Accelerating Zero-Emissions Delivery:

An innovative approach to transforming the last mile

EDF ENVIRONMENTAL DEFENSE FUND + BUSINESS

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Foreword

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Electrifying transportation is critical as the world works toward creating a more sustainable and equitable future. Online sales are rapidly growing, which is increasing the demand for more delivery vehicles that contribute to air pollution, greenhouse gas emissions and congestion. The health of the planet and communities are at risk.

The urgency to find innovative solutions for fleet electrification that can drive down air pollution and climate pollution is at an all-time high as the world struggles with COVID-19 and more frequent natural disasters. We believe there is a better way.

We see leadership as driving change, accepting risk and taking action, which is why IKEA Retail is committed to provide our customers with 100% zero emission deliveries by 2025.

We're seeing encouraging momentum, both from other companies that have transportation-specific climate commitments as well as around innovative technological solutions for vehicle electrification. The problem is, zero-emission vehicle implementation has for the most part been focused on cars or commercially owned fleets, while non-owned fleets are ignored among policymakers. This is leaving a critical gap.

The technology exists today that IKEA and brands can use to drive delivery electrification for real-world ranges and duty cycles. Our largest challenges are legal, financial and practical in nature. Where more progress is needed is around taking the best available option on the market, deploying it at scale and committing to continuously improve it.

Accelerating Zero-Emissions Delivery introduces an innovative model for accelerating commercial vehicle electrification by harnessing customer demand to overcome a variety of barriers. Giving independent contractors access to electric trucks without becoming cost burdened, enables brands like us to continuing progress against our sustainability and delivery commitments even when we don't own or control the vehicles that operate in our supply chain.

We aim to improve our own delivery options and to provide a blueprint for other like-minded companies to follow. Together we will demonstrate that zero emission zones can be successful and that there is a demonstrable demand for zero emission delivery that is currently being unmet.

By leveraging the collective purchasing power of brands, we can send a message to transportation suppliers, policy makers and communities that zero emissions deliveries are a priority and are possible. The transition to a sustainable transportation future is not only possible today, it's more important than ever before.

Executive summary

We're experiencing growing demand for freight movement in the U.S. and around the world, which is driving increased consumption of fossil fuels and worsening air pollution. The scrutiny over transport's harmful impact on climate change and health — which fall disproportionately on low income communities and communities of color — is at an all-time high. This is especially true as companies start to disclose their emissions from a year of unprecedented home deliveries fueled by the Coronavirus pandemic.

Air pollution causes and worsens medical conditions including heart disease, diabetes, lung disease, asthma — conditions that put people at greater risk of COVID-19 complications or death. What's worse, warehouses and distribution centers that manage last-mile deliveries are often concentrated in low income communities and communities of color. As a result, air pollution, including emissions from diesel trucks, is disproportionately concentrated in these neighborhoods.[1]

Achieving a net zero emissions future in 2050 rests on our ability to electrify commercial vehicles. Transportation is expected to be the largest source of new greenhouse gas (GHG) emissions through 2050 with medium- and heavy-duty vehicles projected to account for a significant portion of the growth.[2]

Companies are setting ambitious climate goals, many of which include transportation as the centerpiece. Currently, though, there remain significant barriers to the ability of companies to meet their targets.

There is a critical gap: no mechanism exists for companies to get to zero-emissions shipping in their supply chain when they don't directly own or operate the vehicles.

This white paper introduces the concept of a Zero-Emissions Delivery Zone (ZED Zone), a new innovative financing model that can accelerate commercial vehicle electrification, while delivering substantial financial, social and environmental returns for forward-thinking investors.

Why embrace a ZED Zone model?

A shipper or group of shippers can catalyze **$1 million** of health benefits from reduced air pollution by **sponsoring 15** electric delivery vehicles through this ZED Zone model.[3]

Further, this model can unlock solutions for driving environmental and health benefits, including:

- Creating a lever for business customers to transform shipping practices for non-owned vehicles in their supply chains.
- Focusing zero-emissions vehicle (ZEV) depots to improve health and reduce disproportionate health disparities from air pollution, with help from state and local leaders.
- Introducing a new role for public and private finance.
- Building capacity for a scalable pipeline of ZEV adoption projects.

A collaborative approach to transforming last-mile delivery

Urban last-mile delivery applications are ideal for the ZEV options that are already available.[4] The Ford E-Transit van was only the latest announcement in a string of zero-emissions last-mile vehicles:[5]

Volvo, Daimler, Rivian and Lion Electric are among manufacturers investing to develop zero-emission solutions. As a result, we're seeing industry-wide collaboration. For example, virtually all of the legacy OEMs have formed strategic relationships with or acquired smaller zero-emission suppliers to bolster their acumen in electric drive technology.[6]

The technology advances driven by electric vehicles (EVs) used in last-mile deliveries is likely to have a knock-on effect to reduce costs for EVs in other duty cycles.[7]

New roles and relationships can ensure companies using last-mile trucks deliver on their promise of sustainability and health.

How stakeholders can take action

Shippers

Meet climate and equity commitments by cleaning up trucking in operations and supply chain. Solidify demand for clean shipping by making time-bound commitments to adopt and pay for 100% clean shipping. Leverage collective purchasing power by demanding action from financiers, carriers and EV managers to offer EV delivery options.

Private and public finance

Create finance innovations that enable zero-emissions trucking and share in growth potential. Provide the capital needed to purchase EVs and charging and make them available to carriers and EV managers. Work with project developers to build a pipeline of ZEV projects. Systematize transactions and share data to reduce deal costs and improve liquidity.

State and local government

Use the levers of government to focus zero-emission trucks where they can do the most good. Issue maps of at-risk neighborhoods where ZEVs should be prioritized. Create enabling policies such as access preferences for ZEVs and workforce development.

OEMs, enterprise fleet managers and third party logistics providers

Build a business of operational and financial performance in zero-emissions trucking. Develop expertise and build new business lines as EV managers, who form a critical conduit between customers demanding 100% clean shipping and carriers.

Introduction

Almost every product, whether delivered to individual households or to local stores, gets to its final destination via fossil fuel-based shipping. Medium- and heavy-duty vehicles (MHDV) required for moving these goods are a leading contributor to local air pollution and GHG emissions.

Introduction

Today, there are 1.2 million straight trucks — a common delivery vehicle type — registered in the U.S. in 2020, with over 450,000 "for hire."[8] As demand for last-mile services grows, with projections estimating an increase of roughly 12% annually through 2025, so too will the need for more trucks on the road.[9]

Increased access to last-mile delivery is bringing essential convenience and safety to consumers during the coronavirus pandemic. But, pollution from delivery trucks can cause significant local health and environmental impacts.

Air pollution causes and worsens medical conditions including heart disease, diabetes, lung disease, asthma — conditions that put people at greater risk of COVID-19 complications or death. Globally, air pollution is estimated to be responsible for up to 33 million visits to the emergency room for asthma and 4 million new cases of childhood asthma.[10, 11] One study estimates that in the U.S. "more than 20,000 people die prematurely every year as a result of the health burden from the motor vehicle pollution on our roads and highways and millions more suffer from respiratory illnesses, lost work days and lost school days."[12]

What's worse, warehouses and distribution centers that manage last-mile deliveries are often concentrated in low-income communities and communities of color.

As a result, air pollution, including emissions from diesel trucks, is disproportionately concentrated in these neighborhoods.[13]

Many companies have set ambitious climate goals and reducing delivery emissions will be a critical component for meeting them.

Companies, too, have set transportation-specific targets. IKEA committed to 100% zero-emissions last-mile delivery and to become climate positive. Etsy offsets 100% of carbon emissions from shipping. Unilever committed to zero-emissions shipping using a phased integration of electric vehicles into their owned and leased fleets. Walmart announced zero-emissions shipping at all stages of their supply chain by 2040.[14, 15, 16]

Most companies contract for shipping services through carriers rather than, or in addition to, owning their own fleets. In many cases, carriers optimize delivery by shipping multiple items from different companies in the same truck. For both shippers and carriers, the operational complexity and cost burden makes it prohibitive for shippers to request specific vehicles to make their deliveries.

