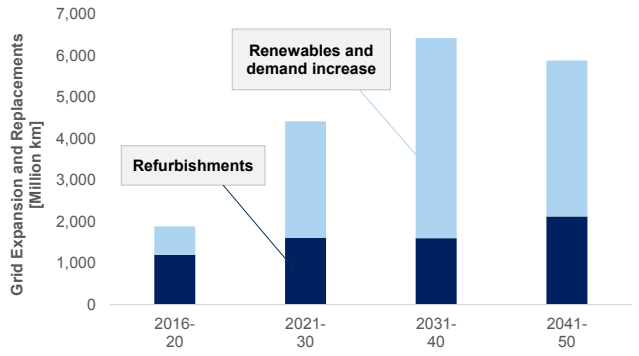
EU investments for the Green Deal are also significant. As detailed in our European Utilities team's report, EU Green Deal estimate up +50%, now at €10 trn, we see the need for $1.0 trillion (0.8 billion Euros) in transmission and distribution investments by 2050, mostly to upgrade the grids' resilience (digitalization) to accommodate the rising share of intermittency (e.g. renewables), and to cope with the rising electrification of mobility. We note that the acceleration in renewables deployments under the REPowerEU initiative — a c.15% upgrade vs. the 'Fit for 55' plan, implying a 3.5x increase in capacity vs. 2021 base and, on average, c. 100 GW added annually in the 2020s — would necessarily involve expansion/strengthening of EU's electricity

networks as more renewables are integrated into the grid replacing legacy assets.

US transmission expansion critical, with potential for bottlenecks around permitting. In the United States, the recent Princeton University Net-Zero America study estimates in its most aggressive scenario for electrification and reliance on renewable energy that transmission capacity needs to expand by ~75% by 2030 and 3.5x through 2050, with total capital investment invested in transmission of $0.5 trillion through 2030 and $2.5 trillion by 2050. The study recommends the need for a 60% expansion of UHV capacity during the 2020s. Regionally, the Princeton study highlights the greatest investment needs will be in Texas, California, New York, North Carolina, Montana and Nebraska. Rights of way and permitting issues could be a meaningful bottleneck for investment, due to local concerns regarding land use and time to receive approvals.

Exhibit 24: Per IEA projections, annual builds in electricity networks are estimated to increase by 130% in the 2020s vs. 2016-2020 — driven by a 33% increase in annual refurbishments and expansion driven by renewables/electrification more than tripling in the same period

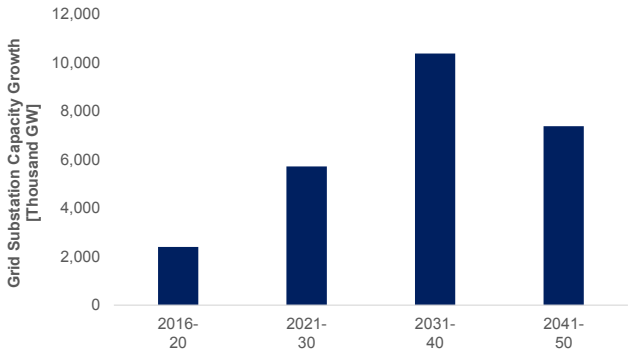
Annual average electricity grid expansion and replacement needs per time periods in the Net Zero by 2050 scenario, driven by (1) refurbishments and (2) renewables installations and broadly demand increase. Values in Million km of annual new build.



Source: IEA, Goldman Sachs Global Investment Research

Exhibit 25: Paired with electricity networks' expansions, IEA estimates call for annual substations build-outs almost doubling in the 2020s vs. the 2016-2020 average

Annual average substation capacity growth in electricity networks in the Net Zero by 2050 scenario. Values in thousands of GW.



Source: IEA, Goldman Sachs Global Investment Research

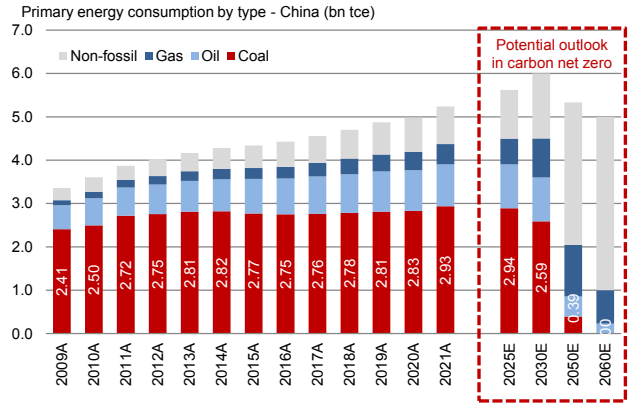
Case study: Investing to decarbonize China

Chinese coal demand may stay more resilient in the medium term, as China takes more paced approaches in the energy transition for climate change. Nevertheless, the long-term profile of coal demand remains in contracting trend. We see China taking steps on innovative models facilitating smoother energy transitions, by leveraging existing coal-fired assets and also improve the utilization of renewables. We highlight individual projects in co-generation and carbon capture.

China's transition away from coal appears gradual for now

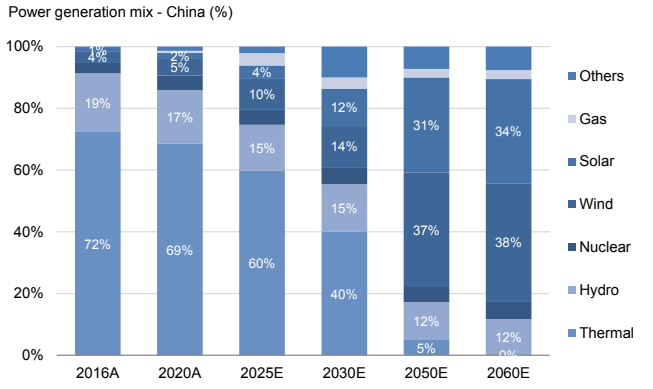
Chinese coal demand may stay more resilient in the medium term, as China takes more paced approaches in the energy transition for climate change. Nevertheless, the long-term profile of coal demand remains in contracting trend. We estimate coal demand would decline to 88% of the current level by 2030E, and further decline to 0%-13% by 2050E-2060E. In the meantime, renewable energy contribution of total energy consumption is targeted to increase to 20% in 2025E, 25% in 2030E and 80% in 2060E, from 17% in 2021.

Exhibit 26: Potential China Net Zero outlook
Long-term energy target set by the Chinese government (2020-2060E)



Source: NDRC, NBS, GEIDCO, Goldman Sachs Global Investment Research

Exhibit 27: China's power generation mix: Renewables are expected to gain market share



Source: NDRC, GEIDCO, Goldman Sachs Global Investment Research

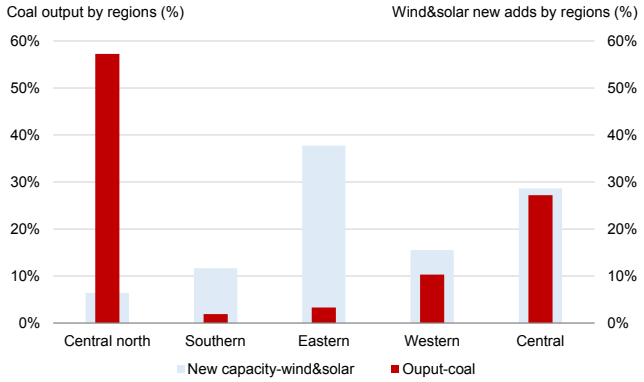
The potential exit of coal in the long run could be a challenging transition, in terms of managing the large liability (including bank loans) and the large number of workers. Based on data from the International Energy Agency and National Bureau of Statistics, we estimate total liability of China's coal mining sector and thermal coal-fired power assets would be Rmb3.7 tn and Rmb10.7 tn, respectively. The direct number of workers in the two sectors is 3.2mn and 2.6mn, respectively. We see the liability from the power sector as the largest long-term legacy issue that could prove difficult to solve.

At current coal prices, we estimate the aggregated liability on coal mining could be paid off in ~11 years, yet for upstream power assets, the exit could prove to be difficult, given the poor profits at present, and the relatively young fleet age.

Unfortunately, the geographic matching is poor between the coal miners and the location of the potential new job creation from wind/solar new capacity. We

estimate nearly 60% of coal production is from the central north region (mostly in Shanxi and Inner Mongolia), while we expect the wind/solar new capacity to increase the most in the next 10 years (nearly 500GW, or 38% of total) would be eastern China.

