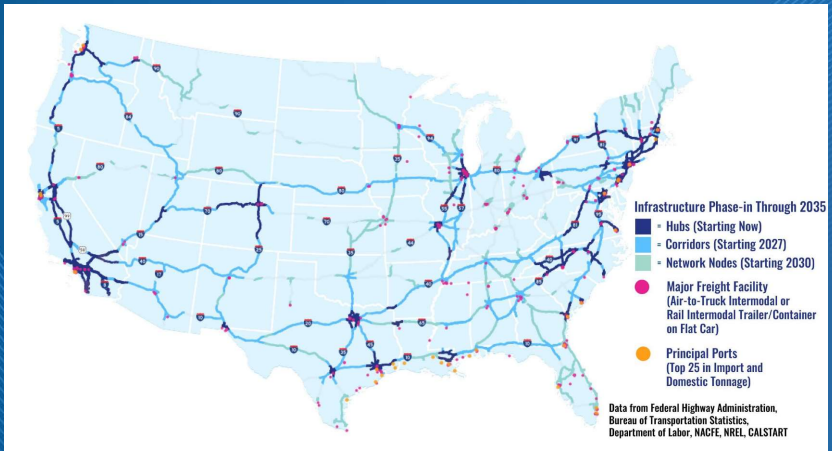
ACT Research Market Vitals
August 23, 2023

Regulations – What's Driving Truck Electrification



Bill Van Amburg
Strategic Advisor
ZE Commercial Vehicles

Agenda

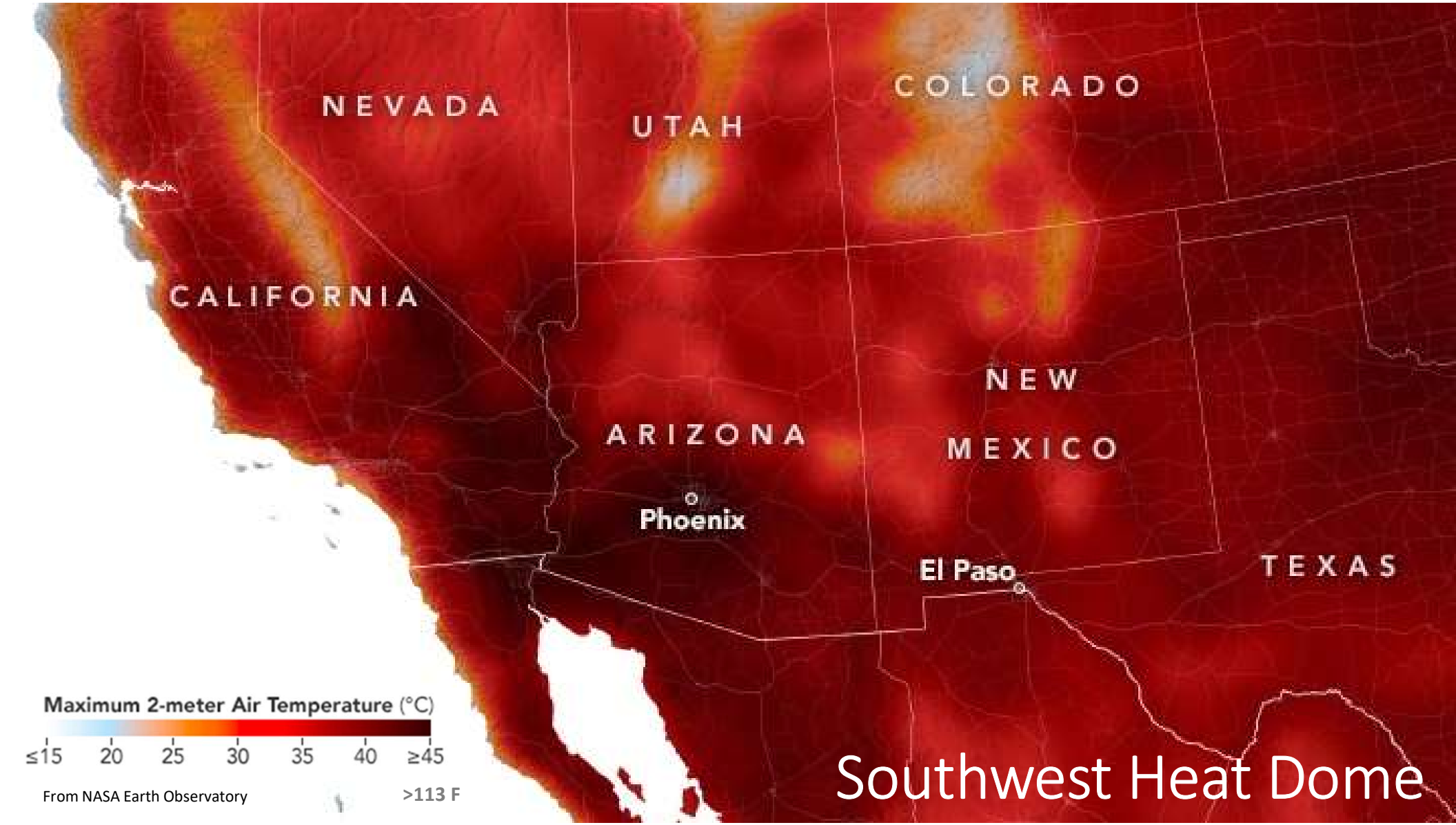
- The urgency for action
- Real solutions arriving
- Regulations aligning on zero
- Infrastructure pains, pathways
- Business sees benefits
- Prepare now to act

Maui Wildfire

From Matthew Thauer/The Maui News and AP

Canadian Fires

From The Narwhal



Southwest Heat Dome

Driven by Climate Change

Studies show climate change caused the intensity of the heat waves

These heat waves no longer rare and are more frequent – NOW:

Once every 15 years in SW US/Mexico	Once every 10 years Europe	Once every 5 in China

However, without climate change would have been extremely rare – BEFORE:

1 in 250-year event in China	Virtually impossible in US and Europe without climate change

Extreme heat in North America, Europe and China in July 2023 made much more likely by climate change

Authors

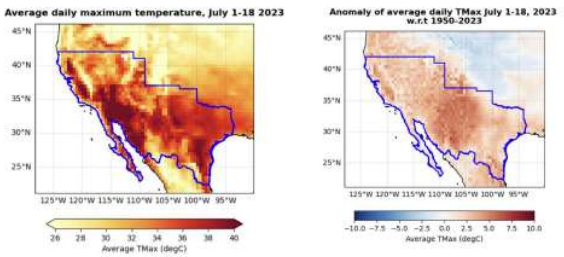
1. Mariam Zachariah, *Grantham Institute, Imperial College London, UK*
2. Sjoukje Philip, *Royal Netherlands Meteorological Institute (KNMI), De Bilt, The Netherlands*
3. Izidine Pinto, *Royal Netherlands Meteorological Institute (KNMI), De Bilt, The Netherlands*
4. Maja Vahlberg, *Red Cross Red Crescent Climate Centre, The Hague, the Netherlands*
5. Roop Singh, *Red Cross Red Crescent Climate Centre, The Hague, the Netherlands*
6. Friederike E L Otto, *Grantham Institute, Imperial College London, UK*

Review authors

1. Clair Barnes, *Grantham Institute, Imperial College London, UK*
2. Julie Arrighi, *Red Cross Red Crescent Climate Centre, The Hague, the Netherlands*

Main findings

Region 1: USA/Mexico



- In all the regions a heatwave of the same likelihood as the one observed today would have been significantly cooler in a world without climate change. Similar to previous studies we found that the heatwaves defined above are 2.5°C warmer in Southern Europe, 2°C warmer in North

DOI: https://doi.org/10.25561/105549

World Weather Attribution study:
https://spiral.imperial.ac.uk/bitstream/10044/1/105549/8/Scientific%20Report%20-%20Northern%20Hemisphere%20Heat.pdf

Massive Flooding in Pakistan

From Reuters and AP

From Mark Schiefelbein/Associated Press

Historic Drought in China

From Getty Images

From Planet Labs

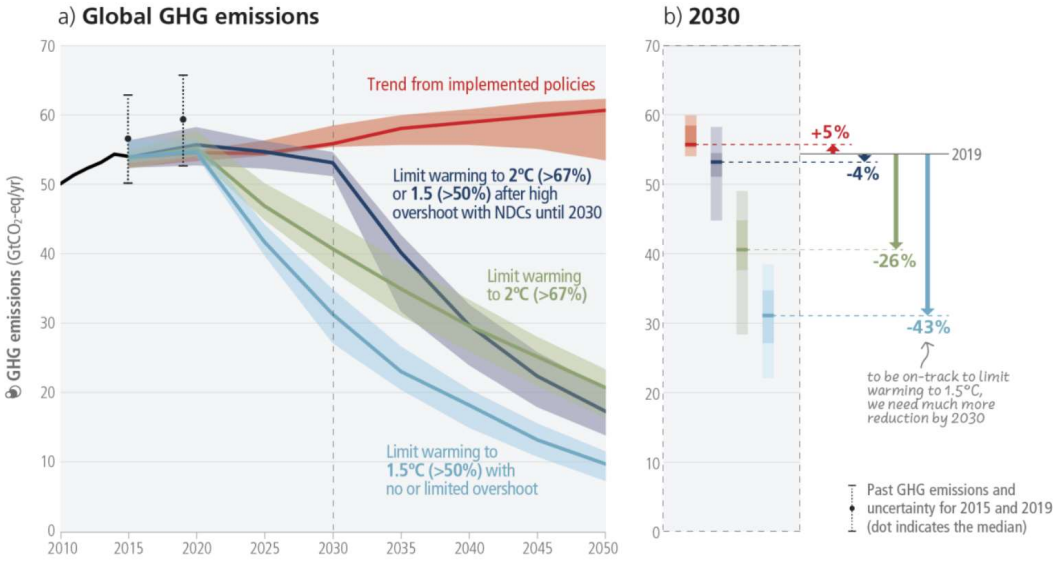
European Drought

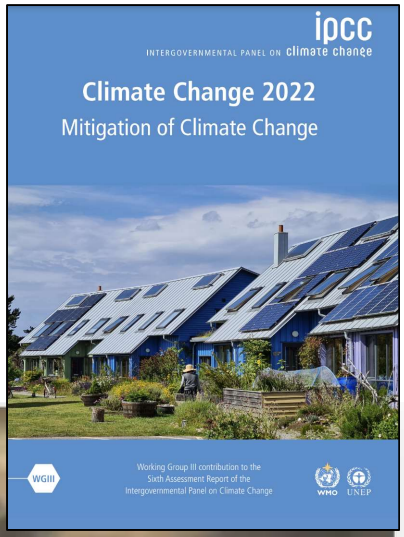
Megadrought in American SW

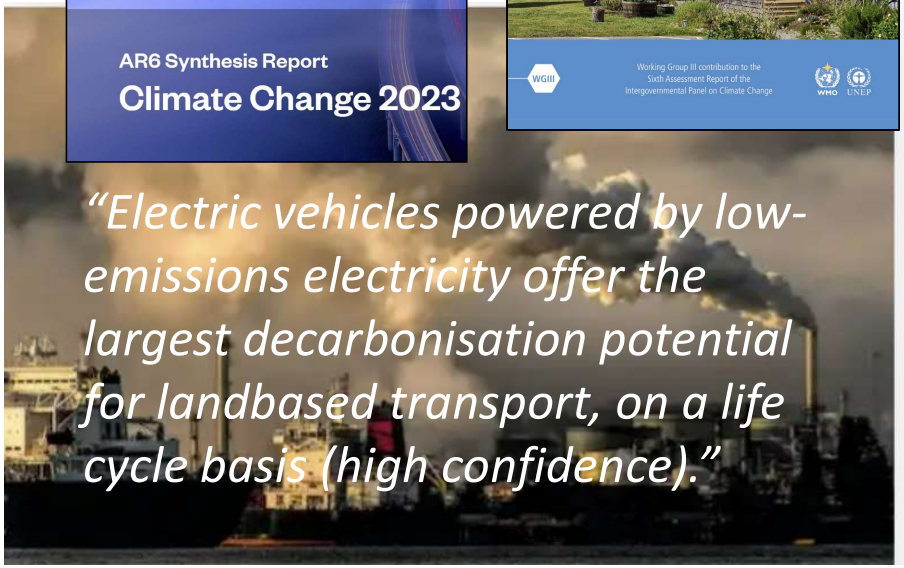
Urgent Action Needed Within Five Years

Human activities, principally through emissions of greenhouse gases, have unequivocally caused global warming.