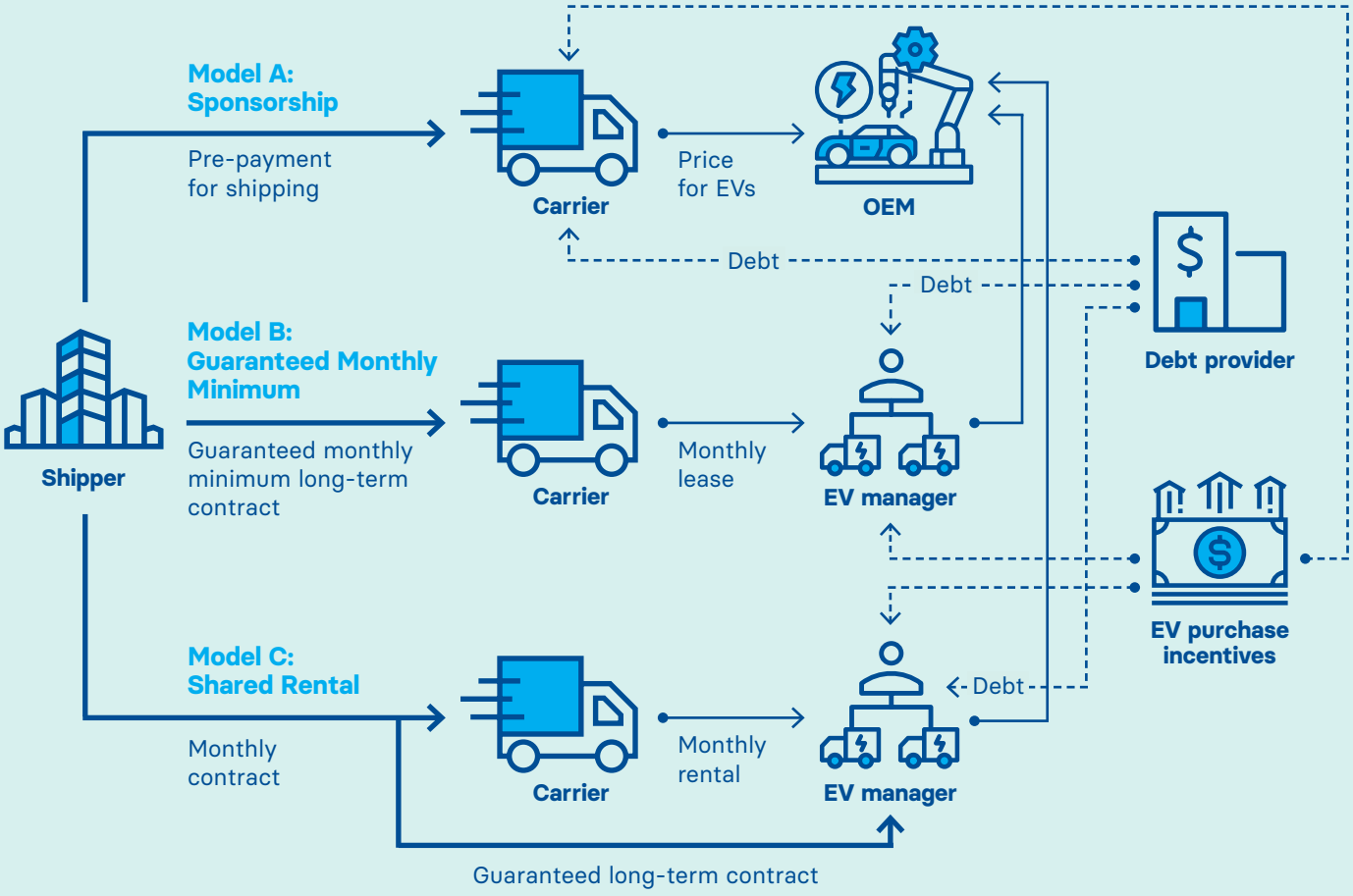
How a zero-emissions delivery zone works

In a ZED Zone model, a shipper or a group of shippers will "sponsor" ZEVs. The number of vehicles will depend on shipper demand, charging availability, depot size and other factors.

A ZED Zone model could take three forms:

- **Model A (Sponsorship):** Shippers pre-pay for shipping and receive monthly discounts on a long-term contract.
- **Model B (Guaranteed Monthly Minimum):** Shippers sign a long-term contract with one carrier at a minimum monthly spend.
- **Model C (Shared Rental):** Shippers sign a long-term contract with an EV manager guaranteeing vehicle use and requiring carriers to rent ZEVs from the EV manager.

Fig.1 **Summary of options for zero-emissions delivery zone**



Driving shared value

1 Creates a lever for customers to transform their supply chains

Much like a virtual power-purchase agreement for renewable energy, organized and aggregated customer demand can play a unique and powerful role overcoming some of the barriers to ZEV adoption. At a macro-economic level, the ZED Zone model begins the process of de-commodifying shipping. Corporate customers can facilitate distinctions based on quality of shipping rather than participating in a "race to the bottom" for emissions. A few examples of how companies can procure better shipping gives stakeholders something to advocate for and creates a window to a world of clean freight.

On a micro-economic level, the ZED Zone model has the potential to dramatically increase capital availability, reduce risk and speed up deployments, without diminishing other important qualities like speed of delivery, inter-operability and flexibility. Pre-payments or long-term contracts from reliable corporates for ZEV services can encourage fleet managers to purchase ZEVs and justify lower costs of financing.

2 Focuses ZEVs to improve health and reduce disproportionate health burdens

The ZED Zone model enables customers to focus and accelerate ZEV depots in at-risk communities. The corporate customers are not paying a surcharge that is spread across a carrier fleet — they are sponsoring a distinct set of vehicles. The shippers' parcels or freight will not necessarily travel on the zero-emissions vehicles they sponsor. Instead, those ZEVs, regardless of what is inside, are launched from depots in communities with a disproportionate burden from air pollution. Even though the trucks will travel outside the at-risk neighborhoods, proximity to trucks starting, stopping and idling is a significant health risk.[17]

State and local leaders have a critical role to play to facilitate the acceleration of ZEVs in high-risk communities. Leaders can first issue maps of at-risk neighborhoods where ZEVs should be prioritized by private actors. Local and regional policymakers can also create enabling policies such as utility make-ready funding, access preferences in central business districts for ZEVs that are launched from depots in at-risk communities, and workforce development in communities around the depots. With this structure for collaboration, the ZED Zone model ensures that the pollution reduction benefits are targeted to communities that need them most.

3 Creates a new role for public and private finance

The ZED Zone model creates new opportunities for public and private finance. With customers subscribed in advance for ZEV services, financiers have the confidence to unlock capital instruments like equity investments, bonds and loans to purchase ZEVs and charging infrastructure. Upfront funding for ZEVs enables cost-smoothing, as financing is repaid as the benefits of lower operating costs are realized.

The customers for ZEV financing are not just the traditional fleet owners. New and existing market players are being asked to take on the risk of owning ZEVs and functioning as EV managers. These include enterprise fleet managers, rental agencies and even OEMs. Creative financing could enable all of these players to take on new roles and deploy ZEVs faster. The ability to focus ZEVs in communities that face a disproportionate burden from air pollution may make a ZED Zone model particularly attractive to public finance such as green banks.

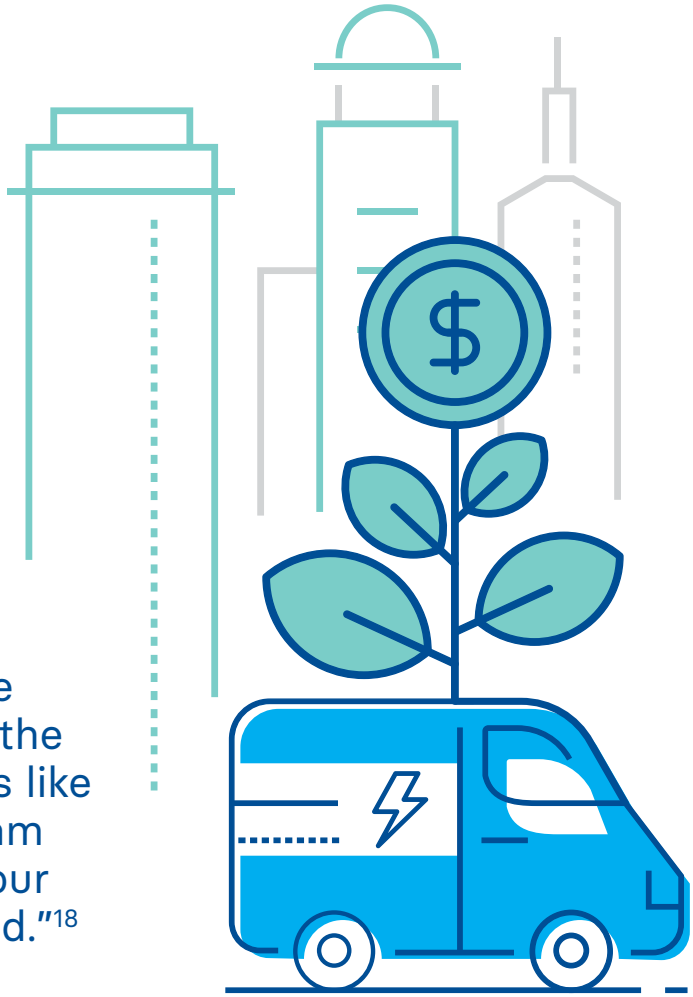
4 Builds capacity for scale

Here is a description that no one today would associate with ZEVs, but one that represents the near future:

