LAZARD

An Inflection Point for Corporate Infrastructure

How Private Capital, Industrial Policy, and Geopolitics are Transforming Global Infrastructure

November 2022

Executive Summary

In 2022, the global infrastructure landscape finds itself at an inflection point. Over the past decade, the definition of infrastructure has dramatically broadened, private capital has become a formidable source of financing, and governments around the world are now appropriating public funds to finance an ever-wider range of critical infrastructure.

No longer limited to the realm of roads and bridges, power plants and airports, today infrastructure increasingly overlaps with large-scale corporate investment projects. These projects encompass everything from cellular towers and fiber optic connectivity for homes and businesses, to new technologies supporting the migration of the global economy to renewable energy.

In light of this tectonic shift, corporates making financing and investment decisions must today consider the role infrastructure capital providers can play in financing long-term real asset projects.

A confluence of factors, including the rise of private capital, the appetite for corporate infrastructure projects among both corporates and investors, rising geopolitical tensions, and reinvigorated domestic industrial policy in the U.S. and Europe, have the potential to meaningfully expand the use of corporate infrastructure.

This paper will investigate these four factors and the part each play in the current inflection point for global infrastructure. To briefly summarize:

1. **The Rise of Private Capital:** Private capital has become a major influence on the industrial landscape, with large pools of capital available for infrastructure investments across dedicated infrastructure funds, private equity strategies, sovereign wealth funds, and pension funds.

2. **Expanding Corporate Appetite for Infrastructure Capital:** While “corporate infrastructure” has long been an area of interest for investors, corporates are showing an increasing inclination to tap infrastructure investors to finance long-term capital investments in assets that mimic traditional infrastructure in their risk and cash flow profile. In many cases, tapping infrastructure capital can provide corporates with a more favorable cost of capital and increased strategic and capital structure flexibility.

3. **Industrial Policy and Reshoring:** In the U.S. and Europe, growing geopolitical tensions and a desire to “reshore” key industries and manufacturing has led to a flurry of policies to invest in traditional domestic infrastructure and incentivize the reshoring of key industries, such as semiconductor production and energy transition-related facilities and technologies.

4. **Industries Primed for Infrastructure Investment:** These factors will impact corporates over the next decade across industries, but especially sectors involved in the energy transition, digital infrastructure, and semiconductor production. In these industries, the confluence of private capital availability and the incentives provided by industrial policy will prove especially important.

These forces will require corporates to be well-versed in the elements influencing private capital allocation, geopolitics, and to understand how those factors have a bearing on capital expenditure. Each will influence corporate decision-making and the ability of corporates to tap infrastructure funds and other sources of private capital to finance the most capital-intensive and strategic projects.

If corporates can navigate these factors nimbly and strategically, the benefits – in the form of lower cost of capital, increased capital structure flexibility, external validation of strategy, and stronger stakeholder engagement – will be meaningful and without substantive incremental cost to the users of this financing.

An Inflection Point for Corporate Infrastructure

The past decade has seen the swift rise of private capital as a force shaping the corporate landscape. The growth of infrastructure private capital, in particular, has been striking, both in its magnitude and the expansion of the types of infrastructure and infrastructure-like projects this pool of capital is willing to fund.

This trend has been met in kind with a growing appetite from corporates to tap pools of infrastructure capital for complex, capital-intensive investments and projects, based on the evolving and simple criteria that an infrastructure asset can essentially be anything that is a “real” asset with a relatively predictable stream of cash flows attached. As a result, corporate infrastructure deals have grown in scale and complexity.

The sheer amount of infrastructure capital, the appetite from corporates for innovative financing solutions, and projected investment needs in key infrastructure verticals, such as the energy transition and digital infrastructure, would be enough on their own to generate robust investment activity for the next decade.

However, geopolitical tensions have spurred a revitalized interest in industrial policy in the U.S. and Europe, as these blocs seek to reshore manufacturing and secure the supply chains that many believe will underpin economic development and security for the next several decades.

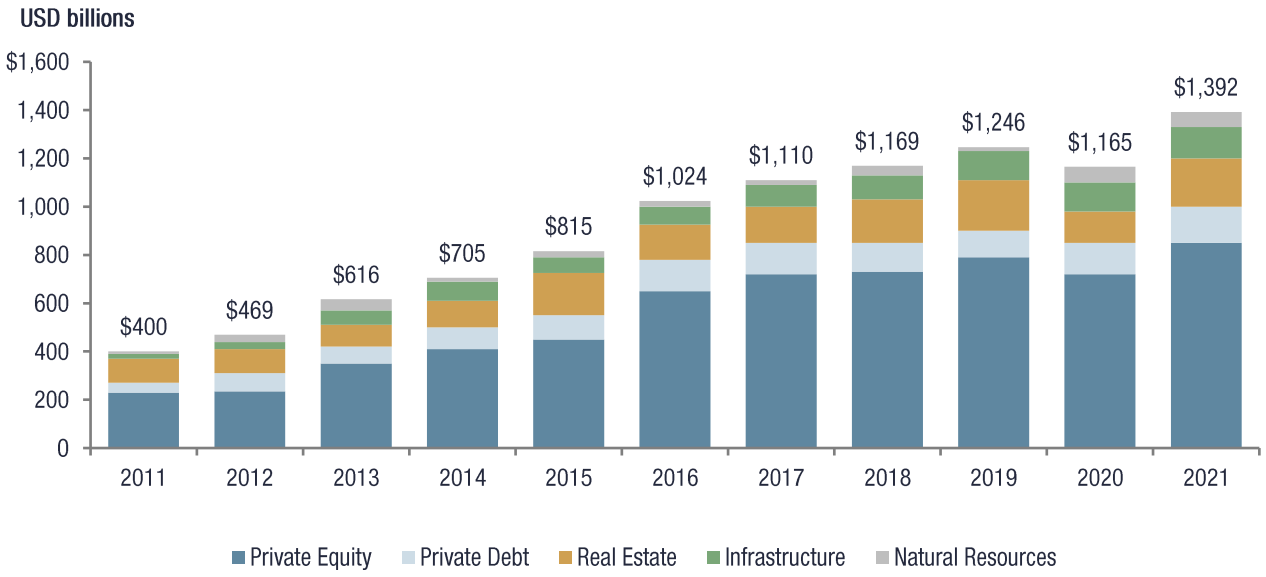
This influx of public sector incentives and renewed focus has the potential to amplify and expand the impact of the deepening confluence between infrastructure capital and corporates, creating an inflection point for novel infrastructure investment around the world.

1. The Rise of Private Capital

Broad Trends in Private Capital

The rise of private capital has been perhaps the most important trend in the investment industry over the past decade. Global private capital[1] fundraising reached a new high of $1.4 trillion in 2021, capping a decade of cumulative fundraising of over $10 trillion (Figure 1).[2] This cumulative fundraising resulted in dry powder of $3.3 trillion as of year-end 2021.[3]

