

GLOBAL INFRASTRUCTURE INITIATIVE

Building resilient infrastructure supply chains

Voices on Infrastructure | June 2022



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Introduction



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Halfway through 2022, it's clear that the global supply chain is still recovering. Inflation is on the rise as scarcity and frictions drive up the cost of energy, steel, and lumber. The postpandemic rebound and large public infrastructure packages are driving up wages. These factors put particularly high stress on the infrastructure ecosystem, an industry already marked by low productivity growth and costs that are outpacing inflation.

Even as these challenges play out—and notwithstanding a potential turndown due to the invasion of Ukraine and monetary tightening—the industry also faces a once-in-a-millennium long-term opportunity. The net-zero-emissions transition adds \$3.5 trillion a year to investment budgets, a sizable part of which will need to be delivered through the infrastructure supply chain. Jobs abound in regions such as the United States, where the Bipartisan Infrastructure Law is working with surging investments to restore advanced supply chains and to unleash massive amounts of funding.

In this environment, three priorities stand out:

- attracting, skilling, and retaining the workforce needed to deliver
- enabling this workforce to increase productivity, including via technology
- raising the material supply chain's resilience and innovation

The construction sector's greatest asset has always been in its people: solving problems, adapting to daily uncertainty, making complex decisions, and doing it all while working with teams of multiple companies operating under layers of contracts. The industry's talent model—for craft trades and project management alike—is rooted in the mindset that, because every project is unique, skills are built through decades of experience with, for example, observing variations in supply chain behavior, craft labor performance, equipment reliability, permitting, and weather delays.

But acknowledging the industry's legacy strengths also highlights the stark challenge ahead. How does an industry that relies on gradual, long-term learning grow its workforce by 30 percent in the next decade? Leaders should invest heavily in capturing the best knowledge from existing workers and combining it with technology to train the new workforce. In an industry that has primarily built its skills by aggregating practical experience over decades, leaders must now apprentice, develop, and retain leaders who don't fit this traditional mold.

In addition to developing new talent, the industry must also enable its existing workforce to boost productivity by being intentional about reducing the degree of variation and uncertainty between projects. This includes investing in technology that truly mitigates rework, deploying modular and prefabrication techniques at scale, and forming more collaborative contracts.

The infrastructure sector also needs to strengthen its resilience, including by diversifying material suppliers and subcontractors, innovating materials, and revisiting contractual structures. Crucially, leaders will need to rethink their capital strategies to incorporate sustainability up-front, leverage advanced analytics, and rely more on asset-based ecosystems than individual project models. Combined, these steps can help form a more resilient, reliable construction supply chain that a new generation of talent can successfully navigate.

Our June 2022 edition begins with an explanation of the 21st Century's first large investment wave and its implications for capital strategies. We then outline a potential framework for resolving the labor gap—a key priority for organizational resilience—and feature two views from the industry on culture and digital innovation. Finally, we round out by looking at what it will take to build the next generation of industry workers to deliver the net-zero portfolio. We hope you find this issue of *Voices* insightful, and we look forward to your thoughts.

News from the Global Infrastructure Initiative

Welcome to the June 2022 edition of *Voices on Infrastructure*, which focuses on building resilient infrastructure supply chains.

Meeting the anticipated demand for infrastructure projects in the coming decades will require the global infrastructure industry to future-proof supply chains. In turn, leaders will need to strategically match the supply and demand for all required resources—skilled labor, materials, and manufacturing capacity—to enable the required scale and pace of project delivery.

I would like to take this opportunity to introduce Melissa Yeo, our new Global Infrastructure Initiative (GII) director, to the GII community. Many of you might remember Melissa from her time with GII three years ago, and we are delighted to have her back. Over the next six months, Melissa will assume the leadership of GII, and we look forward to seeing where she takes our flagship initiative.

In the past two months, we hosted [GII Roundtables](#) in four cities, each with its own distinct topic: Washington, DC (water), Chicago (the energy transition), Hong Kong (construction productivity), and Tokyo (decarbonizing construction). In each instance, we had excellent turnouts of senior leaders with spirited discussions on how to implement solutions on their respective topics. You can read the recaps from each roundtable [here](#). Later this month, our Sydney roundtable will cover scaling electric-vehicle charging to meet net-zero-emissions targets. Please let us know if you would like to engage in our roundtables or site visits.

Last, we are looking forward to our [eighth GII Summit](#), taking place in Tokyo on October 19–21, 2022. The theme is “creating the pathway to sustainable infrastructure,” and the preliminary agenda can be found [here](#). More than 120 CEOs and C-suite leaders are registered to attend, and you can find more details on our [GII website](#).

We hope you enjoy this issue, and we welcome your thoughts on how GII can continue to be a catalyst for driving change toward sustainable infrastructure. If you have comments or would like to subscribe a colleague to *Voices*, please contact us at info@giiconnect.com.



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Here comes the 21st century's first big investment wave. Is your capital strategy ready?

A surge of investment in hard assets will pressure already strained supply chains and project delivery systems. CEOs who transform their capital strategy fast—and first—may win a competitive edge.



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The world will see a once-in-a-lifetime wave of capital spending on physical assets between now and 2027. On current trajectory, roughly \$130 trillion¹ will flood into projects to decarbonize and renew critical infrastructure.

But few organizations are prepared to deliver on this capital influx with the speed and efficiency it demands. Many are burdened with inefficient supply chains and outdated project delivery systems. For one thing, constructing and justifying the cost of a physical asset such as a manufacturing plant is much more difficult than it was decades ago, given inflation, rigorous sustainability requirements, and rapid changes in technology and regulations. Adding to the complexity, the next generation of assets needs to be “set and forget”: the high cost of building them must be offset by lower operating costs.

Delivering on an investment of this magnitude is no longer just the province of IT or engineering experts. Responsibility for end-to-end capital spending projects may need to move squarely into the domain of the CEO and C-suite leaders, who must engage on the portfolio of capital projects to ensure that the CFO is planning appropriately for increased capital outlays for years to come—which may require potential amendments in capital financing and allocation—and for the associated risks in delivery. Boards and shareholders will be particularly interested in the return on such a massive investment and its likelihood of success in achieving the business’s goals.

For decades, capital project leaders have relied on practices that attempt to optimize individual investments, such as a nuclear power plant, an oil refinery, or a pipeline. Cost overruns approach \$1.2 billion on the average project—79 percent of the initial budget—and delays run six months to two years. This approach will not work for new decarbonization and sustainability investments, where groups of similar projects (such as wind farms and solar parks) are delivered repeatedly over a long period of time and require much better performance

than in the past. A project-centric approach also will not work for decarbonizing existing assets, which is a capital-intensive effort that requires long-term planning. Low-carbon projects involve different considerations from traditional capital projects: for example, building a renewable-energy facility may also require building energy-storage capacity to supply backup power if needed. The growing threat of climate risks such as storms and floods means that companies may need to be careful about how they design assets and where they locate them. That may rule out siting a chemical plant near a coastline so it has easy access to a shipping terminal.

A more reliable approach is a portfolio-synergistic strategy in which planning is top-down, with the goal being to develop and deliver each project so that the overall results of the capital spending portfolio are optimized. Implementing this new strategy would be a major business challenge, requiring savvy stakeholder management, capital markets expertise, and an understanding of complex approval processes, as well as the ability to source the necessary talent, navigate supply chain obstacles, and communicate a long-term vision and goals.

That’s a long list of difficult tasks, and organizations are still grappling with it. But some companies are bringing a holistic, CEO-led approach to their capital strategies, leveraging data and analytics to improve the process from design to delivery. In this article, we discuss how these emerging best practices can foster capital excellence and value-creating growth, as well as deliver a competitive advantage for first movers.

A historic investment surge in mobility, power, and buildings

The bulk of capital investment worldwide will go into climate action and sustainability projects, as governments and private-sector organizations move to reduce climate risk and meet the Paris Agreement target of net-zero emissions of greenhouse gases by 2050.² Ninety-three percent of CEOs say that

¹Capital investment will vary by asset class, but on average, an advanced industries company in North America can expect a spending increase of 65 percent over the previous period. An energy and materials company in Asia will see an increase of 57 percent. Across asset classes in Europe, McKinsey projects a 59 percent increase in capital spending, driven by an increase of 120 percent in European energy and materials spending. Our \$130 trillion estimate is based on data from African Development Bank, Asian Development Bank, CP&I practice analysis, Firm Finance, Global Insight, Global Water Intelligence, International Transport Forum, MEED, Moody’s Analytics, National Accounts data, World Bank, World Energy Outlook, and McKinsey Global Institute’s net-zero analysis.

²“What’s in the Paris agreement on climate change?” Economist, October 29, 2021.

sustainability issues are important for the future success³ of their business, and 54 percent expect sustainability to be embedded within the core business strategies⁴ of most companies in the next decade. Governments are imposing carbon taxes and setting decarbonization regulations—for example, in July 2021 the European Commission adopted the Fit for 55 package, a series of legislative proposals to

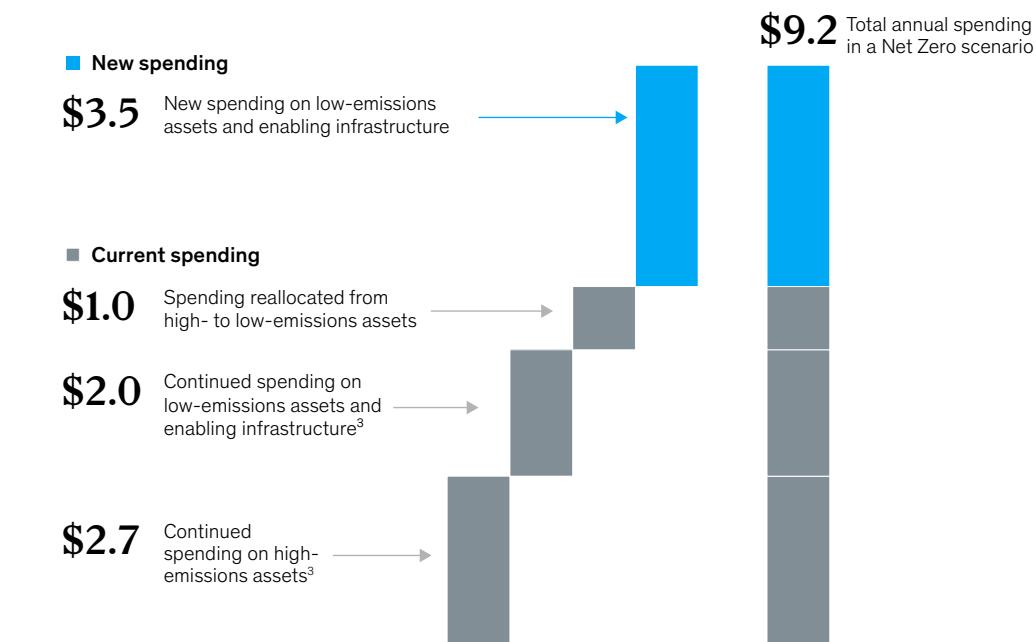
reduce net greenhouse-gas emissions by at least 55 percent by 2030.⁵

Sustainability and decarbonization will receive substantial investment. Reaching net-zero emissions by 2050 requires \$9.2 trillion in annual average spending on physical assets, \$3.5 trillion more than today, according to a new McKinsey report (Exhibit 1).

