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Decarbonizing Mobility Forum: Amsterdam 2023

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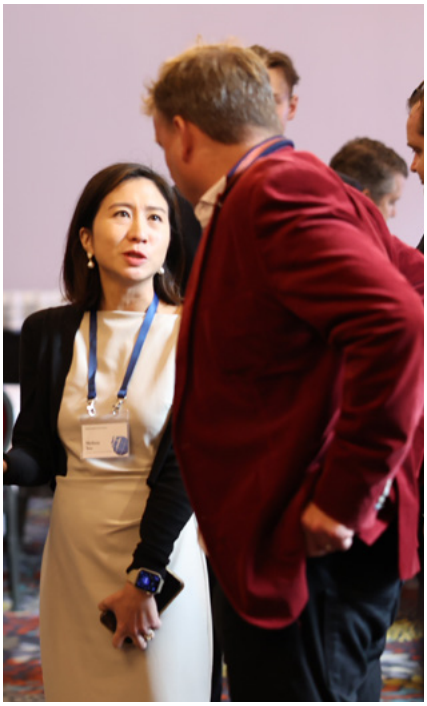

Executive summary

The mobility sector is the third-largest greenhouse-gas emitter,[1] producing nearly eight metric gigatons of CO_2 globally in 2022.[2] According to McKinsey analysis, to dramatically reduce their emissions, automakers across the globe are expected to invest more than $1 trillion into green transportation through 2030—but more can be done. Progress will require strategic cross-collaboration across companies, sectors, governments, and communities, with an openness to build and adopt new technologies at scale.

During the Global Infrastructure Initiative's inaugural Decarbonizing Mobility Forum, held in Amsterdam on September 13 and 14, 2023, leaders across the energy and mobility sectors gathered to discuss ways to accelerate sustainable transportation. The forum brought together more than 80 senior leaders from 56 companies and 15 countries. The event focused primarily on the automotive industry—a significant part of the mobility mix—including automobile electrification and the underlying infrastructure, which are essential parts of the broader actions required to realize green mobility.[3] Conversations centered on the enabling factors for expanding clean energy and net-zero mobility, overcoming roadblocks, and finding new opportunities to deploy critical infrastructure and technology.

The first day of the Decarbonizing Mobility Forum convened industry leaders for a site visit to the Johan Cruijff Arena, networking opportunities, and plenary sessions spanning the topics of battery manufacturing, clean energy, and electric-vehicle (EV) charging infrastructure. The second day tackled sector-specific discussions on net-zero mobility, battery circularity, and hydrogen infrastructure.

Bold innovation, new models of collaboration, and policy support will be vital for the industry to move forward in a meaningful way. This report summarizes the key themes and takeaways that emerged during the forum's discussions and highlights strategies for leaders across the mobility value chain to advance the sector and meet its sustainability goals.

[1] "Digital tech can reduce emissions by up to 20% in high-emitting industries," World Economic Forum, May 24, 2022.
[2] "Transport," International Energy Agency, accessed September 2023.
[3] Kersten Heineke, Nicholas Laverty, Timo Möller, and Felix Ziegler, "The future of mobility," *McKinsey Quarterly*, April 19, 2023.


Denys Nevozhai/Unsplash

Decarbonizing mobility: The state of play in 2023

As leaders of the third-highest-emitting sector, mobility leaders will be focused on decarbonization for the next several decades. By 2050, the sector must cut 91 percent of emissions to stay within the 1.5°C warming limit set by the Paris Agreement.[4] Additionally, to meet net-zero goals, more than $3 trillion must be spent on low-emission vehicles and infrastructure globally every year until 2050; at the end of 2022, investment in this area was about $100 billion.[5]

Policy makers and legislators have tried to sustain the momentum to decarbonize by setting goals and parameters around internal-combustion engines and transportation-related emissions. Consumers have also purchased EVs in greater volumes in recent years: EV sales grew 55 percent from 2021 to 2022.[6]

Stakeholders across the industry—in energy, transportation, manufacturing, and investing—gathered to discuss the path forward, seeking to answer one pivotal question: what actions are needed now to enable sustainable mobility for decades to come?

[4] For more, see "The Paris Agreement," United Nations Framework Convention on Climate Change, accessed September 29, 2023.
[5] Ryan Fisher, "Electric vehicle charging investment approaches the $100 billion mark," Bloomberg, December 20, 2022.
[6] "Global EV Outlook 2023: Executive summary," International Energy Agency, April 2023.

