**Note**: The following is a redacted version of the original report published October 11, 2021 [73 pgs].

Goldman Sachs | Research

**EQUITY RESEARCH** | October 11, 2021 | 5:12PM EST

# GREEN CAPEX

## Making infrastructure happen

We believe Green Capex will be the dominant driver of global infrastructure over the next decade, with $6 trillion of investment needed annually to decarbonize the world, address water needs and shore up transportation and other critical systems. Where will the funding come from for such a substantial increase from the $3.2 trillion per year invested from 2016-20? We believe that will be a critical question well beyond ESG investors as companies, policymakers and investors demand greater clarity from each other on needs and returns. We estimate that more than a third of incremental Green Capex can come from existing publicly traded companies based on their balance sheet and reinvestment spare capacity. Who stands to benefit? We expect equity markets will further reward companies investing in, or exposed to customers' investments in, Green Capex that delivers favorable corporate returns. We expect rising focus and investor support for the Greenablers (Green Enablers) — sectors where Green Capex is needed more urgently to help alleviate future supply-chain bottlenecks and/or reduce execution risks.

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# Table of Contents

# PM Summary

**We believe Green Capex will be a stock-impacting investment theme for both Sustainability fund managers and generalist investors as we expect the market will reward credit for companies that have strong corporate returns and: high and/or rising Green Capex; and/or benefit from Green Revenue (customers' Green Capex).** We focus this report and our companion Investing in Green Capex report on investments to meet Net Zero, Infrastructure and Clean Water goals, with six key takeaways:

1. Green Capex needs to support Net Zero, Infrastructure and Clean Water are significant – $6 trillion annually this decade, up from $3.2 trillion per year in 2016-20.
2. Green Capex spending today does not appear to be sufficient, but we see publicly traded companies able to invest $1+ trillion more per year in Green Capex due to their reinvestment and balance sheet spare capacity (most meaningfully in oil/gas, metals/mining and semiconductors, among relevant sectors).
3. Corporate returns should continue to matter over the medium to longer term. Many sectors important for Green Capex have at- or below-average corporate returns, which could put pressure on managements to lower costs or raise product prices to accommodate more Green Capex. Corporate/project returns will likely influence managements' willingness to invest directly vs. return capital to shareholders who could choose to redeploy into Green opportunities elsewhere.
4. The stock market has rewarded companies with Green Capex and can continue to do so, in our view.
5. We see equity outperformance from Green Revenue/Capex-exposed companies, corporations that are reinvesting a high/rising percent of cash flow in capex and R&D, and the Greenablers — companies in building blocks sectors (e.g., copper/aluminum, electricity transmission, semiconductors, cybersecurity) where increased reinvestment will be needed more urgently due to project lead times.
6. Managements should look to increase Green Capex and/or discuss reasons why Green Capex is not otherwise higher. We see benefits from disclosures to investors of capex/revenue mix for sustainable use cases (part of the EU Green Taxonomy which should have global equity/investor impact). We believe investors will look at four factors when determining the extent to which they should "CARE" about a company's Green portfolio: **C**ore competency, **A**vailable capital, **R**eturns and **E**xecution.

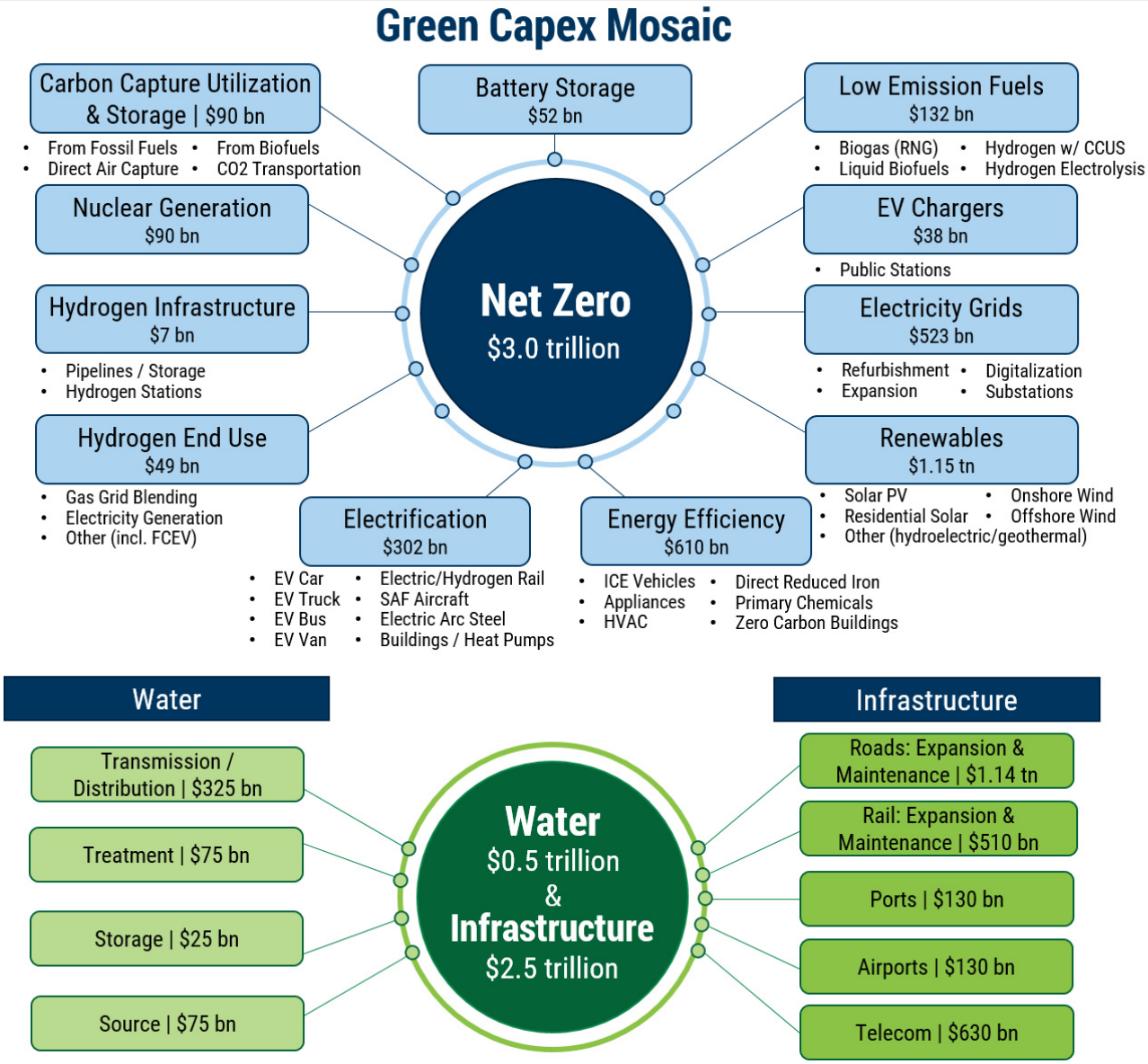
**In our reports, we discuss:**

- **Where Green Capex needs to be deployed to meet Net Zero, Clean Water and Infrastructure-related UN Sustainable Development goals.** We present a mosaic of key technologies and impacted sectors.

- **Where Green Capex is likely to be funded.** We see the bulk of the incremental capital coming from public companies and governments.
- **Where and how much Green Capex spare capacity we see — overall and by key sector.** Reinvestment of cash flow into capex and R&D is expected by GS analysts to be about 50% in 2022 vs. 60%-70% for much of the past decade, while balance sheets have strengthened. As a result, publicly traded companies are investing $1 trillion per year less than they have historically, which we regard as spare capacity that could be deployed into Green Capex.
- **Why Greenablers matter.** While not an exclusive list, we highlight copper/aluminum, semiconductors, electricity transmission and cybersecurity, where lead times are 2 to 12 years for project expansions.
- **Why corporate returns are important medium to longer term.** Some sectors needed to support Green Capex growth have average or below-average corporate returns, which may warrant cost savings or higher product prices to stimulate increased capex. This supports our teams' bullish outlook for Metals/Mining commodities (like copper and aluminum). Our analysis suggests a 1%-4% increase in revenues (without corresponding increase in costs) would be needed to achieve a 1% higher 2022 CROCI in key exposed sectors.
- **How the market and ESG investors have rewarded companies for Green reinvestment despite investor focus on returning cash to shareholders.** Stocks of companies with a high and/or rising percent of cash flow in capex and R&D have outperformed peers, and the reinvestment rates of stocks most overweight in ESG funds are above industry average. We have also seen R&D linkages to alpha in non-tech industries.
- **How managements can engage investors.** We recommend managements provide greater disclosure of sustainable use capex (and revenue) levels and a checklist/framework of key milestones needed for greater reinvestment of cash flow into Green Capex. We also provide three critical questions for investors to ask managements.

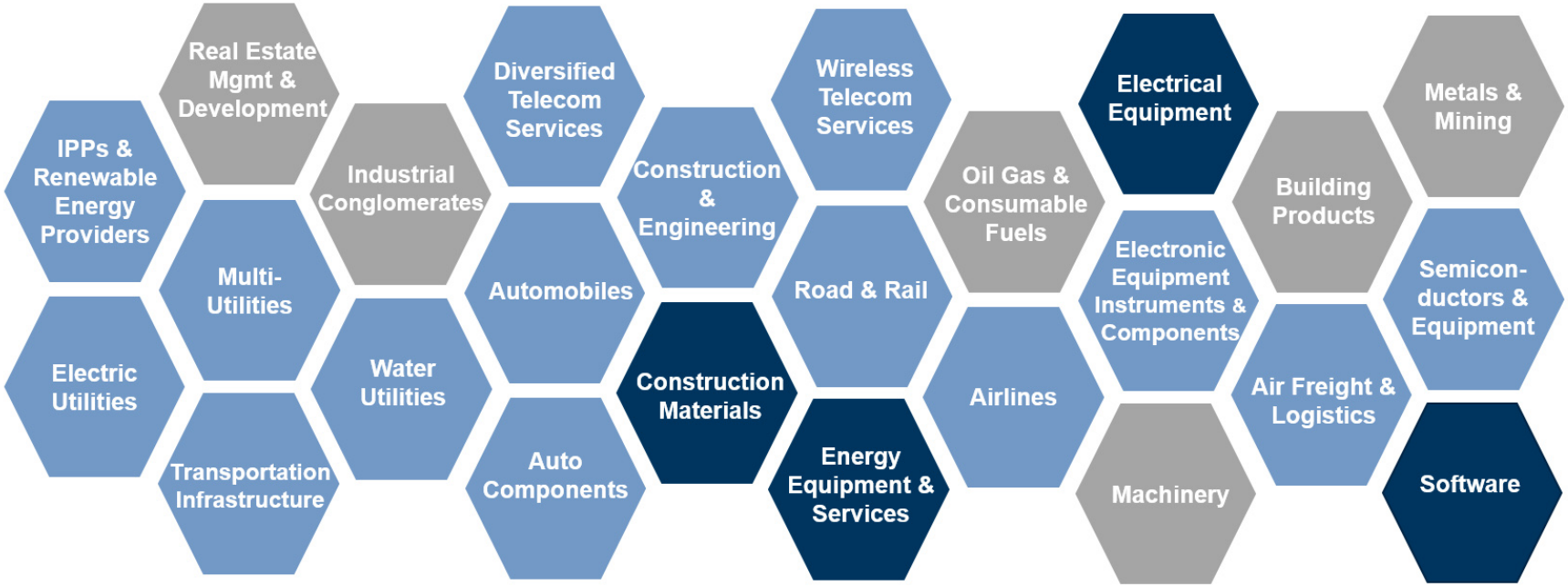
**Defining Net Zero, Infrastructure and Clean Water and related UN Sustainable Development Goals.** Corporates, investors, and other stakeholders are increasingly expected to commit to and quantify various forms of environmental and social impact. Net Zero targets have emerged as a useful tool to indicate a country, company or asset manager's commitment to climate action, uniquely focused on carbon emissions or equivalents. The UN Sustainable Development Goals (SDGs), established by the UN General Assembly in 2015, introduced 17 global objectives that include climate action, but are more broadly focused on inclusive improvement in quality of life around the world. Looking through the SDG lens, we also focus on critical Infrastructure, both digital and physical, that enables climate mitigation, climate adaptation and improved quality of life. This includes infrastructure to secure access to clean water and sanitation, affordable and clean energy, telecommunications services, and international/intranational transport. While we discuss capital requirements of key technologies to support these goals, we note that ultimately innovation and scale among other drivers will make capex more dynamic than static. We note also there are other areas for Green Capex in areas such as agriculture or recycling that contribute to separate Sustainable Development Goals. We focus this report on Net Zero, Infrastructure and Clean Water.

**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

## Sectors where Green Capex is Needed to meet Net Zero, Infrastructure and Water Goals




Color shading is based on sector reinvestment rate of 2022E cash flow into capex and R&D: Dark blue is within 5 p.p. of the all-sector average, gray is below and light blue is above. | Sector order is based on 2022E corporate returns (cash return on cash invested): lowest on the left, highest on the right.

Source: Goldman Sachs Global Investment Research

### UN Sustainable Development Goals addressed by Net Zero, Infrastructure and Clean Water Green Capex


*Source: United Nations*

# Green Capex in NUMBERS

**$6 tn**

Around **$6 trillion in** annual investment in the 2020s is needed to meet Net Zero, Clean Water and Infrastructure objectives, up from legacy $3.2 trillion

**$4 tn**

The >6,500 global companies in our GS SUSTAIN database are expected per Factset to spend **$4 trillion** in capex + R&D (not solely Green) in 2022E

**>$1 tn**

We see **>$1 trillion** of potential additional annual Green Capex in the event of: (a) a 10% increase in reinvestment rate ($0.8 tn); and (b) a 0.5x increase in leverage over rest of decade from sectors ex-Utilities, Real Estate and Financials ($0.3-$0.4 tn)

Growth in investment in global Capex + R&D (not solely Green) in 2022 is expected to be **3%-4% vs. 2021** per GS Research and FactSet

**3%-4%**

Investment in **Capex + R&D** in 2022 (not solely Green) is projected to be <**50% of cash flow**, down from 61% in 2019

**<50%**

**Sectors critical to Green Capex with** average or below-average corporate returns would **need** a **1%-4% increase in pricing** to achieve a 100 bps greater cash return on cash invested

**1%-4%**

**2-8 years**

lead time to facilitate new copper mine

**5-12 years**

lead time to bring on new electricity transmission project

**2-3 years**

lead time for semiconductor plant

**3-5 years**

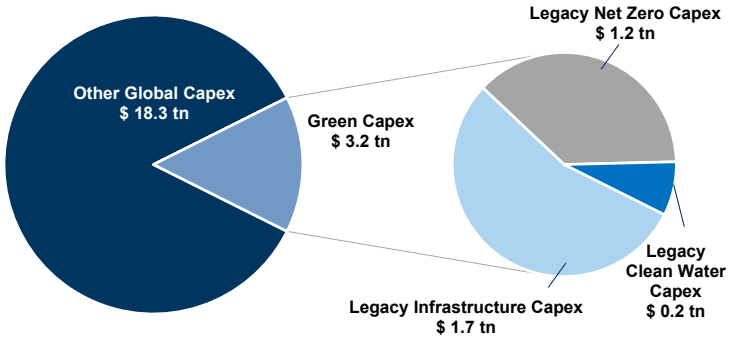
lead time for cybersecurity projects

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

# The Need: Green Capex needs to meet Sustainable Development Goals (SDGs) are immense

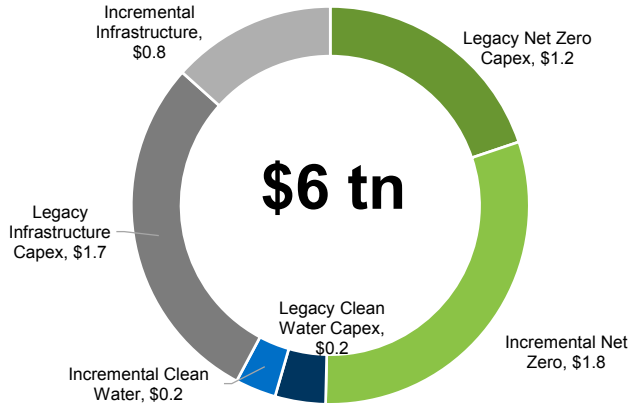
**Green Capex toward Net Zero, Infrastructure and Clean Water, historically about $3.2 trillion per year, needs to increase significantly to achieve Net Zero and other SDGs.** Historically, Green Capex for these three focus areas has been about $3.2 trillion annually, which represents about 15% of average global gross capital formation during 2016-19. Within the $3.2 trillion annually, about $1.2 trillion goes toward Net Zero (per the IEA, 2016-20 average), $1.7 trillion goes towards Infrastructure (per McKinsey, adjusted to 2016-20 average) and $0.2 trillion goes towards Clean Water (per the OECD, adjusted to 2016-20 average). Goldman Sachs Research analysis as well as reports from other government and non-governmental organizations highlight the significant increase in investment needed to meet Sustainable Development Goals — around $6 trillion annually to meet Net Zero, Clean Water and Infrastructure objectives based on the above sources. This will be needed from a combination of governments, private companies and public companies. Geographically, China and the US should represent the greatest percentage of overall and incremental Net Zero/infrastructure investment needs (in 2019, China emitted around 28% of global carbon dioxide, while the US emitted about 15% as per Our World in Data). The incremental $2.8 trillion of annual investment needed this decade represents around 2.7% of global GDP, based on our Economic Research team's forecasts. While we discuss capital requirements of key technologies to support these goals, we note that ultimately innovation and scale among other drivers will make capex more dynamic than static.

**Exhibit 2: Green Capex for Net Zero, Infrastructure and Clean Water has historically represented around 15% of total capex**
Green Capex toward Net Zero, Infrastructure and Clean Water vs. 2016-19 annual global capital investment



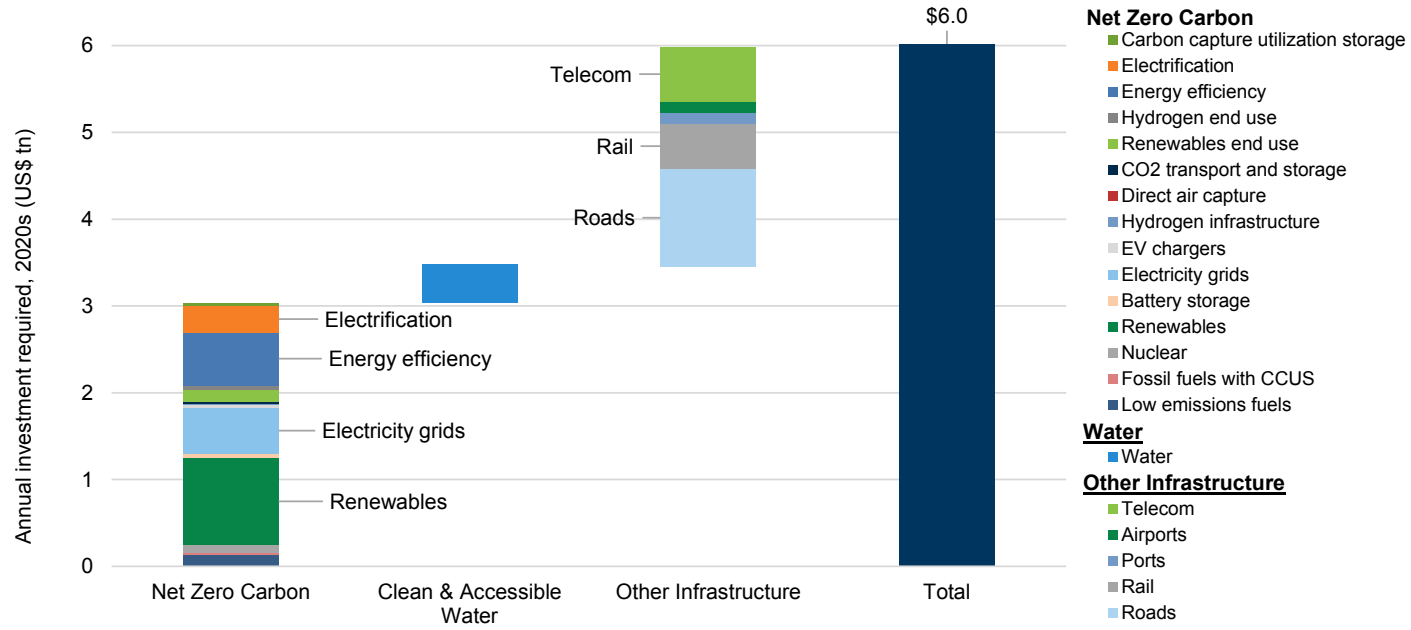

Source: World Bank, IEA, McKinsey, OECD, Goldman Sachs Global Investment Research

**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: Around $6 trillion of Green Capex annually is needed globally to meet Net Zero, Infrastructure and Clean Water goals**
Annual investment required, 2020-2030




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

## Clean Energy: Meeting Net Zero long term likely to require investment step up in medium-term

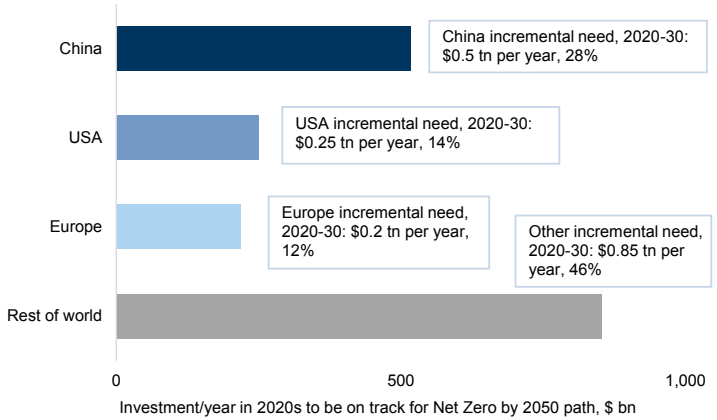
**Significant ramp in investment needed to meet Net Zero goals.** We believe ESG investors and corporates will define Green Capex as a combination of growth and maintenance investment for sustainable use cases. The IEA in May 2021 estimated that Net Zero by 2050 investment requirements (excluding fossil fuels) during the 2020s will be $3 trillion annually (rising to $4 trillion in 2030) vs. $1.2 trillion annually on average in 2016-20. Our colleagues' recent Carbonomics report estimates incremental infrastructure investment (before considering ongoing maintenance and other end use) of $1.3 trillion annually will be needed in the 2020s (en route to $56 trillion total by 2050) to be aligned with a 1.5 degree temperature reduction scenario. As our Energy and Utilities teams have written, meeting Net Zero objectives will likely require capex of about $11 trillion in the EU by 2050 and $16 trillion in China by 2060 (China is pursuing a Net Zero path by 2060, which would likely result in less spending in the 2020s than what is required for a Net Zero by 2050 pathway). A recent Princeton

University report highlighted the need for at least $2.5 trillion of incremental cumulative spending during 2021-2030 for the US to stay on track to meet Net Zero emissions.