Exhibit 28: Coal output and wind solar new adds by region



Source: NDRC, WIND, Goldman Sachs Global Investment Research

Exhibit 29: China coal-fired power plants and coal mines - industry liability, employment and fleets (2020)

		Coal mines	Coal fired power plants
Total assets	Rmb tn	5.6	18.1
Total liability	Rmb tn	3.7	10.7
Employment	mn people	3.2	2.6
Worker age >50	%	22%	n.a.
Fleet			
Less than 10 years	%	n.a.	43%
10-20 years	%	n.a.	43%
20-30 years	%	n.a.	10%
30-40 years	%	n.a.	3%
40-50 years	%	n.a.	0%

Source: IEA, Wind, Goldman Sachs Global Investment Research

Desert co-power generation model an example of integrated decarbonization approach

In February 2022, NDRC and NEA jointly published the plan for building large-scale co-power generation base, with solar, wind and coal power generation integrated into one power source, in the Desert and Gobi areas. The plan targets to build a total of new power capacity of 455 GW by 2030E in these desert energy bases including:

- 284 GW in desert bases in Kubuqi, Wulanbuhe, Tengri, Badai Jaran,
- 37 GW in coal mining subsidence area in Shaanxi, Ningxia, Inner Mongolia, Shanxi,
- 134 GW in other desert and Gobi areas.

Specifically, the plan targets to build 200 GW new power capacity in these bases during 14th FYP (2021-2025) — accounting to nearly 10% of the national installed power capacity as of 2021A. An additional 255 GW co-power generation desert energy base will also be built during 15th FYP (2026-2030).

Within the co-power generation model, to ensure safety and stability of power grid after incorporating higher percentage of renewable energy, thermal power capacity will be incorporated in the new renewable energy base as supporting power source to lower curtailment of renewable energy from local grid. Based on the announced projects, we estimate renewable power typically accounts for an average of 70% of total power capacity, while coal-fired at 30%. The UHV will also be built to transmit power generated from these northwestern regions to eastern coastal provinces.

Exhibit 30: 14th FYP new energy base plan in desert area to sets medium term power generation model in energy transition period - China

14th FYP desert energy base new capacity addition plan, GW				upgraded
Desert energy base	Projects	Renewable	Coal-fired power	Coal-fired power
		GW	GW	GW
Kubuqi	Erdos	39.0	8.0	6.6
Wulanbuhe	Alxa League	21.0	4.0	2.0
Tengri	Tengri Desert	45.0	10.0	5.3
Badain Jaran	Jiuquan, Alxa, HexiJiajiu	23.0	4.0	2.0
Coal mining subsidence area	North Shaanxi, Ningxia, West Inner Mongolia, Erdos, North	37.0	2.0	26.2
Subtotals	GW	165.0	28.0	42.1
Breakdown	%	70%	12%	18%
2021 Year-end power capacity	GW	637.0	1,110.0	1,110.0
% of 2021A capacity by sourcin	%	26%	3%	4%
Total desert energy base	GW	235.1		
National power capacity-2021A	GW	2,377.0		
Desert in total	%	10%		

Source: NDRC, Goldman Sachs Global Investment Research

Unique opportunities in CCUS for China

China's CO2 emissions by sector is unique — the major contributors to CO2 emissions are power generation and industrial process driven emissions — at 80% of the country's emissions according to GS Carbonomics China Net Zero. We view investment and success of CCUS (Carbon capture, utilization and storage) could be more critical and valuable, given China's higher fossil fuel consumption in the total energy mix, large industrial sectors and relatively young facilities, and early stage of de-carbonization. CCUS is an essential solution for deep de-carbonization of industrial emissions that are currently non-abatable, due to the nature of the industrial processes and high-temperature heat requirements, in the cement, steel, chemicals sectors. Specifically, we estimate industrial process related (versus fuel related) CO2 emission from steel, cement, chemical and aluminium industries contribute 24% of total China's emission.

As with most technologies, CCUS will benefit from economies of scale and ongoing technical optimization. We expect to see improving economics for CCUS in China over the coming years, with unit cost to more than half from the current level of US$90-110/t to potentially US$30-40/t by 2050E, driven by ongoing improvement through 1) higher efficiency on absorption materials and process, 2) lower input costs as industry scale builds up, 3) lower logistic costs from the development of pipeline infrastructure, and 4) lower capital cost. Depending on the level of success, we estimate CCUS could help remove 10-24% of China's annual carbon emission or 1.1-2.8 bn tonnes annually, in the coming years, mostly from industrial processes.

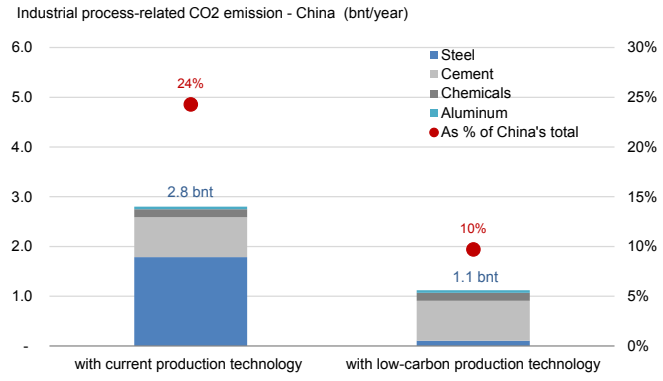
In addition, part of the cost reduction could come from transportation. Large scale industrial based demand on transport of CO2 provides incentives for the construction of infrastructure. Specifically in transportation, currently trucks and inland ships are the most mature and economical way for small scale (<100kt/year) CO2 transport in China, while onshore and offshore pipelines are still in the development stage due to large upfront investment needed for building a pipeline network. However, pipelines are likely to be the preferred and most economical method for large-scale carbon transport. The Ministry of Science and Technology (MOST) of China estimates that the transport cost is

around Rmb1.0/t-km for onshore pipelines currently. With increasing capacity of the pipeline network from 70 km in 2019 to 20,000 km in long run, per MOST, the cost of transport is expected to decline by more than 50% to Rmb0.45/to-km.

Locations of potential CO2 storage sites in China

Meanwhile, storage is likely to be the major approach to secure the capture of the carbon, and likely account for three quarters of the total carbon captured, according to MOST. Based on Pale Blue Dot energy assessments so far, China's undiscovered carbon storage resources, defined as: the estimated quantity of total storage resources, as of a given date, in which the suitability for storage has not been ascertained within the target geologic formation, ranks relatively high among peer counties. According to a 2020 report from the Global CCS Institute, more than 3 trillion metric tons of potential CO2 storage resources have been identified in China, accounting for ~25% of the world total. MOST estimates storage volume in China will increase significantly from 2mnt CO2/yr in 2025 to 670mnt CO2/yr by 2050. Fully installed CCUS facilities across relevant industrial sectors in China would require Rmb4.7tn in total incremental capex, and Rmb 1.1tn in annual operating cost, based on current economics.

Exhibit 31: Process-related CO2 emission from key upstream sectors - China

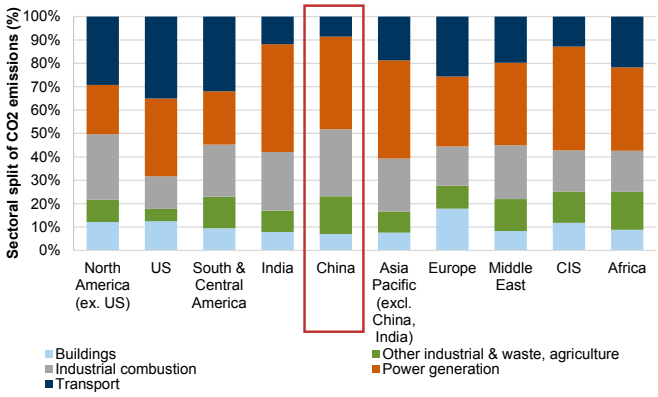


Key upstream sectors include steel, cement, chemicals, and aluminum

Source: GEIDCO, Goldman Sachs Global Investment Research

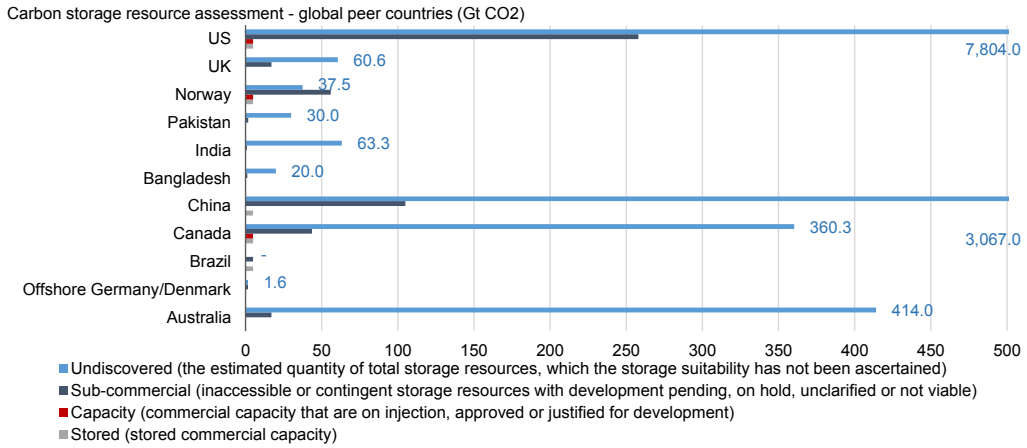
Exhibit 32: CO2 emissions in China are skewed towards industry and power generation (c.80% of total)...

