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GLOBAL INFRASTRUCTURE INITIATIVE

Embracing technology and sustainability in freight transport

Voices on Infrastructure | August 2022



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Introduction

Freight transport is at the heart of global supply chains—from long-distance container shipping to last-mile local delivery—and a significant carbon emitter. In 2020, the transport sector accounted for 21 percent of global carbon dioxide emissions,[1] with trucks, rail, and ocean freight driving a sizable share.



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Rapid decarbonization of the sector will require industry leaders to rethink long-term infrastructure investments, embracing both technology and sustainability. On these points, investor requirements are growing. Our estimates show that as much as $50 trillion of assets are managed by investors who prioritize environmental, social, and governance factors, and that $3 trillion to $5 trillion will be at stake across industries by 2030.

Stakeholders are quickly starting to see sustainability as a competitive advantage, rather than an executive priority. New innovations and markets are already shaping the future of commercial urban transport, with OEM technology, electrification, autonomy, sustainable fuels, and digitalization all being key components of how the industry needs to transform. And customers' behavior is changing, with rising demand for green transportation to help satisfy their own carbon abatement commitments.

Now is the time to scale innovations—such as electric vehicles (EVs), fast-charging infrastructure, and hydrogen fuel cells—to enhance the sustainability and resiliency of our freight transportation system, reduce the sector's outsize impact on the environment, and protect infrastructure from the effects of climate change.

This issue of *Voices on Infrastructure* features insights on these topics and more. McKinsey spoke with Robert Falck, founder and CEO of Swedish freight-technology company Einride, and Christoph Hempsch, head of sustainability for Deutsche Post DHL's German Post and Parcel. The former interview covers how sustainability in freight will depend on the right business case and a combination of infrastructure, EVs, and customer demand; the latter explores how the last mile of delivery transport is evolving to meet the challenges posed by the COVID-19 pandemic, including the e-commerce surge and supply chain disruptions.

McKinsey senior adviser Dick Westney adds his perspective on how the Great Reallocation of energy and infrastructure investments is driving new strategies for managing uncertainties and risks. Other

[1] Ian Tiseo, "Distribution of global carbon dioxide (CO2) emissions in 2020, by sector," Statista, January 19, 2022

articles by McKinsey experts cover critical levers for road-freight decarbonization, such as reimagining the roads ecosystem and ramping up the hydrogen-refueling infrastructure.

Finally, rounding out this issue are recaps of recent McKinsey roundtables held in Hong Kong (on surviving the inflation and productivity crisis in the city's construction industry), Tokyo (on navigating the new normal and decarbonization challenge in Japan's infrastructure industry), and Sydney (on scaling EV infrastructure to meet net-zero targets).

Developing the solutions needed to tackle decarbonization in freight transport will require innovation and fundamental change—from the movement of goods to the establishment of our communities. Implementing these changes can make our transportation systems greener, more resilient, and more equitable. We hope you find this issue of *Voices* insightful, and we look forward to your thoughts.

News from the Global Infrastructure Initiative

Freight transportation plays an essential role in our global economy, and its share of carbon emissions is set to rise. According to one study, if the world continues with business as usual, freight will become the world's highest-emitting sector by 2050.[1] This issue of *Voices* explores how a range of levers—including electrification, alternative fuels, and decarbonizing roads—can result in cleaner, more efficient freight transport.



Tony Hansen
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Director of the GII, Singapore
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With less than three months to go, we have ramped up preparations for our eighth Global Infrastructure Initiative (GII) Summit, which will take place in Tokyo from October 19 to 21. Our theme for the Summit centers on creating a pathway to sustainable infrastructure, factoring in current global geopolitical and macroeconomic realities. We are excited to share our most recent agenda as well as information about speakers, Tokyo infrastructure site visits, and sector roundtables. After the Summit, we will publish a recap report featuring the Summit's key discussion themes for the full GII community.

Our regional roundtables continue apace. In June, we hosted an energizing discussion in Sydney with more than 30 leaders across Australia's electric-vehicle (EV) ecosystem. It was an inspiring and solutions-oriented session on the collaborations needed to grow EV uptake and support the 2.5 million chargers the country needs by 2030.

Our next roundtables will take place in Amsterdam and Washington, DC, on September 20. The former will cover preparing grids for the energy transition, while the latter will focus on creating the capacity to deliver infrastructure. More information on our recent and upcoming roundtables can be found on the GII website.

We look forward to continued engagement with the GII community, and we welcome your feedback on our events, publishing, and industry initiatives. If you have comments or would like to subscribe a colleague to *Voices*, please contact us at info@giiconnect.com.

[1] For more, see "Freight Transportation," MIT Climate Portal, September 4, 2020.



Disrupting transport: An interview with Robert Falck of Einride

Einride's founder and CEO discusses how autonomous technology and digital infrastructure can decarbonize the difficult-to-abate freight industry.



Robert Falck
Founder and CEO
Einride



Melissa Yeo
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According to McKinsey's Global Energy Perspective 2022, the transportation sector is projected to experience the fastest transition to electricity, which is primarily the result of passenger electric vehicles (EVs) reaching cost parity with internal combustion engine vehicles.[1] That said, freight transportation accounts for up to 8 percent of global greenhouse-gas (GHG) emissions, and as much as 11 percent when warehouses and ports are factored in.[2] Decarbonizing freight transportation from start to finish will require owners and operators to fundamentally rethink how infrastructure supports electrification and how new technologies can enable a more sustainable future.

In response, Swedish freight company Einride is working to electrify diesel freight and transition toward the full autonomy of transport vehicles. McKinsey's Melissa Yeo spoke with Robert Falck, founder and CEO of Swedish freight technology company Einride, about why sustainability in freight will depend on the right combination of infrastructure, EVs, regulations, and customer demand.

Melissa Yeo: When you look at the landscape of solutions to decarbonize supply chains, what are the major opportunities that stand out as being particularly exciting? Are there technologies or areas of innovation where we're seeing success?

Robert Falck: The only valuable future technologies are the ones that can be mass-produced and rapidly scaled. These technologies need to be energy efficient, and they need to be suitable for industrial-size production. It is still tricky to mass-produce hydrogen, for example, because the process isn't yet mature. The same goes for the development of fuel cells.

Electrification and battery solutions, however, have the potential of being easier to mass-produce. Therefore, we can reduce costs and provide relatively energy-efficient conversion rates, both of which are a big plus for electrification. So from my side, I think the new technologies that are changing mobility are electrification, batteries, and 5G connectivity.

The digital infrastructure that's required for the rollout of autonomous vehicles is often overlooked. If you're going to deploy at scale, you need high-speed, reliable connectivity solutions. That's going to be one of the major limiting factors in a lot of areas. If you remove the driver from the vehicle, it's going to be difficult to have any operational ability without reliable connectivity.

Melissa Yeo: Beyond technology, what else is needed to effectively decarbonize freight transportation? What do you think would be truly game changing for getting the industry closer to net zero?

Robert Falck: The number one thing is the business case, and it's the common challenge with digitalization. A lot of people think that making everything digital is a want, but it is fundamentally a need. Autonomous technology has real use cases in transportation. Electrification is maturing, but it is quite expensive compared with other technologies. That said, in heavy-duty trucking, we're starting to reach cost parity in terms of performance, at least as it relates to short-haul, middle-mile applications.

Moving forward, it is vital to get electrification, batteries, and 5G connectivity to interact. If they do, then we can deploy route optimization and track capacity across the entire fleet of vehicles, optimizing cost savings and carbon emissions. This creates the potential to reduce GHG emissions by 90 percent.

Once you get this level of connectivity and digitalization in place, you have the means to rewrite the map. Our history has been shaped by our means of transport. People often say that the

[1] "Global Energy Perspective 2022," McKinsey, April 26, 2022.
[2] "Freight transportation," Massachusetts Institute of Technology, September 4, 2020.

first major breakthrough in transportation was the wheel, but it wasn't—it was rafts, sailboats, and transport on waterways. That was how we built civilizations and structured the world until the invention of the railroad. Combining these technologies could unlock a similar economic potential.

Melissa Yeo: Earlier this year, Einride announced the appointment of a remote pod operator to support and supervise automated Einride Pods.[3] Why did you see a market gap for this role? And why not pursue full autonomy?

Robert Falck: I don't think there is such a thing as full autonomy. That's a fictional concept. The automation assistant—whatever that might look like—still serves us and interacts with us. Furthermore, automation is not a new thing. It's been around for more than 200 years and is the basis for much of the wealth we see today. Although the level of autonomy is increasing, automation at its core still serves humans and has a clear limit to what its abilities are.

If you want to solve something that's not in the automation program or something with an AI setup, you need a human in the loop for that decision-making ability. Reaching more than 95 percent uptime for an autonomous system is extremely difficult. And if you're performing at 95 percent or more, you have a very successful autonomous system. The same goes for these kinds of transportation systems.

Melissa Yeo: What other talent gaps are out there? What other types of skill sets or capabilities will become increasingly important in the future of freight?

Robert Falck: For me, it's about creating jobs similar to those created by the manufacturing industry when it went through a similar transition. If you go back 60 or 70 years, there was a lot of manual labor. Today, the focus in the factories is surveillance, maintenance, and making sure the machine is doing what it's supposed to do. And that's also what these new roles will need to be about: securing the operational uptime and making sure it serves the needs of the customer.