**We believe further ramp-up in investment will likely be needed to meet 2030 US greenhouse gas emissions reduction target vs. our base case...** In April, President Biden unveiled a target for US greenhouse gas emissions to fall 50%-52% by 2030 vs. 2005 levels. Our estimates for carbon dioxide emissions (80% of overall US greenhouse gas emissions), before including the impact from carbon capture and land use change, do not achieve this level of reduction at present. We assume about 5-6 million new electric vehicles in the US fleet annually in 2026-30 (putting EVs as 45% of US new sales and 13% of the US fleet in 2030), about 30 GW of new solar/wind capacity adds annually and 10-11 GW of annual coal plant retirements. A combination of demand efficiency, increased deployment of additional clean generation capacity, increased utilization of existing generation or swifter/greater coal plant retirements are needed to fully accomplish this goal.

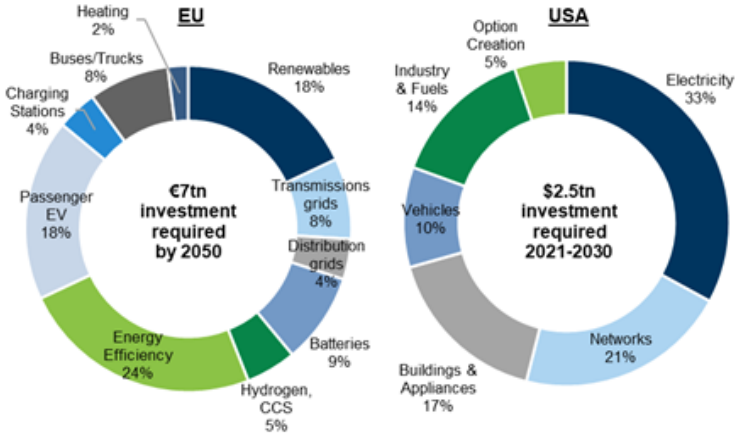
**... Supporting opportunities for companies focused on Clean Energy expansion, carbon capture/sequestration and Energy efficiency.** Importantly, meeting the Net Zero pathway objectives involves not only the expansion of power plant capacity but also of transmission lines, batteries, charging infrastructure, and carbon capture/sequestration. The building blocks to support the shift to clean power generation, energy efficiency, and automation come in part from copper/aluminum, semiconductors, software and cybersecurity among other products. As discussed later in the report, many of these projects have longer lead times, which will require confidence in policy, demand and pricing ahead of aggressive capex increases.

**Exhibit 5: China, US and Europe represent more than half of required investment for Net Zero by 2050 pathway, consistent with weighting of overall emissions**
Incremental investment/yr in the 2020s needed for Net Zero by 2050 pathway, $ bn



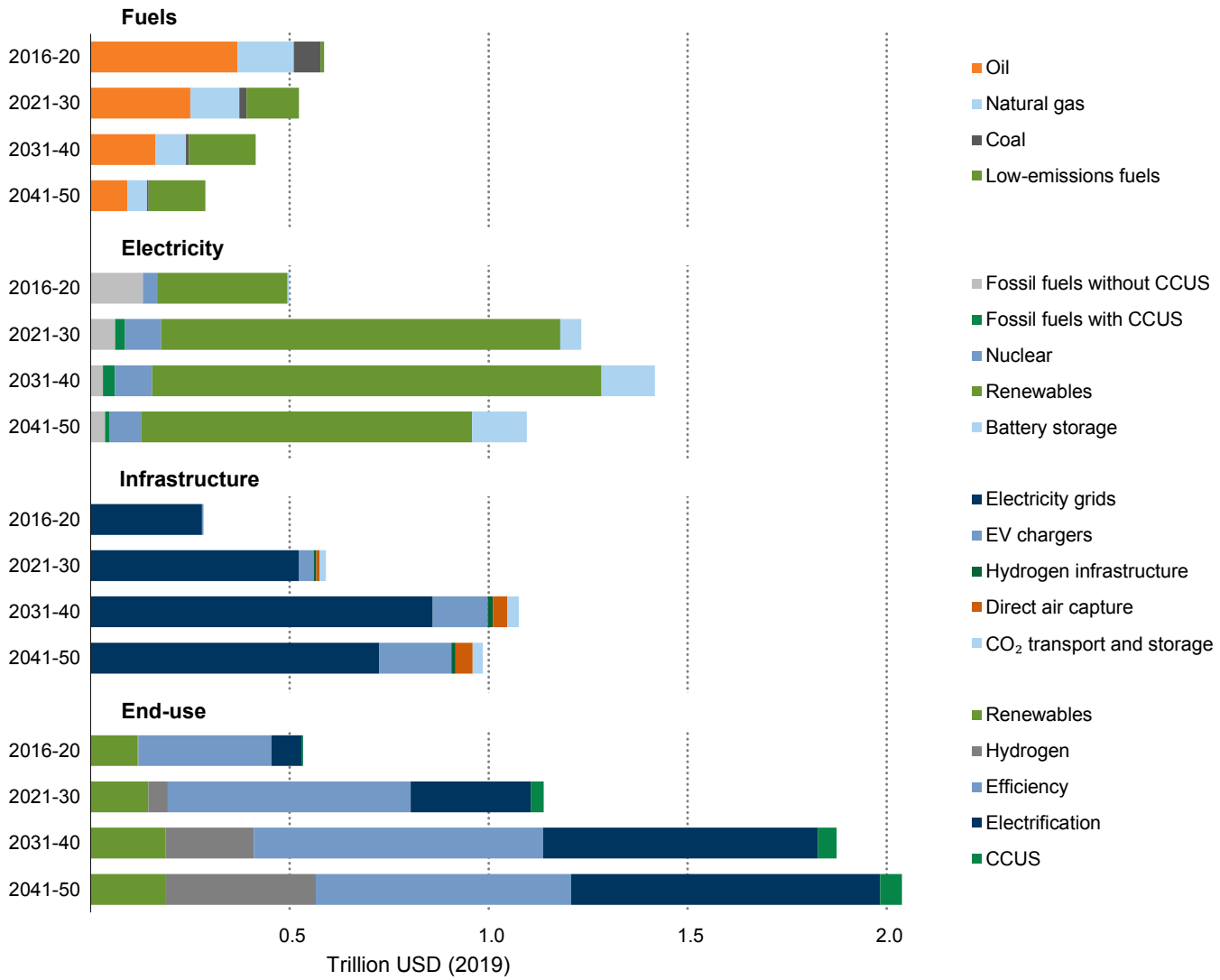

Source: Princeton University, European Commission, IEA, Goldman Sachs Global Investment Research

**Exhibit 6: The drivers of investment needed are diverse**
US and EU Net Zero costs by investment category



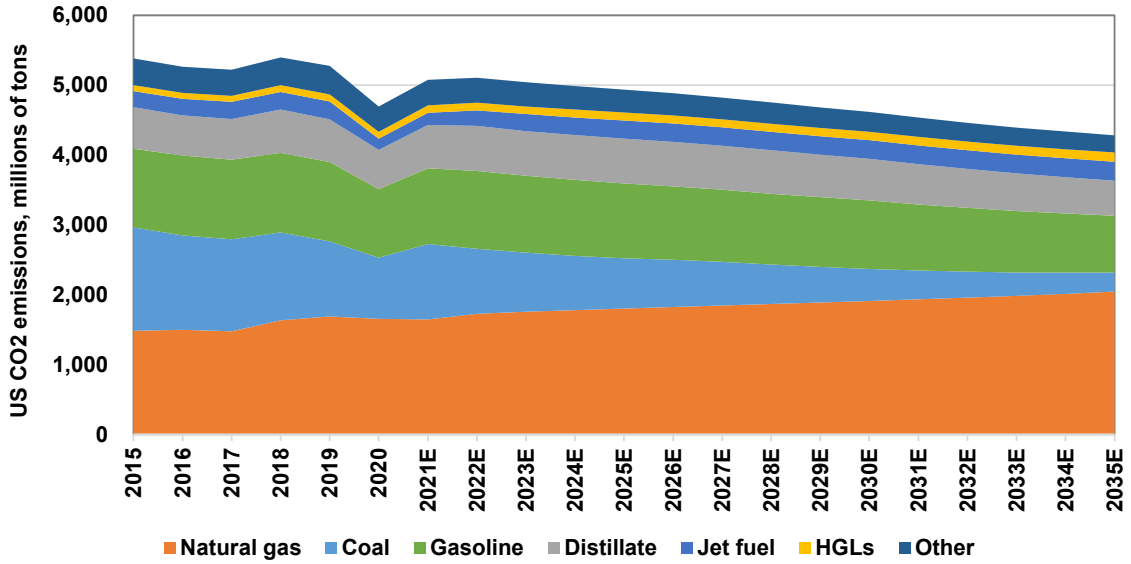

Source: Goldman Sachs Global Investment Research, Princeton University, European Commission

**Exhibit 7: To stay on pathway to Net Zero, around $3 trillion in incremental annual investment needed toward Clean Energy in 2030 vs. 2016-20**
Global average annual energy investment needs by sector and technology based on IEA's Net Zero pathway




Source: International Energy Agency (2021), Net Zero by 2050, IEA, Paris

**Exhibit 8: We believe greater acceleration in Green Capex is needed to achieve President Biden's target for US greenhouse gas emissions to fall 50%-52% by 2030 vs. 2005 levels**
US carbon dioxide emissions, mn MT

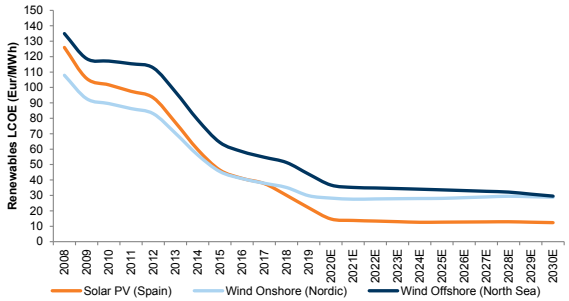



Source: EIA, EPA, Goldman Sachs Global Investment Research

## Innovation and scale are likely to make Green Capex needs dynamic

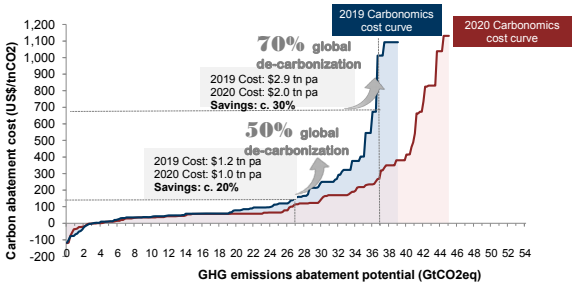
**Investment can drive innovation and scale, leading to lower costs over time.** As has been seen across multiple sectors from semiconductors to shale to solar — greater investment and innovation can lead to lower costs. The levelized cost of energy for renewable power has decreased by more than 70% 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. So we see potential for estimates of costs needed to achieve Net Zero to further evolve. Investment is a catalyst not only to stay on the path to achieving Net Zero but to potentially over time lower the costs via scale/innovation.

**Exhibit 9: Scale fosters cost deflation: Renewable power costs have decreased by >70%...**
LCOE for solar PV, wind onshore and wind offshore with select regions in Europe (EUR/MWh)



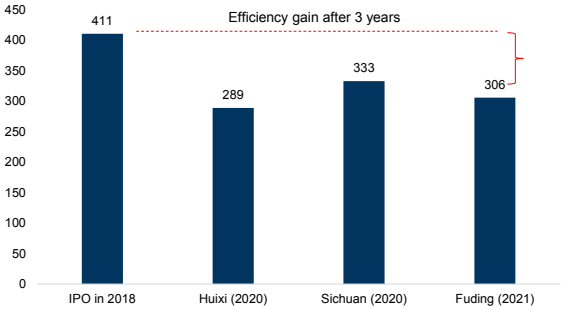

Source: Company data, Goldman Sachs Global Investment Research

**Exhibit 10: ... by lowering the cost of 70% carbon abatement by $1 tn per year**
Conservation carbon abatement cost curve for anthropogenic GHG emissions and associated costs for different levels of de-carbonization




Source: Goldman Sachs Global Investment Research

**Exhibit 11: Lithium-ion battery maker CATL has seen its unit equipment costs fall, an example of potential for innovation/scale to drive lower costs and adoption**
CATL's equipment spending per GWh, Rmb million




Source: Company data, Goldman Sachs Global Investment Research

**Future disruptive innovations that we are watching.** The path to Net Zero will require breakthroughs across multiple green technologies, as decarbonizing harder-to-abate emissions (e.g., emissions in industrial processes, long-haul transport) require solutions that are still relatively nascent and expensive to implement. Our Energy team's Carbonomics analysis, for example, suggests that the costs to decarbonize 50% of the world's emissions currently stand at nearly US$80 or less per tonne, but decarbonizing beyond 75% of the world's emissions through advanced technologies (e.g., CCUS) could require between US$150 to more than US$1,000 per tonne based on current solutions. The urgency to foster cost deflation across various decarbonization technologies and to innovate new solutions is why we believe companies exposed to our Green Capex themes — both public and private — will play an increasing role in a low carbon economy in the long-term. Below we highlight an ecosystem of seven critical technologies that could provide transformational and disruptive solutions to drive decarbonization in the long-term. For more details on the role of each technology, please also see 1st of 40 years: China de-carbonization: A new eco-system of green tech.

**Exhibit 12: Innovations across multiple technologies could help lower the cost of decarbonization and introduce new climate solutions**
Select focus areas for decarbonization technological innovation

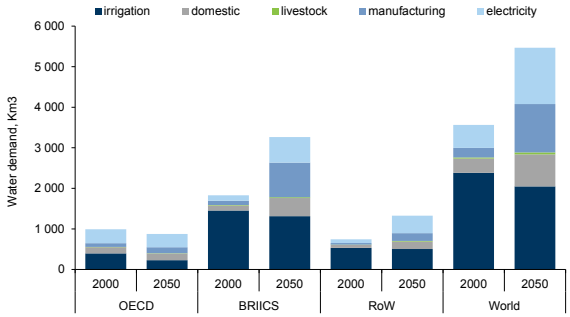
| Technologies | Innovation areas | Technologies | Innovation areas |
|---|---|---|---|
| **Electrification** | Next gen high cell efficiency technologies | **Carbon Capture** | New capture technologies |
| | Optimization of wafer size and thickness | | Optimization of input costs |
| | Changes in module 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 | | |
| | Graphene based super-fast charging | | |

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

## Clean Water: Significant capex needs identified

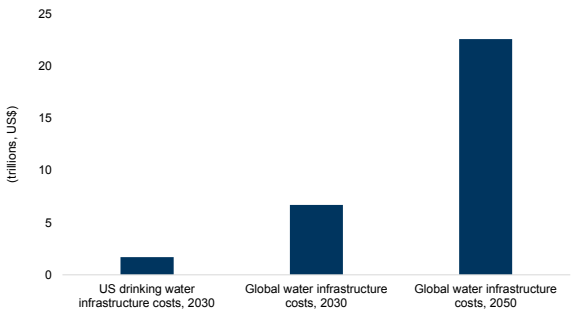
**More than $20 trillion of investment potentially needed to meet global Water goals, near $5 trillion of which is needed by 2030.** We believe significant investment is needed globally to meet water goals and needs. Our Utilities and Clean Energy team in an August report highlighted material incremental investment needs in the US to reverse the aging of the water pipe system, with various proposals for federal funding insufficient to achieve this goal. The American Society of Civil Engineers reports that there is a water main break every two minutes, and six billion gallons of treated water is lost each day in the US. The World Bank estimates that agriculture, health, income and property losses related to water could cause as much as a 6% decline in some countries' GDP by 2050. Estimates for capital required to meet UN goals or countries' water needs vary. A 2018 EPA report indicated that almost $0.5 trillion of investment over 20 years is needed to meet US drinking water needs. In 2016, the World Bank estimated the present value of investment needed to meet global drinking water needs through 2030 was $1.7 trillion. The OECD in 2018 highlighted estimates released in 2015 that full water investment needs in drinking water, sanitation, health, and other water management areas are $22.6 trillion by 2050, of which $6.7 trillion is needed by 2030. Adjusting to present, we estimate about $0.4-$0.5 trillion per year of needed water investment, up from about $0.2-$0.3 trillion per year in 2016-20. As our Utilities and Clean Energy team reported in our recent note on the GS Water Symposium, the American Water Works Association (AWWA) highlighted that funding is a greater challenge than technology development in addressing water-related needs, with cybersecurity and emergency preparedness as evolving areas of focus in the US ecosystem.

**Exhibit 13: Global water demand continues to grow, though increased efficiency in developed economies is stabilizing demand in OECD member countries**
Global water demand in OECD's baseline scenario, 2000 - 2050



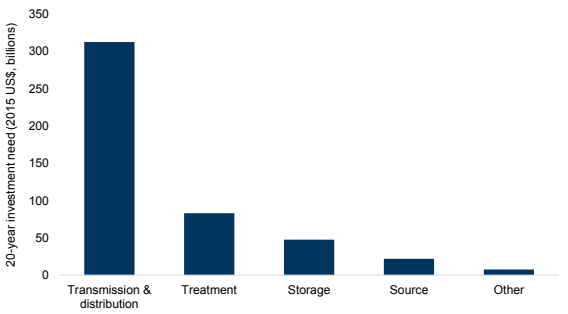

Source: OECD, The Environmental Outlook Basin

**Exhibit 14: World Bank highlights need for more than $5 trillion/$20 trillion in water infrastructure investment needed globally by 2030/2050**
Water infrastructure costs, US and global in 2030 and 2050




Source: Water and Sanitation Program, World Bank, OECD

**Exhibit 15: EPA's assessment of US drinking water infrastructure needs by category**




Taken from the 2015 Drinking Water Infrastructure Needs Survey and Assessment

Source: EPA, Goldman Sachs Global Investment Research

## Infrastructure: Continued need for modernization

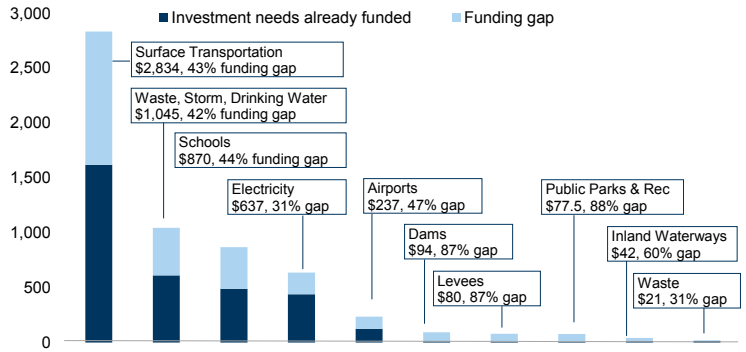
**Global needs could be up to $3.7 tn annually to keep pace with GDP growth and up to $4.7 tn annually to meet the UN Sustainable Development Goals through 2035**. A broader infrastructure report from McKinsey estimates that 14% of global GDP is spent on infrastructure and real estate. In order to meet infrastructure needs, increased investment is required. McKinsey estimates a $5.5 tn spending gap between 2017 and 2035 in infrastructure, with the majority of this gap coming from China, Australia and Japan. More than 60% of investment need through 2035 will come from emerging economies including China, MENA, India, LatAm and Eastern Europe. Annual need for infrastructure is split 30% power, 24% roads, 14% water, 14% telecom, 11% rail, and 5% ports and airports. In our estimates for overall need, we remove power and water to prevent double counting with net zero and water requirements, leaving $2.5 trillion in annual infrastructure investment required.

**A recent report by the American Society of Civil Engineers highlighted $2.6 trillion in unfunded US infrastructure needs.** This estimated investment would move the United States from a C- rating on infrastructure to a B level. While an estimated $200 bn in private funds are earmarked for infrastructure, significant gaps exist to improve infrastructure needs such as rural broadband, aviation, clean water access, hazardous and solid waste, and transit. If left unfunded, these gaps are expected by ASCE to cost $10 trillion in GDP and three million jobs by 2039. In the US, the 2021 multi-week closure, on the back of a discovered break of a key support beam, of the Hernando de Soto that spans the Mississippi River connecting Arkansas and Tennessee on a major interstate highway highlights potential impact and need for greater focus on

infrastructure modernization.

**Exhibit 16: Of the $5.9 trillion in US infrastructure investment needs to 2029, only 56% is funded thus far**

Total investment needs by infrastructure category, 2020 - 2029, funded vs unfunded



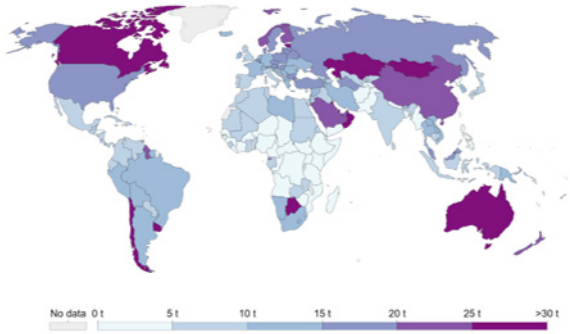

Source: American Society of Civil Engineers, Goldman Sachs Global Investment Research

## Responsible consumption and production: Recycling initiatives could spur additional Green Capex

**While in this report we focus on Net Zero, Clean Water and Infrastructure Green Capex, we note that investors will likely cast a wider net for Green Capex, including Circular Economy measures like recycling.** The Recycling Partnership recently released a report finding that the US requires an investment of $17 bn in residential recycling, in addition to more funding required for recycling operations, over the next five years in order to make recycling as accessible as trash disposal. This is split up between $11 bn in infrastructure (collection investment, new MRF and MRF upgrades, hub-and-spoke transfer, and film and flexible packaging collection and processing) and $6 bn in education. The report finds an estimated $30 bn in economic benefits from this investment over 10 years and nearly 200,000 jobs created.

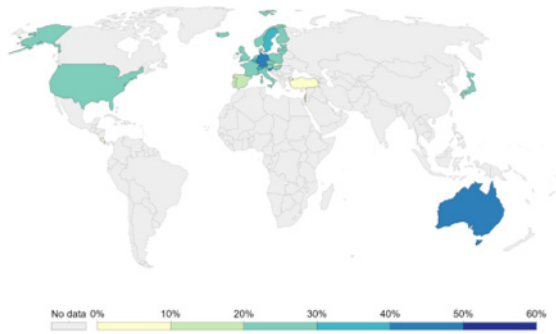
Annual aluminum can demand has been growing 4%-6% since 2018 and our analysts see continued growth on the back of a shifting category mix, especially the rise of hard seltzer and energy drinks, and the focus on sustainability by consumers. Plastic packaging was growing at 5.0% CAGR 2016-2019, faster than glass (+3.5%) and paperboard (+3.7%). The growth of packaging materials underlines the increased need for investment in waste and recycling infrastructure. Thus far more than 35 major consumer brands have made public commitments related to using recycled material in their packaging, including Coca-Cola, Danone, PepsiCo, Nestle and Unilever, while many other public companies have made investment commitments related to the circular economy. In fact, the 2021 Plastics Scorecard found a ninefold increase in plastic reduction goals since 2019. That said, only 5% of funds necessary to expand and update US recycling infrastructure has been secured.