Their discussion illuminated five critical factors that could pave the way to decarbonizing mobility's entire value chain:

1. *Global partnerships.* Strengthening collaborations between private and public institutions could help scale development for vital manufacturing and support infrastructure such as gigafactories and charging networks. Innovative collaborations with, for example, companies that are traditionally competitors could help promote better data sharing to maximize the value of new insights. This approach would require leaders to be open-minded about partnerships and build trust among competitors.

2. *New technologies*. Investing in research and development and rapidly piloting and commercializing new technologies, such as hydrogen synfuel and fuel-cell EVs, could help advance and scale innovations. Additionally, maintaining technology neutrality when reviewing and implementing use cases is important because doing so allows the battery, fuel-cell, and hydrogen sectors to work together.

3. *Industrialization focus.* Stakeholders can develop new approaches to scaling climate technologies with the highest efficiency possible. The technologies, designs, and processes for delivering green technology at scale are nascent. To increase modularization, reduce costs, and boost efficiency, companies can learn from other industries that have successfully scaled, such as solar and batteries.

4. *Nurture talent.* Across the value chain, companies could do more than attract and nurture engineering, procurement, and construction talent; they can also prioritize improving technology skills and tech-driven productivity across their workforces.

5. *Policy support.* Governments and communities play a pivotal role in decarbonization. Participants raised the view that a clearer, more efficient permitting process would speed up the rollout of infrastructure projects.

Unleashing the source: Delivering plants and gigaprojects

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Batteries are a vital component of the energy transition, especially in the transportation sector. To meet the demand for batteries required to sustain global EV adoption, gigafactories and plants that produce batteries must be developed at seven times today's rate. That's no easy feat: many of these factories must be built from scratch, a project that can take anywhere from one to five years to complete, depending on the region. One speaker said, "This is the most complex environment I've ever seen in my career—you have to build everything from scratch, and gigaproject planning is just the tip of the iceberg."

Fortunately, there is opportunity for improvement, and many players have already announced gigafactory growth in other sectors, offering the mobility sector a blueprint on which to build. To scale battery production at the required rate, companies should be aware of the challenges presented to them in the current environment and the opportunities they have looking ahead.

During this session, panelists discussed three challenges of scaling battery gigafactories and plants: labor shortages, technology and resources, and regional development challenges.

— *Labor shortages.* Labor shortages have affected nearly every industry, but the mobility sector is competing for the same talent as building, manufacturing, and other industrial sectors. Further, as automation becomes a differentiating feature for companies, the demand for workers who have skills in advanced technology will increase. The labor market has been additionally distorted by efforts to scale up manufacturing. One

participant said, “Subsidized projects are destroying the market for talent by throwing around money.” The risk is uneven deployment of talent across regions, leading to project bottlenecks.

— *Technology and resources.* Access to raw materials, land, and financing are also tight, especially for projects that require ample resources, such as gigafactories. For example, designing and delivering one gigafactory can require up to $3 billion in investment. On top of that, constructing and operating gigafactories is highly energy intensive. As such, decarbonizing the construction and manufacturing process remains critical to realizing the net-zero benefits of technology.

> “This is the most complex environment I’ve ever seen in my career—you have to build everything from scratch, and gigaproject planning is just the tip of the iceberg.”

— *Regional development challenges.* Building gigafactories in Europe and North America has a demonstrably longer timeline than in parts of Asia, with greater lead times required for government approvals, regulations such as recycling requirements, and other permissions. In contrast, China has sped up development time exponentially by acquiring existing buildings and adapting equipment to the existing infrastructure rather than building from scratch. As such, some organizations in other regions plan to follow suit, breaking from more rigid approaches to improve optimization.

To address these challenges, mobility players should think differently about designing and scaling, costs, and risk management.

— *Designing and scaling.* To scale efficiently, companies can integrate standardization into plant design so delivery can be modularized and adapted to match each plant’s specifications. “No two plants are exactly the same, but design can be modularized to scale up or down,” said one forum participant. Integrating standardized subcomponent designs would help repairs happen faster across geographies and help organizations proactively replace equipment as it degrades over time.