> "[These] projects have become a conventional asset class. The technology is proven at scale, the revenue stream looks and feels like an annuity, and with mainstream customers like Walmart and your local utility, the sizzle has faded."[18]

Learning from the experience of renewable energy project development, the ZED Zone model creates a focused way to start the journey of adopting ZEVs including:

- Tests and refines a unit of adoption for ZEVs, enabling standardized **processes** for projects of similar size, location or similar corporate customer;
- Creates a mechanism for project developers to build a **pipeline** of projects (aggregate demand from shippers, then structure and warehouse deals, and even eventually securitize them); and
- Emphasizes and rewards the role of EV manager, creating an opportunity for excellence in **execution.**



The business case for fleet electrification is clear

Increased demand for last-mile delivery

In 2019, global e-commerce sales were expected to hit nearly US$3.46 trillion.[19] The growing global e-commerce industry is demanding faster delivery and increasing the number of delivery vehicles on the road. Most short-haul deliveries, referred to as last-mile delivery, are made by MHDV. These vehicles are typically diesel-fueled, internal combustion engines that are known to impact local air pollution and contribute to GHG emissions. Although estimates vary widely, spending on last-mile delivery to consumers likely accounted for around $40 billion in 2020, growing at around 12% annually.[20]

Even before COVID-19 hit in North America, e-commerce was projected to double by 2023.[21] The pandemic accelerated a trend to blur the line between e-commerce and offline retail.

Already brands were integrating offline and online customer experiences, for example, by using stores to showcase products and allowing customers to order home delivery. Companies that never thought of themselves as e-commerce brands or wanted to be in the delivery business have now found ways to make home deliveries. Given customer preferences and business imperatives, the need for last-mile delivery will only grow.

In terms of demand for zero-emissions last-mile delivery, there is **significant unmet need**. E-commerce platforms and shippers have made commitments ranging from zero-emissions shipping by a date certain to general pledges to fight climate change, which cannot be achieved without zero-emissions shipping.

Brand/Customer	Climate-related commitments	Current status
E-Commerce Platforms		
Etsy	Offset 100% of carbon emissions from shipping[22] Power operations with 100% renewable electricity by 2020[23] Signatory of 'We are Still in" joint declaration to support climate action	Achieved 100% renewable energy for operations is 2020 100% carbon emissions from shipping are offset through verified emissions reduction project in forest restoration, clean energy and greener manufacturing processes[24]
eBay	50% absolute reduction in Scope 1 and Scope 2 GHG emissions by 2025, and 75% by 2030 (from 2016 baseline)[25] Signatory of 'We are Still in" joint declaration to support climate action	31% reduction in Scope 1 and 2 between 2016 and 2019 64% renewable energy for all data centers
Shopify	Launched Shopify Sustainability Fund, committing to a minimum of $5M annually to fight climate change[26] 100% global operation with renewable energy by 2020	$1M from Fund diverted to carbon offsets Apps to allow customers and buyers to offset their delivery emissions
Shippers		
Amazon	Net Zero Carbon Across Business by 2040 Amazon Shipment Zero commitment to make all Amazon shipment net zero carbon (50% shipment net zero by 2030)[27] Member of Ceres Corporate Electric Vehicle Alliance	Purchase of 100,000 delivery trucks from Rivian[28] E-cargo program in Europe and North America, with pilot in India[29]

Best Buy	Reduce carbon emissions in operations by 75% (over 2009 baseline); carbon neutral by 2050[30] Signatory of 'We are Still in" joint declaration to support climate action	Achieved a 51% reduction in carbon emissions over 2009 baseline
Home Depot	39.9% reduction by 2030 and 50.4% reduction by 2035 for Scope 1 and Scope 2 emissions[31] Member of Ceres Corporate Electric Vehicle Alliance	On track to get 135 megawatts of energy used for renewables and alternative sources by end of 2020 (enough to power 300 stores)[32]
HP	Reduce Scope 1 and Scope 2 GHG emissions from global operations by 60% by 2025, compared to 2015[33] Signatory of 'We are Still in" joint declaration to support climate action	215,800 tonnes of Scope 1 and Scope 2 CO_2e emissions, 44% less than 2015 baseline[34]
IKEA	Climate positive by 2030 Ensure zero emissions from home deliveries and aim to reduce emissions from co-worker and customer travel (scope 3) by 50% in relative terms compared to FY16[35] IKEA North America is a member of Ceres Corporate Electric Vehicle Alliance Signatory of 'We are Still in" joint declaration to support climate action	Making progress to achieve 100% emissions-free IKEA deliveries by 2020 in these five cities: Shanghai (already achieved), Amsterdam, Los Angeles, New York, Paris
Lowe's	Reduce absolute Scope 1 and 2 emissions by 40% below 2016 levels by 2030[36]	Mandated U.S. EPA's SmartWay program for Scope 3 emissions for U.S. transportation

Nestle	Net Zero by 2050	Pilot program in Ohio for zero-emissions trucks. Transport is 17% of Nestle's U.S. GHG emissions[37]
Nike	Absolute reduction of Scope 1 and 2 emissions by 65% and Scope 3 emissions by 30% by 2030[38] Signatory of 'We are Still in" joint declaration to support climate action	Sourced 93% of all materials from sustainable suppliers (2019)[39] 27% renewable energy in owned or operated facilities (2019)
Target	Reduce absolute Scope 1, 2 and 3 GHG emissions by 30% below 2017 levels by 2030[40] 80% of suppliers will set science-based reduction targets on their Scope 1 and 2 emissions by 2023 Signatory of 'We are Still in" joint declaration to support climate action	2.1% reduction in absolute Scope 3 emissions for retail purchased goods and services (from 2017 baseline levels)
Walmart	Zero-emissions for all trucks by 2040 Achieve 18% emissions reduction in own operations by 2025, compared to 2015 baseline[41] Signatory of 'We are Still in" joint declaration to support climate action	6.1% reduction in Scope 1 and 2 annual GHG emissions in 2017 compared with 2015 (latest reporting in 2019 annual report)[42] Pilot program in Houston for grocery deliveries using autonomous electric vehicles

On the carrier side, the last-mile market can be segmented into light goods and heavy goods. Light goods are packages less than 150 lbs.[43] Altogether the carriers USPS, DHL, FedEx, and UPS dominate the market for light goods last-mile delivery in the United States. Although Amazon still partners with USPS and UPS for last-mile delivery, it has recently ended its relationship with FedEx.[44] Amazon has declared its goal to be in the business of last-mile delivery, and already delivers half of its own packages.[45]

In contrast, the carrier space for last-mile delivery of heavy goods like furniture is highly fragmented. JB Hunt, XPO, and Werner are some of the biggest companies in terms of market share, but none captures more than 10% of the heavy goods delivery market.[46]

Health consequences from air pollution

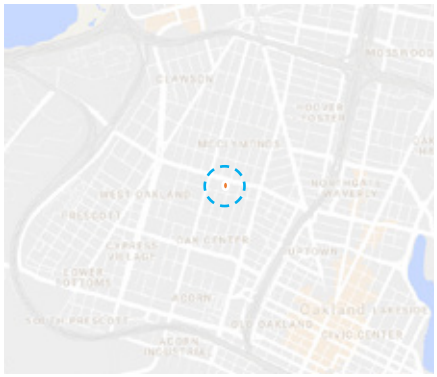
Air pollution accounts for more than 7 million premature deaths each year globally — and more than 600,000 are children under five years old.[47] In particular, communities around the world continue to struggle with the health impacts of local air pollution associated with the movement of goods. In 2015, 385,000 premature deaths globally resulted from transportation-related air pollution alone. "[D]espite making up only about 4 percent of vehicles on the road, the delivery trucks and tractor trailers that distribute our goods also deliver nearly half of the NO_x emissions and nearly 60 percent of the fine particulates from all vehicles."[48] This impact is growing: "EPA estimates that NO_x emissions from these diesel trucks are projected to be one of the largest contributors to national ozone pollution in 2025."[49]

Other segments of the movement of goods may account for more *emissions* overall — such as marine cargo vessels running on dirty bunker fuels. However, *exposure* matters for health outcomes. Last-mile depots may be closer to where people live, and therefore increase the health impact from that exposure.