Figure 1 Global Private Capital Fundraising
Source: PitchBook Data, Inc

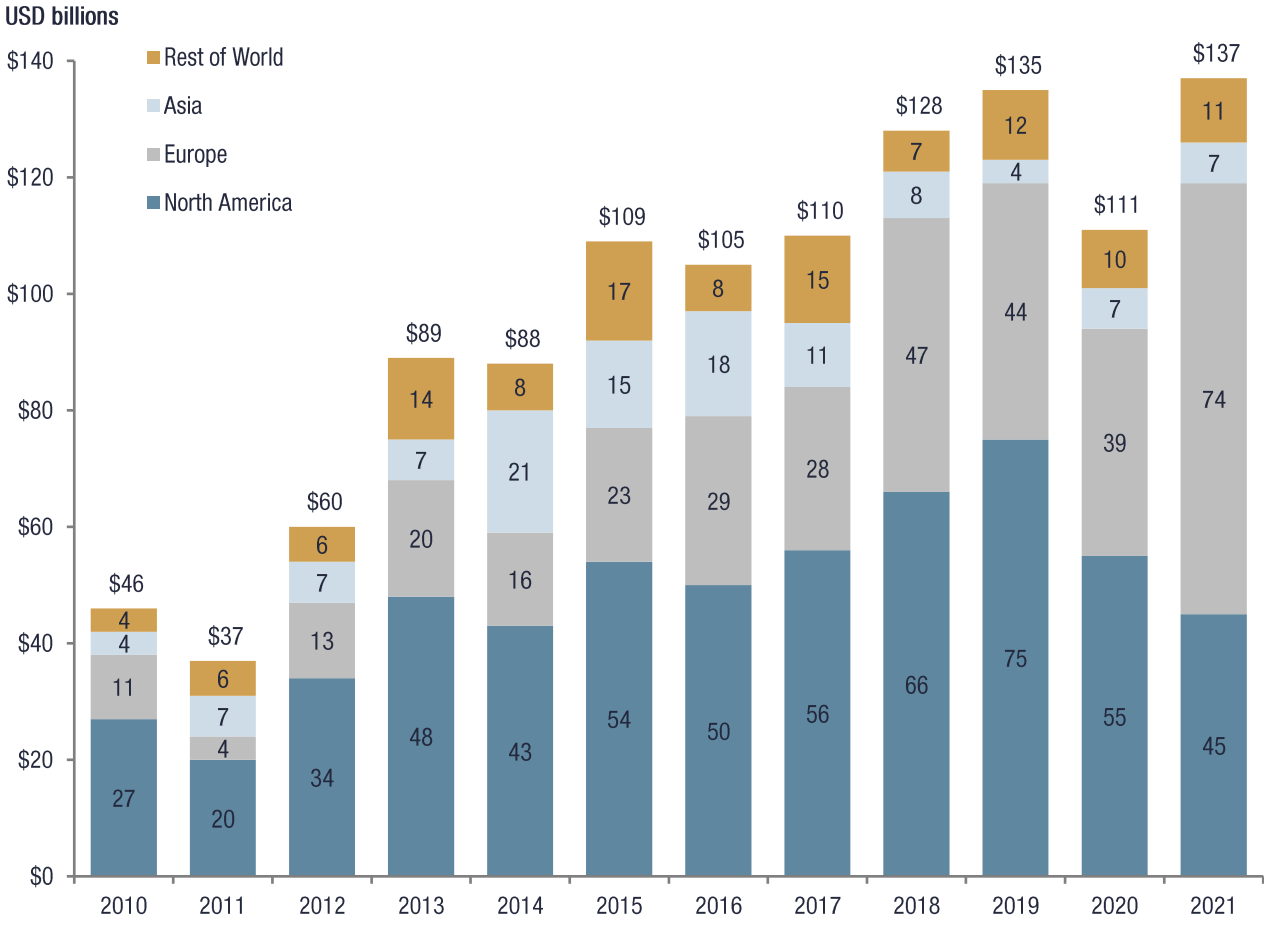


The growth of private capital, in turn, has reflected the increased appetite for private asset classes from limited partners (or LPs, the investors in funds). LPs have increased their target allocations to "alternative" asset classes like private equity, real estate, private credit, and infrastructure every year since 2012.[4] The increase in allocation to private equity by pension funds is illustrative: since 2010, U.S. public pension fund allocations to private equity have increased 39%, from 6.4% to 8.9%.[5]

[1] Comprising private equity, private debt, real estate, infrastructure, and natural resources.
[2] PitchBook Data, Inc.
[3] Ibid.
[4] Coller Capital Global Private Equity Barometer, Summer 2021.
[5] Wall Street Journal, "Retirement Funds Bet Bigger on Private Equity," January 2022.

Infrastructure Capital

Figure 2 Global Infrastructure and Natural Resources Fundraising
Source: McKinsey



Fundraising – and dry powder for infrastructure specifically – has followed the broader trend in private capital. Per an analysis by McKinsey, infrastructure and natural resources funds raised a record $137 billion globally in 2021, with cumulative fundraising since 2011 of $1.1 trillion (Figure 2).[6] Within infrastructure mandates, a variety of strategies have been adopted. Core and Core Plus – strategies focused on brownfield assets where income is the primary form of return, with limited expectation of capital appreciation – remain the most popular forms of funds raised, though their prominence as a percent of total funds raised annually has varied from 45% to 90% since 2000.[7]

[6] McKinsey Global Private Markets Review, March 2022.
[7] Meketa, Infrastructure White Paper, April 2020.

As of the end of 2021, infrastructure dry powder stood at $369 billion (Figure 3), with total AUM of $1.1 trillion.[8] Despite economic and geopolitical uncertainty in 2022, infrastructure fundraising remains active, with major funds recently closed, many of which have energy transition or sustainable mandates:

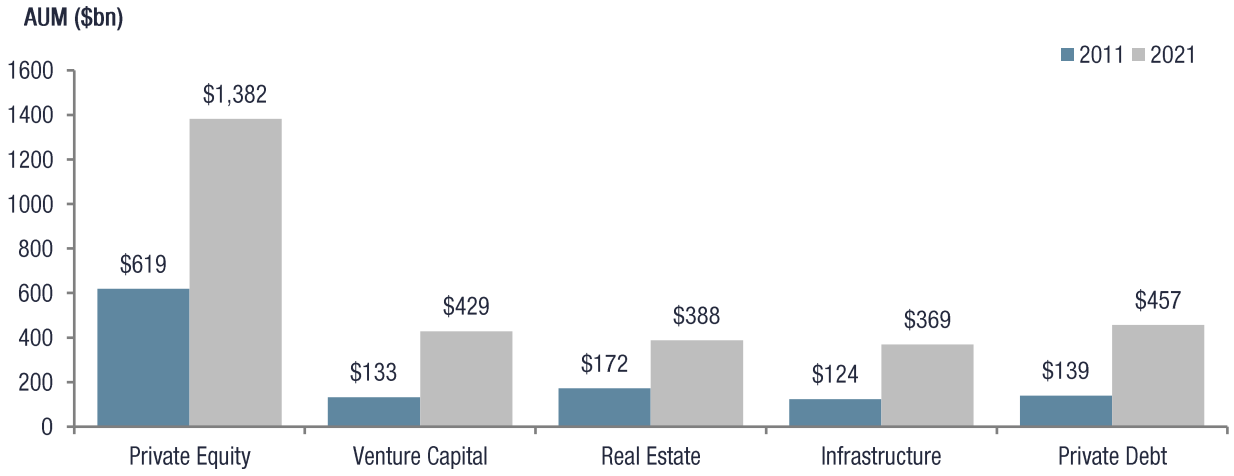
- KKR's $17 billion Global Infrastructure Fund
- I Squared's $15 billion ISQ Global Infrastructure Fund III
- Brookfield's $15 billion Global Transition Fund
- Stonepeak's $14 billion Infrastructure Fund IV
- TPG's $7 billion Rise Climate Fund
- Macquarie's €6 billion European Infrastructure Fund 7
- IFM's $4 billion Net Zero Infrastructure Fund
- Blackstone raising an incremental $3 billion in its open-ended strategy during Q2 2022

Indeed, according to *The Wall Street Journal*, as of August, infrastructure funds had already raised more in 2022 than in the entirety of 2021.[9]

Citing factors such as political instability and inflation risk, roughly two-thirds of LPs have said they will increase their allocation to infrastructure over the next 12 months, with renewables and digital infrastructure as the favored infrastructure asset classes for greater investment.[10]

Beyond institutional allocations, direct infrastructure investments from pension and sovereign wealth funds will likely increase. Sovereign wealth and pension funds made over $36 billion in direct infrastructure investments in 2021, up from $10.7 billion in 2020.[11] Many of these institutions have earmarked billions of dollars for direct infrastructure investments, in addition to billions committed to infrastructure funds.

Figure 3 Private Capital Dry Powder
Source: PitchBook Data, Inc, Private Fund Strategies Report 2021

