Toward Sustainable Fleet Transitions

Opportunities in Circularity, Resilience, and Community Benefits

ARUP enel

Contents

Preface

The transportation industry is poised on the edge of a once in a generation transition to zero-emission vehicles. As we work collectively to meet emissions targets and achieve climate goals, we look to leading organizations and best practice examples for how to successfully electrify our transportation sector. Fleet vehicles are touchpoints for millions to experience the possibilities of electrification, and fleet owners and operators are in a position to be leaders in a transportation revolution.

Enel and Arup have partnered to author this document to serve as a guide for a wide variety of audiences. Fleet owners, fleet managers, maintenance and operations staff, energy providers, sustainability practitioners, and many others can all find useful and practical content in this report.

Recognizing the scale of the opportunity for fleets as well as the depth of the challenges, Arup and Enel have drawn from decades of real-world experience in decarbonization and circularity to present major points that should be addressed when transitioning any kind of fleet. While each transition process will have unique considerations based on vehicle type, organization, and local context, the overarching steps are relevant across a range of fleet types. We are here to help you walk through the steps.

From the first conversations, it is critical to understand that fleet transitions encompass not only battery electric and hydrogen fuel cell electric vehicles (EVs) but also supportive energy infrastructure (electric charging and hydrogen fueling), vehicle storage, maintenance, and operations. Without effectively transitioning each of these components, the fleet transition may face additional risks, complications, and costs. Determining what is being driven is just as important as where vehicles are being stored, how they are fueling, and who is taking care of them. It is important to acknowledge that zero-emission vehicle (ZEV) fleets can sometimes require significantly different operating plans from what fleet owners are accustomed to, leading to disruptions that are as much psychological and cultural as they are technological.

Fleet transitions can and often do happen successfully—if they are done with careful planning, broad engagement, and commitment. The findings contained in this report capture a snapshot of how the industry as a whole may advance in the years ahead, and how leaders are charting a new course not only for their business and assets, but also in service to their employees and communities.

We are grateful for the input and contributions of time and insight from the Center for Transportation and the Environment (CTE) and the City of Pittsburgh.

Executive Summary

This report brings together lessons learned from electric vehicle specialists, energy providers, fleet owners and managers, and circular economy experts. The aim of this document is to catalyze, streamline, and accelerate transition efforts which have the potential to yield benefits far beyond the fleet.

The opportunity for impact is significant, yet the challenges of the transition can get overwhelming—and fleet owners can't do it alone. These challenges include planning and stakeholder engagement, procuring equipment, educating fleet users, site planning and facility design, incorporating sustainability, and accounting for long-term management of vehicles and equipment to ensure that environmental impacts are minimized and value is maximized.

Organizations that want to realize the full benefits of fleet transition, or simply know how to start, need a clear roadmap to guide their process. Facing complex cost-benefit tradeoffs, interdependent financial decisions, and fast-changing technologies, leaders of fleet transitions deserve a better understanding of what questions to ask when, and who needs to be at the table. Arup and Enel together aim to provide such insights with this report.

This work is intended to aid shared conversation and collaboration between multiple stakeholders, including:


Leadership


Utilities


OEMs & vendors


Fleet managers


Facility owners & managers


Community members

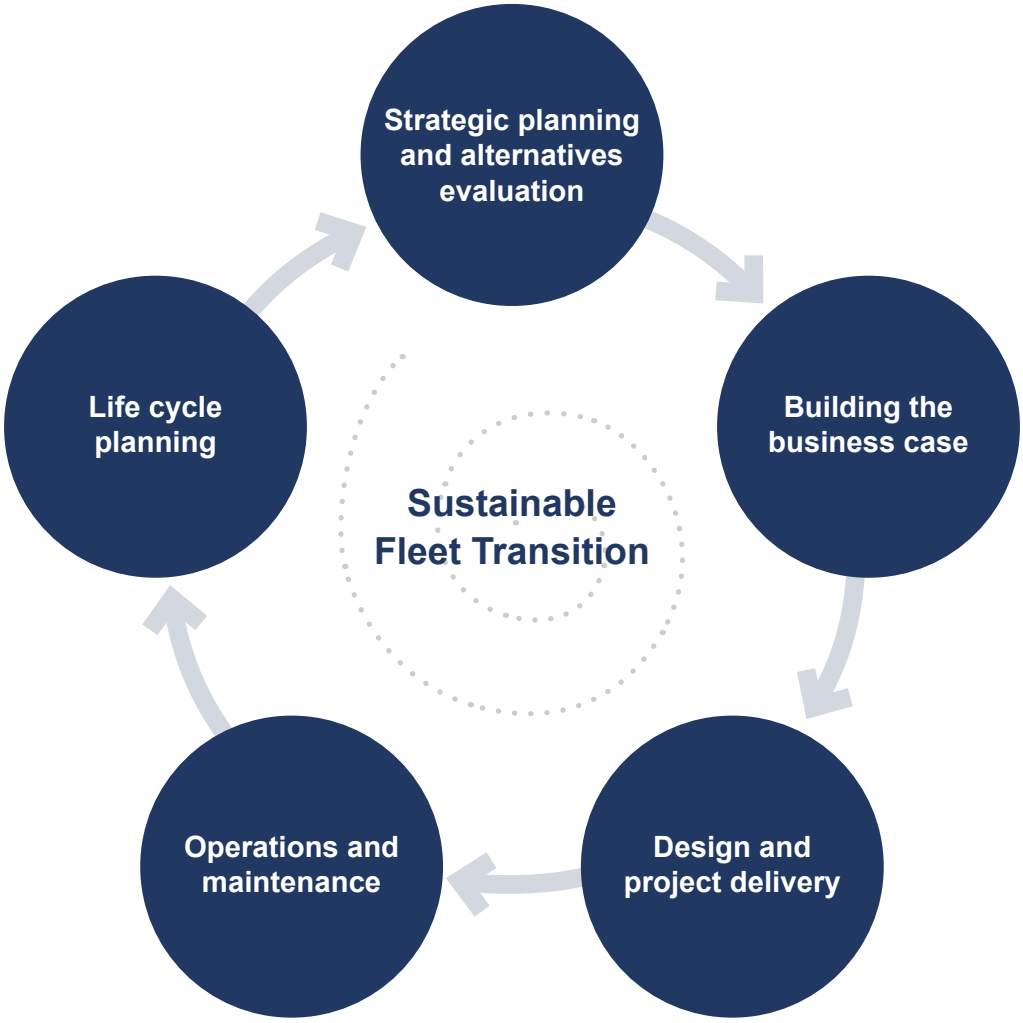

Operational personnel


Technical experts


Authority having jurisdiction


Delivery partners

This document walks through the phases of a typical fleet transition. Each step has unique considerations and calls for engagement with different parties. For each phase, we describe key activities, suggest priority actions for stakeholders, and highlight key lessons learned from our research with experts in the field. While every fleet is different, the framework of these phases can be broadly applied to fleet transitions of all types.



The report also identifies ways that the fleet transition process can be leveraged to create multiple value streams—or "value stacking"—to improve return on investment (ROI) and to realize benefits that extend beyond the fleet. Value stacking can include integrating the design of renewables into projects, improving infrastructure for demand response and resilience, providing public charging, and increasing resource circularity through re-use.

Value stacking opportunities to integrate circularity, resilience, and community benefits in the fleet transition process are highlighted in the side bar throughout the report, and brought together in illustrations on the following pages.

Value stacking

Opportunities for value stacking are spotlighted in this side bar throughout the report.

Value stacking opportunities: quick wins

Integrating circularity, resilience, and community benefits in the fleet transition process