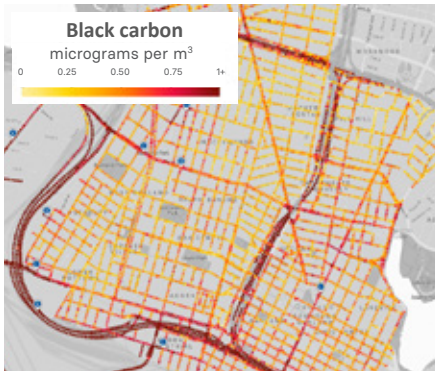
A recent study showed that pollutant concentrations can be eight times worse even from one end of a block to another. Proximity matters for health — living at that toxic end of the block raises the risk of heart attack or death by 40% for elderly people, equivalent to a history of smoking.[50]

Fig.2 **Hyperlocal air pollution and health risks**

Regulatory air pollution monitoring for West Oakland, CA: 1 stationary site



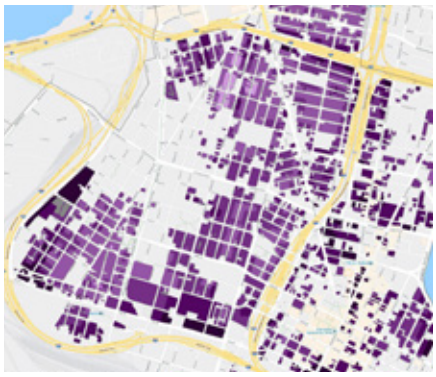
Data: 1 year of air pollution measurements (BC, NO, NO_2) using fast response sensors on Google Street View cars.



Finding: Within West Oakland, some areas had **5-8 times** higher median pollution levels than others. Many parts of the neighborhood had higher air pollution than levels measured at the central regulatory monitor..

Data: Electronic medical records of 41K people insured by Kaiser Permanente health care, linked with air pollution at residential address.

Air pollution's impact on the heart in the elderly (65+)
Estimated traffic pollution-related health risk



Finding: Elderly residents (age 65+) living in areas of West Oakland with the highest concentrations of NO_2 would have **>40% greater risk** of a cardiovascular disease event than those in less polluted areas of the neighborhood.

The harm from diesel MHDVs is often centered around major freight hubs, such as distribution centers and port facilities.

Fig.3 A case study of pollution from facilities in Oakland, CA

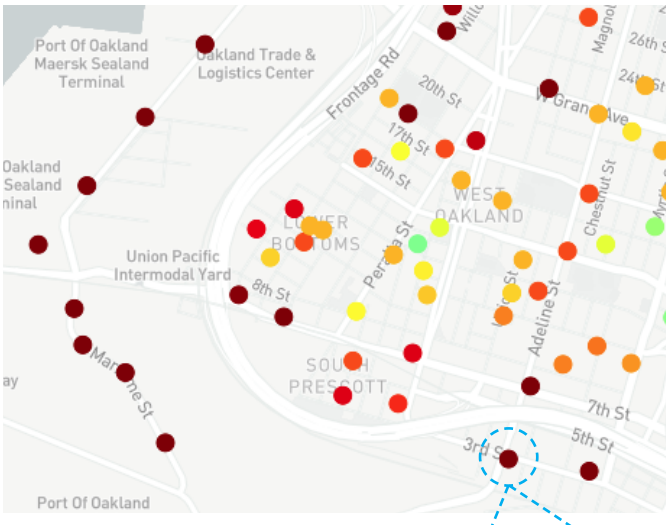
The intersection of 3rd and Adeline is near a major entrance to the Port with heavy truck traffic. Trucks decelerate, idle, and then accelerate as they navigate a four-way stop light at the intersection.

On weekdays, black carbon at this site increases sharply between 3-9 am, dips at noon, and then drops off after 2 pm. At 9 am, average BC is more than 3 times higher at this location that the West Oakland neighborhood average.

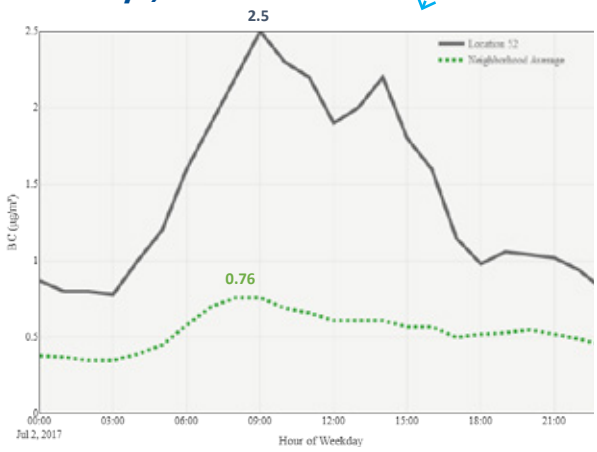
On weekends, black carbon at this location is somewhat above the West Oakland neighborhood average, but much less elevated than on weekdays.

3rd St and Adeline St

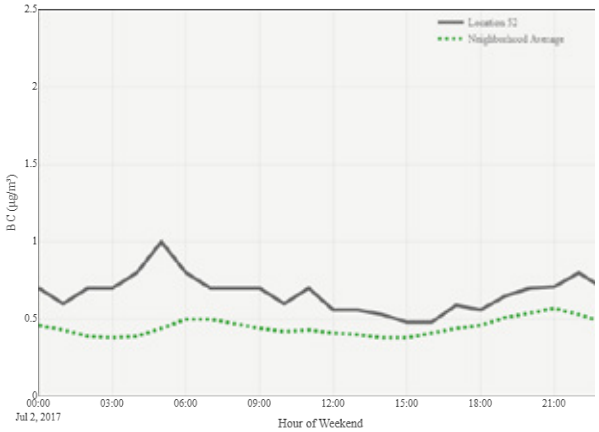
Photos ©2019 Google



Hourly Average Black Carbon (on Weekdays)



Hourly Average Black Carbon (on Weekends)



Low-income communities and communities of color are disproportionately inhaling the pollution and suffering the consequences.[51]

The business case

ZEV readiness for last-mile delivery

Vehicles

Electric trucks have a limited driving range compared to fossil fuel-powered alternatives, but they are uniquely suited for last-mile duty cycles characterized by low average speeds, under 100 miles a day of driving and a high number of stops. Technologies like regenerative braking allow electric vehicles to recover energy from braking that would otherwise be lost.[52]

Updated lists of all eMHDV options (available and announced) can be found at the Global Drive to Zero-Emissions Technology Inventory and from EDF.[58] Improvements in cost and performance of last-mile vehicles will drive down the cost and improve performance of similar ZEVs in different duty cycles, and for heavier vehicles, such as drayage.[59]

For last-mile delivery, vehicles fall into the medium-duty range (Class 3-6). While there is some variation in the types of vehicles used based on duty cycle, box trucks, walk-in vans and city delivery trucks are the most commonly used last-mile vehicle types in the U.S.

Predictable routes and limited daily driving distances of last-mile deliveries can also help mitigated any "range anxiety" by directing vehicles to specific routes and predetermined destinations where charging, fueling or reloading infrastructure is available.

Carriers like FedEx and DHL are even experimenting with e-cargo bikes for urban deliveries.[53] [54]

Electric delivery trucks are a zero-emissions delivery option and have the potential to reduce lifetime cost and improve reliability. These vehicles are a viable alternative today in daily urban applications, ideal for many last-mile delivery applications, and often more efficient and cheaper to operate than conventional diesel trucks.[55]

Last-mile EV options will expand significantly over the next several years.[56] As volumes increase, costs will fall — the most recent estimates are that it will only take two to three more "doublings" of production volume (from a very low baseline) until cost parity.[57]

Several electric medium-duty box trucks and refuse trucks are now available in the market, manufactured by well established companies including Daimler, Ford, Freightliner and Volvo, among others. Other competing e-vehicle manufacturers such as Lion and Chanje exclusively specialize in electric vehicles and recently introduced an all-electric box truck to the commercial U.S. market.