Sectoral split of CO2 emissions by region (%)



Source: European Commission Joint Research Centre (JRC). Emission Database for Global Atmospheric Research (EDGAR) release version 5.0, Goldman Sachs Global Investment Research

Exhibit 33: Carbon storage resource assessment - global peer countries
Billions of metric tons



*US and China scale for undiscovered are extended

Source: Pale Blue Dot Energy, Global CCS Institute, Goldman Sachs Global Investment Research

Capital solutions

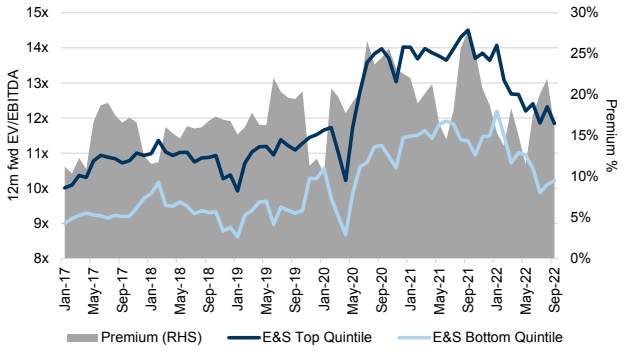
With multiple different investment vehicles — some Sustainability focused and some not — that can used to support Climate Transition, we believe there needs be close attention paid to which solutions are resonating and where gaps lie that could be filled with either innovation, policy support or more collaborate efforts between public, private, government and philanthropic stakeholders. We highlight various investment choices that will likely each be needed to successfully decarbonize.

Public equity

Public company valuations are differentiating companies with favorable environmental and social performance vs. peers. Companies that rank in the top quintile of our GS SUSTAIN Environmental & Social scoring framework have consistently benefited from a multiple premium — on a 12-mo forward EV/EBITDA basis — vs. companies that rank in the bottom quintile over the past 5 years, as shown in Exhibit 34. As reported in our ESG Tracker series, the valuation premium for "ESG leaders" over "ESG laggards" was 16% as of September 2022.

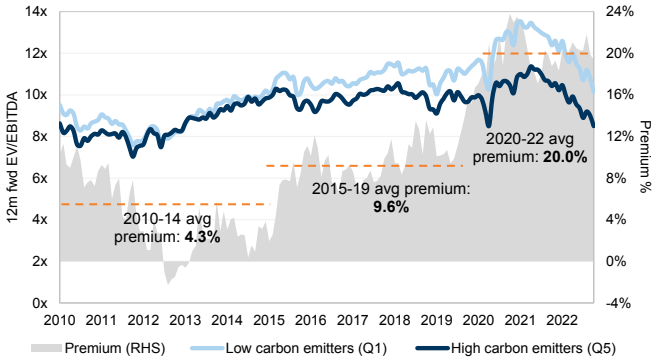
Public company valuations are differentiating lower emitters vs. higher emitters vs. peers. As described in our Net Zero Guide and APAC ESG Regulations reports, we note markets are increasingly pricing carbon emissions, with low carbon-intensive companies trading at a premium vs. high intensity industry peers, as shown in Exhibit 35. On a 12-month forward EV/EBITDA basis, premiums for low emitters have risen from historical averages of 4.3% (2010-2014), to 9.6% (2015-2019), to 19.4% as of October 2022. We believe wider adoption of TCFD-aligned reporting and carbon disclosures requirements may act as catalysts for premiums to accelerate for low emitting peers, or may lead to greater recognition of those high-emitters implementing a robust transition plan.

Exhibit 34: The multiple spread between operational ESG leaders and laggards decreased in September
12m fwd EV/EBITDA & relative premium (trimmed mean), Q1 vs. Q5 SUSTAIN Operational E&S quintiles



Source: FactSet, Goldman Sachs Global Investment Research

Exhibit 35: Despite fragmented carbon pricing schemes globally, the market is now pricing carbon emissions, with low emitting companies trading at elevated premiums versus their higher emitting industry peers on an EV/EBITDA basis
Low carbon (Q1) vs. high carbon emitters (Q5) (Total Scope 1 & 2 GHG Emissions / rGFA) 12-month-forward EV/EBITDA multiples (2010 - 2022), sector relative, excluding Financials

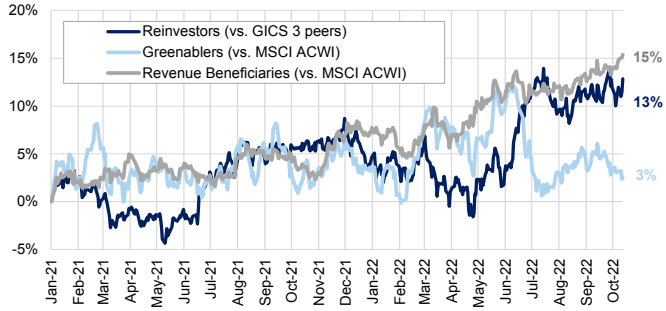


We caveat that some valuation divergence within GICS 3 sectors will be due to differences in business models.

Source: Refinitiv, FactSet, Bloomberg, Goldman Sachs Global Investment Research

Stock performance of companies making Green investment or exposed to others' Green investment with favorable corporate returns have outperformed. All three investment themes outlined in our Green Capex reports — (1) High and/or Rising Reinvestors of cash flows into Capex + R&D; (2) Revenue Beneficiaries of Green Capex spending; and (3) Greenablers — have outperformed their benchmarks since beginning of 2021, with Reinvestors generating the greatest outperformance (see Exhibit 36 for more details).

Exhibit 36: Stocks that screen for our three Green Capex investment themes have outperformed respective benchmarks since the beginning of 2021
Average relative stock performance of Green Revenue Beneficiaries, Green Re-investors and Greenablers since Jan. 1, 2021



Note: Equal weighted indices. Includes stocks with corporate returns above average -- referred to global or regional sector average, ex. Greenablers. Stock selection based on criteria discussed in the report, but includes Neutral and Sell-rated stocks as opposed to just Buy-rated stocks.

Based on our updated stock selection tools per our October 2022 Investing in Green Capex report

Source: Refinitiv, Goldman Sachs Global Investment Research

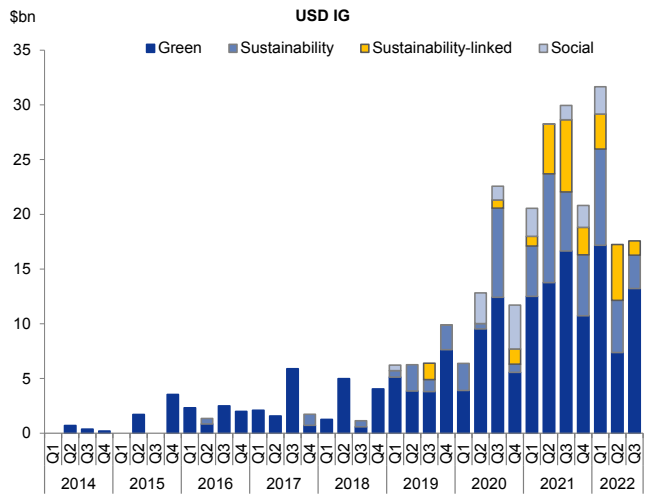
Public fixed income

In contrast to the equity market, ESG investing is a relatively nascent investment

style within the corporate bond market, but is rapidly gaining traction and quickly accumulated assets. As our credit strategists noted in their ESG in credit: A costless benefit to portfolios report, ESG-aware fixed-income investment funds have seen exponential growth over the last several years, going from $57 billion of AUM globally in 2018 to more than $430 billion at the end of 2021 (Exhibits Exhibit 37 & Exhibit 38). In 2022, ESG credit funds has attracted strong inflows despite a difficult year for fixed income demand overall. ESG fund AUM has grown nearly 3% YTD vs. YE 2021, a stark contrast to non-ESG funds which have lost 3% of AUM over the same period. In particular, solar companies have seen record pace in ABS issuance, buoyed by the extension of the solar ITC in the US and higher energy prices globally. Going forward, our credit strategists expect that climate-related commitments from a wide range of investors such as Nordic and British pension funds, and public/private investment partnership such as the Breakthrough Energy Catalyst should continue to provide robust inflows and support the demand for ESG credit.