Exhibit 1

Spending on physical assets for energy and land-use systems in the NGFS Net Zero 2050 scenario would rise by about \$3.5 trillion annually more than today.

Annual spending on physical assets for energy and land-use systems¹ in a Net Zero 2050 scenario,² average 2021–50, \$ trillion



¹We have sized the total spending on physical assets in power, mobility, fossil fuels, biofuels, hydrogen, heat, CCS (not including storage), buildings, industry (steel and cement), agriculture, and forestry. Estimation includes spend for physical assets across various forms of energy supply (eg, power systems, hydrogen, and biofuel supply), energy demand (eg, for vehicles, alternate methods of steel and cement production), and various forms of land use (eg, GHG-efficient farming practices).

²Based on the NGFS Net Zero 2050 scenario using REMIND-MAgPIE (phase 2). Based on analysis of systems that account for ~85% of overall CO₂ emissions today. Spend estimates are higher than others in the literature because we have included spend on high-carbon technologies, agriculture, and other land use, and taken a more expansive view of the spending required in end-use sectors.

³Our analysis divides high-emissions assets from low-emissions assets. High-emissions assets include assets for fossil fuel extraction and refining, as well as fossil fuel power production assets without CCS; fossil fuel heat production, gray-hydrogen production; steel BOF; cement fossil fuel kilns; ICE vehicles; fossil fuel heating and cooking equipment; dairy, monogastric, and ruminant meat production. Low-emissions assets and enabling infrastructure include assets for blue-hydrogen production with CCS; green-hydrogen production using electricity and biomass; biofuel production; generation of wind, solar, hydro-, geothermal, biomass, gas with CCS, and nuclear power along with transmission and distribution and storage infrastructure; heat production from low-emissions sources such as biomass; steel furnaces using EAF, DRI with hydrogen, basic oxygen furnaces with CCS; cement kilns with biomass or fossil fuel kilns with CCS; low-emissions vehicles and supporting infrastructure; heating equipment for buildings run on electricity or biomass, including heat pumps; district heating connections; cooking technology not based on fossil fuels; building insulation; GHG-efficient farming practices; food crops, poultry and egg production; and land restoration.

Source: McKinsey Center for Future Mobility Electrification Model (2020); McKinsey Hydrogen Insights; McKinsey Power Solutions; McKinsey–Mission Possible Partnership collaboration; McKinsey Sustainability Insights; McKinsey Agriculture Practice; McKinsey Nature Analytics; McKinsey Global Institute analysis

⁴A new era of sustainability: UN Global Compact–Accenture CEO study 2010, United Nations Global Compact, June 2010.

⁵Ibid.

⁵“European Green Deal: Commission proposes transformation of EU economy and society to meet climate ambitions,” European Commission press release, July 14, 2021.

Three sector groups—mobility, power, and buildings—would account for approximately 75 percent of the total spending on physical assets in this net-zero scenario. Mobility would account for about 40 percent of the spending, including investments in electric vehicles (EVs) and charging infrastructure. Energy would account for 20 percent and would include developing renewable-energy capacities (for example, solar plants and wind farms), upgrading transmission and distribution networks, and investments in carbon capture, utilization, and storage (CCUS) technologies.

Semiconductor supply chains. The COVID-19 pandemic exposed many supply chain vulnerabilities, particularly those in the booming semiconductor industry.⁶ As a result,

organizations around the world are investing heavily in projects that would help them become more self-sufficient in chip production. In the United States, the Creating Helpful Incentives to Produce Semiconductors (CHIPS) for America Act includes \$52 billion for domestic semiconductor production. In January 2022, Intel announced a new \$20 billion factory outside Columbus, Ohio; the company also expects to construct a multibillion-dollar chip plant in Germany, with supporting facilities to be built in France and Italy.⁷ Taiwan Semiconductor Manufacturing Company plans to build new wafer fab plants outside Taiwan.⁸

Public infrastructure. Globally, governments are investing in public infrastructure and services to drive economic recovery (Exhibit 2).

Ninety-three percent of CEOs say that sustainability issues are important for the future success of their business, and 54 percent expect sustainability to be embedded within the core business strategies of most companies in the next decade.

⁶ “Global semiconductor sales increase 24% year-to-year in October; annual sales projected to increase 26% in 2021, exceed \$600 billion in 2022,” Semiconductor Industry Association, December 3, 2021.

⁷ Mike Wheatley, “Report: Intel to build new chip fab sites in Germany, France and Italy,” SiliconANGLE, December 23, 2021.

⁸ “TSMC confirms plans for semiconductor fab plant in Japan,” Associated Press, October 15, 2021.

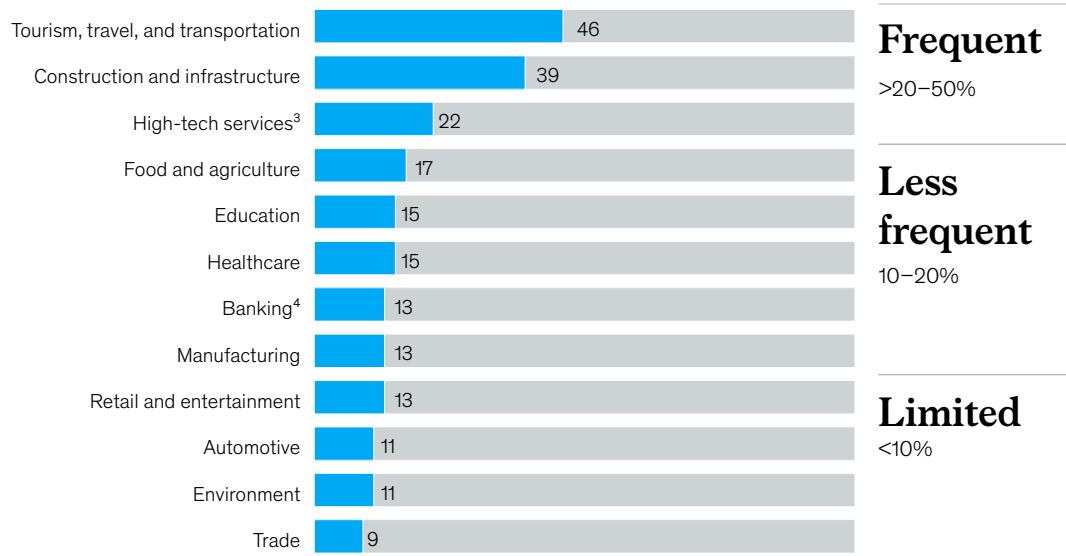
Exhibit 2

Government investments target high-priority sectors and those hit by COVID-19.

Total recovery stimulus,¹ % share



Preliminary nonexhaustive sector² share by country, % (46 countries)



¹Total number made public, collected, and analyzed, to date. Of the 54 countries for which information on stimulus packages was studied, 46 countries have released recovery package/measures so far.

²Top 12 sectors captured based on the frequency of government action. Construction and infrastructure includes real estate.

³High-tech services includes activities such as computer system design, R&D services, software, and telecommunications.

⁴Includes both government credit injection to banks and stimulus to release liquidity pressures for banks.

Source: Official government sources and press coverage of official announcements as of March 28, 2020

For instance, in Europe and the United States, significant funding has been allocated to infrastructure projects across numerous asset classes. In November 2021, the US Congress passed the Bipartisan Infrastructure Law,⁹ which appropriates \$1.2 trillion (including \$550 billion in new funding) to rebuild the country's road and rail infrastructure, deliver high-speed internet access to all Americans, provide greater access to clean water, invest in new clean-power technologies, and improve the nation's overall resilience to the effects of climate change (Exhibit 3).

In Europe, to deliver on the Green Deal's goal of climate neutrality by 2050 and emerge stronger from the pandemic, the European Union has launched the largest stimulus package ever: €807 billion labeled as NextGenerationEU.¹⁰ As of March 2022, the Recovery and Resilience Facility, which funds NextGenerationEU initiatives, has accepted 22 proposals from member states, about 40 percent of which support climate objectives.¹¹