**Exhibit 17: Demand for recycling is likely to increase across continents**
Domestic materials consumption (biomass, fossil fuels, metal ores and non-metal ores) per capita, 2017




Source: UN Statistics Division

**Exhibit 18: Recycling is greatest in Australia, the US, Europe and Japan**
Municipal (including household) waste recycling rates as a % of total waste generated




Source: OECD, Eurostat

# *ESTIMATES from related research*

## New Net Zero Infrastructure

**$56 tn**

"We expect a cumulative **US$56 tn** of **green infrastructure** investments to net zero, reaching >2% of GDP by 2032 in the GS 1.5° scenario."
*Carbonomics: Introducing the GS net zero carbon models and sector frameworks (Jun 23, 2021)*

## *Hydrogen*

**€10 tn**

"**Green hydrogen**… could give rise to a **€10 tn** addressable market globally by 2050 for the Utilities industry alone."
*Green Hydrogen: The next transformational driver of the Utilities industry (Sep 22, 2020)*

## *Copper*

**5.4 Mt / 8.7 Mt**

"By 2030, **copper** demand from the transition will grow nearly **600%** to **5.4 Mt** in our base case and **900%** to **8.7 Mt** in the case of hyperadoption of green technologies."
*Green Metals: Copper is the new oil (Apr 13, 2021)*

## *Aluminum*

**1.3 Mt/year**

"Green demand will grow at an average annual growth rate of 18% y/y in the 2020s, generating **1.3 Mt per year of growth** in demand volumes."
*Green Metals: Solving Aluminum's Climate Paradox (Jun 20, 2021)*

## *China*

**$16 tn**

"We model the country's potential path to net zero by sector and technology, laying out **$16 tn** of clean tech infrastructure investments by 2060."
*Carbonomics: China net zero: The clean tech revolution (Jan 20, 2021)*

**$1.5 tn**

"We identify and analyze an ecosystem of 7 key technologies and highlight 11 solutions we believe can open up a low-cost, efficient path for China to reach net zero. Overall, we estimate a total investment of **$1.5 tn** will be needed to implement them."
*1st of 40 years: China de-carbonization: A new eco-system of green tech (May 31, 2021)*

## *US*

**$39-$117 bn**

"Increased power demand implies a direct need for investment in generation -- our analysis suggests **$39-$117 bn** in investment by 2040 if new gas/wind/solar capacity is used to meet EV driven demand."
*American Utilities: Future of Energy Demand: What Increased Penetration of EVs Means for US Power Demand Trends (Jul 26, 2021)*

**$350-$900 bn**

"Around **$350-$900 bn** of incremental capital investment is required, with various proposed federal funding plans insufficient to bridge the funding gap."
*Americas Utilities: Water: Material investment needed to update aged infrastructure; benefits of industry consolidation (Aug 1, 2021)*

## *Japan*

**¥28 tn**

"Hurdle to maximizing renewables to realize carbon neutrality by 2050: We estimate investment at **c.¥28 tn.**"
*Japan: What if?: 2050 Carbon Neutral Declaration shifts the discussion from "What if" to "How to" (Jan 12, 2021)*

## *Europe*

**€10 tn**

"Our **€10 trillion** estimate for the EU Green Deal reflects the combination of privately funded clean energy investments (c.60%), energy efficiency spending (c.20%) and grants to transition to clean sources of transport and heating (c.20%)."
*The Green Deal: EU Green Deal estimate up +50%, now at €10 trn (Jan 7, 2021)*

# Who will fund Green Capex?

**We believe much of Green Capex will likely need to come from corporates and/or governments. At present, consensus estimates for publicly traded corporate capex — including in sectors that will more likely see Green Capex needs like Utilities — call for a modest increase in overall capex (not just Green) in 2022/2023. This will likely result in greater calls among investors and other stakeholders for: (a) companies to break out Green Capex to monitor portfolio shifts; and/or (b) greater clarity regarding the impediments toward greater capex. We address this point later in the report on "What to ask." Over time, we see greater investor credit for companies with attractive corporate returns investing incremental Green Capex.**

Increasingly we believe investors and broader stakeholders will look more closely at how much Green Capex is being funded and how funding, cost structure and innovation will impact execution towards Net Zero, Clean Water and broader Infrastructure goals. We expect Green Capex will primarily be funded by the private and public sectors, though for some products like residential solar, appliances and electric vehicles, individuals will play an important role.

- Consensus expectations for the >6,800 publicly traded companies in our global GS SUSTAIN database call for a +3%/+2% yoy increase in 2022/23 capex + R&D (not solely Green) off about a $4 trillion base.
- We estimate $0.4 trillion of incremental private equity capital availability annually in the 2020s, based on a 20% CAGR from annualized raises in 2021 for Climate/Infrastructure/Water private equity and venture capital funds.
- We expect $0.4 tn of investment by individuals to support development of residential solar, electric vehicles and energy efficient appliances. As our colleagues recently wrote, power price increases are unlikely to derail the path to Net Zero.
- 31 global banks have announced plans to provide $1.3 trillion of financing per annum for Green or broader SDG-related projects.

**We also expect significant government support to advance these goals.** The level and mix of public sector Green Capex funding via tax incentives vs. direct investments will vary by jurisdiction. We believe monitoring public company capex (and, for some sectors, revenues) as well as deployed/raised private equity capital dedicated for Climate, Infrastructure or Clean Water goals will be important tools to understanding Green Capex trends.

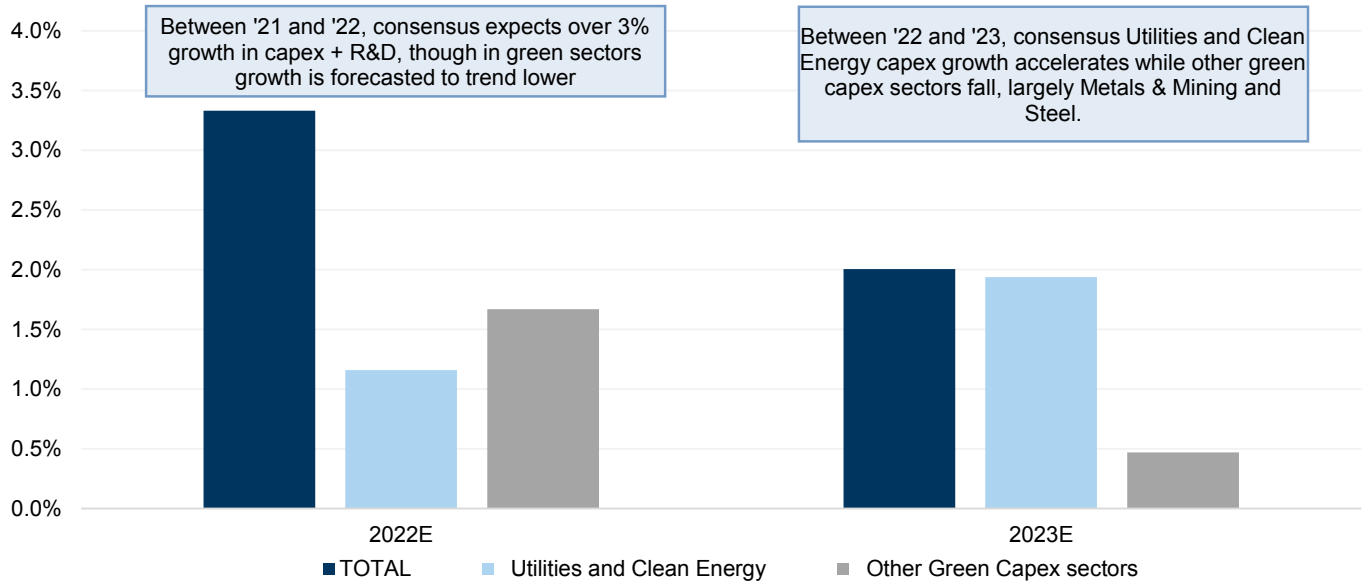
## Publicly traded companies: Increase in or notable shift toward Green Capex may be needed

**Modest capex growth from publicly traded companies may put greater pressure on disclosure of Green Capex vs. non-Green Capex** (already required for European companies as part of the EU Green Taxonomy)**.** Factset consensus estimates call for modest yoy growth in global capex + R&D levels in 2022/23 — about 3.3% in 2022 and 2% in 2023 from

the >6,800 companies in our GS SUSTAIN universe. Our analysts are in aggregate above consensus — companies covered by GS Research are expected to see a 5% CAGR over 2022-23 vs. a 2021 base. Notably, this is for total capex, not specifically for Green Capex. However, the relatively modest annual increase would suggest that either:

- There may be need for publicly traded companies to increase absolute capex in order for Net Zero/Infrastructure/Clean Water objectives to be accomplished; and/or
- Companies are shifting mix toward Green Capex, so Green Capex is growing at a greater rate than total.

**Exhibit 19: Consensus for the >6,800 companies in our GS SUSTAIN database calls for over 3% capex + R&D growth in 2022 and deceleration in 2023; expectations for green sectors is not differentiated (our research analysts are more bullish on capex growth in both years)**
Capex + R&D growth yoy in 2022E and 2023E




Note: All Sectors excludes Financials

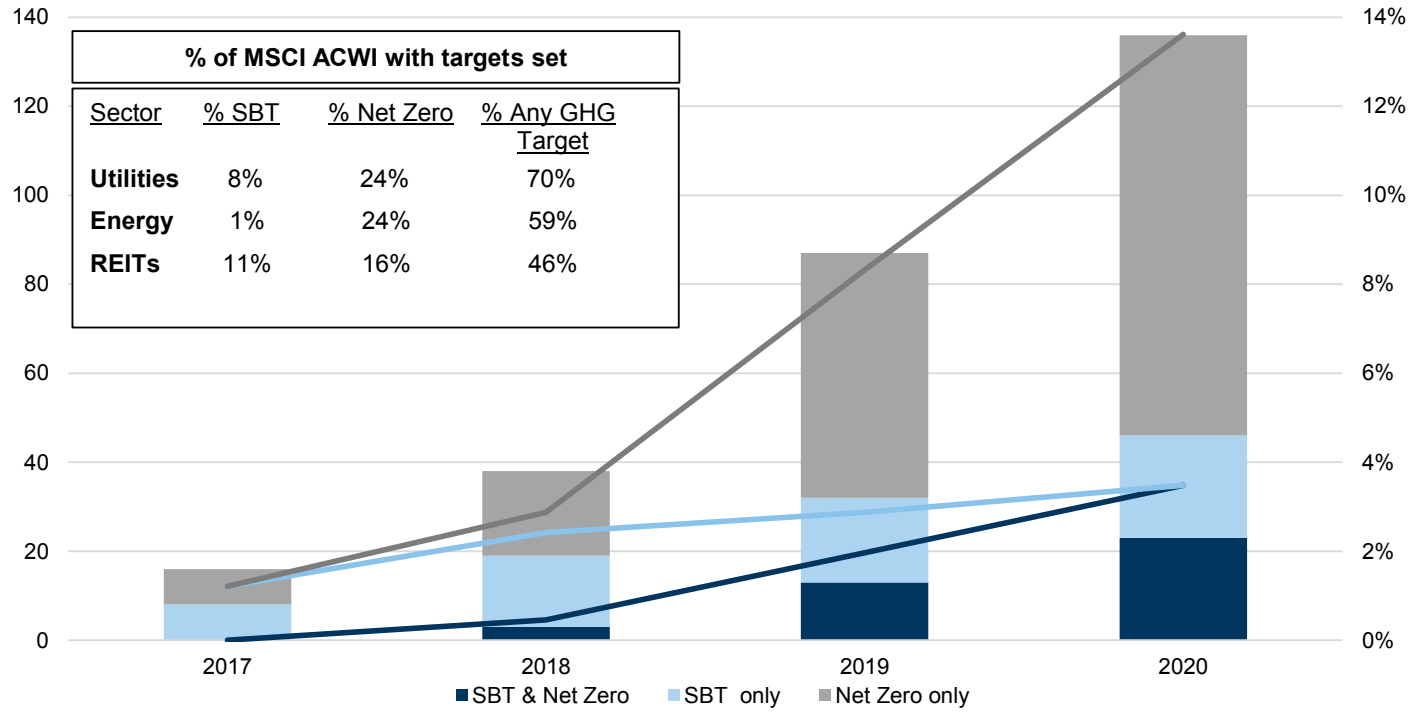
Source: FactSet, Goldman Sachs Global Investment Research

**Consensus expectations for Green sectors are not materially differentiated on a global basis.** On a weighted average basis, we do not see material positive differentiation in capex + R&D growth among sectors most relevant for Net Zero, Clean Water and Infrastructure. Notably, some of the sectors benefit via revenues as customers of those participating in Green projects, though this would potentially require capex expansions or shifts to support acceleration. There are some

positive idiosyncrasies, notably Renewable Electric companies lumped into Utilities and Clean Energy, where consensus calls for double-digit growth. Interestingly, this comes despite a pickup in corporate commitments to Net Zero and/or Science-based targets (not necessarily by 2030) over the past 1-2 years. Additionally, we have seen a pickup in Green initiatives adopted by shareholders in recent years that could also likely push publicly traded companies towards greater Green Capex.

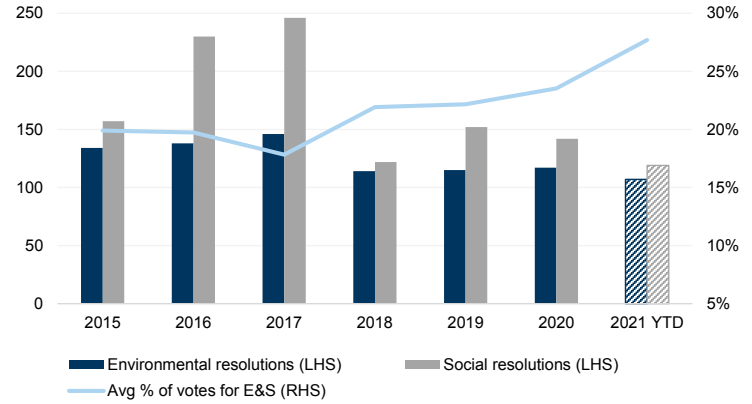
**Engagement and disclosure likely are key next steps.** As we highlight in our report, we believe investors may look for greater disclosure (in addition to regulatory push from the EU Green Taxonomy) for managements to classify/disclose capex for Green or broader sustainable use cases as percentage of total. Additionally, as we highlight in the report, there may be greater investor engagement with managements on the reasons why capex is not otherwise higher.

**Exhibit 20: Companies issuing Net-Zero emissions targets have accelerated in recent years, particularly among heavier industries**
Count and % of companies with some combination of Net Zero and science-based emission targets in four emissions-intensive sectors (MSCI ACWI)



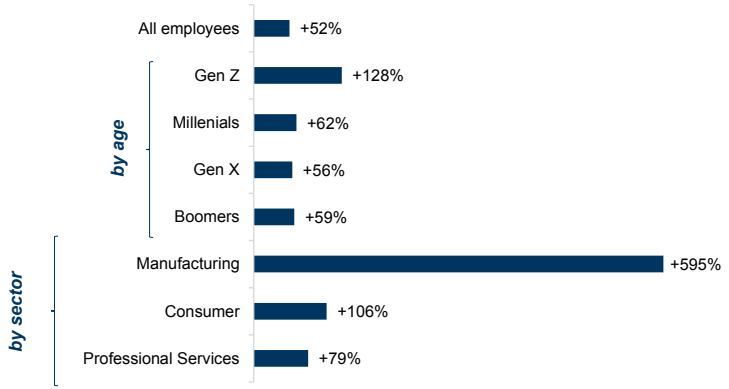

Source: Goldman Sachs Global Investment Research, Bloomberg

**Exhibit 21: Shareholder support of Environmental & Social (E&S) proposals has been ticking up in recent years**
No. of global shareholder proposals on E&S topics and avg. % of votes for, 2015 - current




Source: Proxy Insight, Goldman Sachs Global Investment Research

**Exhibit 22: Employees are increasingly concerned about environmental impact**
% growth in respondents expressing concern about the environment from 2019 to 2020 by employee type; list of employee types is not exhaustive

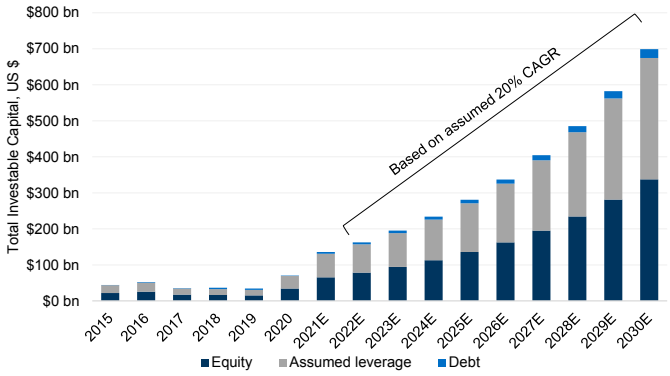



Source: Peakon, Goldman Sachs Global Investment Research

## Private equity capital: Substantial recent raises, likely to be more

We have seen a recent surge in Green private equity capital raises, and strong growth is likely going forward. In 2021 through July, there was $41 bn of private equity capital raised for infrastructure, Climate and Clean Water objectives. Annualizing this and adding leverage to the equity component at 50%/50% equity/debt split would yield about $135 bn in incremental available capital this year. We believe we are likely to see significant growth in private equity capital dedicated for these goals. In a scenario of a 20% CAGR (above the 12% historical CAGR of available capital to invest and consistent with our Asset Managers and Capital Markets team's view of rising market share of ESG/Infrastructure capital), this would imply incremental available capital in 2030 of about $700 bn and average annual incremental available capital in 2021-30 of about $350 billion.

**Exhibit 23: Green private equity capital raised plus assumed leverage in 2021 would be $135 bn based on YTD trends; at a 20% CAGR, annual new available capital would average $0.4 tn this decade**
Green private equity capital raised and forecasted, 2015 - 2030E




Assumes 20% CAGR and 50/50 leverage

Source: Prequin, Goldman Sachs Global Investment Research

## Public sector funding for Green Capex

**Multiple countries are pursuing Net Zero policies, though not all have codified in law.** As more countries have pledged to achieve Net Zero — largely by 2040-2050 — we see continued moves to both codify rules as well as government stimulus. We expect countries will provide infrastructure, water and clean energy stimulus via tax breaks, grants and direct investments. This will likely continue to lead to corporates playing a critical role in globally in achieving these three goals.

**Exhibit 24: Multiple countries are pursuing Net Zero policies, though not all have codified in law**
Countries with Net Zero carbon targets in policies and legislation


Source: Energy & Climate Intelligence Unit, Data compiled by Goldman Sachs Global Investment Research

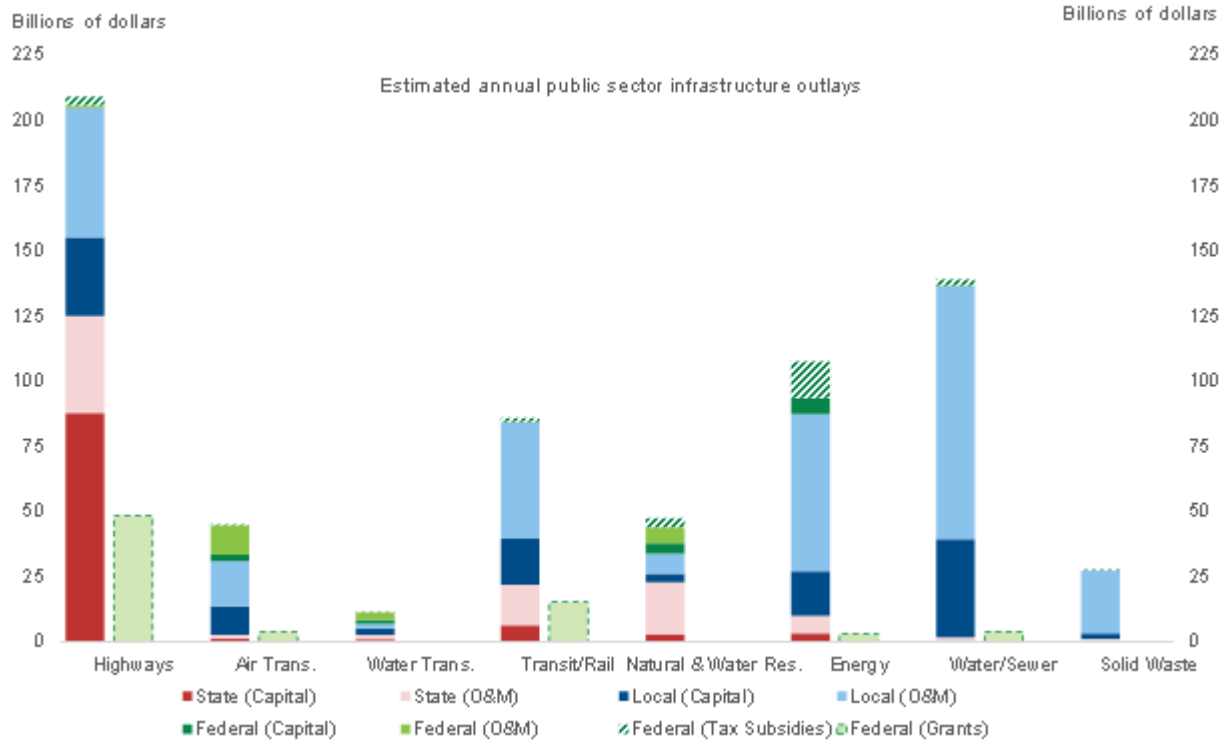
***This section contributed by Alec Phillips, chief US political economist.***

**In the US, federal, state, and local governments spend around $675 bn annually on transportation, energy, and water infrastructure.** Nearly all public spending is carried out by state and local governments or other municipal entities. Federal grants finance a portion of this, though even in segments with the most generous federal funding—highways and transit—federal grants account for only around 20% of the spending.

**However, only 37% of public spending on transportation, energy, and water infrastructure is devoted to capital investment.** The nearly two-thirds that remains goes to operations and maintenance (O&M). In general, federal grants are directed mainly toward capital investment rather than O&M, and it looks likely that most of the incremental funds that Congress might approve in upcoming legislation would also go toward new investment rather than maintaining existing infrastructure.