Although ESG-aware bonds has attracted much attention from investors, there is little evidence of any harvestable systematic premium related to an ESG-type strategies (i.e., Green, Social, etc.) at the individual bond-level (Exhibits Exhibit 39 & Exhibit 40). However, there is some moderate evidence from the primary market that deal tranches issued with an ESG focus can provide borrowers with a funding discount, but the size of this discount varies considerably across time and jurisdictions. At the firm-level, our credit strategies have found that higher ESG scores (based on GS SUSTAIN methodology) are statistically significantly correlated with an issuer's spread premium in recent years. However, the economic effects are small and in the realm of 1-2 bp for a one decile increase in GS SUSTAIN operational Environmental & Social (E&S) or Governance (G) percentile rank. These results suggest both that ESG portfolios can have the added benefit of positive societal externalities, without any drag on returns.

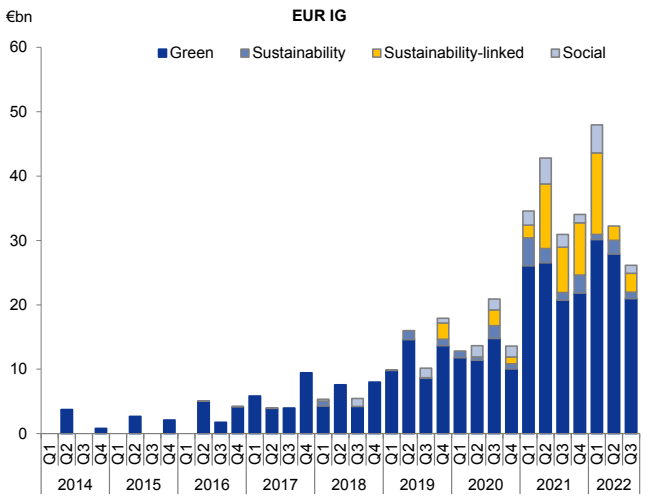
Exhibit 37: USD IG ESG corporate bond issuance



Note: 2022 is as of September 15, 2022.

Source: Dealogic, Goldman Sachs Global Investment Research

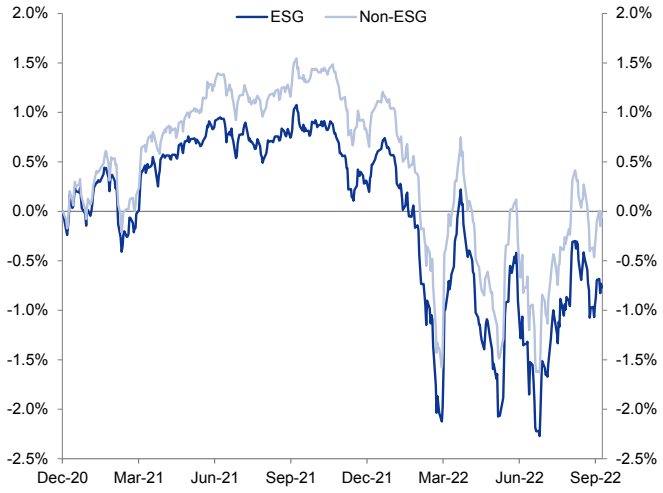
Exhibit 38: EUR IG ESG corporate bond issuance



Note: 2022 is as of September 15, 2022.

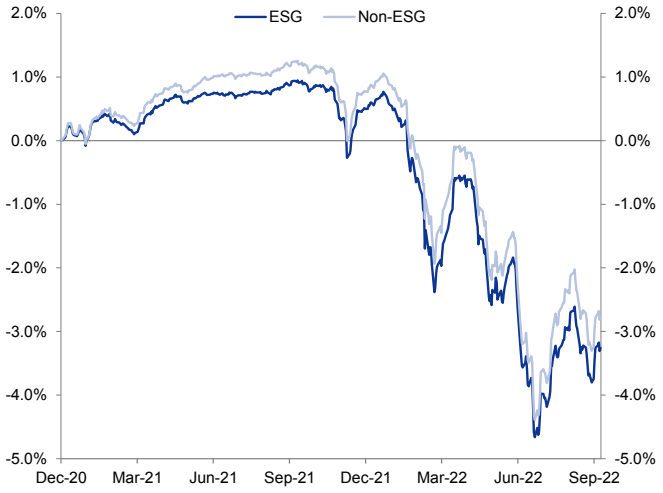
Source: Dealogic, Goldman Sachs Global Investment Research

Exhibit 39: ESG vs non-ESG issuer- and duration-matched USD IG cumulative excess returns
Senior Unsecured IG bonds are matched at the issuer level, only keeping bonds with less than a one-year difference in time to maturity



Source: iBoxx, Dealogic, Goldman Sachs Global Investment Research

Exhibit 40: ESG vs non-ESG issuer- and duration-matched EUR IG cumulative excess returns
Senior Unsecured IG bonds are matched at the issuer level, only keeping bonds with less than a 1 year difference in time to maturity

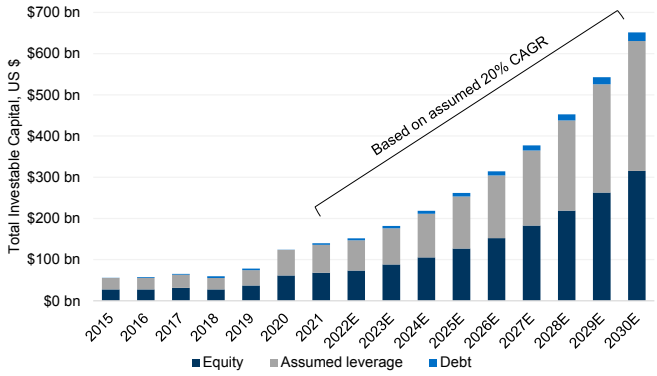


Source: iBoxx, Dealogic, Goldman Sachs Global Investment Research

Private equity

An acceleration in private equity capital raises could be supportive of Green Capex initiatives and contribute to bridge the $2.8 tn annual gap towards Decarbonization, Clean Water and Infrastructure goals. As detailed in our Green Capex report, private equity capital available to invest has seen a 12% CAGR, historically. Going forward, our Asset Managers and Capital Markets team sees rising market share of ESG/Infrastructure capital as a potential catalyst for private capital dedicated to Renewable Energy, Clean Tech, Environmental Services, Utilities and Water funds to accelerate beyond the historical CAGR. A scenario where private equity capital raised grows at a 20% CAGR — in line with our discussion above — would imply incremental available capital from privately held companies of $0.3 tn on average within 2021-2030. See Exhibit 41 for more details.

Exhibit 41: At a 20% CAGR, annual new available capital from private equity fundraising would average $0.3 tn this decade
Green private equity capital raised and forecasted, 2015 - 2030E