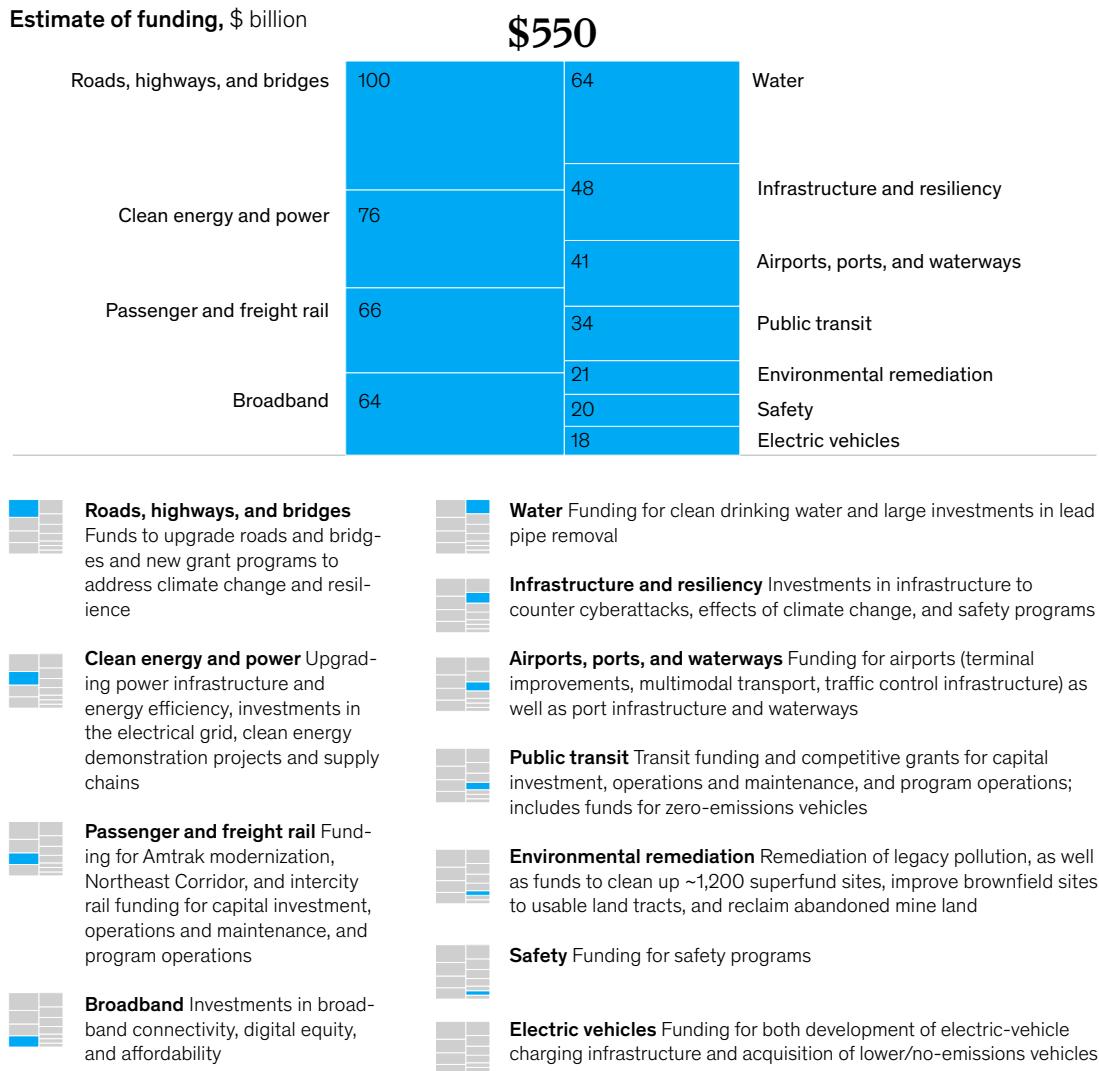
⁹ "President Biden's Bipartisan Infrastructure Law," White House, last accessed February 15, 2022.

¹⁰ "A European Green Deal: Striving to be the first climate-neutral continent," European Commission, site accessed February 22, 2022.

¹¹ "NextGenerationEU: First annual report on the Recovery and Resilience Facility finds implementation is well underway," European Commission press release, March 1, 2022.

Exhibit 3

The US US Bipartisan Infrastructure Law provides \$550 billion in new funding for core infrastructure.



Source: Preliminary estimates based on US Senate H.R. 3684, Bipartisan Infrastructure Law, data current as of March 14, 2022; asset classes provided from White House Guidebook

The operational challenge

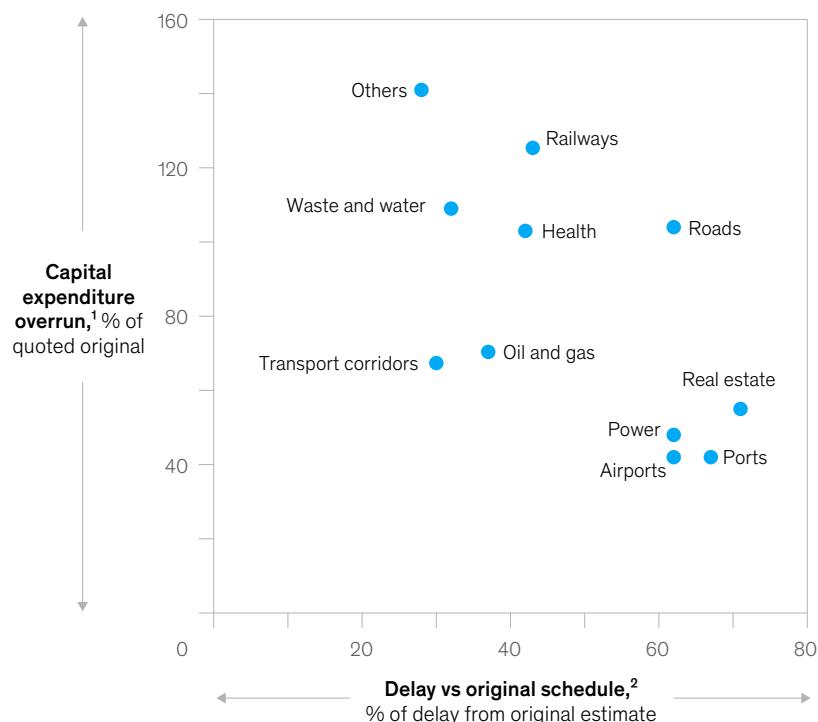
The anticipated capital investment in assets is large, but so are the obstacles to its implementation, including major shortages of labor, equipment, and raw materials. Delivering capital projects is already a challenge. Across industries, projects experience severe cost overruns and delays. As noted earlier, overruns

approach \$1.2 billion on the average project—79 percent of the initial budget—and delays can range from six months to two years. The added burden of growth in capital spending will place more stress on a broken system, with project execution failing to keep pace with anticipated growth (Exhibit 4).

Exhibit 4

Capital project delivery is consistently late and over budget.

Expenditure and delay by sector



The typical schedule delay¹ is between

6–24 months

The share of schedule delays¹ on average compared with initial is

52%

The average cost overrun² for a project is

\$1.21 billion

The average cost overrun² relative to initial budget is

79%

¹n = 427 projects.

²n = 532 projects.

Source: Press releases; McKinsey Overruns Predictive Capability database; McKinsey analysis

Skilled-labor shortages and rising costs have become a major issue in several markets. For example, about 41 percent of the current US construction workforce is expected to retire by 2031, and current construction wage trends far exceed recent rates. In industries such as metals and mining, sustainability challenges will impose additional pressure to produce raw materials to accelerate decarbonization.

Severe capacity constraints are preventing many assets from being built on schedule.

For instance, to meet its requirements for an additional 600 gigawatts of onshore windmill power by 2030, Germany would need to build an estimated 200,000 assets. But availability of space, raw materials, equipment, and labor falls far short of the goal, and approvals are slow. Addressing these issues will be a daunting task, requiring foresight and collaboration among governments, company boards, asset owners, contractors, suppliers, and service providers.

Strategies for capital excellence

Despite these constraints, companies in various industries are already taking steps to optimize capital investment for the new breed of assets. While the basics of effective capital management still apply to all projects, the experiences of these firms reveal some new strategies to consider:

- Incorporate sustainability as a strategy.
- Establish a well-orchestrated ROIC scheme.
- Ensure that technical and engineering expertise is represented in the C-suite.
- Create asset-based ecosystems.
- Deploy advanced analytics for better capital planning.

Incorporate sustainability as a strategy. This means making green operations integral to investment in and management of assets, as these organizations have done:

- An agriculture and food company embarked on a top-to-bottom capital excellence transformation journey with a strong focus on sustainability and quality, including locating and building plants with the lightest consumption of resources possible. The company reviewed its supplier selection, operating model, and level of vertical integration and set up performance management tools to track sustainability implementation.
- Construction industry leaders are playing a vital role in decarbonizing materials such as cement and concrete by focusing on three elements: redesign, reduce, and repurpose, which can achieve up to 48 percent net reduction in emissions.

- Oil and gas players are shifting their portfolios toward greener assets.¹² For instance, Shell expects to cut the number of its refineries from 13 to six,¹³ freeing capital to invest in more sustainable businesses¹⁴ such as electricity, renewables, and services (for example, EV charging). Similarly, BP has embarked on a net-zero journey,¹⁵ and TotalEnergies has conducted several acquisitions in electricity retail, renewables, and the future of mobility.¹⁶
- Pure-play start-ups are building eco-friendly businesses, including purpose-built green assets such as battery factories, renewable-energy production facilities, green hydrogen electrolyzers, and even green steel.¹⁷

Establish a well-orchestrated ROIC scheme. Given the amount of capital available, organizations are at the risk of spending too much for a low return. A robust ROIC plan helps to avoid affecting the company's performance in the long run, especially given that ROIC most likely will be the ultimate key performance indicator driving enterprise value in the capital markets. Today's investment choices—where, when, and how to invest in and build physical assets—will have a significant impact on an organization's performance and ability to survive in the coming years. Here are some examples of long-term ROIC planning:

- A gas company in Europe conducted a thorough assessment of the impact that the European Green Deal would have on its assets and business. New regulation would lead to a 5 percent loss of its business in the next five years, a 30 percent loss in the next 15 years, and a shutdown by 2050. Based on this projection, the company developed a 15-year plan to invest in new businesses based on the capital available, the organization's capabilities, and the time it would take for the new regulations to have an impact.

¹² "Commission proposes new EU framework to decarbonize gas markets, promote hydrogen and reduce methane emissions," European Commission press release, December 15, 2021.

¹³ "Shell accelerates drive for net-zero emissions with customer-first strategy," Shell press release, February 11, 2021.

¹⁴ Ibid.

¹⁵ "Net zero by 2050," BP, site accessed March 3, 2022.

¹⁶ TotalEnergies at a glance 2021, TotalEnergies, July 2021.

¹⁷ David Kindy, "Fossil fuel-free 'green' steel produced for the first time," Smithsonian Magazine, August 31, 2021.

- A food company assessed several potential locations to build its new factory, balancing variables such as the price of carbon compared with the distance to its suppliers and distribution centers. In addition, it performed a complete value improvement analysis to determine the scope of what needed to be built and maximize the ratio of value delivered to the capital spent.