In transportation, the skill set transition is being driven by the market itself. There are a lot of discussions about the shortage of drivers, but there's not really a shortage of drivers. Rather, there's a shortage of people who want to live their lives as truck drivers. Owner-operators [make up] 85 percent of the trucking space because we have a legacy structure of pushing technology—software that automates the delivery of information—which is part of the fossil-fuel manufacturing system. And that ecosystem of operations setup is being challenged as the industry transitions from a mechanical technology system to an electric and digital system.

Melissa Yeo: Einride also launched its US operations at the end of last year. What do you see as being most directly replicable across markets? What do you foresee being most challenging in scaling from the European Union to the United States?

Robert Falck: Close to 90 percent of all transportation could be electric and autonomous based on the business case alone. The potential for this technology is huge, and it will change the business model and the business logic for transportation. This will impact everything from the locations of warehouses to how we build our cities, how those cities are structured, and how the sector competes with rail.

The United States tends to be efficient at adopting new technology. However, the mentality in Europe is such that it is still struggling to adapt to changing environments and new mindsets. I will do my best to convince Europe that this change needs to happen.

[3] "Einride Pod," Einride, accessed July 1, 2022.

Melissa Yeo: You've been a serial entrepreneur who's setting ambitious climate goals in a very hard-to-abate sector. What advice would you have for other "climate disruptors" undertaking similar endeavors?

Robert Falck: At the core, you need to find a business case. There's no sustainability without sustainable businesses. There are a lot of potential cases out there, but without this fundamental insight, change will not happen.

Another very important thing to highlight is that we need to stop subsidizing the old system. New technology will change the world, but the world is still subsidizing the existing system.

If we could look ten years into the future, I think we'd be surprised by how quickly things will change. The market is a marvelous thing: It doesn't care about old-time things. It doesn't care about people's opinions. It drives change—and this time for the better.

Robert Falck is founder and CEO of Einride. **Melissa Yeo**, based in McKinsey's Singapore office, is the director of the Global Infrastructure Initiative (GII).

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Unlocking hydrogen's power for long-haul freight transport

As the demand for hydrogen in transportation increases, it is imperative to develop infrastructure to supply trucks, buses, and cars.



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The transportation industry is under pressure to rapidly decarbonize. Regulatory changes, as well as B2B and B2C customers' demands for greener transportation value chains, are prompting the industry to adapt. In short-haul freight, battery electric vehicles (BEVs)—namely trucks and vans—are already reaching total cost of ownership (TCO) parity in the first use cases, helping simplify the transition for fleets. This is enabled by both rapidly declining battery costs and the launch of new vehicles, including purpose-built battery electric delivery vans.

However, the picture is quite different for long-haul trucking. Long distances, unpredictable routes, high uptime requirements, strict driving-time regulations, and the importance of high payloads have made this sector particularly hard to decarbonize. With current energy densities, batteries are too heavy, charging speeds are too slow, and infrastructure is not yet available to directly electrify trucks on particularly challenging routes.

As a result, long-haul trucking has focused on hydrogen-powered fuel and hydrogen combustion, which are attractive for two reasons. For one, faster refueling and greater range can increase the uptime potential for trucks; furthermore, their lower weight compared with batteries can increase payload capacity. Together, these factors improve hydrogen trucks' TCO, which is the KPI that the highly competitive transportation industry needs to manage.

The hydrogen opportunity

Hydrogen is the required link and a leading opportunity to decarbonize hard-to-abate sectors. As an example, some industrial sectors (such as steel, cement, or refineries) are hard to abate directly with electricity due to practical technological reasons, while others (such as marine, aviation, rail, or mining) consume energy in quantities that exceed what batteries can provide. These factors will drive adoption of hydrogen irrespective of the transport industry and will ensure that clean hydrogen is readily available.

With this in mind, hydrogen is available in the near term for the right use cases, such as for fleets with their own depots or in Switzerland, where fuel cell trucks are already successfully deployed. There are also clear benefits for both vehicles and underlying infrastructure.

Over the coming years, we expect to see a significant increase in the number of hydrogen-powered vehicles on the road. Although passenger cars will also contribute to hydrogen consumption and have previously been the focus segment, in the future, around 95 percent of demand by volume will come from commercial vehicles. Exceptions include Japan and South Korea, where hydrogen for passenger cars is receiving strong support and where domestic OEMs are at the forefront of the development of fuel cell electric vehicles (FCEVs). By 2035, as many as 850,000 hydrogen-fueled heavy-duty trucks (HDTs) could be on the road in Europe. Between them, they would consume 6,900 metric kilotons of hydrogen per year and require up to 4,800 hydrogen refueling stations (HRS) (Exhibit 1).

Ramping up hydrogen infrastructure

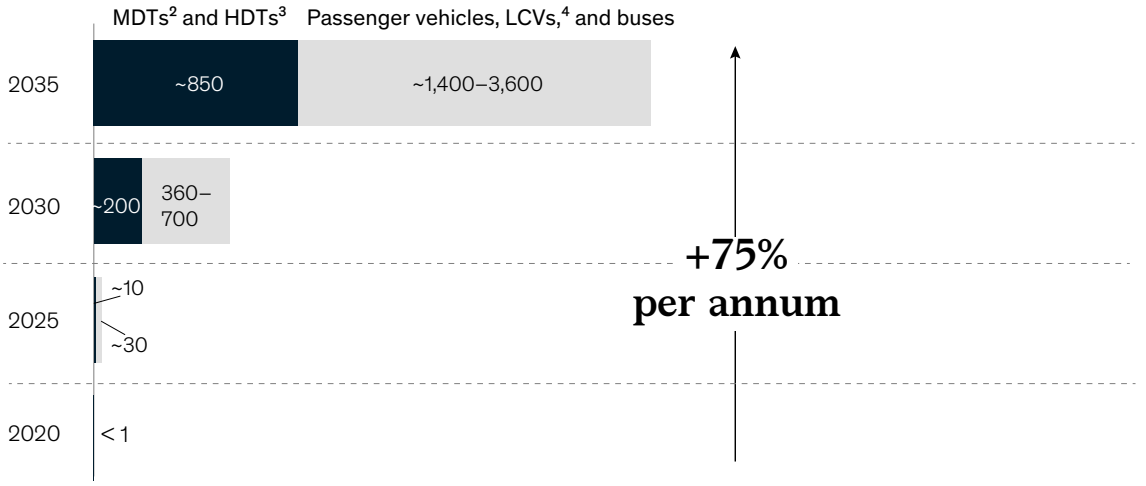
In the coming years, there will be a significant increase in hydrogen-powered vehicles on the road, including fuel cell trucks. Unlike batteries, which directly store electrons to power electric motors, fuel cell trucks use tanks to store energy in the form of molecules in gaseous or liquid form. In fuel cell trucks, hydrogen is converted into electrons and water, with the electrons powering the truck's electric motors. In hydrogen combustion trucks, hydrogen is burned in combustion engines, similar to diesel. The required hydrogen can be created in different ways—either by reforming natural gas and capturing CO_2 or through electrolysis, which is the process of using electricity to separate hydrogen from oxygen.

The technology required for these trucks and to generate hydrogen is already well developed and being deployed. Instead, hydrogen infrastructure is often considered the major

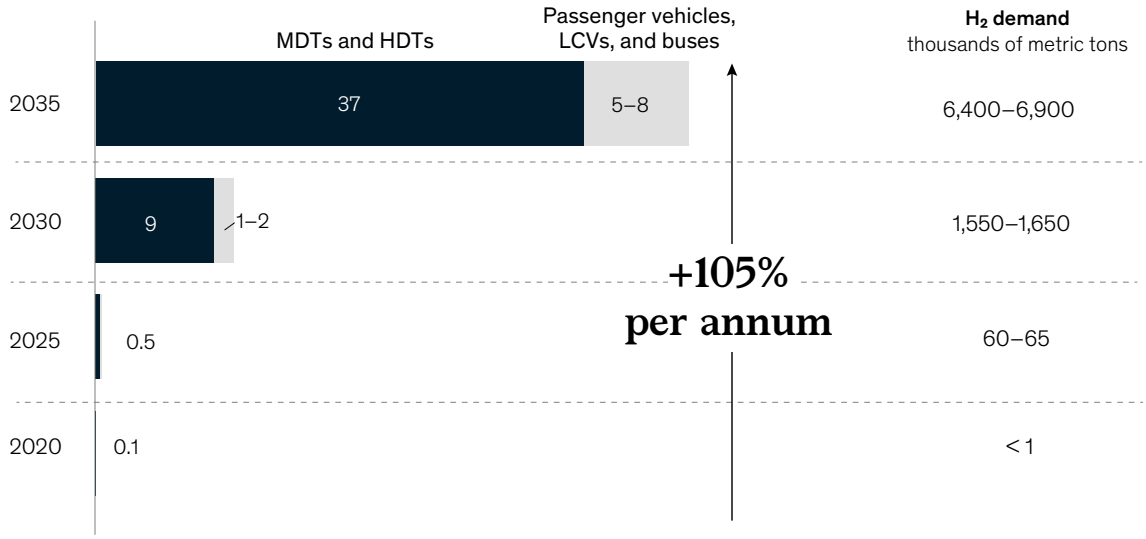
Exhibit 1

The hydrogen refueling market in the European Union is projected to increase 105 percent per annum by 2035.