Companies like Lightning Systems and Motiv also have the technology to retrofit existing Class 2-6 vehicles from companies like Ford, Chevrolet, GMC and Isozu, into plug-in as well as hybrid EVs, a potentially cost-effective alternative for EV transition of a fleet without replacing all existing diesel vehicles.[60]

Charging

A key aspect to consider for operating electric fleets is charging, including charging infrastructure, installation and operation. Currently, there are three main types of EV charging infrastructure: Level 1, Level 2 and Level 3. Increase in level (from Level 1 to Level 3) results in an increase in price but a decrease in the total recharge time (for the same battery size). A Level 1 or 2 charger can be grid connected or off-grid (e.g. solar powered). Level 3, or DC fast charging, is typically grid connected and uses the most electricity, and has the highest capital costs.

When it comes to charging electric trucks, the peak load and grid capacity are a key consideration. Managed charging and on-site battery storage solutions can help to make the most of existing grid resources and reduce or eliminate the need for grid upgrades. Managed charging, also known as smart charging, is a solution which remotely controls vehicle charging. It helps avoid charging during certain peak times of day, or staggers charging through the night, for better load management. Managed charging can reduce both the energy costs and the environmental footprint associated with battery-electric vehicles. Adding on-site battery storage solutions in conjunction with managed charging can help make charging more robust and help meet additional fleet charging needs at peak times.[61]

Barriers addressed

Right now, without owning or leasing a vehicle and managing shipping directly, there is no way to secure zero-emissions shipping. Shipping cost, speed and customer service are the primary competitive factors. Goods from different companies are generally combined on the same third-party truck. It is not practical for shippers to demand delivery of their third-party shipped goods on specific vehicles. Perhaps as a result of this disconnect, only a few companies that are dependent on shipping have a shipping-specific goal for emissions, and companies that don't own vehicles face little accountability pressure for the impact of shipping in their supply chain.

In order to achieve environmental outcomes for what are today commodities, customers must be able to procure a differentiated product or service. The history of personal items like coffee, milk and chocolate, and business inputs like electricity, paper, gas and palm oil, among others, indicates the importance of the first distinctions among products and services. Once a few customers can procure a better solution, other customers have a mechanism to shift their purchases, or can be forced to do so by their stakeholders.

Carriers face a set of challenges before they can adopt ZEVs.

Fig.4 **Total Cost of Electrification: A New Framework for Evaluating Fleet Electrification Barriers[62]**

Hard costs Costs from investment in new assets and fixed infrastructure	Soft costs Costs from additional activities and processes to switch to electric MHDVs	Risks + uncertainties Costs from uncertainties that make financing more expensive or electric MHDVs appear less cost competitive	Frictions Limitations that increase the psychological or practical cost of switching to electric MHDVs
Priority barriers			
High upfront vehicle capital cost	Change to business operations (including routes and schedules)	Uncertain residual value of vehicles and batteries	Lack of capacity to plan and implement fleet switches to electric MHDVs
High upfront and replacement battery costs	Permitting and approvals	Uncertain future capital costs and total lifetime cost	Lack of capacity to use new financing approaches
Technical infrastructure costs, including chargers and system upgrades	Practicalities of switching to new maintenance logistics	Uncertain battery technology performance and life	Inertia in procurement and contracting process
	Knock-on effect of missed charging events	Uncertain maintenance costs	
		Uncertain fuel cost savings	
		Uncertain evolution of incentives and policy standards	

Shippers — as the contractors of delivery services — have a unique role to play helping carriers address certain barriers to zero-emissions shipping. While the remaining barriers also need to be addressed before ZEVs will be operating at scale, shippers do not have as unique or powerful a role to play in resolving those barriers.

The carrier market is bimodal — while most trucks are owned by large firms that own thousands of vehicles, most trucking companies are very small — owning one to five trucks.[63] The credit profile of the latter generally does not support asset-based financing of six-figure vehicles, and they are generally not buying new vehicles anyway, so vouchers are of limited help. Even though these owner-operators are small, they often participate in the supply chains of national brands.

The ZED Zone model is especially useful to get EVs into the hands of this extensive landscape of small owner-operators.

Although large national carriers have the balance sheet to acquire vehicles, they too may be looking for ways to share the risk. Negative experiences with the early ZEV startups have left many reluctant to invest. The ZED Zone model can therefore be helpful to establish customer demand to reduce the perceived risk of EV deployments and demonstrate to large carriers the potential of zero-emissions shipping for customer acquisition and retention.

Zero-emissions delivery zone model

The ZED Zone model is a financial and contractual framework to facilitate a shipper or a group of shippers to accelerate use of ZEVs by a carrier.

It assumes that over the life of the ZEV the cost of operating is similar to a diesel vehicle. Thus, the shippers are not necessarily paying more, but are changing the timing of their payments and taking on some additional counterparty risk due to long-term contracts.

In particular, the ZED Zone model:

- Concentrates resources upfront to mitigate the high upfront vehicle capital cost through changes in contract timing and structure (not necessarily a price premium);
- Focuses the air quality benefits on neighborhoods that need them most;
- Systematizes EV financing and deployment through standard contracts and other resources; and
- Does not require changes to delivery routes or schedules.

Increased resources and certainty

ZEVs currently have a higher upfront cost than diesel vehicles of the same size and weight class. Depending on the model, the initial purchasing price can sometimes be almost double that of the diesel alternative, ranging from $30,000 to more than $100,000 higher for medium- and heavy-duty vehicles.[64]

Although ZEVs are anticipated to cost less over a lifetime of operation (because of lower maintenance and fuel costs), more example cases are needed to confirm that hypothesis and quality data is needed to justify investment decisions. Despite the fact that operating costs for electric alternatives should be significantly less over time, and large carriers generally have the ability to make ZEV purchases, especially at low numbers, they have been reluctant to do so at the speed and scale required.

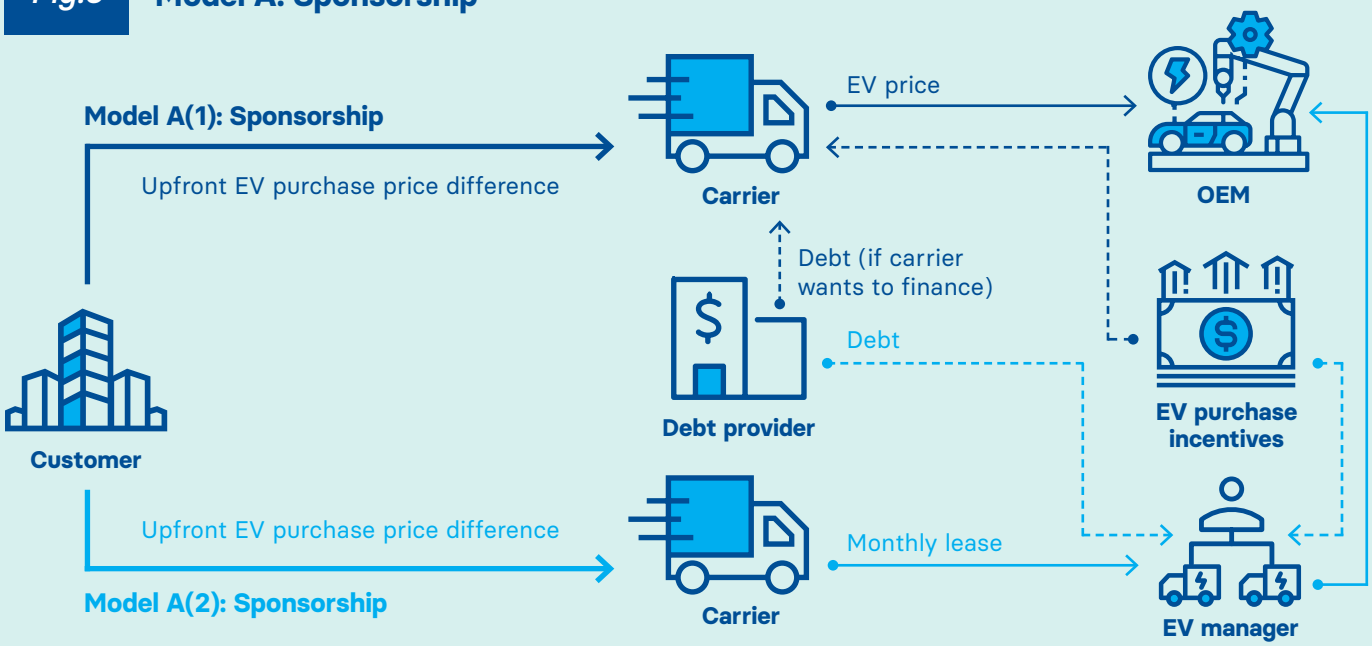
Some or all of that upfront cost difference may be overcome by existing federal, state, local and utility incentives that support the procurement of EVs and charging infrastructure. These include rebates, grants programs, and tax credits and exemptions, among others, and public incentives vary significantly from one region to the next.[65]

The ZED Zone model considers three potential options for procuring zero-emissions shipping: 1) Sponsorship; 2) Guaranteed Monthly Minimum; and 3) Shared Rental.

