

GREEN CAPEX

Greenflation, Returns and Opportunity

The Russia-Ukraine war, inflation, recognition of the need for energy reliability and rising interest rates are driving debates around how private sector and public sector commitment to Green Capex will evolve and whether this raises or lowers the attractiveness of investment opportunities towards achieving Net Zero, Infrastructure and Clean Water goals. We continue to see Green Capex as an underappreciated secular growth trend as investments rise towards Decarbonization, Infrastructure and Clean Water goals. Even as the incremental \$2.8 trillion in annual investment needed this decade vs. 2016-20 is not fully on track: (a) capex + R&D medium-term growth expectations have risen over the past six months, both on an absolute basis and modestly relative to operating cash flow; and (b) governments appear more committed to increasing or stimulating Green Capex, particularly in Europe. We believe corporate returns and forward corporate returns momentum will be a key driver of stock performance, and in this report we present screens that highlight sectors where we see favorable, resilient and/or improving corporate returns levered to technologies needed in the Green Capex mosaic.

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The following is a redacted version of Goldman Sachs Research's report "Green Capex: Greenflation, Returns and Opportunity" originally published June 13, 2022 (54pgs). All company references in this note are for illustrative purposes only and should not be interpreted as investment recommendations.

PM Summary

We continue to see Green Capex as an underappreciated secular growth trend as investments rise towards Decarbonization, Infrastructure and Clean Water goals. Even as the incremental \$2.8 trillion in annual investment needed this decade vs. 2016-20 is not fully on track, capex + R&D growth expectations for Green Capex critical sectors have more than doubled — FactSet consensus now implies a 5.3% CAGR in 2021-24 vs. 2.5% previously. With price inflation a necessity for some sectors and cost inflation a risk for other sectors within the Green Capex mosaic, we believe corporate returns and forward corporate returns momentum will be a key driver of stock performance — particularly as the Street focuses more closely across sectors on profitability. We continue to see favorable investment opportunities of companies through the Green Capex supply chain.

Green Capex takeaways

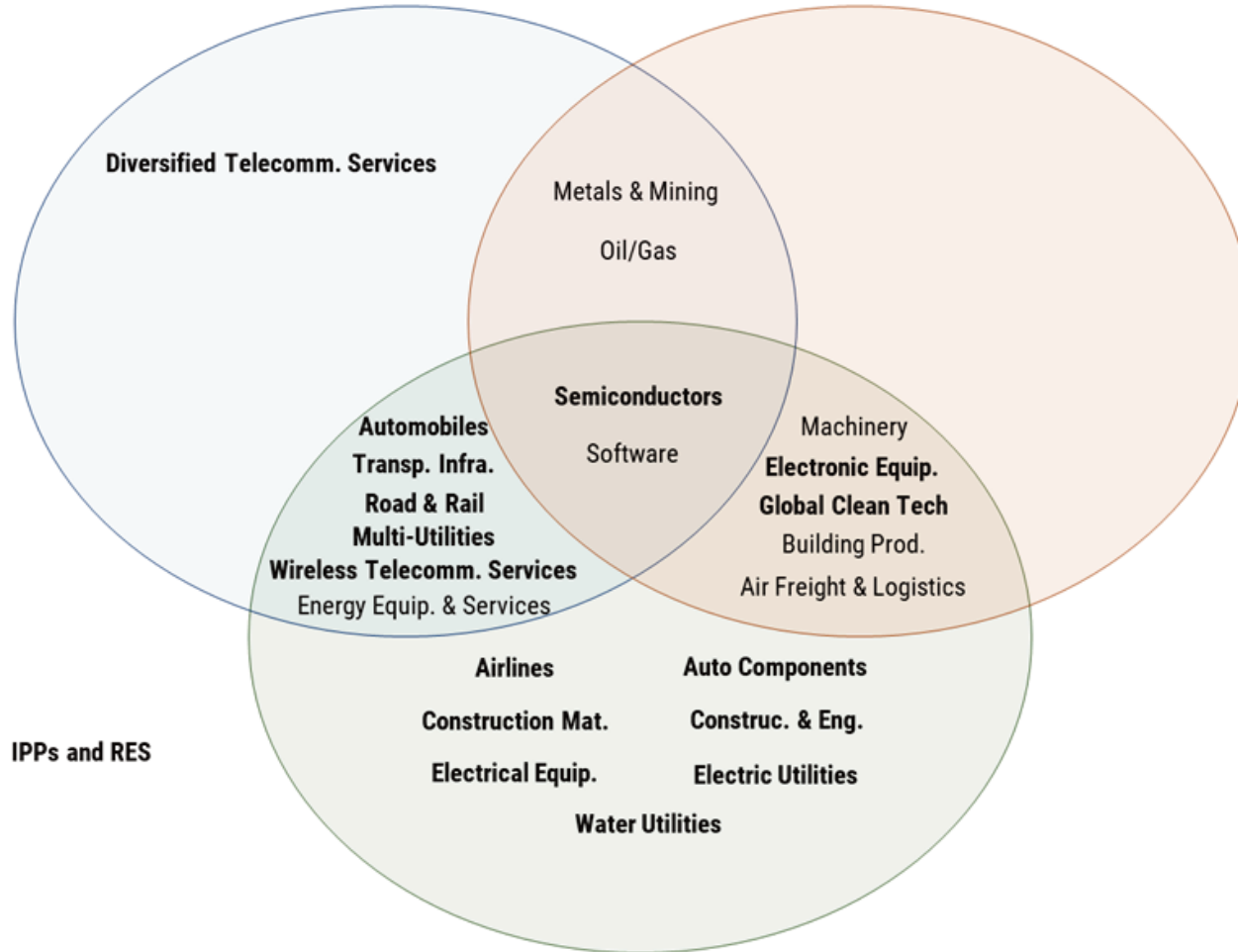
- 1. Capex and R&D expectations for Green Capex-critical sectors have moved higher** over the past six months, now expected based on Factset consensus to grow at a 5.3% annual rate in 2021-24 vs. 2.5% previously.
- 2. Corporate returns revisions are mixed, but the forward remains favorable.** We believe investors will closely look at the implications of inflationary pressures (ability to pass through higher costs to customers) and greater corporate capex on corporate-level returns. Since February, more Green Capex sectors have seen downward revisions to corporate returns by our analysts than upward revisions. However, our analysts expect a majority of Green Capex sectors to have corporate returns above the global median and/or have corporate returns on the rise in 2023 or 2024 vs. 2022.
- 3.** We expect **innovation to accelerate in Clean Reliable Energy and Energy Efficiency** as a result of greater deployment.
- 4. Policy support has strengthened in Europe** via the RePowerEU plan.
- 5. Economic growth and consumer impact are key risks** even as our Economics Research team expects a soft landing in the United States. This could present downside risk to analyst estimates and corporate returns. We have seen a slower-than-expected closing of Green private equity funds since our last update.
- 6. We continue to see underappreciated opportunities throughout the Green Capex supply chain as ESG fund overweights remain highly concentrated.** Excluding Oil & Gas, Metals & Mining and Energy Equipment & Services, we highlight 12 sectors (see [Exhibit 1](#)) that meet at least two of the following three criteria: Corporate returns expectations that have not degraded since our last update published February 2 (before the Russia/Ukraine war); Corporate returns in 2022-23 that are expected to be above global or regional sector median; Corporate returns that are expected to rise in 2023 or 2024 vs. 2022. The **Semiconductors and Software sectors** meet all three criteria.

7. **We maintain our expectations for Green Capex spare capacity at \$1.0 trillion annually.** Spare capacity is now even more heavily concentrated in Oil/Gas, which we believe will increase considerations by Sustainability investors to deploy engagement strategies focused on ESG Improvers or those with low cost and low environmental footprint.

Exhibit 1: With consensus expectations for capex and R&D through 2024 for Green Capex-critical sectors revised up meaningfully vs. 2H21, we focus on implications to corporate returns. Semiconductors is the only sector reinvesting above the global sector median in which returns have not degraded, are still above average and are forecast to rise. Outside of Oil & Gas Metals & Mining and Energy Equipment/Services, there are 12 other Green Capex sectors which have favorable corporate returns and/or returns momentum.

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)

Estimated corporate returns have not degraded **Corporate Returns above average (ex. Fin./RE)**



Corporate Returns rising in 23E/24E vs. 22E

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

Re-investors vs. Revenue Beneficiaries debate

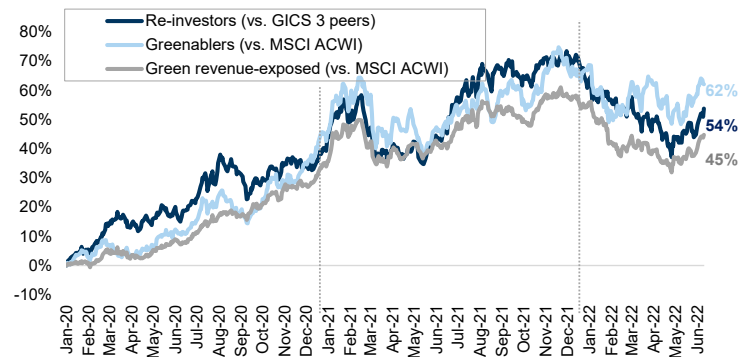
While we believe the need for increased Green Capex is secular, we see normal investor debates over whether equity outperformance can occur during the capex phase vs. harvest phase. Green Capex companies for which consensus Capex + R&D estimates have increased in recent months have not been rewarded by investors vs. their sector peers. This suggests that presently investors are rewarding revenue beneficiaries over re-investors. We believe for companies increasing capex (particularly on longer lead time projects), investors are likely to focus on:

- Whether the increased capex will lead to similar vs. greater vs. lower corporate returns; and
- The time horizon of the investment cycle and when a company would shift from investment mode to harvest mode (when projects come online).

Given the market’s increased focus on profitability, we expect an increased focus on corporate returns and note that the stocks screened as Green Re-investors and Green Revenue Beneficiaries both include only companies where cash return on cash invested exceeds sector regional or global average in 2022E or 23E.

Exhibit 2: Stocks that screen for each of our three Green Capex investment themes have outperformed respective benchmarks since the beginning of 2020 and the beginning of 2021 but not 2022 YTD

Price performance vs. GICS 3 peers for Green Capex stocks among top-100 companies for which consensus Capex + R&D estimates have moved upwards the most vs. 6 months ago (blue line), 3 months ago (light blue line) or 1 month ago (gray line)



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

Source: Refinitiv, FactSet, Goldman Sachs Global Investment Research

Green Capex in NUMBERS

5.3%

Consensus Capex and R&D growth expectations per year for Green Capex critical sectors in 2021E-2024E, up from 2.5%

Total spending the private sector is on track for of the annual \$2.8 tn incremental annual Green Capex needed this decade

\$0.9 tn

52%

Operating cash flow expected to be reinvested back into Capex + R&D in 2022E, up from 50% previously and below 60%-70% in 2000 to mid-2010s

Continued expectation for spare capacity for publicly-traded companies annually, now even more concentrated in Oil & Gas and three other sectors

\$1.0 tn

2

Number of Green Capex sectors where corporate returns estimates have not degraded, are above average and are rising in future years

Number of periods global oil demand has declined in consecutive years over the last 50 years, with price spike and economic weakness in each

3

Source: Goldman Sachs Global Investment Research

Green Capex needs remain robust: Updating what we believe is on track

We continue to believe Green Capex will be the multi-year secular theme driving the next wave of infrastructure as focus rises to decarbonize the world and meet Clean Water and infrastructure goals. We see the need for \$2.8 trillion incremental annual investment on average this decade vs the 2016-20 average. 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) — see [Exhibit 3](#). Green Capex for these three focus areas has been about \$3.2 trillion annually within 2016-2020, which represents about 15% of average global gross capital formation during 2016-19. 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 on path to Net Zero, Infrastructure and Clean Water goals (see [Exhibit 4](#)). With continued inflationary pressures, we see potential upside risk to the \$6.0 trillion annually that is required 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.

We believe the private sector is still on track for \$0.9 tn (in-line with our prior estimate) of the incremental \$2.8 trillion Green Capex needed annually in the 2020s, with the higher contribution by publicly traded companies offset by lower expected private equity fundraising. Compared to our latest update, we believe the private sector remains on track to invest \$0.9 tn more annually on average vs. 2016-20.

- **We raise our estimates for incremental Green Capex on track this decade from publicly traded companies to \$0.6 trillion from \$0.5 trillion previously.** We derive our \$0.6 trillion applying: (1) consensus expectations for capex growth in 2022 and 2023; (2) a 3.5% (vs. 3.0% prior) overall Capex + R&D CAGR post-2023; and (3) a 1.5% Green Capex mix shift — consistent with the findings detailed in our November 2021 ESG of the Future report introducing analyst forecasts for Green Capex and Green Revenue mix.
- **We revise our estimates for incremental Green Capex on track this decade from privately held companies to \$0.3 trillion from \$0.4 trillion previously.** We revise downward our expectations in Green Capex-related private capital raised (Renewable Energy, Clean Tech, Environmental Services, Utilities, Water funds) due to total funds raised in 2021 coming below our prior estimates. Data for 2021 indicates private equity capital raised for infrastructure, Climate and Clean Water objectives totaled \$65 bn. Adding leverage to the equity component at a 50%/50% equity/debt split, the incremental capital available from privately held companies in 2021 would total \$124 bn (vs. \$135 bn based on prior estimates). A scenario where private equity capital raised grows at a 20% CAGR — above the 12% historical CAGR of capital available to invest, and in-line with our Asset Management and Capital Markets teams' view of increasing share of ESG/Infrastructure capital — would imply incremental available capital from privately held companies of \$0.3 tn on

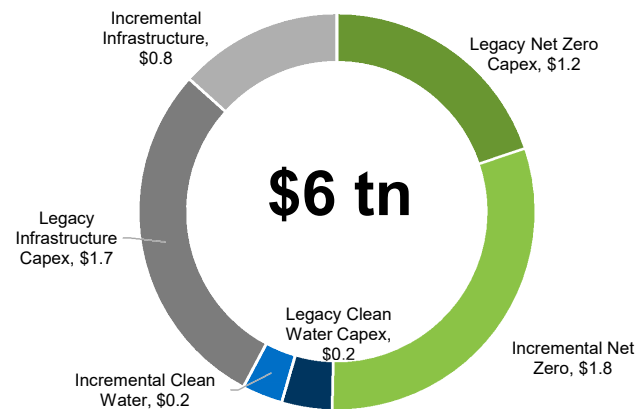
average within 2021-2030 (vs. about \$0.4 tn as indicated in our prior reports).

We maintain our expectations for spare capacity from publicly traded companies of \$1.0 trillion annually. As we detail later in the report, while spare capacity was concentrated in oil/gas, metals/mining, semiconductors and software sectors, it has become even more concentrated in oil/gas as a result of the recent spike in prices and management focus on return of capital. Upward revisions to Oil & Gas operating cash flow have well exceeded the upward revisions to sector capex. Most other sectors are spending incrementally more in capex + R&D without a requisite increase in operating cash flow.