FCEVs[1] in the European Union
thousands of vehicles



H_2 refueling market in the European Union
€ billions



[1]Fuel cell electric vehicles.
[2]Medium-duty trucks.
[3]Heavy-duty trucks.
[4]Light commercial vehicles.

bottleneck to adoption. And it is true: hydrogen refueling stations are not ubiquitous today. Each station requires considerable investment, and a value chain supplying hydrogen is also required.

However, besides the vehicle benefits, hydrogen also benefits the infrastructure side. Hydrogen is already taking off in other industries irrespective of transport, leading to the derisking of investments in hydrogen production and transport. At scale, the infrastructure is less costly to create than e-truck charging infrastructure because it does not require grid upgrades and has a smaller carbon footprint. The faster refueling speed means the hydrogen infrastructure can be used by many more trucks than charging infrastructure.

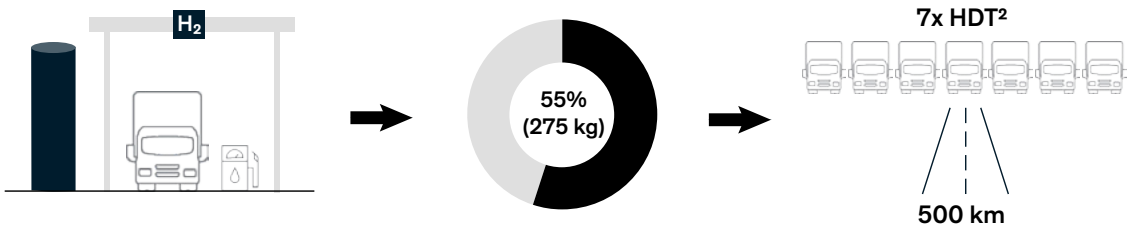
As such, the business case for hydrogen infrastructure is becoming increasingly attractive as hydrogen sourcing costs decline and vehicle demand increases. Our research shows that operators of HRS could reach break-even by as early as 2025 when serving a small fleet of trucks. Specifically, a medium-size HRS with a daily capacity of 500 kilograms (kg) could reach break-even prices at 55 percent utilization, depending on the hydrogen sourcing costs and sales prices (Exhibit 2). In this case, seven long-haul HDTs would be sufficient to provide the required demand for this station.

Compared with storing energy in batteries, hydrogen-fueled trucks can refuel faster and carry a lower weight penalty because tanks weigh considerably less than batteries. Operationally, hydrogen trucks can therefore be deployed on a similar scale with diesel trucks but with the benefit of producing no emissions. This means that they will be cheaper to operate in the long term than diesel trucks. By 2030, the TCO to operate an HDT traveling 500 kilometers per day in Europe is estimated to reach €1.13 per kilometer for diesel, €1.03 for battery electric trucks, and €1.02 for fuel cell trucks.

That said, a number of challenges must be overcome before hydrogen refueling infrastructure can reach scale. To begin, there is limited perspective on the cost development for

Exhibit 2

A medium-size hydrogen refueling station needs to sell 275 kilograms per day to reach break-even prices.



Medium-size HRS[1]	Utilization required for medium HRS[1] to reach breakeven	~8 kg H_2 per 100 km
500 kg capacity per day	**275 kg** daily sales	**275 kg H_2** = ~3,500 km per day

Note: Assumes an electricity price of €0.40 per kWh, €105,000 in operating expenditures per station per year, H_2 sourcing costs of €3.00 per kg, and a sales price of €6.00 per kg.
[1]Hydrogen refueling station.
[2]Heavy-duty trucks.

hydrogen trucking overall and for infrastructure specifically. The timing for ramping up the infrastructure to support long-haul hydrogen trucking is not yet fully clear, and business models need to be developed to support this ramp-up. Infrastructure providers and operators also need to decide whether to concentrate on truck-focused infrastructure or to plan for dual use with passenger cars. Finally, liquid and gaseous hydrogen require partly different infrastructure, resulting in competition between the two.

Building the hydrogen ecosystem

To address these challenges and derisk infrastructure investments, hydrogen infrastructure operators should build an ecosystem that secures supply and demand. That said, accessing funding can be challenging because of the unique nature of investments in hydrogen refueling infrastructure. When compared with traditional mobility infrastructure investments, such as roads, the returns are less certain. And compared with other higher-risk investments in new technologies, the returns are likely lower and will take longer to materialize given the initial capital expenditure to create the infrastructure.

The following example illustrates what this ecosystem could look like for a fleet with 50 FCEV HDTs at three depots, as well as which partners would be required to develop and operate the system:

— *A fleet to ensure offtake.* This requires the operator to commit to purchasing trucks. In this case, we assume the fleet will operate 50 FCEVs.

— *An OEM or retrofitter to provide vehicles.* Today, Hyundai is the only OEM providing hydrogen trucks at scale, with retrofitters providing an alternative route by replacing vehicles' diesel powertrains with e-powertrains and fuel cells, or hydrogen combustion engines.

— *A hydrogen producer to ensure provision of low-carbon fuel.* This requires further electrolysis capacity to be built. Assuming the trucks run an average of 500 kilometers per day, consuming around eight kg per 100 kilometers, the fleet would require 2,000 kg of hydrogen per day, with slightly higher total production to offset losses during transport, storage, and dispensing.

— *HRS infrastructure providers to build refueling stations.* In this case, the fleet would likely operate two 1,000 kg HRS at their main depots and one 500 kg HRS at their smaller depot, thereby providing a gross capacity of 2,500 kg per day.

— *A financing player to provide capital for expansion.* The total cost for 50 FCEVs and three HRS would be between €10 million and €15 million at 2030 prices.

— *Governments and regulators to create a stable legal framework and subsidies.* This includes targeted support for capital expenditures and operational expenditures for vehicles and infrastructure.

Given the potential benefits and hydrogen's expected growth, the transport industry should prepare for a hydrogen-powered future. As vehicle production and demand increase—especially from 2025 onward, when more vehicles become available—so, too, will the demand for hydrogen production and refueling infrastructure.

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DHL on sustainable, customer-centric delivery in the last mile

Deutsche Post DHL's head of sustainability for German Post and Parcel discusses how the logistics industry can work to decarbonize road transportation and meet consumer expectations.



Christoph Hempsch
Head of sustainability
German Post and Parcel
Deutsche Post DHL



Melissa Yeo
Director
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In the months following the outbreak of COVID-19, delivery via road transport faced a number of pressing challenges, including increased safety precautions, urgent timelines, and shifting consumer preferences and expectations. Today, after more than two years of COVID-19 lockdowns, the logistics industry is navigating a series of new challenges regarding the need to decarbonize. Doing so entails addressing ambitious climate targets aimed at lowering greenhouse-gas emissions, which have led to changing regulations and fuel taxes, as well as increased electrification of fleets and increased demand for sources of clean energy.

McKinsey's Melissa Yeo recently spoke with Christoph Hempsch, head of sustainability for Deutsche Post DHL's German Post and Parcel, about how the last mile of delivery transport is evolving to meet the challenges posed by the COVID-19 pandemic, including the boost in e-commerce and disruptions to the supply chain.

Melissa Yeo: Pandemic-induced lockdowns saw a huge rise in e-commerce volumes. What were some of DHL's biggest challenges during this time, and which steps were most critical in addressing them? What changes do you plan to retain after the pandemic wanes?

Christoph Hempsch: The most important thing was to keep our staff members safe, so we invested a lot of time and money into contact-free processes, not only for customers but also inside our network. Wherever possible, we tried to reduce the risk of two employees actually meeting in person. I'm thankful that during that time, we didn't have a single sorting center that closed due to a COVID-19-related incident.

That said, some of our e-commerce customers had troubles with their supply chains because at any point in time there were issues in Asia with production in the ports and with logistics, which meant more volatility in volumes. On one hand, the demand from the recipient side was increasing, and on the other hand, our e-commerce customers didn't know when they could ship out.

We are now more prepared for another pandemic wave or comparable situation with respect to how we treat our operational processes to keep our employees safe, as well as how to react to volatile volumes.

Melissa Yeo: How will infrastructure change in the next five to ten years to accommodate innovations in last-mile delivery? What are some examples of new assets—or existing assets—that will be repurposed for sustainability?

Christoph Hempsch: Sorting capacity and infrastructure will be critical because they cannot be replaced by other processes, and the capacities of the last mile will need to increase.

We will likely see a rise in sites located in city centers—or close to city centers—because the more central the delivery sites are, the fewer delivery routes you actually need. In addition, there will be more opportunities to use smaller delivery vehicles, such as cargo bikes. If the delivery sites are outside the city center, then cargo bikes aren't an option.

We are heavily investing in electrifying our fleet, especially for the last mile. In Germany, we run 20,000 electric vehicles [EVs] every day—out of 60,000 total vehicles—to deliver parcels and letters. The fleet of delivery bicycles has been transformed to a fleet of 19,000 e-bikes and e-trikes. Delivery sites will also become greener. This year, we are investing €600 million in EVs and carbon-neutral delivery sites, which leverage and store solar power and use heat pumps to achieve fossil-free heating.