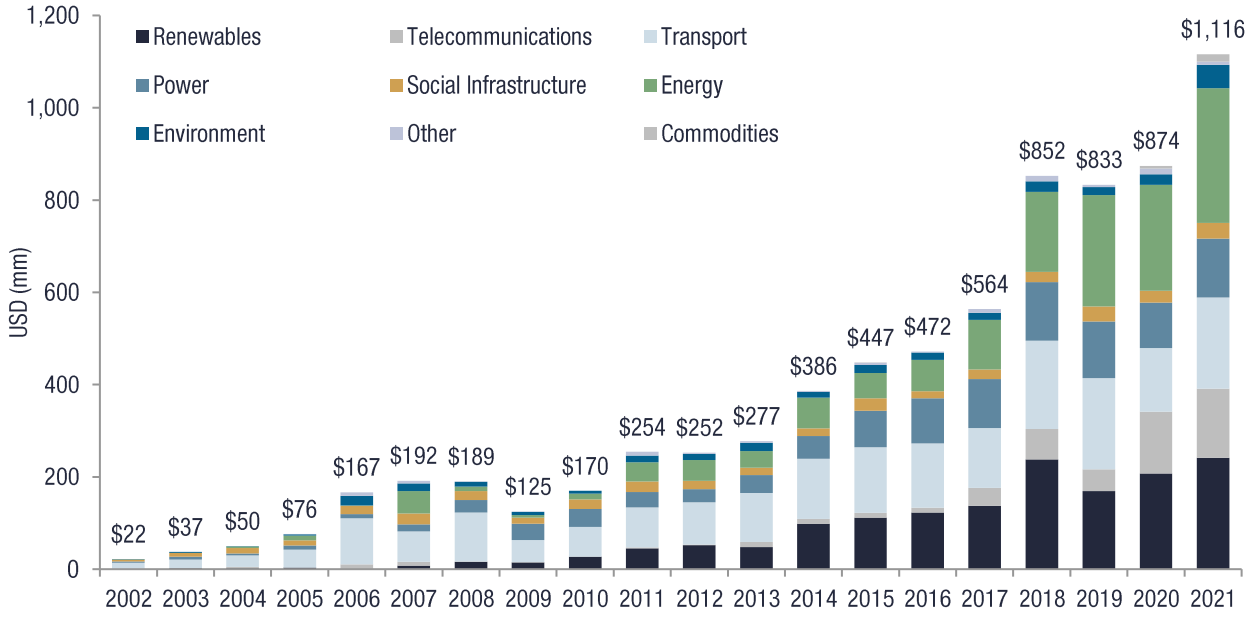


Trends in infrastructure investments over the long term demonstrate the ability of the sector to absorb this wave of capital. Infrastructure capital over the past decade has met trends like decarbonization and

[8] PitchBook Data, Inc.
[9] Wall Street Journal, "Money Pours Into Funds Targeting Solar Power, Cell Towers and Data Centers," August 2022.
[10] Infrastructure Investor, "Infrastructure Investor's LP Perspectives 2022 Study," February 2022.
[11] Sovereign Wealth Fund Institute 2022.

digitalization, leading to a flurry of transaction activity in these areas. Per Infralogic, renewables and telecommunications transactions comprised 35% of total infrastructure deal value in 2021, up from 19% in 2011 (Figure 4), as deal value has risen more than fivefold overall.

Figure 4 Total Closed Deal Value by Infrastructure Strategy, 2002-2022
Source: Infralogic



Other Relevant Pools of Capital

The rapid growth of infrastructure private capital is notable, but other pools of capital will also remain crucial in traditional infrastructure financing, as well as in developing innovative solutions up the risk curve. Project finance will continue to be an important source of capital for corporates. Global project finance loan volume has averaged nearly $300 billion annually since 2018, standing at $306 billion in 2021.[12] Key infrastructure verticals like power, transportation, and telecoms comprised nearly two-thirds of loan volume, while oil & gas and petrochemicals made up a majority of the rest.[13]

On the other side of the risk-return spectrum, venture capital will be a crucial force in bringing new technologies related to infrastructure investment areas like the energy transition to fruition. For example, in 2021, North American energy transition-related venture investments reached a record high of $6.8 billion, up from $1.7 billion in 2020.[14] While the emerging technologies funded by venture capital are expected to need years of development to achieve commercial feasibility, these technologies will likely form an important investment area for infrastructure capital over the long run as companies seek to scale.

[12] Refinitiv 2021 Global Project Finance Review.
[13] Ibid.
[14] S&P Global, "Private money flowing freely to energy transition companies, technologies."

2. Expanding the Corporate Appetite for Infrastructure Capital

As this ever-expanding pool of infrastructure capital struggles to find the returns it desires from traditional infrastructure assets, it is turning to a class of infrastructure projects with increasing appeal for many: corporate real assets.

Functionally, for an asset to be considered infrastructure, it generally must meet two basic criteria:

1. It comprises a real asset, such as a factory, solar array, or data center, etc.
2. It generates a relatively predictable, long-term stream of cash, ideally with inflation-hedging aspects and limited business cycle risk, though these need not be prerequisites in every case

With these two criteria met, virtually any corporate asset can be incorporated into a structure that is amenable to direct investment from infrastructure investors.

Why would a company seek to tap these pools of capital? There are several potential motivations:

- Favorable economics on which to launch and de-risk the most capital-intensive projects, offering in many cases a better cost of capital when accounting for all factors
- Increased capital structure flexibility and strategic optionality
- External validation of corporate strategy and the value of discrete projects
- Stronger engagement with stakeholders, including investors, policymakers, and employees

Importantly, to enjoy these benefits and the attendant cost of capital advantages, the cash flows from the asset in question must be fairly stable, or otherwise made to be stable. If not, it may be difficult to attract infrastructure capital interest. For instance, a manufacturer producing higher-margin, higher-value add products will likely have more capacity to stabilize cash flows and attract infrastructure capital. Long-term offtake agreements can also help mimic the cash flow profile desired by infrastructure capital.

Corporate asset infrastructure thus has the potential to create new opportunities for investors and corporates alike, as investors can move up the value chain and capture new returns, while companies enjoy the financing and capital structure benefits of these arrangements.

> *"This landmark arrangement is an important step forward for Intel's Smart Capital approach and builds on the momentum from the recent passage of the CHIPS Act in the U.S. Semiconductor manufacturing is among the most capital-intensive industries in the world, and Intel's bold IDM 2.0 strategy demands a unique funding approach. Our agreement with Brookfield is a first for our industry, and we expect it will allow us to increase flexibility while maintaining capacity on our balance sheet to create a more distributed and resilient supply chain."* – David Zinsner, Intel CFO

Historical Context

This dynamic is not novel. Companies have long sought to access alternative sources to finance their most capital-intensive projects, or to monetize infrastructure-like assets.

However, the pace of deals over the past several years highlights the increasing complexity and wide-ranging nature of these projects (Figure 5), suggesting a new wave of corporate appetite for novel financing arrangements. Further, the broad sectors represented by these deals demonstrate how corporate infrastructure is expanding beyond the typical sectors represented.

Figure 5 Select Corporate Infrastructure Deals

Deal (Announce Date)	Structure
Intel / Brookfield (8/2022)	• Intel and Brookfield jointly invest up to $30 billion in developing new semiconductor manufacturing facilities in Chandler, Arizona – Inaugurated Intel's Semiconductor Co-Investment Program (SCIP) framework • Intel will fund 51% and Brookfield 49% of the manufacturing facility, with Intel retaining majority ownership and operating control • The structure will provide a $15 billion cumulative benefit to Intel's Adjusted Free Cash Flow through 2026 and is expected to be accretive to earnings during the construction and ramp phase
AB InBev / Apollo (12/2020)	• Apollo and other institutional investors acquired a 49.9% stake in AB InBev's U.S.-based metal container plants for $3 billion – AB InBev has the right to reacquire the minority stake following the fifth anniversary of the transaction close • The transaction provided AB InBev with proceeds used to delever • AB InBev retained operational control, with a long-term supply agreement in place for metal containers
Telefónica / Allianz (10/2020)	• Telefónica and Allianz formed a JV to create Unsere Grüne Glasfaser (UGG), a rural-focused fiber wholesaler in Germany – UGG deploys fiber optic networks in primarily underserved rural and semi-rural areas of Germany, while also providing fiber to the home wholesale access • Allianz and Telefónica both hold 50% in the JV through a co-control governance model, and agreed to invest up to €5 billion via shareholders' equity, a long-term subordinated loan and non-recourse external financing

Historical Constructs at the Intersection of Corporates and Infrastructure: Investors, corporates, and regulators alike have long sought to take assets and provide guarantees around returns and cash flows to encourage investment.

For instance, energy assets have long benefited from purchase power agreements (PPAs). These contracts provide power producers and consumers with certainty of supply and demand, all while stabilizing sometimes volatile cash flows for asset owners. PPAs also allow a broader array of stakeholders to engage in the financing of energy production, especially renewables. Per the International Energy Agency, corporate PPAs underpinned nearly $16 billion of renewable energy development in 2020.

The characteristics of PPAs have also been influenced by regulation, as in the case of utilities where rate base regulations serve to guarantee a certain level of returns to utilities providers, and in corporate organization constructs like master limited partnerships (MLPs). MLPs have existed since 1981, and the initial spate of MLP IPOs included a wide range of industries such as real estate, casinos, amusement parks and sports teams.[15]

Viewed through this lens, the interest in corporate infrastructure-like assets from investors and corporates can also be seen as a progression of the myriad contract and regulatory structures that have been used to impose cash flow stability over long time horizons for corporate assets.