We see an additional gap of \$0.9 tn needed (assuming corporate spare capacity is deployed) which could come from governments and/or individuals. As we note later in the report, we see rising government incentives/investment in Europe post Russia's invasion of Ukraine.

Exhibit 3: An incremental \$2.8 trillion of Green Capex is needed per year in the 2020s to support Net Zero, Infrastructure and Clean Water pathways

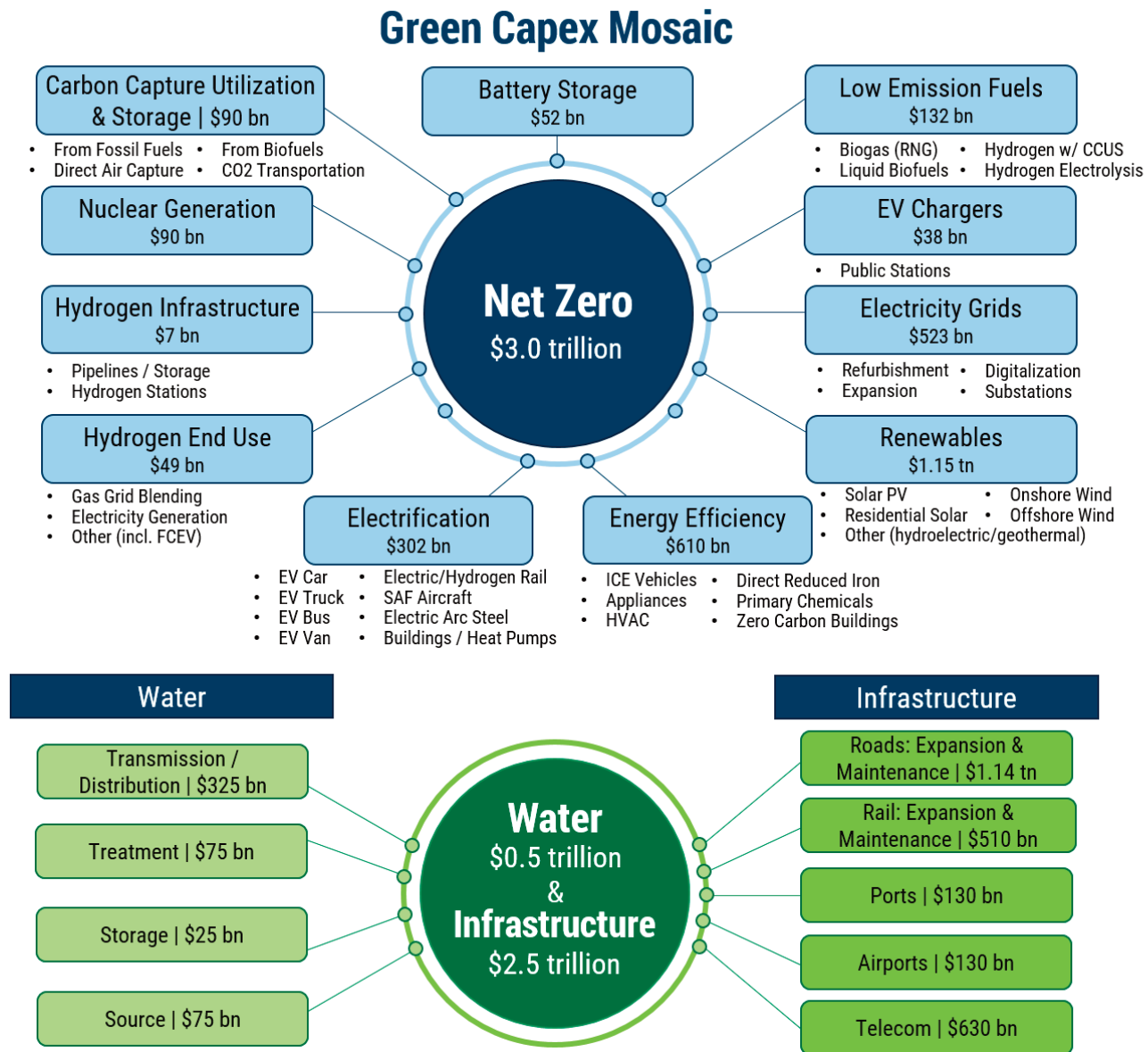
Green Capex in the Net Zero scenario



Source: World Bank, IEA, McKinsey, OECD, Goldman Sachs Global Investment Research

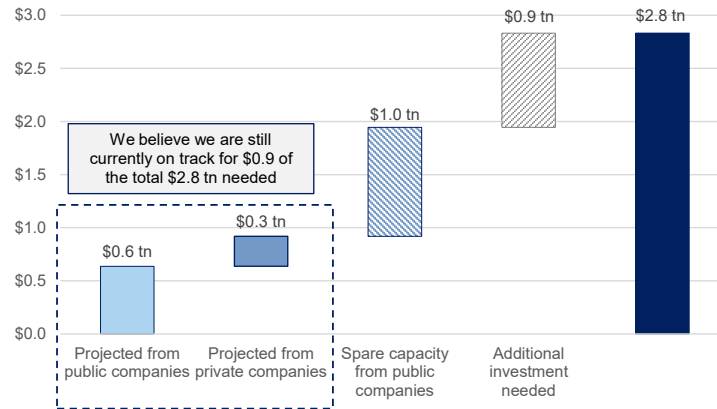
Exhibit 4: The Net Zero, Infrastructure and Clean Water mosaic

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

Exhibit 5: We believe the private sector is still on track for \$0.9 tn — despite a different public/private companies mix vs. prior reports — of the incremental \$2.8 tn Green Capex needed annually in the 2020s — with a greater mix from public companies, more than offset by a decline in our expectations from private equity funds. We see potential for \$1.0 tn of additional Green Capex from publicly traded companies based on estimated spare capacity
 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

Capex + R&D expectations have moved higher in recent months, with modest increase in reinvestment rate

Consensus expectations for overall capex + R&D on the rise — Capex + R&D consensus CAGR in 2021-24 now 5.3% vs. 2.5% previously for key sectors relevant for Green Capex. Since our latest update in December 2021, we have seen consensus estimates for yoy capex + R&D growth rise for 2022 and remain relatively flat for 2023. Expectations now call for 11% yoy growth in 2022 and 3% in 2023 (vs. about 5%/3% previously) — see [Exhibit 6](#). Among sectors most aligned with the Green Capex mosaic, we note a considerable increase in consensus 2022E Capex + R&D YoY growth expectations; in particular FactSet consensus calls for Utilities and Clean Energy to grow 7.7% in 2022E (vs. 0.8% prior), while other Green Capex sectors are projected to see 2022E Capex + R&D increasing by 10.7% (vs. 3.9% prior). Taking into account revisions to 2021 based on reported data, Capex + R&D annual growth in 2021-24 for Green Capex-critical sectors is now expected to be 5.3% vs. 2.5% 6 months ago), based on FactSet consensus.

We continue to assume Green mix shift consistent with our forward-looking analyst estimates. Solely applying overall capex + R&D growth does not factor in mix shift towards Green Capex, an important driver of Green Capex, in our view. As we detailed in our November 2021 ESG of the Future report, our forward-looking forecasts for Green Revenue and Green Capex mix by analysts across 19 sectors implies an annual 1.3% increase in weighting in Capex towards sustainable use cases through 2025E. Given potential for further upside, in our scenario analysis we round this to 1.5% and apply the mix shift to capex and R&D across all sectors.

We raise our expectation for incremental annual Green Capex on track this decade from publicly traded companies to \$0.6 tn from \$0.5 tn. We incorporate overall capex + R&D CAGRs YoY growth expectations in 2022-23 as detailed in [Exhibit 6](#) and a 3.5% longer term, combined with a 1.5% per year Green mix shift. The 3.5% long-term CAGR is larger than what consensus estimates expect for yoy growth in 2023 and 2024 but reflects our expectation that consensus expectations could move higher with greater clarity on avenues for corporates to reinvest cash flow and given trends we see in opportunities/needs for investment. Together this implies \$0.6 trillion in higher annual Green Capex on average this decade ([Exhibit 7](#)) when applied across the >7,000 companies in our GS SUSTAIN database.

We see a slightly higher reinvestment rate in 2022 and 2023 vs. our Oct. 2021 Green Capex: Making Infrastructure Happen report, though the reinvestment rate continues to fall vs. the historical average between 2000 and mid-2010s. Current estimates indicate reinvestment rates of cash flows into capex+ R&D still on the decline vs. the historical highs in the 2000s, now forecast at 52% in 2022E, 50% in 2023E and 49% in 2024E — see [Exhibit 8](#). This represents a 1-2 percentage point upward revision vs. our Oct. 2021 Green Capex report — please see [Exhibit 9](#). While this is incrementally positive towards Green Capex initiatives, reinvestment rates into capex + R&D would still need to move

considerably higher in order to bridge at least partially the gap needed to achieve the full incremental \$2.8 tn annual Green Capex needed in the 2020s on path to Sustainable Development Goals.

Exhibit 6: Capex + R&D FactSet consensus expectations have moved higher since our last update published in early February, with annual growth in 2021-24 from Green Capex sectors now expected to be 5.3% vs. 2.5% previously

Overview of Capex + R&D YoY growth for Green Capex sectors (excluding Oil & Gas and Energy Equipment and Services), based on FactSet consensus; Total line includes all sectors (not just Green Capex sectors)

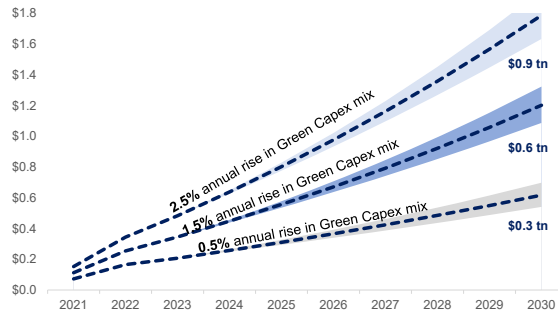
	Capex + R&D YoY Growth -- Weighted Average													2020-2024E CAGR		
	2021		2022E				2023E				2024E					
	Current	vs. -6-mo	Current	vs. -6-mo	vs. -3-mo	vs. -1-mo	Current	vs. -6-mo	vs. -3-mo	vs. -1-mo	Current	vs. -6-mo	vs. -3-mo	vs. -1-mo	Current	-6-mo
Airport Services	-11.9%	↓	4.4%	↑	↑	↓	5.5%	↓	→	→	5.0%	↑	↑	↓	0.5%	0.1%
Aluminum	-18.4%	↓	27.2%	↑	↑	↑	2.4%	↑	↑	↓	7.8%	↑	↑	↓	3.5%	-1.5%
Auto Parts & Equipment	-9.5%	↓	16.4%	↑	↑	↑	5.1%	↑	→	→	2.6%	↑	↑	→	3.2%	-2.0%
Automobile Manufacturers	3.3%	↓	13.3%	↑	→	↑	5.3%	↑	→	↑	3.4%	↑	↑	↑	6.3%	-2.2%
Automotive Retail	32.9%	→	11.0%	→	↓	→	-5.2%	↓	↑	↓	-2.6%	↓	→	↑	8.0%	10.6%
Building Products	7.6%	↓	20.4%	↑	↑	↑	0.2%	↑	↑	↑	-0.6%	↓	↑	→	6.6%	3.5%
Construction & Engineering	-0.6%	↑	3.1%	↓	↓	→	4.1%	↑	↑	↑	4.1%	↑	↑	↑	2.7%	6.3%
Construction Machinery & Heavy Trucks	13.3%	↓	6.7%	↑	↑	→	3.9%	→	→	→	2.7%	↑	↑	↑	6.6%	-1.6%
Construction Materials	41.2%	↑	-1.1%	↑	↑	↑	-6.1%	↓	↓	→	-2.6%	→	↓	↑	6.3%	3.2%
Copper	11.5%	↓	41.0%	↑	↑	↑	-1.8%	↑	↑	↑	-6.6%	↑	→	↓	9.6%	-0.8%
Diversified Metals & Mining	17.4%	→	25.1%	↑	↑	↑	0.0%	↑	↑	↑	-5.4%	↑	↑	→	8.5%	1.1%
Diversified Real Estate Activities	-8.8%	↓	7.6%	↑	↑	↑	-11.7%	↓	↓	↓	8.0%	↑	↓	→	-1.6%	6.0%
Electric Utilities	1.4%	↓	8.2%	↑	↑	↑	-0.8%	→	↓	→	3.4%	→	→	→	3.0%	3.3%
Electronic Components	7.6%	↓	8.0%	↑	↑	→	-3.0%	↓	↓	→	-1.8%	↑	↑	↓	2.6%	-4.9%
Electronic Equipment & Instruments	19.7%	↑	10.3%	↑	↓	→	7.4%	↑	↓	→	-4.4%	↑	↑	↓	7.9%	1.5%
Electronic Manufacturing Services	20.3%	↑	-0.5%	↓	↓	↑	5.8%	→	↓	↓	6.4%	↑	↑	↑	7.8%	1.3%
Heavy Electrical Equipment	3.0%	↑	6.3%	↓	↑	↑	1.7%	↑	↑	→	4.8%	↑	→	→	4.0%	0.1%
Highways & Railroads	-16.3%	↓	-29.5%	↓	↑	↓	35.2%	↑	↑	↑	12.1%	↑	↑	↑	-2.7%	-6.1%
Homebuilding	-7.7%	↓	13.1%	↑	↑	↑	3.0%	↑	→	→	2.0%	↑	↑	↑	2.4%	-2.2%
Household Appliances	24.3%	↑	-7.3%	↓	↓	↓	4.5%	→	→	→	4.7%	↑	↑	↑	6.0%	-4.1%
Independent Power Producers & Energy Traders	9.1%	↑	9.6%	↑	↓	↓	1.9%	↑	↑	↑	0.4%	↓	↑	↓	5.2%	5.0%
Industrial Conglomerates	10.4%	↑	5.2%	↓	→	↑	1.2%	→	→	→	1.5%	↓	↑	↑	4.5%	4.8%
Industrial Machinery	5.6%	↓	18.7%	↑	↑	↑	-1.8%	↓	↓	→	1.9%	↑	↑	↑	5.8%	4.0%
Integrated Telecommunication Services	6.2%	↓	2.9%	↑	→	→	-5.5%	↓	↓	→	-2.2%	↑	↑	→	0.3%	-0.6%
Marine Ports & Services	48.1%	↑	12.0%	↑	↑	↑	-18.1%	↓	↓	↓	0.0%	↑	↑	↑	8.0%	-2.0%
Multi-Utilities	10.6%	↓	0.6%	↑	↓	→	7.3%	↓	↓	↓	-2.1%	↓	↓	→	4.0%	5.3%
Railroads	-13.0%	↓	17.3%	↑	↑	↓	9.5%	↑	↑	→	0.1%	↓	↓	→	2.8%	7.2%
Real Estate Operating Companies	83.8%	↑	-41.5%	↓	↓	↓	-14.9%	↓	↑	↑	-4.4%	↓	↑	→	-3.3%	-0.4%
Renewable Electricity	2.9%	↓	22.4%	↑	↑	↓	8.3%	↑	↑	↓	12.1%	↑	↑	→	11.2%	9.9%
Semiconductor Equipment	15.6%	→	22.4%	↑	↑	↑	5.9%	↓	→	→	3.3%	↓	↑	↑	11.5%	9.2%
Semiconductors	28.5%	→	22.6%	↑	→	→	3.1%	↓	→	→	4.7%	↑	↑	→	14.2%	7.2%
Steel	19.0%	↓	18.4%	↑	↑	↑	-5.9%	↑	↑	↑	-8.6%	→	→	→	4.9%	0.8%
Systems Software	21.4%	→	12.9%	→	→	→	11.5%	→	→	→	11.5%	↑	→	→	14.2%	13.3%
Trucking	21.3%	↓	47.4%	↑	↑	↑	3.0%	→	→	→	4.6%	↓	↑	↑	17.8%	17.8%
Water Utilities	6.6%	↑	5.9%	↑	↑	↑	2.3%	↑	↑	→	0.3%	↓	↑	→	3.8%	2.0%
Wireless Telecommunication Services	1.1%	↓	5.9%	↑	↑	↑	-2.8%	→	→	→	1.0%	↑	↑	↑	1.3%	0.6%
Green Capex sectors	8.6%	↓	10.1%	↑	↑	↑	1.1%	→	→	→	1.7%	↑	↑	→	5.3%	2.5%
Utilities and Clean Energy	4.2%	↓	7.7%	↑	↑	→	1.7%	→	→	→	2.3%	↓	→	→	4.0%	3.9%
Other Green Capex sectors	9.7%	↓	10.7%	↑	↑	↑	1.0%	→	→	→	1.6%	↑	↑	↑	5.7%	2.0%
Total	10.1%	↓	11.2%	↑	↑	↑	2.9%	→	→	→	2.0%	↑	↑	↑	6.5%	4.2%

Arrows refer to revisions in consensus Capex + R&D yoy growth estimates, current estimates vs. 6/3/1-month old estimates. Green arrow: revision >1%. Yellow arrows: revisions between -1% and +1%. Red arrow: revision below -1%.