Last but not least, we have a dense network of more than 9,000 parcel lockers. Partly driven by COVID-19, people are getting used to click-and-collect solutions that don't require physical contact. The parcel lockers are available 24/7 and are normally close to where people live, ideally on the way to or from work. They're convenient, and they're good for the environment. They also make our deliveries more efficient; the more time a delivery driver spends actually delivering or handing over parcels and letters, the better.

Melissa Yeo: Advanced analytics can help optimize routes and understand customer behavior for greener and more effective fulfillment. As technologies get more advanced, what else could analytics achieve? What are other emerging or nascent technologies that could play promising roles?

Christoph Hempsch: The first and foremost example is forecasting and demand planning. With increasing volatility and volumes, it's more important than ever to have a good idea of what volume will arrive, on what day, at what place, and at what time. From there, we can plan the sorting capacities, vehicles, and delivery capacities accordingly.

Although it's relatively easy to create a demand forecast for the network, it can be a challenge to break it down to sites, shifts, and days. This means breaking down the volume and the structural data of delivery districts and planning how many delivery districts are needed on specific days, as well as preparing to change the setup of delivery districts if the volume changes.

We now have a system for real-time tracking, which is based on a route-planning algorithm. This is good for convenience because the better sense you have of when a parcel will arrive, the better you can plan your day and increase the chances of a successful delivery.

Recipient services[1] also help save time and effort. We can tell the customer that a shipment is on its way, and then the recipient can choose a safe place to receive that shipment. For example, if you live in the countryside and you're not at home but you have a garage, or even a preferred neighbor, you can communicate this with the delivery driver through an app.

Melissa Yeo: What is the biggest source of emissions in the last-mile delivery process? What is the biggest hurdle to abatement?

Christoph Hempsch: The biggest challenge is decarbonizing road transportation, and not just for us but for the entire logistics industry. We are probably a couple of years behind passenger EVs, but the technologies are there; it's just a question of industrializing. Electric trucks are also going to be much more reliable than the first EVs were because the OEMs and truck manufacturers now have more than a decade of experience with EVs.

The first thing we try to do is move as much volume as we can from road to rail on our parcel network, which is currently about 6 percent. It might sound like a small number, but that's more than a hundred million parcels every year—a hundred million parcels that used to travel by diesel truck.

The second thing that we started doing is introducing gas trucks—heavy-duty compressed-natural-gas [CNG] trucks—but the key issue is, again, the infrastructure. There are very, very few gas stations in Germany where you can fill up a gas truck, so we started building our own gas stations at selected parcel-sorting centers. That said, in ten years we will hopefully only buy electric—either battery electric or hydrogen electric trucks—but so far, it's been difficult to make this leap.

In the Netherlands, Scandinavia, and the United Kingdom, you can buy hydrotreated vegetable oil [HVO] and use it in your existing vehicles, and that's a quick way to decarbonize your fleet. In Germany, however, HVO is not allowed to be sold, and synthetic biofuels are not available.

Melissa Yeo: How do you measure your sustainability performance, and what other goals lie ahead between now and 2030?

Christoph Hempsch: We have made a commitment to be net-CO_2 neutral by 2050—in line with the Paris Agreement to limit global

[1] When customers purchase items online and pick them up at physical locations.

warming to 2 degrees Celsius. There is also the Science Based Targets initiative,[2] which is a nongovernmental organization [NGO] that validates our targets and our activities. As a group, we have an intermediate target for 2030 not to exceed 29 million tons[3] of CO_2, a number derived from our emissions from a few years ago.

Melissa Yeo: What actions are required by various stakeholders—such as governments, customers, retail partners, and delivery companies—to realize their targets?

Christoph Hempsch: We are already seeing a push in regulation. In many industries, we're seeing carbon pricing and trading mechanisms. For example, in Germany there is a CO_2 tax for fuels, which makes fossil fuels more expensive, and that's of course driving the change to sustainable vehicles. Furthermore, if Europe prohibits the sale of combustion engines after 2035, that would be a major change. In many cases, however, the necessary changes are faced by incentivization—for example, by subsidies for buying green vehicles or free parking for EVs in city centers.

At the same time, I don't know if it takes more regulation or more commitments. Most of the countries in the world agree that global warming that exceeds 2 degrees will endanger our planet. Many companies and organizations have agreed with that as well and subsequently made their own targets, but now they're expected to act on those targets. If you visit the web page of any large retailer, for example, they will probably feature an announcement that they will be carbon neutral by 2050 or even earlier. But are they choosing their partners to achieve that goal? Are they willing to pay for green solutions to achieve that goal? Or are they only saying that because it's 30 years from now?

From a practical standpoint, every customer has an important role in making sustainability a primary criterion when they select their partners and subcontractors. That will have a huge impact on sustainability. That's going to change the whole industry.

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[2] For more, see sciencebasedtargets.org.
[3] Metric tons: 1 metric ton = 2,205 pounds.



Mapping the way: Decarbonizing roads

Road developers and operators have a unique position in the transport industry and can enable significant change around lowering emissions.



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In recent years, global efforts to reduce emissions and environmental impact have strengthened, as evidenced by the industrial economy's commitment to meet net-zero emissions by 2050.[1] And when it comes to road infrastructure, nearly $1 trillion will be invested annually over the next two decades, making it the second-highest area of infrastructure investment.[2]

Various stakeholders, such as road users, governments, and investors, will invest a significant portion of these dollars to pursue the green transition in road transport. As a result, road developers and operators could have a huge impact on lowering emissions, particularly from energy used on road networks, building materials and fleet operations, and the use of private and commercial vehicles.

Navigating the years to come will require operators to build decarbonization road maps around five topics: improving energy efficiency and increasing renewable generation, enabling sustainable mobility, driving circularity, increasing resilience to climate change, and launching alternative tariff models.

Pursuing the green transition in road transport: An overview

Globally, road transportation accounts for about 15 percent of total CO_2 emissions and 74 percent of total transportation emissions.[3] Road developers are also significant drivers of demand for construction materials and equipment that have a substantial carbon footprint. Road players across the value chain are thus in a unique position to make meaningful change toward decarbonization.

In response to increasingly bold environmental regulations such as the UN's Sustainable Development Goals, three groups of relevant stakeholders are actively encouraging the sector to pursue a green transition:[4]

— *Road users* are eager to reduce their own emissions, with 64 percent of drivers describing themselves as environmentally concerned. Interest in new-energy vehicles (NEVs) is increasing among consumers—73 percent of sustainability-minded drivers prefer an NEV for their next vehicle, with a hybrid electric vehicle being the most preferred type.[5] They need the infrastructure, such as electric-vehicle (EV) charging stations, to achieve this.

— *Governments* are increasing their efforts and investments to encourage decarbonization; NextGenerationEU, which has a strong focus on green investments, is just one example.[6]

— *Investors* are increasingly focused on the sustainability profile of their investments. Recently, independent rating agencies have been measuring environmental, social, and governance (ESG) performance, and companies with high ESG ratings have shown lower cost of capital by 1.1 percentage points.[7]

That said, pursuing the green transition in road transport won't be straightforward. The investment required will be substantial, spanning many areas of the road value chain. For example, building out EV charging networks and hydrogen distribution and fueling systems would require an additional $100 billion in annual capital spending over the next 30 years. Stakeholders will need to contend with three primary challenges.

Increasing need for climate resilience

Global CO_2 emissions are spiking, resulting in a rise in global temperatures of more than 1°C over preindustrial levels. The subsequent effects of climate change can cause damage

[1] For more, see "The six-sector solution to the climate crisis," UN Environment Programme, 2020.
[2] For more, see "Bridging infrastructure gaps: Has the world made progress?," McKinsey Global Institute, October 13, 2017.
[3] Hannah Ritchie, "Cars, planes, trains: Where do CO_2 emissions from transport come from?," Our World in Data, October 6, 2020.
[4] For more on sustainable development and resilient infrastructure, see "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation," UN Department of Economic and Social Affairs, Division of Sustainable Development Goals, 2022.
[5] For more, see Axel Schmidt et al., *What sustainable drivers want: Busting the myths of sustainability: A wake-up call for automakers,* Accenture, 2021.
[6] For more, see "Recovery plan for Europe," European Commission, December 2020.
[7] "Bloomberg launches proprietary ESG scores," Bloomberg, August 11, 2020.

to road infrastructure; for example, increased temperatures can damage road surfaces or cause flooding. Furthermore, these events can have complex and nonlinear knock-on effects, which can have implications for the broader economy and result in the need for more investments in resilient infrastructure construction.[8]

High-impact Scope 3 emissions

Many road operators recognize their unique role in the industry and are actively trying to reduce emissions they do not cause directly, such as those caused by infrastructure users (otherwise known as Scope 3 emissions). For example, 80 percent of total road construction emissions are in the form of embodied carbon and are generated by the production process of material used to build roads.[9]

Requirement for new competencies and capabilities

Investors are taking ESG issues more seriously, resulting in a growing green-bond market and an impact on the cost of capital. Yet some players lack a comprehensive view on the topic as well as the capabilities to develop an internal proposition. According to a recent study, just 29 percent of Fortune 100 board directors have relevant ESG credentials. And these are largely concentrated on the social element of ESG—21 percent of directors have relevant social experience, while only 6 percent have governance or environmental experience.[10]

How road operators can navigate the years to come

Road operators that hope to stay ahead of the curve should undertake initiatives around the following topics: energy efficiency and renewable generation, sustainable mobility, circularity, resilience to climate change, and alternative tariff models.