Ensure that technical and engineering expertise is represented in the C-suite. Today, the C-suite tends to be dominated by business leaders. Given the technical challenges ahead and the importance of decisions to be made on assets that will affect future growth, companies may want to consider bringing engineering and technical expertise to the board, appointing chief technology officers (CTOs), and strengthening internal capabilities.

- For instance, a company that wanted to enter the telecommunications market as quickly as possible assigned project management for its network deployment to the CTO as a direct responsibility. The project was deemed too strategically important for the deployment to be managed by a contractor.

Create asset-based ecosystems. Shifting away from individual projects, companies by asset class could create successful working communities of contractors, subcontractors, suppliers, and technology providers. These ecosystems could be built on a shared culture of continuous improvement and a drive toward the technical limit of what is feasible. They could also be a key enabler to solve the challenges related to resource shortages and could allow the development of joint road maps to meet long-term cost and delivery targets rather than create bespoke projects starting from scratch each time. Such ecosystems are already evolving:

- Tesla is building its leading-edge “gigafactories” to expand Europe’s battery capacity and unlock the energy storage, grid utilization, and mobility strategies needed to achieve decarbonization. Strong collaboration, partnerships, and

commitments among internal and external stakeholders may be necessary to scale battery capacity at the required rate.

- Similarly, in public infrastructure, utility companies have started to shift toward a long-term partnership model. They offer contractors the opportunity to bid for a portfolio of projects instead of a single project, with a commitment to provide work for several years, guaranteeing them revenue for a long period of time. This type of partnership builds trust between owners and contractors, allows the development of joint and repeatable operating models, and offers an incentive for contractors to supply relevant resources and skills to satisfy the contract terms. As a result, after a learning curve, projects are delivered faster, with greater accuracy and less owner involvement.

Deploy advanced analytics for better capital planning. Analytics-driven insights have the potential to transform the way organizations work on capital projects and portfolios, targeting key business decisions across the full project development life cycle. Companies can leverage analytics tools at any stage of a project, from capital portfolio optimization to planning optimization and real-time process tracking. For example:

- At its Kalinganagar plant in India, Tata Steel deployed advanced analytics in a three-phased project to improve the facility’s performance, winning acclaim for becoming one of the leaders in the adoption of Fourth Industrial Revolution technologies.
- An engineering firm wanted to understand drivers of overall profitability to increase profits in three years. Using advanced analytics, the firm assessed data from thousands of projects over the past six years and was able to identify patterns that led to increases in project profitability. Analytics also significantly improved forecasting accuracy over the firm’s existing business tools.

- An oil and gas company leveraged AI-based analytics to forecast project duration and identify high-risk activities for a project that had been delayed more than a year. A machine learning (ML) algorithm was trained to assess historical performance across projects and schedules. The ML tool predicted total project delay with near-total accuracy and identified key risk activities. It had the potential to generate millions of dollars in savings if used during project execution.
-

The key to capital excellence in the era of physical assets is getting them into action fast. CEOs may need to rally stakeholders around a common goal, as companies and governments did during COVID-19 vaccine development. Leaders could also accelerate existing internal and external processes to complete capital projects with more precision and speed than ever before. The payoff? First movers will gain a substantial competitive edge—and those who do not act fast will have a hard time catching up.

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Closing labor gaps to revitalize US infrastructure

US construction projects are short-staffed today, and the problem is set to get worse. Here's what the sector can do to close the gap.



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The US construction sector seems set for a jobs boom. The [US Bipartisan Infrastructure Law](#) projects \$550 billion of new infrastructure investment over the next decade, which our modeling suggests could create 3.2 million new jobs across the nonresidential construction value chain. That's approximately a 30 percent increase in the overall US nonresidential construction workforce, which would mean 300,000 to 600,000 new workers entering the sector—every year.

That said, a rise in rates could bring the economy and housing investment to a stop. Even if infrastructure remains strong, building construction could suffer. In addition, the industry is already struggling to attract and retain the workers it needs. Between December 2019 and 2021, construction wages grew by 7.9 percent, reflecting intense competition for employees.¹ And the prospect of higher pay and better working conditions is tempting experienced personnel away from construction and into sectors such as transportation and warehousing, where wages grew by 12.6 percent over the same period.

No end in sight

The labor supply imbalance in construction has multiple root causes, and some are likely to persist. For example, the pandemic accelerated the retirement of many in the baby boomer generation, with an estimated 3.2 million leaving the US workforce in 2020. According to the [American Opportunity Survey](#), among those who are unemployed, concerns about physical health, mental health, and lack of childcare remain the dominant impediments preventing reentry into the workforce. Record job openings and [quit rates](#) highlight employees' growing emphasis on feeling valued by their organization, on supportive management, and on flexibility and autonomy at work. And the pipeline of new

construction workers is not flowing as freely as it once did: training programs were slow to restart operations after the pandemic, and falling migration rates have made it more difficult to attract the international workforce that has been an important source of talent for engineering, design, and contracting activities.

Impact on projects

The interconnected nature of the construction value chain means the labor mismatch generates knock-on effects across the project life cycle and supply chain. By late 2021, project owners reported that up to 25 percent of material deliveries to sites were either late or incomplete. In project execution, the combination of higher hourly rates, premiums and incentives, and overtime payments resulted in overall labor costs that were as much as double prepandemic levels. Meanwhile, difficulty accessing skilled and experienced people led some owners to report project delays related to issues with the quality and productivity of on-site work.

The industry knows from recent experience that skills shortages can hit productivity hard. In the shale-oil boom, the productivity of some tasks fell by 40 percent or more during construction peaks (exhibit). Overall productivity declined by about 40 percent per year when labor was in short supply, forcing owners to extend project timelines by 20 to 25 percent. The impact of a long-term, nationwide labor mismatch might be even more severe than the shale industry's experience, given that oil companies were able to attract new workers from around the country.

Getting back into balance

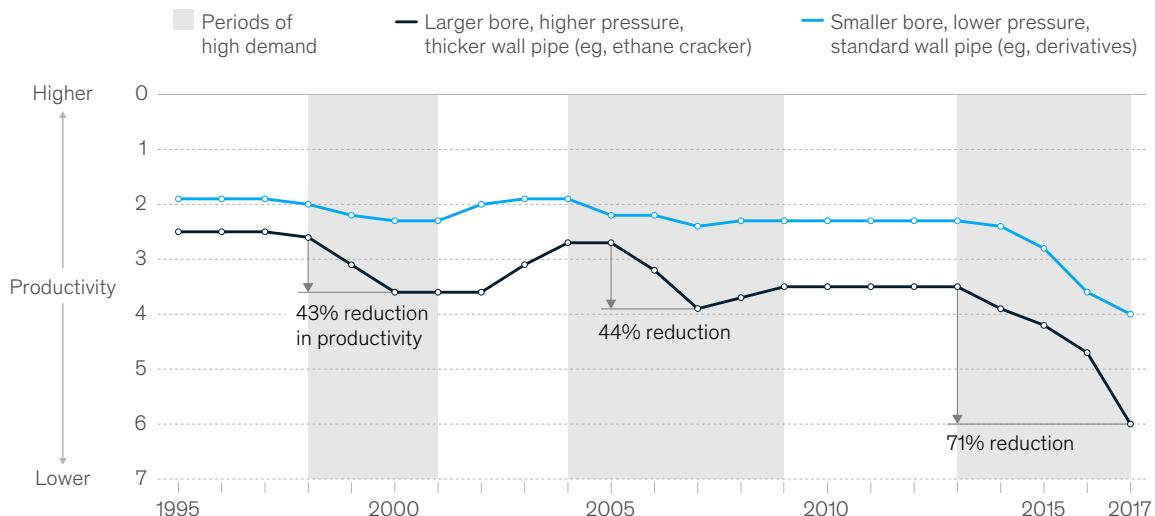
To avoid a decade or more of rising costs, falling productivity, and ever-increasing project delays, companies in the industry should consider thoughtful actions now.

¹Quarterly Census of Employment and Wages, US Bureau of Labor Statistics, accessed March 10, 2022.

Exhibit

During the shale-oil boom, tight labor market conditions correlated with steep productivity declines.

US Gulf Coast piping productivity for major process-industry projects, work hours per linear foot of pipe



Source: Westney Capital Analytics Construction Insider

Those actions could address three components of the challenge. First, companies could do everything possible to maximize productivity through measures aimed at improving efficiency across the value chain. Second, they could expand the pool of available labor by doubling down on accessing diverse talent and working harder to retain the employees already in their organization. Finally, they could consider making labor a strategic priority, giving it attention from senior leadership within companies.

Improving construction productivity

Rigorous control of project scope, design simplification, and standardization can improve productivity long before work starts on the ground. Increasing the use of off-site and [modular construction](#), for example, could allow projects to capture multiple benefits, including accelerated design cycles; the greater productivity associated with industrialized, factory floor manufacturing techniques; automation; and less time spent on site.

During project delivery, smarter execution management, enabled by digital technologies and analytics techniques, could drive better, faster decision making. Real-time data collection, for example, gives project managers earlier, more detailed insights about progress, allowing them to intervene more effectively to maintain productivity and keep projects on track. And lean construction is a proven way to drive significant and sustainable productivity.

Reimagining talent

To ensure access to the skills they need, construction sector companies can accelerate the onboarding of recruits, boost retention by revisiting what employees want beyond wages, and invest more in developing their pipelines of future workers.

In the near term, employers could prioritize the review of job applications and reduce the number of steps in both the interview and the onboarding process. Competitive wages

are now table stakes. [Research on attrition in the postpandemic workplace](#) has shown that employees are placing more emphasis on autonomy, flexibility, support, and upward mobility. In the medium term, both the public and private sectors could look to reduce hiring timelines and shift to a skills-based approach when hiring.