Source: FactSet, Goldman Sachs Global Investment Research

Exhibit 7: We now see incremental Green Capex from publicly traded companies would be \$1.2 tn by 2030, with an annual average of \$0.6 tn in the 2020s — in a scenario where the percent weighting for publicly traded companies of Green investments across all sectors were to rise at a 1.5% annual pace and overall capex + R&D grows at a 3.5% CAGR (vs. 3.0% in our prior reports)

Incremental Green Capex at different rates of mix shift and post-2023 Capex + R&D growth rates. Values in \$ tn

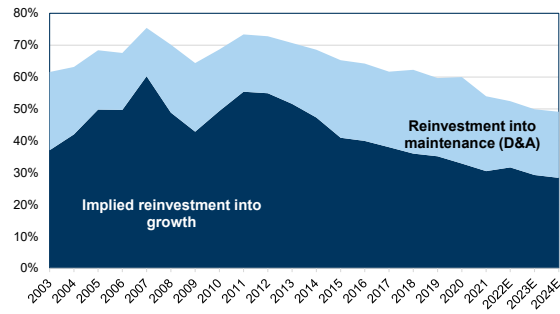


Bands are indicative of 2.5% / 3.5% / 4.5% range in post-2023 Capex + R&D growth rates

Source: Goldman Sachs Global Investment Research

Exhibit 8: Reinvestment Rates of cash flows into Capex + R&D have declined to near 52% vs. the historical average of 60%-70% between 2000 and mid-2010s

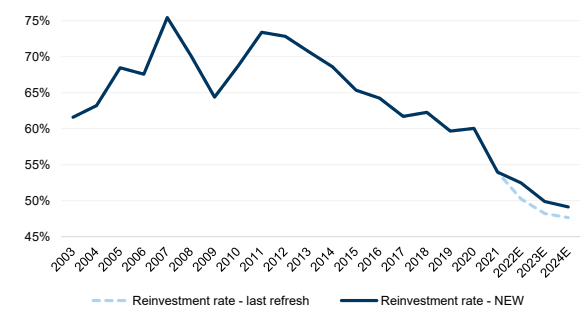
Weighted average reinvestment rate, (capex + R&D) / (operating cash flow + R&D), split by D&A and implied reinvestment into growth; excludes Financials and Real Estate



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

Exhibit 9: Consensus expectations for reinvestment rate of operating cash flow back to Capex + R&D has risen slightly since our Oct. 2021 report by about 1-2 percentage points

Consensus estimates for reinvestment rates of cash flows into Capex+R&D, 2003 - 2024E — excludes Financials and Real Estate



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

Implications to corporate returns: Mixed overall, but still favorable momentum in coming years among Green Capex sectors

In aggregate, average corporate returns across sectors (not just those relevant for Green Capex) remain strong and have been revised higher, with consensus expectations calling for increase in 2023-24. Our analysts' estimates imply an upward revision to industry's corporate returns in 2022E-2024E — to 12.9% on average in 2022-24E vs. 12.5% previously as discussed in our Feb. 2 note, referred to all sectors ex. Financials and Real Estate ([Exhibit 10](#)). This compares with pre-pandemic corporate returns of 10.5% in 2019 and 10.9% on average in 2010-2019 average for all sectors.

However, since the end of January, more Green Capex-critical sectors have seen downward CROCI revisions by our analysts than upward ones. On a weighted average-basis, sectors most critical to Green Capex are currently forecast to have corporate returns of 10.6%/11.0% in 2022E/2023E — ex. Oil/Gas. This implies a 20 bps downward revision for 2022E vs. prior estimates from our Feb. 2 report, with 2023E forecast flat. See [Exhibit 10](#).

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 ([Exhibit 12](#)). 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. As we have highlighted, we believe sectors with lower corporate returns may need three factors to improve returns and receive greater investor credit for incremental Green Capex:

- Inflation, i.e., higher product prices
- Innovation, i.e., lower costs
- Policy support

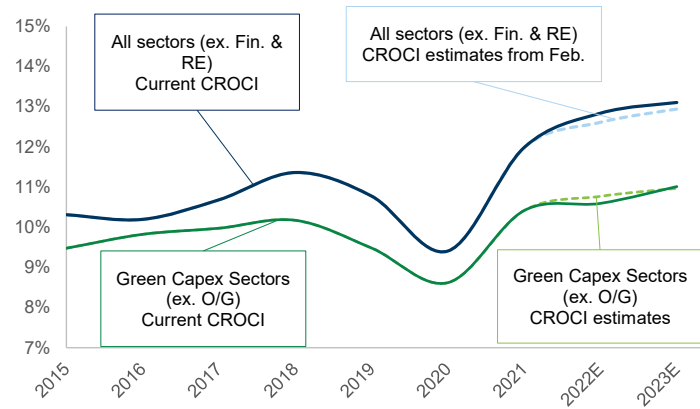
While Utilities (Electric/Multi/Water) have below-average corporate returns, they are in a unique position due to their regulated status and may not be held to the same corporate returns standards as other sectors. However, given Utilities' leverage profile and already-high reinvestment rates, fully financing incremental Green Capex may warrant equity issuance.

We continue to see positive momentum in corporate returns among Green Capex-critical sectors. We note that, on a 2023E vs. 2019 basis, our analyst forecasts imply corporate returns are expected to improve for the majority (14) of Green Capex-critical sectors: Air Freight & Logistics, Airlines, Automobiles, Auto Components, Building Products, Electrical Equipment, Electronic Equipment, Energy Equipment & Services, Machinery, Metals & Mining, Oil & Gas, Road & Rail, Semiconductors and Software. Corporate returns are expected to remain flat on a 2023E vs. 2019 basis for Diversified

Telecom, Electric Utilities and Transportation Infrastructure, and to decline for the remaining sectors: Construction & Engineering, Construction Materials, IPP & Renewable Electricity Producers, Multi-Utilities, Water Utilities and Wireless Telecom. As we discussed above, we believe that an improving outlook for corporate returns would be supportive for Green Capex, demonstrating that such initiatives are either not deteriorating corporate returns or are leading to an improvement in medium-term or longer-term.

Exhibit 10: CROCI estimates for covered companies have been revised upwards since our Feb. 2 note, projecting about 13% corporate returns in 2022E-2024E

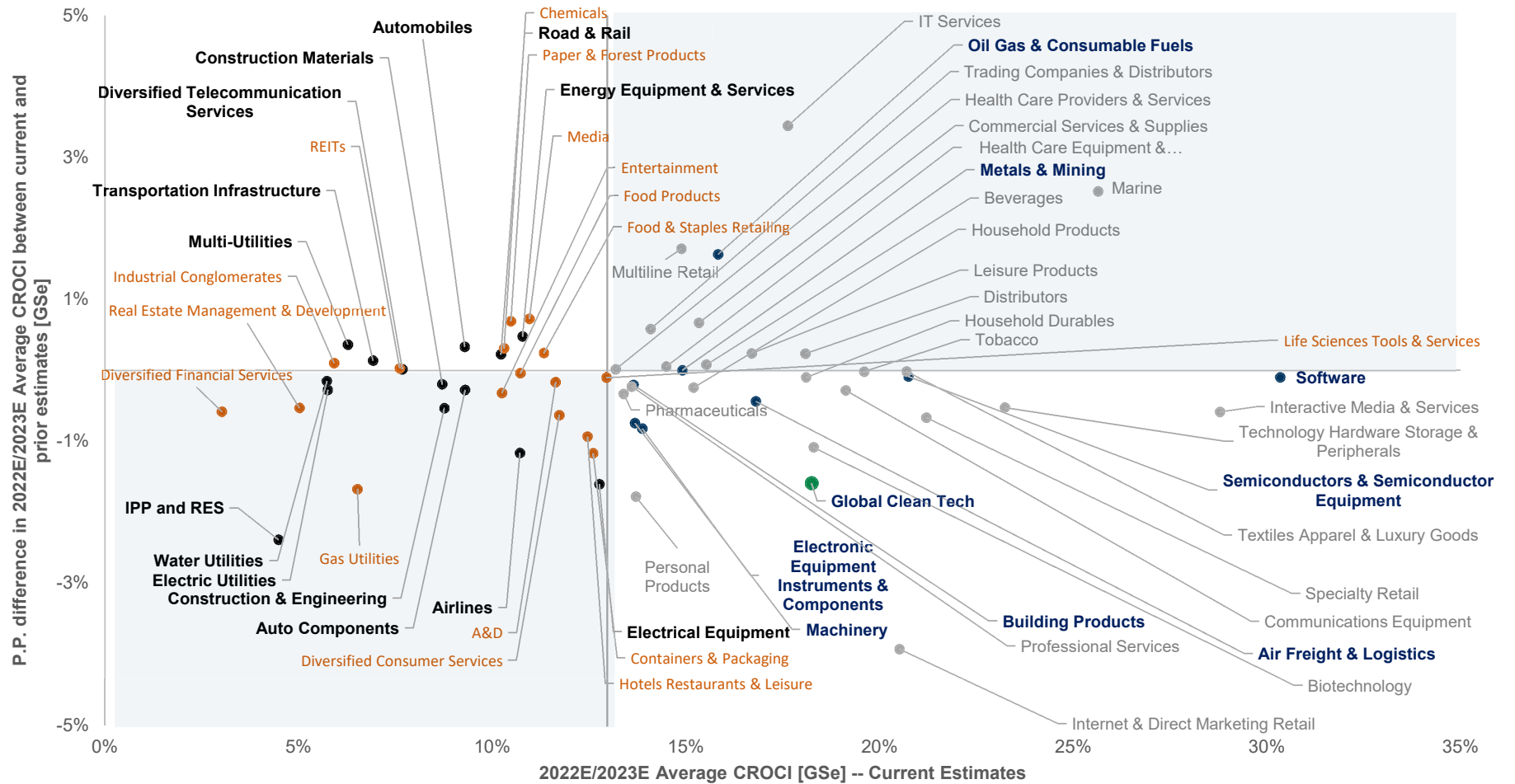
Weighted Average CROCI, all sectors. Comparison of current values (as of June 2) vs. as published in our Feb. 2 Green Capex note; Green Capex sectors exclude Oil & Gas



Source: Goldman Sachs Global Investment Research

Exhibit 11: While corporate returns expectations have not degraded overall since late January, there is significant differentiation by sector

Overview of current CROCI estimates by sector (based on 2022E/2023E average — horizontal axis) and percentage points difference in 2022E/2023E average CROCI between current and prior (Feb. 2, 2022) estimates. Vertical line denotes current estimates for average 22E/23E CROCI for all sectors (ex. Financials and Real Estate)

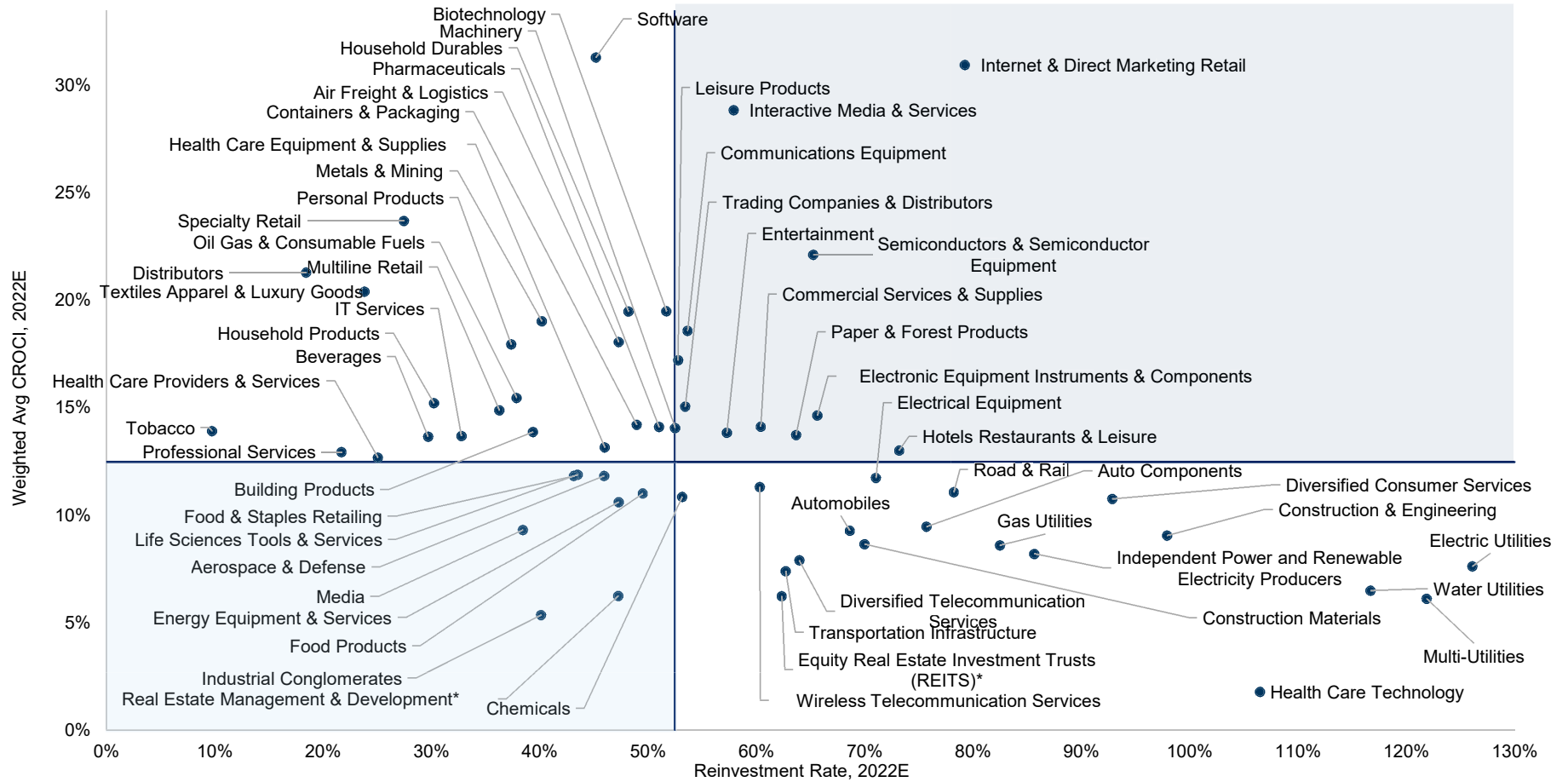


Blue dots and labels: Green Capex sectors with above-average corporate returns. Black dots and labels: Green Capex sectors with below-average corporate returns. Gray dots and labels: Other sectors with above-average corporate returns. Orange dots and labels: Other sectors with below-average corporate returns. Green dot: global clean tech companies