Energy efficiency and renewable generation

One significant lever in increasing energy efficiency is the replacement of lighting with LED technology. In road management, the majority of electricity use is driven by road lighting, and LED replacements can reduce energy requirements by 20 to 30 percent. Additionally, LEDs exhibit far superior light distribution by focusing beams in a targeted direction, thus reducing the number of lights needed in an area. By installing LEDs, one major roads operator was able to save €20 million on energy consumption.

Distributed generation, especially through the implementation of photovoltaic (PV) systems, is a reliable solution for the self-production of clean energy. Road operators can leverage a variety of solutions for PV panel placement, including applications in spare spaces without traffic loads—such as spare ground, facilities, and buildings—and advanced applications such as solar pavement solutions in structures that see heavy traffic.[11]

Enabling sustainable mobility

Deploying the infrastructure needed to enable full access to sustainable mobility is central to achieving decarbonization goals, and high-impact projects often involve the installation of electric-charging and hydrogen stations. Indeed, the number of electric-charging stations is expected to grow at a CAGR of nearly 32 percent by 2028.[12]

Other solutions include the development of intermodal hubs, which play a crucial role in facilitating the use of sustainable transportation modes. Globally, travelers value the importance

[8] For more on resilient infrastructure, see "Delivering sustainable infrastructure: Insights from industry leaders," McKinsey, September 16, 2021.
[9] Xianwei Wang et al., "Estimation of carbon dioxide emission in highway construction: A case study in southwest region of China," *Journal of Cleaner Production*, September 2015, Volume 103.
[10] Tensie Whelan, "U.S. corporate boards suffer from inadequate expertise in financially material ESG matters," NYU Stern Center for Sustainable Business, January 2021.
[11] Yiqing Dai, Yundi Lu, and Yan Yin, "Strategies to facilitate photovoltaic applications in road structures for energy harvesting," *Energies*, 2021, Volume 14, Number 21.
[12] Pooja Chandak, "Electric vehicle charging stations market to grow USD 12490 million by 2028 with a CAGR of 31.5%, report," EMobility+, June 16, 2022.

of having interconnected means of transportation. In the United States, for example, the National Center of Intermodal Transportation (NCIT) has promoted a national intermodal system.[13] Road operators could also repurpose disused toll barriers into intermodal facilities, generating environmental and social benefits.

Initiatives that promote circularity

Circular-economy initiatives aim to reduce the environmental impact of road infrastructure by taking advantage of waste or other elements of asset management, such as recycled road surfaces, systems for water runoff recovery, recycled mowed grass, separate waste management, and measures for conserving biodiversity.

Notably, circular marketplaces represent an effective solution to drive coordination and collaboration within road operators' supply chains. In fact, some companies provide digital matchmaking platforms that enable others to find new high-value reuse options for materials or waste products.

Resilience to climate change

Building resilient infrastructure is key to coping with global warming and the subsequent increase in natural disasters. Initiatives to build resilient infrastructure fall into two groups: structural adaptation measures and management (or nonstructural) adaptation measures.[14] While the former category includes building new infrastructure capable of resisting to a harsher environment, management adaptation measures typically leverage advanced continuous monitoring to drive maintenance operations. Indeed, stakeholders can use data, analytics, and new technologies to better prepare for and respond to extreme climate events such as flooding, storms, and wildfires. To this end, powerful, off-the-shelf predictive models can be leveraged to boost asset risk management. These models can also help detect vulnerable assets, quantify potential impact, and define and prioritize key actions based on cost-benefit analyses.

Alternative tariff models that promote sustainable mobility

Reducing travel times and traffic congestion can also lead to sustainable mobility. The free-flow system, for example, enables the dynamic identification of vehicles and assessment of tolls through detection without stopping. The system also enables dynamic pricing to reward users based on virtuous behavior, time of use, or environmental parameters.

The effective implementation of decarbonization initiatives will require collaboration across the supply chain. For instance, by using intermittent road closures (instead of full road closures), construction companies can reduce greenhouse-gas emissions related to work projects by up to 24 percent.[15] Downstream, road operators can help orchestrate traffic data, helping the 15 percent of users who believe eco-routing solutions are the most important connected service for sustainability.[16] Thus, collaboration along these lines will likely be the success factor when adequately assessing, managing, and preparing for anticipated future climate events.

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[13] Elisa Conticelli et al., "Assessing the performance of modal interchange for ensuring seamless and sustainable mobility in European cities," *Sustainability*, 2021, Volume 13, Number 2.
[14] For more, see *Climate-resilient infrastructure*, Organisation for Economic Co-operation and Development (OECD), 2018.
[15] Christopher S. Hanson and Robert B. Noland, "Life-cycle greenhouse gas emissions associated with a highway reconstruction: A New Jersey case study," *Journal of Cleaner Production*, November 2015, Volume 107.
[16] For more, see *Sustainable drivers*, 2021.



Managing capital risk in the race to net zero

How the Great Reallocation of energy and infrastructure investments is driving new strategies for managing uncertainty and risk.



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The race to net-zero emissions has begun, and the Great Reallocation of capital is underway.[1] In addition to the moral imperative of reallocating capital to help progress the goals of the net-zero transition, a growing number of asset owners and investors are responding to the fact that conventional strategies can offset only some of the factors causing climate change. Yet the path to change is not so straightforward: stakeholders are demanding rigorous and transparent reporting, and the public is alert to any hint of greenwashing.

Heightened uncertainties are an inevitable part of capital reallocation, and many of the most pressing uncertainties around the net-zero transition are related to capacity. To begin, 30 million new jobs in renewable energy and energy efficiency must be mobilized by 2025.[2] Production capacity of the materials required to ramp up renewable power must also be increased. Other uncertainties are associated with scaling new or significantly improved technologies at a far greater pace than past prudence has allowed.

Navigating this hazardous mix of speed and uncertainty will require asset owners and investors to come face to face with the net-zero capital expenditures conundrum: how to make prudent and profitable investments while addressing the effects of climate change. This conundrum is further conflicted by uncertainties over which owners and investors have limited control.

Key difference: Risk vs. uncertainty

The terms "uncertainty" and "risk" are often used interchangeably, but some studies define them differently. An uncertainty is created by a range of possible outcomes for which probabilities cannot be reasonably estimated. A risk, in contrast, is created by an event for which the probability of occurrence—and the impact if it should occur—can be reasonably estimated. This distinction is particularly important for net-zero portfolios, where capital investments are often exposed to higher-than-normal levels of uncertainty. Although the goal of both uncertainty and risk management is to maximize the probability of success, they are often managed using different strategies.

Let's start with uncertainty: Imagine an asset owner planning to approve funding for a portfolio of renewable-energy projects. Looming legislation could change the current tax incentives on which the project's economics depend. Despite extensive scenario planning, the owner can provide neither useful estimates of the probability of each scenario, nor the potential impacts on tax incentives. This is why the goal of uncertainty management is resilience, mainly stress testing via scenario planning, off-ramps, and investments in real options.[3]

Next, let's consider risk: Imagine the same asset owner negotiating a renewable-energy project with a site owner. The asset owner identifies a medium risk of an unfavorable negotiation outcome—for which the impact would be high. In this instance, the goal of risk management is mitigation by reducing the probability of the most critical risks and the impact they would have if they should occur. Mitigation techniques the asset owner might use include risk surveillance, probabilistic analysis using Monte Carlo simulation,[4] and a risk register.

[1] "Playing offense to create value in the net-zero transition," *McKinsey Quarterly*, April 13, 2022.
[2] "Global roadmap for accelerated SDG7 action," United Nations Secretary General, November 3, 2021.
[3] Real options allow management to preserve the opportunity to make strategic decisions later in the project development process than would normally be the case. An example is found in liquefied natural gas (LNG) projects wherein the choice of liquefaction technology is kept open by engaging competing engineering firms to perform parallel, independent engineering designs. This extra cost creates value by enabling the optimal design to be selected without delaying the final investment decision.
[4] Monte Carlo simulation is a predictive model that uses random variables to determine different outcomes. For more, see "Monte Carlo simulation," Palisade, accessed June 16, 2022.

Uncertainty surrounds technologies and market incentives crucial to net-zero portfolios

Unraveling the net-zero capital expenditures conundrum starts with deconstructing uncertainties in the capital expenditures portfolio. Net-zero financing road maps published by the UN Framework Convention on Climate Change (UNFCCC) provide a useful way to look at net-zero portfolios in terms of business risk and uncertainty (Exhibit 1).[5]

Each decarbonization project archetype will require rapidly scaling new or nascent technologies. For example, carbon capture, utilization, and storage (CCUS) technologies will be critical to fighting climate change—but reaching targets will require CCUS to grow by a factor of 20 as soon as 2030.[6] Another critical but nascent technology, direct air capture, will need to be scaled from 5 metric tons (MT) of CO_2 per year today to 980 MT CO_2 per year by 2050.[7] It's an ambitious leap.