Projected global GHG emissions from NDCs announced prior to COP26 would make it *likely* that warming will exceed 1.5°C and also make it harder after 2030 to limit warming to below 2°C



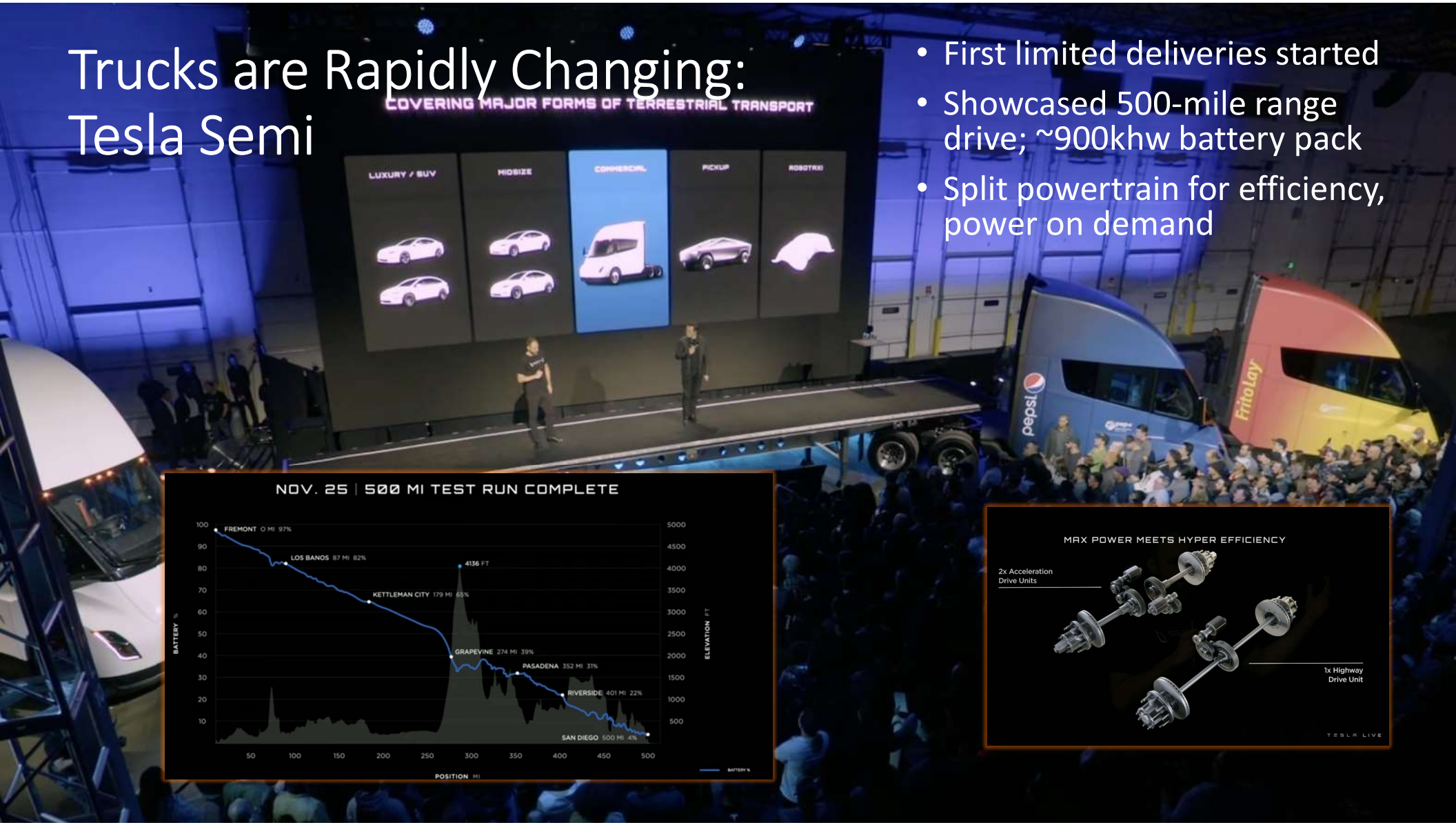




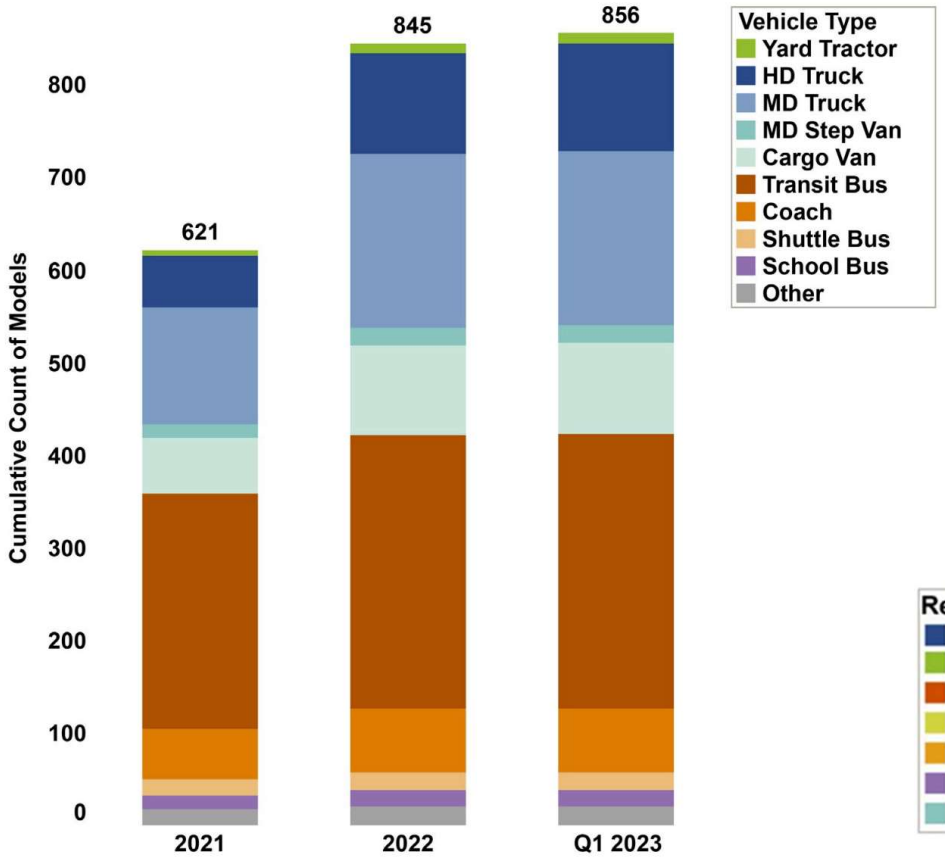
From: IPCC Sixth Assessment Report, https://www.ipcc.ch/report/ar6/wg3/; AR6 Synthesis Report page 72

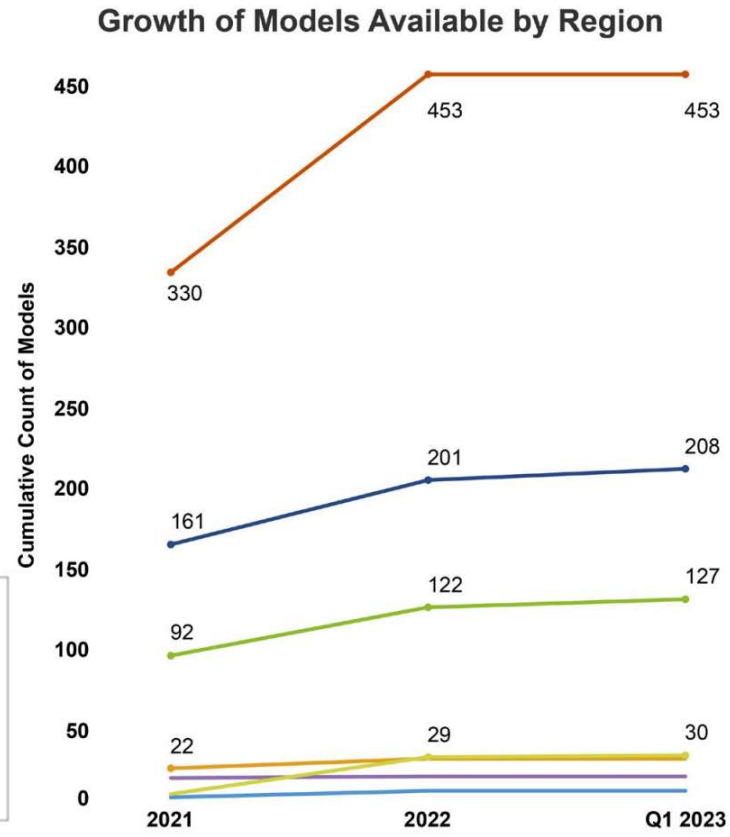
Trucks are Rapidly Changing: Tesla Semi

- First limited deliveries started
- Showcased 500-mile range drive; ~900khw battery pack
- Split powertrain for efficiency, power on demand



Global ZECV Model Availability and Expansion





https://globaldrivetozero.org/tools/zeti-data-explorer/

https://globaldrivetozero.org/site/wp-content/uploads/2023/06/Final_ZETI-Report-June-2023_Final.pdf