While corporate infrastructure-like assets may only need to meet two criteria as a starting point, firms and investors alike must be cognizant of the potential ratings agency treatment of these investments, lest the ratings agencies treat them more like debt and thus reduce the potential flexibility and cost of capital benefits of these arrangements. This risk, however, can generally be ameliorated by careful attention to a few key areas:

- Ensuring an adequate and transparent degree of equity-like risk sharing
- Balancing infrastructure capital expectations of a guaranteed minimum return or downside protection
- Creating shared governance rights for both parties
- Structuring the partnership and investment to minimize levering the joint venture, if needed

Careful structuring with these considerations in mind can thus maximize the chance that credit ratings agencies take a view of a given investment structure as equity-like rather than debt-like.

[15] Latham & Watkins, “Master Limited Partnerships (MLPs): A General Primer.”

3. Industrial Policy and Reshoring

If the growth in infrastructure capital is making increasing access to such financing possible and more attractive to corporates, geopolitics and industrial policy in the U.S. and Europe may be the accelerant that further fuels these financings. Companies are not immune to geopolitical tensions between the U.S. and China. They have also seen the impact supply chain snarls have had over the course of the past two years and the potential benefits of reshoring key parts of their value chains.

The particulars of industrial policy in the U.S. and Europe will influence the development of infrastructure, local supply chains, and manufacturing, with major ramifications for the energy transition and key technological industries. This in turn will have major impacts on the kinds of corporate infrastructure projects pursued over the coming decade.

Industrial Policy in the U.S.

Three relatively recent policies demonstrate the shift in U.S. industrial policy thinking (Figure 6).

Figure 6 Summary of Recent U.S. Legislation with Infrastructure Implications
Source: Press and Government Reports

Legislation	Key Provisions and Details
Bipartisan Infrastructure Law (BIL)	• **Broadband:** $42.5 billion in state grants to develop broadband networks, as well as $2 billion in specific loans and grants to increase broadband access in rural areas • **Power and the Grid:** The Senate Energy and Natural Resources Energy Infrastructure Act includes broad programs to increase electrical grid resiliency and flexibility, map U.S. natural resources critical for clean energy technologies, research and develop carbon capture and clean hydrogen technologies • **Roads and Bridges:** $110 billion in incremental spending, including $55 billion in increased contract authority, a $37 billion bridge grant program, and various other grant programs for miscellaneous surface transportation projects
Creating Helpful Incentives to Produce Semiconductors for America and Science Act (CHIPS)	• $39 billion in financial assistance to build out semiconductor manufacturing in the U.S. • $11 billion in research and workforce training • $2 billion for the “CHIPS for America Defense Fund” focused on accelerating semiconductor research and development for defense and other use cases

Legislation	Key Provisions and Details
Inflation Reduction Act (IRA)	• $30 billion in production tax credits for U.S.-manufactured solar panels, wind turbines, batteries, and critical minerals processing • $10 billion in investment tax credits to develop clean technology manufacturing facilities • $30 billion in tax credits for states and electric utilities for clean electricity and energy storage • $6 billion for a new Advanced Industrial Facilities Deployment Program to help reduce emissions from high-emitting industrial processes like chemicals, steel, and cement • $27 billion for a clean energy technology accelerator • Additional "friend-shoring" incentives, such as expanding the electric vehicle tax credit to vehicles produced in North America broadly, as well as battery minerals produced or recycled in countries with preferential trade deals

These three Acts bring total U.S. support for domestic manufacturing, the energy transition, and infrastructure to nearly $1 trillion[16] over the next decade, a surge in federal spending and incentives arguably without domestic analogue over the past 20-plus years. Moreover, these pieces of legislation are not inclusive of other actions the Biden administration has taken, including executive orders related to electric vehicle battery supply chains and rare earth minerals and regulatory actions taken by federal agencies.

Industrial Policy in Europe

EU industrial policy is largely shaped by its pledge to reach climate neutrality by 2050, which will require the bloc to reduce emissions by at least 55% by 2030 (relative to 1990 levels). The framework for the EU's achievement of this goal is the European Green Deal, which encompasses €1 trillion in investments, as well as the European Climate Law, which enshrined the EU's 2050 pledge into the statute book. Key industrial policy goals of the European Green Deal and Climate Law include:

- Mobilizing the investment of €800 billion in offshore renewable energy, with investment predominantly coming from the private sector,[17] and an overall target that 45% of annual energy production comes from renewables by 2030 (up from a target of 40% set in 2021, in response to energy pressures from the Russian invasion of Ukraine)
- Promoting zero- and low-emissions vehicles, including reducing emissions from cars by 55% by 2030, extending carbon pricing to road and air transport, and phasing out combustion vehicles by 2035[18]

[16] Based on $550 billion in above-baseline investment from the BIL, $52 billion in industry support within CHIPS, and $369 billion in total energy security and climate change investments in the IRA.
[17] "An EU Strategy to harness the potential of offshore renewable energy for a climate neutral future." European Commission, November 2020.
[18] "Delivering the European Green Deal." European Commission, accessed August 2022.

- Encouraging sustainable product design via “ecodesign requirements” that promote the circular economy and reduce waste[19]

The EU’s “New Industrial Strategy for Europe” further outlines seven key areas of support for EU industry, many of which overlap with the bloc’s climate goals:[20]

- Strengthen the EU’s single market through common regulation
- Maintain European competitiveness by emphasizing fair trade and reciprocal market access for European firms
- Support European industry on the path toward climate neutrality
- Create a more circular economy and manufacturing sector
- Incentivize research and development initiatives, especially those related to cutting-edge technologies in the energy transition and digital space
- Increase investment in reskilling and training for European workers
- Encourage further investment in the EU, especially by partnering with member states and private capital sources

The EU is further providing direct support to companies in certain industries. The bloc’s €750 billion Next Generation fund provides loans and grants to companies focused on green and digital initiatives. In the same vein as the CHIPS Act, the EU has proposed the European Chips Act, with €43 billion in spending to support the development of the European semiconductor industry.

Reshoring

The incentives embedded in U.S. and European industrial policy are likely to stoke further interest in “reshoring," or relocating manufacturing and industrial facilities to their respective home markets. The concept has recently been in vogue, with the supply chain issues resulting from the COVID-19 pandemic spurring corporate interest in the benefits of reshoring, or at least “near-shoring” to neighboring markets where logistics are simpler and geopolitical tensions less fraught.

Reshoring in the U.S.

Although the aggregate data raise questions about the extent of reshoring to date, there have been some recent, high-profile examples of U.S. companies announcing plans to reshore manufacturing operations:

- GM’s announcement that it will spend upward of $4 billion on electric vehicle and battery production in Michigan
- Toyota’s $1.3 billion battery plant to be constructed in North Carolina
- Intel’s announced plans for $20 billion-plus in investments to construct chip factories in Ohio and Arizona
- Micron Technology’s announcement that it will invest $150 billion in memory chip manufacturing over the next decade, including up to $100 billion for a New York factory
- Texas Instruments’ under construction wafer fabrication plant in Sherman, Texas, with an anticipated spend of as much as $30 billion across the full scale of this project
- First Solar’s announcement of a $1.2 billion investment in new solar panel manufacturing facilities
- LG Energy Solutions and Honda’s announcement of a new $4.4 billion battery plant

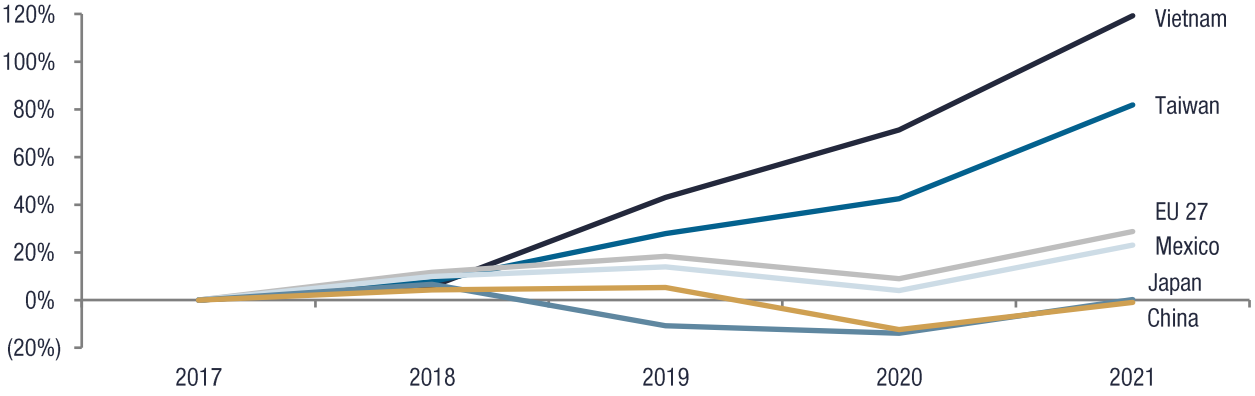
[19] “Making sustainable products the norm in Europe.” European Commission Factsheet, March 2022
[20] “A New Industrial Strategy for Europe.” European Commission, October 2020.