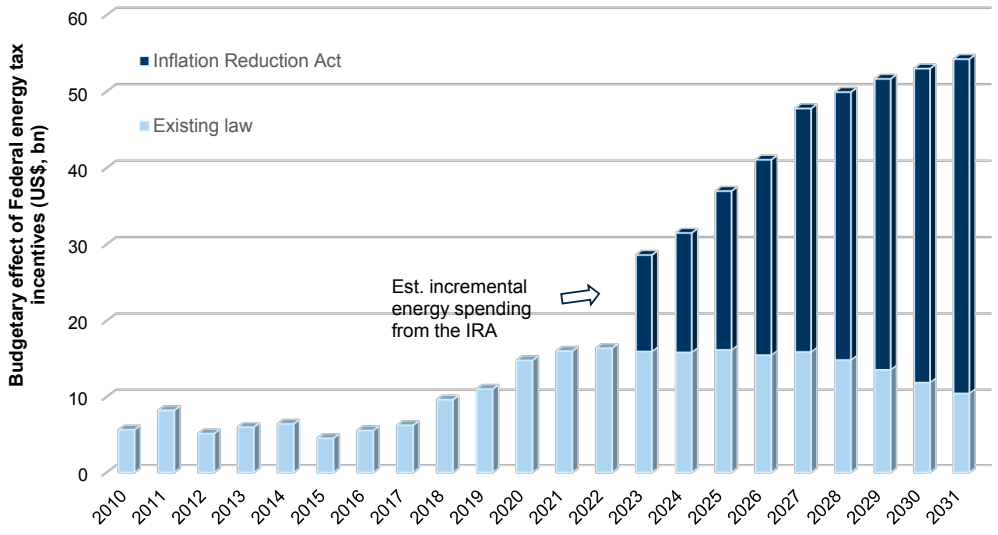
Assumes 20% CAGR and 50/50 leverage

Source: Preqin, Goldman Sachs Global Investment Research

Government investment

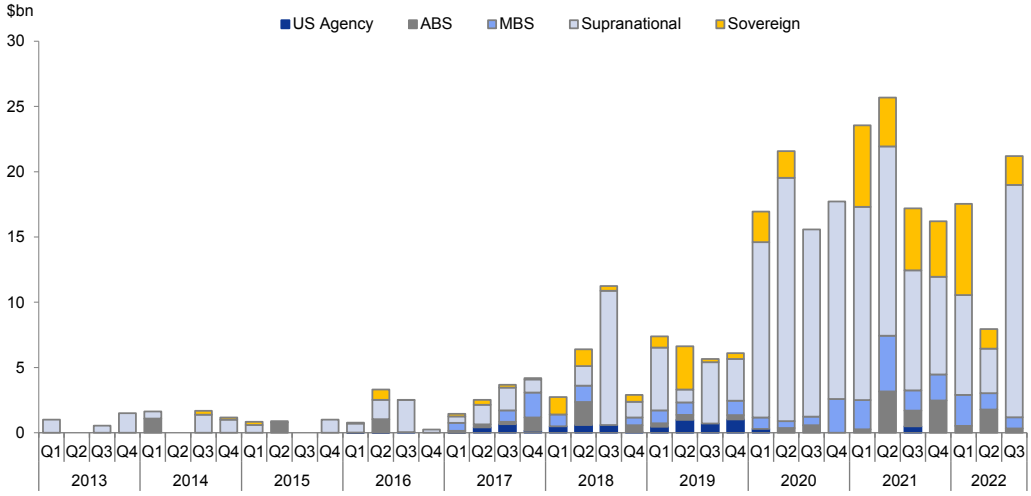
Government policies and investments could play a key role in bridging the gap towards achieving $2.8 tn incr emental Green Capex annually. We note that governments are likely to play a critical role in: (1) supporting Green Capex with multiple mechanisms — e.g., direct investment; and (2) providing the necessary regulatory clarity to stimulate additional engagement in Green Capex from public and private companies. We believe this to be of particular importance to bridge the $0.9 tn gap in incremental annual Green Capex needed (assuming deployment of public company spare capacity to Green Capex by corporates or investors). Among policy measures, we note the recent Inflation Reduction Act (IRA) and Chips and Science ACT, China's 14th 5-year plan and EU's Green Deal as supportive of Green Capex initiatives. In the US, the incremental tax incentives provided by the IRA — about $265 bn over 10 years — should provide tailwinds for the secular theme of Green Capex, impacting virtually every vertical in our Green Capex mosaic (Exhibit 42). We believe the bill will be most transformative for residential standalone and utility-scale battery storage, commercial building energy efficiency and green hydrogen, while accelerating investment in longer-term CCUS projects. In Europe, we note the recent REPowerEU initiative should generate additional support to Green Capex, with particular regard to renewables, electrification and hydrogen verticals, among others. In China, the Renewable Energy Development Plan for the 14th 5-year Plan Period released in June encouraged more optimized renewables developments, efficient storage (including hydrogen production), innovation in renewables and market-driven regulation of renewable deployments.

Exhibit 42: The Inflation Reduction Act is estimated to triple the total US Federal tax incentives on energy by 2031, representing about $27 billion per year incrementally



Source: US Department of Treasury, Congressional Budget Office, Goldman Sachs Global Investment Research

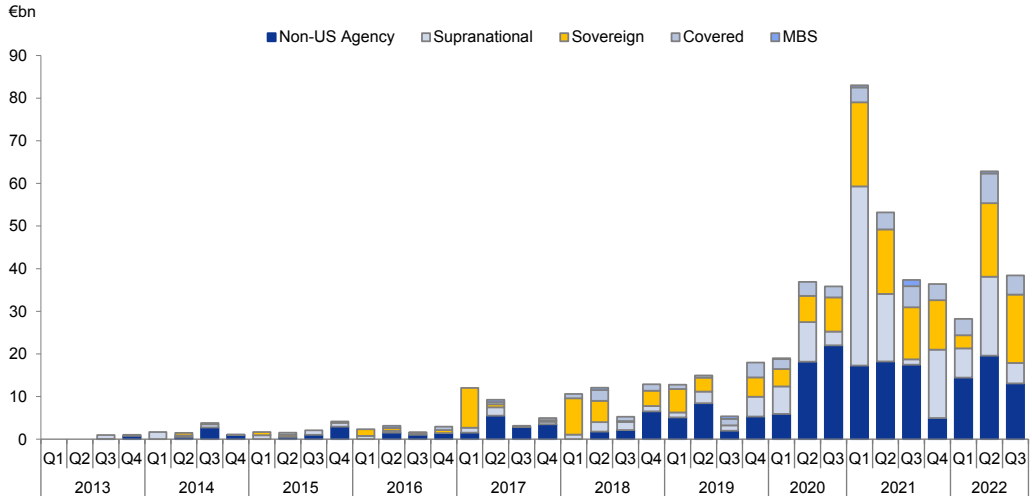
Exhibit 43: USD ESG sovereign, quasi-sovereign, and structured issuance
Includes: US Agencies, ABS, Supranationals and Sovereigns



Note: 2022 is as of September 15, 2022.

Source: Dealogic, Goldman Sachs Global Investment Research

Exhibit 44: EUR ESG sovereign,quasi-sovereign, and structured issuance
Includes: Non-US Agencies, Supranationals, Sovereigns, Covered bonds, and MBS



Note: 2022 is as of September 15, 2022.

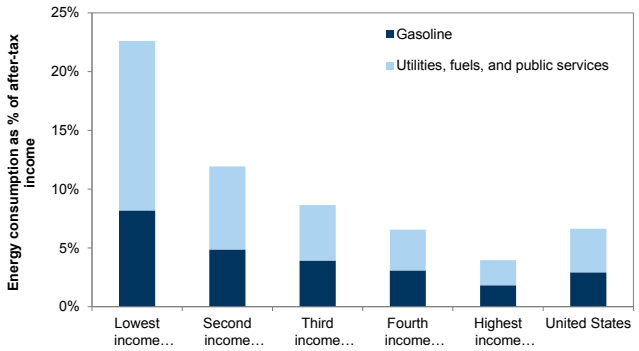
Source: Dealogic, Goldman Sachs Global Investment Research

Matching lower supply of high-emitting products with lower demand while minimizing social impact critical

A spike in energy and food prices has financial and social repercussions more pronounced in lower-income populations. Whether looking at lower-income countries or income disparity within a country, higher fuel prices are having a more meaningful impact to those with lower income. In the US, which has seen rising income and wealth gap over much of the past 40 years, gasoline and power/utilities spending represented 23% of after-tax income for the bottom quintile of income earning households vs. just 4% for the top quintile in 2019 (Exhibit 45). The disparity in consumer spending on food consumption is even more stark. In 2019, food spending represented 36% of after-tax income for the lowest quintile vs. 8% for the highest quintile (Exhibit 46). The surge in energy and food prices seen in recent months risks increasing this disparity.

Exhibit 45: Consumer spending on energy and utilities represented 23% of annual after-tax income for the lowest income quintile in the US in 2019 vs. 4% for the highest quintile

US energy spending as percent of after-tax income quintiles, 2019

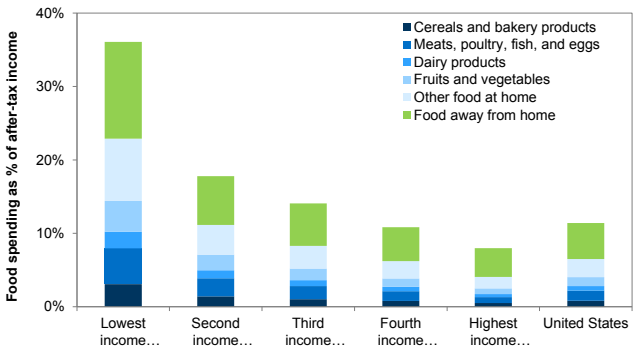


Utilities excludes telephone services

Source: US Bureau of Labor Statistics, Goldman Sachs Global Investment Research

Exhibit 46: Consumer spending on food consumption represented 36% of annual after-tax income for the lowest income quintile in the US in 2019 vs. 8% for the highest quintile

US food spending for consumer units in different income quintiles, 2019



Source: US Bureau of Labor Statistics, Goldman Sachs Global Investment Research

Decarbonization via a fossil fuel price spike represents an area where environmental and social goals compete, at least in the shorter term. Clear affordable and reliable demand alternatives — and related infrastructure — to shift consumption away from fossil fuels can ease the burden on lower-income populations. Electric vehicles were disproportionately purchased by those in higher income brackets in the US in 2019. While a spike in fossil fuel prices that forces down demand has the potential to accelerate decarbonization, investments/innovations or policies that can successfully mitigate the negative impacts on lower-income individuals and countries are key to simultaneously advance social and environmental sustainable development goals. Similarly, energy consumption per-capita has been on the rise globally, with large disparities between the global average and higher-consuming countries like the US/Japan/Europe. For Sustainable Development Goals like No Poverty and others to make meaningful advances, per-capita electricity consumption on a global basis is likely to increase. This will likely create additional pressure on electricity prices.