Brightdrop ZEVO 600


Ford E-Transit

Rivian Electric Van

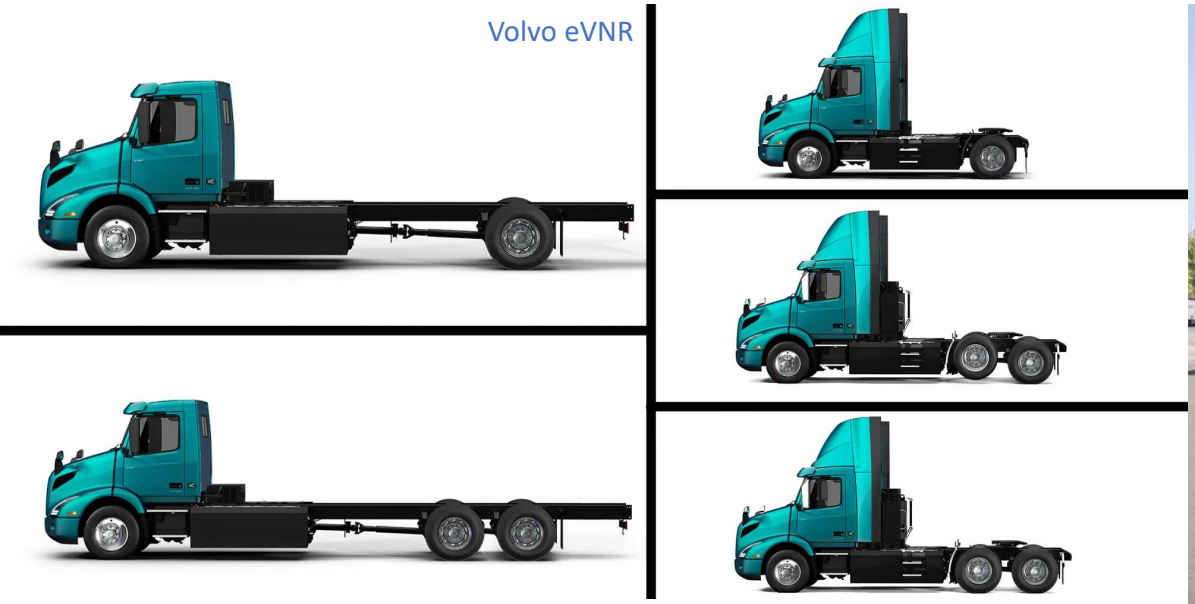
Kenworth K270E & Peterbilt 220EV

Freightliner eM2

Mack MD Electric

Navistar eMV

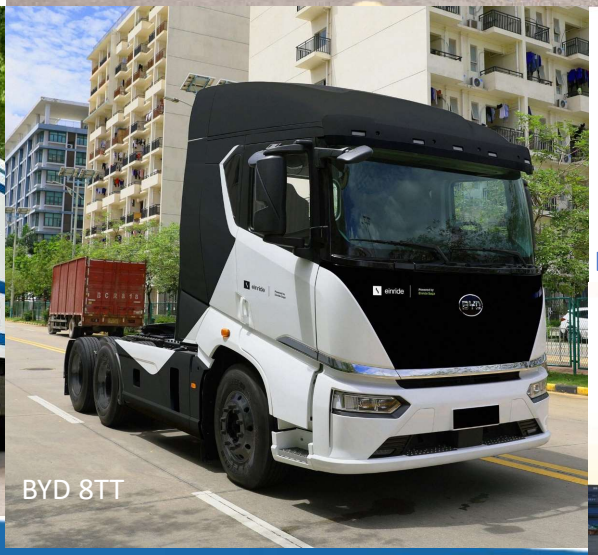
Volvo eVNR



Freightliner eCascadia

Peterbilt e579

Kenworth e T680

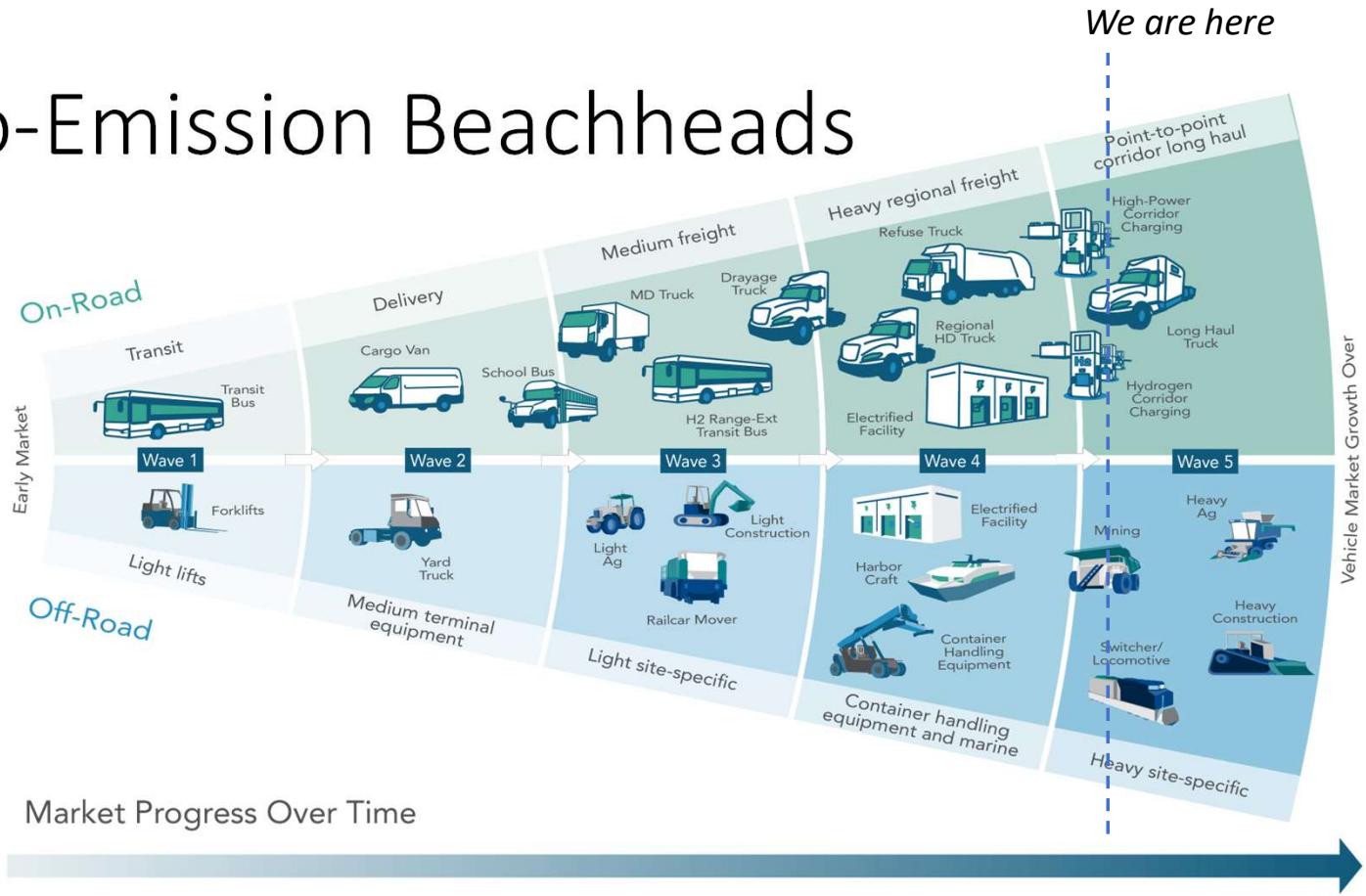


BYD 8TT

Lion 8

Nikola Tre BEV

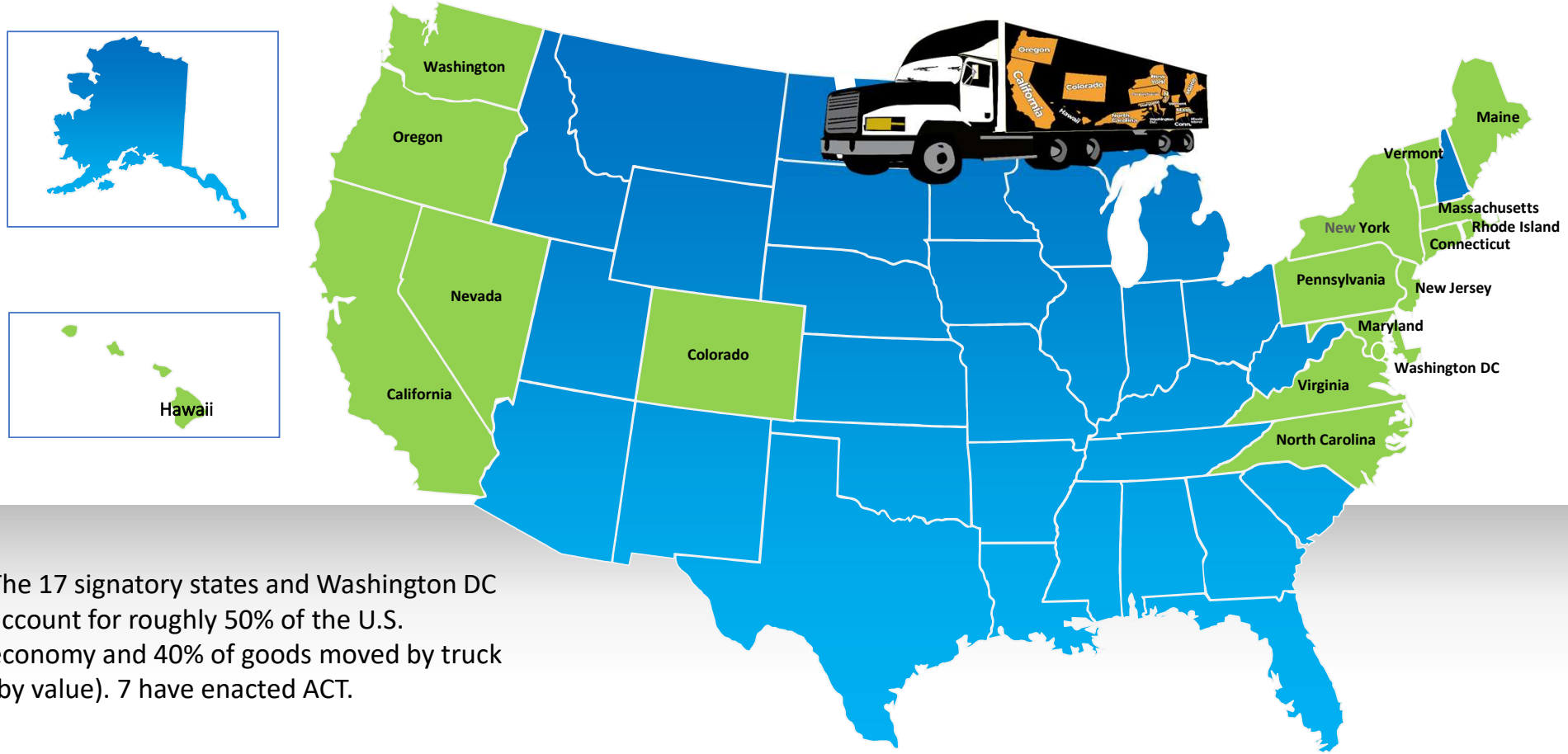
Zero-Emission Beachheads



Source: The Beachhead Strategy
https://calstart.org/beachhead-model-background/

16

17 States Sign MHD ZEV MOU



The 17 signatory states and Washington DC account for roughly 50% of the U.S. economy and 40% of goods moved by truck (by value). 7 have enacted ACT.