In the first option, a shipper pays upfront for the difference in the cost of purchasing EVs. In the second, the EVs are purchased on the strength of a long-term minimum price contract with one carrier. In the third, a shipper guarantees utilization of vehicles not to one carrier but to an EV manager, which makes them available to carriers that want to do business with the shipper.

In all three, the shipper is not necessarily paying more over time, but is shifting the timing of payments and taking on counterparty risk. Depending on preferences and financial profile, this upfront capital and/or enhanced contract enables the carrier or EV manager to fund the EV adoption using existing resources, or to finance the new vehicles with external debt on the strength of the locked-in customer demand.

Fig.5 **Model A: Sponsorship**

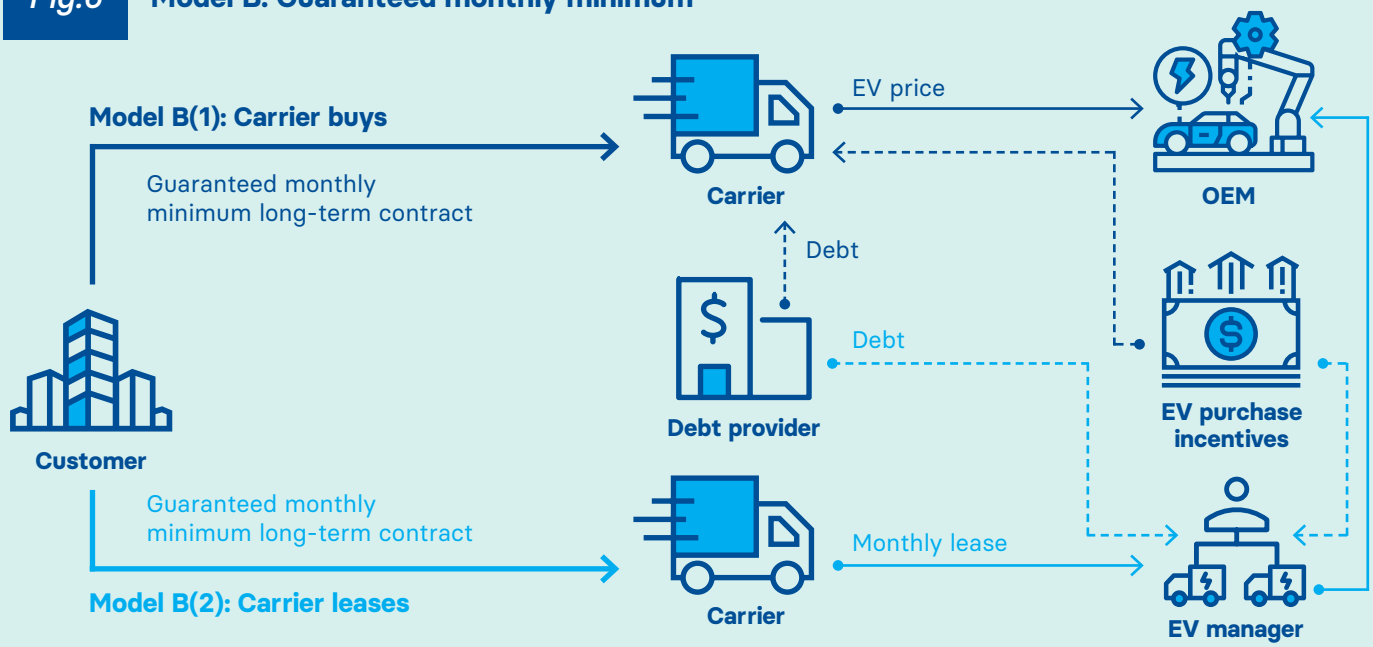


Similar to a Virtual Power Purchase Agreement, the ZEV Sponsorship Agreement allows a carrier to operate EVs by changing how they charge shipper(s). The carrier will identify the cost differential for a set of EVs in a frontline neighborhood after taking into account local EV purchase incentives. The shipper(s) will pre-pay this amount. In exchange, they will receive shipping services for free or a reduced rate for a fixed period of time.

With the help of its upfront payment, a carrier could use its existing resources to purchase EVs, or it could finance the remainder using its normal sources of capital. If the carrier does not want to own the ZEVs, it could enter into a lease with an EV manager. The EV manager could finance the EV purchases on the basis of its lease with the carrier.

Model A: Sponsorship	
Pros	***Cons***
Reduces the need for carrier debt, which is helpful if shipper has lower cost of capital.	Potential for counterparty risk as shipper pays upfront. It increases loss if shipper no longer can or wants to work with carrier.
If carrier decides to lease, EV manager might be able to take on lower cost secured debt.	

Fig.6 **Model B: Guaranteed monthly minimum**



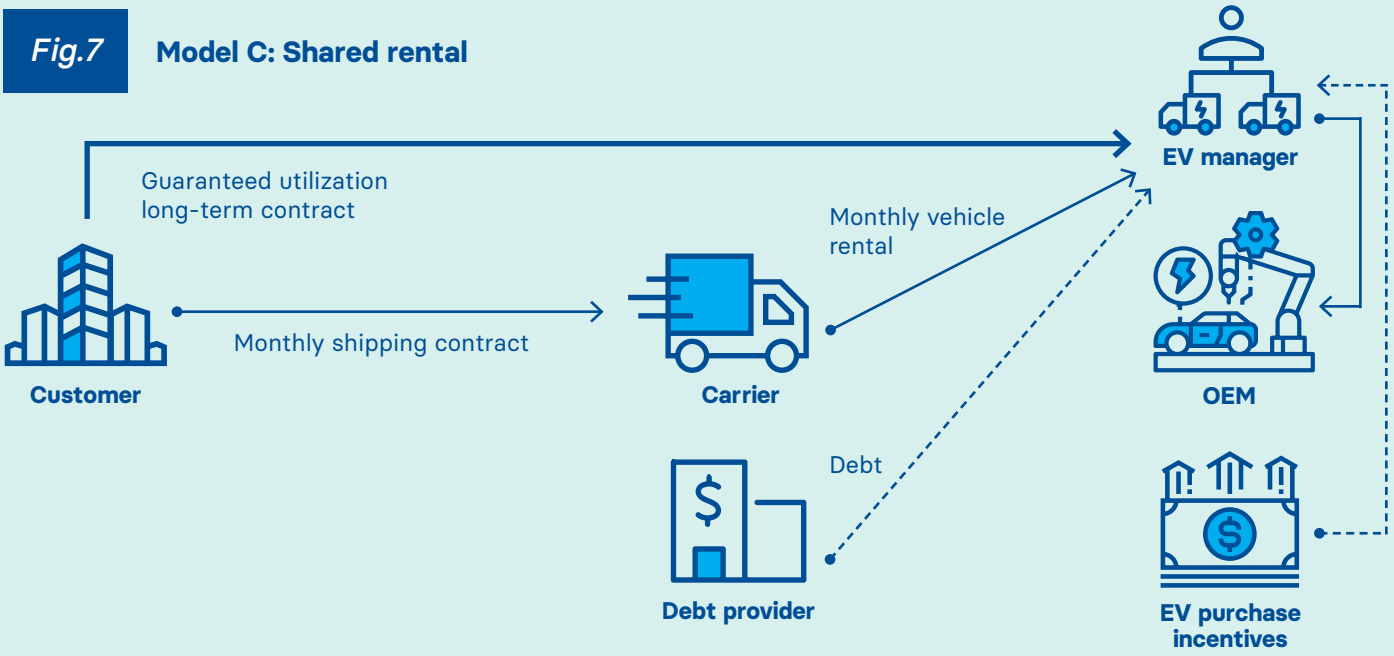
A guaranteed monthly minimum model is another alternative which allows carriers to operate EVs and addresses the challenge of high upfront costs. In this case, shipper(s) agree to a long-term contract and minimum monthly payments. These monthly payments are applied to services the shipper receives from the carrier in the normal course of business.