Route modeling

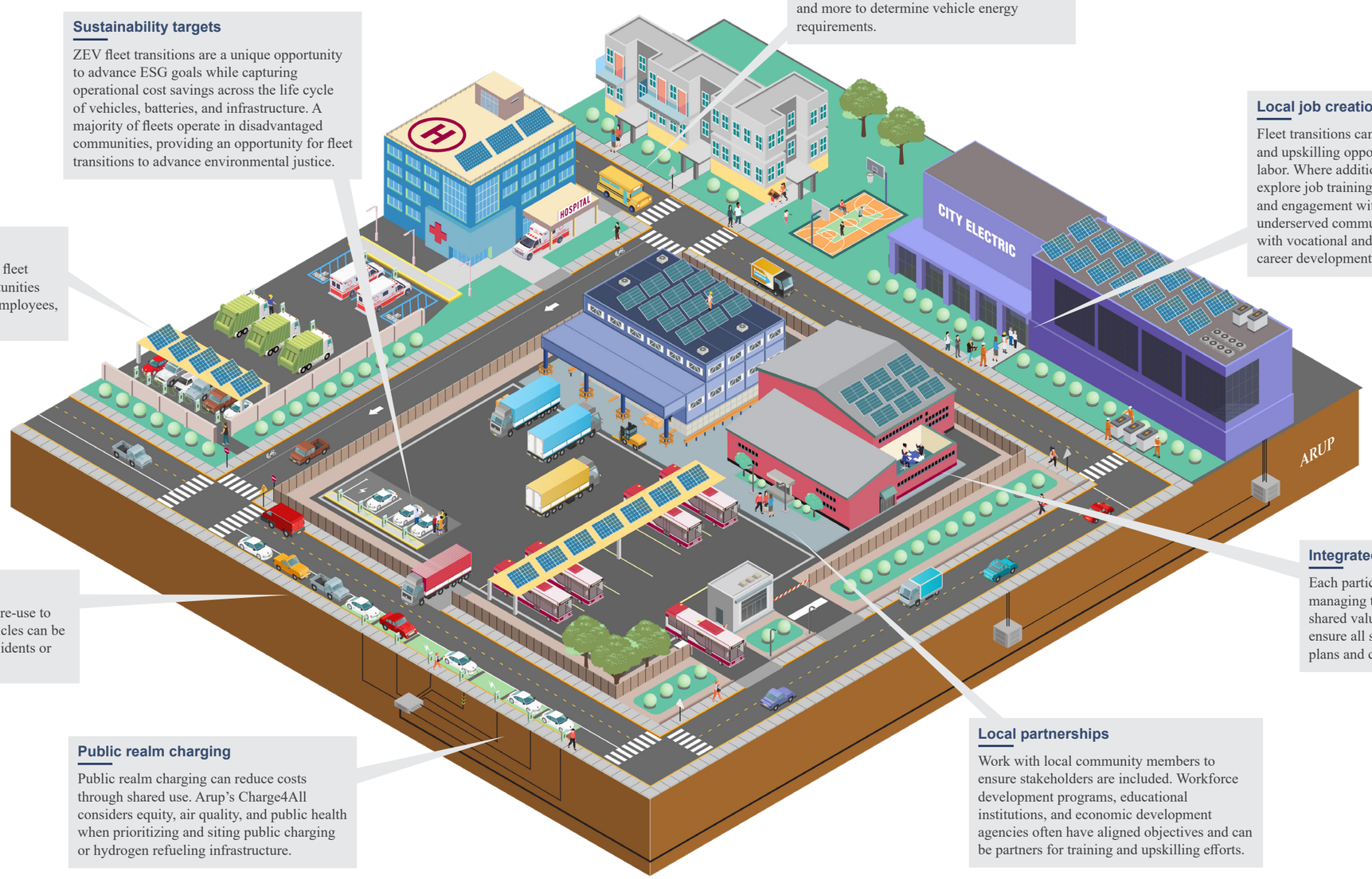
Robust modeling can build confidence, determine appropriate phasing, and clarify costs. Arup's Charge4Fleets™ includes a physics engine that considers topography, local climate, vehicle specifications, speed, and more to determine vehicle energy requirements.

Sustainability targets

ZEV fleet transitions are a unique opportunity to advance ESG goals while capturing operational cost savings across the life cycle of vehicles, batteries, and infrastructure. A majority of fleets operate in disadvantaged communities, providing an opportunity for fleet transitions to advance environmental justice.

Charging utilization

Defining charging schedules for fleet vehicles helps to identify opportunities for infrastructure sharing with employees, visitors, public, and others.



Local job creation

Fleet transitions can add significant jobs and upskilling opportunities for local labor. Where additional staff are needed, explore job training programs, local hiring, and engagement with disadvantaged or underserved communities in coordination with vocational and technical schools and career development centers.

Spark EV adoption

Leverage end-of-life fleet vehicle re-use to catalyze public EV adoption. Vehicles can be sold or donated to low-income residents or residential car-share programs.

Integrated design & delivery

Each participant has a role to play in managing transition risks and uncovering shared value benefits. Engage broadly to ensure all stakeholders are aware of project plans and can voice concerns.

Public realm charging

Public realm charging can reduce costs through shared use. Arup's Charge4All considers equity, air quality, and public health when prioritizing and siting public charging or hydrogen refueling infrastructure.

Local partnerships

Work with local community members to ensure stakeholders are included. Workforce development programs, educational institutions, and economic development agencies often have aligned objectives and can be partners for training and upskilling efforts.

Value stacking opportunities: innovative approaches

Integrating circularity, resilience, and community benefits in the fleet transition process

Microgrids

Use on-site and en-route distributed energy investment such as microgrids to reduce the costs of grid energy service while also improving fleet resilience. Microgrids can also provide a solution for grid inadequacies in rural and over-extended urban areas.

Resilience

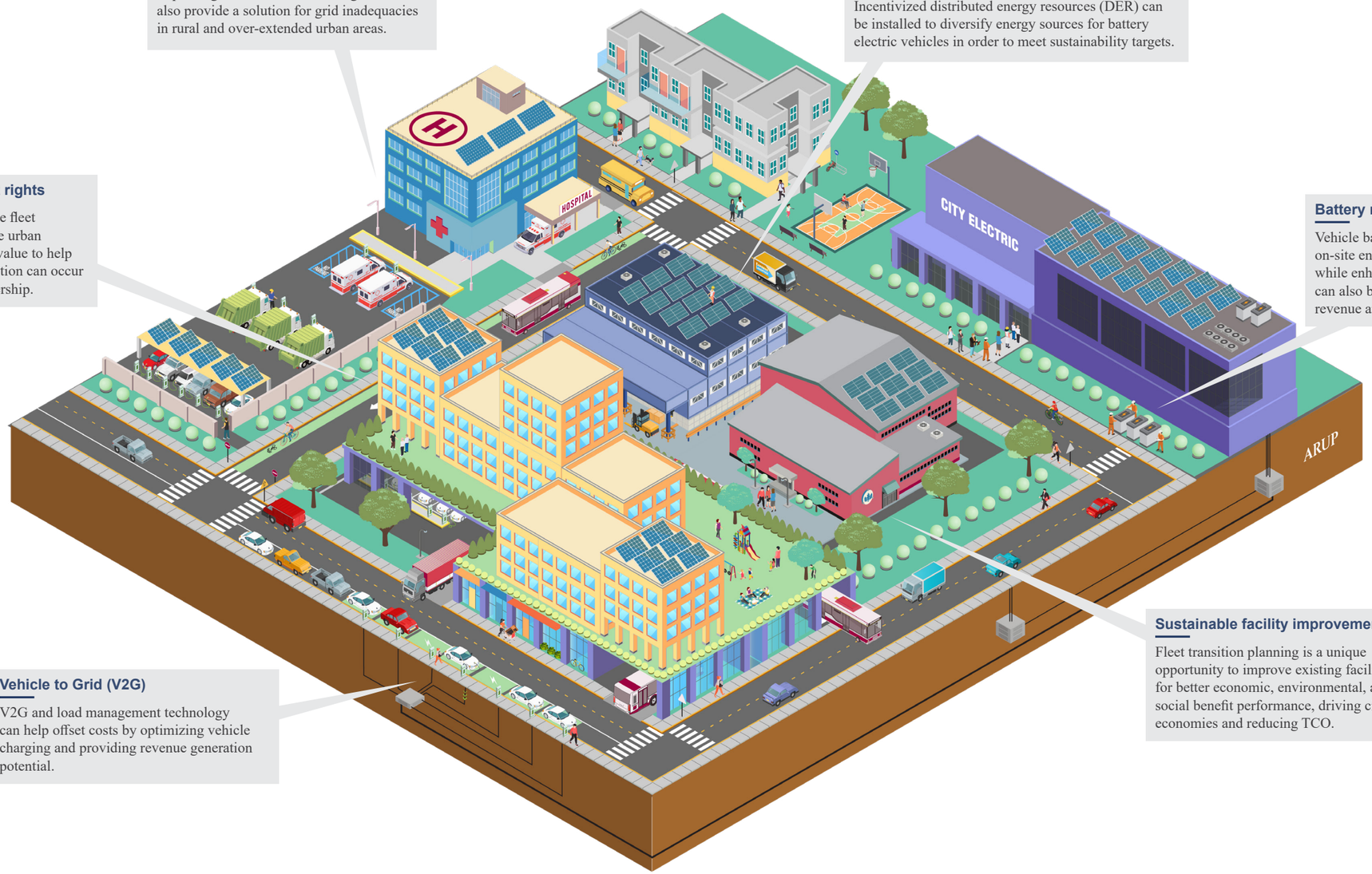
On-site renewables improve resilience for site and fleet operations, as well as for the grid serving the community, through programs like demand response. Incentivized distributed energy resources (DER) can be installed to diversify energy sources for battery electric vehicles in order to meet sustainability targets.

Transferable development rights

The developable airspace above fleet lots is often high value in dense urban environments. Unlocking this value to help finance a successful fleet transition can occur through a public-private partnership.

Battery re-use

Vehicle batteries can be used for additional on-site energy storage, furthering resilience while enhancing material circularity. They can also be sold to generate additional revenue and reduce waste.



Vehicle to Grid (V2G)

V2G and load management technology can help offset costs by optimizing vehicle charging and providing revenue generation potential.