— *Costs.* Standardization can also help manage cost barriers. Developers could use past projects as a template to have a better idea of the planning that would be involved for future projects, allowing developers to spend more time on the design of a project, learn from the innovative choices that others have made, and integrate new technologies into spaces that weren’t previously considered. For example, parametric cost modeling could help gigafactory developers forecast the cost of a project based on similar or past projects.

— *Risk management.* Above all, scaling gigafactories requires alignment from all relevant stakeholders and an awareness of the risk involved. Managing risk necessitates a broad lens that considers the cost of energy, site selection, access to skilled labor, supply chain dynamics, and the ability to scale in the current environment. Tools such as smart procurement, establishing project controls, and clear processes can help avoid the risk of overspending and time overrun. Governments can also work with energy transition companies to speed up processes by making permitting easier. In general, aligning incentives and putting the right ecosystem in place can help derisk projects and transfer the total cost of ownership across a network of players.

Accelerating distribution: Expanding infrastructure

EV adoption has increased substantially over the past decade, but the charging infrastructure required to sustain this adoption has not grown at the same pace. In the early days of adoption, mobility service providers were the main target for EV charging-infrastructure investors, but as demand increases, more value has been placed on creating owner-operator networks of charging stations. These networks could offer more reliable charging for EV drivers in many convenient locations, but consumers may not see the benefit unless standardization is balanced with a regional approach.

Fortunately, there is ample opportunity to improve and expand EV charging infrastructure. Many panelists in this session expressed a commitment to setting ambitious goals in this area, with some aiming to build 100,000 charging points by 2030. Mobility players should keep geography, the consumer, and long-term financial impact in mind when strategizing opportunities to scale EV charging infrastructure.

During this session, participants discussed a variety of key challenges:

— *Customer-centricity.* Many companies have focused on building infrastructure without considering the voice of the customer—one of the most essential pieces of improving EV adoption. One participant remarked that the industry is "embryonic" in its thinking about critical factors that shape customer engagement, such as lifetime value, acquisition cost, and reviews. Mobility players expect the EV market to be up to 20 times more competitive by 2030, increasing the importance of getting charging speed, amenities, and location right.

— *Standardization.* Most EV drivers charge their vehicles on the go, but many find the reliability of charging networks subpar. Participants discussed the need to standardize charger types and stations and increase availability across geographies in general. As one participant noted, “Even if there were enough chargers, they may not be the right kind or in the right place.”

Mobility players can consider customer use when building charging stations and calibrate charging speed to the location of a charger. Active collaboration with OEMs is also critical given that OEMs have the most influence over how cars are built and therefore the underlying infrastructure. One participant said, “Customers give OEMs the benefit of the doubt, which they don’t give charging providers . . . . Often the constraint is the car!”

Expanding EV charging infrastructure will require proactivity in three areas: regionalized funding, ubiquity, and business integration.

— *Regionalized funding.* Use of EVs has increased most substantially in the European Union, with primary markets in Germany and the United Kingdom. Funding for long-term infrastructure can align with these geographic trends. Upticks in use will lead to upticks in revenue; therefore, companies that follow consumer trends will see a return on their investments while also providing adequate service.

— *Ubiquity.* Ease of access and the nuances of each location’s needs will be important considerations when scaling infrastructure. In the United States, for example, in addition to battery engines, access to hydrogen-based gas alternatives will be required to meet the demand for green energy and create a more sustainable mobility sector. Alternatively, in the United Kingdom, hydrogen could be less of a priority because battery ranges are sufficient to cover any distance over the island. Improving efficiencies and avoiding underuse will also require strategic placement of EV chargers to meet the needs of local consumers. For example, high-powered 350-kilowatt chargers may not be required everywhere, and mobility and charging leaders can assess placement based on individual business cases.

— *Business integration*. Integrating business processes into EV charging infrastructure is another important aspect for investors to consider. Many companies already provide fleets with integrated billing and customer support services, but innovators are working to make the sector even more software-driven. This shift will increase competition, cause some companies to consolidate, and provide a natural exit for others. As a result, managed-service providers and charging-point operators are under more pressure to improve and integrate their own products.

Harnessing clean energy to power the transition


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The mobility transition will not only require the manufacture of green vehicles and the necessary charging and refueling infrastructure to support them but will also require sufficient amounts of green power and hydrogen at a competitive cost. This energy demand requires a significant ramp-up of renewable-energy production as well as a build-out and revamp of the infrastructure to transport, store, and convert power.