Source: Goldman Sachs Global Investment Research

Exhibit 12: While reinvestment rate has risen, there are still relatively few sectors with above-average corporate returns investing more than 60% of adjusted cash flow in R&D and capex in 2022E — suggesting capacity for further investment

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 13: Among the 23 Green Capex-critical sectors, 12 are estimated to have rising corporate returns in 2022E vs. 2019 (with estimates flat for 1 sector and declining for the remaining 10). In 2023E and 2024E, estimates indicate that 14 and 15 sectors will have rising corporate returns vs. the prior year, respectively.

Overview of sector-level weighted average CROCI in 2019 and 2022E-2024E. Highlighted sectors are forecast to have rising corporate returns throughout the considered period.

Green Capex-critical sectors		CROCI (2019)	CROCI (2022E)		CROCI (2023E)		CROCI (2024E)	
Air Freight & Logistics	↑	12.9%	17.2%	↑	16.5%	↓	18.0%	↑
Airlines	↑	12.2%	8.1%	↓	13.3%	↑	13.9%	↑
Auto Components	↑	9.4%	8.8%	↓	9.8%	↑	10.2%	↑
Automobiles	↑	9.0%	9.1%	↑	9.5%	↑	9.7%	↑
Building Products	↑	11.5%	13.2%	↑	14.1%	↑	14.4%	↑
Construction & Engineering	↓	10.2%	8.8%	↓	8.7%	→	8.8%	→
Construction Materials	↓	10.4%	8.7%	↓	8.7%	→	9.0%	↑
Diversified Telecommunication Services	↓	8.3%	7.8%	↓	7.5%	↓	7.4%	→
Electric Utilities	→	5.9%	5.5%	↓	6.0%	↑	6.2%	↑
Electrical Equipment	↑	10.0%	11.1%	↑	14.4%	↑	15.4%	↑
Electronic Equipment Instruments & Components	↑	10.3%	13.6%	↑	14.2%	↑	14.2%	→
Energy Equipment & Services	↑	7.9%	9.1%	↑	11.4%	↑	12.1%	↑
Independent Power and Renewable Electricity Producers	↓	4.7%	4.6%	→	4.4%	↓	4.5%	↑
Machinery	↑	12.7%	13.3%	↑	14.1%	↑	14.5%	↑
Metals & Mining	↑	8.6%	16.0%	↑	13.8%	↓	12.9%	↓
Multi-Utilities	↓	6.6%	6.2%	↓	6.4%	↑	6.2%	↓
Oil Gas & Consumable Fuels	↑	10.2%	16.2%	↑	15.4%	↓	13.3%	↓
Road & Rail	↑	8.7%	9.6%	↑	10.9%	↑	11.8%	↑
Semiconductors & Semiconductor Equipment	↑	14.5%	20.6%	↑	20.9%	↑	20.0%	↓
Software	↑	27.5%	28.1%	↑	32.6%	↑	33.9%	↑
Transportation Infrastructure	↓	7.5%	6.7%	↓	7.2%	↑	7.4%	↑
Water Utilities	↓	6.3%	5.7%	↓	5.8%	→	5.8%	→
Wireless Telecommunication Services	↓	11.2%	10.5%	↓	10.5%	→	11.2%	↑
All Sectors, Weighted Average (ex. Financials and Real Estate)	↑	10.8%	12.8%	↑	13.1%	↑	12.8%	↓

Green arrows indicate an increase greater than 0.1%, red arrows indicate a decrease greater than 0.1%, yellow arrows represent changes between +/- 0.1%. Arrows beside sector names refer to the percentage point difference in 2023E CROCI vs. 2019 CROCI. Arrows in 2022E and 2023E/2024E columns refer to the percentage point difference vs. 2019 CROCI and vs. 2022E/2023E CROCI, respectively.

Source: Goldman Sachs Global Investment Research

Green Capex spare capacity has expanded, but more concentrated in oil/gas

We raise our forecast for annual Green Capex “spare capacity” from publicly traded companies by 7%, though our revised forecast still rounds to \$1.0 trillion annually. As we detail above, for publicly listed companies, the reinvestment rate of operating cash flow back into capex and R&D decreased during the past decade from a historical range of 60%-70% and is now expected on a bottom-up basis to be about 50% in 2022. At the same time, balance sheets are expected to de-lever from historical levels — net debt/EBITDA ratios are expected to fall to 1.3x in 2022E for companies in GS coverage — ex. Utilities, Real Estate and Financials. For those sectors that are most critical for Green Capex, we see spare capacity among publicly traded companies of an additional \$1.0 tn per year of Green Capex, should reinvestment rates of cash flows and R&D into capex return to 70% and balance sheets normalize at 1.5x Net Debt/EBITDA ([Exhibit 14](#)). This represents a 7% increase vs. our prior estimates, though still rounds to \$1.0 tn annually.

However, Green Capex spare capacity is even more concentrated (vs. prior estimates) in a handful of sectors. Our analysis suggests that the sectors where the largest Green Capex spare capacity lies include Oil & Gas, Metals & Mining, Software and Semiconductors, which account for more than 90% of the total. We believe those four sectors are particularly relevant due to the following catalysts:

- **Oil & Gas**, relevant due to potential for contribution toward carbon capture utilization and storage, biofuels, hydrogen and renewables — for those pursuing.
- **Metals & Mining**, relevant for key products such as copper, aluminum, lithium, nickel, cobalt, which enable downstream electrification, automation, efficiency (we highlighted copper and aluminum as Greenablers in our Green Capex report).
- **Semiconductors**, relevant for energy efficiency, automation, electric vehicles, solar — see our deep-dive on Semiconductors as Greenablers for more details.
- **Software**, relevant to cybersecurity (highlighted as a Greenabler theme in our Green Capex report) and automation/efficiency solutions.

Given the increased concentration among those 4 sectors, the willingness, core competencies, and ability to execute on Green Capex projects — particularly among oil/gas and metals/mining companies — will be critical given the high percentage of overall spare capacity these sectors represent.

The increase in Green Capex spare capacity is driven by the Oil & Gas sector, which more than offsets the decrease in spare capacity across the majority of other sectors. The most material shift in Green Capex spare capacity came from an increase in the Oil & Gas sector, where we revise our expectations higher by almost 60%. This is a function of greater free cash flow due to higher oil/gas prices. We now see more than \$0.6 trillion of Green Capex spare capacity for the Oil &

Gas sector vs. \$0.4 trillion as reported in our Green Capex: Making Infrastructure Happen report. Please see [Exhibit 15](#). While more modest, we also note a 3% increase in Green Capex spare capacity among Metals & Mining companies. In our view, the increase in the potential ability to deploy more capital across commodity producers is primarily attributable to elevated commodity prices (see our deep-dive on a supply-driven oil price spike for more details) and, given the criticality of Oil/Gas and Metals & Mining companies in Green Capex spare capacity, underlines to a greater extent the potential for engagement vs. exclusion and the shift from aspiration to action on path to decarbonization, clean water and infrastructure goals.

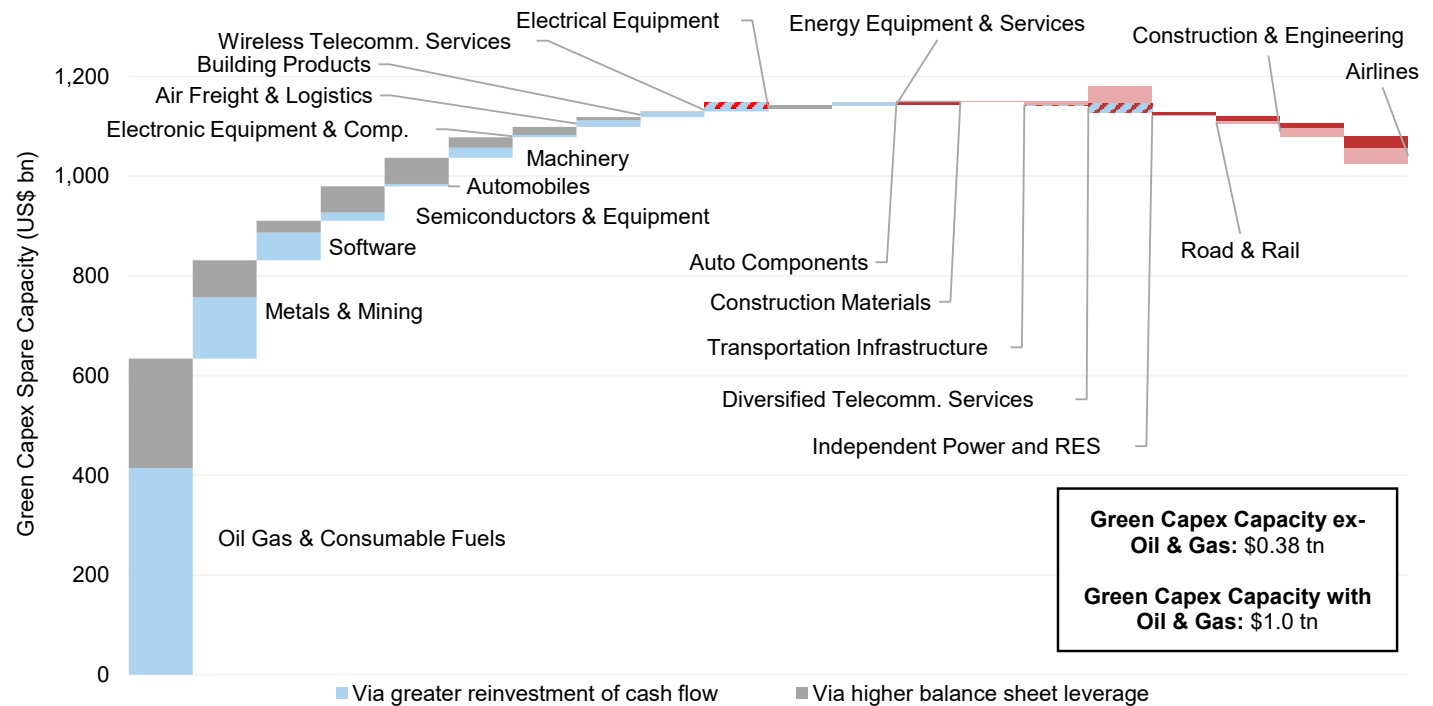
We continue to believe the capability to generate favorable returns on Green Capex initiatives — particularly for those sectors such as Oil/Gas and Metals & Mining that have below-average corporate returns — will be key regarding managements' decisions on how to allocate resources vs. returning capital to shareholders. In our view, investor would “**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
- **E**xecution to meet goals and raise revenue contribution from Green initiatives that are material.

Even if this spare capacity were deployed, we would still need \$0.9 trillion per year of additional annual investment to meet Net Zero, Clean Water and Infrastructure goals. We note, however, that 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.

Exhibit 14: We see a c.7% increase vs. our Oct. 11, 2021 report in annual spare capacity for Green Capex from Green Capex-critical sectors based on 70% reinvestment rate and 1.5x leverage — though still rounds to \$1.0 tn

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

Exhibit 15: The 7% increase in Green Capex spare capacity vs. our prior report is driven by the Oil & Gas sector, one of 4 Green Capex-critical sectors for which spare capacity is forecast on the rise (while it is expected on the decline for 14 sectors and flattish for 2)

Change in Green Capex spare capacity vs. our Oct. 11, 2021 report — via Greter Reinvestment of Cash Flows into Capex+R&D, Higher Leverage and Total

	Change in Green Capex spare capacity vs. our prior report							
	Driven by Reinvestment Rate			Driven by Leverage		Total		
	Via Δ CF+R&D \$ bn	Via Δ Capex+R&D \$ bn	Total Δ \$ bn		\$ bn		\$ bn	
Air Freight & Logistics	\$5	\$2	\$7	↑	(\$0)	→	\$7	↑
Airlines	(\$17)	(\$8)	(\$25)	↓	(\$7)	↓	(\$32)	↓
Auto Components	\$0	(\$6)	(\$6)	↓	(\$3)	↓	(\$9)	↓
Automobiles	\$0	(\$1)	(\$0)	→	(\$3)	↓	(\$3)	↓
Building Products	(\$0)	(\$0)	(\$1)	→	(\$1)	↓	(\$2)	↓
Construction & Engineering	(\$1)	(\$7)	(\$8)	↓	(\$4)	↓	(\$12)	↓
Construction Materials	(\$2)	(\$5)	(\$7)	↓	(\$2)	↓	(\$10)	↓
Diversified Telecommunication Services	(\$14)	\$1	(\$12)	↓	\$0	→	(\$12)	↓
Electrical Equipment	(\$4)	(\$8)	(\$12)	↓	(\$1)	↓	(\$13)	↓
Electronic Equipment Instruments & Components	(\$3)	(\$3)	(\$6)	↓	(\$4)	↓	(\$10)	↓
Energy Equipment & Services	\$2	(\$1)	\$1	↑	\$1	↑	\$3	↑
Independent Power and Renewable Electricity Producers	\$4	(\$5)	(\$1)	→	\$0	→	(\$1)	↓
Machinery	(\$14)	(\$2)	(\$16)	↓	(\$7)	↓	(\$23)	↓
Metals & Mining	\$31	(\$28)	\$2	↑	\$4	↑	\$6	↑
Oil Gas & Consumable Fuels	\$172	(\$36)	\$136	↑	\$95	↑	\$231	↑
Road & Rail	(\$4)	(\$4)	(\$8)	↓	(\$2)	↓	(\$10)	↓
Semiconductors & Semiconductor Equipment	\$4	(\$21)	(\$18)	↓	\$2	↑	(\$16)	↓
Software	(\$5)	\$2	(\$4)	↓	(\$15)	↓	(\$19)	↓
Transportation Infrastructure	\$1	(\$1)	(\$1)	→	\$1	→	\$0	↑
Wireless Telecommunication Services	\$2	(\$0)	\$2	↑	(\$9)	↓	(\$7)	↓
Total	\$157	(\$132)	\$25	↑	\$45	↑	\$70	↑
<i>Excluding Oil Gas and Energy Services</i>	<i>(\$17)</i>	<i>(\$95)</i>	<i>(\$112)</i>	<i>↓</i>	<i>(\$51)</i>	<i>↓</i>	<i>(\$164)</i>	<i>↓</i>

Green arrows: increase greater than 5%. Yellow arrows: percent change between +5% and -5%. Red arrows: decrease greater than 5%.