Sustainable facility improvements

Fleet transition planning is a unique opportunity to improve existing facilities for better economic, environmental, and social benefit performance, driving circular economies and reducing TCO.

Context: why move to a ZEV fleet?

With the renewable energy transition well underway, the need for energy systems to become electrified has increasingly been a focus of both producers and consumers. Enel has dubbed this "the decade of electrification," noting that to decarbonize and meet net zero ambitions, organizations must also move away from fossil fuels in all energy applications, not the least of which is in the transportation sector.[1] Millions of delivery trucks, government-owned vehicles, buses, and specialized vehicles such as garbage trucks and fire engines will transition to being powered by battery or fuel cell electric drive trains rather than conventional gasoline or diesel combustion in the coming decades.

Fleet transitions are accelerating thanks to new legislative requirements, corporate sustainability goals, technological advancements, up-front incentives to overcome higher capital costs, and growing awareness of the operational cost savings over the life of ZEVs. The recent passing of the Inflation Reduction Act extends EV tax credits for another decade and provides billions of dollars in EV funding.

The opportunity for impact is significant: Emissions from medium and heavy-duty vehicles (MHDV) represent approximately 30% of the emissions from the transportation sector.[2] More than 14 million large trucks (single-unit and tractor-trailers) and buses were registered in the US in 2019, representing 5% of all registered vehicles yet roughly 10% of all vehicle miles traveled (VMT) in the US.[3] Nearly 500,000 school buses, 99% of which are diesel,[4] travel a cumulative six billion miles per year and carry 26 million students to school,[5] exposing developing lungs to harmful toxins. Air pollution can irritate and seriously harm human respiratory systems, especially those of children. In the US, air pollution likely causes 200,000 premature deaths, 53,000 of which can be attributed to exhaust from vehicles.[6]

And the benefits are vast, as well: ZEVs are safer for drivers and passengers, as well as for assets being shipped.[7] Electric vehicles are cleaner and quieter, improving the experience for drivers, passengers, and those who live in high-traffic areas.[8] From day one, the operating costs of electric buses are roughly one third those of similar diesel buses.[9] Incentive programs in numerous states can significantly reduce high start-up costs, ensuring that replacing diesel vehicles with electric is financially feasible for many fleet owners.[10] The benefits of electrification also extend to job creation and local industry: School bus electrification alone represents an estimated $150 billion manufacturing opportunity across the US.[11] When viewed and managed holistically, fleet electrification efforts catalyze opportunities to modernize the grid, increase renewable energy consumption, and think differently about energy use, distribution, and storage.

30% of emissions

Emissions from MHDV represent approximately 30% of the emissions from the transportation sector.[2]

45 billion gallons

MHDV burned nearly 45 billion gallons of fuel in 2020, equivalent to 400 million metric tons of CO_2e[12]—the same amount created by 107 coal-fired power plants in one year.[13]

300 billion miles

Commercial trucks and buses drove more than 300 billion miles across the US in 2020.[14]

3.5 million drivers

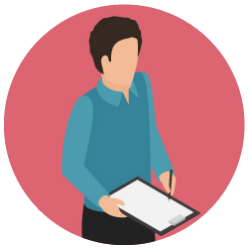
There are currently roughly 3.5 million MHDV drivers in the US.[15]

Identifying and aligning stakeholders for success

Fleet transition requires thoughtful planning and engagement of a broad set of stakeholders, and it is important to engage them early and often. While exact roles and responsibilities differ across organizations, the key stakeholder groups include:

Leadership

Whether sitting in the C-suite or in government agencies, leadership must buy in to the process of transition. The idea to transition to ZEVs will either come directly from leadership or will require their approval. In many cases, leaders develop goals or requirements that necessitate transition, such as net zero targets. No matter who is championing the transition effort, leadership must be fully on board, clear on objectives for the transition, and committed to working through challenges along the way.



Fleet managers

Fleet managers are typically the most directly engaged party in the transition with the most knowledge on fleet needs and challenges. In some cases, a fleet manager may not exist and management duties are distributed amongst a variety of parties. Regardless of an organization's structure, individuals responsible for the management of the organization's strategy for vehicles and supporting infrastructure will play a central role in the transition process.

Operational personnel

Key operational personnel include those responsible for the scheduling and use of vehicles, including managers, drivers, mechanics, and other technicians responsible for equipment operations and maintenance—more generally, anyone who takes part in keeping things running smoothly and efficiently. Proper training and early buy-in of operational personnel are core to successful delivery of an electrified fleet.

Community members

Having a robust stakeholder engagement process should include relevant community members and partners, which may include riders for public transit, students and families for school systems, nonprofit entities that focus on community needs and issues of public welfare, local labor organizations, and others who may potentially be impacted by the development or operation of the fleet. This can help to surface issues early as well as uncover opportunities to improve community life and strengthen the social capital of the project.

Utilities

Early utility engagement is critical for aligning fleet transition timelines with potential upgrades to grid service. The cost and mitigations are often a driving factor in identifying preferred fleet technology solutions. In some cases, multiple utilities will play a role in the transition, and the appropriate entities will first need to be identified and engaged. Their involvement supports the development of more sustainable and cost-effective solutions. In many cases, utilities administer or facilitate incentive programs.

Facility owners & managers

Electrification changes the fueling process, requiring facilities to accommodate this new energy demand. The facility manager is the fleet manager’s counterpart who will guide the process of developing a fueling plan for the vehicles from a space, timing, and electrical or hydrogen demand perspective. In some cases, fleets and facilities will be owned by the same party, while in other cases they may be distinct and independent stakeholders. Large facility upgrade projects associated with the transition may require additional project management, upskilling, and dedication of personnel from this group.

Technical experts

Technical experts encompass engineers and planners responsible for project design and delivery, as well as specialists in electrification and energy, vehicle technology, and financial analysis that may provide support over the course of the transition process. These roles may be filled by internal employees, temporary strategic hires, or external consultants, as well as delivery partners. When functioning as an Owner’s Representative or Owner's Engineer, these experts may also identify risks and legal concerns and ensure that delivery partners meet design specifications and operational expectations.

Delivery partners

The fleet transition process will likely include additional partners involved in many phases of the project life cycle, such as third-party financing entities, providers of leases for vehicles and equipment, or external operators responsible for delivering multiple assets and components through an “as-a-service” model. Other stakeholders such as community partners and OEMs may fall in this category too, so it is important for organizations to think through how these different and interrelated entities will most efficiently and effectively work together for an integrated team execution.

OEMs & vendors

Original equipment manufacturers (OEMs) and vendors include manufacturers of zero-emission vehicles and providers of charging infrastructure and other related or integrated energy equipment, such as photovoltaic panels or Battery Energy Storage Systems (BESS), as well as fleet management and telematics software companies. Input from these stakeholders often occurs through more formal lines of communication such as Requests for Information (RFI) led by technical experts or the fleet operator. Establishing a true partnership where organizations can co-create benefits will increase organizations’ understanding and availability to deliver value with a fleet transition program.

Authority having jurisdiction

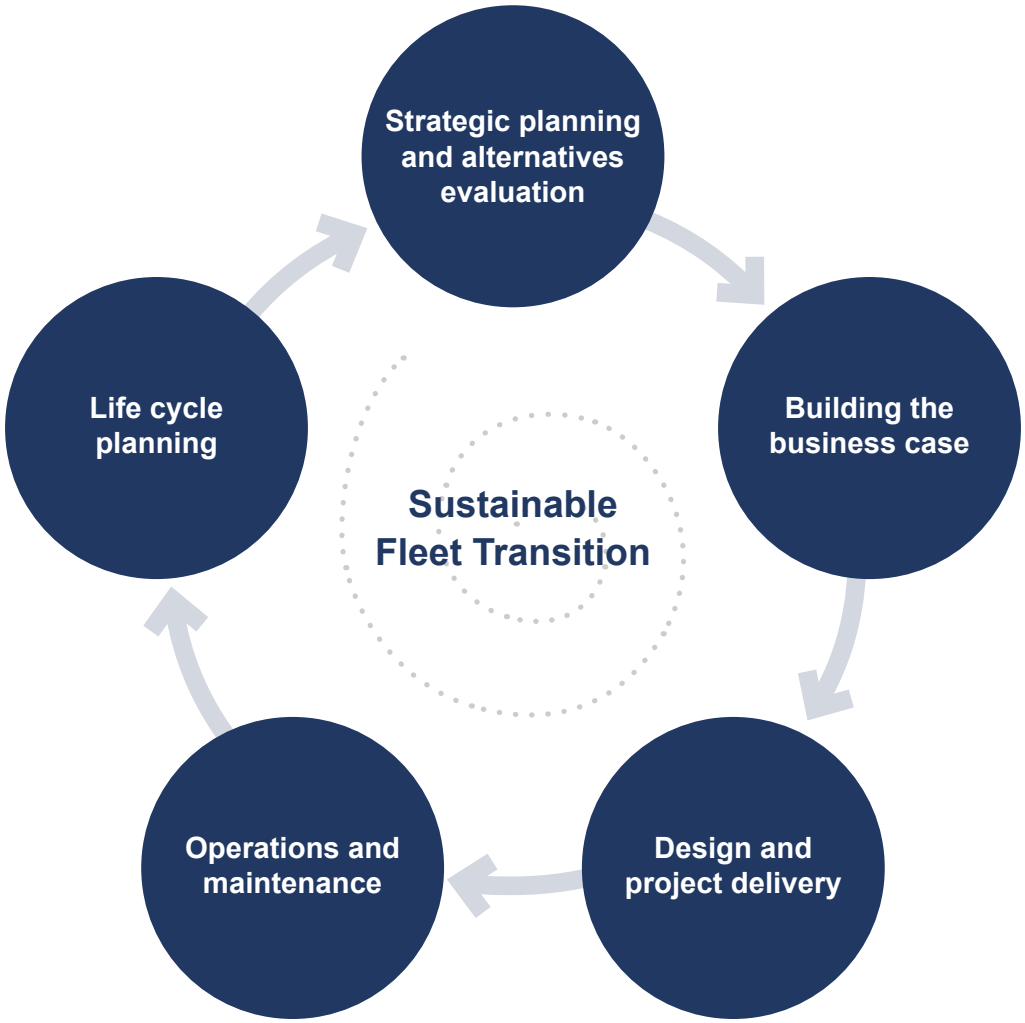
Authorities having jurisdiction (AHJs) are the organizations responsible for enforcing codes and regulations and managing public approvals. These can include fire departments, zoning and buildings departments of local governing offices, electrical inspectors, or labor departments. Understanding and mapping AHJ approval processes and timelines prior to commencing design is helpful in ensuring smooth design and construction outcomes.