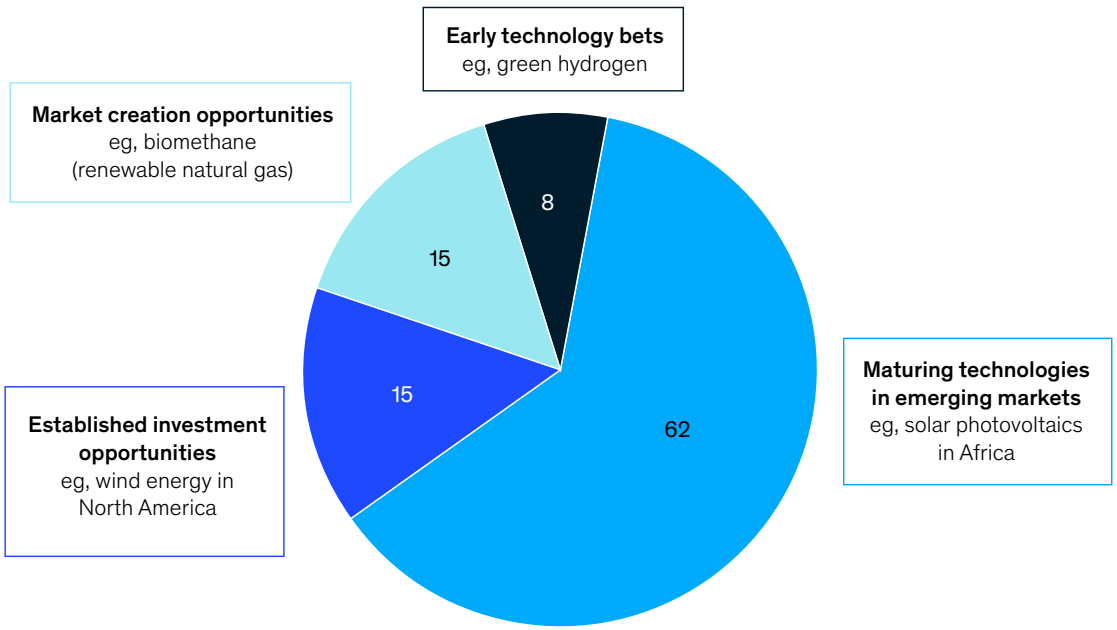
Already, the rapid transition of the transportation sector to battery electric vehicles is requiring huge investments in battery technology and manufacturing and in charging infrastructure. Overall, the transportation sector is responsible for 24 percent of direct CO_2 emissions from

[5] "Financing roadmaps," UN Framework Convention on Climate Change and Glasgow Financial Alliance for Net Zero, November 2021.
[6] *Energy technology perspectives 2020 – Special report on carbon capture, utilisation, and storage: CCUS in clean energy transitions,* International Energy Agency, September 2020.
[7] "Direct air capture," International Energy Agency, November 2021.

Exhibit 1

Of the decarbonization archetypes, maturing technologies in emerging markets will need the lion's share of global investment.

Required allocation of global investment by decarbonization archetype, 2021–25, %



Source: "Financing roadmaps," UN Framework Convention on Climate Change and Glasgow Financial Alliance for Net Zero, November 2021

fuel combustion, and it is also undergoing significant transformation.[8]

Other new technologies are required as well. Consider aviation, which is arguably the most difficult form of transportation to decarbonize and is therefore an important part of the net-zero-emissions puzzle. The demand for jet fuel is expected to double by 2050. One solution is drop-in sustainable aviation fuel (SAF), which can be used with no changes to aircraft or infrastructure. Recent research shows the viability of wet waste as a source of SAF, and airlines are working with scientists to make SAF a reality.[9]

That said, rapid scale-ups can create "valleys of death" for investors, which require some form of government guarantee to reduce uncertainty. Decarbonization projects are already creating major challenges to supply capacity for commodities such as lithium, copper, nickel, and cobalt, as well as critical metals such as tellurium, which is essential for solar photovoltaic cells. Although the supply of tellurium increased by 130 percent from 2010 to 2020, a further increase of 850 percent will be required by 2030 to meet the energy transition demands expected today.[10] And it's far from clear what the source of these additional supplies will be.

Different archetypes can illustrate various types and levels of uncertainty (Exhibit 2).

[8] "Tracking transport 2020," International Energy Agency, May 2020.
[9] "From wet waste to flight: Scientists announce fast track solution for net-zero-carbon sustainable aviation fuel," US National Renewable Energy Laboratory, March 15, 2021.
[10] "The raw materials challenge: how the metals and mining sector will be at the core of enabling the energy transition," McKinsey, January 10, 2022.

Exhibit 2

The maturity and scale-up of new technologies affect market uncertainties.

Archetype	Level of uncertainty				
	Technology		Capacity		Market
	Maturity	Scale-up	Workforce	Materials	
Early technology bets, eg, green hydrogen	High	High	Medium	Medium	High
Maturing technologies in emerging markets, eg, solar photovoltaics in Africa	Low	Medium	High	High	High
Established investment opportunities, eg, wind energy in North America	Low	Medium	High	High	Medium
Market creation opportunities, eg, biomethane (renewable natural gas)	Medium	High	Medium	Medium	High

Public–private collaboration can help resolve uncertainties surrounding net-zero investments

Stable and effective public policy can play a role in translating business leaders' commitments into concrete investment decisions. Business leaders have an increasingly important role to play, and new ideas on how and why to play that role are evolving, as illustrated by the examples below.

Business leaders are trusted—and expected—to lead on climate change

The 2022 Edelman Trust Barometer (a survey of 36,000 respondents from 28 countries) indicates that societal leadership is now a core business function; people want more leadership from business, not less. For example, 68 percent expect CEOs to inform and shape policy debates on global warming and climate change. While business is rated a competent and effective driver of positive change, most respondents said business leaders are not doing enough to address climate change. The only institutions that saw an increase in public trust were NGOs.[11]

High-impact coalitions help business and government collaborate effectively

Fighting climate change requires global solutions and collaboration. The United Nations provides one forum for dialogue between government and business, and it has launched numerous public–private initiatives to facilitate the energy transition. For example, the Energy Compact Action Network is a coalition of governments and businesses that has pledged more than $2 trillion in six months to meet energy-transition goals.[12]

Business leaders today also have new models for addressing societal imperatives. Research led by Rosabeth Moss Kanter, founding chair of the Harvard Advanced Leadership Initiative, recently outlined the role of an emerging organizational form, the high-impact coalition, that reaches across business, governments, and nongovernmental organizations (NGOs).[13] Voluntary and relationship-based, these coalitions align disparate actors in support of a moral imperative, such as achieving net-zero emissions.

High-impact coalitions are characterized by open boundaries, which allow participants to engage when and how they see fit. Because proven approaches to addressing global imperatives seldom exist, a "loose-tight" management model keeps structures and rules loose while emphasizing tight relationships. The combination of open boundaries and loose-tight management enables diversity of participation while allowing each participant to work in the most effective way.

"If everything seems under control, you're not moving fast enough."

—Mario Andretti, world-champion race car driver

The race to net-zero emissions, like all races, is forcing participants to move faster than they would have previously considered prudent. And, just as in Formula One, the whole world is watching, the measures of success are clear, and the risks are significant. Racing teams all start with the same set of rules—winners are those who execute strategies with the right balance of innovation, consistency, and the management of uncertainty and risk.

Like Formula One teams, asset owners are operating with the same set of rules, technologies, uncertainties, and risks. By starting now to develop portfolio strategies that face risks and uncertainties head-on, asset owners can help ensure the industry moves fast enough to achieve net-zero-emissions goals.

[11] *Edelman trust barometer 2022*, Edelman, January 2022.
[12] *Energy Compact Action Network*, Energy Compacts and United Nations, May 2022.
[13] Tuna Cem Hayliri and Rosabeth Moss Kanter, "Creating high-impact coalitions," Harvard Business Review, March–April 2022.

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This article is the fourth in a series of five covering the challenges of delivering the net-zero portfolio and exploring the transformational opportunities it presents. It follows "Building the net-zero workforce," which was published in June.

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McKinsey & Company

Roundtable

Hong Kong 2022: Surviving the productivity and inflation crisis

Hong Kong's construction industry faces a number of challenges resulting from supply-chain congestion, rising demand and fuel costs, and a changing workforce.



August 2022

On April 28, 2022, McKinsey's Global Infrastructure Initiative hosted a roundtable with senior leaders from across the value chain, including owners, engineering and construction players, material suppliers, investors, and public-sector leaders to navigate the path forward.