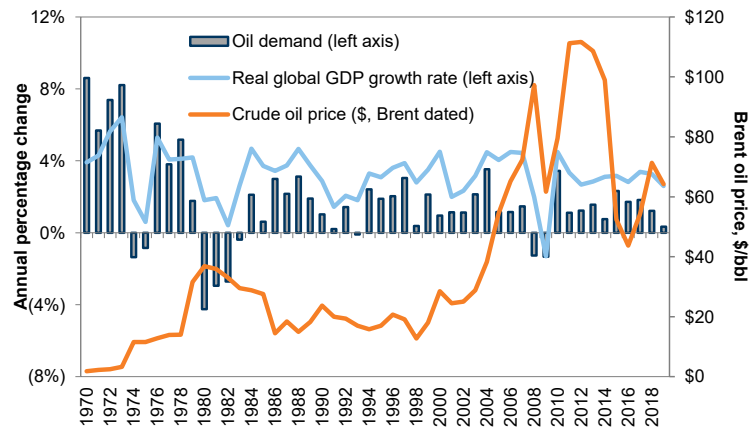
Source: Goldman Sachs Global Investment Research

Economic growth and consumer impact are key risks

Lowering oil demand in the face of a supply shortage has typically taken a price spike and a recession. Global oil demand has only fallen in consecutive years three times in the past 50. The past two periods in history where we saw a price spike in oil prices large enough to drive a decrease in demand were 2004-08 and 1979-81. In both these periods, we also saw concurrent or subsequent global recessions (1982 and 2009). We have seen other periods of economic weakness such as 2020 (driven by the COVID-19 pandemic) and 1992 (flattening of oil demand after a more modest increase in oil prices in 1989-91). Overall, lower yoy oil demand has been relatively rare — even during the COVID-19 pandemic, demand fell only 9% yoy in 2020 and came back sharply in 2021. The focus towards electrification and cost reduction in cleaner alternatives like solar/wind provide greater confidence that oil demand via innovation and policy will decrease on a more secular basis. Our Energy team’s base case under normal economic conditions is that global oil demand will not secularly decline before 2030. However, underinvestment in supply and the potential/actual disruption of production resulting from the Russia-Ukraine war is warranting prices high enough to lower demand.

Exhibit 16: Past periods of multi-year demand decreases often occurred concurrent with spikes in oil prices and slowdowns in global GDP

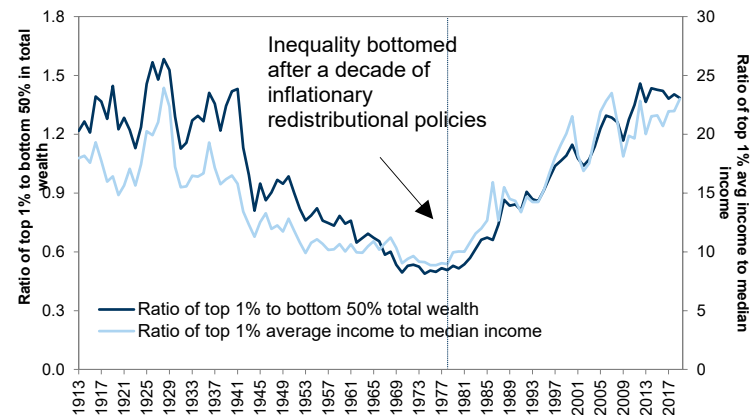
Oil demand growth (left axis), global GDP growth (left axis) and Brent oil price (right axis), 1970-2019



Source: BP Statistical Review of World Energy 2021, World Bank, Goldman Sachs Global Investment Research

Exhibit 17: As our Commodities Research team has highlighted, the gap in both wealth and income in the US has been on the rise for much of the past 40 years

Ratio of the top 1% to bottom 50% of total wealth (left axis) and top 1% to median total income (right axis) in the US

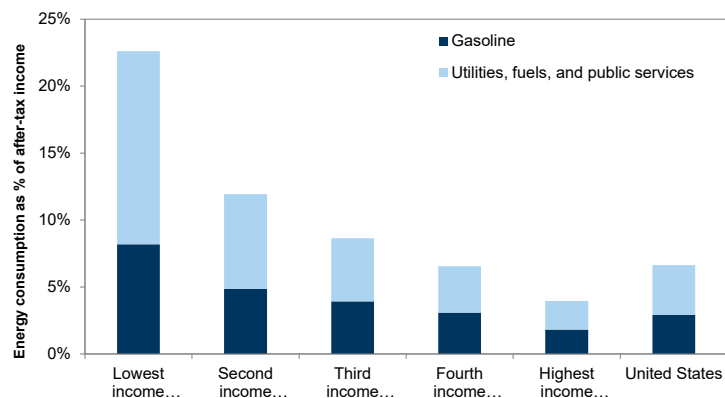


Source: Goldman Sachs Global Investment Research, Haver Analytics, IEA, EIA

A longer-than-expected inflationary environment, in particular with regard to food and energy prices, could lead to a greater impact on consumer behavior and pose a risk to corporate cash flows over time in sectors important for Green Capex. As detailed in our Sustainability implications of an oil price spike report, higher commodity prices have

refocused attention on the Social aspects of ESG. The spike in commodity prices comes at a time when wealth and income inequality in the US are at the highest levels in nearly a century — putting additional financial burden on low-income consumers (Exhibit 17). In 2019, energy spending — including gasoline and utilities — represented 23% of after-tax income for US consumers in the lowest income quintile versus just 4% for those in the top quintile. The gap for food consumption is even more stark — 36% for consumers in the bottom quintile compared to 8% for those in the top quintile (Exhibit 19). We believe there are potential implications for both consumer, corporate and government investment in Green Capex if these inflationary pressures are prolonged.

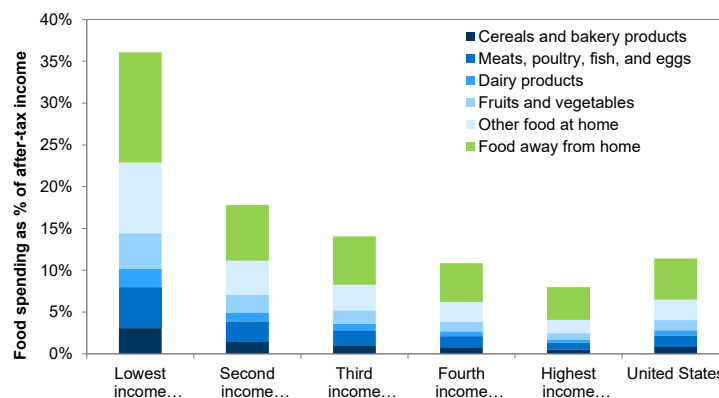
Exhibit 18: Consumer spending on energy consumption represents 23% of annual after-tax income for the lowest income quintile in the US, versus 4% for the highest quintile
US energy spending as percent of after-tax income quintiles, 2019



Excludes telephone services

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

Exhibit 19: Consumer spending on food consumption represented 36% of annual after-tax income for the lowest income quintile in the US, versus 8% for the highest quintile
US food spending for consumer units in different income quintiles, 2019



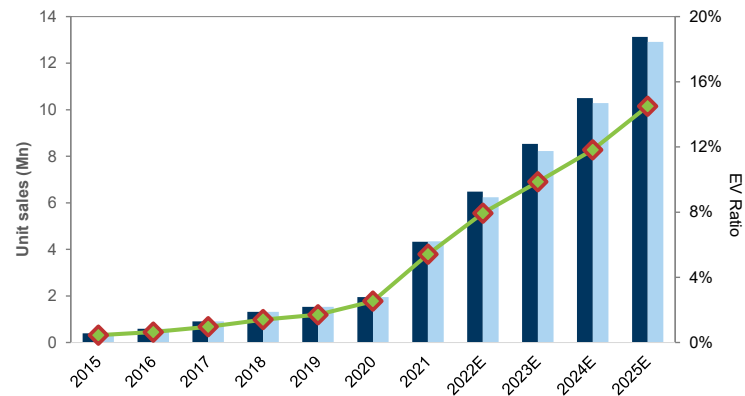
Source: US Bureau of Labor Statistics, Goldman Sachs Group Inc.

Economic uncertainty could lead to fewer expected global vehicle sales, though EV penetration is expected by our analysts to remain on track. As recently noted by our Global Auto teams, 2022E global auto sales volumes have been revised downwards to a 2.1% YoY decline versus a 1.7% YoY increase previously. Key drivers of this change include the challenging macro environment in China, the US, and India and protracted production constraints. Production volumes have also been lowered to +2.2% YoY (vs. +5.7% YoY prior) in response to slow progress in resolving semiconductor shortages and delays with parts procurement due to lockdowns in major cities in China. Our colleagues expect a moderate recovery trend in both auto production and sales in 2023. **Looking at the EV segment, the Global Auto teams have kept the EV share of total auto sales largely the same,** reflecting an improvement in the total cost of ownership (TCO) on account of higher gasoline prices, the launch of new EVs by automakers in response to environmental regulations by governments

around the world, and front-loaded demand in anticipation of further price hikes for EVs ([Exhibit 20](#)).

Exhibit 20: Our Global Auto team have recently revised downwards their expectations for auto sales in 2022E-25E, while keeping EV weighting unchanged

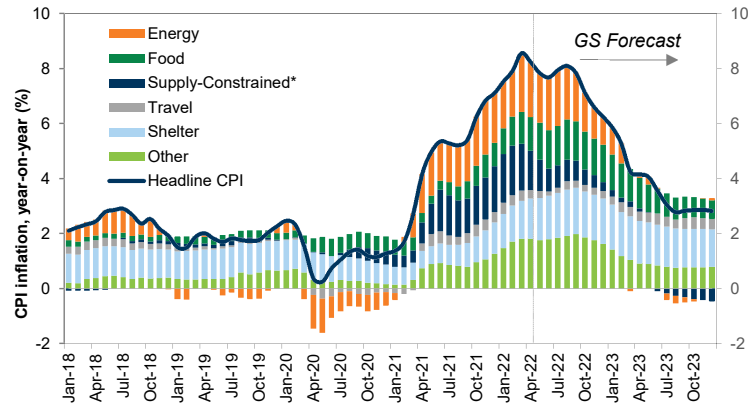
Global EV sales forecast, June 22 estimates (dark blue) vs January 22 estimates (light blue), and EV weighting



Source: IHS Global Insight, IEA, Goldman Sachs Global Investment Research

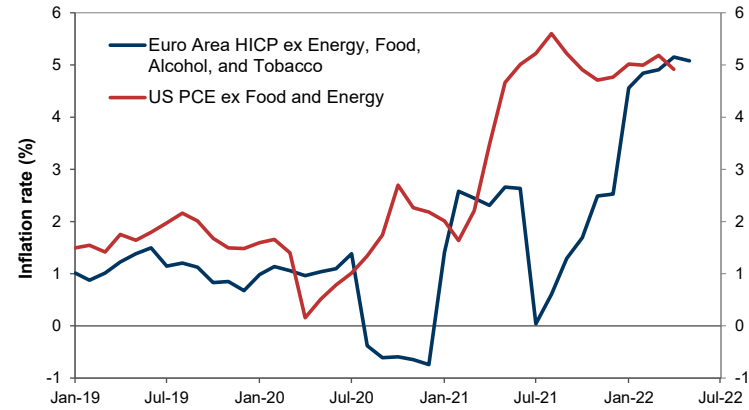
In recent weeks, our Economics team has revised its US GDP growth forecast for 2022 and 2023 to 2.5% and 1.6% respectively. In the US, slower economic growth would likely lead to slower growth in business investment and consumer spending, and higher unemployment. Nevertheless, our economists believe that the US economy will make a soft landing, with a 35% risk of a recession within the next two years. Our Economics team expects current high levels of inflation to ease in the near term as many central banks from around the world are on path to tighten monetary policy. Our economists project that headline inflation for 2022 will be 7.1% in the US, 8.7% in the UK, and 7.6% in the Euro Area. Our Economics team expects the FOMC to raise the Federal funds rate by 50 bp in four consecutive meetings in June, July, September and November, and by 25bp in its December and January meetings. The terminal rate forecast from our economists is 3.25-3.5%. For the Eurozone, our economists believe that higher than expected inflation pressure will lead the ECB to end its asset purchases and start raising interest rates in July.

Exhibit 21: Our Economists in April highlighted that further supply-side problems are a risk to their expectations of a slowdown in goods inflation, which accounts for the entirety of the forecasted decline in inflation in 2022



Source: Department of Commerce, Department of Labor, Goldman Sachs Global Investment Research

Exhibit 22: Euro Area inflation covering towards US levels



Source: Haver Analytics, Goldman Sachs Global Investment Research

Innovation could accelerate in Clean Reliable Energy and Energy Efficiency as a result of greater deployment

We believe higher commodity prices should accelerate innovation with greater focus among policymakers, corporates and investors on Clean Reliable Energy and Energy Efficiency. On the back of renewables deployments and policy initiatives, we expect hydrogen to likely see acceleration in Europe (particularly driven by the push to reduce reliance on natural gas imports from Russia), with our EU Energy team noting a 3.5x upward revision in EU's Green Hydrogen targets due to REPowerEU. We could see battery storage deployed at an accelerated pace in the US, particularly at the utility-scale. In addition, we believe energy efficiency could become a more impactful theme particularly in regions — such as the US — where there is a greater potential for initial impact focusing on consumer emissions rather than corporate emissions (please see our ESG of the Future report on corporate Greenhouse Gas emissions for more details).

We are watching seven key technologies, with particular focus on hydrogen and battery storage. Staying on path with Sustainable Development Goals will require breakthroughs across multiple green technologies to abate costs and bridge gaps in economic competitiveness. Focusing on Net Zero targets, the urgency to foster innovation across various decarbonization technologies is why we believe companies exposed to the themes (see our Green Capex report) will play an increasing role in the transition towards a low carbon economy and in the long-term. [Exhibit 23](#) highlights 8 critical technologies — and related innovation areas — that could provide transformational and disruptive solutions to drive decarbonization in the long-term (see our colleagues' China de-carbonization: A new eco-system of green tech for more details).