These recent announcements notwithstanding, interest in reshoring remains mostly that: simply interest. Though U.S. manufacturing construction has reached new highs (Figure 7), and U.S. manufacturing employment has expanded, Kearney's reshoring index indicates that total manufactured goods imported as a percent of U.S. domestic output *increased* in 2021, suggesting the U.S. continues to overwhelmingly rely on imported goods manufactured internationally.[21]

This is also evident in the value of goods imported to the U.S. over time (Figure 8), which shows that countries like Vietnam and Taiwan have been the primary beneficiaries of recently shifting supply chains.

Figure 7 Total Construction Spending, U.S. Manufacturing ($ billions)
Source: U.S. Census

Figure 8 Value of Goods Imported to the U.S., Change since 2017
Source: U.S. Census and Moody's Analytics



Sentiment indicates that could change, however. Earnings call references to reshoring remain elevated,[22] and one survey of CEOs indicated that 78% have already reshored some operations or are considering reshoring, with 34% indicating they will reshore over the next three years.[23] The reasons that executives cite as driving reshoring — labor cost and availability, delivery times, logistics costs, and carbon footprint[24] — will continue to loom large.

[21] Kearney Reshoring Index 2021.
[22] Bloomberg, "US Factory Boom Heats Up as CEOs Yank Production Out of China," July 2022.
[23] Kearney Reshoring Index 2021.
[24] Kearney Reshoring Index 2021.

Reshoring in Europe

As in the U.S., empirical evidence on the prevalence of reshoring in Europe is limited. The *European Reshoring Monitor* captured data on European reshoring from 2015–2018, observing a total of 253 cases of reshoring over that period, mostly comprised of relocating previously offshored jobs.[25] Though data are incomplete, in the 99 cases where job creation statistics were available, a cumulative 12,840 jobs were created.[26] The relatively low number of jobs created from reshoring likely speaks to the role of automation in driving the decision to reshore.

A report produced for the European Parliament called expectations for large-scale reshoring in the near-to-medium term "unrealistic," though it noted that the EU's green transition policies will likely have a positive impact on reshoring as firms internalize environmental externalities and focus on novel industrial approaches like the circular economy.[27] The same report noted that geopolitical tensions, specifically between the U.S. and China, will be the "decisive factor" in driving reshoring decisions.[28]

The Promise of "Friend-Shoring"

Geopolitical tensions have also stoked interest in the idea of "friend-shoring" — relocating manufacturing facilities within the borders of broader alliances and making domestic industrial policy inclusive of allies. As United States Treasury Secretary Janet Yellen put it in April 2022:

> *"Favoring the friend-shoring of supply chains to a large number of trusted countries, so we can continue to securely extend market access, will lower the risks to our economy as well as to our trusted trade partners … [R]ather than being highly reliant on countries where we have geopolitical tensions and can't count on ongoing, reliable supplies, we need to really diversify our group of suppliers. Friend-shoring means that we have a group of countries that have strong adherence to a set of norms and values about how to operate in the global economy and about how to run the global economic system. We need to deepen our ties with those partners and to work together to make sure that we can supply our needs of critical materials."*[29]

A "super-bloc" comprising the U.S. and Europe would be a major economic force. The U.S. and Europe together represent 40% of global GDP.[30] If other U.S. allies such as Japan, the U.K., and Canada are included, this group comprises more than 50% of global GDP.[31] Such advanced economies could achieve greater supply chain security and collective independence via friend-shoring and help to mutually reinforce key industries across individual economies.

Already, green shoots of friend-shoring have taken root. In October 2021, the U.S. and EU announced the formation of the Trade and Technology Council, with the aim of harmonizing approaches on trade policy and advanced technologies (though the launch of the Trade and Technology Council also shows the

[25] "Post Covid-19 value chains: options for reshoring production back to Europe in a globalised economy." Directorate-General for External Policies, European Parliament, March 2021.
[26] Ibid.
[27] Ibid.
[28] Ibid.
[29] Janet Yellen remarks at the Atlantic Council, April 2022.
[30] Admiral William McRaven, Peter Orszag, and Theodore Bunzel, "Made in the Alliance," Foreign Affairs, April 2022.
[31] Ibid.

potential pitfalls of friend-shoring, as the inaugural meeting of the council was nearly canceled after France took issue with a U.S. announcement that it would share advanced submarine technology with Australia).

The IRA also contains tax credit provisions that stand to benefit North American and other trade allies alongside American producers of key technologies. Again, though, the IRA demonstrates the nuances of friend-shoring: a provision to favor battery supply chains in countries with which the U.S. has a preferential trade agreement excludes the EU.

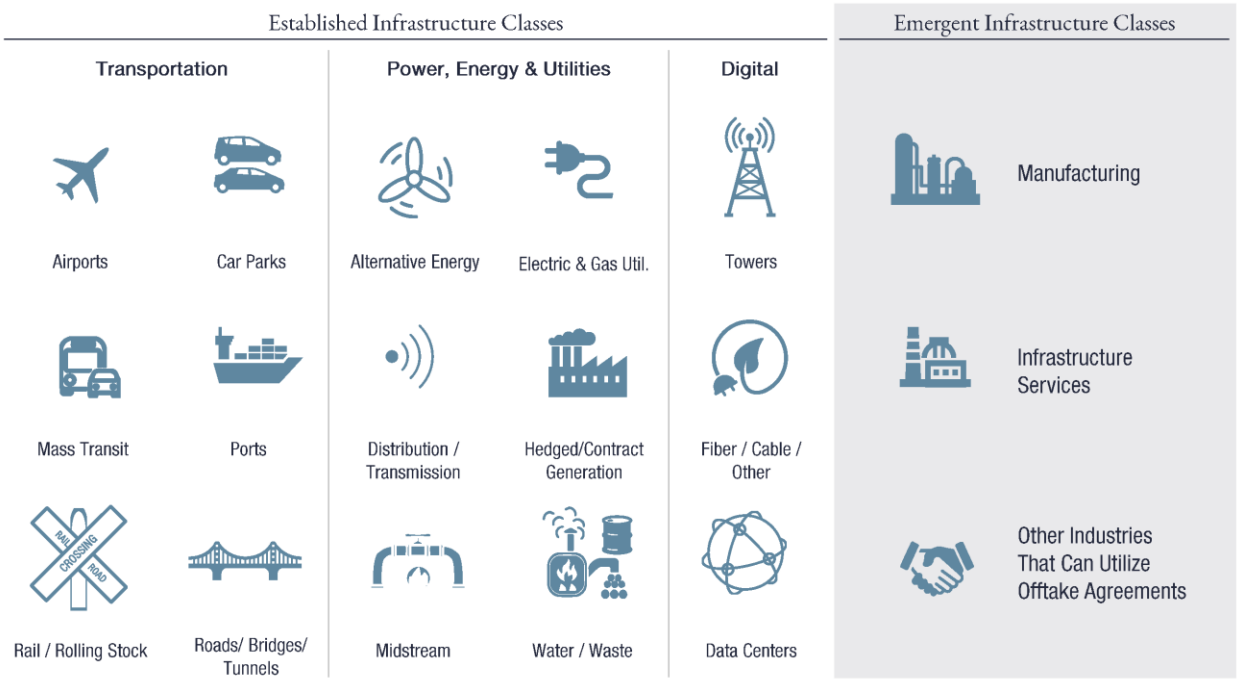
Regardless of the exact geography or set of strategic considerations influencing reshoring, near-shoring, or friend-shoring, these decisions represent major capital expenditure outlays that have already presented, and will continue to present, significant opportunities for infrastructure capital.

4. Industries Primed for Continued Infrastructure Investment

In this environment, infrastructure capital will have the greatest impact on sectors and industries where a preexisting need for private sector investment is supercharged by geopolitical and industrial policy imperatives. The energy transition and digital infrastructure will be particular focus areas, as well as industries like semiconductors and battery production where corporate infrastructure investments can be an attractive alternative to traditional financing arrangements. Importantly, each of these industries present stable, long-term cash flows, or the ability for the corporate entity to ensure a minimum degree of cash flow stability, with either being key to securing the lower cost of capital that infrastructure capital can provide.

Of course, these particular sectors are not exhaustive of the broad array of infrastructure classes, all of which remain important for infrastructure capital (Figure 9).