We believe the two most important factors influencing the positive and negative repercussions of decarbonization are: (a) the speed of transition (rapid vs. gradual); and (b) whether the transition is driven by lower supply vs. lower demand. The matrix of rapid vs. gradual and supply-driven vs. demand-driven transition has implications for path to decarbonization, economic impact, demographic impact, energy reliability and the pace of innovation, as seen in Exhibit 47. We also believe it will impact investment opportunities. Based on policy and investor ownership in recent years, there has been a more meaningful focus on reducing supply of commodities that has helped to contribute to upward pressure on commodities. More recently, we are seeing increased government stimulus such as RePower EU and the Inflation Reduction Act. We expect continued debate on the positive and negative ramifications of policy and investment choices made (or not made) towards stimulating greater supply vs. demand of high emitting commodities and stimulating innovation to make more competitive the cost of cleaner technologies.

Exhibit 47: We believe the pace and catalyst for meaningful decarbonization have positive and negative repercussions with varied impacts for capital flows

Key initial potential implications from a rapid vs. gradual and supply- vs. demand-driven energy transition

		Speed of the transition	
		Rapid	**Gradual**
Catalyst for the transition	**Supply-driven**	Spike in fossil fuel prices	Driven by pace of innovation
		$ go to fossil fuel companies	$ to companies with lowest cost
		Quicker transition	Longer period of transition
		Economic growth volatility/risk	Less risk of recession
		Faster pace of innovation	Greater need for adaptation solutions
		Burden on lower-income population	Inequality impact a function of innovation
	Demand-driven	Spike in fossil fuel prices	Higher prices but without spike
		$ go to consumers' governments	$ go to consumers' gov'ts + innovators
		Quicker transition	Longer period of transition
		Economic growth volatility/risk	Less risk of recession
		Faster pace of innovation	Greater need for adaptation solutions
		Capital use by gov'ts key for inequality	Capital use by gov'ts key for inequality

Source: Goldman Sachs Global Investment Research

Disclosure Appendix

Reg AC

We, Brian Singer, CFA, Trina Chen, Enrico Chinello, Ph.D., Michael Hao Wu, CFA, Joy Zhang, Derek R. Bingham, Evan Tylenda, CFA, Brendan Corbett, Emma Jones, Keebum Kim, Madeline Meyer, Varsha Venugopal, Grace Chen and Rachit Aggarwal, hereby certify that all of the views expressed in this report accurately reflect our personal views about the subject company or companies and its or their securities. We also certify that no part of our compensation was, is or will be, directly or indirectly, related to the specific recommendations or views expressed in this report.

I, Michael Puempel, Ph.D., hereby certify that all of the views expressed in this report accurately reflect my personal views, which have not been influenced by considerations of the firm's business or client relationships.

Unless otherwise stated, the individuals listed on the cover page of this report are analysts in Goldman Sachs' Global Investment Research division.

GS Factor Profile

The Goldman Sachs Factor Profile provides investment context for a stock by comparing key attributes to the market (i.e. our coverage universe) and its sector peers. The four key attributes depicted are: Growth, Financial Returns, Multiple (e.g. valuation) and Integrated (a composite of Growth, Financial Returns and Multiple). Growth, Financial Returns and Multiple are calculated by using normalized ranks for specific metrics for each stock. The normalized ranks for the metrics are then averaged and converted into percentiles for the relevant attribute. The precise calculation of each metric may vary depending on the fiscal year, industry and region, but the standard approach is as follows:

Growth is based on a stock's forward-looking sales growth, EBITDA growth and EPS growth (for financial stocks, only EPS and sales growth), with a higher percentile indicating a higher growth company. **Financial Returns** is based on a stock's forward-looking ROE, ROCE and CROCI (for financial stocks, only ROE), with a higher percentile indicating a company with higher financial returns. **Multiple** is based on a stock's forward-looking P/E, P/B, price/dividend (P/D), EV/EBITDA, EV/FCF and EV/Debt Adjusted Cash Flow (DACF) (for financial stocks, only P/E, P/B and P/D), with a higher percentile indicating a stock trading at a higher multiple. The **Integrated** percentile is calculated as the average of the Growth percentile, Financial Returns percentile and (100% - Multiple percentile).

Financial Returns and Multiple use the Goldman Sachs analyst forecasts at the fiscal year-end at least three quarters in the future. Growth uses inputs for the fiscal year at least seven quarters in the future compared with the year at least three quarters in the future (on a per-share basis for all metrics).

For a more detailed description of how we calculate the GS Factor Profile, please contact your GS representative.

M&A Rank

Across our global coverage, we examine stocks using an M&A framework, considering both qualitative factors and quantitative factors (which may vary across sectors and regions) to incorporate the potential that certain companies could be acquired. We then assign a M&A rank as a means of scoring companies under our rated coverage from 1 to 3, with 1 representing high (30%-50%) probability of the company becoming an acquisition target, 2 representing medium (15%-30%) probability and 3 representing low (0%-15%) probability. For companies ranked 1 or 2, in line with our standard departmental guidelines we incorporate an M&A component into our target price. M&A rank of 3 is considered immaterial and therefore does not factor into our price target, and may or may not be discussed in research.

Quantum

Quantum is Goldman Sachs' proprietary database providing access to detailed financial statement histories, forecasts and ratios. It can be used for in-depth analysis of a single company, or to make comparisons between companies in different sectors and markets.

Disclosures

Distribution of ratings/investment banking relationships

Goldman Sachs Investment Research global Equity coverage universe

	Rating Distribution			Investment Banking Relationships		
	Buy	Hold	Sell	Buy	Hold	Sell
Global	48%	36%	16%	64%	59%	50%

As of October 1, 2022, Goldman Sachs Global Investment Research had investment ratings on 3,100 equity securities. Goldman Sachs assigns stocks as Buys and Sells on various regional Investment Lists; stocks not so assigned are deemed Neutral. Such assignments equate to Buy, Hold and Sell for the purposes of the above disclosure required by the FINRA Rules. See 'Ratings, Coverage universe and related definitions' below. The Investment Banking Relationships chart reflects the percentage of subject companies within each rating category for whom Goldman Sachs has provided investment banking services within the previous twelve months.

Regulatory disclosures

Disclosures required by United States laws and regulations

See company-specific regulatory disclosures above for any of the following disclosures required as to companies referred to in this report: manager or co-manager in a pending transaction; 1% or other ownership; compensation for certain services; types of client relationships; managed/co-managed public offerings in prior periods; directorships; for equity securities, market making and/or specialist role. Goldman Sachs trades or may trade as a principal in debt securities (or in related derivatives) of issuers discussed in this report.

The following are additional required disclosures: **Ownership and material conflicts of interest:** Goldman Sachs policy prohibits its analysts, professionals reporting to analysts and members of their households from owning securities of any company in the analyst's area of coverage. **Analyst compensation:** Analysts are paid in part based on the profitability of Goldman Sachs, which includes investment banking revenues. **Analyst as officer or director:** Goldman Sachs policy generally prohibits its analysts, persons reporting to analysts or members of their households from serving as an officer, director or advisor of any company in the analyst's area of coverage. **Non-U.S. Analysts:** Non-U.S. analysts may not be associated persons of Goldman Sachs & Co. LLC and therefore may not be subject to FINRA Rule 2241 or FINRA Rule 2242 restrictions on communications with subject company, public appearances and trading securities held by the analysts.

Distribution of ratings: See the distribution of ratings disclosure above. **Price chart:** See the price chart, with changes of ratings and price targets in

prior periods, above, or, if electronic format or if with respect to multiple companies which are the subject of this report, on the Goldman Sachs website at https://www.gs.com/research/hedge.html.

Additional disclosures required under the laws and regulations of jurisdictions other than the United States