Fleet transition phases: key considerations

The transition to a sustainable zero-emission fleet is a multi-step process requiring engagement with a variety of stakeholders to make complex decisions. Each step has unique considerations and calls for engagement with different parties. Below is a guiding summary of typical fleet transition phases and the contributions of key stakeholders.

The phases of fleet transition are identified and developed to provide insight to fleet owners and operators regarding the key questions, steps, and opportunities during each phase.

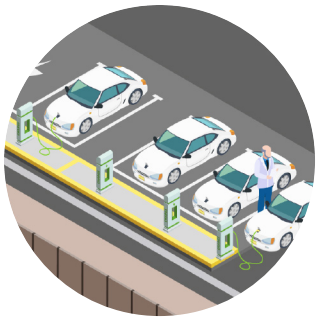
For owners and operators who have begun their fleet transition journey, this can still be a useful resource for reflecting and refining future vehicle and infrastructure design specifications and preferred procurement methods that best manage risk.



Strategic planning and alternatives evaluation

Gather stakeholders to align goals, share foundational knowledge, identify potential risks and constraints, and ensure you have the right approach for long-term success.

The fleet transition process involves many players, from state and local government to community members, private sector operators, suppliers, and service providers. Motivation to begin strategic thinking about fleet transition often differs by sector. Public entities may start considering fleet transition due to current community sentiment, pending legislation, or budget considerations that will impact planning for vehicles and facilities. Many private companies are driven by internal or regulated decarbonization targets or the need to address customers' and employees' expectations for sustainability. In all cases, gaining alignment between both internal and external stakeholders is critical to setting a clear path forward. Many of the considerations in this phase will flow through the whole process, especially stakeholder engagement, knowledge sharing, and utility coordination. This phase is an opportunity to establish goals and to identify how fleet transition fits into an organization's broader sustainability and business objectives.



Sustainability targets

ZEV fleet transitions are a unique opportunity to advance ESG goals while capturing operational cost savings across the life cycle of vehicles, batteries, and infrastructure. A majority of fleets operate in disadvantaged communities, providing an opportunity for fleet transitions to advance environmental justice.

Lessons learned:

- **Engage stakeholders early to build buy-in:** Bringing a wide range of stakeholders together to the table is a critical step to properly assess the impacts of fleet transition throughout an organization. Consider creating learning resources to establish a baseline understanding of technology and operations across stakeholders. Support from key advocates and local influencers such as community organizations and environmental groups can also build political momentum for change, making it easier to push beyond business as usual.
- **Start small with a pilot:** Pilots can be a critical strategy to test out transition models and to demonstrate proof of concept before embarking on a full transition. A pilot can also help identify pain points early and provide quantifiable evidence of benefits.
- **Create and assign dedicated and empowered roles:** Organizations that establish dedicated roles related to fleet transition are often better positioned to create a long-term electrification vision that ties into strategic goals. The title may differ by organization—examples include Head of Energy Management, Director of Bus Modernization, and VP of Electrification—but such a role can create a project champion who is positioned to sketch out the big picture and drive forward action.

Strategic planning and alternatives evaluation

Key Activities:

1. Goal-setting: Establish the driving purpose and priorities behind the fleet transition, such as emissions reduction, regulatory compliance, reliability, long-term cost savings, or brand image.

2. Stakeholder engagement: Map stakeholders, hold internal and external strategic workshops, and coordinate with the relevant utilities to ensure alignment of goals and objectives and to develop an understanding of relevant processes, timelines, and potential costs.

3. Baseline assessment and requirements gathering: Assess operational practices, procurement schedules, use case characteristics, and fleet use metrics to identify gaps and opportunities and to address challenges early before the design phase.

4. Context research: Identify relevant regulations and funding programs, business opportunities, legal constraints, and sequence of approval processes.

5. Preliminary site investigation: Evaluate the community context and gather feedback from stakeholder engagement activities, gain an understanding of relevant facilities and surrounding sites, and identify grid connection points—existing or needed—as well as potential space constraints.

6. Initial transition plan analysis: Determine the initial timelines based on requirements, net zero targets, or other dependencies and business needs.

Photo credit: VTA

Vineyard Transit Authority (VTA), Massachusetts

Holistic consideration of the VTA's sustainability goals and service requirements allowed for the development of a more resilient, circular and sustainable system born out of innovation and collaborative partnerships. Read the case study ⟶

Route modeling

Robust route modeling can build confidence, determine appropriate phasing, and clarify costs. Arup's Charge4Fleets includes a physics engine that considers topography, local climate, vehicle specifications, speed, and more to determine vehicle energy requirements.

Public realm charging

Public realm charging can reduce costs through shared use. Arup's Charge4All considers equity, air quality, and public health when prioritizing and siting public charging or hydrogen refueling infrastructure.

Strategic planning and alternatives evaluation

Who to engage:

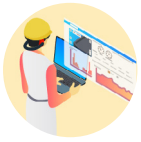
LEAD

Fleet managers

Fleet managers can provide knowledge of operational practices, current and future requirements, and potential implications of transitioning to zero-emission vehicles.

Facility owners & managers

Facility owners and managers can gather and provide available information on the site characteristics, details of particular structures, future plans and potential known issues.



Utilities

Utilities can provide information on energy constraints and potential upgrades as well as pricing, timeline, and incentive programs such as demand response, make-ready support, and managed charging programs.

Community members

Community members impacted by transition plans can provide consultation and context to improve the outcomes for the project and allow organizations to co-create benefits such as enhanced accessibility and equity, training opportunities, and improved community satisfaction.

Technical experts

Technical experts can support baseline assessment and requirements gathering, as well as conduct preliminary site investigations to help define opportunities and constraints.

Operational personnel

Operational personnel can inform training plans to ensure that the transition plan will meet the training needs of drivers and mechanics.

Leadership

Leadership play a key role in establishing overarching goals and driving purpose behind the fleet transition. Leaders can also be effective advocates and project champions to build buy-in among stakeholders.

Building the business case

Develop a business case that considers not only return on investment but also the value of first mover advantage, greenhouse gas emissions reductions, customer retention, and other environmental and social benefits.

The business case establishes a framework for the entire fleet transition process and benefits from increasingly detailed modeling over time. After the initial vision and realistic goals have been established, the business case provides a viable model for capital investment and future operations. The business case is needed to secure ongoing leadership support, engage financial and community partners, and establish expectations for cash flow and finance linked to capital investment and operational savings.

The relationship between capital and operational costs and the potential for non-monetary benefits must all be considered to create a strong case that represents the total cost of ownership (TCO). A clear understanding of utility rate tariffs and incentives are often critical to overcoming potentially prohibitive initial costs of infrastructure and vehicles. Procurement and financing models most appropriate to the context must also be identified, including options such as "as-a-service" models which can help to better manage and assign risk in delivery and during subsequent operations—leading to lower costs and less disruption.

Microgrids

Use on-site and en-route distributed energy investment such as microgrids to reduce the costs of grid energy service while also improving fleet resilience. Microgrids can also provide a solution for grid inadequacies in rural and over-extended urban areas.