Sources:
U.S Bureau of Economic Analysis https://apps.bea.gov/itable/iTable.cfm?ReqID=70&step=1#reqid=70&step=1&isuri=1;
FHWA Freight Analysis Framework https://faf.ornl.gov/faf4/Extraction1.aspx

NESCAUM

Advanced Clean Fleets (ACF): ZEV PURCHASE Requirements

- Newest CA regulation
- Applies to fleets in three categories:
  - Public fleets
  - Drayage Fleets
  - High-Priority Fleets (federal and private >50 vehicles)
- **Zero Emission-only sales by 2036**

Table 6: High Priority and Federal Fleet Zero-Emission Vehicle Phase-In Schedule

Group	Percentage of Fleet that Must be ZEV	10%	25%	50%	75%	100%
1	Box trucks, vans, two-axle buses, yard trucks, light-duty delivery vehicles	2025	2028	2031	2033	2035
2	Work trucks, day cab tractors, three-axle buses	2027	2030	2033	2036	2039
3	Sleeper cab tractors and specialty vehicles	2030	2033	2036	2039	2042

https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/acf22/isor2.pdf

Projected ACF Phase In

Figure 5: Drayage Fleet Over Time

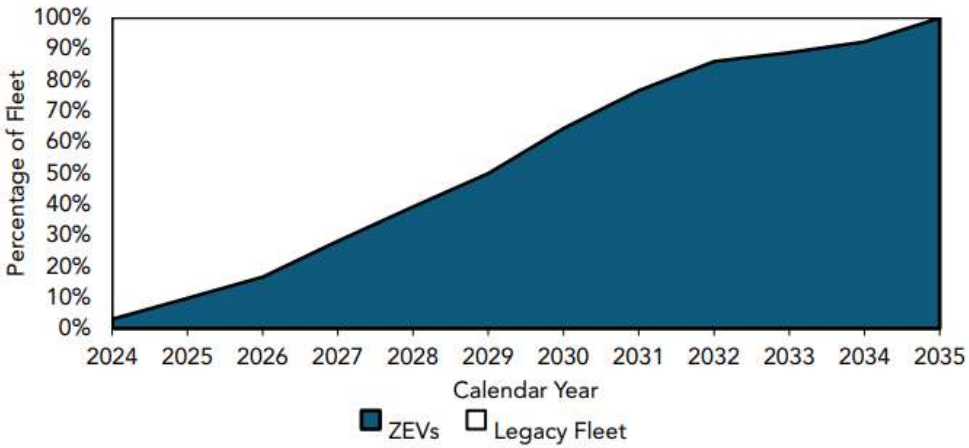
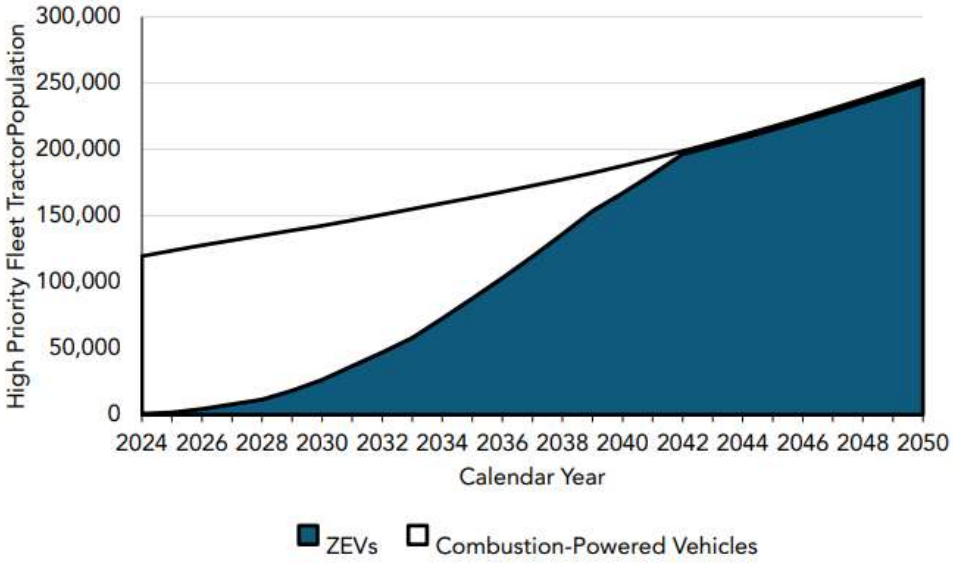


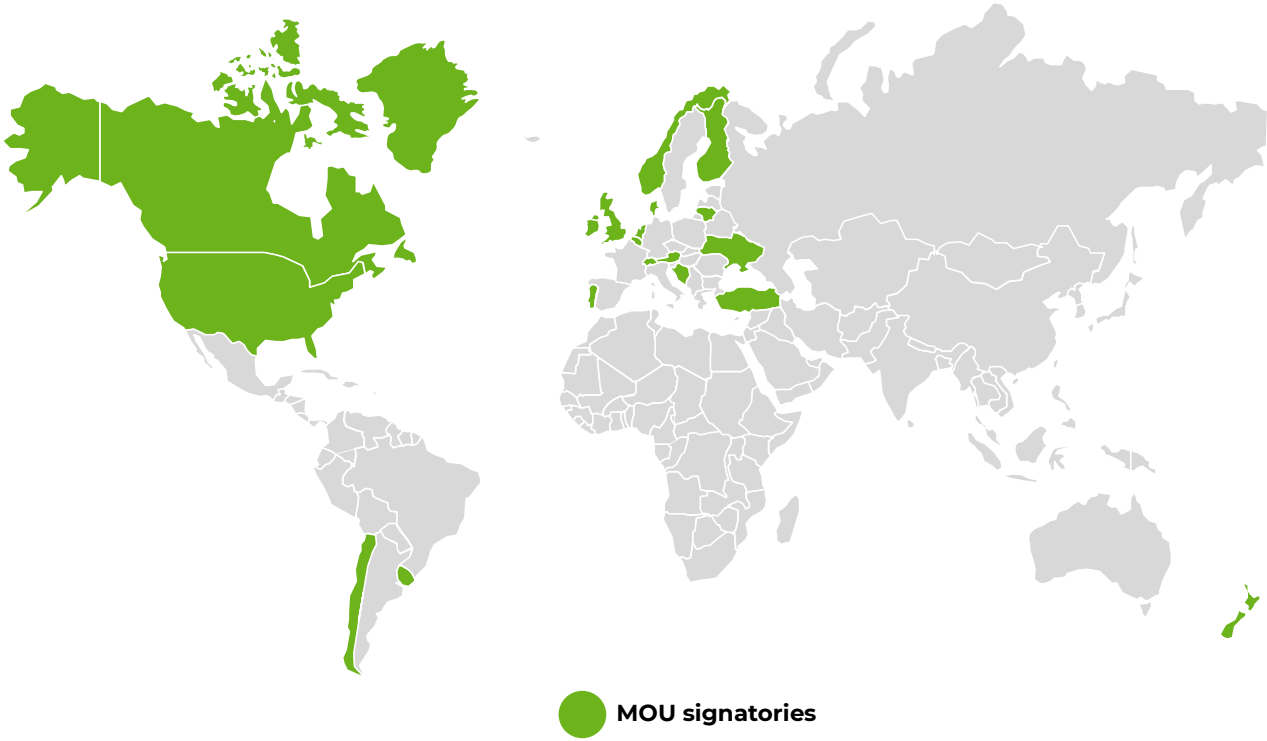
Figure 9: Tractor Population Over Time for High Priority and Federal Fleets



https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/acf22/isor2.pdf

27 Leading Countries Sign Global MOU

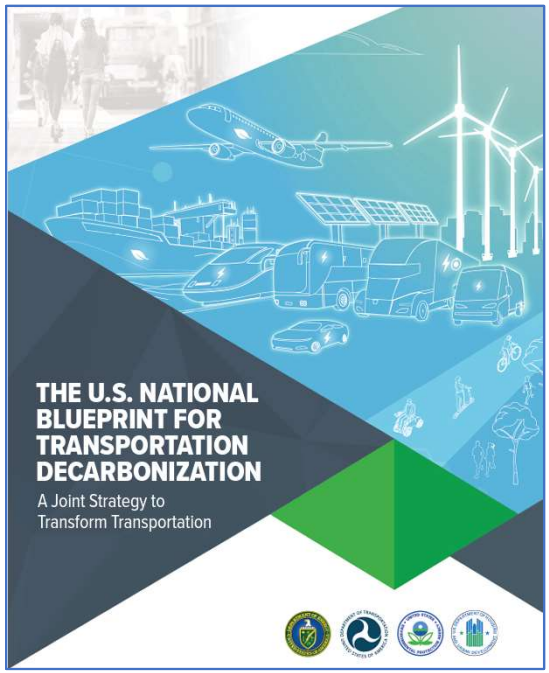
100% Zero-Emission Trucks and Buses by 2040



MOU signatories

Aligns with Paris Agreement goals

A Clear Direction for the U.S.



Transportation Mode	Share of Current Transportation Emissions	Federal GHG Emissions Reduction Goals
Light-Duty Vehicles	49%	• Achieve 50% of new vehicle sales being zero-emission by 2030 supporting a pathway for full adoption, and ensure that new internal combustion engine vehicles are as efficient as possible • Deploy 500,000 EV chargers by 2030 REF • Ensure 100% federal fleet procurement be zero-emission by 2027 REF
Medium and Heavy-Duty Trucks and Buses	21%	• Aim to have 30% of new vehicle sales be zero-emission by 2030 and 100% by 2040 REF • Ensure 100% federal fleet procurement is zero-emission by 2035 REF
Off-road	10%	• Work to establish specific targets • Focus resources to develop technology pathways and set efficiency and zero-emissions vehicle and equipment targets
Rail	2%	• Work to establish specific targets • Focus resources to develop technology pathways and set efficiency and zero-emissions vehicle targets • Encourage greater use for passenger and freight travel to reduce emissions from road vehicles
Maritime	3%	• Continue to support the Zero-Emission Shipping Mission (ZESM) goals to ensure that 5% of the global deep-sea fleet are capable of using zero-emission fuels by 2030, at least 200 of these ships primarily use these fuels across the main deep sea shipping route, and 10 large trade ports covering at least three continents can supply zero-emission fuels by 2030 REF • Support the U.S. domestic maritime sector by performing more RD&D into sustainable fuels and technologies and incentivize U.S. commercial vessel operators to move towards lower GHG emissions • Work with countries in the International Maritime Organization to adopt a goal of achieving zero emissions from international shipping by 2050 REF
Aviation	11%	• Reduce aviation emissions by 20% by 2030 when compared to a business-as-usual scenario • Achieve net-zero GHG emissions from the U.S. aviation sector by 2050 • Catalyze the production of at least three billion gallons of SAF per year by 2030 and ~35 billion gallons by 2050, enough to supply the entire sector REF

At COP27 on November 16, 2022, the United States joined the Global Memorandum of Understanding on Zero-Emission Medium- and Heavy-Duty Vehicles REF. First introduced at COP26, the Global MOU puts countries on a path to 100% new zero-emission MHDV sales by 2040 at the latest, with an interim goal of at least 30% new sales by 2030 REF.