The following disclosures are those required by the jurisdiction indicated, except to the extent already made above pursuant to United States laws and regulations. **Australia:** Goldman Sachs Australia Pty Ltd and its affiliates are not authorised deposit-taking institutions (as that term is defined in the Banking Act 1959 (Cth)) in Australia and do not provide banking services, nor carry on a banking business, in Australia. This research, and any access to it, is intended only for "wholesale clients" within the meaning of the Australian Corporations Act, unless otherwise agreed by Goldman Sachs. In producing research reports, members of the Global Investment Research Division of Goldman Sachs Australia may attend site visits and other meetings hosted by the companies and other entities which are the subject of its research reports. In some instances the costs of such site visits or meetings may be met in part or in whole by the issuers concerned if Goldman Sachs Australia considers it is appropriate and reasonable in the specific circumstances relating to the site visit or meeting. To the extent that the contents of this document contains any financial product advice, it is general advice only and has been prepared by Goldman Sachs without taking into account a client's objectives, financial situation or needs. A client should, before acting on any such advice, consider the appropriateness of the advice having regard to the client's own objectives, financial situation and needs. A copy of certain Goldman Sachs Australia and New Zealand disclosure of interests and a copy of Goldman Sachs' Australian Sell-Side Research Independence Policy Statement are available at: https://www.goldmansachs.com/disclosures/australia-new-zealand/index.html. **Brazil:** Disclosure information in relation to CVM Resolution n. 20 is available at https://www.gs.com/worldwide/brazil/area/gir/index.html. Where applicable, the Brazil-registered analyst primarily responsible for the content of this research report, as defined in Article 20 of CVM Resolution n. 20, is the first author named at the beginning of this report, unless indicated otherwise at the end of the text. **Canada:** This information is being provided to you for information purposes only and is not, and under no circumstances should be construed as, an advertisement, offering or solicitation by Goldman Sachs & Co. LLC for purchasers of securities in Canada to trade in any Canadian security. Goldman Sachs & Co. LLC is not registered as a dealer in any jurisdiction in Canada under applicable Canadian securities laws and generally is not permitted to trade in Canadian securities and may be prohibited from selling certain securities and products in certain jurisdictions in Canada. If you wish to trade in any Canadian securities or other products in Canada please contact Goldman Sachs Canada Inc., an affiliate of The Goldman Sachs Group Inc., or another registered Canadian dealer. **Hong Kong:** Further information on the securities of covered companies referred to in this research may be obtained on request from Goldman Sachs (Asia) L.L.C. **India:** Further information on the subject company or companies referred to in this research may be obtained from Goldman Sachs (India) Securities Private Limited, Research Analyst - SEBI Registration Number INH000001493, 951-A, Rational House, Appasaheb Marathe Marg, Prabhadevi, Mumbai 400 025, India, Corporate Identity Number U74140MH2006FTC160634, Phone +91 22 6616 9000, Fax +91 22 6616 9001. Goldman Sachs may beneficially own 1% or more of the securities (as such term is defined in clause 2 (h) the Indian Securities Contracts (Regulation) Act, 1956) of the subject company or companies referred to in this research report. **Japan:** See below. **Korea:** This research, and any access to it, is intended only for "professional investors" within the meaning of the Financial Services and Capital Markets Act, unless otherwise agreed by Goldman Sachs. Further information on the subject company or companies referred to in this research may be obtained from Goldman Sachs (Asia) L.L.C., Seoul Branch. **New Zealand:** Goldman Sachs New Zealand Limited and its affiliates are neither "registered banks" nor "deposit takers" (as defined in the Reserve Bank of New Zealand Act 1989) in New Zealand. This research, and any access to it, is intended for "wholesale clients" (as defined in the Financial Advisers Act 2008) unless otherwise agreed by Goldman Sachs. A copy of certain Goldman Sachs Australia and New Zealand disclosure of interests is available at: https://www.goldmansachs.com/disclosures/australia-new-zealand/index.html. **Russia:** Research reports distributed in the Russian Federation are not advertising as defined in the Russian legislation, but are information and analysis not having product promotion as their main purpose and do not provide appraisal within the meaning of the Russian legislation on appraisal activity. Research reports do not constitute a personalized investment recommendation as defined in Russian laws and regulations, are not addressed to a specific client, and are prepared without analyzing the financial circumstances, investment profiles or risk profiles of clients. Goldman Sachs assumes no responsibility for any investment decisions that may be taken by a client or any other person based on this research report. **Singapore:** Goldman Sachs (Singapore) Pte. (Company Number: 198602165W), which is regulated by the Monetary Authority of Singapore, accepts legal responsibility for this research, and should be contacted with respect to any matters arising from, or in connection with, this research. **Taiwan:** This material is for reference only and must not be reprinted without permission. Investors should carefully consider their own investment risk. Investment results are the responsibility of the individual investor. **United Kingdom:** Persons who would be categorized as retail clients in the United Kingdom, as such term is defined in the rules of the Financial Conduct Authority, should read this research in conjunction with prior Goldman Sachs research on the covered companies referred to herein and should refer to the risk warnings that have been sent to them by Goldman Sachs International. A copy of these risks warnings, and a glossary of certain financial terms used in this report, are available from Goldman Sachs International on request.

European Union and United Kingdom: Disclosure information in relation to Article 6 (2) of the European Commission Delegated Regulation (EU) (2016/958) supplementing Regulation (EU) No 596/2014 of the European Parliament and of the Council (including as that Delegated Regulation is implemented into United Kingdom domestic law and regulation following the United Kingdom's departure from the European Union and the European Economic Area) with regard to regulatory technical standards for the technical arrangements for objective presentation of investment recommendations or other information recommending or suggesting an investment strategy and for disclosure of particular interests or indications of conflicts of interest is available at https://www.gs.com/disclosures/europeanpolicy.html which states the European Policy for Managing Conflicts of Interest in Connection with Investment Research.

Japan: Goldman Sachs Japan Co., Ltd. is a Financial Instrument Dealer registered with the Kanto Financial Bureau under registration number Kinsho 69, and a member of Japan Securities Dealers Association, Financial Futures Association of Japan and Type II Financial Instruments Firms Association. Sales and purchase of equities are subject to commission pre-determined with clients plus consumption tax. See company-specific disclosures as to any applicable disclosures required by Japanese stock exchanges, the Japanese Securities Dealers Association or the Japanese Securities Finance Company.

Ratings, coverage universe and related definitions

Buy (B), Neutral (N), Sell (S) Analysts recommend stocks as Buys or Sells for inclusion on various regional Investment Lists. Being assigned a Buy or Sell on an Investment List is determined by a stock's total return potential relative to its coverage universe. Any stock not assigned as a Buy or a Sell on an Investment List with an active rating (i.e., a stock that is not Rating Suspended, Not Rated, Coverage Suspended or Not Covered), is deemed Neutral. Each region's Investment Review Committee manages Regional Conviction lists, which represent investment recommendations focused on the size of the total return potential and/or the likelihood of the realization of the return across their respective areas of coverage. The addition or removal of stocks from such Conviction lists do not represent a change in the analysts' investment rating for such stocks.

Total return potential represents the upside or downside differential between the current share price and the price target, including all paid or anticipated dividends, expected during the time horizon associated with the price target. Price targets are required for all covered stocks. The total return potential, price target and associated time horizon are stated in each report adding or reiterating an Investment List membership.

Coverage Universe: A list of all stocks in each coverage universe is available by primary analyst, stock and coverage universe at https://www.gs.com/research/hedge.html.

Not Rated (NR). The investment rating, target price and earnings estimates (where relevant) have been suspended pursuant to Goldman Sachs policy when Goldman Sachs is acting in an advisory capacity in a merger or in a strategic transaction involving this company, when there are legal, regulatory or policy constraints due to Goldman Sachs' involvement in a transaction, and in certain other circumstances. **Rating Suspended (RS).** Goldman

Sachs Research has suspended the investment rating and price target for this stock, because there is not a sufficient fundamental basis for determining an investment rating or target price. The previous investment rating and target price, if any, are no longer in effect for this stock and should not be relied upon. **Coverage Suspended (CS).** Goldman Sachs has suspended coverage of this company. **Not Covered (NC).** Goldman Sachs does not cover this company. **Not Available or Not Applicable (NA).** The information is not available for display or is not applicable. **Not Meaningful (NM).** The information is not meaningful and is therefore excluded.

Global product; distributing entities

The Global Investment Research Division of Goldman Sachs produces and distributes research products for clients of Goldman Sachs on a global basis. Analysts based in Goldman Sachs offices around the world produce research on industries and companies, and research on macroeconomics, currencies, commodities and portfolio strategy. This research is disseminated in Australia by Goldman Sachs Australia Pty Ltd (ABN 21 006 797 897); in Brazil by Goldman Sachs do Brasil Corretora de Títulos e Valores Mobiliários S.A.; Public Communication Channel Goldman Sachs Brazil: 0800 727 5764 and / or contatogoldmanbrasil@gs.com. Available Weekdays (except holidays), from 9am to 6pm. Canal de Comunicação com o Público Goldman Sachs Brasil: 0800 727 5764 e/ou contatogoldmanbrasil@gs.com. Horário de funcionamento: segunda-feira à sexta-feira (exceto feriados), das 9h às 18h; in Canada by Goldman Sachs & Co. LLC; in Hong Kong by Goldman Sachs (Asia) L.L.C.; in India by Goldman Sachs (India) Securities Private Ltd.; in Japan by Goldman Sachs Japan Co., Ltd.; in the Republic of Korea by Goldman Sachs (Asia) L.L.C., Seoul Branch; in New Zealand by Goldman Sachs New Zealand Limited; in Russia by OOO Goldman Sachs; in Singapore by Goldman Sachs (Singapore) Pte. (Company Number: 198602165W); and in the United States of America by Goldman Sachs & Co. LLC. Goldman Sachs International has approved this research in connection with its distribution in the United Kingdom.

Effective from the date of the United Kingdom's departure from the European Union and the European Economic Area ("Brexit Day") the following information with respect to distributing entities will apply:

Goldman Sachs International ("GSI"), authorised by the Prudential Regulation Authority ("PRA") and regulated by the Financial Conduct Authority ("FCA") and the PRA, has approved this research in connection with its distribution in the United Kingdom.