Lessons learned:

- **Identify complementary projects:** Seek out synergies with utilities and public charging infrastructure. Fleets can provide guaranteed demand for charging infrastructure that is shared with the public, which can help to smooth out demand charges. If a microgrid is part of the fleet electrification plan, it may also provide value to utilities to help manage peak demand and reduce total cost of ownership for the fleet operator.
- **Consider non-monetary benefits:** When developing the business case, it can be beneficial to incorporate—or even quantify—the impact of carbon reductions, improvements to air quality, public health benefits, and job creation.
- **Integrate and optimize procurement:** Make sure that all relevant incentives are being utilized to reduce initial costs. Consider the lifetime costs of vehicles and charging infrastructure when comparing against traditional costs. Develop strong and trusted relationships with OEMs, delivery partners, and third party technical experts to ensure high-quality procurement. Organizations should also consider the life cycle impact of vehicles and equipment if they want to achieve net zero, incorporating sustainability criteria into the process.

Building the business case

Key Activities:

1. Preliminary design: Establish vehicle and infrastructure needs and develop an early 5% design concept that can be used for cost estimating and early partner engagement.

2. Delivery model comparison: Assess potential ownership and operating model alternatives and conduct a risk identification and risk tolerance assessment to better inform project decisions.

3. Capital and operational cost analysis: Coordinate across budget divisions to assess total cost of ownership, estimate equipment purchases and grid upgrade costs, estimate tariffs and rates, and identify applicable incentives. Consider revenue-generating options associated with facility upgrades and utility programs that coincide with potential new business models.

4. Procurement and financing analysis: Review procurement policies and identify appropriate funding and financing sources as well as government incentives.

5. Refinement of fleet transition plan: With the above information, develop a preliminary vehicle replacement timeline, define future charging requirements, and identify necessary infrastructure upgrades. The resulting plan will be refined and updated over the course of the fleet transition.

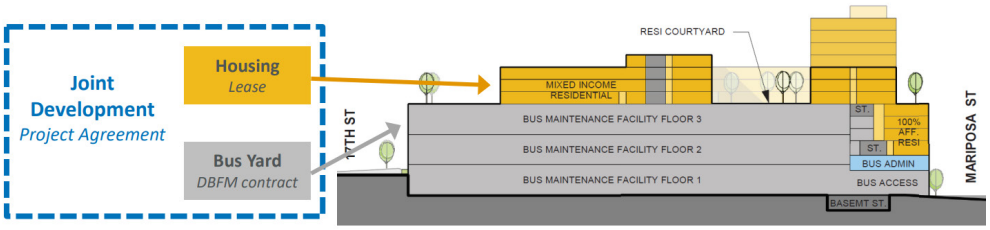


Image credit: SFMTA / Arup

Potrero Yard Modernization, California

The Potrero Yard Modernization Project replaces the existing two-story maintenance building and bus yard with a modern, three-story bus maintenance and storage facility, designed to serve the SFMTA's transition to an all-electric fleet using electric trolley buses and new battery electric buses (BEBs). Read the case study ⟶

Vehicle to Grid (V2G)

V2G and load management technology can help offset costs by optimizing vehicle charging and providing revenue generation potential.

Transferable development rights

The developable airspace above fleet lots is often high value in dense urban environments. Unlocking this value to help finance a successful fleet transition can occur through a public-private partnership.

Building the business case

Who to engage:

LEAD

Fleet managers

Fleet managers can provide insight into the benefits and challenges of a fleet transition, and can identify operational considerations with impact on the business case.

Technical experts

Technical experts such as energy, engineering, and financial professionals can develop estimates of project costs and benefits.

Leadership

Leadership can endorse the project and can communicate a compelling case for electrification to both internal and external stakeholders.

Delivery partners

Delivery partners including third-party financing, leasing, and operating entities can support the project team to identify appropriate models.

Utilities

Utilities can provide information on tariffs, rates, incentives, power purchase options, and interconnection implications.

OEMs & vendors

OEMs and vendors can engage through an RFI process to help project stakeholders understand technology options and limitations that will help define specifications.

Design and project delivery

Work closely with technical experts, delivery partners, and OEMs to assess technology options, design approach, and delivery steps to facilitate a successful fleet transition.

With vehicle, charging, and hydrogen fueling technology and availability evolving rapidly—even over the course of a single project—it can be challenging to coordinate project elements and to ensure a smooth process from design through construction. Long delivery times between order and receipt for utility interconnection, vehicle delivery, and batteries are a common cause of delays and need proactive management.

Insights from early deployments can help ensure that vehicle purchases, charging infrastructure, grid upgrades, and other project elements are well integrated. It is essential to maintain close communication across partners involved in project delivery and to ensure adequate project management capacity.

Charging utilization

Defining charging schedules for fleet vehicles helps to identify opportunities for infrastructure sharing with employees, visitors, public, and others.

Lessons learned:

- **Design infrastructure to anticipated standards rather than minimum standards:** Due to the rapid nature of change in technology and technology availability, work with technical experts and delivery partners to determine if it is appropriate to design in anticipation of future availability. Developing a design that is flexible and forward-looking is likely to save money over time with thoughtful, long-term planning that takes into account future needs.
- **Implement knowledge sharing and establish forums for communication:** In an environment of rapidly changing technology and standards, open communication across the design team, vendors, OEMs, and AHJs can create positive feedback loops to make timely adjustments and to inform future project phases. Creating forums for knowledge transfer among organizations with similar fleets can further support the diffusion of lessons learned. Similarly, open channels of communication with community members and partners can inform other stakeholders, help alleviate concerns, and head off potential issues before they grow.
- **Prepare for project delivery:** Organizations differ in their level of experience delivering major capital projects. Ensure that the project team includes the required level of project delivery experience, whether from internal capacity or external support.

Design and project delivery

Key Activities:

1. Technology selection: Evaluate technologies based on preferred or planned energy infrastructure needs, available grid capacity, site characteristics, and budget.

2. Definition of delivery approach and roles: Work with delivery partners, technical experts, OEMs, and vendors to define the expected outcomes and roles for each participant.

3. Project management: Ensure continued engagement with all stakeholders to meet timelines and expectations, particularly utilities and AHJs. The project manager should regularly communicate the status of project scope, schedule, and budget as well as risks and mitigation plans as they arise.

4. Permitting and approvals: Ensure all project team members are clear on responsibility for compliance with applicable codes and finalize the analysis of potential future requirements.

5. Staff training and upskilling: Start to determine what additional training current staff such as drivers and mechanics will require, and evaluate whether additional staff will be needed.

Integrated design & delivery

Each participant has a role to play in managing transition risks and uncovering shared value benefits. Engage broadly to ensure all stakeholders are aware of project plans and can voice concerns.

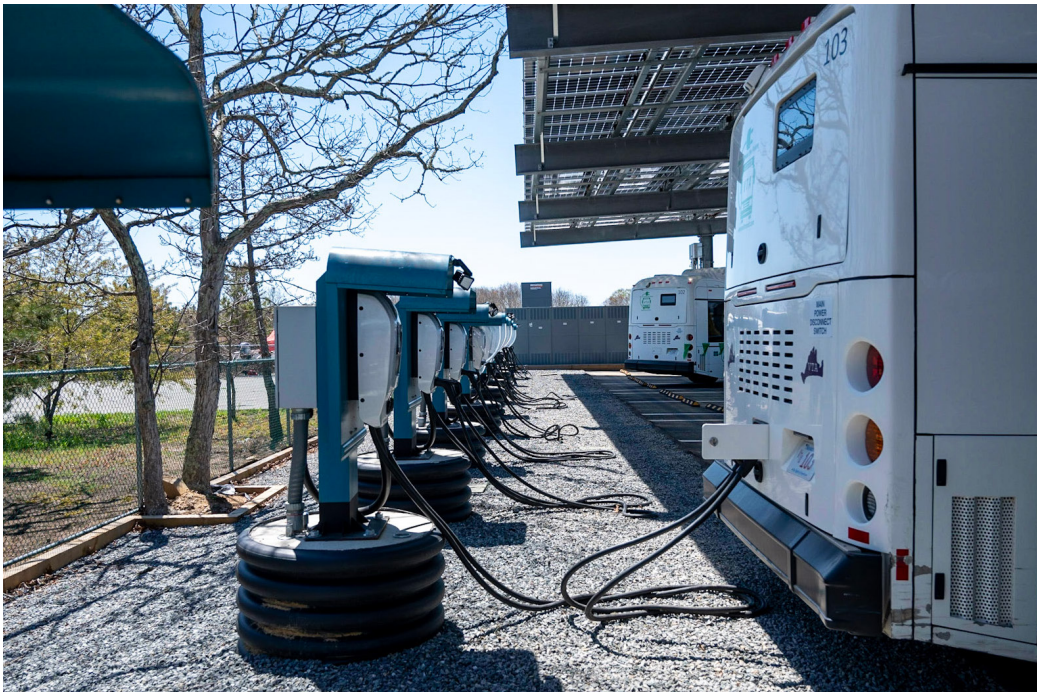


Photo credit: VTA

Resilience

On-site renewables improve resilience for site and fleet operations, as well as for the grid serving the community, through programs like demand response. Incentivized distributed energy resources (DER) can be installed to diversify energy sources for battery electric vehicles in order to meet sustainability targets.