**We discuss two pieces of upcoming legislation that look likely to increase the amount of US public funding for capital investment later in the report.**

**Exhibit 25: US outlay (not all capex) for transportation, energy and water infrastructure currently totals around $0.7 trillion per year**
Estimated annual US public sector infrastructure outlays, $ bn



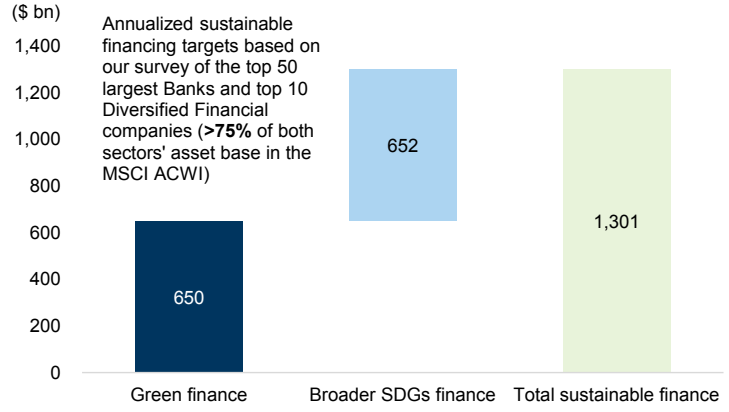

Source: White House Office of Management and Budget. Congressional Budget Office. Department of Commerce. Goldman Sachs Global Investment Research

## Financing Green Capex and Sustainable Development Goals: $1.3 tn per year of support from 31 banks

**As discussed in our Banks ESG Roadmap, we believe banks will play a significant role in mobilizing Green Capex as conduits of Sustainable Capital.** We surveyed the top 50 largest Banks and top 10 largest Diversified Financial companies in the MSCI ACWI (>75% of the total asset base for both industries), and found that 31 companies had set targets that imply $1.3 trillion in sustainable financing per annum. Of this total amount, about 50% has been explicitly allocated to green activities, while the remaining half will be directed at broader Sustainable Development Goals which include climate change mitigation/adaptation. We caveat that there will be variations in how banks define sustainable or green activities in the absence of standardized global guidelines, as well as in what types of banking activities are leveraged to achieve these

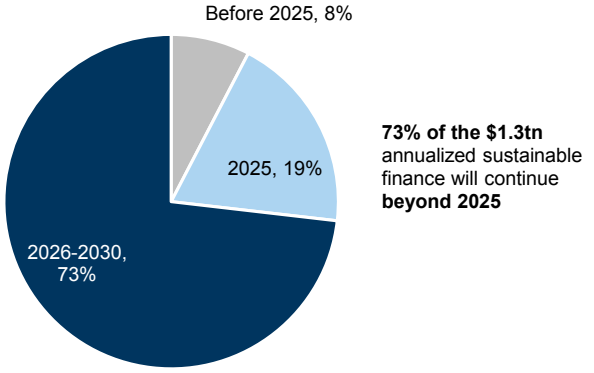
targets in the long-term. Based on company disclosures, the combination of lending, underwriting, investing and all other banking related services will count toward achieving these goals.

**Exhibit 26: Sustainable finance targets set by major Banks and Diversified Financials companies suggest $1.3 trillion will be mobilized each year to enable various SDGs**
Sustainable finance targets announced by major banks across regions, as of August 2021; includes combination of underwriting and direct investments




Source: Company data, Goldman Sachs Global Investment Research

**Exhibit 27: Of the $1.3 trillion annualized amount announced as of last month, 73% extend beyond 2025**
Breakdown of sustainable finance in terms of timeline (% based on annualized financing targets)




2030 targets include all targets that expire between 2026-2030

Source: Company data, Goldman Sachs Global Investment Research

## Innovation and scale should provide incentive for private sector and recognition for leaders

**As highlighted earlier, costs and scale could provide a greater incentive for investment and ultimately differentiation.** We believe innovation and scale could make the costs required to meet Net Zero, Infrastructure and Clean Water goals dynamic. At the same time, the ability to lead innovation and scale provides an incentive for greater investment. Scale and differentiation could provide barriers to entry for others, which could further drive investor recognition for innovation and differentiation.

# The Greenablers: Longer lead time investment needed in key sectors on critical path

**We believe the building blocks needed to execute on Sustainable Development Goals will require investment with long lead times — 2-12 years — to avoid bottlenecks and delays.** This could increase urgency among Sustainability investors in pushing companies toward codifying Green Capex plans, particularly companies that make building blocks on the critical path. While we highlight copper mining, semiconductors, electricity transmission and cybersecurity as examples of areas of focus in this report, these are not a complete list, and further mapping of Green Capex related product needs could lead to additional sectors being included. As examples, lithium, cobalt, manganese, nickel and phosphate are critical at present to battery technology for EVs, as is silicon for anodes and solar panels.

**The need for long lead time project spending to source Energy generation is a shift from Energy demand growth that has largely been supplied by short-cycle oil and natural gas for much of the last decade.** Short-cycle shale was the main driver of meeting Energy demand (oil and natural gas) growth during the past decade. Much of energy demand growth was sourced by short-cycle shale oil and natural gas where investment lead time was 9 months. This comes in sharp contrast to prior periods where long lead time projects — 4-7 years — were the main source of meeting oil and natural gas demand. Long lead time capital spending by the major integrated oils continued through 2014 until realization of shale's longer-term materiality and capital availability led to a reprioritization of capital to fix balance sheets, increase short-cycle spending and diversify into Clean Energy sources. Importantly, while majors were still focused on long lead time projects in the first half of the 2010s, long-term corporate guidance for Exxon and Chevron were consistently revised down. While there were multiple reasons for this including asset sales, it is a reminder that execution is not a guarantee.

**Building blocks to meet SDGs require long lead time investment; lack of clarity on long-term demand raises potential for bottlenecks.** While over the past year there has been much focus on Green Capex for "final products" such as residential solar expansion, offshore wind farms, electric vehicles, and — there has only recently begun to be a focus on the "building blocks" needed to ensure execution to achieve key Sustainable Development Goals. These include semiconductor chips, copper, electricity transmission lines among other products. We also believe cybersecurity could play a more important role toward automation and related Energy efficiency gains.

**As mentioned above, the sectors we are highlighting as Greenablers in this report are not a complete list,** and further mapping of Green Capex related product needs could lead to additional sectors being included. As examples, lithium, cobalt, manganese, nickel and phosphate are critical at present to battery technology for EVs, as is silicon for anodes and solar panels.

**Exhibit 28: The Greenabler themes we highlight permeate all critical sectors of Net Zero, Clean Water, and Infrastructure**
Exposure to Greenabler theme of critical technologies, with qualititave level of criticality

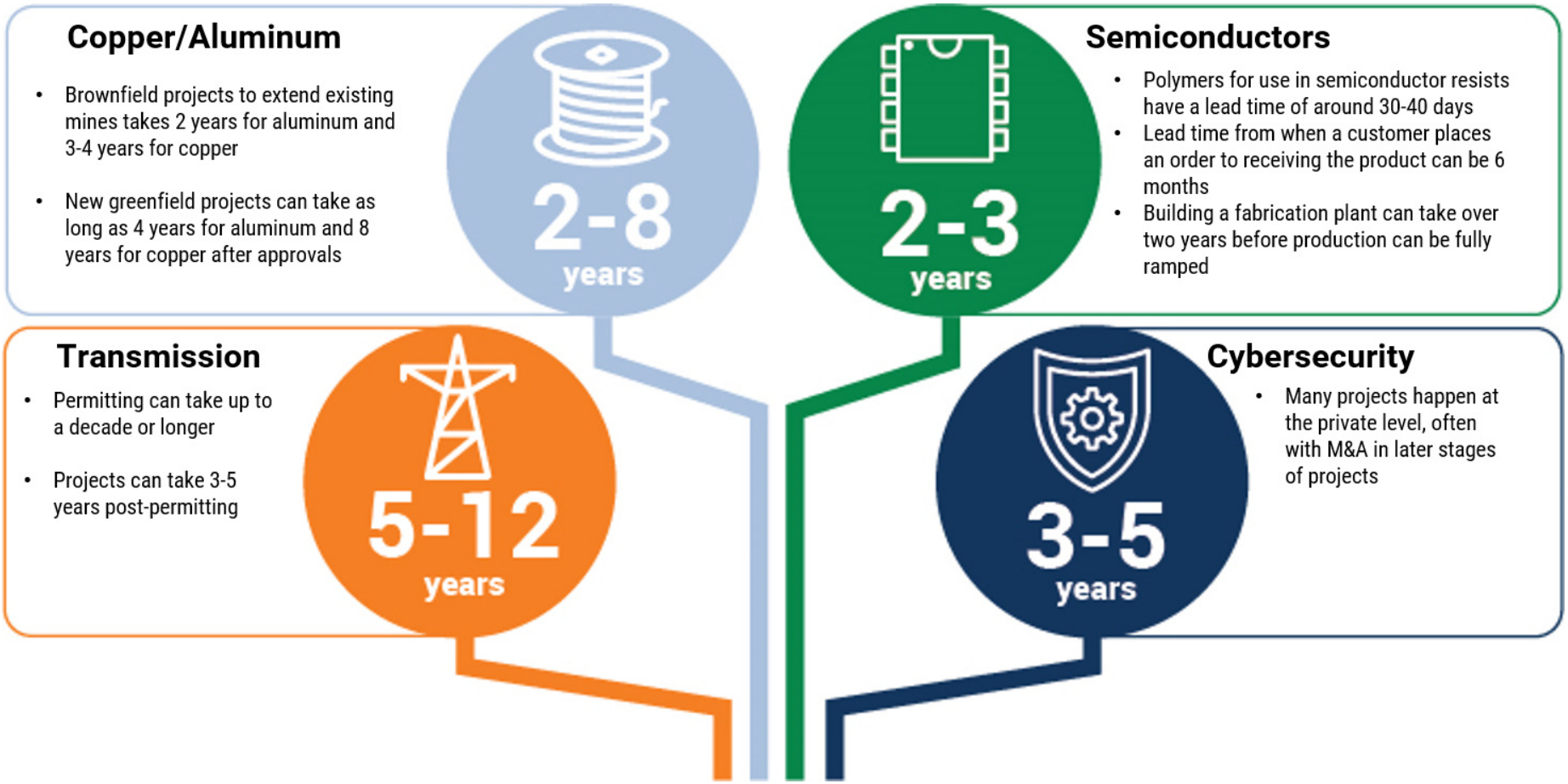
| | Cybersecurity | Electricity Transmission | Copper & Aluminum | Semiconductors |
|---|---|---|---|---|
| **Net Zero** | | | | |
| **Carbon Capture, Util. & Storage** | | | | |
| From Fossil Fuels | | Needed | | |
| From Biofuels | | Needed | | |
| Direct Air Capture | | Needed | | |
| $CO_2$ Transportation | | Needed | | |
| **Battery Storage** | | Highly critical | Needed | Highly critical |
| **Low Emission Fuels** | | | | |
| Biogas (RNG) | | Needed | | |
| Hydrogen (w/ CCUS) | | Needed | Needed | |
| Liquid Biofuels | | Needed | | |
| $H_2$ Electrolysis | | Highly critical | Highly critical | Highly critical |
| **EV Chargers** | | | | |
| Public Stations | Highly critical | Highly critical | Highly critical | Highly critical |
| **Electricity Grids** | | | | |
| Refurbishments | Highly critical | Highly critical | Highly critical | Needed |
| Digitalization | Highly critical | Highly critical | Highly critical | Highly critical |
| Expansion | Highly critical | Highly critical | Highly critical | Needed |
| Substations | Highly critical | Highly critical | Highly critical | Highly critical |
| **Renewables** | | | | |
| Utility-scale PV | Needed | Highly critical | Highly critical | Highly critical |
| Residential PV | Needed | Highly critical | Highly critical | Highly critical |
| Onshore Wind | Needed | Highly critical | Highly critical | Highly critical |
| Offshore Wind | Needed | Highly critical | Highly critical | Highly critical |
| Others | Needed | Highly critical | Highly critical | Highly critical |
| **Energy Efficiency** | | | | |
| ICE vehicles | | | | Needed |
| Appliances | Needed | Needed | Needed | Needed |
| HVAC | Needed | Needed | Needed | Needed |
| Direct Reduced Iron | | Needed | Needed | Needed |
| Primary Chemicals | | | | |
| Zero Carbon Buildings | Needed | Needed | Needed | Needed |

| | Cybersecurity | Electricity Transmission | Copper & Aluminum | Semiconductors |
|---|---|---|---|---|
| **Net Zero (cont.)** | | | | |
| **Electrification** | | | | |
| EV Cars | Highly critical | Highly critical | Highly critical | Highly critical |
| EV Trucks | Highly critical | Highly critical | Highly critical | Highly critical |
| EV Buses | Highly critical | Highly critical | Highly critical | Highly critical |
| EV Vans | Highly critical | Highly critical | Highly critical | Highly critical |
| Electric / $H_2$ Rail | Highly critical | Highly critical | Highly critical | Highly critical |
| SAF Aircraft | | | | |
| Electric Arc Steel | Needed | Highly critical | Highly critical | Highly critical |
| Buildings/Heat Pumps | | Highly critical | Needed | Needed |
| **Hydrogen End-Use** | | | | |
| Gas Grid Blending | | | | |
| Electricity Generation | Highly critical | Highly critical | Highly critical | Highly critical |
| Others | | | | |
| **Hydrogen Infrastructure** | | | | |
| Pipeline / Storage | Highly critical | | | Needed |
| Hydrogen Stations | Highly critical | Highly critical | Needed | Highly critical |
| **Nuclear Generation** | Highly critical | Highly critical | Needed | Highly critical |
| **Water** | | | | |
| **Transmission / Distribution** | Highly critical | | Needed | |
| **Treatment** | Highly critical | | | |
| **Storage** | Needed | | | |
| **Source** | Needed | | | |
| **Infrastructure** | | | | |
| **Roads: Expansion & Maint.** | Needed | | | |
| **High-Speed Rail: Exp. & Maint.** | Highly critical | Highly critical | Highly critical | Highly critical |
| **Ports** | Highly critical | Highly critical | | Needed |
| **Airports** | Highly critical | Highly critical | | Needed |
| **Telecom** | Highly critical | Highly critical | Highly critical | Highly critical |

*Highly critical*
*Needed*

Source: Goldman Sachs Global Investment Research

**Exhibit 29: 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

## Why Greenablers matter: Semiconductors case study

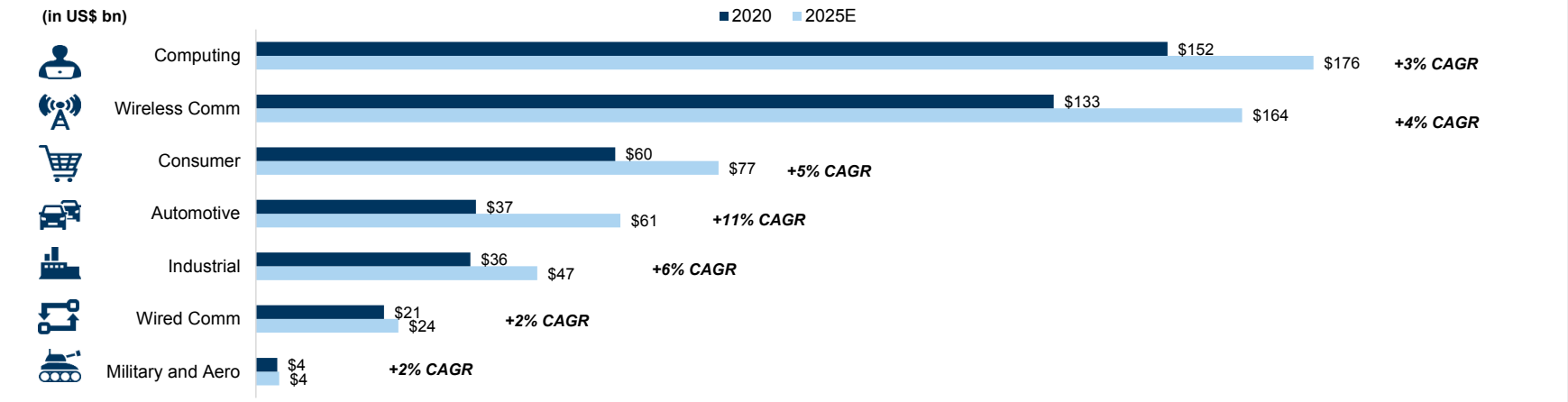
While all Greenablers highlighted in this report contribute to Net Zero, Water and Infrastructure goals in several ways, the enabling impact of some are more visible than others depending on their end-products. Copper and aluminum for instance, play a direct role in the production of batteries, renewables and transmission cables. The role of Semiconductors can be relatively more challenging to analyze, as the products are significantly less homogeneous and serve various end-markets not conventionally perceived as "Green." Despite these challenges, Semiconductors stand out as important Greenablers as they (1) help improve efficiencies of end-products and (2) help accelerate digitalization of "analog" activities which foster innovations with environmental and social benefits.

**Most Semiconductors indirectly contribute to various UN SDGs, but are nonetheless significant Greenablers.** Semiconductors are technologies that are necessary for the production of advanced technologies such as 5G, AI and high performance computing (HPC), the proliferation of which plays a significant role in driving social impact through consumer and industrial processes. Data from IDC suggests that as of 2020, more than two-thirds of the industry revenue is generated through electronic products such as computing devices (34%), wireless communication equipment (30%) and other consumer electronic products (14%). While these end-markets are not conventionally associated with Net Zero or other UN SDGs, semiconductors contribute to climate change mitigation by improving energy efficiency of these end-products through innovation. Our analysis of computing power efficiency data shows that chips have become more than 1,300x more power efficient between 2002-2020, which has ultimately enabled a wider adoption of digital technologies at cheaper cost and lower power usage.

Innovation and re-investments are critical in this industry, as leading-edge technologies demand increased processing power, which requires more complex designs to be patterned onto the surface of the wafer. This has also led to the production of smaller, less power intensive chips for use in appliances such as cellphones and tablets, significantly decreasing the energy consumption of these devices. This helps accelerate digitalization through connected devices, which abates emissions that would have otherwise occurred through "analog" alternatives (e.g., reducing travel demand through tele-meetings). A widely cited report published by Ericsson in 2015 estimated that these solutions will help reduce 7%-15% of global GHG emissions by 2030 compared to the average global emissions baseline based on IPCC's six GHG scenarios. Lastly, semiconductor-enabled products also help promote social objectives set by UN SDG 9 (Industry, Innovation and Infrastructure), such as the goal to achieve universal and affordable access to the internet. Devices that are enabled by semis (broadband connection, mobile devices) ultimately help improve livelihoods and quality of education for underserved populations in rural regions.

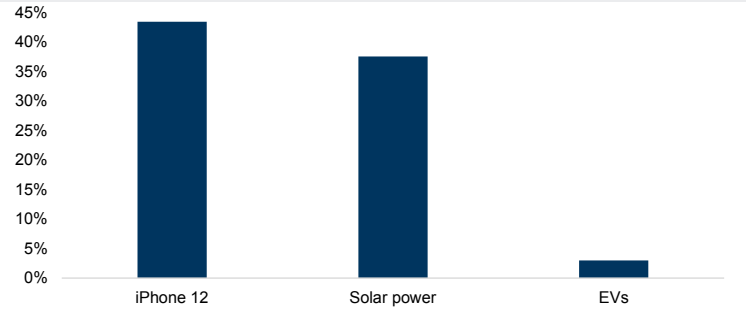
**Some semis directly contribute to Net Zero goals.** Semiconductor materials are used as the base ingredient in solar panels due to properties that enable easier transformation of light energy into electrical currents. Power semiconductors are used by Utilities and EV makers to perform critical functions such as power switching (controlling power on or off) or power rectifying (converting AC to DC). Semiconductors are also the base technology that are used to make LED lighting devices which are 7-8X more power efficient than traditional alternatives (IEA). In other words, semiconductors are building blocks that directly enable the expansion of electricity grids, renewables, EVs and other Green technologies.

**Exhibit 30: Computing, wireless communications, consumer are some major end markets for semiconductors, with automotive growing at double-digit CAGR**
Semiconductor market size by application (2020-2025E)




Source: IDC, Bloomberg

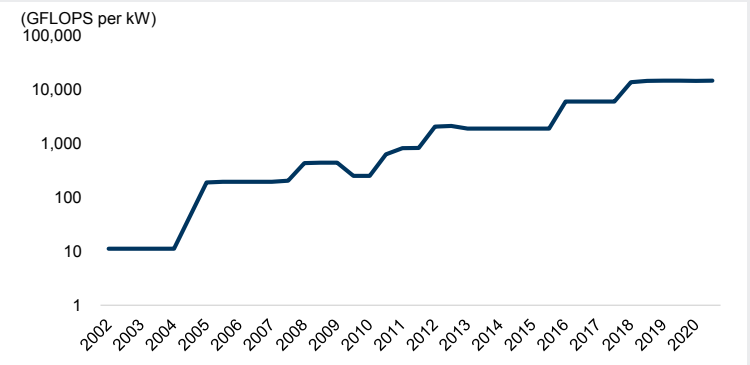
**Exhibit 31: Semiconductor devices are not the biggest cost components in every Green product like EVs, but they are critical building blocks**
Estimates of cost contribution of Semiconductor devices by product




Note: (1) Semiconductor devices in iPhone 12 includes A14 Bionic chipset, Qualcomm X55 5G modem, RAM and flash memory, (2) Costs for solar power are based on IRENA median installation costs. Semiconductor devices include modules and inverters

Source: IRENA, Fomalhaut Techno Solutions, Goldman Sachs Global Investment Research

**Exhibit 32: Innovations in chip design and manufacturing have exponentially increased computing power efficiencies of semis, making end products more power efficient**
GFLOPS per kW of the top supercomputers worldwide




Source: top500.org, Goldman Sachs Global Investment Research

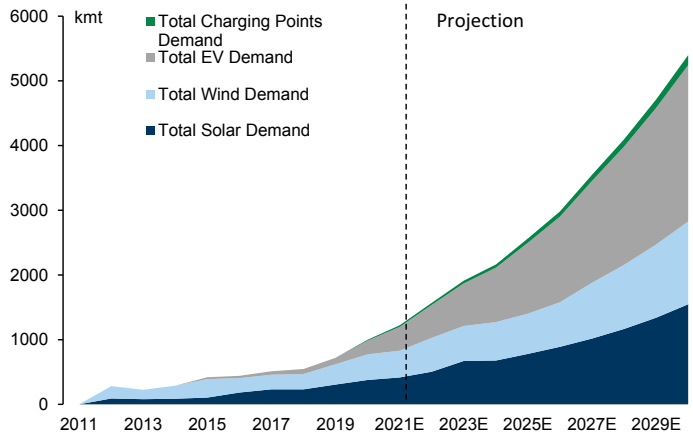
## Copper/Aluminum: Undersupply likely as capacity expansions needed

**Copper is likely to be undersupplied due in part to lead times for permits to bring on new mines.** Copper is a critical path product both for electric vehicles as well as infrastructure to source and transmit solar/wind/hydrogen power. Our analysts believe that Energy transition will drive 2.6 Mt of demand by 2025 (9% total global demand) and then 5.4 Mt in 2030 (16% of total global demand), and that the market appears on track to be short 8.2 million tons of supply by 2030. Companies at our Copper Day symposium in May noted interest but not final sanction of growth projects, and some projects where companies are seeking sanction face regulatory hurdles. Additionally, copper futures curve is currently in backwardation, which sets expectations for lower prices than front month on a longer-term basis. Importantly, the lead time to permit and build a new copper mine is 2-3 years for brownfield projects and up to 8 years for greenfield projects. Overall our Commodities Research team notes it is unlikely we will see brownfield/greenfield expansions come online before 2023/24.