2. **Implement policy and regulation** to reduce new vehicle GHG and criteria emissions and set ambitious targets for transitioning to zero-emissions vehicles on a timeline consistent with achieving economy-wide 2030 and 2050 emissions reduction goals. This effort should account for the wide range of MHDV vehicles and applications. One example of such regulatory action is EPA's Clean Trucks Plan, which will reduce the emissions of GHGs and other harmful pollutants through a series of rulemakings REF

US Proposing Truck CO2 Standards Based on Initial ZEV Penetrations

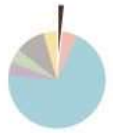
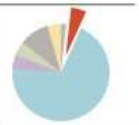
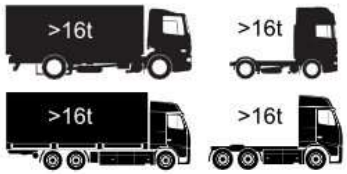
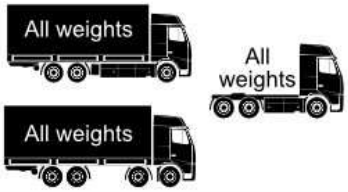
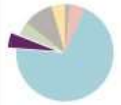
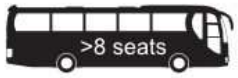
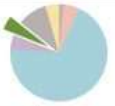
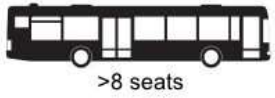
Table ES-4 Aggregated Projected ZEV Adoption Rates in Technology Packages for the Proposed Standards, Aggregated Projected ZEV Adoption Rates in Technology Packages for the Alternative Standards, and California ACT ZEV Sales Requirements

	MY 2027	MY 2028	MY 2029	MY 2030	MY 2031	MY 2032 and later
Proposed						
Vocational	20%	25%	30%	35%	40%	50%
Short-Haul Tractors	10%	12%	15%	20%	30%	35%
Long-Haul Tractors	0%	0%	0%	10%	20%	25%
Alternative						
Vocational	14%	20%	25%	30%	35%	40%
Short Haul Tractors	5%	8%	10%	15%	20%	25%
Long Haul Tractors	0%	0%	0%	10%	15%	20%
CARB ACT						
Vocational	20%	30%	40%	50%	55%	60%
Tractors	15%	20%	25%	30%	35%	40%

US EPA: https://www.epa.gov/system/files/documents/2023-04/hd-ghg-veh-phase-3-nprm-2023-04.pdf

Europe Poised for World Leading CO2 Standards

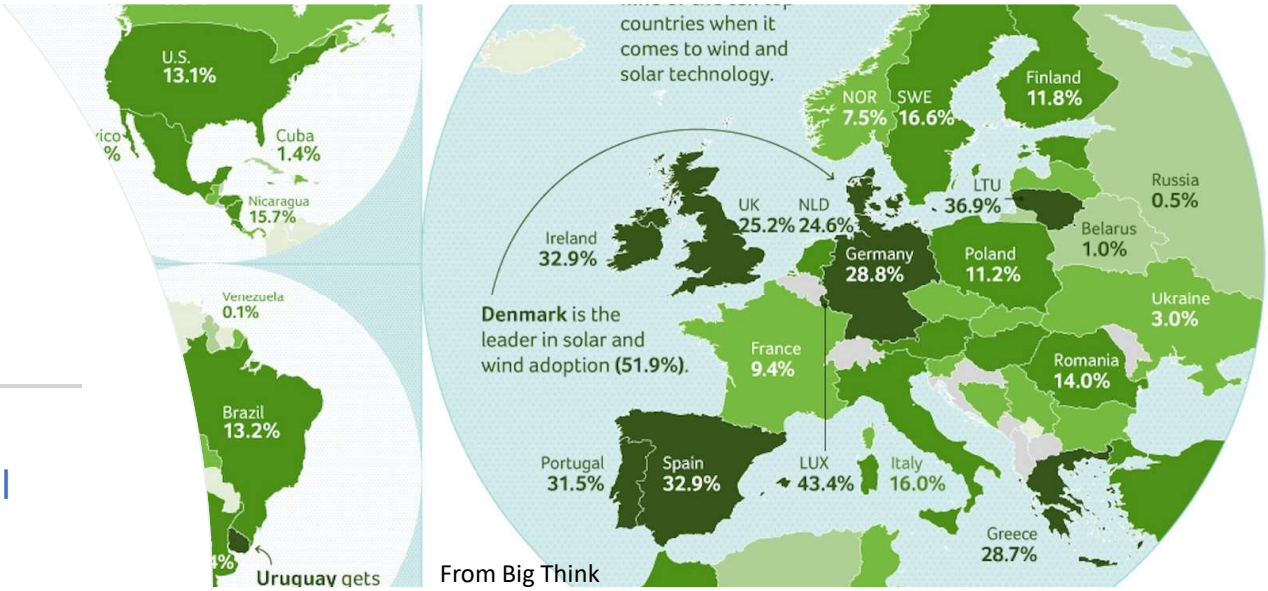
- Carbon reduction numbers will require meaningful zero emission truck and bus sales to comply
- 100% of buses ZE by 2030
- And final rule may be strengthened: Studies show >60% CO2 reductions by 2030 needed to achieve climate neutrality by 2050

Reduction targets relative to baseline	2025	2030	2035	2040	Annual emissions share
	0%	43%	64%	90%	
	0%	43%	64%	90%	
4x2 and 6x2 trucks 	15%	43%	64%	90%	
6x4 and 8x4 trucks 	0%	43%	64%	90%	
	0%	43%	64%	90%	
	0%	100%	100%	100%	

From ICCT: https://theicct.org/eu-co2-hdv-standards-explained-feb23/

World on pace for shift to renewable electricity production

- US set a record in April 2022 – 20% of all electricity from wind and solar alone – California was 100%!
- US 40% zero carbon electricity in 2022
- Increasing every year and is ahead of climate change targets
- Solar and wind now cheapest source of new electricity generation (International Energy Agency)



From Big Think

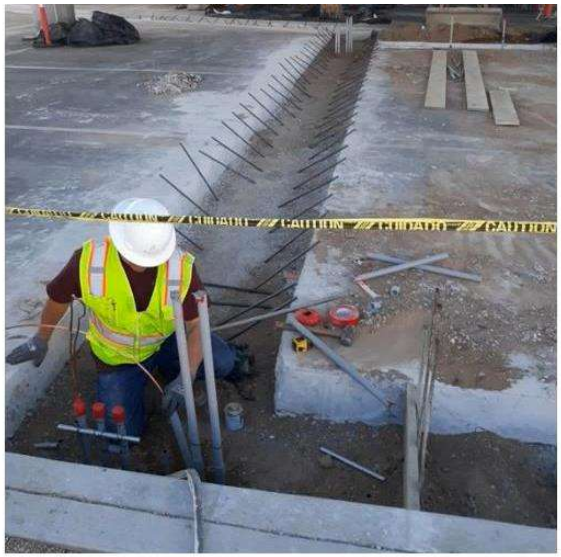

From Electrek

Growing Pains – But Scalability Emerging

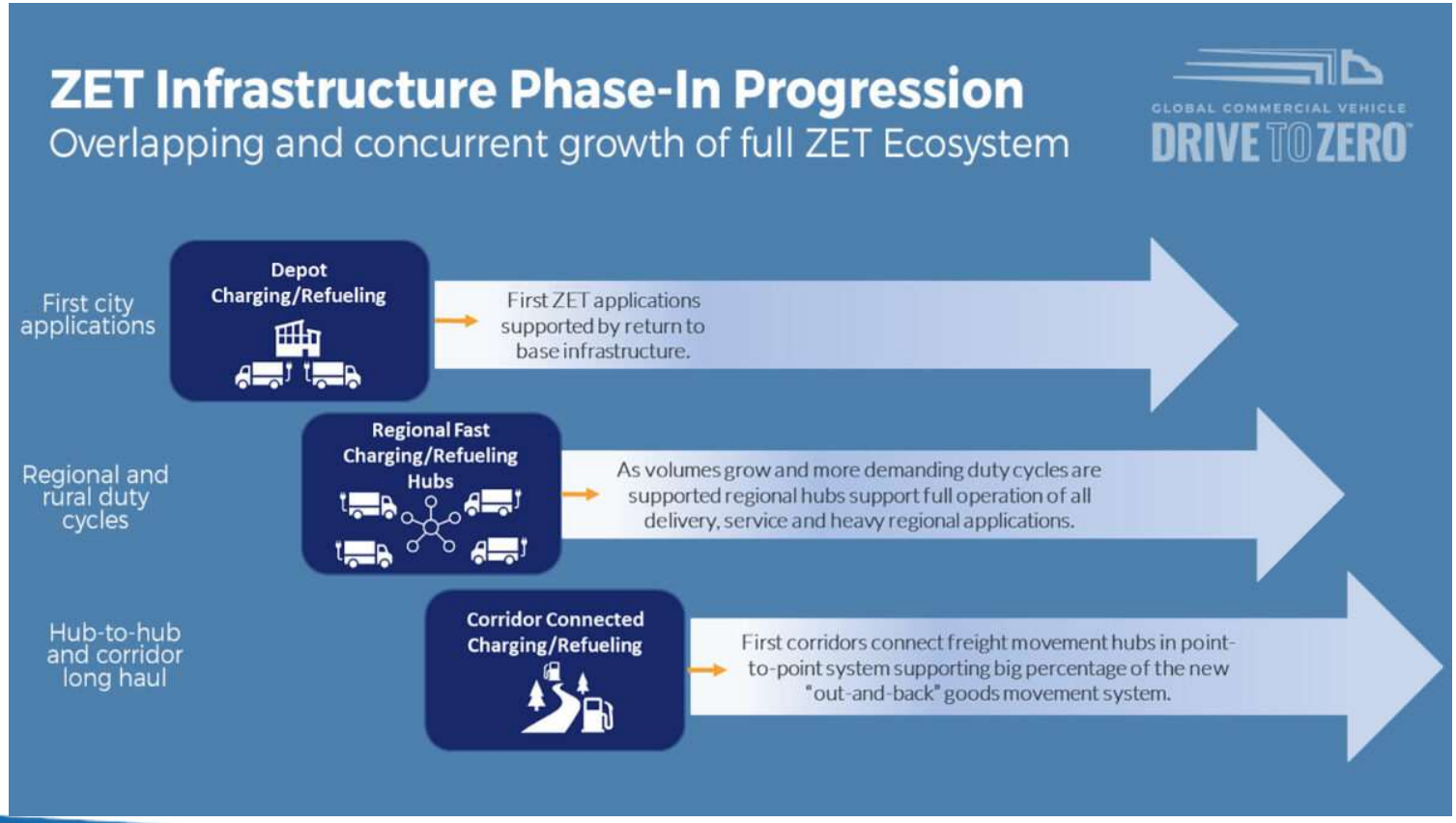
Utilities and Infrastructure Providers Working on Interconnect Timing, Distribution Grid Upgrades