Design and project delivery

Who to engage:

LEAD

Technical experts

Technical experts such as engineers and planners will lead the delivery of technical aspects of the project driven by detailed analysis. These may include electrical or structural experts, architects, and construction leads.

Facility owners & managers

Facility owners and managers can ensure safe access to sites and key areas for site walks, design, and construction activities. They can coordinate with utilities to plan, communicate, and manage power disruptions for other facility users as well as any other impacted neighbors.

Delivery partners

The role of delivery partners will vary based on the procurement model chosen for the fleet transition. Delivery partners may be involved in the procurement of vehicles, design and construction of charging or refueling infrastructure, financing, and operations.

Utilities

Utilities are responsible for approving the charging approach and associated power requirements, delivering and installing grid-side equipment, and performing necessary upgrades prior to installation of charging and other behind-the-meter equipment.

OEMS & vendors

OEMs and vendors will be engaged to finalize contract terms for the delivery and testing of vehicles, charging or hydrogen refueling infrastructure, and other possible equipment in the design. They may also engage in planning for staff training and upskilling.

Community members

Community members may see increased noise, traffic, or construction impacts during project delivery. They can engage by joining informational sessions and community meetings to give feedback, engaging with educational resources, and celebrating project milestones.

Fleet managers

Fleet managers will be responsible for working with OEMs to plan for staff training and upskilling needs.

Authority having jurisdiction

AHJs can coordinate closely with the project team to finalize permits and approvals for infrastructure upgrades in line with the project schedule.

Operations and maintenance

Focus on personnel needs, maintenance requirements, and technology evolution to maintain a smoothly operating fleet and to train, upskill, and hire for full fleet transition.

Fleets of different types—from school buses and delivery vehicles to public transit and rideshare—vary widely in terms of route patterns, vehicle storage, and energy needs. While operations and maintenance will look different for every fleet, change management strategies and training are needed to adapt to changes introduced by ZEVs. Zero-emission fleets and their supportive energy infrastructure require different maintenance than traditional fleets and fueling infrastructure. A fleet transition is also a significant transition for employees, and people and organizational culture issues can prove to be just as important to the transition as technology implementation.

Successful operations rely on continued monitoring of routes, charging patterns, and driving behaviors to provide insights that can improve performance. Furthermore, right-sized management of spare parts and equipment can improve operational expenses, reduce costs, and enhance the circularity of the organization's activities.

Local partnerships

Work with local community members to ensure stakeholders are included. Workforce development programs, educational institutions, and economic development agencies often have aligned objectives and can be partners for training and upskilling efforts.

Lessons learned:

- **Engage staff early and communicate a commitment to training and a just transition:** Proper training and early buy-in of operational personnel are core to the successful delivery of an electrified fleet. Making it clear that a fleet transition will not leave workers behind is crucial to retaining highly skilled employees and making sure the fleet can operate once it is transitioned. A fleet transition is as much about the staff as it is the vehicles and charging equipment.
- **Collect data early and often:** Use data insights to fully understand the life cycles of vehicles and batteries, plan for circularity, and respond to user feedback. Many unknowns remain in terms of battery lifespan, and collecting data will help extract as much value as possible for the organization over the lifetime of a battery.
- **Schedule maintenance and technology upgrades gradually:** Intelligently spacing out maintenance and technology upgrades will ensure continuously smooth operations of the fleet. It also provides ample time to upskill existing staff and train new staff, as there will be a gradual transition in needs from traditional skills to new skills.

Operations and maintenance

Key Activities:

1. Training: Develop training plans and support resources to ensure retention and upskilling of workforce, for fleet operation and maintenance as well as for facilities and charging or refueling infrastructure. Be sure to incorporate feedback and update as the program matures.

2. Maintenance planning: Develop, execute, and refresh maintenance and safety plans. Revisit the definition of maintenance space requirements and clearances during mixed fleet operations and identify opportunities for improvement and optimization over time.

3. Monitoring and evaluation: Ensure robust data management to gain fleet performance insights. Telematics implementation and testing should be incorporated into the program and information shared with key stakeholders for ongoing improvement.

Local job creation

Fleet transitions can add significant jobs and upskilling opportunities for local labor. Where additional staff are needed, explore job training programs, local hiring, and engagement with disadvantaged or underserved communities in coordination with vocational and technical schools and career development centers.

Metbus, Santiago

Through strong partnerships and robust data collection, Enel was able to prove and validate that large scale deployment of BEBs is not just feasible, but cheaper for both operations and maintenance. Read the case study →

Operations and maintenance

Who to engage:

LEAD

Fleet managers

Fleet managers play a key role in understanding the big picture and making sense of data to inform decisions regarding fleet operations, route optimization, and ongoing investment.

OEMs & vendors

OEMs and vendors should remain engaged for warranties, component replacements, virtually delivering updates for chargers and vehicles, and providing telematics enablement.

Operational personnel

Operational personnel such as drivers and maintenance staff are at the core of operations and will provide invaluable feedback on the effectiveness of the transition. For public transit and school buses, the same is true for ridership.

Technical experts

Technical experts should continue to be engaged to monitor and evaluate the success of operations for a period after the fleet transition. It is likely that adjustments will need to be made as operational realities lead to additional requirements.

Delivery partners

Delivery partners who are contracted to play an ongoing "as-a-service" role in fleet transition may take a service partnership role in this stage.

Life cycle planning

While this is the last phase of the fleet transition presented, it is also the first in a process of continuous improvement.

These considerations will begin in the earliest project design stages to design out excess materials and resources. As the program matures and as technology evolves new information and opportunities will arise. Extending the service life and value of vehicles, batteries, and equipment is an ongoing opportunity for a sustainable fleet transition—optimizing and eventually maximizing sustainability, equity, and total cost of ownership.

With long life cycles, planning for end-of-use and decommissioning is often overlooked early in the planning and design phases. While some organizations starting their journey toward ZEVs tend to focus on successful near-term implementation, a full life cycle perspective is needed to effectively consider impacts throughout the value chain, as well as to ensure that embodied carbon and embodied material toxicity are not re-released at the end of product use. End-of-use planning can be an opportunity to reduce waste and extract additional value from vehicles and batteries, as well as to support public EV adoption and renewable energy storage. Decommissioning of batteries and vehicles, as well as right-sizing of fleets and infrastructure, provide opportunities for cost reduction, revenue generation, and furthering of business, sustainability, and equity goals.

Battery re-use

Vehicle batteries can be used for additional on-site energy storage, furthering resilience while enhancing material circularity. They can also be sold to generate additional revenue and reduce waste.

Lessons learned:

- **Get educated on circularity:** Organizations undertaking fleet transition are often focused on successful near-term implementation and may not yet have a full life cycle perspective. Engage the support of technical experts as well as sustainability organizations which can provide training and educational resources for upskilling on circularity.
- **Assign circularity champions:** Empowering individuals within the organization with the responsibility to enable circularity will help ensure knowledgeable advocates are in place to maximize value and extend useful life. Circularity can take additional planning, but the resultant additional value that it enables often justifies the additional time.
- **Contact potential partners early:** Circularity often requires partnerships as technology or infrastructure is transitioned to new organizations for second uses. This could be in the form of take-back and lease service agreements or the sale of batteries to commercial or industrial entities, researchers, or academia. There may also be a community-based use for the batteries that can help achieve equity objectives, such as to serving multi-tenant housing or a community partner to add resilience. Partners may need to be engaged to plan on-site uses of infrastructure and determine any capital costs or revenue-generating opportunities.

Life cycle planning

Key Activities:

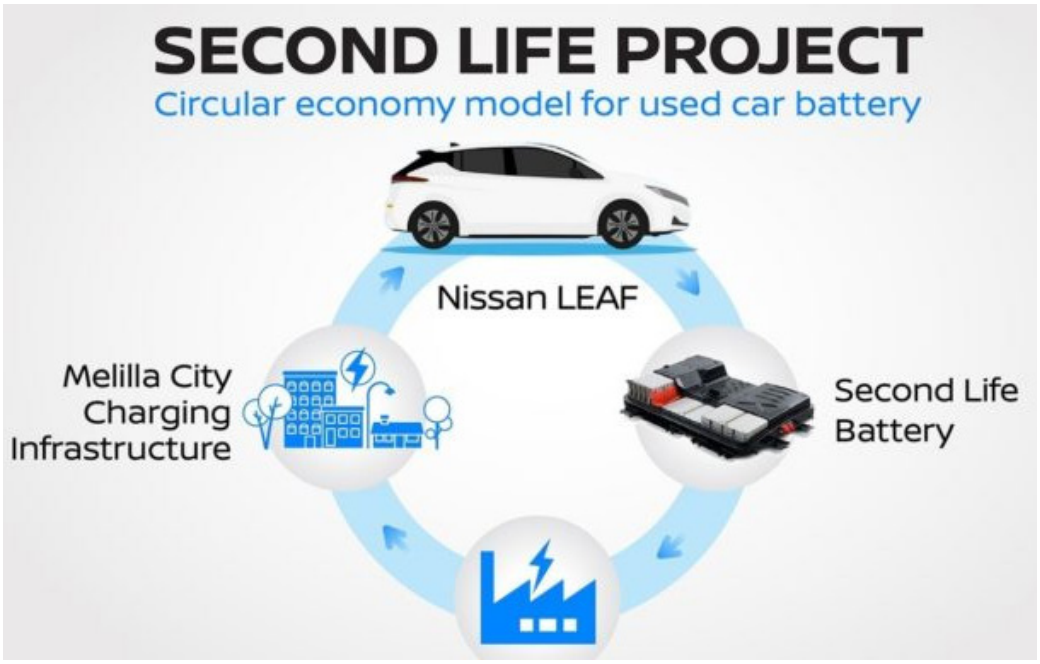
1. Partnership development: Engage with local organizations for battery and vehicle re-sale, identify markets for re-use, and consider other socially valuable avenues such as use in research settings, job training programs, and redeployment to benefit disadvantaged or traditionally underserved communities.