**Climate policies are also driving deficits in aluminum.** Aluminum lies at the center of the decarbonization debate as it is a significant emitter (2% of all global emissions), but also an enabler of clean technologies including solar/wind/EVs. Our analysts estimate that climate policies will drive an increase in annual green aluminum demand from 3 million tons in 2020 to 16 million tons by 2030, which implies green aluminum's mix will increase from the 4% levels to 19% by 2030. The importance of decarbonizing and expanding the aluminum supply chain is becoming more critical as climate policy risks continue to advance (e.g., carbon border tax which is expected to be rolled out next year). While an aluminum smelter has a shorter construction timeline (brownfield ~2 years, greenfield 3-4 years) than a copper mine (brownfield 3-4 years, greenfield 6-8 years), from a starting point of essentially no growth appetite from the sector, the time lags still mean that supply growth is set to decelerate sharply into mid-decade.

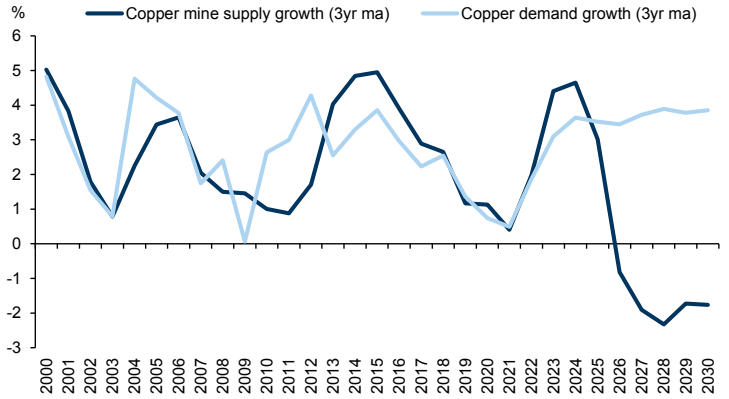
**Higher prices could lead to some substitution/innovation.** We note consumers, particularly as prices rise, will likely look for ways of reducing consumption intensity. In August, Daikin announced plans to reduce its copper use in air conditioners by 50% by substituting into aluminum. Investors will likely look to measure the ability for consumers to find ways to reduce intensity, particularly without a shift into another product requiring long lead time capital investment.

**Exhibit 33: Acceleration in green electrification trends is set to drive strongest decade in copper demand growth post-2000**
Copper demand, per year, from green sectors



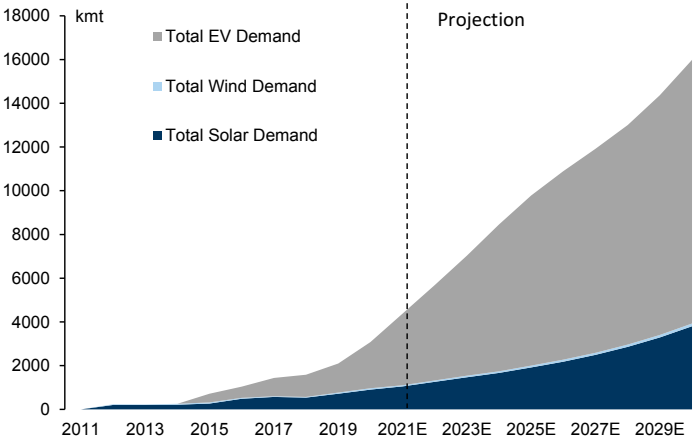

Source: Goldman Sachs Global Investment Research

**Exhibit 34: Mine supply expected to fall well below demand after 2024**
Copper mine supply growth vs copper demand growth, yoy %



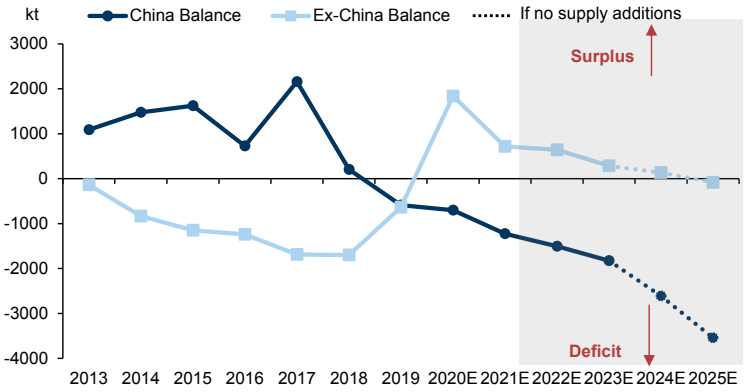

Source: Woodmac, Goldman Sachs Global Investment Research

**Exhibit 35: Global green aluminum demand to rise by 13 million tons over the decade, increasing by 18% yoy on average**
Aluminum demand, per year, by green sector




Source: IEA, IRENA, Goldman Sachs Global Investment Research

**Exhibit 36: Global aluminum market is set to trend into significant deficit over the next 3 years**
Aluminum China and Ex-China balance

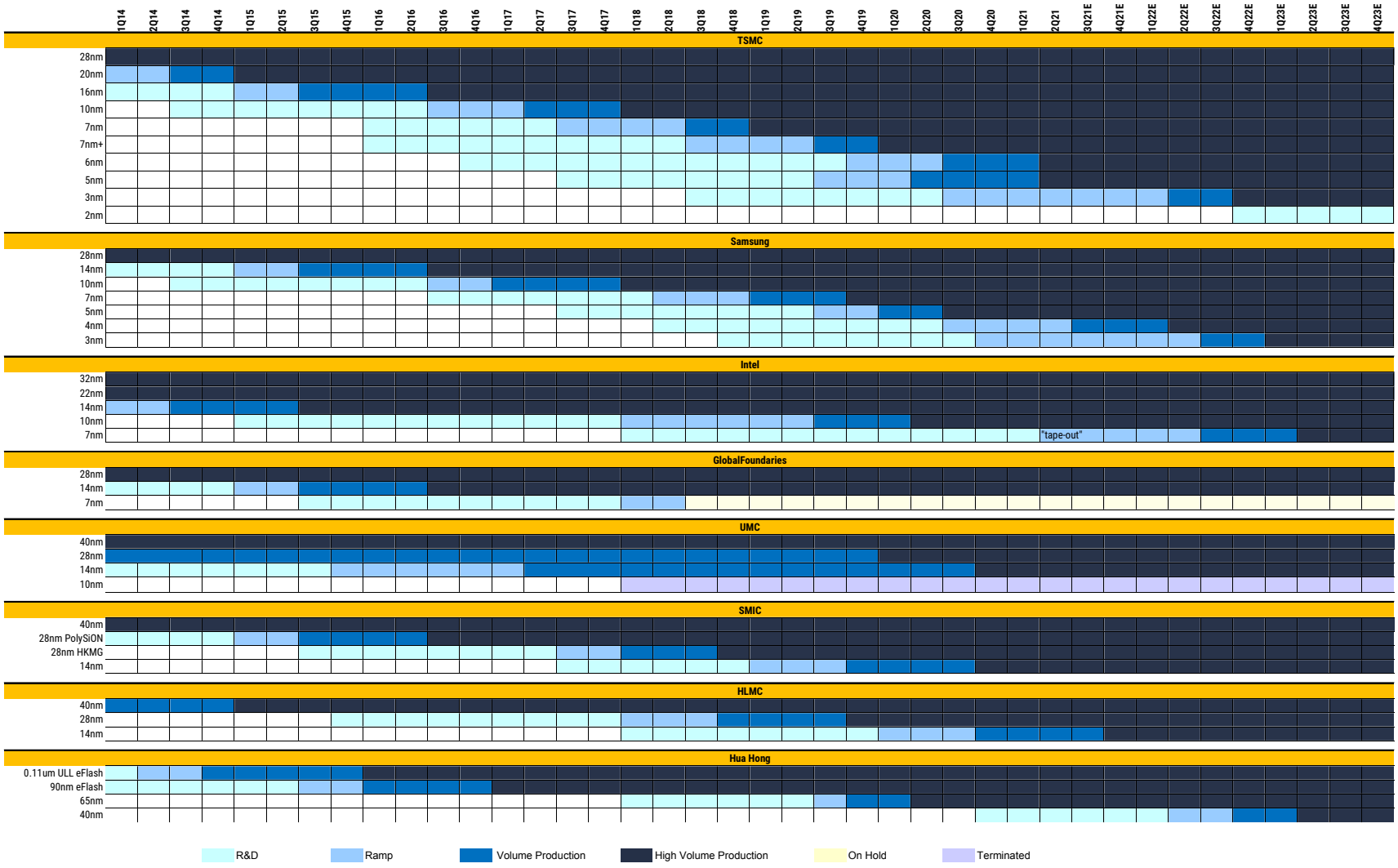



Source: Woodmac, CRU, Goldman Sachs Global Investment Research

## Semiconductors: Capex on the rise to address chip shortage; confidence in Green Demand key

**Semiconductor chips are in the critical path to multiple pathways toward Clean Energy, Clean Water and other SDGs.** Solar panels and electric vehicles use semiconductors, automation critical to energy efficiency is driven by semiconductors and the improved computing power has contributed to energy efficiency across the board. As is well known, semiconductors are currently in short supply which is already causing delays in car production and other key end markets. We have seen a pickup in announcements of capex from key companies like TSMC and Intel, though there is healthy debate regarding long-term demand growth and whether the pickup in capex announcements will be cyclically sufficient. The lead time to build a greenfield semiconductor plant is 2-3 years, while the lead time toward next generation technology from R&D to high volume production can be 4 years.

**Exhibit 37: Lead time from R&D to high volume production for semiconductor expansions can be 2-4 years**
Life cycle stages of innovation in semiconductor chip design (falling nanometers over time) from R&D to production




Source: Data compiled by Goldman Sachs Global Investment Research

## Electricity transmission: Critical for successful renewables expansion; potential for bottlenecks in the US

**There remains a lack of full clarity on what the level and form of Green transportation will look like longer term** — how much will be needed to transport hydrogen, electricity and carbon dioxide (for utilization and storage). While there is potential for some pipelines currently transporting oil and natural gas to be repurposed should demand and contractual obligations allow, the geographical differences from where solar and wind generation utilization will be the greatest vs. where demand centers are located for electricity should likely drive a significant need for additional electricity transmission. What is clear is that electricity transmission expansions do not happen overnight. Rather, 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 this report.

**China is making transmission one focus of its Five-year plan.** In China, as our colleagues wrote recently in China de-carbonization: A new eco-system of green tech, we 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. 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.

**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. Our estimates imply c.50% upgrades in the capex run-rate observed in the published National Energy Plans and assume a better interconnected Europe.

**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.

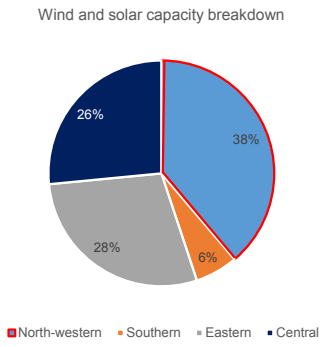
**Exhibit 38: Power sector lead times vary by technology**
Estimated power project development times and pre-Final Investment Decision costs

| Technology | Pre-FID Study Time (years) | Pre-FID Cost (% of TIC) | Financing Cost (% of TIC) | Total Pre-FID Cost (% of TIC) | Financial Close (years) | Construction Time (years) FID to COD | Overall Development Time (years) concept to COD |
|---|---|---|---|---|---|---|---|
| **Power Generation** | | | | | | | |
| Biomass with carbon capture | 2.5 | 9.0% | 1.5% | 10.5% | 0.5 | 4 | 7 |
| CCGT | 1 | 4.5% | 1.0% | 5.5% | 0.5 | 2 | 3.5 |
| CCGT with carbon capture | 2.5 | 9.0% | 1.5% | 10.5% | 0.5 | 4 | 7 |
| CT | 1 | 4.5% | 1.0% | 5.5% | 0.5 | 1 | 2.5 |
| Geothermal | 2 | 9.0% | 1.0% | 10.0% | 0.5 | 2 | 4.5 |
| Nuclear | 5 | 24.1% | 3.0% | 27.1% | 1 | 5 | 11 |
| Offshore wind | 2.5 | 10.0% | 1.5% | 11.5% | 0.5 | 3 | 6 |
| Onshore wind | 1.5 | 5.5% | 1.0% | 6.5% | 0.5 | 2 | 4 |
| Solar pv | 1 | 5.5% | 1.0% | 6.5% | 0.5 | 1 | 2.5 |
| Storage li-ion | 1 | 4.5% | 1.0% | 5.5% | 0.5 | 1 | 2.5 |
| **Transmission** | | | | | | | |
| Transmissions Assets | 2.5 | 5.7% | 1.0% | 6.7% | 0.5 | 4 | 7 |
| **Distribution Networks** | | | | | | | |
| Distribution Assets | 1 | 2.5% | 0.5% | 3.0% | 0.5 | 1 | 2.5 |

FID - Final Investment Decision
COD - Commercial Operation Date

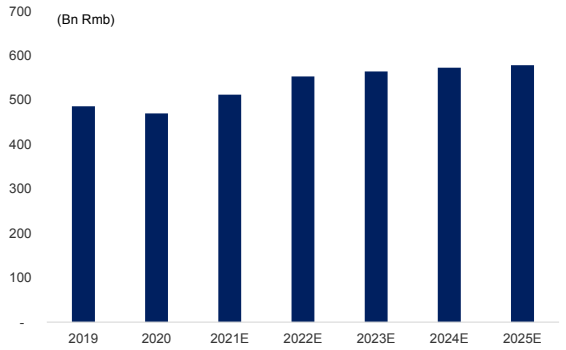
Source: Princeton University

**Exhibit 39: China's wind and solar capacity is somewhat concentrated in Northwestern China which will likely warrant substantive transmission investment**
Geographic breakdown of wind and solar capacity as of 2020




Source: Wind

**Exhibit 40: We expect China to invest Rmb2,781bn in its grid system over the 14th Five-year plan period**
Historical and forecast of China grid system investment




Source: Wind, NEA, Gao Hua Securities Research

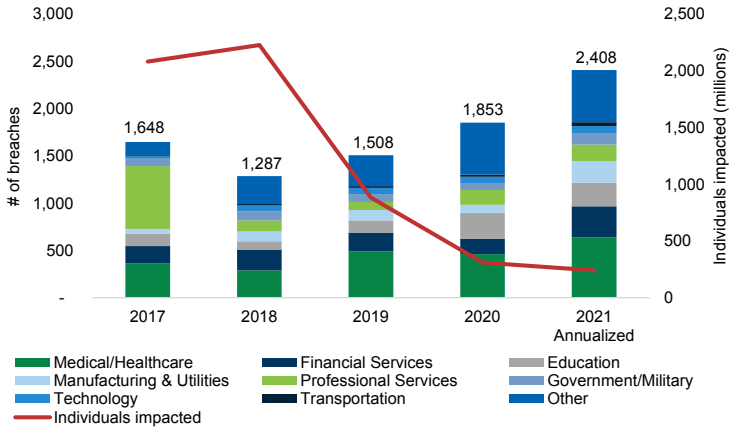
## Cybersecurity: Critical path for sustainable automation

**We believe a greater reliance on automation could increase the risk around cyberattacks.** As we wrote in our Utilities roadmap report, cyberattacks can hit both IT and OT systems, causing financial loss, theft of consumer data, equipment malfunction and damage, power disruptions and even blackouts. Vulnerabilities exist across the value chain, including in generation, transmission, backup systems, communication between systems, remote access and mobile devices, third-party services and vendors, black-start capabilities and final distribution.

With increased aging infrastructure and electrification, cybersecurity will be needed to protect investments in infrastructure and water and will be required to prevent attacks and hacks in electric vehicles and other green technologies. Security protections for Internet of Things (IoT) devices are not necessarily advanced and create further points of vulnerability. This has become more relevant with the recent cyberattack on the Colonial Pipeline which caused disruptions to gasoline distribution in portions of the East Coast, following a number of smaller hacks on municipal water and infrastructure systems, including an attempt to poison the water supply of Oldsmar, FL, two ransomware intrusions at wastewater plants in Maine, and a hack that deleted programs in a Northern California water plant used to treat drinking water, all in 2021.

In the United States, the White House recently announced a ransomware task force and is exploring partnerships with cyber insurance providers and infrastructure companies in order to prevent further attacks on existing infrastructure and enhance security efforts for new infrastructure, water, and electrification and automation efforts. In order to address the latest risks, public/private information sharing about threats will be crucial, as well as joint efforts to develop technologies, resources and strategies to detect and mitigate threats.

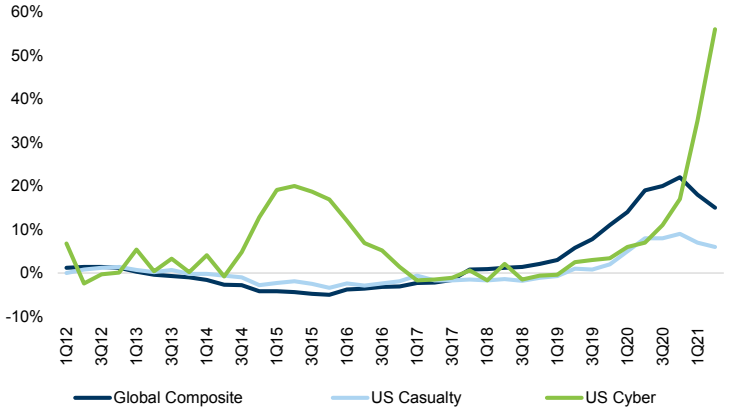
**Exhibit 41: Data breaches have been steadily growing in number since 2018 while the number of individuals impacted is trending down**
Total breaches by industry and individuals impacted




*Annualized as of 8/24/21

Source: Identity Theft Resource Center, Goldman Sachs Global Investment Research

**Exhibit 42: Marsh's cyber insurance pricing, largely historically in-line to above casualty pricing, has spiked in 1H21 as data breaches have accelerated**




Source: Marsh, Goldman Sachs Global Investment Research

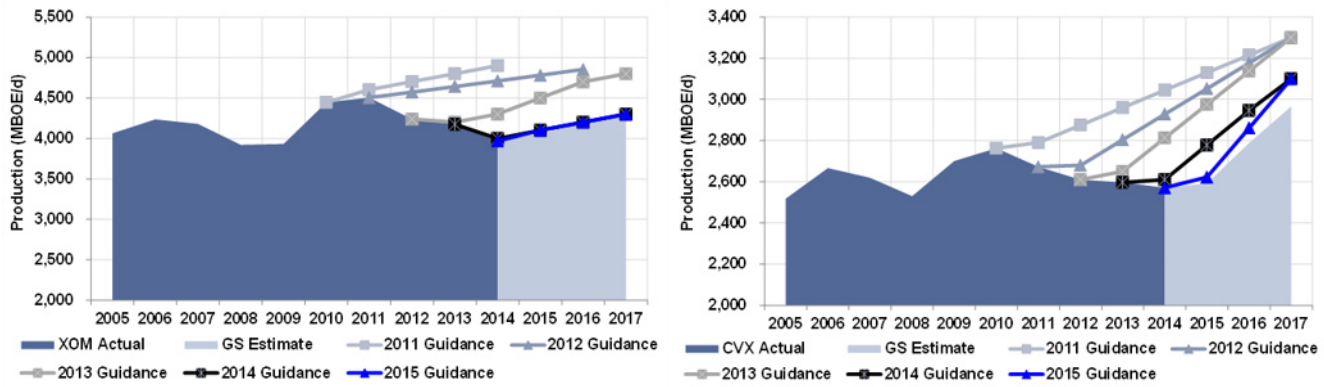
## Long lead time large project investments also bring normal course execution risks

**Wind and solar may require long lead times as well.** In addition to the Greenablers sectors highlighted above, we note that projects to expand renewables capacity and build out electric vehicle capacity also take time. Our Utilities and Clean Energy teams believe permitting and constructing a utility scale solar development in the US takes around 2-4 years, an onshore wind farm takes 3-4 years and an offshore wind farm takes 5-10 years. Within solar, utility scale has the lowest levelized cost of energy.

**Large projects face normal-course execution risks.** While the projects and capital spending associated with shifting the source of energy consumed from fossil fuels to renewables is not apples-to-apples with the expansion of energy supply capacity in past decades, it is important to note that long lead energy projects should not always be assumed to start up on time. We highlight two examples. First, when long lead time capital projects dominated the capex budgets of the US oil majors Exxon, Chevron and Conoco in the past decade, companies (particularly Exxon and Chevron) continuously revised down five-year expected production profiles. This not only reflected timing/level of execution of expansion but also base levels of declines. Second, two recent attempts to build new nuclear capacity in the US have either been canceled (VC Summer) or delayed (Vogtle). While these are risks, ultimately the Street is likely to first be focused on sufficient commitment of Green Capex.

**Exhibit 43: As capex intensity increases, we see some rising risk of execution, even by large companies; we highlight in the first half of the decade Exxon and Chevron's multi-year production guidance was consistenly greater than actual reported production**

Exxon and Chevron long-term projected multi-year production trajectory at annual analyst meetings vs. actual production through 2014 (forecasted post-2014 as published March 2015)




Source: Company data, Goldman Sachs Global Investment Research

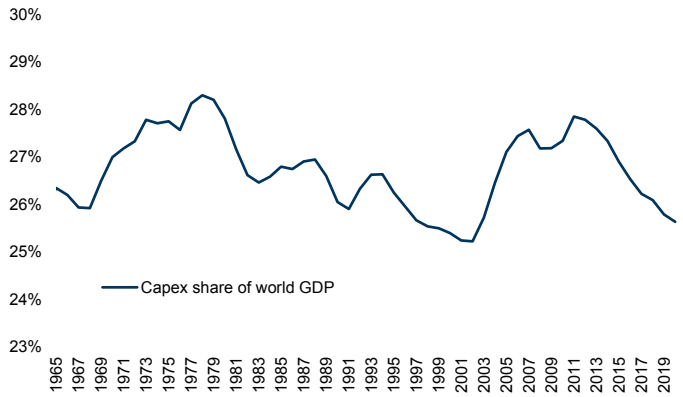
**Certain focus areas for Green Capex are already facing some component supply shortage.** In 2021 YTD, Chinese EV demand has substantially outperformed expectations — new energy vehicle penetration of total passenger car sales has increased from 8% in Jan 2021 to 20% in August. But upstream capacity has not been sized up proportionately, causing component shortage and price rallies of key inputs: cathode +24%, anode +30%, and LiPF6 +187%. Our China Autos team believes this suggests significant cost pressure on the supply chain.

# Green Capex capacity: Ample opportunity for publicly traded companies to grow Green Capex

**We believe there is ample capacity for additional Green Capex across most sectors, supported by free cash flow and balance sheets.** The exception is Utilities, where equity financing will likely be needed due to leverage. Reinvestment of cash flow has been falling in recent years, and **our bottom-up projection globally for 2022 calls for about 50% of operating cash flow before R&D to be invested in capex and R&D vs. a 60%-70% historical range**. We believe the need for and path to Green Capex will become a greater focus among investors in coming months and years, particularly from those with ESG mandates. At the same time, the Street's focus — particularly in the US — has been more toward FCF and its use vs. capex based on our GS Dataworks study of conference call transcripts. And companies in the semiconductor space — key Greenablers — that have announced capex increases have not seen shares initially rewarded vs. peers.