- **Battery storage:** As was discussed during our Global Sustainability Forum and described by our colleagues in The Great Battery Race report, battery storage is increasingly in focus among managements and investors, which highlighted their key role for companies' operations and on path to broader decarbonization targets.
- **Hydrogen:** 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.

Exhibit 23: Innovations across multiple technologies could help lower the cost of decarbonization and introduce new climate solutions

Select focus areas for decarbonization technological innovation

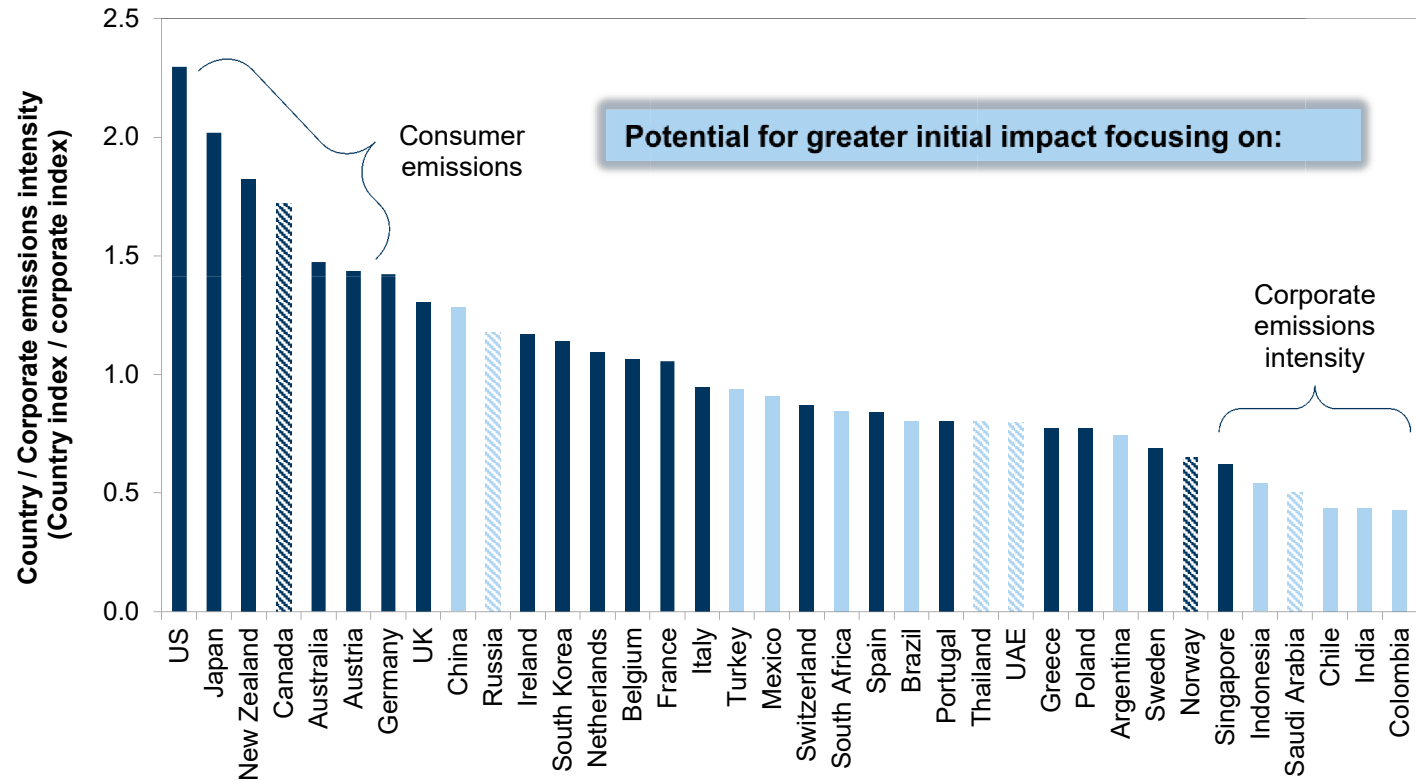
Technologies	Innovation areas	Technologies	Innovation areas
Electrification	Next gen high cell efficiency technologies	Carbon Capture	New capture technologies
	Optimization of wafer size and thickness		Optimization of input costs
	Changes in module design	Low Carbon Fuel	Localization of clean hydrogen 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

Energy Efficiency: Our analysis of consumer vs. corporates greenhouse gas emissions suggests solutions to reduce consumer emissions might receive greater focus in regions where the opportunity for initial impact focusing on consumer emissions is greater. We believe energy efficiency could become a more impactful theme in countries — like the US — where consumer emissions represent a greater opportunity for initial impact (please see [Exhibit 24](#) and our ESG of the Future report on corporate GHG emissions for more details), with deployment of solutions likely to be accelerated by the recent spike in commodity prices. As we detail in our Green Capex: Making Infrastructure Happen report, achieving Net Zero targets will require an all-in approach across multiple technology verticals, with investments in Energy Efficiency that would need to exceed \$600 bn annually in the 2020s in order to meet those targets. **In our view, investor focus could tend to gravitate towards those companies that are instrumental or levered to Energy Efficiency themes.** As a result, we see the opportunity for greater recognition among ESG investors of companies whose products/services can enable greater energy savings or lower energy consumption, on the residential side (e.g., energy-efficient homes and HVAC products) and commercial/industrial side (e.g., electrification and factory automation).

Exhibit 24: 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 stripped bars represent countries with more than 3500 degree days in 2019.

Source: Goldman Sachs Global Investment Research

Policy support leading to rise in long-term investment in Europe

Policies and government support could play a key role in bridging the gap towards achieving \$2.8 tn incremental Green Capex annually. We note that governments are likely to play a critical role in: (1) supporting Green Capex with multiple mechanisms — e.g., fiscal policy; 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), as we detail above. Among policy measures, we note the recent Infrastructure Bill in 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, with particular regard to renewables, electrification and hydrogen verticals, among others. In the US, we are watching for greater details and clarity regarding potential consideration by Congress of the climate initiatives from the Build Back Better bill, which could provide additional stimulus towards clean electricity, electric vehicles and energy efficiency. Please see Alec Phillips and Joseph Briggs note, Build Back Later or Build Back Never, for the latest update on our Economics team's views.

Europe

REPowerEU likely to accelerate Green Capex investments, accelerating the energy transition while protecting most-exposed consumers. The European Commissions detailed in March 2022 a comprehensive plan — REPowerEU — to reduce reliance on natural gas imports from Russia, as a response to the conflict in Ukraine. **We believe all these initiatives will be supportive of Green Capex investments, which are likely to accelerate, in our view.** In its May 18 update, the EU Commissions outlined faster permitting, higher capacity targets and EU grants/loans to support a 5x acceleration in annual renewable capacity additions by 2026E-2030E — based on our colleagues' view. As our European Utilities team wrote:

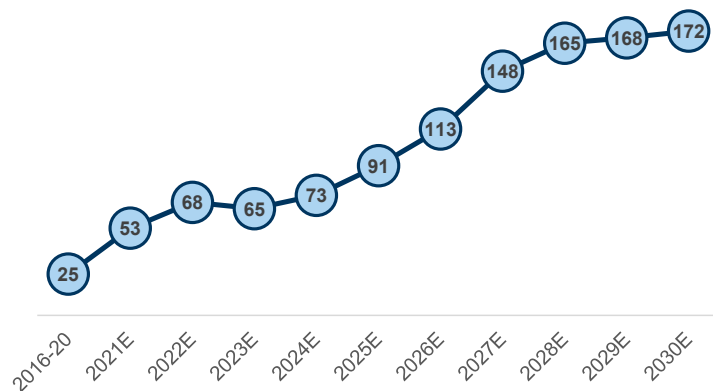
- **Renewable targets are to be increased.** The Commission proposes to increase the headline 2030 target for renewables from 40% to 45% under the Fit for 55 package. This includes a dedicated EU Solar Strategy to double solar photovoltaic capacity by 2025 and install 600GW by 2030.
- **Energy efficiency targets to be stepped up.** The Commission proposes to enhance long-term energy efficiency measures, including an increase from 9% to 13% of the binding Energy Efficiency Target under the 'Fit for 55' package of European Green Deal legislation. As our EU Utilities team has noted, meeting all the goals outlined in the 'Fit for 55' package would require the mobilization of €3.7 tn of capital by 2030, in their view. Our Utilities team estimates that more than half (c.€2.2 tn) could be privately funded investment, carried out for the most part by green energy companies ([Exhibit 26](#)).

- Innovation fund to be used for hydrogen development.** The Commission will roll out carbon contracts for difference to support the uptake of green hydrogen by industry and specific financing for REPowerEU under the Innovation Fund, using emission trading revenues to further support the switch away from Russian fossil fuel dependency.

Our EU Utilities team estimates that the plan would imply more than €1 trn in investments in renewables by 2030, and c.€0.7 trn in power networks. See [Exhibit 25](#) for more details. This would be paired with further investments in storage technologies and green hydrogen, beside a strong increase in power demand — thanks to the electrification push of the overall economy. REPowerEU is deeply centered on energy security: developing wind and solar is one of the three key pillars (alongside energy savings and the diversification of energy import sources) to reduce fossil fuel imports and boost energy security. As our colleagues note, the EU aims to reach a renewable installed base of 1,200+ GW by 2030. This would imply: (1) a c.15% upgrade vs the recent “Fit for 55” plan, (2) a nearly 3.5x increase in the RES installed base vs 2021, and (3) c.100 GW annual additions from now until the end of the 2020s, on average. Our colleagues expect the annual run-rate to approach c.150 GW annually in the 2nd half of the decade, or 5x larger than the current run-rate. As a reference, this pace would be broadly similar to the current amount of wind/solar annual additions, globally.

Exhibit 25: Annual investments in wind/solar could rise from c.€25 bn pa in 2016-20, to c.€170 bn by 2030E

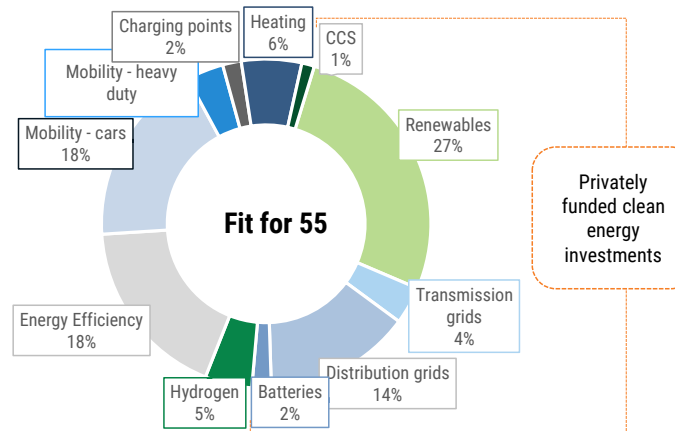
Annual capex for renewables evolution in Europe, GSe (€ bn)



Source: Goldman Sachs Global Investment Research

Exhibit 26: Fit for 55 plan implies c.€3.7 tn of capital mobilisation by 2030E, more than half in clean energy investments

EU Fit for 55 mobilized cumulative investments breakdown (percentage)



Source: Goldman Sachs Global Investment Research

China

China’s 14th 5-year plan encourages more optimized renewables developments, efficient storage (including hydrogen production), innovation in renewables and market-driven regulation of renewable deployments. On June 1,

the Chinese government announced the [Renewable energy development plan for the 14th 5-year plan period](#). While most numerical targets are untouched in regard to the carbon peak action plan (China is targeting an increase in non-fossil energy consumption to account for 20% of the total, rising to 25% by 2030), the plan proposes (please see our Asia Clean Energy team note for more details):

- **Optimized development of renewables, particularly on a large-scale**, combined with an expansion of power transitions — for new power lines, renewable energy should be no less than 50% — among other initiatives.
- **Promotion of energy storage and consumption**, through accelerated construction of pumped storage — in parallel to a push to advance other earlier-stage technologies, local consumption of renewable energy and improvements in delivery and consumption of renewable energy across regions. The plan also encourages hydrogen production utilizing renewable energy and hydrogen consumption.
- **Innovation-driven, high-quality development of renewable energy**, via greater efforts to innovate in renewable energy technology and improvements in the modernization of renewables industry and supply chains.
- **Achieve market-oriented development of renewable energy by optimizing mechanisms**, via streamlining processes in the renewable energy industry and improving the mechanisms to guarantee renewable energy consumption.

United States

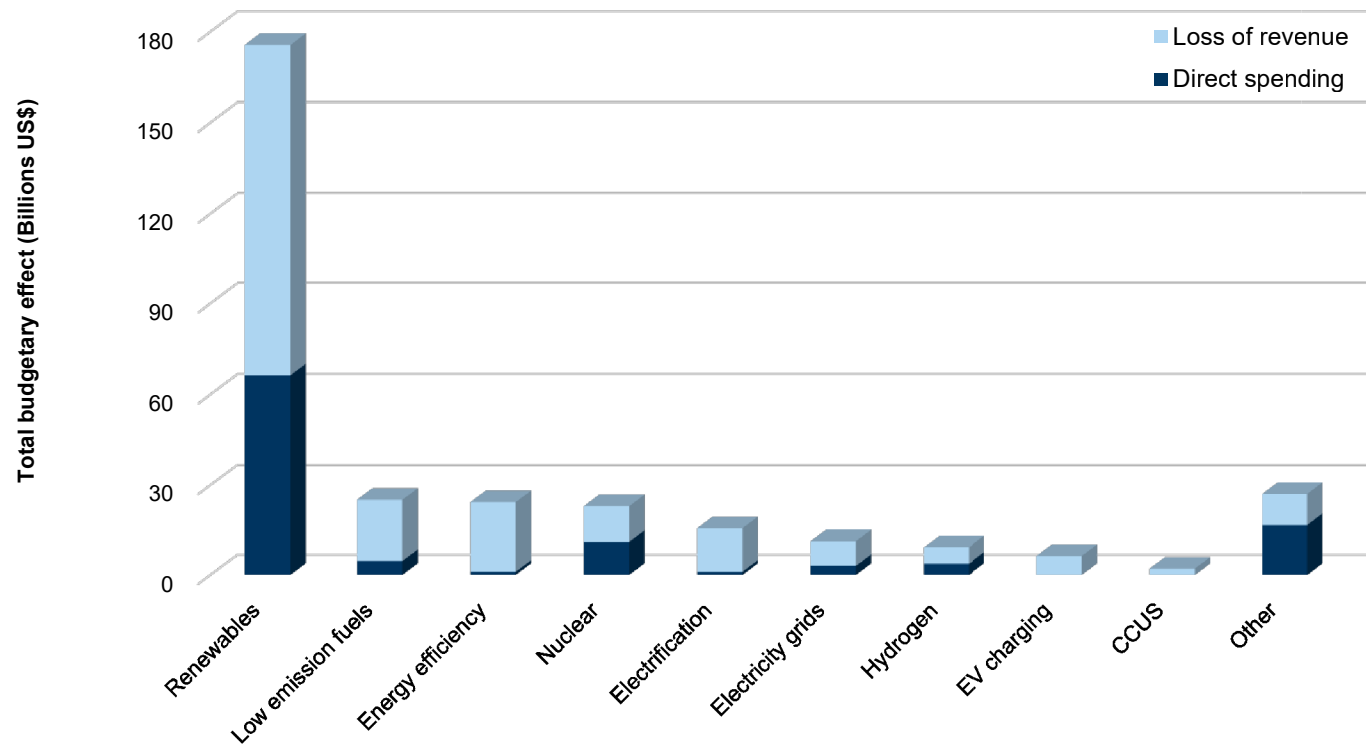
Build Back Better climate initiatives — which may be revisited by Congress in some form — included c.\$325 billion in green energy tax incentives over 10 years, 55% of which directed towards renewables. Most of the green energy provisions in the Build Back Better Act (BBB) would come in the form of tax credits that incentivize businesses to invest in and produce renewable energy and low emission fuels, and individuals to make purchases that improve the energy efficiency of their homes and transportation choices. The BBB would extend, and in many cases expand, existing clean energy tax incentives, making the dollar amounts larger and payment terms more favorable. According to the Congressional Budget Office (CBO), these changes would result in \$111 billion in incremental direct Federal spending and \$224 billion in potential loss of government revenues. In addition, the BBB would introduce labor requirement that companies must meet in order to claim the maximum allowed credit rate.