2. Right-sizing and fleet planning: Review vehicle performance and utilization data and refine the vehicle replacement schedule based on continuous learning.

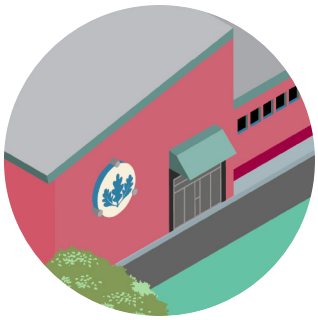
3. Compliance: Be sure to adhere to regulations and programs for safe handling and re-use, while also working with policy makers, regulators, and other stakeholders to ensure the promotion of product life extension, second life opportunities, and standardization of requirements and specifications.

Spark EV adoption

Leverage end-of-life fleet vehicle re-use to catalyze public EV adoption. Vehicles can be sold or donated to low-income residents or residential car-share programs.



Second Life Storage System, Melilla, Spain
Enel's Second Life energy storage project uses circular economy principles to enhance grid stability in Melilla, Spain, using energy stored in disused batters from Nissan electric vehicles.
Read the case study ⟶



Sustainable facility improvements

Fleet transition planning is a unique opportunity to improve existing facilities for better economic, environmental, and social performance, driving circular economies and reducing total cost of ownership.

Life cycle planning

Who to engage:

LEAD

Technical experts

Technical experts can help develop and test re-use plans for batteries, develop standards and best practices for new or novel applications, and analyze potential for fleet right-sizing.

Utilities

Utilities will need to be kept abreast of all infrastructure changes and may have use for decommissioned batteries.

OEMS & vendors

OEMs and vendors may offer decommissioning included in their products and corresponding warranties, and increasingly EV OEMs are requesting—or even requiring—that their batteries be returned at the end of their operating life.

Delivery partners

Delivery experts can help evaluate feasibility of vehicle re-use programs or secondary market sales to support clean transportation adoption, which may also include better access for underserved or disadvantaged communities.

Facility owners & managers

Facility owners and managers can identify and reserve space for safe battery storage, and incorporate solar and stationary storage feasibility into facility expansions, retrofits, and maintenance projects.

A call to action

Electrification is happening. Preparing for it, planning for it, and engaging the right partners will ensure that the best outcomes are achieved when it is time to transition your fleet. The benefits can be significant: long-term cost savings for the organization, improved health for drivers and communities, new jobs and upskilling for maintenance workers, and more resilient energy systems. Improved battery technology offers the opportunity to improve circularity through second life applications. Distributed energy resources allow for additional resilience and the proliferation of clean energy generation and storage. Fleet owners, managers, and operators can find innovative new means of delivering on the ambitions of circularity and sustainability.

Given the growth outlook for fleet electrification across North America, fleet operators, owners, financers, and other interested parties should engage early to assess and understand the fleet transition approach that will provide the greatest value for their organization, the environment, and society.

We need more collaboration with jurisdictions, utilities, facility owners and managers, technical experts, vendors, and community members to achieve the full potential. Join us.

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Case Studies

Vineyard Transit Authority (VTA), Massachusetts

Potrero Yard Modernization, California

Metbus, Santiago

Second Life Storage System, Melilla, Spain

Vineyard Transit Authority (VTA), Massachusetts

Photo credit: VTA

Holistic consideration for the VTA's sustainability goals and service requirements allowed for the development of a more resilient, circular and sustainable system born out of innovation and collaborative partnerships.

Arup and Enel worked with the Vineyard Transit Authority (VTA) and their partners to develop a microgrid solution comprised of a state-of-the-art solar charging carport and battery energy storage system (BESS) to provide clean and resilient charging to the VTA's electric bus fleet. The microgrid design includes canopy-mounted solar photovoltaic throughout the depot, a 1.5 MWh battery storage system, and an on-site diesel generator to provide clean and affordable power with always-on dependability. Dependability is especially important for island communities like Martha's Vineyard that have a higher risk of extreme weather, and where access challenges make spare parts delivery more difficult. The battery doubles as a behind-the-meter resource, enabling the VTA sell energy back to the grid and participate in Massachusetts clean energy storage programs.

Arup also provided engineering services for two in-route induction charger stations. These in-route stations include provisions for battery energy storage systems and for future photovoltaic systems. The VTA is working toward the goal of fully electrifying its fleet by 2027, with half of the agency's 32 buses already electrified. Over its lifetime, this project is estimated to generate $1 million from the battery's market revenue and serve as a blueprint for other island and coastal communities. This project has a 20-year power purchase agreement (PPA) locked in which includes 30% savings for power produced over the next two decades. The project is a public-private partnership with multiple funding sources, including $2 million from a partnership between Enel X and VTA and another $2 million financed by the Federal Transit Administration, the Massachusetts Department of Transportation, and the Massachusetts Clean Energy Center.

Potrero Yard Modernization, California

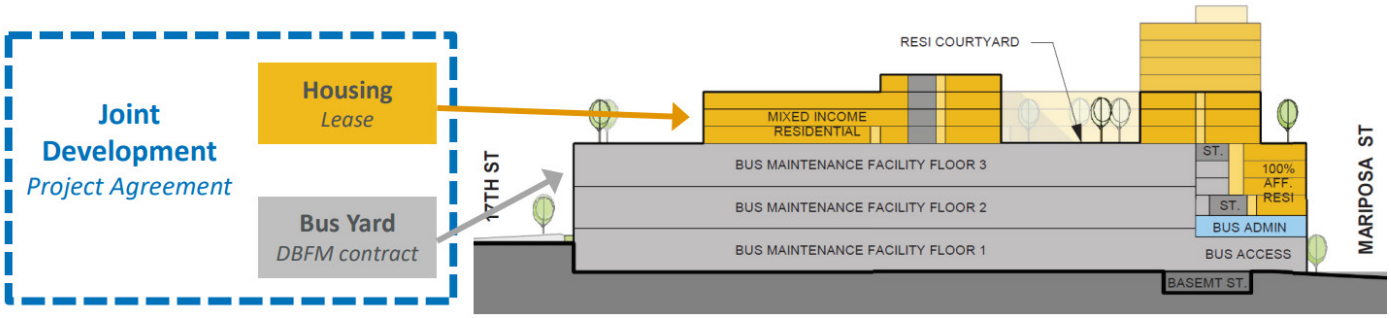


Image credit: SFMTA / Arup

The Potrero Yard Modernization Project replaces the existing two-story maintenance building and bus yard with a modern, three-story bus maintenance and storage facility, designed to serve the SFMTA's transition to an all-electric fleet using electric trolley buses and new battery electric buses (BEBs).

As SFMTA's financial advisor, Arup advised the City on a procurement strategy that outlined a range of complex project components to ensure a commerical structure that allows appropriate financing and successful operations.

In addition to the bus maintenance facility, the site will be home to over 500 rental units of low- and middle-income affordable housing, adding significant value to the site. The strategy that was developed for the site ensured competition, innovation, and clarity of responsibilities between the lead infrastructure developer and the housing developer.

In a city where space is at a premium, co-locating a state-of-the-art BEB depot with housing is an innovation that sets a model for transit-oriented development in cities around the globe.

The project agreement was unique in that it provided cost and schedule certainty for the SFMTA's bus yard and ensured delivery regardless of fluctuations in the housing market. When the modernization is complete, the improvements will not only facilitate the transition to a battery electric fleet but also improve the efficiency of bus maintenance and improve working conditions for staff.

Metbus, Santiago

Through strong partnerships and robust data collection, Enel was able to prove and validate that large scale deployment of BEBs is not just feasible, but cheaper for both operations and maintenance.