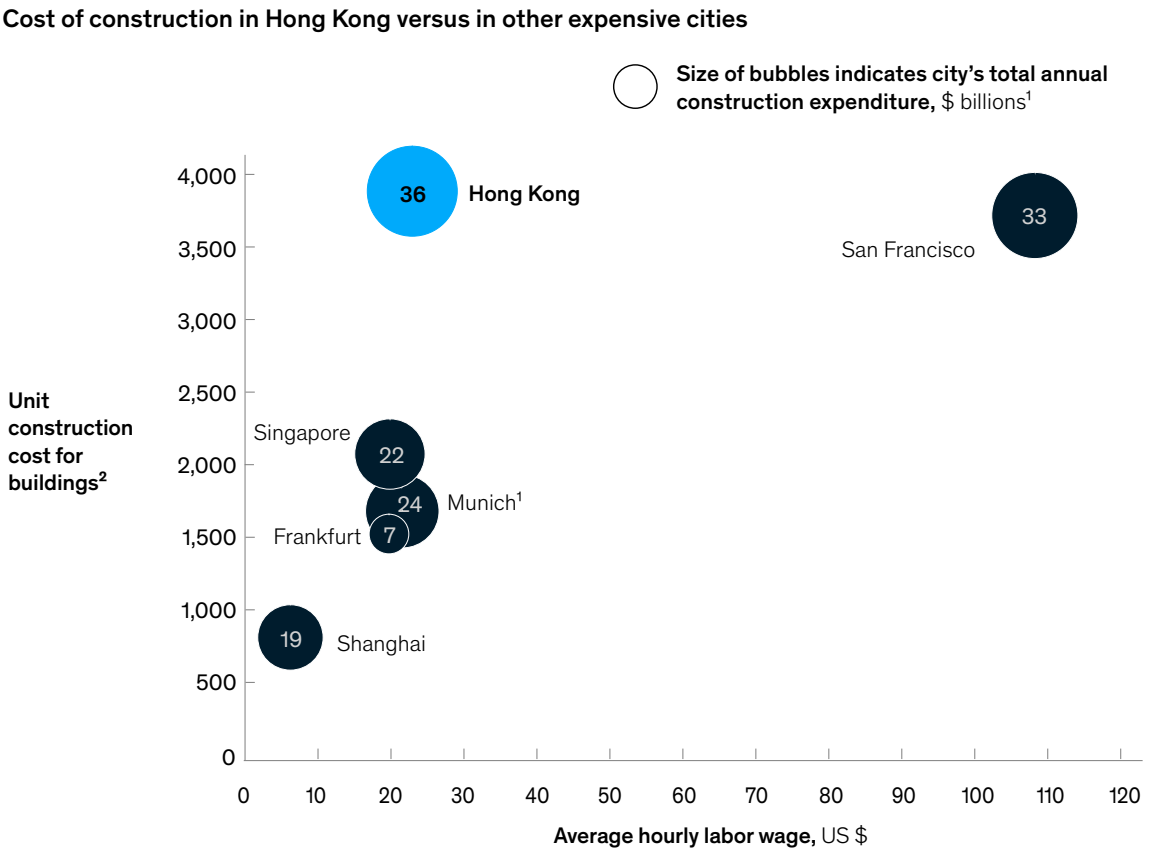
A robust project pipeline, compounded by supply constraints and labor shortages, has fueled inflation in construction costs to an unsustainable level. In fact, Hong Kong's construction cost is among the highest in the world (at $36 per square meter of building construction), especially when compared with other cities with similar labor wages (Exhibit 1).

Since 2012, Hong Kong's wage level has inflated twice as much as the Consumer Price Index (CPI), with material costs not far behind. More recently, reasons for this include supply-chain and freight disruptions and bulk-material price volatility. On the former point, the COVID-19 pandemic has led to unusual levels of supply-chain congestion and rising consumer demand and fuel costs. And on the latter, global supply-chain disruption and resumption of economic activities have increased costs for key commodities.

Over the next ten years, productivity and cost trends are expected to worsen, with additional construction costs of approximately $14 billion to $22 billion due to inflation alone (Exhibit 2). Furthermore, a whopping

Exhibit 1

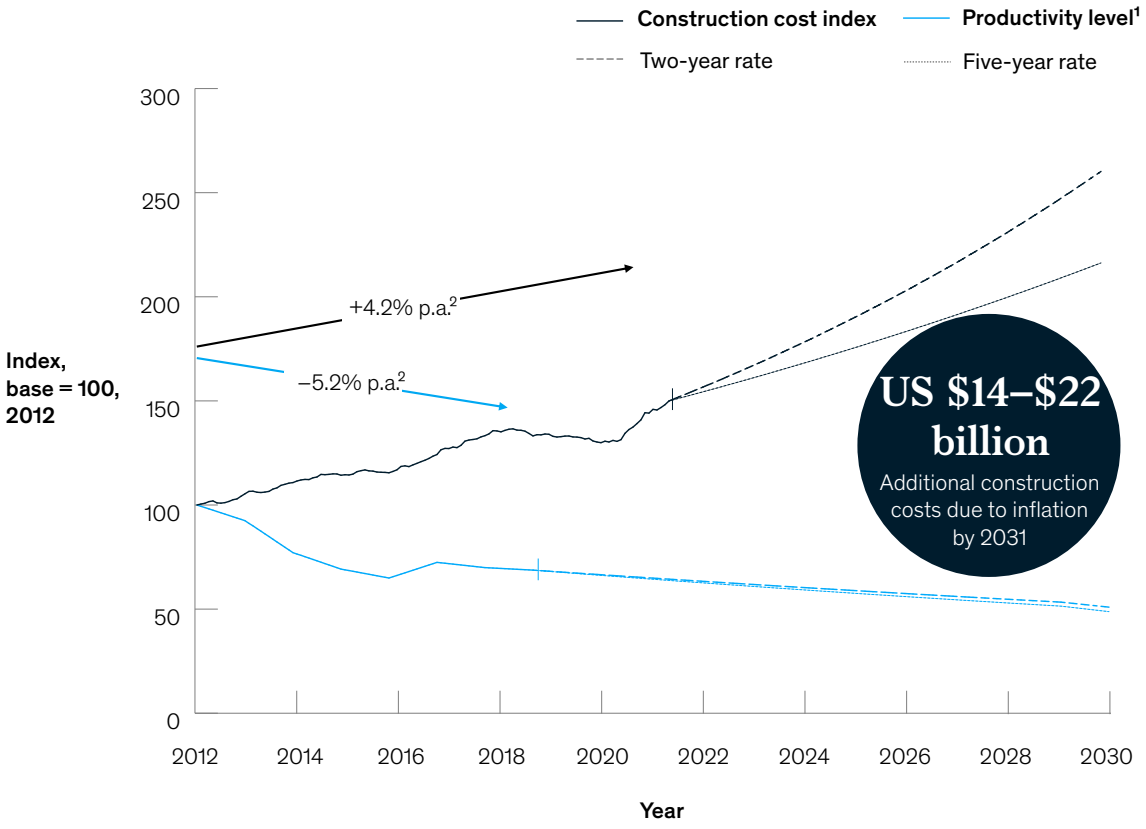
Hong Kong's construction cost is among the highest in the world, especially when compared with other regions with similar labor wages.



[1]2021 figures: Hong Kong, San Francisco, Shanghai, and Singapore; 2020 figures (latest available): Frankfurt and Munich.
[2]Cost of total completed floor areas.
Source: Building and Construction Authority of Singapore; Federal Statistical Office of Germany; IHS Markit; Turner & Townsend; McKinsey analysis

Exhibit 2

Hong Kong's construction productivity and cost trends are expected to worsen by 2030.



[1]A three-year moving average of the combined public-sector and private-sector productivity levels. Private-sector productivity is calculated by total completed floor areas divided by the number of labor participants, and public-sector productivity is calculated by the total number of public rental housing units divided by the number of labor participants.
[2]Per annum.
Source: Bureau, Hong Kong Special Administrative Region; McKinsey analysis

41 percent of the active workforce is expected to retire in the next ten years. This means that the workforce needs to triple in size to meet demand by 2030, increasing from around 247,000 manual workers (as of March 2022) to 858,000 (approximately 160,000 more than the current hiring rate).

Surviving the productivity and inflation crisis will require proven change agents. To begin, lean construction can effectively leverage productivity gains and mitigate viability through process optimization. New digital tools can uplift project performance across the asset life cycle. Offsite construction can help optimize design and reduce reliance on manual labor. And regulatory and contractual innovations can help catalyze productivity improvement.

Overall, productivity can potentially be improved by some 35 to 50 percent. With this in mind, the following key themes that emerged from the roundtable can help industry leaders navigate the years to come:

1. *Systemic change is needed:* Hong Kong's construction productivity and costs are expected

to worsen in the next eight years. Accelerating inflation coupled with declining productivity will drive up construction costs by up to US $22 billion by 2031—and Hong Kong is already among the most expensive cities in the world for construction. There was strong consensus among roundtable participants that systemic transformation is needed across commercial constructs, talent, government incentives, and tech-enabled ways of working. Incremental shifts will not deliver the type of step change needed.

2. *Reinvent the workforce:* With 41 percent of active laborers retiring in the next decade, along with increasing attrition and decreasing new entrants, Hong Kong's construction industry will face a labor shortage of more than 300,000 full-time equivalents (FTEs) by 2031. Even if the industry increases labor productivity by 50 percent, it would still be unable to meet the construction pipeline demand. Alleviating measures would include consolidating roles enabled by more integrated and streamlined processes as well as creating new digitally enabled roles that could replace multiple traditional roles and allow talent beyond Hong Kong to contribute remotely. Partnering with the education sector would help develop, attract, and recruit much-needed talent.