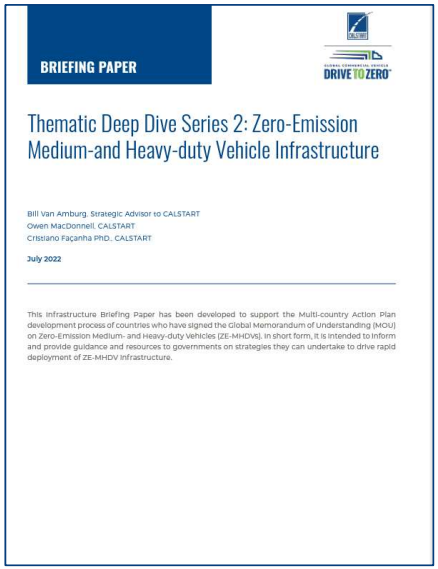
- Partner with the utility and inform them of your short, medium and long term electrification plans
- Utility can plan distribution upgrades in parallel with EV fleet expansion
- Where possible, install a dedicated service feed for the EV equipment allowing for more attractive TE rates and increased resiliency
- Size equipment based on immediate and anticipated needs
- Perform minor and major upgrades concurrently

SOUTHERN CALIFORNIA EDISON



Context for Infrastructure: NOT Everywhere, All-At-Once




BRIEFING PAPER

Thematic Deep Dive Series 2: Zero-Emission Medium-and Heavy-duty Vehicle Infrastructure

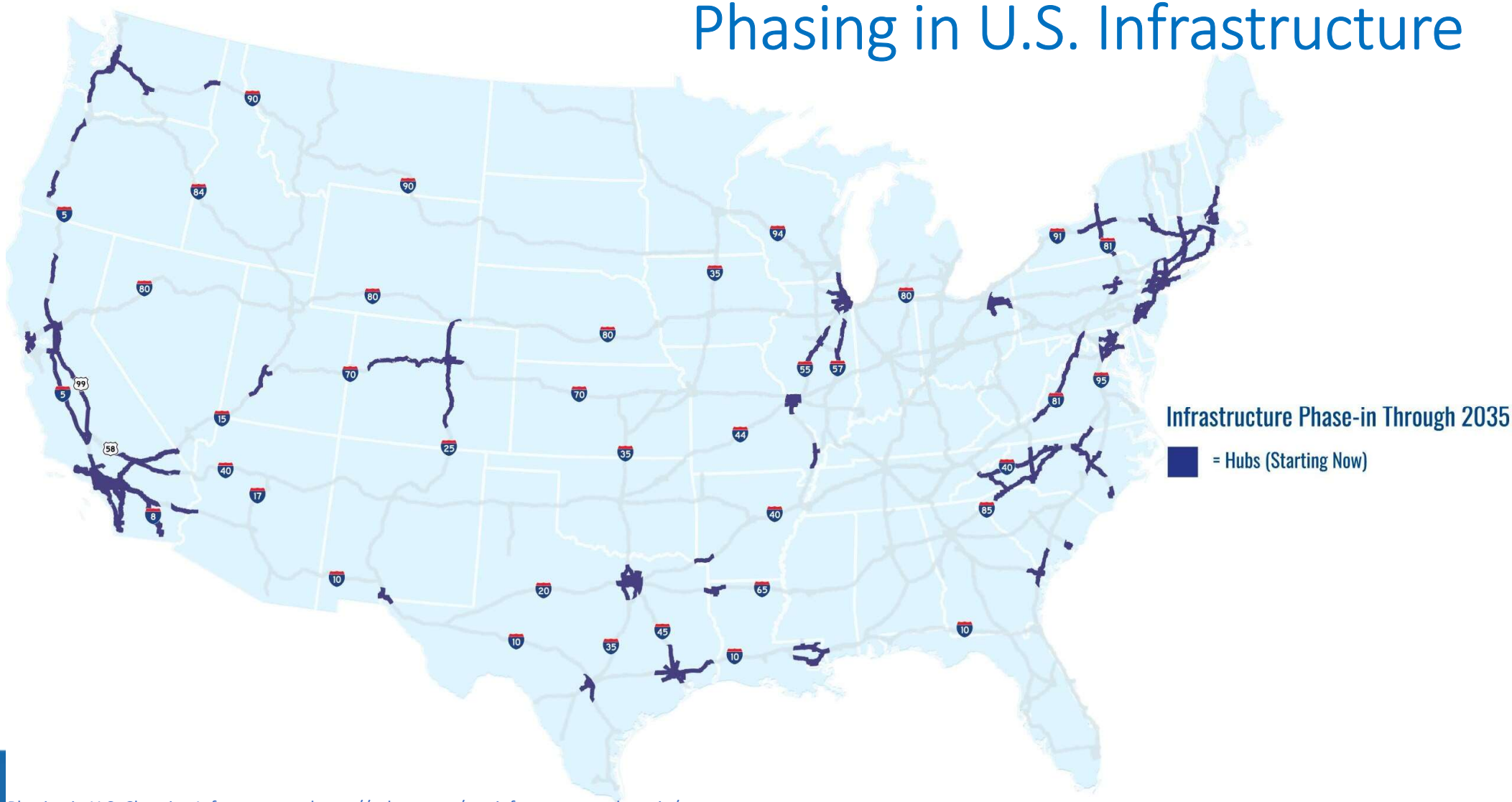
Bill Van Amburg, Strategic Advisor to CALSTART
Owen MacDonnell, CALSTART
Cristiano Façanha PhD., CALSTART

July 2022

This Infrastructure Briefing Paper has been developed to support the Multi-country Action Plan development process of countries who have signed the Global Memorandum of Understanding (MOU) on Zero-Emission Medium- and Heavy-duty Vehicles (ZE-MHDVs). In short form, it is intended to inform and provide guidance and resources to governments on strategies they can undertake to drive rapid deployment of ZE-MHDV infrastructure.

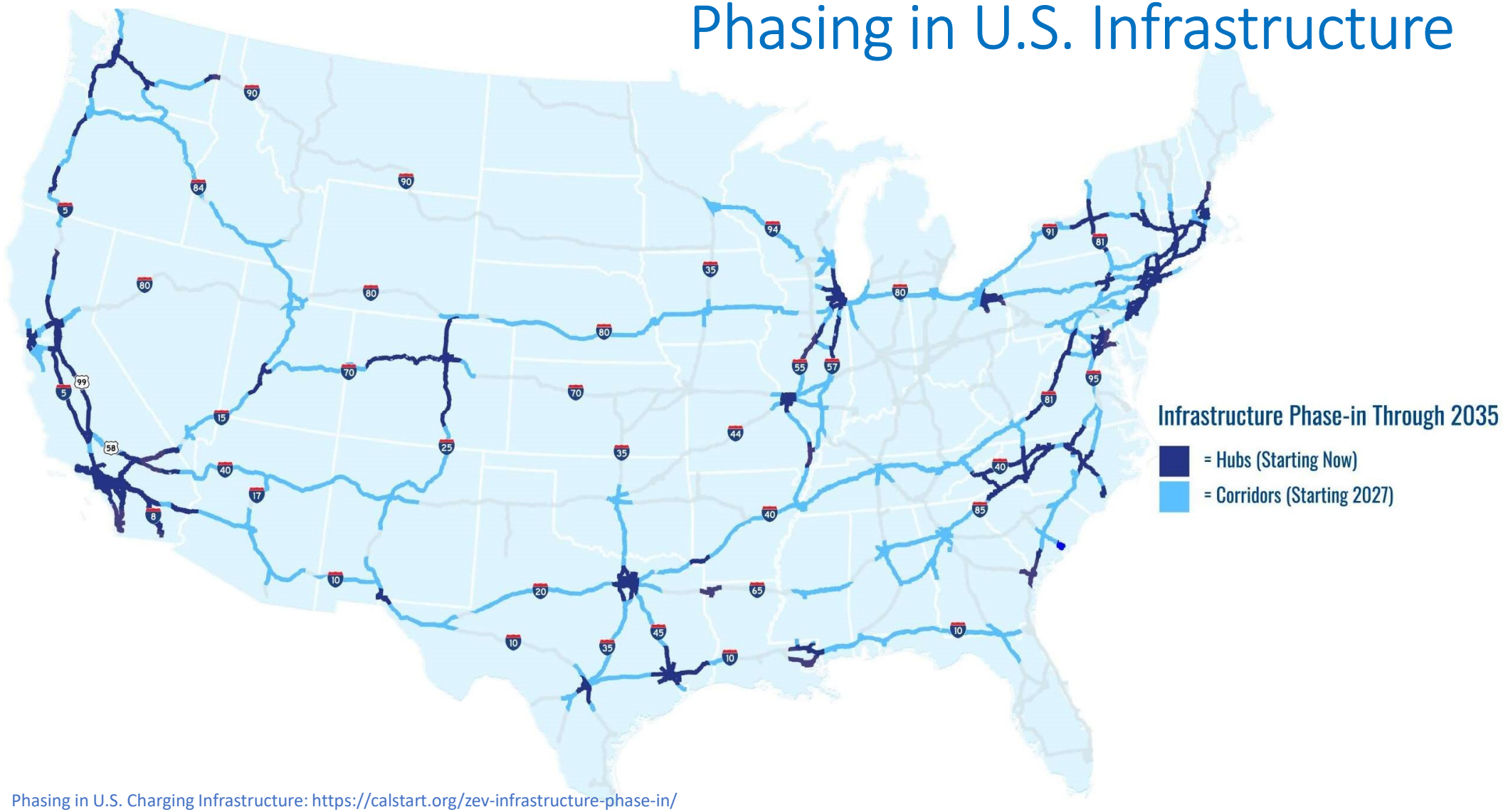
https://globaldrivetozero.org/publication/tdd2_infrastructure/