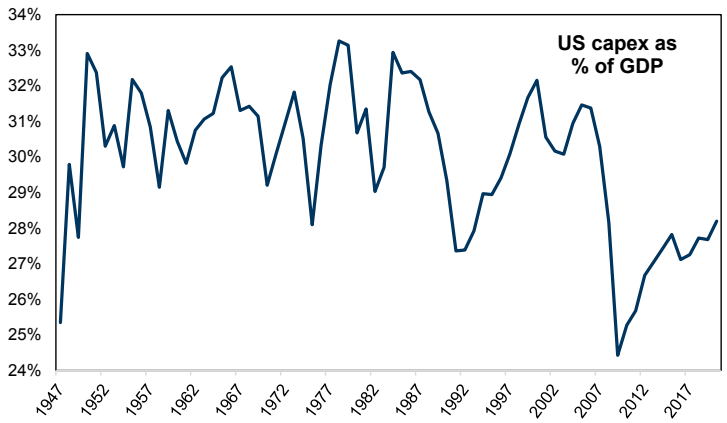
**Capex levels globally and in the US are relatively low — overall US capex levels have recovered only to the bottom of pre-2008 range as percentage of GDP.** We note that capital investment can come from governments, private companies and public companies — not just the publicly traded companies covered in our analysis by GS Research. When looking more broadly at capex trends in the US, levels relative to GDP have been rising in recent years but are still only to the bottom of the range seen in prior to 2008. When looking at global capex levels, the trend is down for much of the last decade as percentage of global GDP.

**Exhibit 44: Global capex as percentage of GDP was on the decline even before the pandemic**
Global capital expenditures as percentage of GDP




Source: Maddison Project Database, World Bank

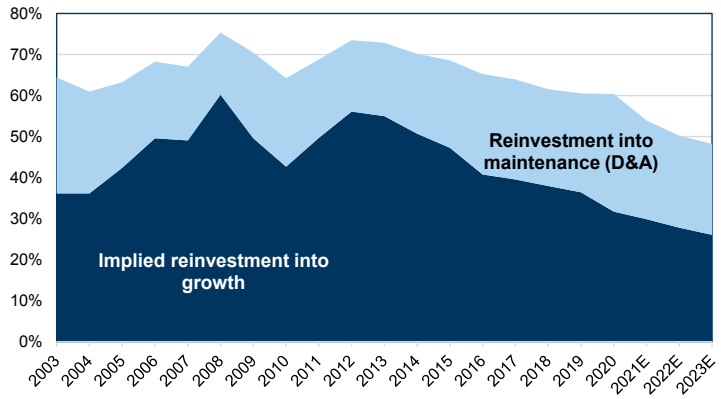
**Exhibit 45: Overall US capex levels have recovered only to the bottom of pre-2008 range as percentage of GDP**
US capex as a % of GDP, 1947 - 2020




Source: Federal Reserve Economic Data

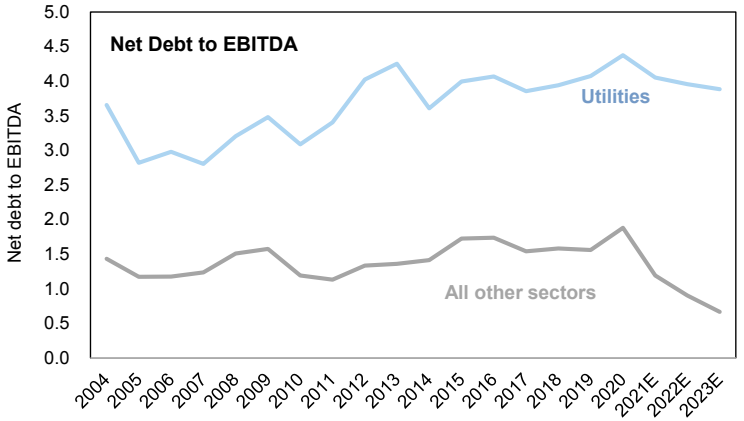
**From a bottom-up perspective, cash flow growth has well exceeded capex growth for much of the past 10 years.** This has led to a significant increase in FCF and strengthened balance sheets. Even before the pandemic in 2020, companies globally have been lowering levels of investment relative to cash flow. To calculate reinvestment rate, we look at the sum of capital expenditures and R&D expense as a percentage of the sum of operating cash flow and R&D expense as a measure of investments companies make toward maintenance and future growth. **For companies with active or historical coverage by GS Research, we expect a reinvestment rate in 2022 of 50% of adjusted operating cash flow vs. 64% in 2015-19 and 69% on average in 2005-2014.** When stripping out depreciation as an indicator for maintenance capital, 2022 implied investment for growth is projected to be 28% of operating cash flow pre-R&D and post-DD&A vs. 40% in 2015-19 and 51% on average in 2005-14.

**Exhibit 46: Reinvestment rate of companies under GS coverage has slowly declined in recent years to about 50% in 2022E**
Weighted avg 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: Goldman Sachs Global Investment Research, FactSet

**Exhibit 47: Net debt/EBITDA in 2022E is expected to fall to 0.9x for companies in GS coverage, excluding Utilities, Real Estate and Financials**
Net debt to EBITDA by sector, 2005-2022E

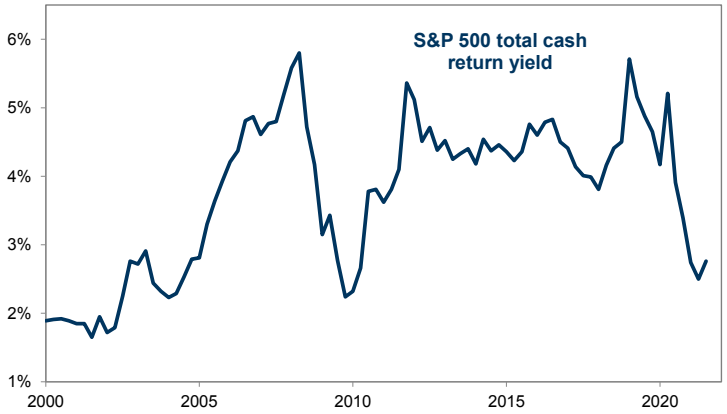



Note: "All other sectors" excludes Financials and Real Estate and companies with negative EBITDA

Source: FactSet, Goldman Sachs Global Investment Research

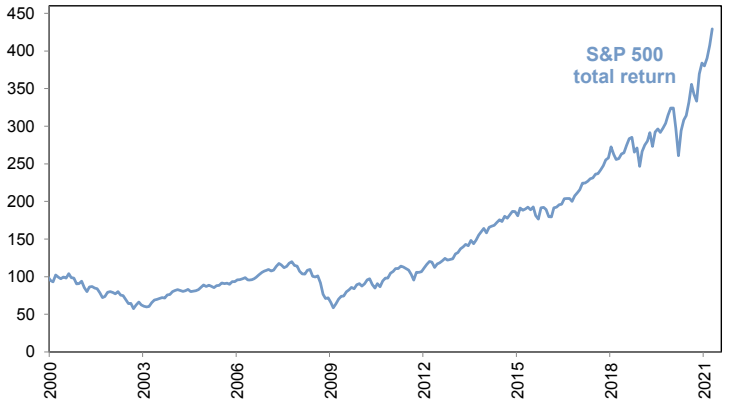
**Lower reinvestment rates have in part resulted in greater free cash flow, stronger balance sheets, and increased return of capital to shareholders.** Net debt/EBITDA in 2022E is expected to fall to 1.2x for companies in GS SUSTAIN coverage (excluding Financials) vs. average of 1.8x over 2012-2019. When also excluding Utilities and Real Estate, leverage in 2022E is expected to be 0.9x vs. 1.5x average in 2012-19. The increased FCF from falling reinvestment rates has also supported greater return of cash to shareholders, though cash return yield dropped mid-2020 as the pandemic's impacts spread. Cash return yield (dividend and net buyback yields as a percent of net income) grew to an average of around 5% in 2019 and the beginning of 2020.

**Exhibit 48: For much of the past 10 years, S&P 500 companies have returned between 4%-5% of net income to shareholders**
S&P 500 index-level total cash yield (dividend and net buyback yields as a percent of net income)




Source: Compustat, Goldman Sachs Global Investment Research

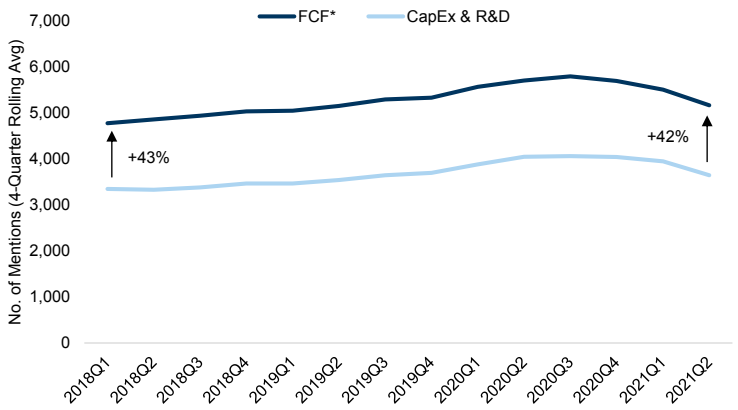
**Exhibit 49: This has been during a period of strong performance for the US market**
S&P 500 total return since 2000




Source: Compustat, Goldman Sachs Global Investment Research

**This has been well-received by investors.** Investor discussions indicate that favorable free cash flow — and the return of capital to shareholders via dividends and share buybacks — have been well received. There has been pressure from investors on companies in sectors with below-average corporate returns and high reinvestment rates — like Integrated Oils and Exploration & Production companies within Energy — to reduce spending levels, in part due to pre-pandemic oil oversupply and weak balance sheets. But there has been less pressure from investors in sectors with favorable corporate returns to increase capex, at least until there is a noteworthy impact from undersupply. A recent example is the chip shortage in semiconductors, where we have seen multiple companies announce capex increases, sparking an investor debate over whether there is a secular shortage or the recent increases will balance/oversupply the market in 2022+. Overall, our GS Data Works analysis shows that consistently in recent year earnings conference calls there has been a >40% greater focus on free cash flow and return of capital to shareholders relative to capital expenditures and R&D.

**Exhibit 50: Street focus is more on FCF/return to shareholders vs. capex**
Mentions on earnings conference calls of ACWI component companies, 4 qtr rolling average




* Free cash flow, dividend or share repurchase

Source: Refinitiv, Goldman Sachs Global Investment Research

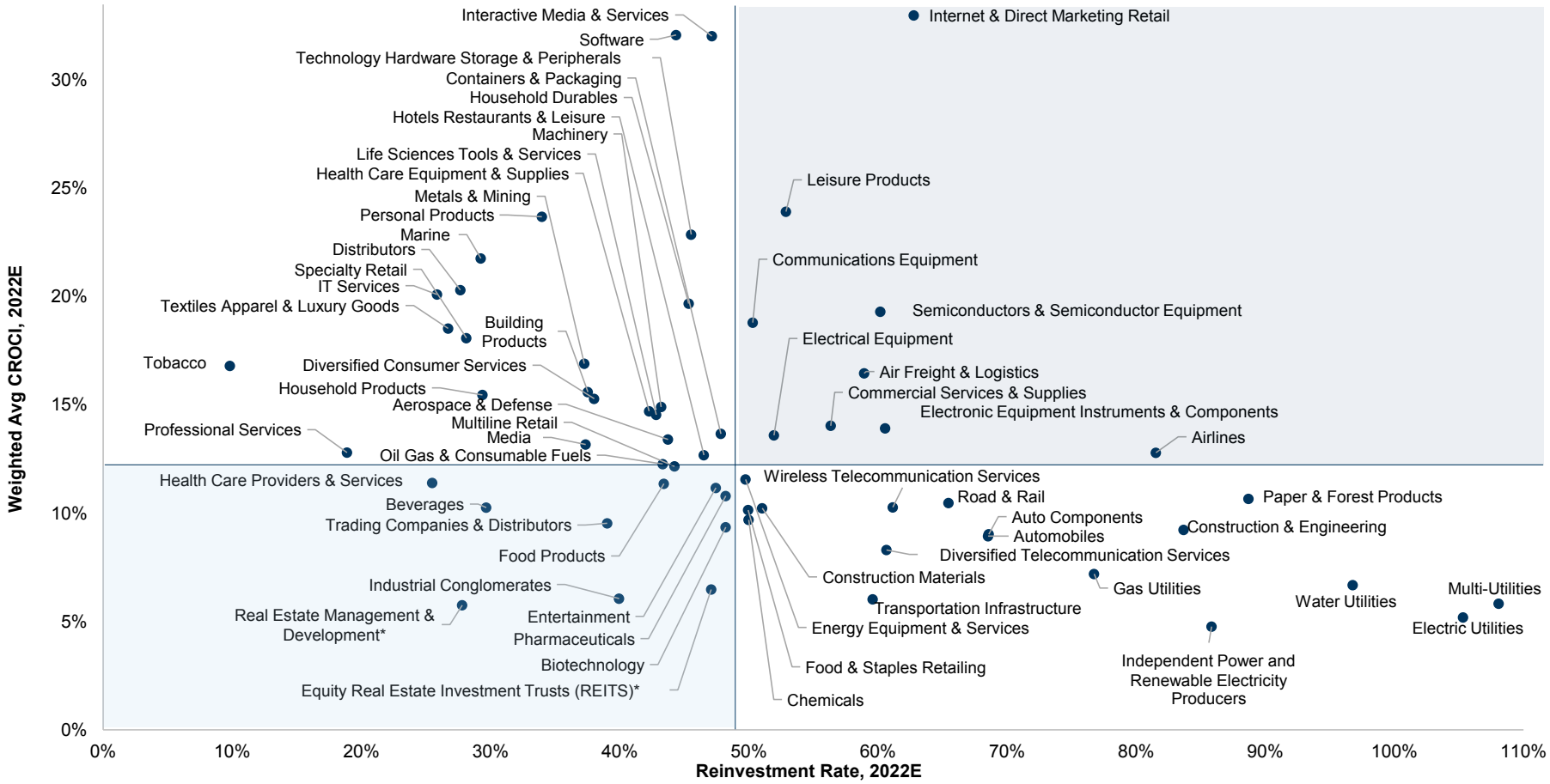
# A sector-by-sector look at reinvestment rate, corporate returns and spare Green Capex capacity

**Current consensus expectations for publicly traded capex does not call for a major increase at present.** Consensus expectations for investment in capex and R&D for the >6,800 global companies covered by GS SUSTAIN is about $4 trillion in 2022E. This represents Green and non-Green capex + R&D from all sectors, not just ones that are predominantly focused or essential to achieve Net Zero, Clean Water and Infrastructure goals. As mentioned earlier, we will likely need to see a significant need in Green Capex from publicly traded companies and governments to achieve the incremental $2.8 trillion of annual Green Capex needed. But consensus expectations for yoy growth in publicly traded investment in capex and R&D calls for only 2% CAGR in 2022E/23E vs. 2021E (GS analysts are above consensus).

**A look into reinvestment rate and corporate returns by sector.** Exhibit 51 considers expected Reinvestment rate of cash flow into capex + R&D vs. cash return on cash invested. Weighted average expected CROCI is about 12% in 2022E, while as mentioned average reinvestment is about 50%. As we detail below, some sectors that will likely be critical to achieving Net Zero, Clean Water and Infrastructure goals have average or below-average corporate returns.

**Exhibit 51: Among sectors with above-average corporate returns, very few are 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: Goldman Sachs Global Investment Research, FactSet

## Quantifying Green Capex spare capacity: $1+ trillion annually of potential among publicly traded companies

We believe that **there is ample capacity for companies to allocate more capital to Green Capex and an opportunity for investor/management engagement.** We expect sectors with above-average corporate cash return on cash invested on a weighted average basis to reinvest only 49% in 2022E based on our analysts' aggregated views/models. **A 10% increase in reinvestment rate from all sectors (excluding Financials) would add $0.8 trillion to annual global capex, while a 10% increase in reinvestment from sectors with above-average corporate returns would add $0.4 trillion to annual global capex.** We note that Utilities — which will be critical to capex growth for Net Zero and Clean Water in particular — have lower corporate returns (offset by less risk due to regulation), high reinvestment rate and greater leverage. As such, equity or asset sales will likely be needed to fund a surge in Green Capex. If companies in sectors outside Utilities, Real Estate and Financials were to spend incremental Green Capex that, before considering incremental cash flow, would result in an aggregate leverage increase of 0.5x over the remainder of the decade, Green Capex could rise annually by $0.3-$0.4 trillion.

**But not all sectors are Green Capex-critical; measuring spare capacity for most relevant sectors.** We believe investors will look more closely at the spare capacity for Green Capex from sectors most relevant to achieving Net Zero, Infrastructure and Clean Water goals. This will be based on the incremental capex before a threshold reinvestment rate or leverage is reached. Some sectors like Utilities already have high reinvestment rates and high leverage; because Utilities are largely regulated, we do not consider spare capacity as regulators vs. managements approve the passthrough of capital expansions. For other relevant sectors, **we see $1.0 trillion of annual Green Capex capacity** when we consider the sum of:

- Incremental capex/R&D capacity to achieve a 70% 2022E reinvestment rate of cash flow; and
- Incremental capex/R&D capacity per year over remainder of decade based on difference between 2022E net debt/EBITDA and 1.5x.

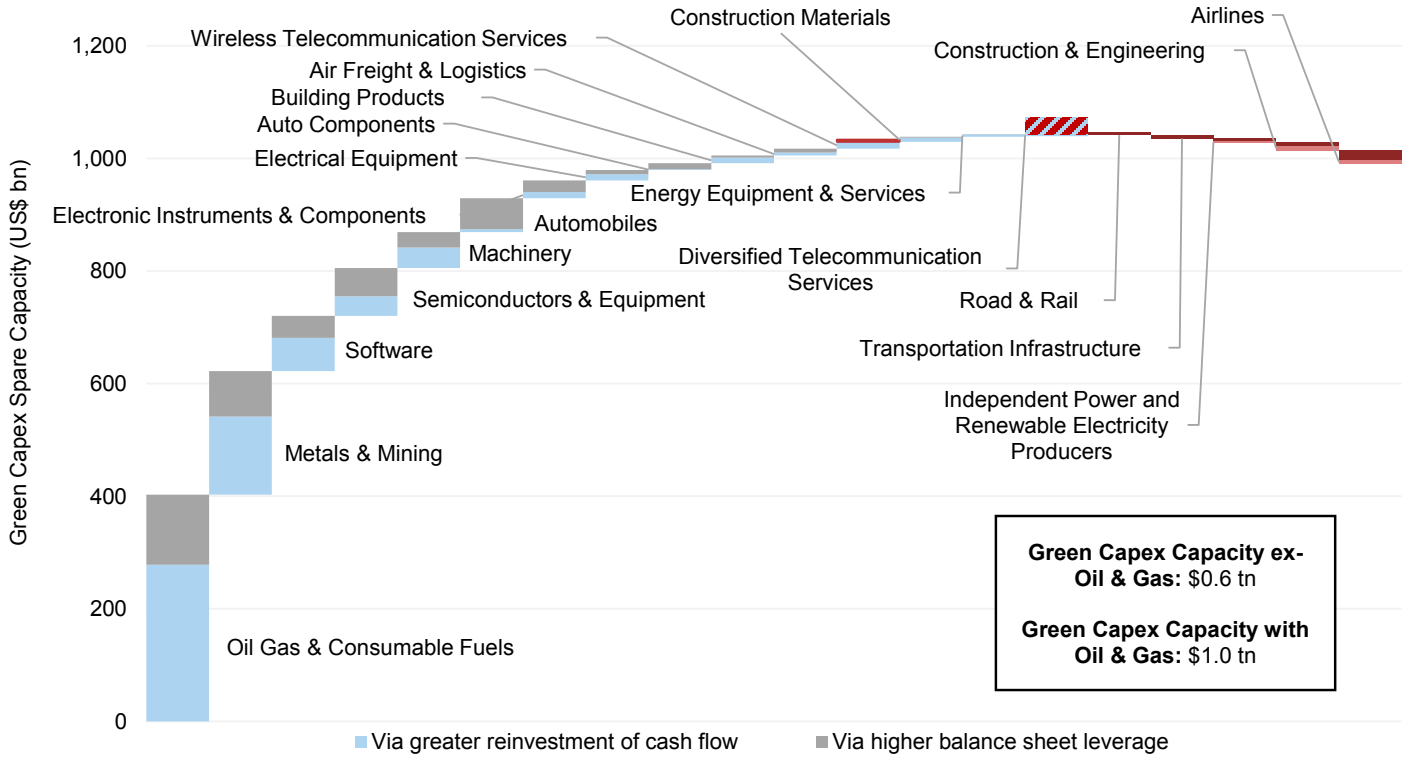
The most meaningful sectors with Green Capex capacity include oil/gas (relevant due to potential for contribution toward carbon capture utilization and storage as well as renewables for those pursuing), metals/mining (relevant for copper, aluminum, lithium and steel) and semiconductors (automation, electric vehicles, solar). The willingness, core competencies, and ability to execute on Green expansions — particularly among oil/gas and metals/mining companies — will be key given the high percentage of overall spare capacity these sectors represent. **Additionally, how managements view the returns from incremental investment opportunities will be key to whether the spare capacity is invested directly vs. returned to shareholders for potential deployment into attractive Green Capex opportunities elsewhere.**

While our 70% reinvestment rate benchmark implies 30% of cash flow is left over for debt paydown or returning cash to shareholders, we note that some companies pay greater than 30% of their cash flow in dividends (particularly in aggregate among metals and mining companies). If we limited our Green Capex spare capacity for these companies, the overall spare

capacity for Green Capex-critical sectors would fall to $0.8 trillion from $1.0 trillion. We note, however, that the 30% buffer for debt paydown and returning cash to shareholders for remaining companies is more than sufficient to offset this difference.