3. *Redefine policies, standards, and requirements:* Although lean construction and digitalization can help alleviate the challenge, Hong Kong's construction players can only do so much without some fundamental innovations. For example, digital certifications, inspections, audits, and approval solutions could become accepted alternatives by the government and private developers, or digital construction capabilities could be formalized and recognized by the education sector and professional bodies. Participants discussed a potential government-led alliance to connect the modular construction ecosystem, standardize requirements, and integrate upstream suppliers to support scale.

4. *Reconfigure incentives to encourage innovation, not stifle it:* The industry should shift away from awarding contracts based on minimum cost, which sets a norm of transactional behavior and discourages longer-term investments in quality. "The industry [habitually focuses] on ticking the box instead of delivering a good job," said one participant. One alternative was the increasing use of a two-envelope approach, in which technical capabilities are evaluated independent of price point. Across the board, participants stressed the need for new mindsets, greater transparency, and increased risk sharing to navigate the crisis.

5. *Take a long-term view when investing in digital:* It will take time for digital solutions to produce a positive return on investment. Many organizations give up after a few pilots fail to gain momentum. The challenge is usually not in finding the solution itself, but rather in establishing the commitment and resilience to sustain coordinated behavioral change. "Make it really easy to be digital and really hard not to be," said one participant. Realizing the benefits of technology will require adoption by the full industry, including small and medium-size enterprises and older workers. While senior members of the workforce have the most practical expertise, they are also generally the slowest to adopt new technologies. Solution providers, educational institutions, and the public sector can take steps to make digital tools accessible for those over 60 years old—for example, through more intuitive user interfaces or targeted training programs.

Hong Kong's construction industry has passed a crucial tipping point, and society can no longer absorb escalating construction costs. Isolated actions will not be sufficient; only a coordinated effort among all stakeholders can achieve the necessary change. The good news is that solutions are available and can be deployed rapidly if players commit to transformation. There will be challenges ahead as well as opportunities—and what remains to be seen is who will emerge stronger for their efforts.

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Roundtable

Tokyo 2022: Navigating the new normal and decarbonization challenge in Japan's infrastructure industry

The changing macroeconomic context puts infrastructure at an inflection point.



July 2022

The net-zero transition will add an estimated $3.5 trillion a year to global investment budgets, much of which will need to be delivered through the infrastructure supply chain. To increase delivery at the required scale and pace, the industry will need to overcome historic productivity challenges and manage the current supply chain constraints driven by the pandemic and geopolitical instability.

On May 17, 2022, McKinsey's Global Infrastructure Initiative convened a roundtable discussion in Tokyo titled "Japan's construction and infrastructure industry: The new normal and the challenge of decarbonization." The audience comprised senior leaders across engineering and construction, owners, operators, real estate, and technology. The following key themes emerged from the roundtable:

1. *Japan's construction industry is on the cusp of transformation.* The sector has been largely stagnant for 20 years, with construction productivity lagging at just 0.6 percent a year from 2000 to 2020. Now, new market conditions are driving innovation across areas such as technology, consolidation, productization, and sustainability. McKinsey research suggests that a more productized value chain could create $250 billion to $300 billion in new value by 2035—while also creating risks for players like general and specialty contractors. Already the industry has seen rapid growth in modular, digital, and off-site techniques, reflecting its direction of travel and the potential shifts to come.

2. *Decarbonization is a key imperative, with pockets of meaningful progress.* Buildings affect more than 30 percent of global anthropogenic carbon emissions. Two major green levers are switching to renewable heat sources, such as deploying A2A heat pumps in commercial buildings, and decarbonizing materials, such as optimizing low-carbon materials and reducing demand. Some strategies are already seeing success: one engineering and construction firm reached net-zero emissions on an office building through techniques such as leveraging the natural environment for lighting and heat, generating solar energy, and producing hydrogen on-site for storage and subsequent use.

3. *Measuring decarbonization progress is a key challenge.* Achieving net-zero emissions by 2050 will require emission reductions by about 90 percent in both the building and transportation sectors. To take practical steps forward, companies will need to accurately and transparently measure and report their emissions data as part of their ESG reporting. Doing this will help the industry establish benchmarks, set realistic targets, and measure progress. While some carbon accounting tools exist, they have yet to be adopted by the industry and used at scale.

4. *The energy transition presents investors with major opportunities and risks.* Approximately $60 trillion of capital will be needed by 2050 to achieve a 1.5° pathway, presenting a huge infrastructure investment opportunity. Hydrogen is a particularly dynamic space, with $160 billion of projects already announced. At the same time, climate change creates new risks for infrastructure assets (such as floods and forest fires), which are often unaccounted for in projects. Investors must also consider the risk of stranded assets—for example, coal plants or gas pipelines that face dwindling demand in a net-zero world. According to the Network for Greening the Financial System (NGFS), $2.1 trillion in such assets could be exposed in the power sector alone.

5. *While ESG is seen by some as costly, investors are willing to commit capital today.* Activist investors are taking action, and nearly $400 billion has been raised in ESG-related funds in the past five years. All investors can consider steps to diagnose their portfolios and gain a clearer view of embedded risks, while positioning themselves as the best partners for developing a new generation of infrastructure assets that are fit for a net-zero future. ESG is primed to become an active value proposition and a key differentiating factor as markets mature.

6. *Collaborate to drive efficiency across system-level changes.* Improving productivity in construction and decarbonizing the built environment will require 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 on capability building, planning, financing, and project delivery could help allocate costs and risks, drive innovation, scale impact, and facilitate aligned policies and regulations.

McKinsey & Company

Roundtable

Sydney 2022: Scaling EV infrastructure to meet net-zero targets

Driven by policy, technological innovation, and expanded consumer choice, the global electric vehicle (EV) market has seen incredible growth over the past decade, and it will only accelerate.



July 2022

In the broader context of meeting climate targets through low-emission vehicles, a critical enabler is the scaling of the infrastructure required to meet demand. This entails several key infrastructure segments—in particular, downstream EV charging infrastructure (EVCI) and the grid network to support it.

Current EV uptake in Australia is at a comparatively low rate; roughly 2 percent of car sales are battery or plug-in hybrid, compared to more than 20 percent in some European markets (and more than 80 percent in Norway). With new models on the market, rising fuel prices, and increased consumer awareness, EV uptake is expected to grow significantly in the next 10 years. Hence, considerable innovation and investment will be required from stakeholders across the value chain to provide the appropriate infrastructure to allow the EV market to thrive.

On June 22, 2022, McKinsey's Global Infrastructure Initiative (GII) hosted a roundtable with senior leaders across the EV and EVCI ecosystem to discuss these issues and potential actions. Participants represented fleet managers, charging networks, automakers, investors, industry associations, and transport operators. The following key themes emerged:

1. *Australia is lagging in EV adoption, but the opportunity is vast.* While just 20,000 EVs were sold in Australia last year, 3 million EVs are projected to be on the country's roads by 2030, requiring 2.8 million charging points and AUD $18 billion (US $12.5 billion) in charging infrastructure investments. "I am optimistic that the dialogue is no longer about whether we should embrace EVs, but how we embrace them faster," said one executive. That said, participants agreed that this opportunity will not be realised by market momentum alone; concerted, holistic action is needed.

2. *Sizable grid upgrades are critical to enable uptake of EVs.* Across the board, participants saw cost and variability of grid interconnections as a real barrier to ensuring reliable, safe, and affordable electrification. Given the projected need for 2.8 million connection points, network expansion must be undertaken thoughtfully and with collective, cross-sector funding so they are not borne by consumers or properties in a fragmented way. Better system visibility is imperative; it will facilitate data transparency for load and capacity planning.

3. *The public sector could play an important orchestrating role.* EVs present a timely opportunity to reimagine Australia's transport infrastructure across the four ACES technologies: autonomous, connected, electrified, and smart. Participants consistently agreed that the public sector is well-positioned to coordinate this effort across industries that are currently siloed. For example, to enable electrification, the public sector could consider establishing national targets and incentives for EV adoption (such as fuel efficiency standards and tariff reform), or derisking grid and charging infrastructure investments.

4. *Define the commercial model to create an investible proposition.* Participants agreed that a more robust commercial model will be essential for Australia's EVCI to meet anticipated demand. The need for investment is clear, but there is not yet enough certainty in the investment case for underlying infrastructure to scale. "We need to shift the balance of 'build it and they will come,'" said one executive. Beyond potential increases in EV incentives and cofinancing support, the group discussed strategies such as demand-based pricing, advertising, and colocation with retail or entertainment areas.

5. *Close the gap in technical labor and skills.* Analysis by Infrastructure Australia in October 2021 found that by 2023, one in three (105,000) skilled positions could go unfilled across the infrastructure sector. To realize the EV opportunity, Australia will need far more skilled personnel—such as EV electricians, engineers, and planners—who can tackle the associated operational and technological challenges. This could become a major impediment observed internationally, not just in Australia.

6. *Broaden the range and perception of EV availability.* To grow and sustain consumer demand for EVs, some participants raised specific considerations around which EVs are available in Australia—a challenge recently compounded by supply chain disruptions. One participant highlighted that the country is a right-hand-drive market, whereas manufacturers often focus on the left-hand-drive markets of the United States, most of Europe, and China. Another participant described a prevailing image of EVs as being unaffordable and "only available to higher-income car owners," which limits mass uptake.



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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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