Phasing in U.S. Infrastructure



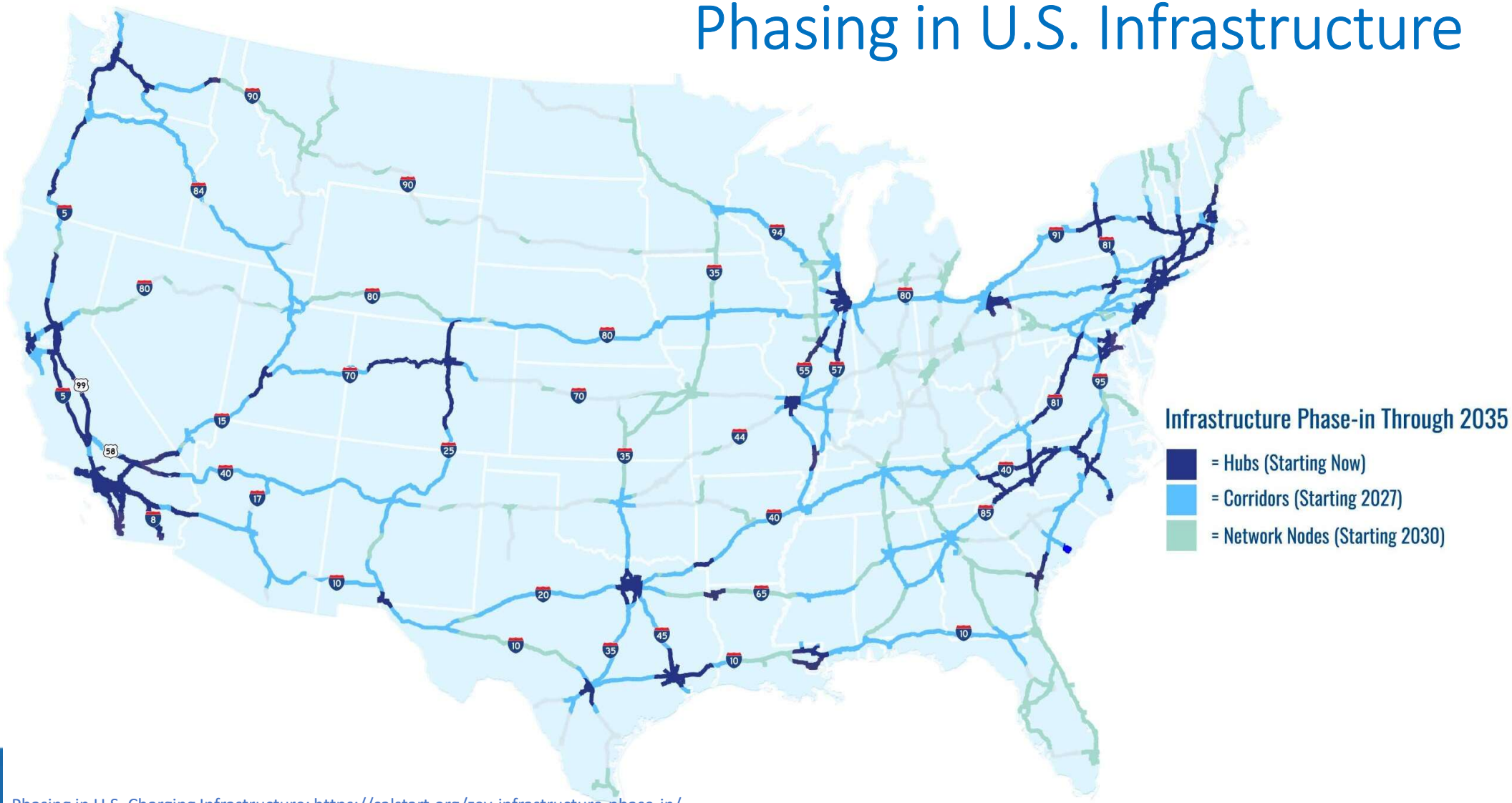
Phasing in U.S. Charging Infrastructure: https://calstart.org/zev-infrastructure-phase-in/

Phasing in U.S. Infrastructure



Phasing in U.S. Charging Infrastructure: https://calstart.org/zev-infrastructure-phase-in/

Phasing in U.S. Infrastructure



Phasing in U.S. Charging Infrastructure: https://calstart.org/zev-infrastructure-phase-in/

US 2021 Bipartisan Infrastructure Law & 2022 Inflation Reduction Act

Funds

Infrastructure Investment and Jobs Act (IIJA) invests $550 Billion over 5 years – roads, bridges, mass transit, corridors

Inflation Reduction Act (IRA) invests $369 Billion over 10+ years in vehicle purchase tax credits, infrastructure installation tax credits, energy and manufacturing investments

EVs

$2.5 B (300+M/yr) for charging and fueling infrastructure grants

Alt. Fuel Corridor program included

MHD infrastructure included

Up to $40k tax credit per ZE truck;