Based on our Green Capex Mosaic categories, we estimate that about \$176 billion of the green energy spending from BBB would be directed towards renewables, approximately 55% of the total (Exhibit 27). The largest programs within this category are the extension of the existing renewable electricity Production Tax Credit (\$55 billion) and clean energy Investment Tax Credit (\$53 billion), and a potential new clean electricity ITC (\$37 billion).

In addition to tax incentives, BBB would also provide approximately \$39 billion over ten years in direct funding for renewable energy, energy efficiency and sustainable transportation through the Department of Energy. These include

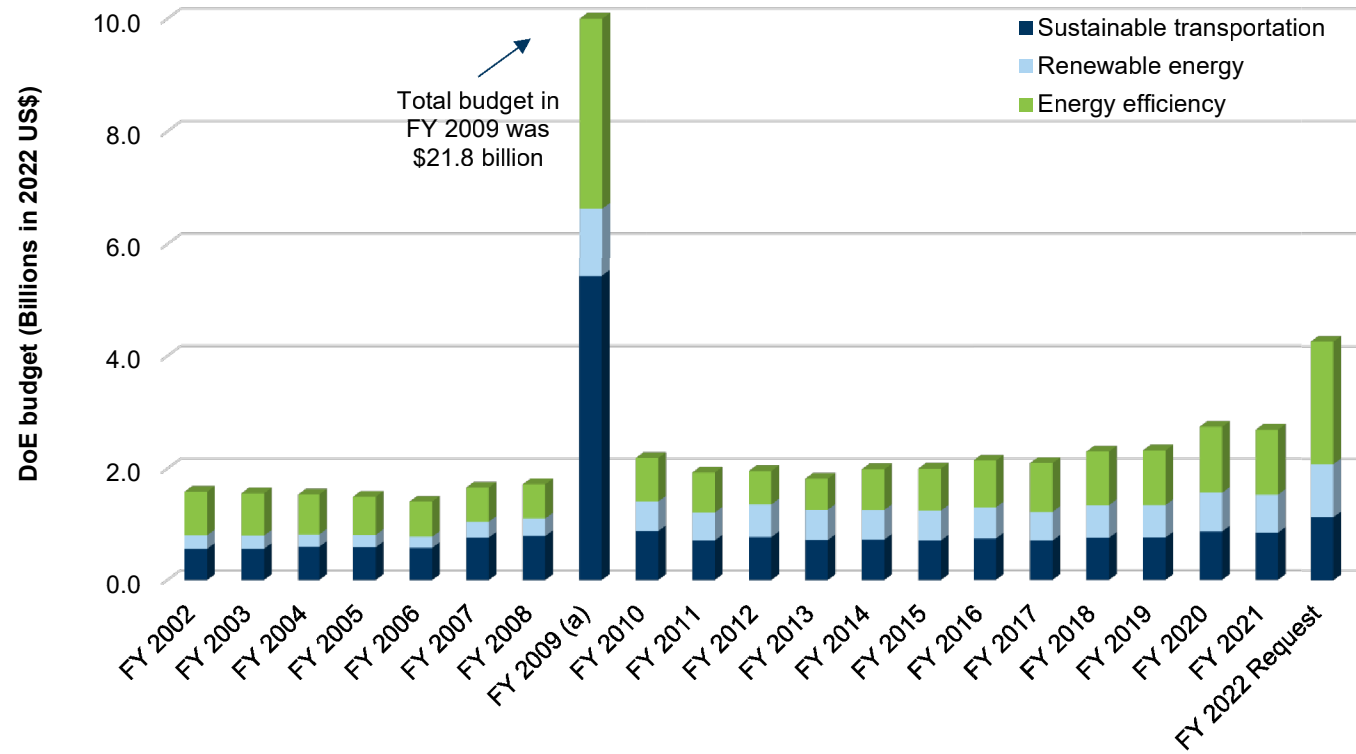
\$12.5 billion for residential efficiency and electrification rebates, \$7 billion for low-carbon reinvestment in energy communities, and \$6.5 billion for the production of electric and other advanced-technology vehicles. Annual Federal spending on these three areas have largely stayed flat at around \$2 billion on an inflation-adjusted basis, over the past decade — in its budget proposal for FY 2022, the Biden Administration significantly increased the budget requested for these areas to \$4.3 billion (Exhibit 28). Please see our report on the outlook for US emissions for more details on BBB. We reiterate it is not our Washington Economics Research team’s base case view that a bill passes this year, and as there is greater clarity on potential proposals we can compare vs. current policies and what was considered in Build Back Better.

Exhibit 27: Renewables make up more than half of the total green energy tax incentives in the climate portion of the Build Back Better Act
 CBO estimates of 10-year green energy spending in the BBB, categorized based on the GS SUSTAIN Green Capex Mosaic



Source: Congressional Budget Office, Congressional Research Service, Goldman Sachs Global Investment Research

Exhibit 28: Federal spending on energy efficiency, renewable energy, and sustainable transportation have stayed largely flat over the past decade
 Annual budget for these three areas within the Department of Energy, FY 2002 - FY 2022



Total budget for FY 2009 included \$16.7 billion in additional funding provided by the American Reinvestment and Recovery Act. Budget for FY2022 does not include funding from the Infrastructure Investment and Jobs Act.

Source: US Department of Energy, Goldman Sachs Global Investment Research

Sectors that stand out post our latest update

Ahead of valuation considerations, we believe ESG and generalist investors will look incrementally at investment attractiveness for stocks of companies exposed to Green Capex based on: (a) corporate returns attractiveness, resilience and momentum; and (b) spare capacity for reinvestment via free cash flow and balance sheet strength. These can both capture the financial health as well as the opportunity for engagement towards directing capital to maximize Green Capex or ESG improvement. We consider sectors that stand out in this section.

Corporate returns

Among the 23 Green Capex-critical sectors, Semis and Software are the two where returns expectations have not degraded since February, are forecast above average and on the rise in coming years. Sector-level estimates for Semiconductors and Software indicate returns expectations roughly unchanged vs. our Feb. 2 report, above the weighted average for all sectors ex. Financials and Real Estate of 12.8% (referred to the 2022E/2023E average) and rising in 2023E or 2024E vs. 2022E (Semis returns are forecast to increase in 2023E vs. 2022E, Software returns are expected on the rise in 2023E and 2024E vs. 2022E). See [Exhibit 29](#) for the full overview.

On the back on the favorable corporate returns outlook, we believe Semiconductors and Software could potentially attract greater appreciation of their role in the Green Capex supply chain. On Semis particularly, we highlighted in our Greenablers: Semiconductors report the sector's contribution to emissions avoidance via enabling more energy-efficient products — in our view, this is a key example of the sector's impact, still underappreciated among ESG investors. Importantly however, our analysts on the back of the first two days of our Global Semiconductor conference highlighted company commentary regarding weakness in demand from consumer-facing end markets as well as a shortage of foundry supply, even as signals for demand from autos and data centers remain robust. On Software, we believe Cybersecurity is a potentially overlooked area among ESG investors that could receive greater attention, given its critical role in insulating against cyber-threats as electrification and digitalization accelerate on path to Decarbonization, Clean Water and Infrastructure goals.

More broadly, ex. Semis and Software, returns expectations are favorable for 12 other Green Capex-critical sectors. In particular, our analysis indicates:

- Returns expectations have both not degraded vs. our Feb. report and are rising in 2023E or 2024E vs. 2022E for 6 sectors: **Automobiles, Energy Equipment & Services, Multi-Utilities, Road & Rail, Transportation Infrastructure** and **Wireless Telecomm Services**.
- Returns are expected to be both above average (referred to the 2022E/2023E average, ex. Financial and Real Estate) and

are rising in 2023E or 2024E vs. 2022E for 4 sectors: **Air Freight & Logistics, Building Products, Electronic Equipment** and **Machinery**. For covered **Global Clean Tech** companies — mostly inclusive of solar/wind/water/battery storage/hydrogen — corporate returns have degraded vs. prior reports (mostly due to supply chain pressure and inflationary environment) but are still both above average and projected on the rise.

- Returns expectations have both not degraded vs. our Feb. report, and are above average (vs. 2022E/2023E average, ex. Financials and Real Estate) for 2 sectors: **Oil/Gas** and **Metals/Mining**. As described in earlier sections, given the elevated concentration of Green Capex spare capacity in the sectors, we believe investors' focus on ESG Improvers could rise — see section below.

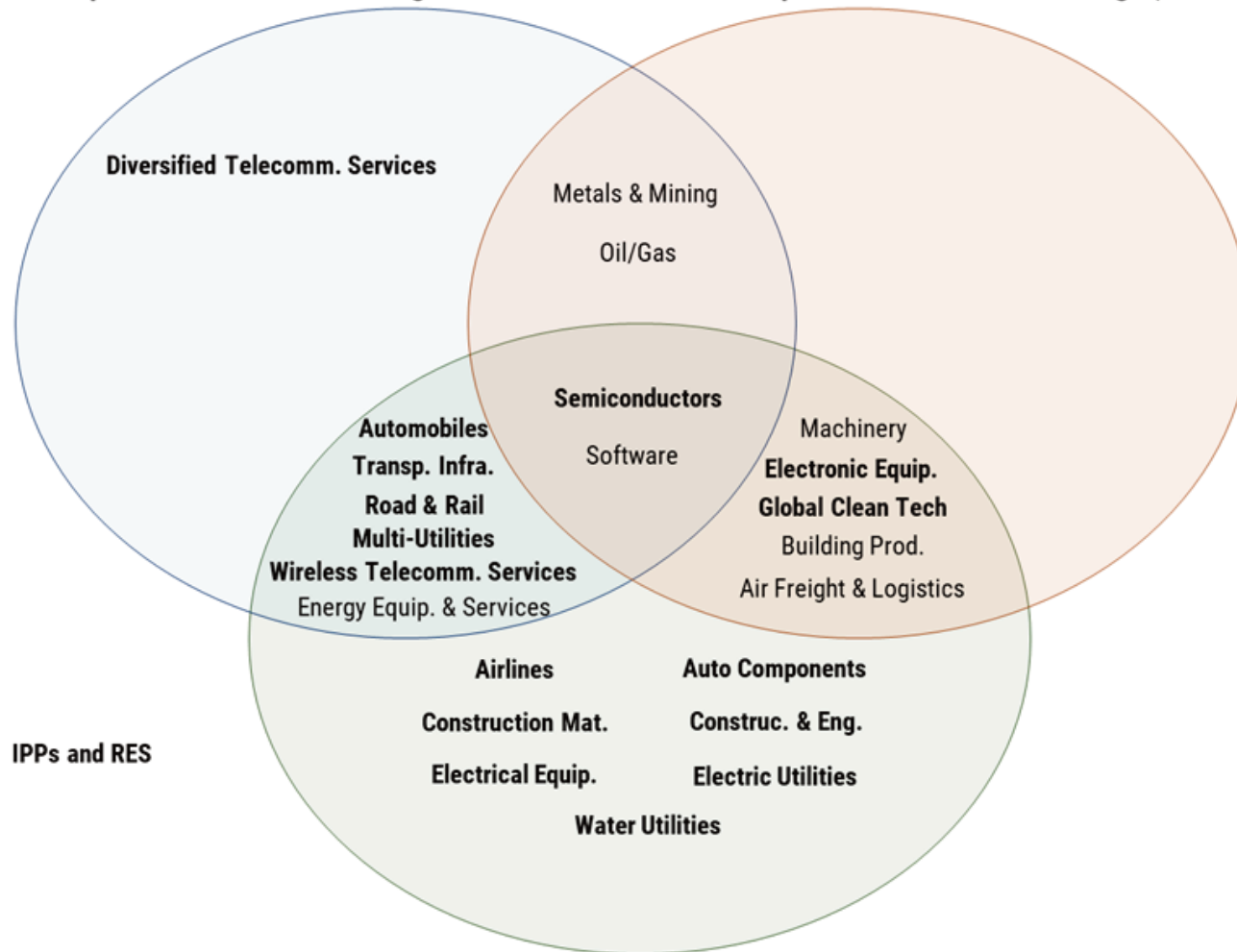
Among the 23 Green Capex-critical sectors, reinvestment rates of operating cash flow into capex + R&D are expected above global average in 2022E/23E for 16. The remaining 7 — Air Freight & Logistics, Building Products, Energy Equipment, Machinery, Metals & Mining, Oil/Gas and Software — are forecast to have reinvestment rates below average. We note that Global Clean Tech companies are expected to see reinvestment rates above average.

Exhibit 29: Semiconductors and Software are the two sectors for which returns have not degraded, are still above average and are forecast to rise. We highlight 11 other sectors in addition to Oil & Gas and Metals & Mining that meet two of our three corporate returns criteria

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)

Estimated corporate returns have not degraded

Corporate Returns above average (ex. Fin./RE)



Corporate Returns rising in 23E/24E vs. 22E

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

Green Capex spare capacity

We believe the more favorable outlook on corporate returns in Oil & Gas and Metals & Mining sectors could over time drive greater consideration for ESG Improvers strategies. As seen in [Exhibit 29](#), Oil & Gas and Metals & Mining are the two sectors for which corporate returns are forecast to not degrade/improve (vs. prior expectations from February) and to be above-average in 2022E/2023E. We believe the ability to maintain a favorable profile in corporate returns while potentially deploying more Green Capex will be a key area of focus for investors in selecting which companies to reward — as detailed earlier and in our Green Capex series, **Returns** is one of the four pillars of our “CARE” framework, i.e., the lens we believe investors could use when evaluating companies’ new Green initiatives. As a result, we see opportunity for greater recognition of ESG Improvers, where investors could potentially reward those companies for which the mix of Green Revenue/Capex is forecast to increase and/or Greenhouse Gas emissions intensities are projected to meaningfully decline.