Figure 9 Overview of Infrastructure Classes
Source: Lazard



Infrastructure Services: In addition to physical assets, investor interest in infrastructure services firms has grown. These service providers offer the opportunity to secure "asset light" exposure to the same infrastructure end markets and megatrends, encompassing the energy transition, digital infrastructure, and traditional utilities. These services firms allow infrastructure capital to engage with other facets of the infrastructure market and will likely be the subject of considerable transaction and investment activity as their respective end markets grow and develop.

Decarbonization and the Energy Transition

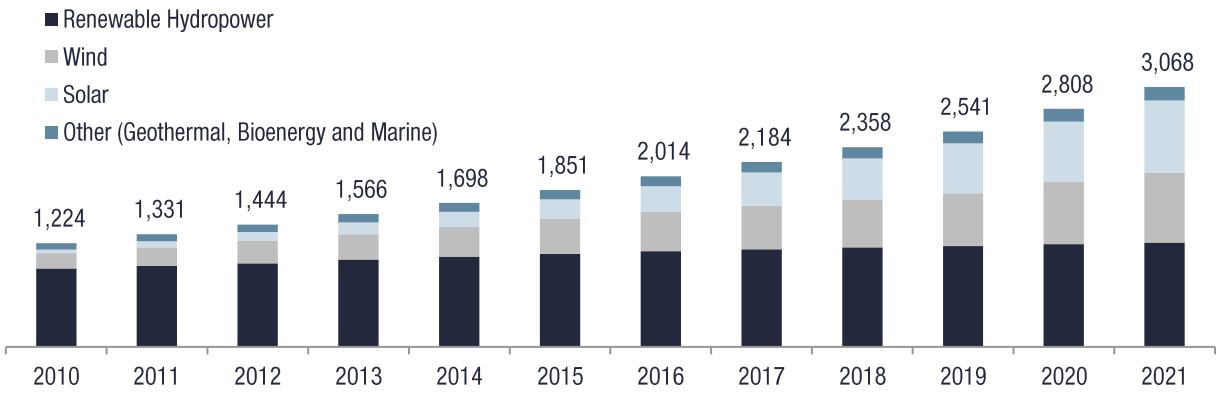
The ongoing energy transition and effort to decarbonize the world economy is one of the most serious priorities for governments around the globe and a major opportunity for infrastructure capital. As the Intergovernmental Panel on Climate Change (IPCC) stated in its 2022 report: "Climate change is a threat to human well-being and planetary health. Any further delay in concerted anticipatory global action on adaptation and mitigation will miss a brief and rapidly closing window of opportunity to secure a livable and sustainable future for all."

Investment Needs and Long-Term Trends

Renewable Energy

Investment in renewable energy capacity over the past decade has been substantial and is accelerating. According to the International Renewable Energy Agency (IRENA), cumulative renewable energy capacity[32] has nearly tripled from 1,224 GW to 3,068 GW since 2010 (Figure 10). This has been driven primarily by the rapid adoption of wind and solar power, where cumulative capacities have grown at an annual rate of 15% and 32%, respectively, well above capacity growth for other forms of renewable energy.

Figure 10 Cumulative Worldwide Renewable Energy Capacity (Gigawatts), 2010–2021
Source: IRENA



Swift adoption of wind and solar renewable energy has been made possible by the rapid decline in the cost of these technologies. The levelized cost of energy for renewables has dropped dramatically and remains low despite recent supply chain volatility.

However, as dramatic as the scope of added renewable power has been, even more will be required to achieve net zero emissions goals by 2050. In a scenario where renewable energy provides the lion's share of global electricity, BloombergNEF estimates that an average of 816 GW of wind, 632 GW of solar, and 257 GWh of battery storage must be installed *annually* between now and 2050.[33] This implies annual solar and wind capacity additions roughly equal to current global capacity.

Net zero investments in key technologies must average $2 trillion in the next decade and nearly $3 trillion in the decade after (Figure 11).

[32] Renewable energy forms include geothermal, bioenergy, solar, wind, marine, and renewable hydropower.
[33] BloombergNEF New Energy Outlook.

Figure 11 Estimated Annual Investment Needed for Select Energy Transition Technologies
Source: International Energy Agency (2021), Net Zero by 2050, IEA, Paris[34]

Select Energy Transition Technologies	Estimated Annual Investment Needs ($bn) 2021-30	2031-40	2041-50
Renewables	$1,148	$1,316	$1,019
Hydrogen	55	235	389
Carbon Capture and Storage	82	142	134
Battery Storage Capacity	52	134	138
EV Charging Infrastructure	38	138	181
Renewable Fuels	132	168	142
Electricity Grid Infrastructure	523	859	725

Electric Vehicles, Batteries, and Charging Infrastructure

Beyond renewables, there are major potential infrastructure investment opportunities in manufacturing the key components of electric vehicles (EVs), especially batteries. The IEA estimates that EV battery demand will grow tenfold by 2030, from 340 GWh to 3,500 GWh.[35]

BloombergNEF estimates that EVs will comprise 23% of global vehicle sales in 2025, up from 10% in 2021.[36] If road transport is to become net zero by 2050, EVs and zero-emission vehicles will need to comprise 61% of new vehicle sales in 2030, rising to 100% by 2038.[37]

Growing adoption will require a concomitant increase in EV charging infrastructure, representing another opportunity. One estimate suggests the U.S. must invest $87 billion in EV charging infrastructure to support a goal of having 100% of passenger vehicle sales be EVs by 2035.[38] Globally, one estimate

[34] Renewables investment includes both electricity and end-use. Hydrogen investment includes both infrastructure and end-use. Carbon capture and storage investment includes investment in fossil fuels with attendant carbon capture, direct air capture, carbon dioxide capture and storage, and end-use carbon capture.
[35] IEA, Global Supply Chain of EV Batteries, July 2022.
[36] BloombergNEF, Electric Vehicle Outlook.
[37] Ibid.
[38] Atlas Public Policy, "How much should the U.S. invest in public EV charging? $39 Billion," April 2021.

suggests that investments in EV charging infrastructure must total between $1.0–1.4 trillion cumulatively between now and 2040.[39]

EV charging fits well within the traditional wheelhouse of infrastructure investors, while EVs and batteries will present potential corporate asset infrastructure investing opportunities.

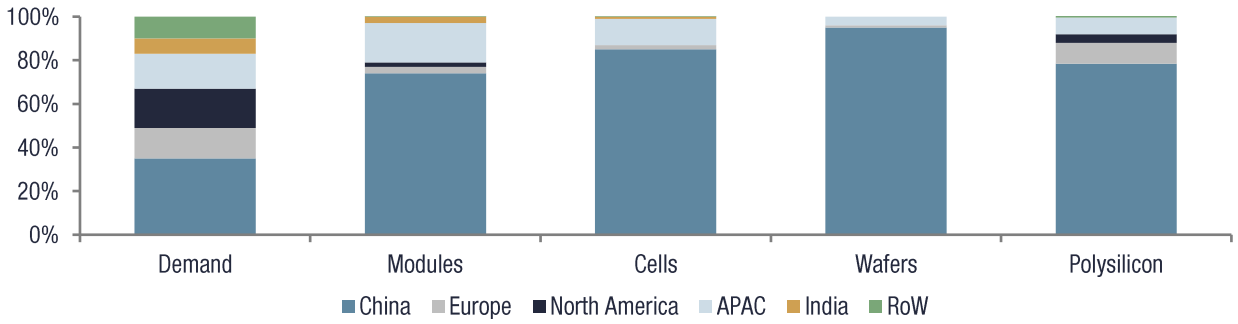
Renewable Energy: Policy Environment and Reshoring Implications

Climate change has motivated significant deployment of public sector resources in both Europe and, more recently, the U.S., with the former maintaining the aforementioned legal requirement to achieve net zero emissions by 2050 that animates the European Green Deal and other investments in renewables.

This need for dramatic investment will also interact with the push in the U.S. and Europe to reshore key energy transition-related supply chains. For example, China dominates the solar photovoltaic value chain (Figure 12), with the U.S. and Europe hardly figuring as global players.

This is a supply chain discrepancy the IRA is explicitly meant to tackle, with $30 billion in incentives for the development of U.S. solar and wind supply chains. As already noted, manufacturers like First Solar have responded to these incentives with plans to invest in U.S. solar manufacturing capacity.