**Exhibit 52: We see ~$1.0 trillion of annual spare capacity for Green Capex from Green Capex-critical sectors based on 70% reinvestment rate and 1.5x leverage**

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 53: Screen of GS SUSTAIN covered companies that represent the bulk of spare Green Capex capacity are largely oil/gas and metals/mining companies; willingness and core competencies to execute Green expansions are key**

Green Capex spare capacity by company in key relevant sectors needed for Net Zero, Infrastructure and Clean Water

| | Sub-sector | Company Name | Implied Green capex spare capacity: Greater reinvestment | Higher leverage | Total ($ bn) |
|---|---|---|---|---|---|
| 1 | Oil Gas & Consumable Fuels | Saudi Aramco | $80 | $48 | $128 |
| 2 | Software | Microsoft Corp. | $33 | $27 | $60 |
| 3 | Oil Gas & Consumable Fuels | Royal Dutch Shell Plc | $13 | $9 | $22 |
| 4 | Oil Gas & Consumable Fuels | Chevron Corp. | $14 | $8 | $22 |
| 5 | Oil Gas & Consumable Fuels | Exxon Mobil Corp. | $15 | $7 | $21 |
| 6 | Wireless Telecom | China Mobile (HK) | $5 | $14 | $19 |
| 7 | Metals & Mining | Vale | $10 | $6 | $16 |
| 8 | Automobiles | Toyota Motor | $4 | $12 | $15 |
| 9 | Oil Gas & Consumable Fuels | Petrobras | $13 | $2 | $15 |
| 10 | Metals & Mining | BHP Group Ltd. | $10 | $6 | $15 |
| 11 | Automobiles | Volkswagen | $0 | $14 | $14 |
| 12 | Oil Gas & Consumable Fuels | TotalEnergies SE | $10 | $4 | $13 |
| 13 | Oil Gas & Consumable Fuels | Equinor | $6 | $7 | $13 |
| 14 | Metals & Mining | Rio Tinto Ltd. | $8 | $5 | $13 |
| 15 | Oil Gas & Consumable Fuels | Gazprom | $8 | $4 | $12 |
| 16 | Metals & Mining | Glencore Plc | $8 | $4 | $12 |
| 17 | Oil Gas & Consumable Fuels | ConocoPhillips | $7 | $5 | $11.6 |
| 18 | Automobiles | Daimler AG | $3 | $7 | $10.3 |
| 19 | Semiconductors & Equipment | Broadcom Inc. | $9 | $1 | $10.2 |
| 20 | Oil Gas & Consumable Fuels | CNOOC | $5 | $5 | $10.0 |
| 21 | Oil Gas & Consumable Fuels | BP Plc | $7 | $3 | $9.7 |
| 22 | Electronic Equip. & Components | Hon Hai | $5 | $4 | $9.5 |
| 23 | Oil Gas & Consumable Fuels | Surgutneftegaz | $2 | $8 | $9.4 |
| 24 | Oil Gas & Consumable Fuels | China Shenhua Energy | $5 | $4 | $9.3 |
| 25 | Metals & Mining | ArcelorMittal | $6 | $3 | $9.3 |

| | Sub-sector | Company Name | Implied Green capex spare capacity: Greater reinvestment | Higher leverage | Total ($ bn) |
|---|---|---|---|---|---|
| 26 | Metals & Mining | Freeport-McMoRan Inc. | $6 | $3 | $8.7 |
| 27 | Oil Gas & Consumable Fuels | Reliance Industries | $6 | $2 | $8.4 |
| 28 | Oil Gas & Consumable Fuels | Lukoil | $5 | $4 | $8.3 |
| 29 | Semiconductors & Equipment | Nvidia Corp. | $6 | $2 | $7.8 |
| 30 | Oil Gas & Consumable Fuels | Canadian Natural Resources | $6 | $2 | $7.7 |
| 31 | Air Freight & Logistics | United Parcel Service Inc. | $5 | $2 | $7.2 |
| 32 | Software | Adobe Systems Inc. | $5 | $2 | $6.9 |
| 33 | Automobiles | Stellantis NV | ($0) | $7 | $6.6 |
| 34 | Metals & Mining | Zijin Mining | $5 | $1 | $6.2 |
| 35 | Semiconductors & Equipment | Texas Instruments Inc. | $4 | $2 | $6.1 |
| 36 | Semiconductors & Equipment | Qualcomm Inc. | $4 | $2 | $6.1 |
| 37 | Semiconductors & Equipment | Applied Materials Inc. | $4 | $2 | $6.0 |
| 38 | Machinery | Caterpillar Inc. | $4 | $2 | $5.9 |
| 39 | Machinery | Weichai Power | $3 | $2 | $5.8 |
| 40 | Automobiles | BMW | $1 | $5 | $5.8 |
| 41 | Semiconductors & Equipment | ASML Holding | $4 | $2 | $5.8 |
| 42 | Oil Gas & Consumable Fuels | Occidental Petroleum Corp. | $5 | $0 | $5.7 |
| 43 | Oil Gas & Consumable Fuels | Rosneft | $5 | ($0) | $5.4 |
| 44 | Oil Gas & Consumable Fuels | Pioneer Natural Resources C | $4 | $1 | $5.2 |
| 45 | Oil Gas & Consumable Fuels | EOG Resources Inc. | $3 | $2 | $5.1 |
| 46 | Wireless Telecom | America Movil SAB de CV | $3 | $2 | $5.0 |
| 47 | Oil Gas & Consumable Fuels | Suncor Energy Inc. | $3 | $2 | $4.9 |
| 48 | Machinery | Deere & Co. | $3 | $2 | $4.9 |
| 49 | Metals & Mining | Norilsk Nickel | $4 | $1 | $4.9 |
| 50 | Wireless Telecom | KDDI | $3 | $2 | $4.7 |

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.

Source: Goldman Sachs Global Investment Research

**Some companies in sectors such as Semiconductors and Autos have recently announced further Green Capex commitments.** Earlier in June 2021, our global Semiconductors team highlighted that various manufacturers including TSMC and Samsung made announcements to significantly elevate capex to cope with the longer semiconductor cycle and the current shortage issues. More recently, TSMC is also looking to build a new ¥800 billion ($7 billion) plant with Sony Group according to Nikkei in October 8. Automakers also raised Green Capex commitments, including GM (EV/AV investment commitments raised to $35 billion through 2025 in Jun 2021 vs. previous target of $27 billion), Toyota (¥1 trillion or $8 billion battery-related investments through 2030 announced in Sep 2021) and Ford ($11.4 billion EV investments announced along with SK Innovation in Sep 2021 to start EV and lithium-ion battery production from 2025).

# How variability in corporate returns could impact need for price increases or cost-cutting to stimulate greater Green Capex

**Project returns and corporate returns key to management decision-making on allocating greater Green Capex.** We believe managements are likely to look to two key factors before allocating additional Green Capex:

1. **Project level returns.** This will be driven by both where a project stands on the cost curve and any benefits via lower discount rate from Green investments. While some areas like solar power have become cost competitive with fossil fuel generation, there remains for now a green premium in many other technologies that need to be deployed to meet Net Zero. Our colleagues' Carbonomics report addresses the cost curve and its evolution by technology. We believe confidence in public policy, supply chain/raw materials cost, ability to lower costs via scale and confidence in terminal value will be critical to managements' willingness to accelerate Green Capex.
2. **Corporate level returns.** The focus on FCF and return of cash to shareholders may result in some managements to be less initially willing to meaningfully accelerate capital spending until there is offsetting benefits to corporate returns and/or free cash flow. As we discuss below, this may be more relevant in sectors with average or below-average corporate returns. Overall, we believe managements may be unlikely to want to sacrifice corporate returns or FCF until there is greater confidence that increased reinvestment in Green Capex will be rewarded. We believe investors will reward this — particularly via additional capital allocation from ESG funds — assuming corporate returns do not meaningfully suffer.

Inflationary potential can result from two key sources: (1) underlying supply chain cost increases; and (2) demand + ability to achieve greater margins/corporate returns to support expansions.

## Green Capex-critical sectors with above average corporate returns: Pressure to invest more capital may rise

Key sectors with above-average corporate returns (sector >1% above median) that will likely be positively impacted by Green Capex include **Semiconductors, Software, Air Freight and Logistics, Machinery, Metals & Mining, Building Products and Electronic Equipment/Instruments/Components**. Among these, Semiconductors have the greatest projected reinvestment rate of cash flow into capex, though at only about 60% on a weighted average basis. Building Products, Machinery, Software and Metals & Mining are each sub-50%. As there is greater recognition of Green Capex needs, we believe **there will likely be a rise in investor pressure for companies in these sectors to discuss why they are not investing more capital.** We note for the mining portion of metals and mining — which includes Greenablers like Copper/Aluminum — our forecasts are above the strip and consensus which reflects the need for upward prices given

imbalanced supply-demand. We believe confidence in longevity of higher prices by the Street and by managements is key for greater copper/aluminum expansion capex.

## Green Capex-critical sectors with near average corporate returns: Potential for modest inflationary pressure

Key sectors that have around average (within 1% of median) corporate cash return on cash invested that will likely be impacted by Green Capex include **Electrical Equipment, Airlines and Oil/Gas**. Among these sectors, only Airlines is investing more than 65% into capex and R&D. While we expect investors will push managements on what it takes to invest more capital, we see potential for **at least modest inflationary pressure in the underlying product prices in these sectors** or sufficient investor confidence in rising corporate returns to see a meaningful increase in Green Capex commitment beyond a mix shift. Like Metals & Mining, Oil/Gas corporate returns are aided by our bullish price views.

## Green Capex critical sectors with below-average corporate returns: Potential for more meaningful inflationary pressure

Key sectors that have below average corporate cash return on cash invested that will likely be impacted by Green Capex include **Utilities, Construction Materials, Automobiles/Auto Components, Transportation Infrastructure, Road & Rail, Industrial Conglomerates, Diversified/Wireless Telecommunications Services, Energy Equipment/Services and Engineering & Construction**. Among these, only Utilities and Engineering & Construction are reinvesting above 80% of cash flow into capex and R&D. Utilities are unique due to their largely regulated status which in part offsets the lower corporate returns and accommodates greater investor comfort with higher leverage. At the same time, however, given the extensive Green Capex demands likely for the sector, fully financing Green Capex through operating cash flow or debt issuance is unlikely. **We believe asset sales and equity will likely be sources of financing Utilities managements will consider.** For non-Utilities sectors with below-average corporate returns, we believe there will be less investor pressure for capex increases. At the same time, **for non-Utilities sectors there may be stronger case for inflationary pressure if expansions are needed**. Expectations for upward pricing pressure may rise for Green products these sectors manufacture or enable to justify an expansion in Green Capex.

## How to frame potential inflationary pressure from margin expansion

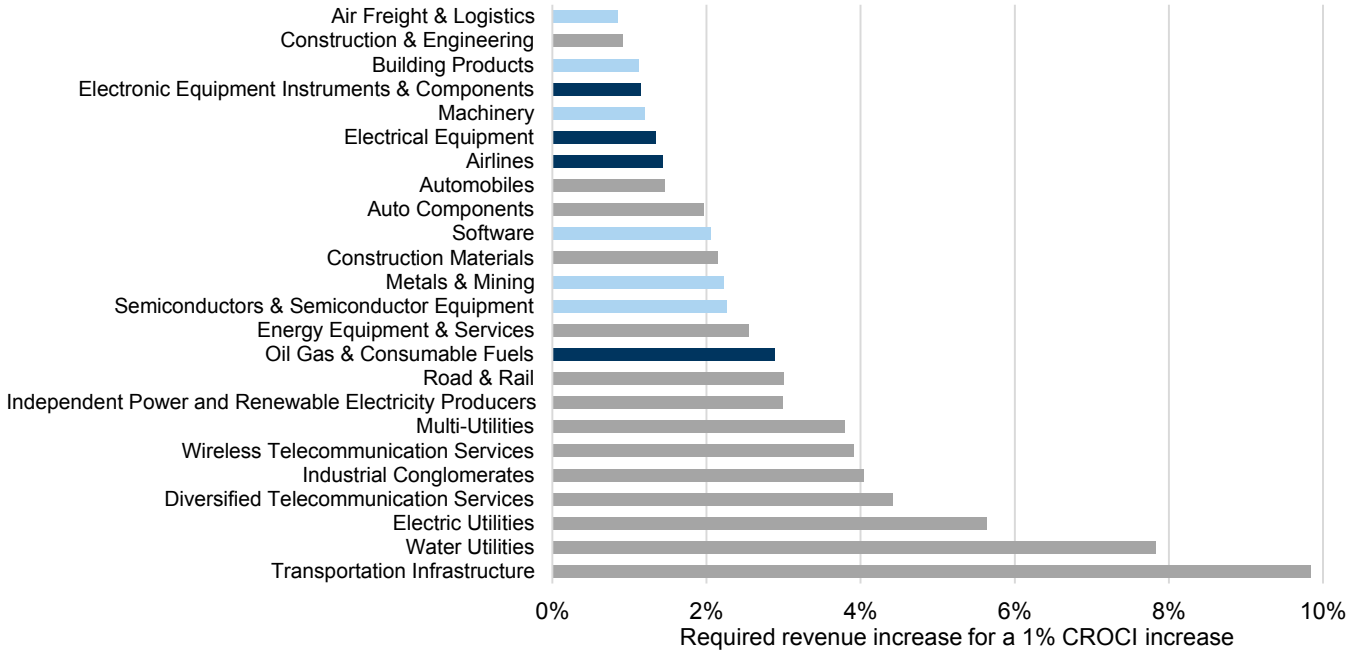
**What is needed for key sectors to achieve a 1% higher corporate return? 1%-4% higher pricing if achieved via top-line.** As discussed above, there are multiple sectors critical to achieving Green Capex goals where we see average or below-average corporate returns. Ultimately, managements are likely to base their decisions on how much capital is available and whether the project-level rates of return meet thresholds. However, given focus on near-term FCF and corporate returns,

if managements do not meaningfully invest incremental capital until corporate returns move higher, this would imply that either pricing moves higher or costs move lower. We consider a scenario of what is needed for Green Capex-critical sectors to see a 1% increase in cash return on cash invested. After-tax cash flow would need to increase via either higher revenues or lower costs. If this amount were to come from the top-line with no change to cost structure (i.e., via margin expansion), a 1%-4% increase in revenues would be needed for the bulk of Green Capex-key sectors (excluding Utilities where the mechanism to drive greater corporate returns is largely determined by regulators).

The risks to assuming pricing power/inflationary pressure are: (a) managements are comfortable with their corporate returns and do not hold back on Green Capex because of corporate returns concerns; and/or (b) over time, cost deflation via innovation makes Green Capex projects more returns-accretive than non-Green spending which accommodates greater corporate returns without the need for upward pricing pressure.

**Exhibit 54: Sectors where Green Capex will likely be needed that have below global median forecasted cash return on cash invested tend to require greater revenue increases in order to lift corporate returns**

Implied revenue increase (assuming no change in costs) required for a 1% increase in CROCI, '22E / '23E average, select sectors




Sectors highlighted in gray have below-median '22E CROCI and those highlighted in light blue have '22E CROCI within 1 percentage point of median

Source: Goldman Sachs Global Investment Research

# Why and when investors will CARE about Green Capex increases

**We expect significant debates about allocation of the $1+ trillion per year of Green Capex spare capacity,** especially given that much of the spare capacity exists among commodities companies. Investors will likely try to determine if managements should be the ones making the incremental Green Capex or are better off returning cash to shareholders who can then potentially allocate that cash to other companies pursuing Green Capex. We believe investors will look at four factors when determining the extent to which they should "CARE" about a company's Green portfolio:

- **C**ore competency. Does the company have a core competency in the technology being pursued or is there confidence in the company's ability to develop that competency?
- **A**vailable capital. Does the company have spare capacity via free cash flow/balance sheet?
- **R**eturns. Where does the technology/product being pursued lie on the cost curve and what is the impact of investment on short, medium and longer term corporate returns?
- **E**xecution. What is the company's track record of execution and what are risks/confidence level?

**For Greenabler sectors** investing in more traditional business lines (i.e., copper, aluminum, semiconductor sectors as examples), the key debate will likely be over secular vs. cyclical demand and whether companies' incremental capex commitments move the market closer to oversupply. Greater confidence in secular Green Revenue demand can allow these investments to be appreciated.

**For pure-play and newer companies** where there is little history or expectation of free cash flow, the key debate will be the ability for these investments to drive innovation, adoption, lower costs and product differentiation. Over time (but not necessarily immediately), there will be expectations for competitive corporate returns, which we address further in the subsequent case study on Semiconductors vs. Shale.

**For larger/bellwether companies** where there are legacy expectations for free cash flow, the key debate will likely be whether the company has core competency to execute on the Green Capex initiative/technology and the nearer-term implications on corporate returns. When there is confidence in growth and returns accretion (or sufficient decrease in discount rate to offset any returns degradation), the incremental investments are likely to be appreciated.

**Together, this may lead to greater appreciation for investments in technologies higher on the carbon abatement/Infrastructure/Clean Water cost curves among the smaller/pure-play companies initially but should not deter managements of larger companies from pursuing if they are confident in core competency, execution, returns and ability to push down costs.**

# Reinvestment can drive innovation and adoption, but corporate returns matter too: Case studies in Semiconductors and Shale

**We believe investors will be comfortable with rising Green Capex via increased reinvestment rates even if it over time results in cost deflationary innovation, if there is sufficient adoption and product differentiation to avoid deterioration in corporate returns.** This is best seen looking at two case studies:

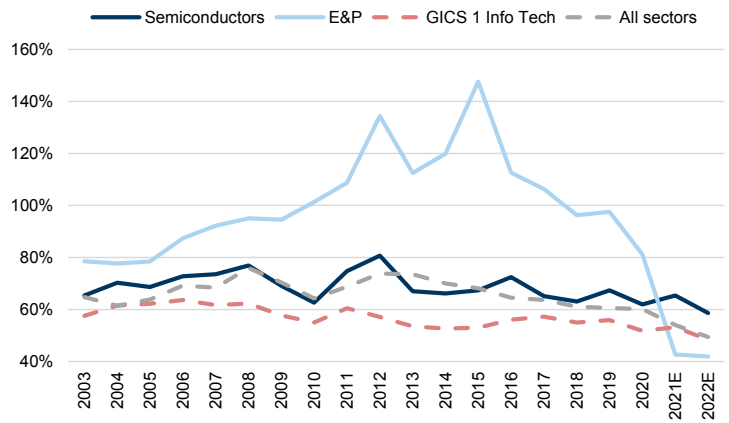
- Semiconductors' innovation in smaller more powerful chips.
- Oil and gas producers innovation in applying horizontal drilling with fracture stimulation in US shale reservoirs.

**Similarities in innovation, price deflation, customer adoption.** In both cases, above-market reinvestment of cash flow led to innovation that pushed down pricing. In both cases, this then resulted in greater adoption — a significant increase in demand for chips and use of data processing for Semiconductors, and a significant increase in US natural gas demand inside and out of the US which helped to displace coal.

**Major difference in corporate returns and stock performance.** The main difference is that corporate returns degraded to below industry levels for shale companies, while corporate returns remained high for Semiconductor companies. This led to materially differentiated stock performance — 71% outperformance of global Semiconductor companies in 2004-19 vs. the MSCI ACWI global index and 134% underperformance of US shale producers vs. the S&P 500. We attribute this largely to better product differentiation and capital discipline among Semiconductor companies relative to US shale producers.

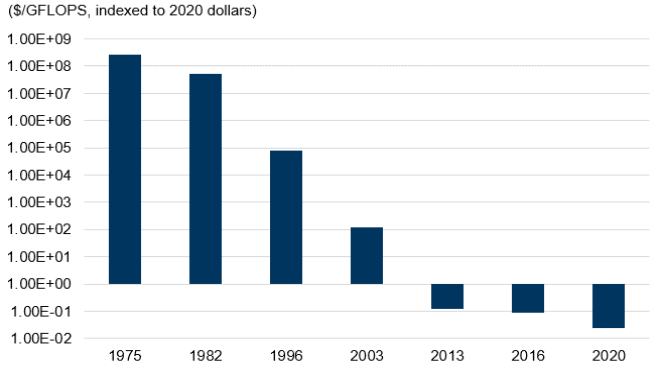
**Implications for managements and investors: Corporate returns matter over the longer term.** We believe that over time, investors will look closely at whether companies making major increases in reinvestment rate are maintaining strong corporate returns. We believe there is significant room for investor capital to support those who are. For the sectors where corporate returns are below-average presently, investors will likely closely watch management discipline as well as the level of product differentiation/competition as Green Capex picks up. Signs of oversupply could lead to less investor interest. However, with Green Capex needing to move from $3 trillion to $6 trillion annually, we do not believe we are currently facing Green oversupply.