Divestment Dilemma: The higher concentration of Green Capex spare capacity could also increase consideration of engagement (vs. exclusion) strategies for ESG Improvers with favorable free cash flow. Oil & Gas and Metals & Mining sectors represent a higher portion of the Green Capex spare capacity we see among public companies vs. our prior reports — now accounting for more than 80% of the total vs. 63% prior — on the back of the inflationary commodities’ environment. As we noted in our Divestment Dilemma: Exclude or Engage report, we see a rising debate among investors as to whether to engage with sectors historically excluded from ESG focus based on quantifying ESG Improvement. **As Green Capex spare capacity grows and becomes more concentrated in the Oil & Gas and Metals & Mining sectors, we see a rising case for engagement vs. exclusion to have voice in how free cash flow should be redirected (Green Capex, return to shareholders or base business).**

Green Capex increases have not been appreciated in stock prices over the past six months

Green Capex companies for which consensus Capex + R&D estimates have increased in recent months have not been rewarded by investors. The strong focus on returning cash to shareholders provides limited visibility on whether investors — at least initially — will support capex increases not funded by asset sales that result in rising reinvestment rates. In recent months, stocks in Green Capex sectors for which consensus Capex + R&D expectations have been revised upwards the most vs. prior estimates have generally underperformed their sector peers, on an average-basis ([Exhibit 30](#)) — for a similar analysis related to the Semiconductors industry, please see our Semiconductors Greenablers report. Part of the reason for this is likely a debate within each Green Capex sector as to whether the need for expansion is cyclical or secular.

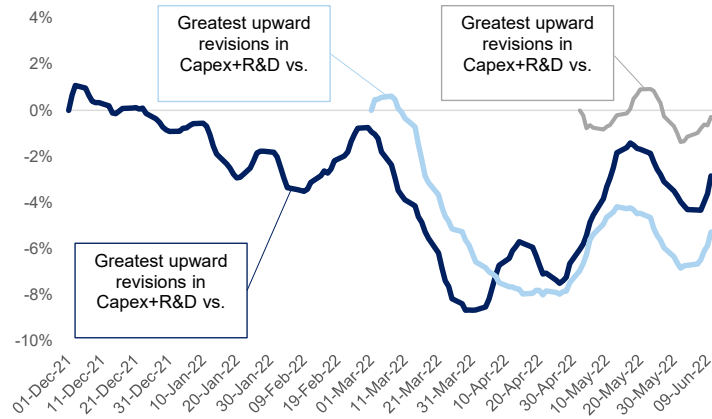
While we believe the need for increased Green Capex is secular, we see normal investor debates over when in the Capex vs. FCF cycle will drive equity outperformance. We believe for companies increasing capex (particularly on longer lead time projects), investors are likely to focus on:

- Whether the increased capex will lead to similar vs. greater vs. lower corporate returns; and
- The time horizon of the investment cycle and when a company would shift from investment mode to harvest mode (when projects come online).

Particularly among Greenablers — i.e., those sectors where capital investments are needed more urgently due to longer project lead-times (see our Green Capex report for more details) — we believe there will likely be a more urgent focus on the level of Green Capex among Sustainability investors in the coming months and years to have greater confidence in execution on sufficiently expanding electric vehicle penetration, renewables capacity, automation and broader infrastructure, among other key goals.

Exhibit 30: Out of the 100 companies with the largest upward revisions in 2022E consensus Capex + R&D estimates, stocks in Green Capex sectors have generally underperformed their sector peers

Price performance vs. GICS 3 peers for Green Capex stocks among top-100 companies for which consensus Capex + R&D estimates have moved upwards the most vs. 6 months ago (blue line), 3 months ago (light blue line) or 1 month ago (gray line)

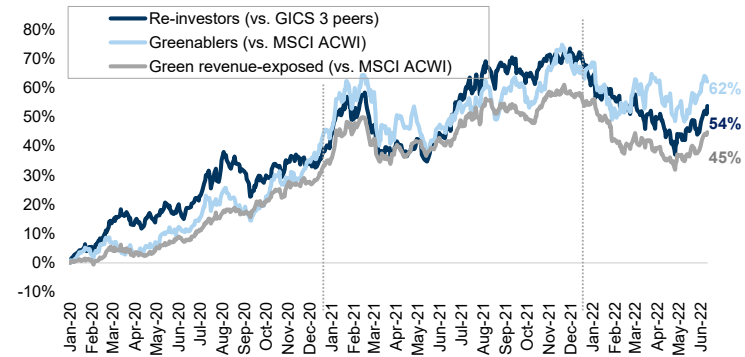


Rolling 7-day average

Source: FactSet, Thomson Reuters, Goldman Sachs Global Investment Research

Exhibit 31: Stocks that screen for each of our three Green Capex investment themes have outperformed respective benchmarks since the beginning of 2020 and the beginning of 2021 but not 2022 YTD

Average relative stock performance of Green Revenue Beneficiaries, Green Re-investors and Greenablers since Jan. 1, 2020



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

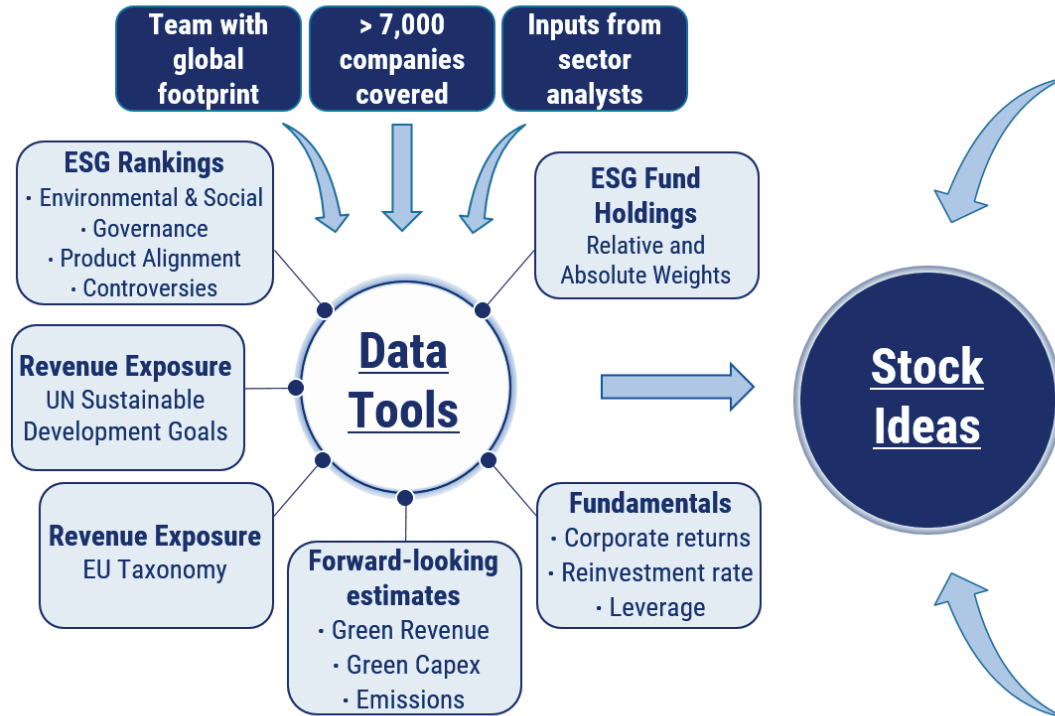
Source: Refinitiv, FactSet, Goldman Sachs Global Investment Research

How GS SUSTAIN can help

GS SUSTAIN can provide access to proprietary tools and resources to quantify impact and identify ESG Improvers, enabling greater recognition of underappreciated opportunities across sectors. Our offering of SUSTAIN tools can help investors to answer ESG questions at the portfolio and security levels, enabling more systematized and quantitative reporting while providing detailed and transparent data sets for idea generation, security selection and corporate engagement.

- **Our multi-pronged SUSTAIN scoring framework** can help provide greater granularity and objectivity for asset managers in both security selection and reporting. The framework across >7,000 companies includes our recently introduced Product Alignment framework, based on the SDGs, EU Taxonomy and GS analyst views, and can help investors cast a wider net in the search for impact ideas aligned to less obvious sustainability themes. Existing pillars detail performance around sector-specific environmental and social operational metrics, governance, and controversies.
- **Forward-looking estimates.** Looking ahead, we believe investment performance will be more driven by future change and have taken our first steps toward incorporating forward-looking estimates in our proprietary industry analyst inputs, which now include sustainable product revenue and capex in select industries. Of the more than 3,000 companies under GS coverage globally, 53% saw a change in net E&S scores as a result of our analyst survey inputs. Furthermore, we have taken first steps to offering quantitative forecasts of sustainable product revenue/capex for ~650 companies in 19 industries. We now add Scope 1 and 2 greenhouse gas emissions for a smaller segment of companies in 7 sectors.
- **EU Taxonomy revenue alignment.** We see the EU Taxonomy as one of the most seminal regulatory developments driving standardization in reporting for corporates/asset managers. Our EU Taxonomy alignment tool maps company revenues to Taxonomy-defined activities to estimate potential Taxonomy-eligible and aligned revenue based on technical screening checks where data exist, and “Do No Significant Harm” and “Minimum Social Safeguards” criteria.
- **SDG revenue alignment.** The UN Sustainable Development Goals (SDGs) have emerged as one of the most commonly used frameworks for taxonomizing impact across a broad set of sustainability challenges. Our SDG alignment tool employs granular revenue data, GS analyst inputs and other company metadata to map alignment, exposure and misalignment to ten of the SDGs we deem to be most investable.
- **ESG fund ownership.** Aggregating fund holdings across a universe of ~3,000 ESG funds, we analyze this pool of ESG assets to better understand trends in ESG ownership at both the sector and company level. The full dataset provides absolute and momentum ESG ownership detail for well over 10,000 securities.
- **ESG fund flows, valuations and performance.** Our ESG Tracker series analyzes the aforementioned ESG fund universe to gauge ESG fund flow momentum and sizing relative to the broader market, breaking out differences by strategy, fund type and fund style. The tracker also examines valuation and performance across categories.

GS SUSTAIN What We Offer



Investment Themes

Green Capex	Impact from US\$6.0 trillion in annual capex needed this decade to support Net Zero, Infrastructure, and Clean Water goals; Net Zero Guide for investors/corporates
Circular Economy	Beneficiaries from rising deployment of energy/waste/food efficiency solutions, driven by commodity inflation and regulation, to reduce resource consumption
Greenablers	Sectors critical to meet Sustainable Development Goals requiring long lead time investments (green metals, semiconductors, electricity transmission, cybersecurity)
Supply Chain Risks	Assessment of geographical exposure, concentration, engagement and ESG score of Tier-1 suppliers, starting with the Automotive sector

Industry Trends

ESG Integration	The PM's Guide to the ESG Revolution helps investors navigate the current ESG landscape, fusing data tools and scoring metrics with the ESG investing life cycle
Regulation	Implications for investors from the EU Green Taxonomy, SFDR and ESG regulatory efforts in the US and Asia Pacific
ESG Improvers	Identifying company transformations via new forward-looking estimates on Green Revenue, Green Capex and Greenhouse Gas Emissions by company by year.
Capital Flows & Trends	ESG fund flows, top ESG fund holdings and where we see crowding of over/underweight positions, Exclusion vs. Engagement, ESG shift From Aspiration to Action

Source: Goldman Sachs Global Investment Research

GS SUSTAIN ESG Pillars

Product Alignment

Key issues addressed
How do the company's products & services impact consumers, communities, & the environment in the use-phase and at end-of-life?

Outputs

- Headline Product Impact (NEW)**
 - Product Portfolio
 - Product Strategy
- Forward-looking forecasts (NEW)**

Inputs and sources

- Business activity taxonomy
- Specialized raw data
- Industry analyst qualitative and quantitative input

EU Taxonomy & SDG alignment

- Net revenue alignment to the SDGs and the EU Green Taxonomy

Operational E&S

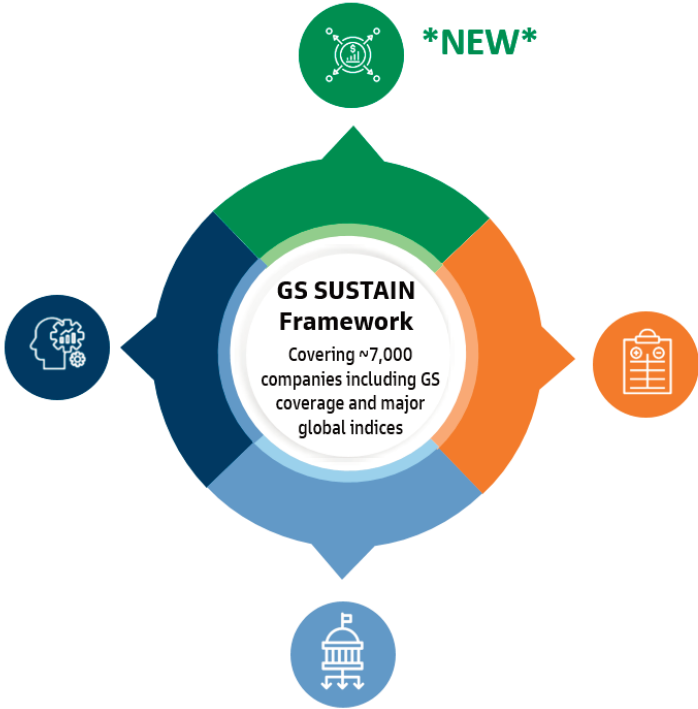
Key issues addressed
What are the industry-relevant measurables offering insight into exposure and performance on key environmental & social issues?

Outputs

- Headline E&S Rank**
- E&S Momentum**
- E&S Disclosure %**

Inputs and sources

- Corporate disclosure
- Specialized alt-data
- Industry analyst inputs



Controversies

Key issues addressed
Does the company have real-time or a history of ESG exposures not yet reflected in company disclosures or captured or quantified by available data?

Outputs

- Headline Controversy Rank**
 - Long-term track record
 - Long-term momentum
 - Short-term 1m sentiment
 - Short-term 3m sentiment

Inputs and sources

- Media controversy coverage
- News sentiment analysis

Governance

Key issues addressed
Has the company put in place foundational structures of accountability, checks & balances, and shareholder alignment?

Outputs

- Global-relative Governance Rank**
- Region-relative Governance Rank**

Inputs and sources

- Corporate disclosure
- Specialized raw data

ESG Fund Holdings 'Nifty Fifty Series'

- How widely owned, over/underweight (v. benchmark), companies are in ~3,000 ESG funds (active & passive) representing US\$2tn in AUM
- Covers the market's view of ESG, offering ESG discovery value

Source: Goldman Sachs Global Investment Research

Disclosure Appendix

Reg AC

We, Brian Singer, CFA, Enrico Chinello, Ph.D., Michael Hao Wu, CFA, Derek R. Bingham, Evan Tylenda, CFA, Sharmini Chetwode, Ph.D., Madeline Meyer, Keebum Kim, Brendan Corbett, Emma Jones, 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.

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

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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
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