Figure 12 Solar PV Manufacturing Capacity by Country and Region, 2021
Source: IEA



For EVs and batteries, these supply chains are similarly concentrated in China. Roughly 75% of all lithium-ion batteries are produced in China.[40] Only a third of EV production is centered in the U.S and Europe.[41]

In response, the U.S. and Europe have launched a concerted policy response, including increased cooperation between the two. In March 2022, the European Commission and U.S. Department of Energy announced support for collaboration between the European Battery Alliance and the U.S. Li-Bridge Alliance to accelerate supply chain development for lithium-ion batteries. The EU has also pledged €900 million for research and innovation in batteries, with the aim of making the bloc the second-largest producer of batteries in the world.

In the U.S., the BIL provides a total of $7.5 billion in grants and funding for EV charging infrastructure.

[39] BloombergNEF, Electric Vehicle Outlook.
[40] IEA, Global Supply Chain of EV Batteries, July 2022.
[41] Ibid.

Digital Infrastructure

Investment Needs and Long-Term Trends

Digital infrastructure has become a major growth area concurrent with the ever-increasing digitalization of the world economy. Internet connectivity growth has been explosive: one estimate suggests that in the 20 years between 1997 and 2017 North American internet protocol (IP) traffic increased by a factor of 10,000.[42]

Rapid growth can also be seen in the square footage of data centers in the U.S., which has developed alongside the demand for cloud computing and the increasing data-intensiveness of digital applications. Looking only at four major providers of cloud computing capacity — Amazon, Microsoft, Alphabet, and Meta — total data center square footage increased by 37% annually between 2005 and 2017.[43] The result is that data center square footage has more than doubled every three years.

Several interrelated factors have driven this rapid fiber optic and data center development, and will continue to drive investment over the next decade-plus:

- **5G Adoption:** The accelerating adoption of 5G technology will stress existing infrastructure both as the number of data subscriptions increases and the volume of data on these networks expands. Total mobile subscriptions are expected to grow from 8.2 billion in 2021 to 9.1 billion in 2027, with 5G expected to increase to 4.4 billion subscriptions.[44] Meanwhile, global monthly mobile network data traffic doubled from Q1 2020 to Q1 2022, now standing at 93 exabytes (93 billion gigabytes).[45] By 2027, estimates suggest monthly mobile network data traffic will more than triple to 368 exabytes.[46] 5G adoption is driven by ever-growing customer demand for video on mobile devices, accounting for 63% of mobile traffic in 2019 and 76% by 2025.[47]
- **The Internet of Things (IoT):** Between 2018 and 2023, Cisco anticipates that the number of internet connections stemming from the IoT will grow from 6.1 billion to 14.7 billion, encompassing both consumer and business applications.[48] The growth in the IoT is largely connected to the growth in 5G, with the former expected to enable wider applications for the latter through reduced latency. Remote monitoring, asset tracking and process optimization by customers continues to drive demand for IoT connectivity in urban, rural, and remote locations with needs served by both terrestrial and satellite-based wireless services.
- **Fiber-to-the-X (FTTx):** FTTx refers to last-mile fiber optic delivery, whether to a household, business, or other end user. Though all forms of fiber optic have seen rapid growth over the past 20 years, FTTx has been a notable driver of growth alongside data center use cases.[49] Besides the increased connection speed, Fiber-to-the-Home (FTTH) presents significant OpEx and CapEx savings for network operators, generating significant demand for investments in these networks.

[42] Winzer, et al., "Fiber-optic transmission and networking: the previous 20 and the next 20 years," 2018, Optics Express.
[43] Ibid.
[44] Ericsson Mobility Report, June 2022.
[45] Ibid.
[46] Ibid.
[47] Ibid.
[48] Cisco Annual Internet Report (2018–2023).
[49] Winzer, et al., "Fiber-optic transmission and networking: the previous 20 and the next 20 years," 2018, Optics Express.

Ever-growing consumer demand for both downstream and upstream video and rich media services (i.e., TikTok) ensure that FTTx will continue to see increased deployment across the globe.

- **Still-Low Broadband Penetration:** Overall broadband penetration remains low across the world (Figure 13). As of the end of 2021, only 29% of connections worldwide had broadband speeds of greater than 100 Mbps. Growth in high-speed broadband access is expected to be rapid through 2023, which is increasingly important given the anticipated bandwidth demands of use cases like ultra-HD streaming, virtual reality, and cloud gaming.
- **Developments in Data Centers:** Edge data centers are smaller, locally located centers meant to reduce latency and improve overall performance for users. These centers are expected to help bridge the gap between total "useable" data generated (85 zettabytes in 2021, equal to 85 trillion gigabytes) and current data center traffic (21 zettabytes in 2021).[50] Edge data centers also have applications for delivering 5G service in densely populated areas.[51] This is a dynamic that is expected to change given the demand for cloud and outsourced data centers, representing a significant opportunity for infrastructure capital.

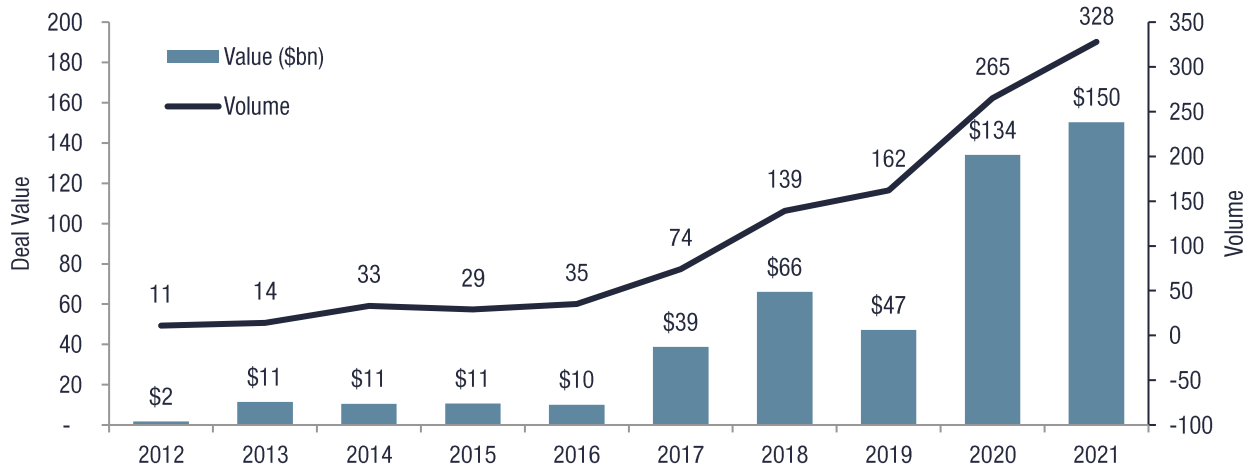
Figure 13 Average Number of Devices and Connections per Capita
Source: Cisco Annual Internet Report (2018–2023)

Region	% Greater Than 100 Mbps						
	2018	2019	2020	2021	2022	2023	CAGR
North America	**16%**	**23%**	**31%**	**37%**	**40%**	**46%**	**24%**
Global	11%	20%	24%	29%	34%	39%	29%
Asia Pacific	14%	20%	26%	33%	42%	53%	31%
Latin America	1%	1%	1%	1%	2%	2%	15%
Western Europe	10%	13%	15%	17%	19%	22%	17%
Central and Eastern Europe	3%	3%	4%	4%	5%	6%	15%
Middle East and Africa	0%	1%	1%	1%	1%	2%	n.a.

These trends are evident in total deal volume in the telecommunications space[52] (Figure 14). Deal value has increased 50% annually since 2012, with record levels in 2021 and 2020.

[50] PwC, "Edge data centers: how to participate in the coming boom."
[51] Ibid.
[52] Includes transactions in fiber optics, wireless transmission, data centers, broadband, subsea cable, and other miscellaneous telecoms investments.

Figure 14 Closed Telecoms Transactions, 2012–2021
Source: Inframation



Digital Infrastructure: Policy Environment and Reshoring Implications

Telecoms and digital infrastructure have often found themselves at the center of geopolitical tensions. Perhaps most notable was the U.S. Secure Equipment Act which requires the Federal Communications Commission to adopt rules stating it will not review applications for networking equipment from firms including China's Huawei and ZTE, that are considered national security threats. Digital infrastructure also frequently collides with flashpoints like privacy and cybersecurity.

In this context, it is interesting that reshoring has received relatively less airtime for digital infrastructure, outside of the focus on semiconductors and other high-tech components that comprise data center servers. Likely reasons may be that:

- Data centers are generally located within the relevant nation's borders, so relocation of these facilities is less salient
- Fiber optics and other key inputs are relatively commoditized and don't carry either the energy independence implications of battery supply chains or the high-tech and national security importance of semiconductors

Telecoms are a key focus area of U.S. legislation. The BIL contains $42.5 billion in grants to states for expanding high-speed broadband deployment. In the EU, the bloc's goal of covering all households with a gigabit network by 2030 is largely shaped on a country-by-country basis, though the EU has suggested that member states should allocate 20% of their post-pandemic Recovery and Resilience Facility to digital projects.[53]

[53] Progressive Policy Institute, "Funding the Next Generation of European Broadband Networks," September 2022.