European Economic Area: GSI, authorised by the PRA and regulated by the FCA and the PRA, disseminates research in the following jurisdictions within the European Economic Area: the Grand Duchy of Luxembourg, Italy, the Kingdom of Belgium, the Kingdom of Denmark, the Kingdom of Norway, the Republic of Finland, the Republic of Cyprus and the Republic of Ireland; GS -Succursale de Paris (Paris branch) which, from Brexit Day, will be authorised by the French Autorité de contrôle prudentiel et de resolution ("ACPR") and regulated by the Autorité de contrôle prudentiel et de resolution and the Autorité des marches financiers ("AMF") disseminates research in France; GSI - Sucursal en España (Madrid branch) authorized in Spain by the Comisión Nacional del Mercado de Valores disseminates research in the Kingdom of Spain; GSI - Sweden Bankfilial (Stockholm branch) is authorized by the SFSA as a "third country branch" in accordance with Chapter 4, Section 4 of the Swedish Securities and Market Act (Sw. lag (2007:528) om värdepappersmarknaden) disseminates research in the Kingdom of Sweden; Goldman Sachs Bank Europe SE ("GSBE") is a credit institution incorporated in Germany and, within the Single Supervisory Mechanism, subject to direct prudential supervision by the European Central Bank and in other respects supervised by German Federal Financial Supervisory Authority (Bundesanstalt für Finanzdienstleistungsaufsicht, BaFin) and Deutsche Bundesbank and disseminates research in the Federal Republic of Germany and those jurisdictions within the European Economic Area where GSI is not authorised to disseminate research and additionally, GSBE, Copenhagen Branch filial af GSBE, Tyskland, supervised by the Danish Financial Authority disseminates research in the Kingdom of Denmark; GSBE - Sucursal en España (Madrid branch) subject (to a limited extent) to local supervision by the Bank of Spain disseminates research in the Kingdom of Spain; GSBE - Succursale Italia (Milan branch) to the relevant applicable extent, subject to local supervision by the Bank of Italy (Banca d'Italia) and the Italian Companies and Exchange Commission (Commissione Nazionale per le Società e la Borsa "Consob") disseminates research in Italy; GSBE - Succursale de Paris (Paris branch), supervised by the AMF and by the ACPR disseminates research in France; and GSBE - Sweden Bankfilial (Stockholm branch), to a limited extent, subject to local supervision by the Swedish Financial Supervisory Authority (Finansinpektionen) disseminates research in the Kingdom of Sweden.

General disclosures

This research is for our clients only. Other than disclosures relating to Goldman Sachs, this research is based on current public information that we consider reliable, but we do not represent it is accurate or complete, and it should not be relied on as such. The information, opinions, estimates and forecasts contained herein are as of the date hereof and are subject to change without prior notification. We seek to update our research as appropriate, but various regulations may prevent us from doing so. Other than certain industry reports published on a periodic basis, the large majority of reports are published at irregular intervals as appropriate in the analyst's judgment.

Goldman Sachs conducts a global full-service, integrated investment banking, investment management, and brokerage business. We have investment banking and other business relationships with a substantial percentage of the companies covered by our Global Investment Research Division. Goldman Sachs & Co. LLC, the United States broker dealer, is a member of SIPC (https://www.sipc.org).

Our salespeople, traders, and other professionals may provide oral or written market commentary or trading strategies to our clients and principal trading desks that reflect opinions that are contrary to the opinions expressed in this research. Our asset management area, principal trading desks and investing businesses may make investment decisions that are inconsistent with the recommendations or views expressed in this research.

The analysts named in this report may have from time to time discussed with our clients, including Goldman Sachs salespersons and traders, or may discuss in this report, trading strategies that reference catalysts or events that may have a near-term impact on the market price of the equity securities discussed in this report, which impact may be directionally counter to the analyst's published price target expectations for such stocks. Any such trading strategies are distinct from and do not affect the analyst's fundamental equity rating for such stocks, which rating reflects a stock's return potential relative to its coverage universe as described herein.

We and our affiliates, officers, directors, and employees, excluding equity and credit analysts, will from time to time have long or short positions in, act as principal in, and buy or sell, the securities or derivatives, if any, referred to in this research.

The views attributed to third party presenters at Goldman Sachs arranged conferences, including individuals from other parts of Goldman Sachs, do not necessarily reflect those of Global Investment Research and are not an official view of Goldman Sachs.

Any third party referenced herein, including any salespeople, traders and other professionals or members of their household, may have positions in the products mentioned that are inconsistent with the views expressed by analysts named in this report.

This research is not an offer to sell or the solicitation of an offer to buy any security in any jurisdiction where such an offer or solicitation would be illegal. It does not constitute a personal recommendation or take into account the particular investment objectives, financial situations, or needs of individual clients. Clients should consider whether any advice or recommendation in this research is suitable for their particular circumstances and, if appropriate, seek professional advice, including tax advice. The price and value of investments referred to in this research and the income from them may fluctuate. Past performance is not a guide to future performance, future returns are not guaranteed, and a loss of original capital may occur. Fluctuations in exchange rates could have adverse effects on the value or price of, or income derived from, certain investments.

Certain transactions, including those involving futures, options, and other derivatives, give rise to substantial risk and are not suitable for all investors. Investors should review current options and futures disclosure documents which are available from Goldman Sachs sales representatives or at

https://www.theocc.com/about/publications/character-risks.jsp and https://www.fiadocumentation.org/fia/regulatory-disclosures_1/fia-uniform-futures-and-options-on-futures-risk-disclosures-booklet-pdf-version-2018. Transaction costs may be significant in option strategies calling for multiple purchase and sales of options such as spreads. Supporting documentation will be supplied upon request.

Differing Levels of Service provided by Global Investment Research: The level and types of services provided to you by the Global Investment Research division of GS may vary as compared to that provided to internal and other external clients of GS, depending on various factors including your individual preferences as to the frequency and manner of receiving communication, your risk profile and investment focus and perspective (e.g., marketwide, sector specific, long term, short term), the size and scope of your overall client relationship with GS, and legal and regulatory constraints. As an example, certain clients may request to receive notifications when research on specific securities is published, and certain clients may request that specific data underlying analysts' fundamental analysis available on our internal client websites be delivered to them electronically through data feeds or otherwise. No change to an analyst's fundamental research views (e.g., ratings, price targets, or material changes to earnings estimates for equity securities), will be communicated to any client prior to inclusion of such information in a research report broadly disseminated through electronic publication to our internal client websites or through other means, as necessary, to all clients who are entitled to receive such reports.

All research reports are disseminated and available to all clients simultaneously through electronic publication to our internal client websites. Not all research content is redistributed to our clients or available to third-party aggregators, nor is Goldman Sachs responsible for the redistribution of our research by third party aggregators. For research, models or other data related to one or more securities, markets or asset classes (including related services) that may be available to you, please contact your GS representative or go to https://research.gs.com.

Disclosure information is also available at https://www.gs.com/research/hedge.html or from Research Compliance, 200 West Street, New York, NY 10282.

MINDCRAFT: OUR THEMATIC DEEP DIVES

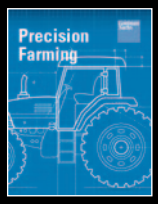
The Future of Batteries

Carbonomics

Europe's Energy Crisis

China Agriculture

Precision Farming



Green Capex

The Circular Economy

Byte-ology

Gene Editing

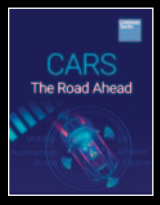
The Metaverse

Cloud Computing

5G

Blockchain

Cars: The Road Ahead



Music in the Air

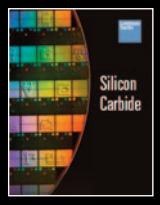
China Property

China's Credit Conundrum

Age of Automation

China Post-95s

Silicon Carbide



China Decarbonization

The Survivor's Guide to Disruption

Sustainable ESG Investing

Black Womenomics

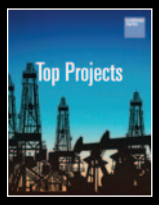
Inclusive Growth

Market Cycles

Top of Mind

What Matters for IPOs

Top Projects

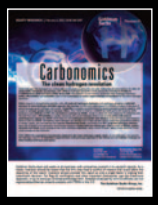


Tracking the Consumer

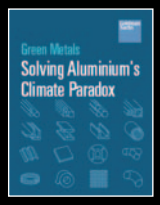
EU Taxonomy

Balanced Bear

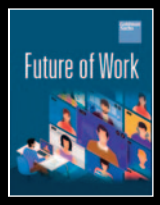
Clean Hydrogen



Green Metals



The Future of Work



What the Market Pays For

The Great Reset

The Competitive Value of Data

Mindcraft and Themes Tracker Promo