The main challenges in this transition come down to costs, availability of power grids, and regulations:

— *Costs.* Inflation and higher financing costs have increased the economic challenges of generating renewable power and investing in power infrastructure. In particular, offshore wind has had many projects put on hold recently or even canceled because of the high costs of capital, equipment, and engineering, procurement, and construction services.

— *Availability of power grids.* Power grids will need to expand to handle increased energy demand for electric vehicles, hydrogen production, and the electrification of industries and buildings. Similarly, grids will need to transform to handle the intermittency of renewables by incorporating energy storage assets, such as batteries, heat storage, and pumped hydrogen. Grids can also be adapted to handle the demand for flexibility by, for example, providing electrolyzers.

— *Regulations.* In addition to deploying capital to support clean-energy or decarbonization initiatives, governments can adapt regulations to allow for the mobility transition. The permit process for renewable-power generation and grid expansion, for example, needs to be streamlined and accelerated. Power system regulations need to adapt to enable, and provide incentives for, the rapid build-out of grids to support the increasing number of renewables. Clear regulations on demand for

synthetic fuels, for instance, can reduce uncertainty and spur investment in the development of these new value chains.

Overcoming the challenges of scaling clean-energy solutions will take collaboration and regulation-enabled flexibility:

— *Collaboration.* For the mobility transition to succeed, all elements need to be in place; the availability of vehicles, the generation of clean power and hydrogen, and the provision of charging and refueling networks. Coordination among industries and across the value chain are crucial and can happen through both regulatory frameworks and partnerships. For example, utilities, charging and refueling operators, and equipment OEMs could work together to offer clean mobility as a solution to customers. For hydrogen mobility, collaboration with other hydrogen offtakers could be vital in producing hydrogen at scale and at more attractive prices. One example could be the production of hydrogen for both industrial use and for use in a local bus fleet.

— *Regulation-enabled flexibility.* New regulation is required across the mobility system, primarily to bring the energy and mobility transitions together. For example, many EV chargers do not encourage users to charge during off-peak hours because regulation allows them only to tap into a fixed power price. If regulation were to enable flexible power prices for residential users, these price signals could be incorporated into the charging pattern, reduce grid congestion, and increase the use of renewable power as it is produced. Governments are starting to integrate energy system aspects into offshore auctions by, for instance, including energy flexibility assets such as batteries and electrolyzers into auction scoring.

Meeting the demands of net-zero mobility

The needs and economics of EV charging infrastructure continue to evolve. Adoption of electric passenger cars is growing in all regions, requiring additional charging infrastructure across residential, work, fleet, destination, and on-the-go use cases. Electrification in mid- and heavy-duty truck segments is also picking up; total cost of ownership is expected to reach parity with internal-combustion-engine vehicles in the coming years.

In this roundtable, leaders across the mobility sector convened to explore levers for meeting the demand of net-zero mobility for passenger cars. Four crucial themes emerged:

— *Accelerate now.* Demand for EV charging is accelerating across the globe, but the supply side of charging infrastructure still has a long way to go before it establishes a fully fledged charging infrastructure that provides a dense, differentiated network across use cases and customer segments. McKinsey analysis suggests that by 2030, the charging infrastructure will be robust enough to enable more charging at malls, car parks, and grocery or retail stores so that consumers can rely less on overnight charging at home. EV players can tap into these areas of demand and use existing legislation to accelerate the development of charging infrastructure.

— *Double down on customer-centricity.* Competition among EV companies is intensifying along the value chain. Customers increasingly expect smooth charging experiences, interoperability, charger uptimes, and

navigation, requiring major investments in EV software and hardware. “Customer experience should be at the heart of the transition,” one panelist said. “We have to educate customers and make infrastructure easy for them to use so they can be part of the value chain and collectively enable the transition.”

— *Stakeholders can work together to build a universal ecosystem.* Legislators, manufacturers, consumers, and other stakeholders can align to ensure that the right goals and incentives are set during the mobility transition. Collaboration will be critical, and leaders could be open to working with the full value chain and across sectors to achieve the optimal pathway to scaling up EV charging.

— *Explore alternative financing mechanisms.* Scaling the EV charging infrastructure requires major investments over the next decades. Players can define the right mix of financing options to spread risks, lower financing costs, and accelerate rollout.