In the longer term, the construction industry can consider a new approach to talent attraction, development, and retention. Talent acquisition could begin early through partnerships with educational institutions, including universities, colleges, and high schools. Companies could also look more widely for potential recruits by considering individuals who have taken alternative educational paths, such as technical degrees or hands-on experience. The [Rework America Alliance](#), a Markle-led coalition in which McKinsey is a partner, illustrates the importance of skills-based—rather than credential-based—hiring. Moreover, identifying and attracting talent from outside the traditional paths used by the construction industry could also help it to increase the diversity of its workforce. Today, 88 percent of the sector's workforce is White, and 89 percent is male.²

Looking at labor through a strategic lens

Labor and skills shortages have the potential to slow growth and erode profitability across the construction value chain. For C-suites, there's no other single issue that could protect against significant cost erosion. Companies could consider establishing a systematic talent

acquisition and retention program that is led by a C-level executive and is a core part of the CEO agenda. That program could be tasked with building a robust fact base focused on current and emerging labor availability gaps, as well as with identifying a bold set of initiatives that address labor-related issues across the value chain. Leadership will likely need to be increasingly present in the field and on the jobsite too, celebrating and recognizing top talent throughout the organization.

The labor challenge extends well beyond corporate boundaries. Since the successful delivery of a project could be jeopardized by labor shortages in a single value chain participant, project owners and contractors may want to adapt the structure of project relationships and contracts. Moving away from traditional contracting methods to [collaborative contracts](#), for example, allows participants to share market risks and opportunities as a project evolves.

The US construction sector is poised to revitalize, replace, and expand the country's infrastructure. Done right, this will power inclusive growth and set up the economy for success in the 21st century. To do so, the sector will need to address its labor challenges. This calls for the application of a diverse set of tools and approaches to create better jobs, get the most out of its people, and optimize agility and collaboration across the value chain.

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²Labor force statistics from the Current Population Survey Database, US Bureau of Labor Statistics, accessed March 10, 2022.



Infrastructure leaders need new capabilities to move toward net-zero emissions

As the infrastructure sector increases its focus on sustainability, leaders must acquire and hone capabilities to manage new complexities in delivering projects on time and within budget.



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In the October 2018 edition of *Voices*, we wrote about the role of cultural change¹ in reducing bottlenecks, increasing innovation, and overcoming the widespread inefficiencies that beleaguer so many large-scale infrastructure projects. As we move through this decade of action on climate change, organizations involved in infrastructure—whether policy makers, planners, financiers, developers, or operators—must consider how the demands and capabilities of leadership will change.

In the past, infrastructure leaders, many of whom come from an engineering or technical background, haven't always been known for—or didn't have to employ—soft skills. In this era of net-zero emissions, however, as the sector adopts novel technologies and adapts to new ways of working, many leaders will be forced outside their traditional frame of reference and will need to develop new capabilities, including interpersonal skills, to encourage people to change their behaviors and mindsets.

In this article, we explore the leadership attributes and capabilities we believe infrastructure companies will need as they move along the sustainability maturity curve, as well as the cultural shifts leaders will need to drive in their organizations.

We expect many of these issues to be discussed at the 2022 Global Infrastructure Initiative Summit in Tokyo as part of the “Leadership and workforce development” content pillar.

A new imperative for infrastructure leaders

As sustainability considerations come to the fore, the rising complexity of projects will mean more frequent interactions with partners up and down the value chain. To be effective in a more interdependent world, employees at all

levels will need to be able to call upon a range of soft skills, including the ability to influence those outside their sphere of control. The most senior executives will need to effectively convey purpose, focus on outcomes, and learn to facilitate collaboration and exert influence among a partnership of different entities at the organizational level.

Purpose attracts people and capital

Given the social significance and environmental footprint of most infrastructure projects, there is a growing expectation among employees, investors, and other stakeholders that projects will be designed sustainably and implemented in a way that creates long-term value.

Today's leaders must first genuinely believe in rising to their organizations' societal purpose; they must then convince stakeholders that they believe in this shared mission. And they are more likely to succeed in doing so if the leaders' own rewards are linked to employee satisfaction and engagement as well as environmental, social, and governance (ESG) targets.

Competition for talent is fiercer than ever, especially for hard-to-abate sectors such as infrastructure that have not been natural destinations for sustainability-oriented talent. To attract and retain the best talent, particularly much-needed IT talent from outside the sector, infrastructure leaders must communicate the societal purpose behind their organizations' activities with clarity and authenticity.

Next-generation leaders will need to have a strong sense of purpose about their work, articulate the organization's purpose coherently and convincingly, and see sustainability and strategy as fully integrated concepts.

Leaders must focus on outcomes

Purposeful leadership is necessary but not sufficient. Leaders—and the people they hire—must have a laser-sharp focus on results.

¹ Manie Dreyer, Greg Stanmore, and Hugh Thorneycroft, “Changing culture: How to break infrastructure’s vicious circle,” Spencer Stuart, October 2018.

We expect many of these issues to be discussed at the 2022 Global Infrastructure Initiative Summit in Tokyo as part of the “Leadership and workforce development” content pillar.

Successful leaders will always be measured by outcomes. However strong their sense of purpose, it is their leadership authority that will likely determine how successful they are in managing risk and driving results without compromising safety.

There will, of course, be trade-offs. Completing high-quality projects on time and within budget in a way that meets emissions reduction goals will be a unique challenge for infrastructure leaders. They will confront difficult decisions, particularly when faced with inflation and a rising cost base.

As a consequence, leaders will have to work with stakeholders across the value chain to modify or replace the traditional economic metrics against which the success of infrastructure projects is assessed. This will test not only their strategic skills but also their powers of persuasion.

Collaborate and influence on the path to net-zero emissions

To reduce emissions, infrastructure leaders must embrace creativity and collaboration, both of which fall outside the normal frame of reference for many. Lasting change will occur at scale, however, only by industry leaders forming cross-sector and cross-disciplinary alliances.

Few of today’s leaders built their careers on industry collaboration, alliances, or cross-sector partnerships. Yet it is precisely this systems-thinking mindset that will spur lasting impact as we work toward net-zero emissions. This is all the more reason for leaders to consider executives

without traditional infrastructure backgrounds and hire lateral thinkers who will stretch outside their silos, challenge assumptions, and approach problems from different angles.

We also expect that infrastructure leaders will need to use their influence in advocating for changes in legislation to accelerate innovation and investment in decarbonization and green tech. Voluntary efforts are clearly not enough to move the dial. As one CEO recently told us, “Technology is moving faster than expected. We have the technology and the capital—now we need the policies to make this transition happen.”

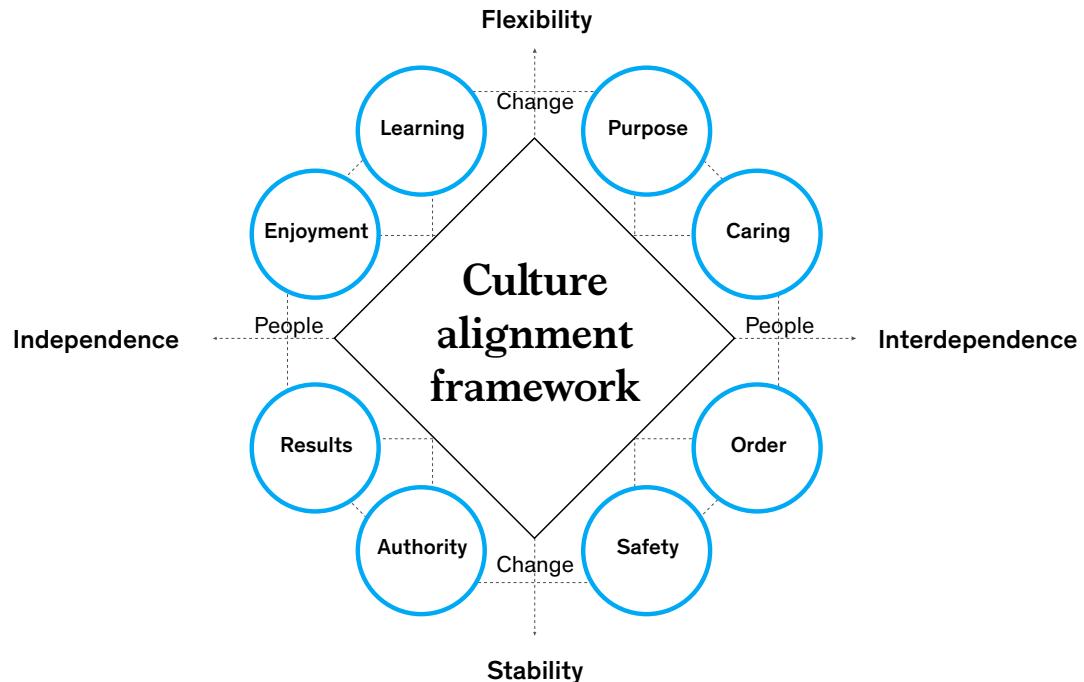
What next-generation infrastructure leaders need

We examined the dominant cultural styles and leadership capabilities that characterize each of the four infrastructure domains today (Exhibit 1). We then conducted a gap analysis to identify key characteristics for next-generation leaders who can ensure competitive advantage for their organizations in striving toward net-zero emissions imperatives.

In the following sections, we offer guidance for policy makers and planners, finance leaders, developers, and operators to help situate their specific roles within the industry ecosystem. We identify changes to culture and capabilities that will need to be reflected in leadership teams of the future.

Exhibit 1

The cultural alignment framework consists of eight distinct sociocultural styles that apply to organizations and leaders.



Policy makers and planners

Of all the participants in infrastructure projects, it is governments, policy makers, and planners who are best placed to create the conditions for long-term, sustainable value creation. In democratic societies, making the investment case to an electorate will require purpose-driven leadership, a willingness to learn from

mistakes, and the ability to collaborate with and influence stakeholders across the infrastructure ecosystem (Exhibit 2).

Finance leaders

For financiers of long-term infrastructure projects, a growing focus on ESG—and the accompanying need to consider nonfinancial

Exhibit 2

Through purposeful learning and collaboration, policy makers and planners can grow value sustainably.

	Today	Future
Culture	Focused on results, caring, safety, and order	Focused on learning and purpose , in addition to results, caring, safety, and order
Leadership capabilities	Acting strategically	Acting strategically, collaborating and influencing

Exhibit 3

Leaders in finance need to create intentional, purposeful cultures to meet the future needs of investors.

	Today	Future
Culture	Results	Results and purpose
Leadership capabilities	Driving results	Driving results and strategic thinking

factors in investment decisions—suggests the need for a stronger culture of purpose (Exhibit 3). Fund managers will always be returns-driven. A new generation of financiers is becoming increasingly demanding about emissions, diversity, and social impact; despite having guaranteed returns over the period of the investment, they will seek to influence sustainable outcomes in the development and construction processes. They will also look at opportunities to invest in companies that will gain a long-term competitive advantage as a result of their approach to ESG.