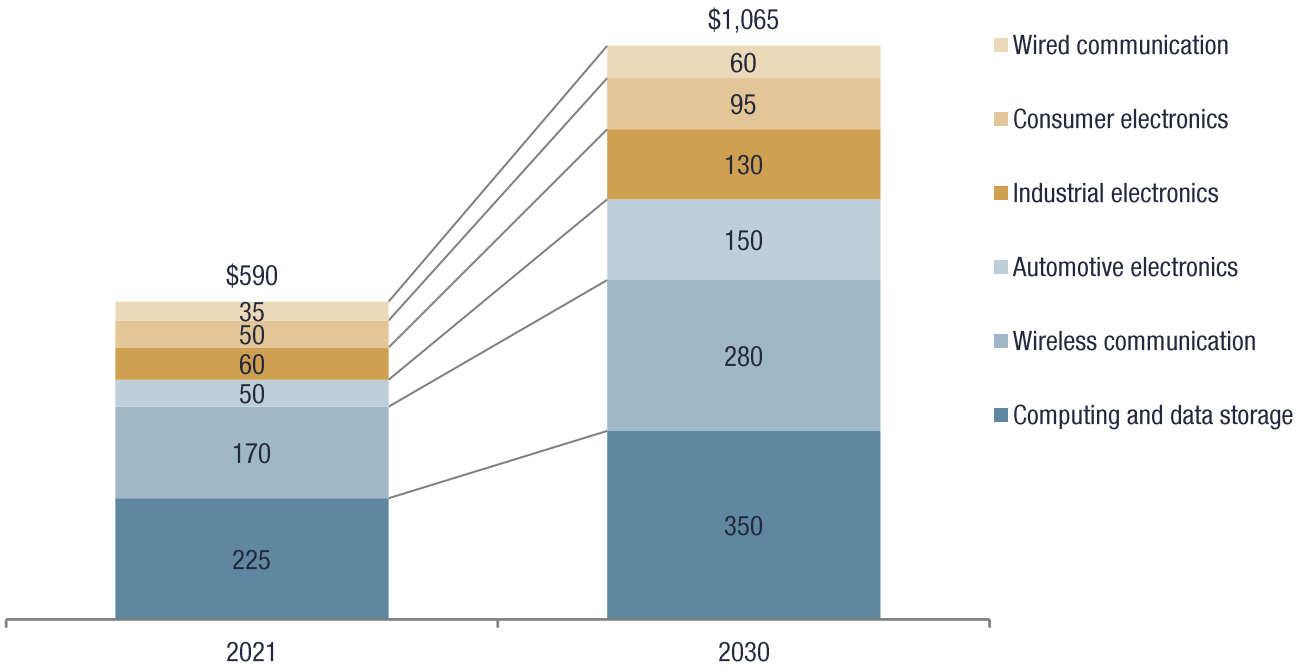
Semiconductors

Investment Needs and Long-Term Trends

Semiconductors are another area in which growing demand and geopolitical imperatives will influence the allocation of capital and development of major projects across the U.S. and Europe (and indeed already have).

From the demand side, between 2021 and 2030, total global semiconductor market value is expected to grow 80%, with most of the growth coming from computing, wireless communications, and automotive electronics (Figure 15).

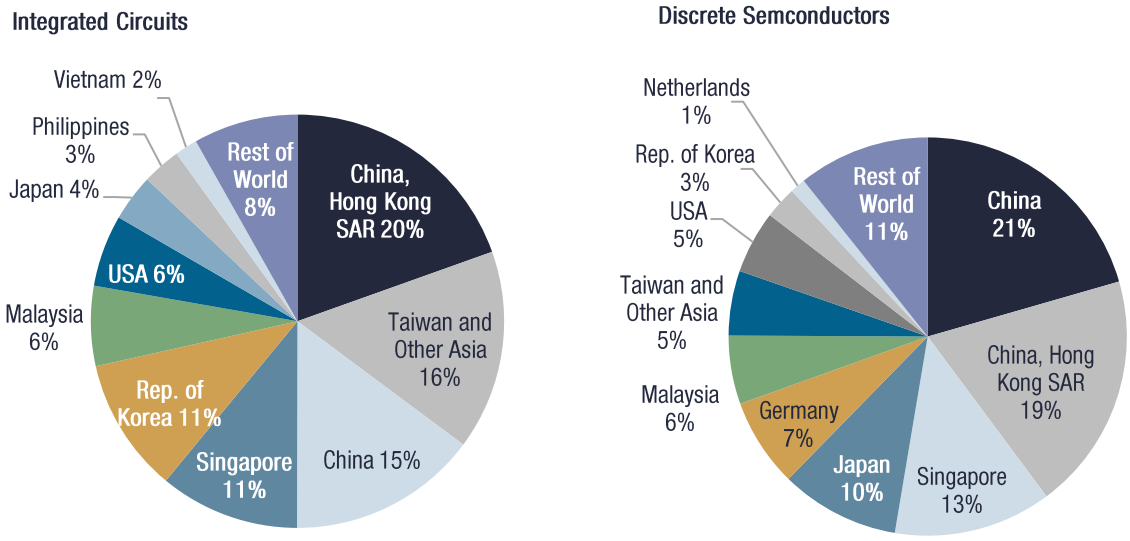
Figure 15 Global Semiconductor Market Value by Vertical ($bn), 2021–2030 (Projected)
Source: McKinsey



Semiconductors: Policy Environment and Reshoring Implications

This rapidly growing demand is colliding with increased pressure to broaden supply chains away from their traditional centers in East Asia as geopolitical tensions build (Figure 16). East Asia dominates the production of integrated circuits and discrete semiconductors, with limited production among western countries, a dynamic that both the U.S. and Europe view as having major defense and innovation implications for their respective economies.

Figure 16 Global Share of Semiconductor Exports, 2020
Source: UN Comtrade[54]



Indeed, the semiconductor sector was one of the first industries to see the confluence of each dynamic factor of the current moment in infrastructure capital. The Intel-Brookfield deal highlighted the power and influence of infrastructure private capital; the impact of domestic industrial policy; the potential financial benefits of corporate asset infrastructure investments; and the geopolitical impulse to reshore a key industry.

Given existing commitments from companies like Intel and Micron to expand manufacturing in the U.S. and Europe, infrastructure capital-related dealmaking in semiconductors is likely to continue.

[54] Total value of exports for each category. Discrete semiconductors excludes value from solar cells/panels. Taiwan data incorporated with trade data from other territories belonging to Asia and countries that do not report specific country recipients of their exports. Classification is per UN internal rules.

Conclusion:
The Infrastructure Moment as Lazard Sees It

Lazard believes these infrastructure dynamics will affect more companies in more ways than most observers currently appreciate:

- Companies of all sizes must now become fluent in the forces shaping the private capital landscape and how these are influencing capital provider decision-making
- Companies must also understand how broad infrastructure has become as an asset class. Once considered emergent assets, renewable energy and digital infrastructure will likely become the dominant infrastructure asset class of the next decade. Companies need to consider how corporate infrastructure will impact their industry and open new avenues for novel financing approaches
- Geopolitical tensions and the attendant pressures these tensions will place on companies cannot be ignored. The rapid realization in the U.S. and Europe of the importance of reshoring key renewable and digital supply chains has led to a remarkably swift deployment of resources to safeguard both supply chains and critical manufacturing. Companies may find themselves in a position of having to make complicated relocation decisions sooner rather than later

Lazard is focused on understanding these dynamics and helping clients unlock the myriad benefits that can accompany partnering with infrastructure capital. Across sector groups and geographies, our bankers are assessing how infrastructure capital might impact our corporate clients. We are also investing in distinct capabilities on digital infrastructure, corporate infrastructure, climate change, the energy transition, and geopolitical advisory.

The moment is complex. The investments called for over the next decade and beyond across digital infrastructure, the energy transition, and other key areas are considerable, all while the broader stakeholder focus on these investments has been revitalized. This makes corporate financing decisions all the more important. Corporates navigating these issues may find a potential solution in partnerships with infrastructure capital and novel financing constructs.

Above all though, corporates that can navigate this inflection point nimbly and creatively will likely reap meaningful benefits.