A carrier can then choose how it wants to acquire the EVs. On the strength of the contract, the carrier can finance the EV purchase itself, or it can enter into a lease with an EV manager. The EV manager could finance the EV purchases on the basis of its contract with the carrier.

A shipper may not want to give an upfront payment to a small carrier and accept the risk that they will go out of business or reduce the quality of their services. This model reduces counterparty risk (but still requires a long-term contract with one carrier).

Model B: Guaranteed monthly minimum	
Pros	***Cons***
Reduces upfront cost for shipper and somewhat lower counterparty risk from carrier.	Long-term contract still creates risk if shipper no longer wants to work with carrier.
If carrier decides to lease, EV manager might be able to take on lower cost secured debt.	

Fig.7 **Model C: Shared rental**



A shared vehicle rental model is an option which gives shippers increased flexibility to switch carriers, with the help of an EV manager. In this case, shipper(s) agree to a long-term contract with an EV manager that guarantees vehicle utilization. On the strength of this contract, the EV manager finances the EV purchase. The shipper then requires carriers that want its business to rent EVs from the EV manager. In this model, the shipper is not tied to a carrier but rather contracts directly with the EV manager.

The shared vehicle rental model requires a new role for EV managers. The EV manager owns the vehicles, side-stepping the challenge of small carrier credit. OEMs, vehicle rental and management platforms, or new companies could all play the role of financing and owning new EVs. Due to the tight connection between revenue from guaranteed customer demand and asset utilization, a portfolio of EV managers could be attractive to asset-based lenders like green banks or investment banks with climate commitments.

Model C: Shared rental	
Pros	***Cons***
Reduces upfront cost for shipper.	Multiple contracts add complexity to set up.
Flexibility for shippers to switch carriers.	Requires EV managers which could be a new business line or a new business entirely.
EV manager should be able to take on lower cost secured debt.	

Focus on at-risk neighborhoods

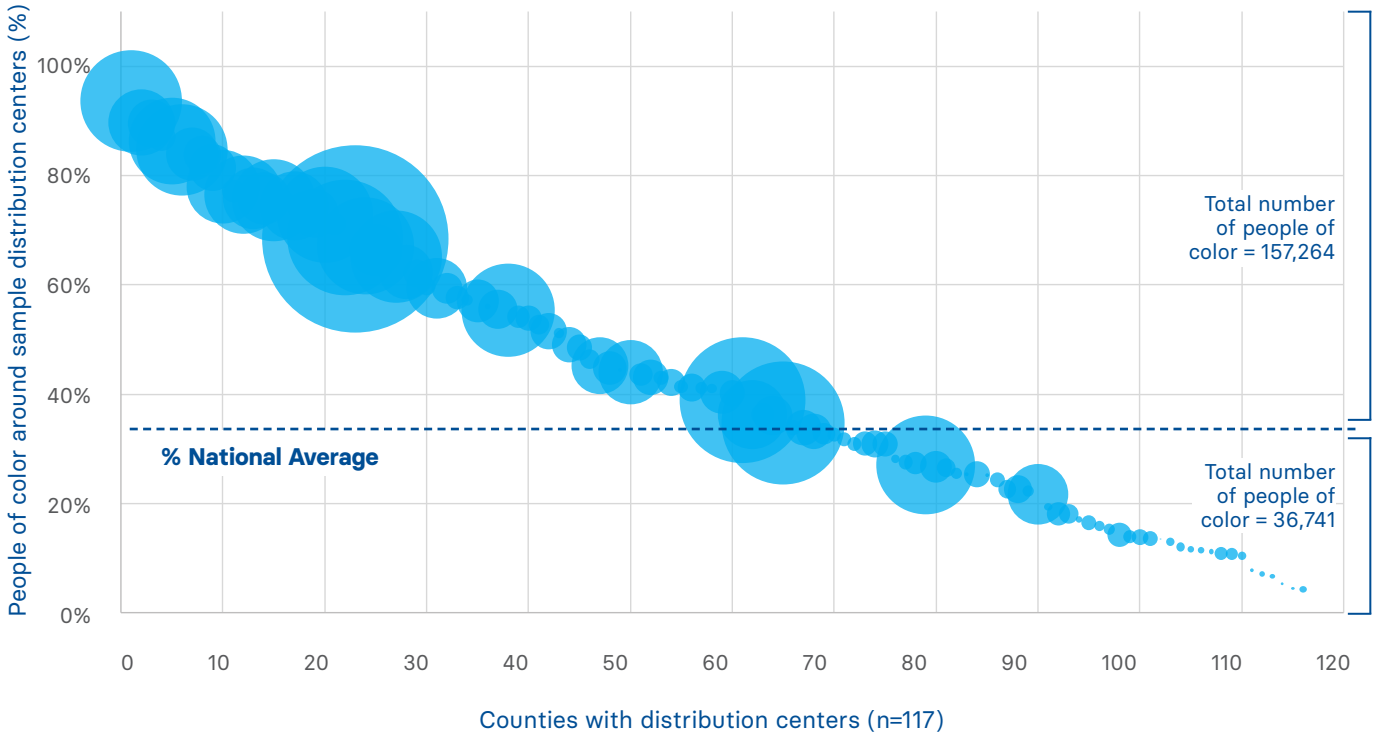
The ZED Zone model concentrates the zero-emissions trucks and air quality benefits in communities that face a disproportionate health burden from air pollution. In this case, shippers using the ZED Zone model, sponsor vehicles where they are needed most, regardless of which vehicles carry their own packages.

EDF's research in Oakland, Houston and London demonstrates that local air pollution around facilities that attract trucks is dramatically higher than what is measured by regional monitors, and higher than what is expected by standard modeling practices.[66,67]

Air pollution, including emissions from diesel trucks, is disproportionately concentrated in low income communities and communities of color. A plan to electrify trucks without regard for the existing burden from air pollution in these communities would miss an opportunity to focus the benefits of clean trucks where they are needed most.

Institutions with a neighborhood focus could take the lead on sponsoring vehicles of local or specialized fleets. Hospitals and universities in at-risk communities, for example, could catalyze ZEVs in the fleets that enter their campuses. A local agency like a port or an economic development non-profit or utility could act as an intermediary to collect groups of customers and carriers ready to transition to ZEVs.

Fig.8 **People of color within 1/2 mile of a select sample of distribution centers**



**The relative size of the data point represents the number of people of color living within 1/2 mile of select distribution centers in the US.*

Best practice for financing

By applying the lessons of project finance to depots of ZEVs, developers can facilitate adoption at scale. Carriers and EV managers who move first may have an advantage in locking in projects with investment grade corporate counterparties who care about brand impacts and may be willing to share more risk, pay a premium or offer longer term contracts.

Some critical early steps include:

- Disseminate data about vehicle, charging, battery performance, cost of purchase, resale and operating revenue;
- Standardize anything that can be standardized to reduce transaction costs and enable bundling and liquidity. For example, form contracts and standard project finance structures, standard project sizes and designs, underwriting, insurance, etc.; and
- Develop a bench of advisors such as financial analysts and lawyers who use tested models and metrics.

Systematization can empower shippers and carriers who are not national players or do not have the staff to devote to becoming experts to collaborate on ZEVs.

Other potential impacts

Residual value

Many (but not all) carriers resell their vehicles at a certain point, such as a set number of years or miles driven. This resale value can form a significant part of the financial benefit of the vehicle.

Fleets operating electric vehicles found that, in some cases, the residual value was due to the electric motors, parts of the control systems and especially batteries, being repurposed for other uses, including energy storage, water pumping, etc.

Unfortunately, the public track record of ZEVs is so short and sparse that not enough data exists to model resale value. This blind spot leaves a critical hole in the business proposition for adoption. Shippers can help reduce this uncertainty on their own and through partnerships. The ZED Zone model will provide an opportunity to explore and test reducing the uncertainty about residual value. A couple of options can be explored:

- **Buyback guarantee:** For shippers that have their own use for batteries, such as their facilities or buildings, they can include a buyback guarantee for the batteries at the end of the contract.
- **New business line:** Some shippers may be able to create a new B2B or B2C business reselling used batteries.
- **Partner to reduce uncertainty:** For shippers that don't want to or can't take the batteries themselves, they can work with partners to define residual value. For example, a green bank could finance the batteries and promise to buy them back after a set number of years or miles, or keep them on their books entirely and lease them out. State and local agencies could promise to buy the batteries for use as on-site storage to help meet local renewable energy or resiliency goals. At low numbers, state and local agencies could even promise to buy the entire vehicle for their own use.