Developers

Engineering, procurement, and construction organizations lie at the heart of the infrastructure ecosystem. Their success will depend on the ability to create effective alliances and attain

shared goals with government planners and asset owners. Their cultures will need to promote interdependence, learning, and flexibility as workforces adopt new low-carbon technologies and sustainable practices (Exhibit 4). Leaders will need to effect this change by collaborating across the value chain and focusing on building the right talent while still tightly controlling costs and safety.

Operators

A culture of safety and the prudent management of risk have been essential for organizations managing and operating infrastructure projects. However, as projects become more complex and new sustainability-focused technologies emerge, there must be a greater emphasis on learning (Exhibit 5).

Exhibit 4

In the infrastructure ecosystem of the future, developers must acquire a more collaborative- and people-oriented attitude.

	Today	Future
Culture	Results, safety, and authority	Purpose, learning, results, order, safety, and caring
Leadership capabilities	Driving results, leading change, collaborating and influencing	Acting strategically, leading change, developing people, collaborating and influencing

Exhibit 5

Operators will need to expand their focus beyond safety, order, and management to influence and bring together different groups.

	Today	Future
Culture	Safety, order, and authority	Safety, order, learning , and purpose
Leadership capabilities	Driving results and leading people	Driving results, collaborating and influencing

And as joint ventures become more complex, leaders will need to demonstrate a willingness to collaborate with and influence third-party organizations.

Learning and innovation are the new watchwords

A common thread for infrastructure leaders of all stripes is that learning will need to be a high priority for their organizations, as well as for themselves. As has happened in many other industries, in infrastructure the leadership tide is turning toward the collaborative and away from the authoritative. Indeed, the steady erosion of command and control attitudes—and of what a recent Institution of Civil Engineers review calls

the traditional “heroic” style of leadership²—has been a natural consequence of workforces becoming more diverse, inclusive, and purpose-oriented. It is also necessary for innovation, which usually goes hand in hand with more decentralized decision making.

As new technologies emerge, especially those that smooth the path to net-zero emissions, infrastructure organizations should encourage a growth mindset and a heightened focus on learning while empowering individuals to make decisions within their spheres of influence. Those that succeed will be well positioned to make rapid progress toward net-zero-emissions goals and deliver sustainable outcomes for a wide range of stakeholders.

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² Andrew Crudgington, “A systems approach to infrastructure delivery – putting the principles into practice,” Institution of Civil Engineers, April 20, 2022.



Built to last: An interview with Jennifer Lin of Trimble

Trimble's chief platform officer discusses how becoming more tech-forward will help the industry become more sustainable, efficient, and attractive to younger generations.



Jennifer Lin

Senior vice president and
chief platform officer
Trimble



Tony Hansen

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For future infrastructure projects to meet net-zero targets, the global industry will have to future-proof supply chains to withstand unanticipated shocks, including pandemics, labor and materials shortages, regional conflicts, reshoring businesses, technology shifts, monetary policy shifts, and changing regulations. Better situational intelligence will help leaders strategically match the supply and demand for all required resources for projects while improving the scale and pace of project delivery.

McKinsey's Tony Hansen recently spoke with Jennifer Lin, Trimble's chief platform officer, about the role technology will play in helping organizations meet this goal.

Tony Hansen: Technology can produce real, discrete improvements in the way we work. It can help remove many "frictional inefficiencies" that are systemic, such as communicating changes quickly, and allow us to make calculations that were previously impossible or impractical. With this in mind, how can technology enable resilient supply chains?

Jennifer Lin: Technology not only transforms how supply chains work; it also drives business resiliency in several ways. Online data sharing creates new levels of transparency between producers, operators, and customers, opening up possibilities for better team coordination. Connected platforms are instrumental in delivering smarter, greener systems that are more adaptable. By connecting people and data, digital technologies also enable more efficient workflows and faster execution.

Looking specifically at transportation and logistics, smarter workflows help shippers and carriers adjust to the dynamic nature of their markets. For example, a connected supply chain allows shippers and carriers to collaborate and improve utilization of the resources on hand. This, in turn, optimizes vehicle routing, scheduling, and even procurement, which creates a more efficient system across the combined operation.

The connected supply chain also reduces costs and leads to more sustainable operations. For example, we estimate that just a 1 percent improvement in truck capacity utilization across North America would be worth seven billion fewer "empty miles" annually, saving approximately \$8.4 billion and removing 11 billion pounds of carbon dioxide emissions from the environment.

Last, advances in data analytics make it possible to analyze the massive amounts of data coming out of the supply chain and dynamically adjust operations accordingly, allowing the supply chain to become more flexible, efficient, and profitable. For instance, when matching carrier capacity to shipper needs, companies could avoid disruptions by using analytics to dispatch carriers with excess capacity to a shipper that needs freight moved.

Tony Hansen: In what ways can technology adoption help the infrastructure industry meet net-zero requirements?

Jennifer Lin: While there is a lot we must do to reach net-zero emissions, reducing waste in labor, equipment, and materials during the construction process can lower global carbon emissions substantially.

Architects, engineers, and designers are now able to estimate embodied carbon while in the process of exploring design options. Out in the field, visualization tools such as mixed reality make it easier to identify construction errors that would produce negative downstream impacts early enough to prevent such effects.

On the work site, just-in-time material procurement aligns raw-material orders with construction schedules to reduce excessive materials, and precision machine control improves the accuracy and efficiency of heavy earthmoving equipment so that jobs can be completed in less time, using less fuel.

Tony Hansen: What role will technology play in the successful delivery of infrastructure projects?

Jennifer Lin: Despite significant technological advances, US infrastructure is often better known for its high costs and missed timelines than for its technological prowess or efficiency. The Bipartisan Infrastructure Law creates a tremendous opportunity for America to regain an enviable status among the world's infrastructure leaders, but history shows us that funding alone won't ensure success. America spends more per mile on roads than any other country that discloses spending but ranks 13th globally for infrastructure quality.

Digital construction technologies have been proven to help city, county, and state governments shave weeks—or even months—off project timelines and have been used to better manage labor shortages. When implemented by state departments of transportation and other asset owners, digital tools and processes help ensure infrastructure is designed and built faster, cheaper, and more efficiently.

Digital project delivery unlocks the ability for stakeholders to access and use data when they need it. Although stand-alone digital solutions can quickly transform a single workflow, deploying them in isolation often results in a network of disconnected teams producing silos of disparate data. This fragmentation of effort strips away gains faster than individual teams can make them. Ensuring the right data is accessible to the right people at the right time can increase transparency, drive new partnerships and collaboration, improve construction workflows, shorten project life cycles, and lead to better outcomes.

Tony Hansen: What recent advancements in technology make you excited about the potential for change in the built environment?

Jennifer Lin: The rate of technology innovation and its potential to transform the built environment are unprecedented. I'll touch on a couple things that I'm most excited to see growing in adoption. First is the continued shift to constructible design-build project delivery. Labor-intensive workflows and siloed teams are being replaced with more efficient communication

across humans and machines. Outcome-focused planning and collaboration among all stakeholders is happening early in the project life cycle so that stakeholders are aligned long before construction begins.

Second, constructible models, collaboration platforms, and construction management tools are improving intelligent automation and removing the potential for human error while increasing accurate execution at every project stage. Working with a shared model, stakeholders are effectively creating a continuously updated single source of truth about the project that not only ensures transparency across owners, engineers, and contractors but also helps improve the longevity of an operational asset for more predictive maintenance.

Tony Hansen: What needs to change in talent development and retention to mitigate the skill and labor constraints across the value chain? How can technology help?

Jennifer Lin: The construction industry's labor shortage, first prompted by the loss of 600,000 skilled workers during the 2008 recession, has been exacerbated by retiring baby boomers and the COVID-19 pandemic. As the Bipartisan Infrastructure Law creates new demand for workers, the pressure is on to cultivate the next generation of skilled workers in construction and the public sector.

Attracting young people to traditional industries remains an uphill battle, but the increased use of tech is creating new channels of skilled talent. Academic outreach programs have proved successful in educating young people about the professional, financial, and personal merits of a career in construction and are overturning misconceptions that dissuade good talent. Millennials and Gen Zers want to do work that they find interesting and meaningful, but when envisioning careers in construction, they don't anticipate opportunities to work with the latest advances in technology. Highlighting the use of emerging technologies can help attract digital natives.

Tony Hansen: How is Trimble addressing the need to attract, train, and retain the talent required to lead in this industry?

Jennifer Lin: Today's construction jobs need workers with a combination of domain knowledge and technical skills. At Trimble, we're partnering with academic institutions via hands-on engagement with two outreach programs: Trimble Technology Labs and the Visiting Professionals Program.

Trimble Technology Labs provides students with the latest technology solutions used by today's leading architects, engineers, construction managers, farmers, and surveying professionals. There are 28 labs across 16 countries on five continents. The Visiting Professionals Program brings construction industry leaders into university classrooms to engage with students through workshops, lectures, tech demos, and hands-on training.

Jennifer Lin is senior vice president and chief platform officer at Trimble. **Tony Hansen**, based in McKinsey's Seattle office, is the managing director of the Global Infrastructure Initiative (GII).

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Building the net-zero workforce

A four-step strategy can help enable the next generation of industry workers to deliver the net-zero portfolio.



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The journey to net-zero emissions has begun, and it is already clear that the road will be rough. According to UN Secretary-General António Guterres, 30 million jobs in renewable energy and energy efficiency must be created by 2025, rising to 60 million by 2030.¹ Assuming the delivery of planned investments, this net-zero workforce, the size of a large nation, will require the project delivery sector to grow its workforce at roughly twice the rate that it did in the five years leading up to the global outbreak of COVID-19.²

That said, the sector's workforce is already at capacity as new construction ramps up. Recently exposed supply chain vulnerabilities have led to rapidly growing investments in semiconductor factories in Europe and the United States.³ And a recent study anticipates the CAGR for the next five years to be about 11 percent, with strong demand in both developed and emerging economies.⁴

A net-zero workforce is needed to deliver the net-zero portfolio

If global warming is to be limited to 1.5 degrees Celsius by 2050, work must begin now to build a net-zero workforce that is tailored to the vision and scope of the net-zero portfolio.