Resilient battery supply chain and circularity

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Rapid decarbonization is needed in transport, which contributes approximately 21 percent of global CO_2 emissions. And although there is no one-size-fits-all solution, a resilient battery supply chain will play an important role. Leaders across the value chain can learn from adjacent industries and collaborate to solve common challenges.

In this roundtable, leaders across transport explored circularity in the battery value chain. Five key themes emerged:

— *Being open to new tech and chemistry.* As organizations work toward standardization, they need to ensure that innovation isn't stymied. Battery science is still rapidly changing, and alternative chemistry is still being developed. Using chemicals such as sulfur could potentially bring down costs and overall weight, especially for heavy vehicles. Furthermore, advances in technology are helping to increase vehicle life cycles, existing factories are being retrofitted to help increase production, and recycling is on a trajectory to become a multibillion-dollar market.

— *Finding a balance between localizing and regionalizing supply chains.* Trends to increase localization of supply chains can increase innovation and opportunity but can also exclude innovations happening in other regions if focused too narrowly. Government and organizations can try to strike a balance when driving for policies that require strict localization.

— *Sharing knowledge.* Global and transparent knowledge sharing can help speed up innovation and delivery of the new technology needed to meet decarbonization goals. This means incorporating efforts from across the value chain rather than focusing on a single area. One example is the Global Battery Alliance, which unites several international organizations, nongovernmental organizations, industry leaders, and governments to help establish a sustainable battery value chain.[7]

— *Strengthening Scope 3 reporting requirements.* Broader requirements for reporting Scope 3 emissions, especially among OEMs, will force each link of the mobility value chain to review its emissions and procurement standards, in turn creating better accountability and long-term sustainability impacts.

— *Creating safety standards.*Industry-wide regulation could help create safety standards and protect companies and consumers from labor and sustainability issues. Leaders should not assume that certain problems are regionally limited. Because there are many common challenges, it is critical for leaders to learn from different industries and work more collaboratively to solve these common challenges.

[7] For an example, see "Action partnerships: Battery Passport," Global Battery Alliance, accessed October 2, 2023.

Hydrogen: Building the business case in 2023

The limited hydrogen infrastructure currently in the marketplace remains a bottleneck to scaling adoption. When looking at specific applications for hydrogen in large fleets, however, cost projections start to decrease. Infrastructure investors can understand where and when it makes sense to invest in hydrogen vehicles and refueling stations. Further uptake will likely be driven by long-range use cases, large vehicles, and the need for flexibility.

In this roundtable, four themes emerged as transport leaders explored critical unlocks for increasing investment in and scaling the hydrogen ecosystem.

— *Scaling hydrogen use continues to be a challenge.* Industry players could leverage high-scale hydrogen users and higher-capacity electrolyzers to support fleet business cases. Fleets typically have fewer decision points when purchasing or updating vehicles, subsequently enabling faster adoption. Links to hydrogen production and industrial cases generally create increasingly interesting commercial uses, which is important because adoption among industrial applications can help drive down production costs. Huge wins will likely be found in aviation and shipping—both of which have enormous amounts of emissions—so it's key not to isolate expansion efforts to land mobility. Still, passenger cars will need to be considered when planning and building infrastructure for hydrogen refueling stations (HRSs).

— *Stakeholder coordination and capital deployment are critical.* Long-term capital investments are important in this space; the Bipartisan Infrastructure Law in United States, for example, allocates $1.5 billion to support hydrogen electrolysis.[8] These investments can also help close the economic gap between hydrogen and traditional fuels over time. The levelized cost of hydrogen matters, and with a global trading market, investors could understand how assets will be protected even if the first end use doesn't come. Combining incentives between governments and regional producers will be useful to ensure that consumers aren't stuck with the bill.

— *Tech neutrality can help ensure the most efficient transition.* The objective is to reduce the total carbon impact of green, blue, and gray hydrogen. And although it's critical to decarbonize quickly, the diversification and inclusion of different technologies will be key. In addition, quantifying the impact for society—particularly less noise, less pollution, and better driving experiences—could help improve the business case for impact investors.

— *Standardization remains a challenge.* Today, more than 1,000 HRSs are operational globally, with China leading in terms of deployment. Moving forward, a protocol of standardized fueling for gas-powered passenger cars helped us accelerate in the past; now, we need something similar for hydrogen. This entails working with OEMs to accept standardized fueling stations.

[8] "The economics of demand-side support for the Department of Energy's clean hydrogen hubs," The White House, July 5, 2023.

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