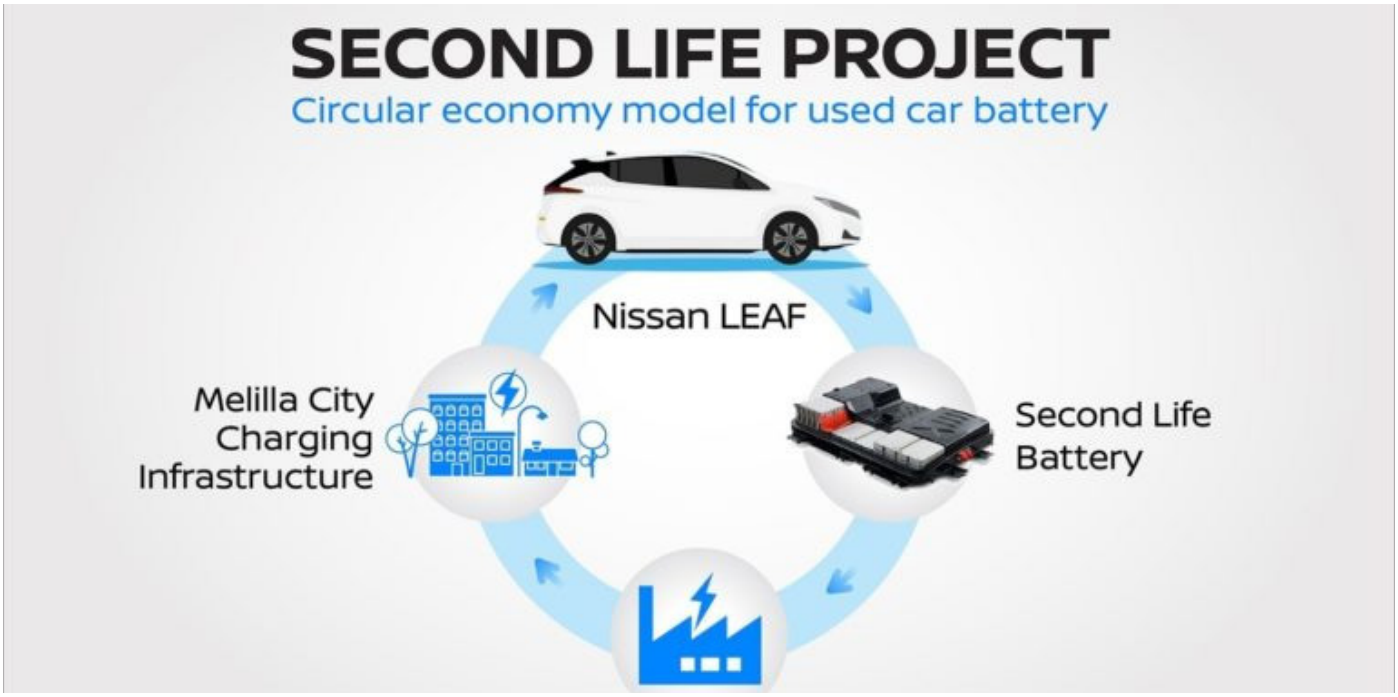
Enel partnered with bus manufacturer BYD to bring BEBs to one of Santiago de Chile's largest bus operators, Metbus. The city is home to 776 BEBs as of September 2020, making it one of the largest fleets of BEBs outside of China. Over four years, Metbus was able to deploy a fleet of 436 BEBs by entering an innovative financial model with Enel X, an Enel subsidiary, and BYD.

Enel X financed the buses—complete with air conditioning and Wi-Fi—and leased them to Metbus for 10 years. Ownership will be transferred to Metbus at the end of this period. Metbus operates the buses and provides basic maintenance, while BYD handles major maintenance operations for a fixed rate of $0.09/km. Major operations include replacement of battery packs and electric drivetrains.

Chargers are utilized at approximately one charger for every two buses. Buses are charged through a combination of partial charging throughout the day and full charging overnight. This has been highly reliable, with buses being 99.6% available on average. All electricity used for charging is certified to come from renewable sources.

The Metbus fleet is delivering excellent operational results. After 15 million kilometers of operation, operational costs were found to be 70% cheaper than an equivalent diesel bus. Maintenance costs were found to be 30% cheaper than the equivalent. While capital costs are higher up front, they are competitive over a 10-year period.

Second Life Storage System, Melilla, Spain



Enel's Second Life energy storage project uses circular economy principles to enhance grid stability in Melilla, Spain, using energy stored in disused batters from Nissan electric vehicles.

The Second Life project operates out of a conventional power plant in Melilla, Spain. Combining 78 Nissan electric vehicle batteries as a source of energy, the Second Life project has a capacity of 4MW and can produce up to 1.7 MWh. A key principle of the project is resilience and dependability: Should the main power plant be disconnected, the storage facility can provide energy to Melilla for up to 15 minutes, enough time to reset the power plant and restart supply.

Enel developed this project in collaboration with Nissan and Loccioni. Advanced technology was used, which is based on the different energy demand load profiles of EVs and stationary storage. Once the useful life of a battery within an electric vehicle has come to an end, the battery can be repurposed and assembled in a large stationary storage system for a second life. When each battery is removed from an electric vehicle, it is placed directly in the overall storage system exactly as it was placed in the vehicle. The simplicity of this process greatly reduces costs and improves safety.

The Second Life project received the 2020 BASF – Sustainability Excellence Club Award for Best Circular Economy Practice among large businesses in Spain. It was also selected as a "member initiative" by the World Economic Forum for its innovation and delivery on sustainability principles.

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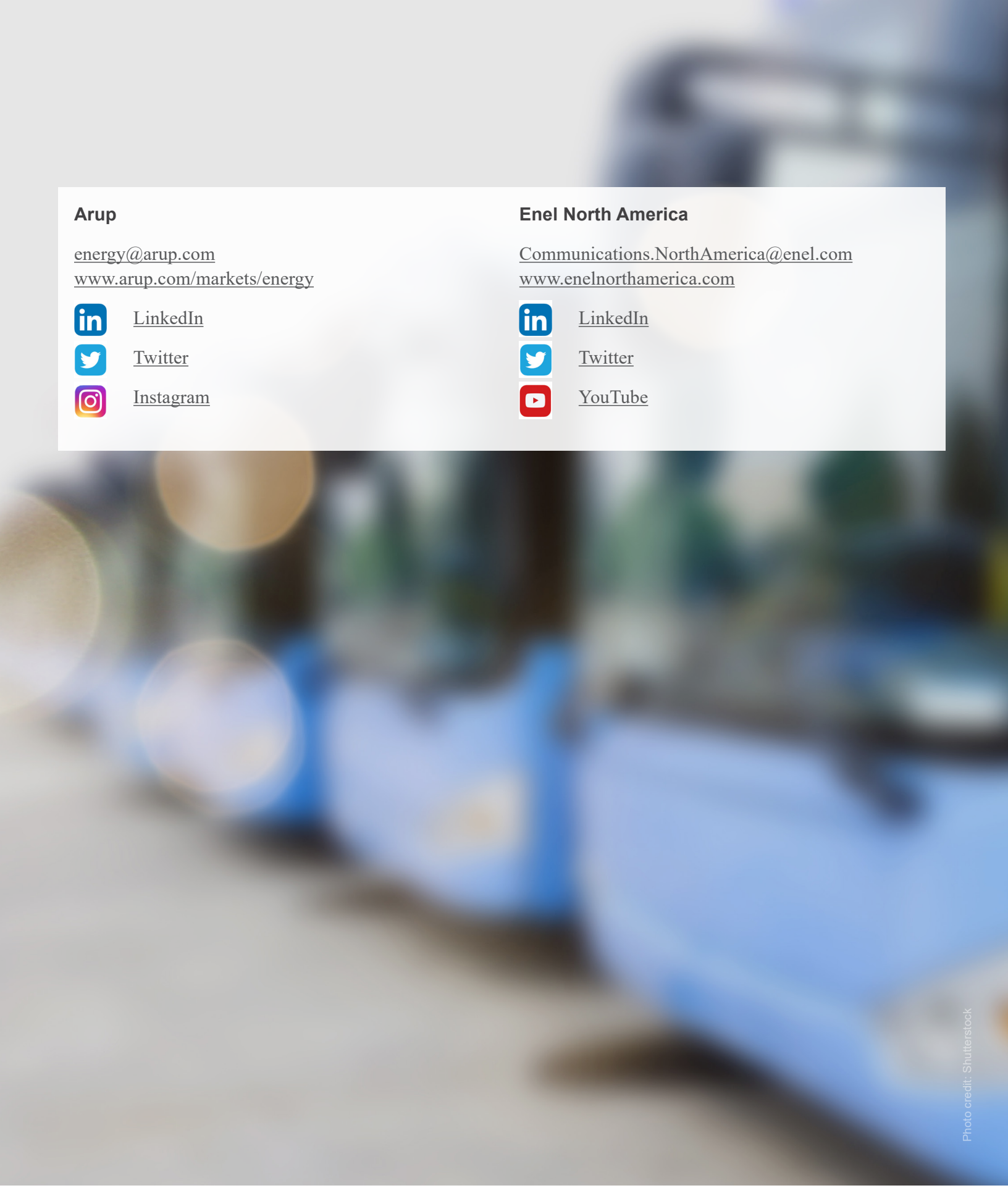

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