Leaders can drive a four-step strategy that leverages the competitive advantages of working toward net-zero emissions while overcoming past barriers to high performance (exhibit).

Harness enthusiasm

In 2017, the World Economic Forum surveyed 25,000 people aged 18 to 35, representing 186 countries. For the third year in a row, nearly half of respondents agreed that "climate change and the destruction of nature" is the most serious issue facing the world today.⁵

Many people want the results of their work to be important, and what can compare with

¹"Global roadmap for accelerated SDG7 action in support of the 2030 Agenda for Sustainable Development and the Paris Agreement on Climate Change," United Nations, 2021.

² Based on employment data from McKinsey and Westney Capital Analytics. Our analysis is based on the years from 2014 to 2019 to account for any skewing caused by COVID-19. For more on how the sector can close the gap in the years to come, see Garo Hovnanian, Ryan Luby, and Shannon Peloquin, "Bridging the labor mismatch in US construction," McKinsey, March 28, 2022.

³ Steffen Fuchs, Homayoun Hatami, Tip Huizenga, and Christoph Schmitz, "Here comes the 21st century's first big investment wave. Is your capital strategy ready?," *McKinsey Quarterly*, March 18, 2022.

⁴ Construction global market report 2022, Research and Markets, December 2021.

Exhibit

There are four steps in driving the success of the net-zero workforce.

1

Harness enthusiasm



2

Embrace technology



3

Standardize work



4

Build skills



working to combat climate change? Today's workforce also wants long-term careers with job security and opportunities to advance and diversify. Work on the net-zero portfolio offers both of these things (see sidebar, "Building the net-zero workforce is an opportunity to address social goals"). That said, maintaining the carbon balance necessary to reach net-zero emissions will require capital investments long past 2050.

National Grid's *Building the net zero energy workforce* report illustrates how asset owners in Europe are leveraging these advantages. Seventy-eight percent of respondents of all ages in the United Kingdom consider it important to play a part in reaching net-zero emissions, and 57 percent expressed interest in working for organizations that contribute to this goal. Among respondents aged 18 to 24 ("Generation Net Zero"), tackling climate change is the second most popular cause they want as part of their jobs (the first is helping provide education for young people). Finally, National Grid launched The Job That Can't Wait, a recruiting campaign that shows how working with the utility was helping to tackle climate change.⁶

Embrace technology

Steeped in technology since childhood, the net-zero generation is attracted to career opportunities that offer technology-based learning and growth. Regrettably, the construction industry is among the least digitalized sectors, ranking last in Europe and second to last in the United States (ahead of only agriculture).⁷

The challenge has not been a lack of innovation—there has been no shortage of improved practices and technologies—but rather insufficiently widespread adoption. The slow uptake has caused the project delivery sector to lag far behind others in productivity improvement. Although the world economy has improved productivity by an average of 2.8 percent per year over the past 20 years, global construction productivity has improved by only 1.0 percent per year. In most advanced economies, it has not improved at all.⁸

The net-zero workforce must be highly productive to meet climate change goals, and widespread technology adoption can improve

⁵ Global Shapers Annual Survey 2017, World Economic Forum, 2017.

⁶ Building the net zero energy workforce, National Grid, January 2020.

⁷ "The next normal in construction: How disruption is reshaping the world's largest ecosystem," McKinsey, June 2020.

Building the net-zero workforce is an opportunity to address social goals

Although most people agree that slowing the progression of climate change will produce long-term benefits for future generations, short-term sacrifices are required. Ongoing support for work toward net-zero emissions requires people to view long-term benefits as worth the present-day costs. That said, opportunities resulting from the rapid ramp-up of the net-zero workforce will enable leaders to provide real benefits that people can enjoy today.

Strategies for building the net-zero workforce also offer unprecedented opportunities to address the Sustainable Development Goals adopted by UN member states in 2015.¹ This is a potential win-win proposition—by explicitly addressing these Sustainable Development Goals, the industry could increase its value proposition for employees and society.

¹ "The 17 goals," The United Nations, accessed April 15, 2022.

productivity in many ways. McKinsey's recent mapping of the global construction technology ecosystem found that the largest areas of application are 3-D printing, modularization, robotics, digital-twin technology, AI, and supply chain optimization. These technologies are also being used to enhance project management tasks such as estimating, manpower optimization, materials management, scheduling, and risk management. Out in the field, applications are found in progress and performance dashboards, compliance assurance, and drone-enabled inspections.⁹

Productivity also requires minimizing or eliminating nonproductive activities, such as waiting for materials or information, redoing work, or dealing with ineffective supervision. Furthermore, design process applications are enabling disciplines to be more highly integrated to reduce nonproductive time and improve efficiency.

Safety can be better assured when every person across the project delivery ecosystem has a safety-driven mindset as well as the skills and tools to implement best practices. On this point, technology has a clear role to play in improving construction safety. Examples include using wearable technology to track someone's location and using cell phones for immediate notification if an incident occurs. Similarly, productivity improvement techniques, such as modularization and advanced 3-D modeling, can help. Technology-enhanced training methods can greatly improve safety awareness and skills. For example, the virtual work environment offers a safe way to provide training for potentially hazardous areas, as well as to learn safety practices by experiencing accident risk scenarios in real time.

Standardize work

The global scope and decades-long time span of net-zero investments can enable portfolio

strategies that will have a profound impact on productivity.¹⁰ Perhaps the most effective of these is standardization.

Standardization enables rapid upskilling, consistently high and continuously improving engineering and construction productivity, an attractive investment climate for expanded manufacturing and assembly facilities, and the critical mass of applications needed for rapid implementation of new technologies. It also facilitates modularization and prefabrication, enabling production to be moved from construction sites to indoor facilities where higher levels of quality, safety, and productivity can be achieved.

Standardized designs provide the basis for cross-functional integration during the design process, resulting in standardized work packages that can drive continuous improvements in productivity. These standardized work packages also enable lean construction, which leverages collaboration via integrated planning and performance management to reduce waste and optimize execution efficiency.¹¹

Build skills

The net-zero workforce would provide opportunities across the project delivery ecosystem, including asset owners and operators, engineering and construction contractors, providers of technology-driven solutions, and materials suppliers using green technologies. While conventional engineering, manufacturing, project management, construction, and operations skills will still be in demand, new technology-driven skills—particularly related to AI, data analytics, and digital design—will be as well. As the industry becomes more driven by technology and automation simplifies rote tasks, opportunities for higher-skilled positions are likely to increase, with the bonus of enabling entry-level team members to be more productive.

⁸ "Reinventing construction through a productivity revolution," McKinsey Global Institute, February 27, 2017.

⁹ "Rise of the platform era: The next chapter in construction technology," McKinsey, October 30, 2020.

¹⁰ For more on standardization, see Tom Brinded, Justin Dahl, Erikhans Kok, and Richard Westney, "Capturing the net-zero opportunity with portfolio synergies," McKinsey, April 6, 2022.

¹¹ "Bridging the labor mismatch," March 28, 2022.

Standardization and technology combine to create numerous pathways for rapidly acquiring new skills. According to a research report from the Construction Industry Training Board (CITB), immersive learning is revolutionizing skills acquisition.¹² By fully involving trainees in a realistic, interactive, and digital environment, immersive learning helps trainees acquire key skills, such as operating a crane or scaling a wind turbine, quickly and in ways that appeal to young people.

For those already engaged in the industry, building the net-zero workforce can provide opportunities for reskilling. For example, as the energy sector transitions from oil and gas to clean and renewable energy, process-engineering skills can be redeployed to design carbon capture, utilization, and storage (CCUS) facilities. Similarly, offshore engineering skills can be applied directly to the design of fixed and floating offshore wind installations, and

gas-processing skills can be applied to the latest hydrogen technologies.

With the planet on the road to net-zero emissions, progress depends on how well the actors that make up the global project delivery ecosystem manage essential transformations.

Transformations are typically driven by external forces, advances in science and technology, or leaders seeking to improve performance. Climate change provides the call to action; science and technology provide the means; and leaders across the globe can provide new public, financial, and delivery strategies to ensure that the capacity to deliver these projects will not only have an impact on the tens of millions of people joining the industry—but also transform it into the high-performing engine of progress that the world needs today.

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This article is the third in a series of five covering the challenges of delivering the net-zero portfolio and exploring the transformational opportunities it presents. It follows “[Capturing the net-zero opportunity with portfolio synergies](#),” which was published in April. Please check McKinsey.com in August for the next two articles in the series, which discuss how to ensure bankability and progress on Sustainable Development Goals.

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¹² “A new reality: Immersive learning in construction,” Construction Industry Training Board (CITB), September 30, 2017.

Roundtable

Washington, DC 2022: Future-proofing our water infrastructure

The United States faces aging water infrastructure, with the average water-network pipe built 45 years ago and high rates of breakage in recent years. Even as the investment backlog grows, new issues have emerged such as climate resilience, cybersecurity, and a relatively slow rate of digital innovation.



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The Bipartisan Infrastructure Law (BIL), signed in November 2021, commits more than \$55 billion to funding the modernization of water infrastructure. Amid this influx in capital, concerted effort is required to maximize value and ensure long-term resilience, affordability, and equity.

On April 12, McKinsey's Global Infrastructure Initiative (GII) hosted a roundtable with senior leaders across the water landscape to discuss these issues and potential actions. Participants represented investors, operators, service providers, the public sector, and technology providers. The following key themes emerged:

- *The funding for water infrastructure in the BIL provides the conditions for a “once in a generation” investment opportunity, but it is not a standalone solution.* After years of grappling with aging assets, the BIL will unlock private capital and awareness at an opportune moment for infrastructure. However, to achieve safe, affordable and resilient water infrastructure, the new funds must be used wisely. One participant said, “Instead of ‘build back better,’ I’m worried we’re on a path to ‘build back the same.’” Funding should be deployed to new assets that are designed and delivered for current and future needs. One example is integrating climate resiliency at the scoping and feasibility stage, not as an afterthought, and ensuring that the benefits of resiliency investments are measured as part of a broader sustainable business plan for the utility, city and region.
- *Design water infrastructure solutions holistically.* Innovating in procurement and removing organizational silos will be essential to optimize the planning, delivery, and operations of utilities, so that solutions are designed, funded and deployed holistically instead of in a compartmentalized, project-specific way. Build on proven models such as DC Water’s Blue Plains projects that provide holistic solutions to water infrastructure needs in ways that generate environmental and financial benefits for the community.
- *Reach low-income and vulnerable populations.* BIL funding now prioritizes communities that have historically lacked access. However, to unlock this funding, government agencies could work to ensure

technical assistance is available in a cost-effective manner to help small utilities and underserved communities address environmental justice issues head-on and compete for funding (e.g. for technical design, holistic business planning and grant writing). Consider moving beyond capex grants to equipping these underserved regions and utilities to effectively maintain and operate any new infrastructure that receives funding.