**Exhibit 55: Semiconductors have generally reinvested above market in the past two decades, and US shale producers' reinvestments rates were significantly higher than other sectors during the shale era**
Global Semiconductor and US E&P sector reinvestment rate



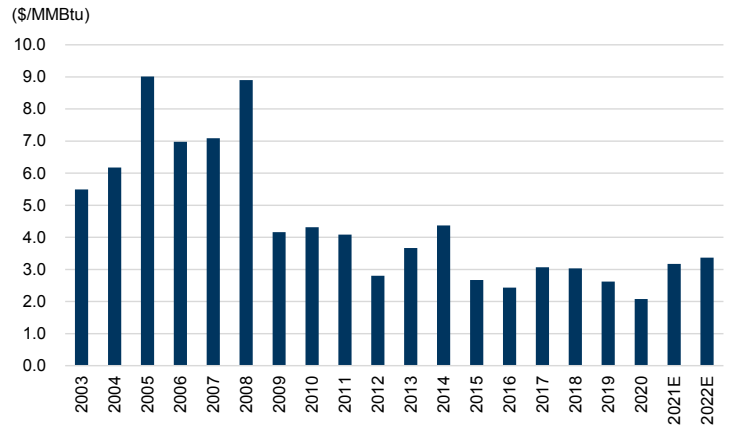

Source: Company data, Goldman Sachs Global Investment Research

**Exhibit 56: Adjusted for inflation, the cost of computing has declined exponentially through innovation in chip design**
Cost per Giga floating point operations per second (GFLOPS), indexed to 2020 dollars



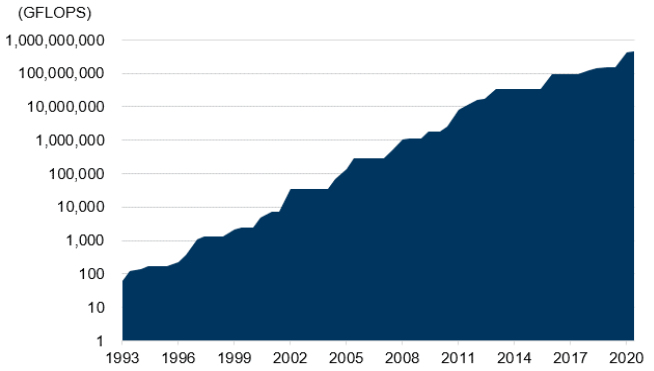

Source: Company data, top500.org, Refinitiv, Goldman Sachs Global

**Exhibit 57: Similarly, innovation in applying horizontal drilling with fracture stimulation in US shale reservoirs drove down natural gas prices in the US**
Henry Hub natural gas price ($/MMBtu)



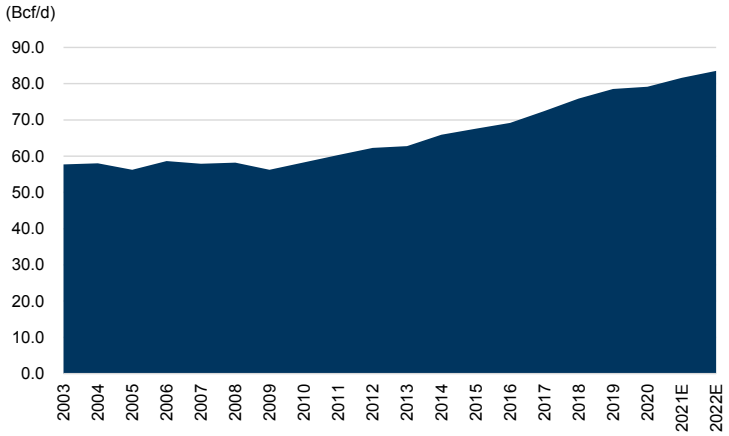

Source: ICE, CME, Goldman Sachs Global Investment Research

**Exhibit 58: Deflation in computing costs has led to wider adoption of semiconductors across multiple electronic products, as well as greater demand for more computing power**
GFLOPS of the top supercomputers worldwide



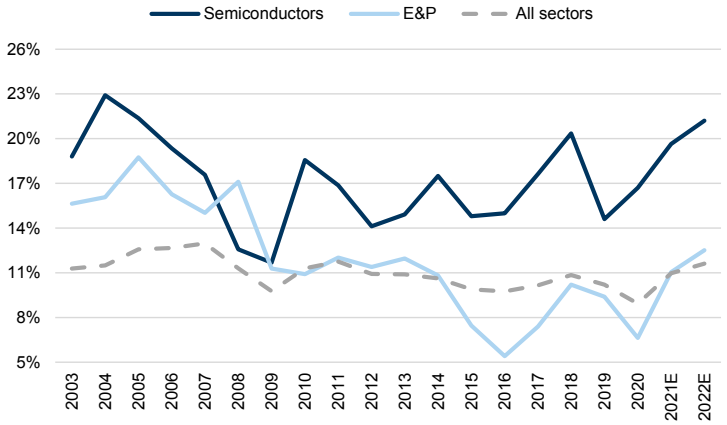

Source: top500.org, Goldman Sachs Global Investment Research

**Exhibit 59: Lower costs also led to greater demand for natural gas, partly taking share from coal which contributed to lower US carbon dioxide emissions**
US domestic weather/price-normal natural gas demand (adjusted for net exports)



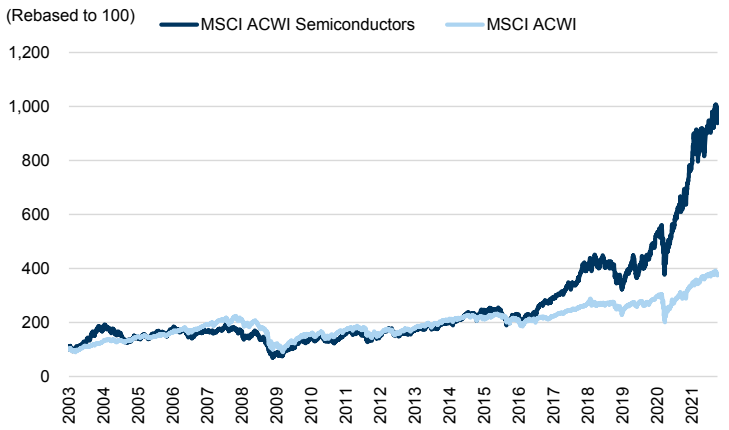

Source: EIA, Goldman Sachs Global Investment Research

**Exhibit 60: While global semiconductors have continued to outperform other sectors on corporate returns except during the GFC, US shale producers have seen deteriorating corporate returns in recent years**
Global Semiconductors and US E&P sector CROCI




Source: Company data, Goldman Sachs Global Investment Research

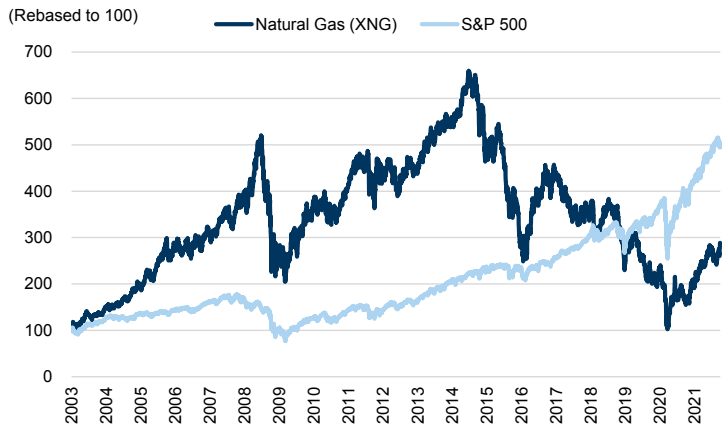
**Exhibit 61: Semiconductor stocks have significantly outperformed the global benchmark with the advancement of new technologies**
Semiconductors stock performance vs. MSCI ACWI




2021 price as of Sep 29

Source: Refinitiv, Goldman Sachs Global Investment Research

**Exhibit 62: After initially outperforming, stocks of US gas producers underperformed the S&P 500 as corporate returns degraded**
Stock performance of natural gas-focused producers vs. S&P 500




2021 price as of Sep 29

Source: Refinitiv, Goldman Sachs Global Investment Research

# What to ask: How managements and investors can engage on Green Capex

**While there is both a need for a substantial increase in Green Capex and ample capacity for Green Capex, our recommendation is not automatically that sectors with at or above-average corporate returns invest more capital.** The reason being there are multiple potential reasons that hold back investment — for example, lack of clarity on public policy, forward commodity prices, or confidence in project rates of return. So rather than recommending an immediate push for capex increases, we instead believe **what is critical is a push for investors to engage with management regarding their frameworks for reinvestment and what is holding back greater Green Capex.**

**How can managements engage investors?** We make two recommendations to managements preparing for investor engagement on Green Capex.

1. We recommend **greater disclosure of sustainable use capex levels**, particularly for diversified companies or those transitioning toward more Sustainable Development Goal-aligned sources of cash flow (soon required for European companies as part of the EU Green Taxonomy).
2. Second, we recommend companies with attractive corporate returns to provide a **checklist/framework of key milestones needed for greater reinvestment of cash flow**.

**How can investors engage managements?** We believe investors should consider adding the following questions to companies with above-average corporate returns and strong balance sheets where there is capacity for greater reinvestment:

1. **Why not invest more?** *What are the **key hurdles to reinvesting additional capital** toward products that would advance Sustainable Development Goals?* The answer to this question should help better understand policy constraints, financial constraints, product pricing outlook and other factors that may be otherwise holding back investment.
2. **What if everyone invests more?** *What would be the potential **impact on product pricing and potential innovation** if an additional 10% of company and industry peer cash flow were designated for capex + R&D?* The answer to this question should help provide some greater understanding on managements' expectations for the elasticity of product pricing to capex and the impact R&D spending could have toward both revenues and costs.
3. **How much is too much?** ***At what level of additional annual company investment** in capex + R&D **would incremental rates of return move below threshold**, and what are the key drivers that would push rates of return lower (lower quality projects, cost inflation, etc)?* The answer to this question should help provide insight into company's ability to execute greater investment program based on attractiveness of future projects and other constraints.

## Potential constraints to Green Capex now

**With capital relatively inexpensive and available due to a combination of low interest rates, Green bonds and Sustainability bonds, we believe the main financial constraint to greater Green Capex is rate of return.** While managements, Boards and investors may debate the right level of FCF to be dedicated to dividends and share repurchase, ultimately we do not believe availability of capital should be in itself the primary constraint to greater Green Capex for companies with attractive corporate returns and balance sheets. We believe confidence in rate of return and execution will likely be the main constraint. This will put increased focus on where on the cost curve (carbon abatement, infrastructure addition, water purification) individual projects lie as well as the confidence in execution.

**Some companies may cite policy clarity as a constraint.** We believe greater clarity on the extent and mechanism of government support for infrastructure, Clean Energy and Clean Water expansion could be one area of focus by managements as they determine their level of Green Capex commitment near-term.

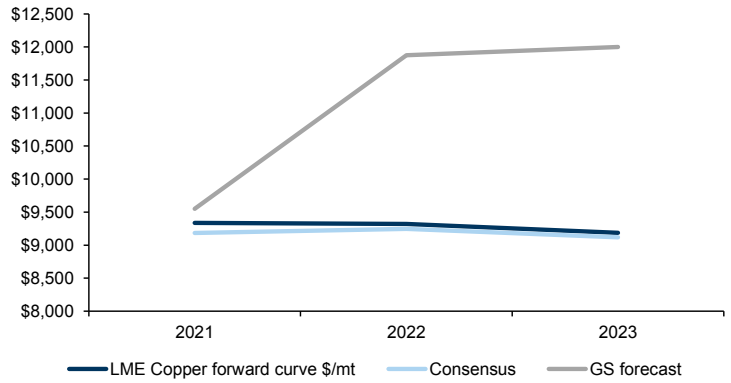
- **In the US,** on 8/10, the US Senate voted to pass a ~$1 trillion infrastructure plan, of which an additional $550 bn (above projected federal spending levels) would be allocated to infrastructure-related projects. The bill still requires passage through the House, and could face delays given intra-party challenges, including consideration of a $3.5 trillion budget framework. This would increase government commitment to Green Capex via largely tax breaks and grants.
- **In China,** the government has outlined mid-term environmental targets in their latest 14th five-year-plan, but the government's pace toward and policy support to achieve Net Zero by 2060 still remains largely uncertain, as balancing growth and decarbonization could pose near-term constraints. Our China economists argue that a two-step approach (accelerating decarbonization post 2030) could be a feasible way to strike a balance between the economic target of doubling income by 2035 and the goal of reaching carbon neutrality by 2060.
- **In Europe,** our European Utilities team estimates that €10 trillion of investments will be made by 2050 to achieve the European Union's Green Deal. Of this total amount, our analysts believe 40% will be financed through grants and government subsidies to support energy transition, with the remaining 60% coming from privately funded investments. Policy support to enable decarbonization should be a major priority by the EU government, as they have previously outlined that the EU Green Deal will be the core focus of the European Commission's COVID recovery plan.

**Commodity futures curves are not in meaningful contango, which reflects expectation for flattish or lower prices medium to longer term.** Our Commodities team's estimates for Copper and Aluminum prices are meaningfully above consensus — partly the driver of above industry average corporate returns for metals and mining companies. The LME futures curve for copper does not call for meaningful price expansion, for aluminum the futures curve calls for higher prices in 2022, then a reduction in 2023. Flattish longer-dated futures curves for copper/aluminum is likely one reason that could weigh on how aggressively managements are willing to commit capital to expansion projects that our equity and

commodities teams believe will be needed to meet demand as Green demand expands.

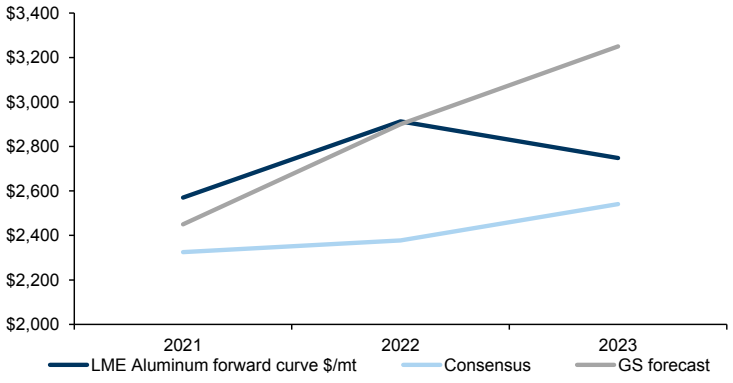
**Labor availability, in particular skilled labor, could be a medium-term constraint.** The current tightness is labor markets (see here and here for references) could partially mute Green Capex roll-outs, though some of the current tightness could be alleviated in the medium term which is when Green Capex could see a more meaningful rampup. While our channel checks indicate that, at the moment, the majority of labor constraints do not involve skilled and specialized workers, the limited pool of those individuals might create temporary air pockets or delays in spending and projects, as the demand for their skills is expected to increase considerably throughout the decade. In the future, however, some of our channel checks suggest concern that skilled labor availability — particularly among electricians — may be a contributor that could limit the pace of acceleration in electrification/infrastructure developments in areas like transmission/telecommunications.

**Exhibit 63: The copper futures curve calls for flat to down prices in coming years; increases may be needed to stimulate new investments**
Copper futures curve, consensus and our Commodities team's estimates




Source: Bloomberg, Goldman Sachs Global Investment Research

**Exhibit 64: Our team is bullish on aluminum prices, particularly in 2023 vs. futures curve/consensus, due to expected undersupply**
Aluminum futures curve, consensus and our Commodities team's estimates




Source: Bloomberg, Goldman Sachs Global Investment Research

**Technology hurdles.** Further technological innovation may be needed to fully accommodate requisite capital spending. In electric vehicle batteries, this remains a key hurdle, resulting in: (a) significant delays seen in timelines of battery plant completions for new entrants (including auto OEMs); and (b) capital raises without OEM backing — i.e., companies achieving lab scale but not necessarily commercial scale.

**Chevron case study highlights willingness and risks around committing to additional Green Capex.** On September 14, Chevron held a briefing on its energy transition activities with focus on renewable fuels, carbon capture and hydrogen. Management raised its overall capital budget by $1 bn annually in 2022-25 to support its lower carbon investments, which it expects to deliver >$1 bn of cash flow in 2030 (10% of guided 2028 cumulative capital spending) and enable >30 million tons

of annual CO2 emissions reductions. In considering some of the debates over sizing investments, management highlighted: (a) its focus on project and corporate returns; (b) the need for technology advancement, market development and policy to help determine the potential future capital commitment; and (c) the importance of customer demand — willingness of individuals to accept higher prices — to support return on investment for corporates.

## Potential increases in US infrastructure spending

***This section contributed by Alec Phillips, chief US political economist.***

**There are two pieces of upcoming legislation that look likely to increase the amount of public funding for capital investment.**

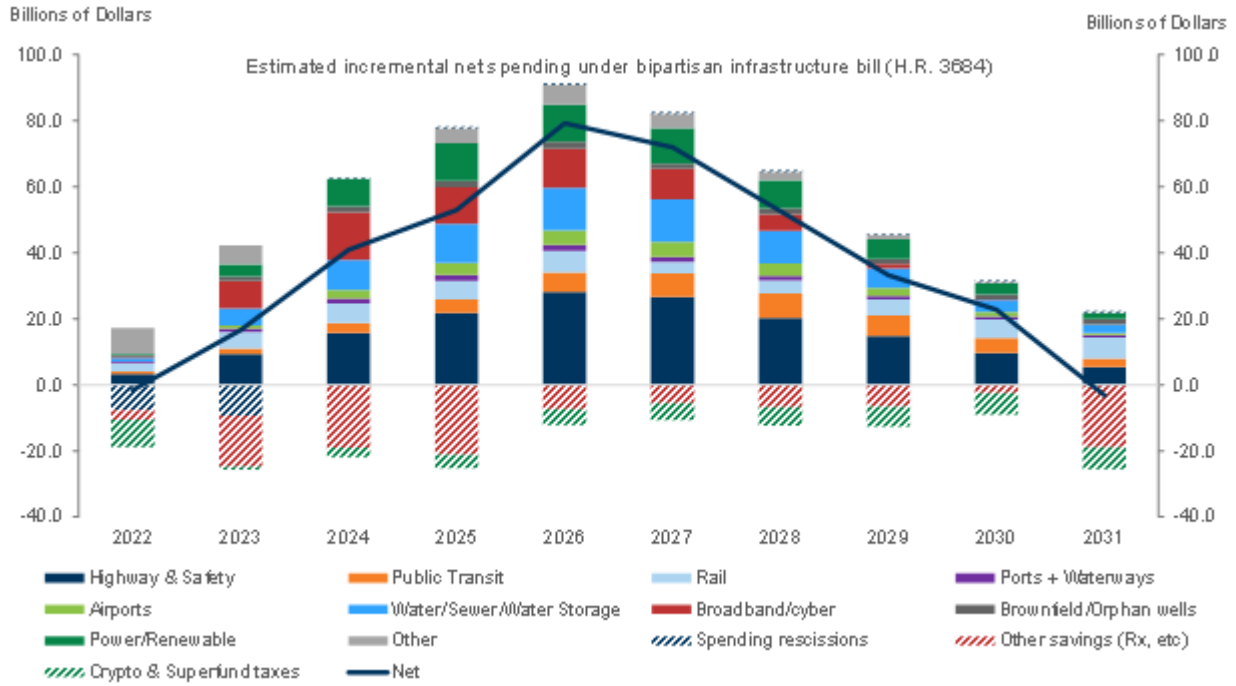
**First, the bipartisan infrastructure bill that passed the Senate August 10 and looks likely to pass the House in coming weeks would increase overall infrastructure funding by roughly $550 bn over the next ten years.** That spending boost would occur gradually, with the amount of incremental spending rising until 2026, after which the amount of new funding would gradually decline but would still be greater than under the "business as usual" baseline scenario.

Most of the funding boost goes to traditional infrastructure investment. Unsurprisingly, the greatest amounts of funding are in areas that the federal government already funds, like highways and public transit. However, some areas that receive relatively little federal funding currently would see a more substantial boost under the bill. For example, federal funding for water and sewer projects would increase from only around $4 bn currently to around $16 bn by the middle of the decade, though this would still be a fairly small increase in total public spending, which amounts to nearly $140 bn annually. The bill also includes $65 bn for broadband, primarily via grants to states.

While the Biden Administration and congressional Democrats have linked the infrastructure bill to climate-related issues, the funding for clean energy, energy efficiency, and electrification (including EVs) is much more limited than what the White House had sought. Among the provisions:

- $7.5 billion in low-emission and zero-emission buses and ferries.
- $7.5 billion to build out a national network of EV charging stations.
- $18 bn in funding for grid reliability and resilience, smart grids.
- $16 bn for various programs to develop domestic rare earth and other minerals resources, to incentivize domestic battery materials processing and production, and for tax credits to manufacturers of advanced energy technologies.
- $28 bn for carbon capture and storage, clean hydrogen programs, and credits for nuclear reactors.

**Exhibit 65: Key areas of incremental net spending in the US bipartisan infrastructure bill under consideration**
Billions of dollars




Source: Congressional Budget Office. Goldman Sachs Global Investment Research

**A second piece of legislation that Democrats expect to pass through the reconciliation process with only Democratic support is likely to provide additional funding for clean energy through a combination of tax credits and, potentially, tax penalties.** While the details are not yet clear, potential provisions under discussion include:

- A $150 bn over ten years clean electricity program that provides per-megawatt grants to electricity suppliers that increase the amount of clean energy supplied by more than a target amount, and imposes per-megawatt penalties on electricity suppliers that have not increased by a target amount.
- Further EV funding: The package might include incentives for electrification of medium- and heavy-duty vehicles, and additional funds for recharging infrastructure.
- Energy efficiency: The legislation is likely to include funding for federal rebate schemes for energy efficient appliances and funding for weatherization programs.
- $250 bn over ten years in tax incentives for clean energy investment and production. The Senate Finance Committee

passed legislation earlier this year that would overhaul and extend several tax incentives for clean energy, including the production tax credit (PTC) and investment tax credit (ITC). The House Ways and Means Committee passed a slightly smaller package that addresses most of the same areas. Some version of these proposals looks likely to become law as part of the broader "Build Back Better" legislation. While the amount of funding is significant, we note that federal tax incentives for clean energy and energy efficiency already total around $15 bn annually, so much of the cost of the policy relates to simply extending incentives that would otherwise expire rather than increasing them.

Additional funding for other areas of infrastructure is possible, but the Biden Administration reached an understanding with Republican negotiators on the bipartisan infrastructure bill that the forthcoming reconciliation legislation would not add funds to areas covered by the infrastructure bill. If this holds, it would limit the amount of additional funding for electric vehicles, power grid, and broadband, for example.

**After this year, we expect that the prospects for a further substantial boost to public funding for infrastructure might be limited for a few years.** Prediction markets and most independent political analysts expect Republicans to win the House of Representatives in 2022, which would reduce the odds of further legislated increases until after the 2024 elections, we believe.

## The EU Green Taxonomy could impact investor ownership and corporate behavior, beyond just Europe

We believe the EU Green Taxonomy and Europe's SFDR regulations, which will require corporates and asset managers to classify investments as green or not green, will have an impact not just on investors/corporates in Europe but beyond as well.

**For corporates,** as part of the Taxonomy, 11,000 companies within scope of the Non-Financial Reporting Directive (NFRD) will be required to disclose:

- The proportion of turnover from activities eligible to the Taxonomy environmental objectives
- The proportion of turnover from activities meeting strict performance criteria aligned with Taxonomy environmental objectives
- CAPEX and OPEX (optional) associated with taxonomy-aligned activities
- Some financial companies may also be required to make Taxonomy-related disclosures under the Financial Market Participant requirements

**For investors,** most financial market participants marketing financial ESG products (Article 8 and 9 funds under SFDR) in the EU will be required, for each relevant product, to disclose as part of the Task Force on Climate-Related Financial Disclosures:

- How and to what extent the Taxonomy has been used in investment selection

- Which environmental objectives the investments contribute to
- The proportion of the underlying investments with Taxonomy-aligned turnover or capex

The existing EU Taxonomy is planned to expand beyond climate mitigation and adaptation to establish standards around sustainable use and protection of water and marine resources, transition to a circular economy, pollution prevention and control, and protection and restoration of biodiversity and ecosystems.

# Disclosure Appendix

## Reg AC

We, Brian Singer, CFA, Derek R. Bingham, Evan Tylenda, CFA, Madeline Meyer, Keebum Kim, Sofie Alabaster, Brendan Corbett and Emma Jones, 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.

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**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.

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| | Rating Distribution | | | Investment Banking Relationships | | |
|---|---|---|---|---|---|---|
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# MINDCRAFT: OUR THEMATIC DEEP DIVES

The Great Reset


The Survivor's Guide to Disruption


The Future of Mobility


Artificial Intelligence


Cloud Computing

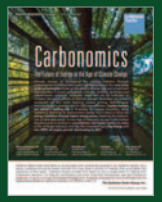

Edge Computing


Extended Reality

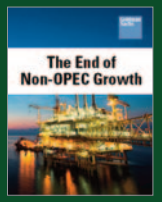

5G: From Lab to Launchpad


Climate Change


Carbonomics




The End of Non-OPEC Growth




Reimagining Big Oils


The Rise of Renewables

Shale Scale to Shale Tail

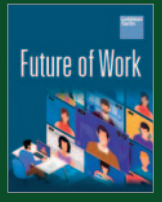
IMO 2020


The Genome Revolution


Digital Health


The Future of Finance


Future of Work




Drones


Space


Factory of the Future


eSports: From Wild West to Mainstream


Music in the Air


EVs: Back to Reality


Venture Capital Horizons


ESG Rising


Womenomics

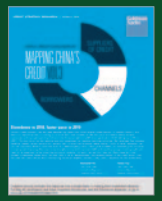

The Chinese Consumer


Feeding China's Changing Appetite


New China, Old China


China A Shares in Anatomy


China's Credit Conundrum

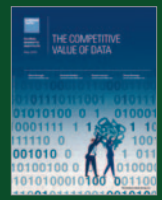



Japan Aging

Made in Vietnam

What the Market Pays For


The Competitive Value of Data




What Matters for IPOs


Top of Mind


...and more

The Mindcraft Library