While reducing residual value uncertainty may introduce additional partnership complexity, with associated transaction costs and counterparty risks, it may be necessary for some carriers. Fortunately, the need to reduce residual value risk should decrease over time as performance of vehicles is better understood, and the resale market becomes more robust.

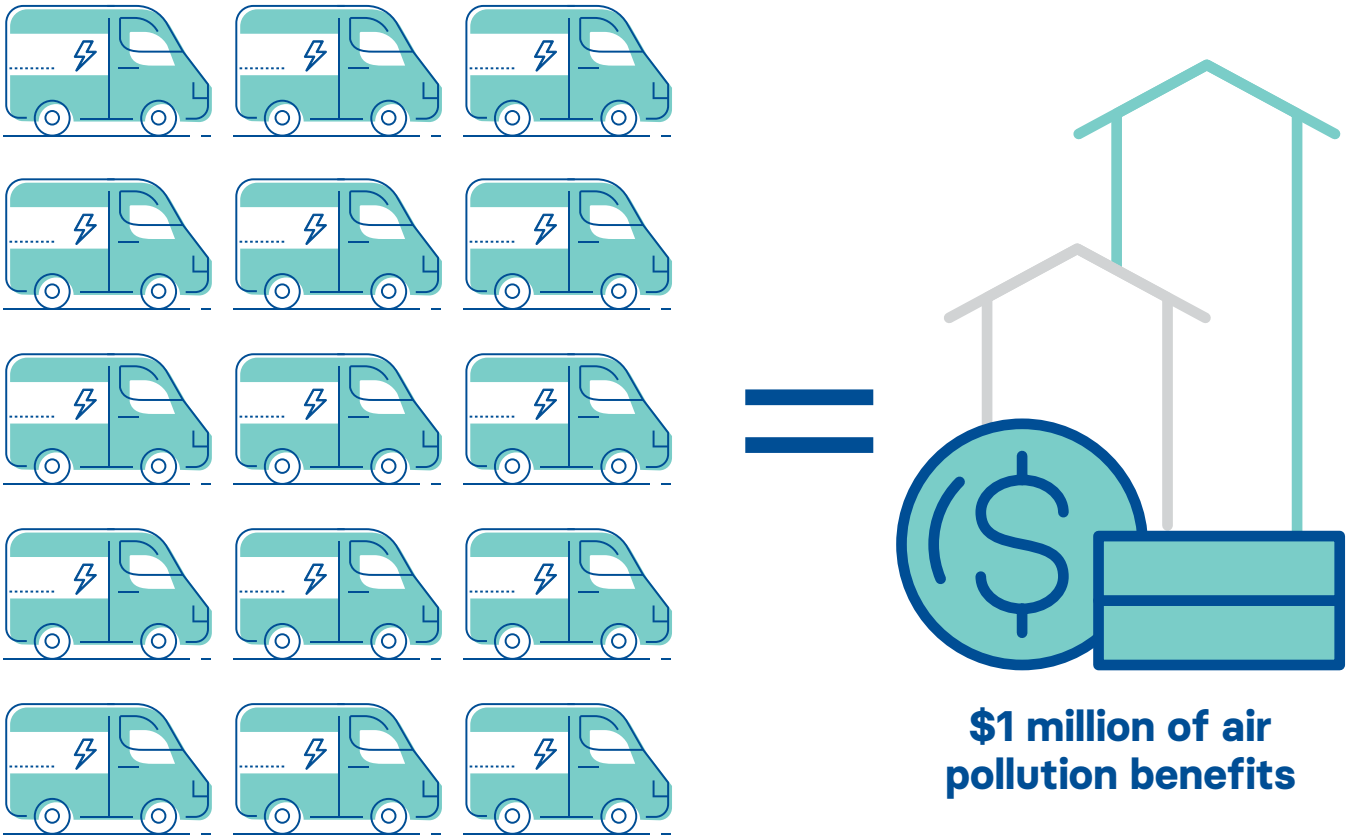
Enabling policies

Many shippers, not controlling their own fleets, have been less vocal and less influential advocates for ZEV policies. If shippers have a plausible way to influence zero-emissions shipping, they may become a more powerful voice in favor of, and collectively advocate for, enabling policies. For example, policies like the availability of charging infrastructure and access to dedicated curb space significantly influence the adoption curve of ZEVs.

Scenario: GHG and air pollution impact

Diesel powered delivery trucks emit, on average, between 4.35 and 7.47 grams of NOx per mile traveled, while electric vehicles have zero tailpipe emissions.[68] Over time, diesel vehicles become more dirty and inefficient, while electric vehicles improve their environmental performance as our electricity grids get cleaner. The pollution from last-mile trucks is exacerbated due to their unique operational profile. Many of these vehicles have significant idling times, during which they continue to pollute. This is inefficient, costs money and contributes to air pollution. Many depots and warehouses are also located in low income communities and communities of color. Since emissions are greatest when vehicles start, idle or accelerate, communities by depots may be exposed to health risks from delivery vehicles. EPA's BenMap Tool can calculate potential air pollutant reductions from vehicle electrification. Assuming a diesel Class 4-5 Truck with a Gross Vehicle Weight Rating between 14,001 – 19,500 lbs; one EV would eliminate 0.078 MT of air quality pollutants (NOx, VOC and PM 2.5), which has a dollar value of $68,103.[69, 70]

A shipper or group of shippers can catalyze $1 million of air pollution benefit by sponsoring 15 electric delivery vehicles.[71]



Conclusion

The impact that last-mile delivery has on the climate and human health will continue to grow. And yet, most shippers use third-party carriers rather than owning their own vehicles, making it difficult to manifest climate and equity commitments in their shipping supply chain.

A ZED Zone model can catalyze new resources from public and private finance, focus benefits on zero-emissions shipping on at-risk communities and inspire new roles to speed clean deployments. Many partners have a role to play.

Shippers

Solidify demand for clean shipping by making time-bound commitments to adopt and pay for 100% clean shipping. Leverage collective purchasing power by demanding action from financiers, carriers and EV managers to offer EV delivery options.

Private and public finance

Provide the capital needed to purchase EVs and make them available to carriers and EV managers. Work with project developers to build a pipeline of ZEV projects. Systematize transactions and share data to reduce deal costs and improve liquidity.

State and local government

Issue maps of at-risk neighborhoods that face a disproportionate health burden from air pollution where ZEVs should be prioritized. Create enabling policies such as access preferences for ZEVs and workforce development.

OEMs, enterprise fleet managers and third party logistics providers

Develop expertise and build new business lines as EV managers — the conduit between customers demanding 100% clean shipping and carriers.
With collaboration and creativity, last-mile delivery can achieve its promise of health and sustainability and drive us closer to a zero-emissions future.

With collaboration and creativity, last-mile delivery can achieve its promise of health and sustainability and drive us closer to a zero-emissions future.

Glossary of terms

At-risk communities:

Communities that face a disproportionate burden from air pollution related to health risk and potentially cumulative burden from other sources

Air quality:

The degree to which ambient air is assessed and measured with pollution indicators within a particular range, such as the amount of particulate matter, carbon monoxide or sulphur dioxide Carrier: On-the-road shipping companies who execute last-mile deliveries

EV manager:

Third party transportation and logistics service provider that owns electric vehicles

Last-mile delivery:

The last stage in the logistics process when goods move from a transportation hub to the final delivery destination, typically the home of an individual consumer

MHDV:

Medium- and Heavy-duty vehicles, typically fall in Classes 4 and up and are over 14,000 lbs

OEM:

Original Equipment Manufacturer, traditionally defined as a company whose goods are used as components in the products of another company

Power purchase agreement (PPA):

A long-term financial agreement in the electricity sector in which a third-party developer owns, operates and maintains the generation system, and a customer agrees to site the system on his property and purchases the electric output from the service provider for a predetermined period

Scope 1 emissions:

Emissions from sources that are owned or controlled by the company

Scope 2 emissions:

Indirect emissions from sources that are owned or controlled by the company

Scope 3 emissions:

Emissions from sources not owned or directly controlled but related to the company's activities

Shipper/Customer:

Companies shipping products to a consumer, whether pure-play e-commerce or omnichannel retail models, that contract all or some of their shipping services to third party carriers

ZED Zone:

Zero-Emissions Delivery Zone

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