— *Institute structural rewards for innovation.*

Participants discussed the industry’s culture of conservatism and risk aversion. The industry needs different structures to reward true innovation. These include rate structures and procurement models with incentives for achieving KPIs around water quality and service, using different technologies and operating models instead of defaulting to the status quo. Novel solutions can “start small, simple and decentralized” before being replicated and scaled. For example, by encouraging shared service subscription offerings in a consolidated regional model, small utilities could access technology to improve their performance at affordable rates.

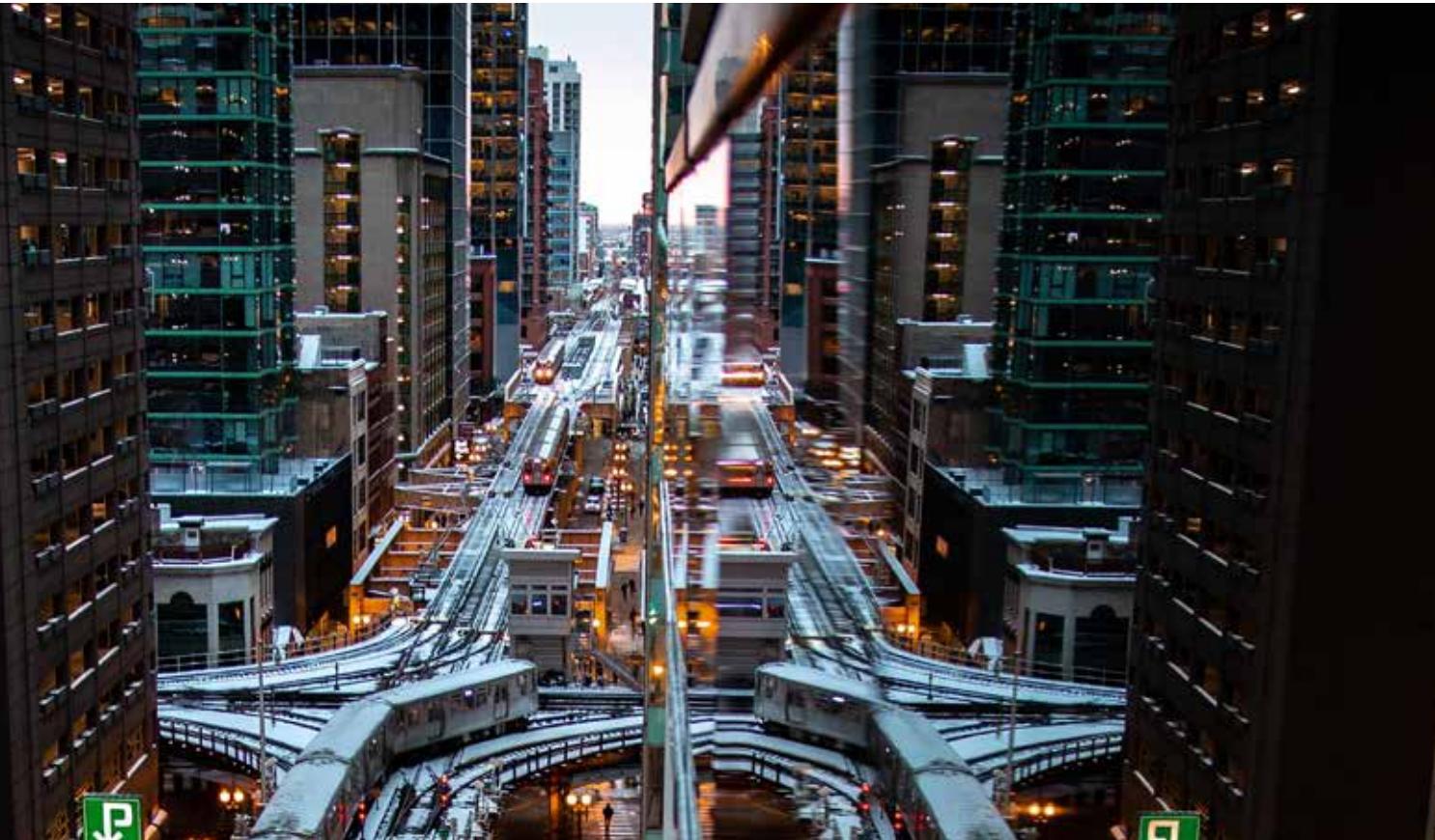
— *Double down on talent attraction.* Amid a retiring workforce, innovation can be enabled by injecting new talent and making the water landscape more attractive to new generations of the workforce. “Rebranding” could enhance the recruiting value proposition as an opportunity to have a meaningful career in a sector critical to the environment and sustainability, with the opportunity to solve pressing societal and community issues. The limiting factor is rarely technology; rather, it is more often a shortage of expertise amid an aging workforce.

— *Elevate awareness around the importance of water.* Many participants felt that water is elevated only in times of crisis. In reality, as one participant said, “nothing happens without water”—from manufacturing consumer products to cooling a power plant. Educating the public and decision-makers can assist with talent attraction, investment, and broader community activation. Engaging constituents as true customers—with distinct needs and preferences—could be one way to start.

Roundtable

Chicago 2022: Preparing our power grids for energy transition and climate change

The energy sector is undergoing a major transformation.



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With the shift to net-zero resources, the need to replace aging infrastructure and build resiliency for climate risk will require a dramatic increase in capital spending on our energy systems, delivered at unprecedented pace. We face this task from a challenging starting point—with weak construction sector productivity, growing supply chain challenges, and emerging labor shortages—particularly in critical skilled trades. Improving project performance and the delivery of capital are paramount to accelerating the energy transition and preparing our energy systems to both mitigate and respond to the impacts of climate change.

On April 27, McKinsey's Global Infrastructure Initiative (GII) hosted a roundtable with senior leaders from utilities, transmission operators, power producers, engineering and construction companies, and investors to identify what steps need to be taken now to accelerate the transition. The following key themes emerged:

- ***Collaborate to drive efficiency across system-level changes.*** Achieving net-zero targets will need to be implemented in a way that maintains energy system safety, reliability, and affordability. This requires coordinated collaboration with all stakeholders—across the value chain, regions, and sectors—to achieve the consensus needed to progress. Strategic partnerships and cross-industry collaboration/coalitions on capability building, planning, financing, and project delivery could help allocate costs and risks, drive innovation, scale impact, and facilitate aligned policy and regulations.
- ***Think big ... and small!*** The scale of the challenge offers an opportunity for the energy sector to embrace innovation and to reimagine how we plan, finance, build, and operate our energy systems. Not only do we need a much bigger grid and to dramatically shift our generation mix, we can also better leverage distributed resources (e.g., energy efficiency, demand response) to complement these larger-scale solutions which often have

higher costs and longer lead times. This will require restructuring regulatory incentives and market mechanisms such that utilities assess distributed solutions as they would large capital projects.

- ***Embrace uncertainty.*** The traditional utility planning model requires high degrees of certainty to ensure regulatory compliance and ability to meet set standards. As we embark on this new era—with less long-term predictability around customer behaviors, technologies, and weather events—previously held standards and models will no longer hold. New tools and processes must be established to enable probabilistic planning and decision-making, transparently testing and comparing scenarios across stakeholder groups to jointly decide on a path forward, despite inherent uncertainty.
- ***Align policy and regulation with the challenge.*** Across the energy system, from generation to consumption, policy has a major impact. For example, updating energy codes to encourage efficient consumption can reduce the need for infrastructure investments to meet rapidly growing load. Additionally, transparent, streamlined permitting and approval processes that take a portfolio approach to infrastructure reviews can accelerate needed projects. Overall, a national energy policy would be transformational to help remove uncertainty, encourage investment, and achieve the required speed and scale.
- ***Take a portfolio approach.*** Having a full portfolio perspective of the energy system's needs enables stakeholders—including utilities, EPCs, power producers, and regulators—to realize efficiencies by standardizing design, prioritizing projects, driving economies of scale, managing risks, and accelerating execution. This holistic approach includes a cross-sectoral view that incorporates shifts in the transportation sector, buildings, and industry, all of which impact the energy system requirements and the ability to scale projects at the required pace.



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The world's largest organizations turn to McKinsey & Company to make radical change when it matters most. From more than 130 locations in 65 countries, McKinsey's Capital Excellence Practice, together with our global network of industry and sector experts, helps companies deploy best-in-class thinking across the capital-projects portfolio and project-delivery value chain.

Partnering with organizations and their leaders, we challenge traditional approaches to productivity improvement and environmental sustainability in capital projects, transforming capital strategy, project planning, and delivery practices throughout the project lifecycle. Our integrated approach brings together functional and sector specialists who can be on the ground where and when organizations need them, guiding capital projects for public- and private-sector entities in sectors including real-estate and infrastructure development, transport and logistics, metals and mining, energy and materials, aerospace and defense, and advanced manufacturing.

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Global Infrastructure Initiative

Since 2012, McKinsey & Company's Global Infrastructure Initiative (GII) has convened many of the world's most senior leaders in infrastructure and capital projects to identify ways to improve the delivery of new infrastructure and to get more out of existing assets. Our approach has been to stimulate change by building a community of global leaders who can exchange ideas and find practical solutions to improve how we plan, finance, build, and operate infrastructure and large capital projects.

GII consists of a global summit, regional roundtables, innovation site visits, and the *Voices on Infrastructure* digital publication. The eighth GII Summit will take place in Tokyo on October 19–21, 2022.

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