30% tax credit on ZE infrastructure

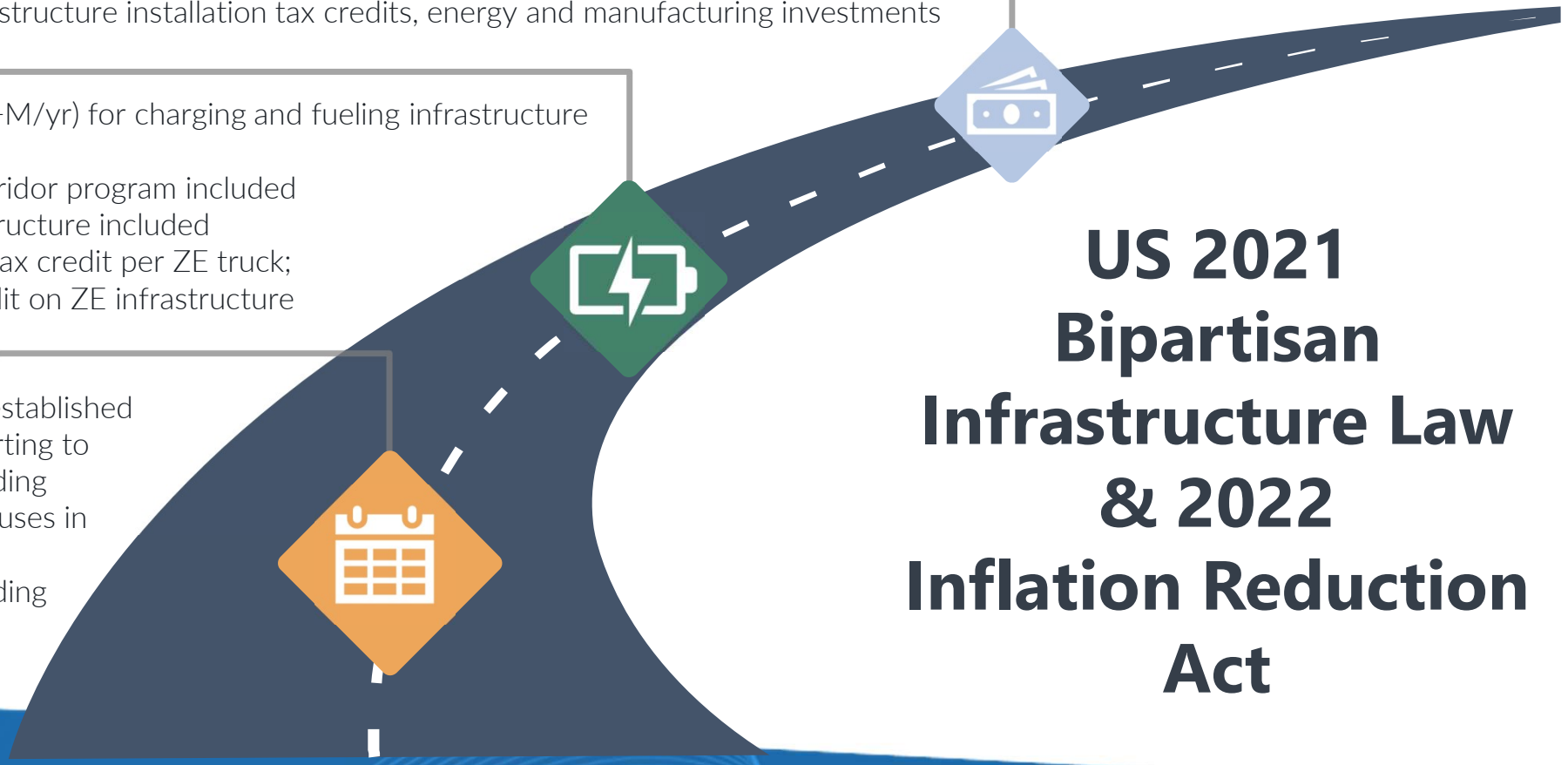
Timing

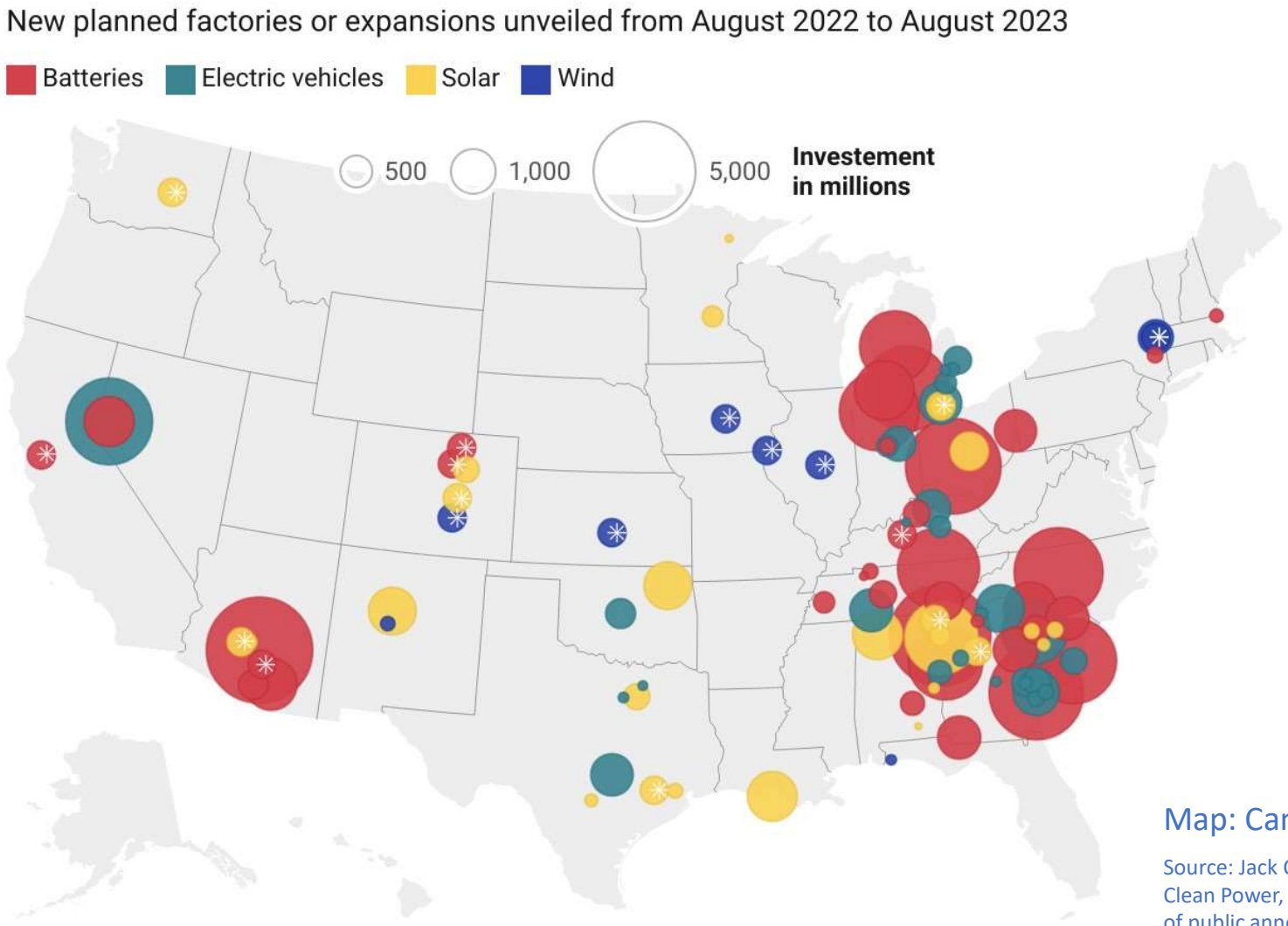
Framework established

Agencies starting to program funding

EV schools buses in first wave

Corridor funding authorized





Map: Canary Media

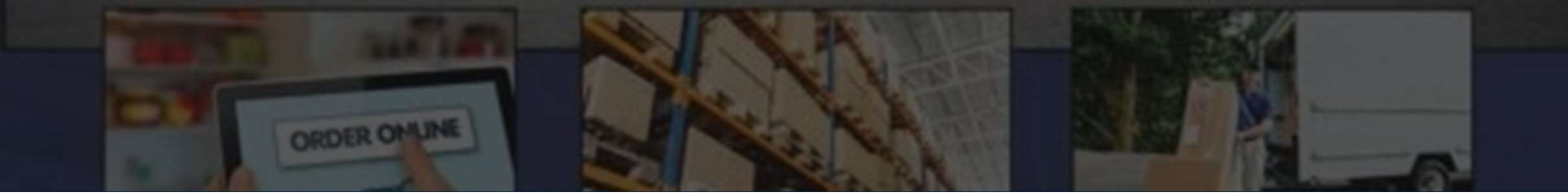
Source: Jack Conness, American Clean Power, Canary Media analysis of public announcements

https://www.canarymedia.com/articles/clean-energy-manufacturing/the-us-climate-law-is-fueling-a-factory-frenzy-heres-the-latest-tally

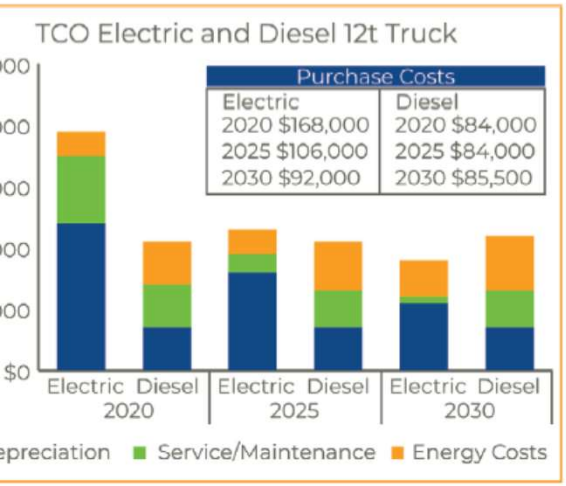
Trucking is changing:

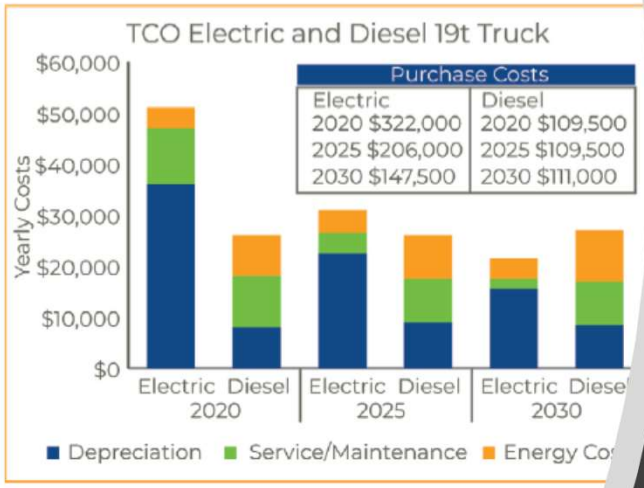
Hub-to-hub, drop-and-hook, relay and pony express. Shorter routes, higher utilization.

- **The average dry van truckload length of haul has dropped from about 800 miles 20 years ago to about 500 today.**
  American Transportation Research Institute
- **Data point: in March 2020, the industry ordered 3,900 Class 8 tractors. The vast majority — 3,300 — were day cabs.**
  ACT Research
- **Commercial truck trips of 100 miles or less grew by 7 percent 2011 to 2018; now 26% of all truck trips. Routes of fewer than 500 miles now 63% percent of all truck trips.**
  *American Transportation Research Institute (**ATRI**)*

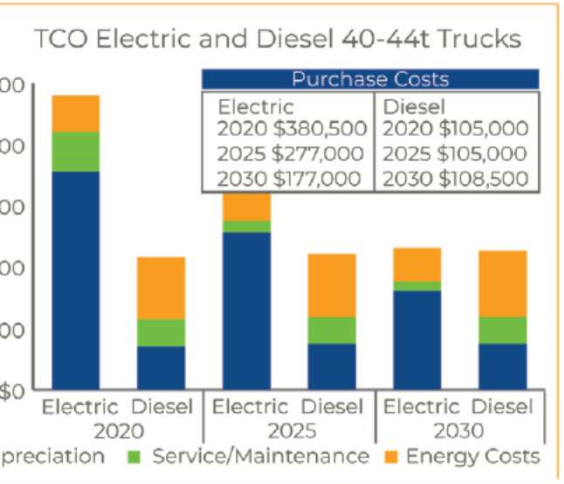


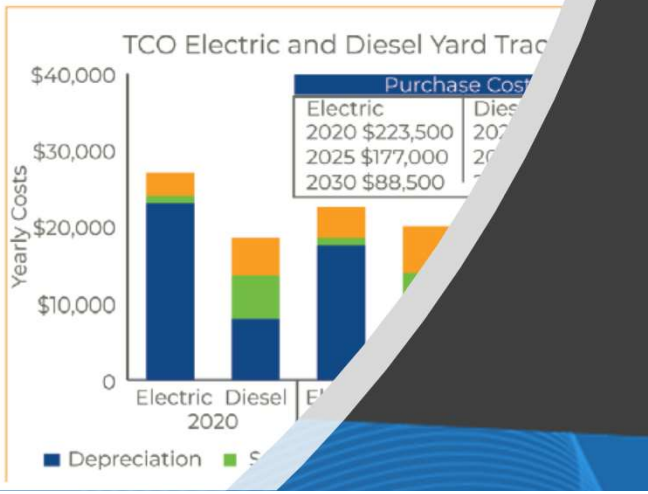
2-5. TCO for cargo vans (12T) and medium-duty trucks (19T)





2-6. TCO for heavy-trucks (40-44T) and yard tractors





Zero-emission trucks will achieve cost parity by 2030

Source: Welch et al (2020): Moving Zero-emission Freight toward Commercialization

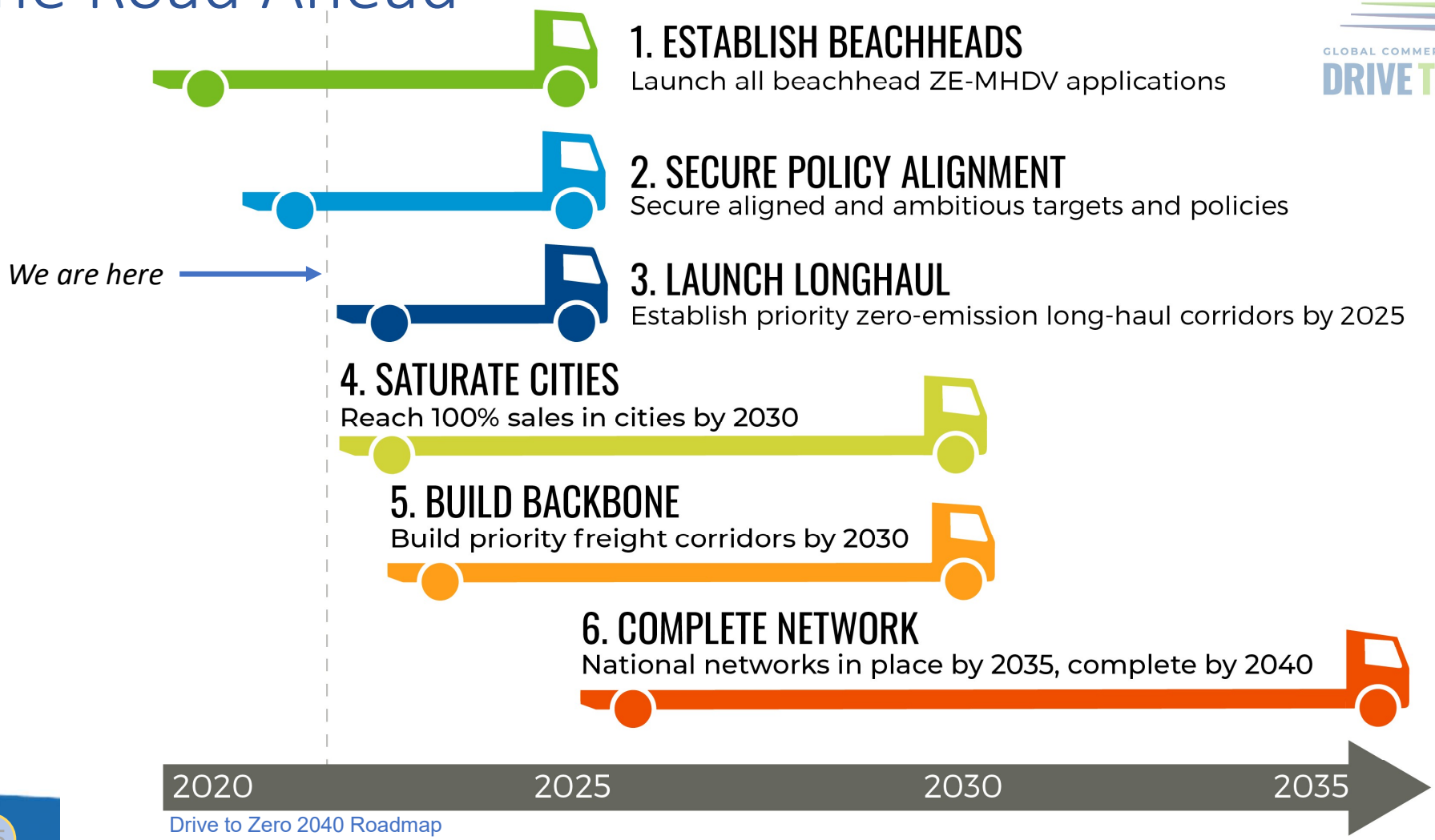

IKEA
IKEA
100% ELECTRIC
HOME DELIVERY
IKEA
LION


DHL
DHL
DHL
BYD


FritoLay
696 kWh
Energy Storage
for Facility &
Light Duty
Vehicle EVSE
Li-ion
Battery
Electric
Forklifts
Solar
Photovoltaic
Carport &
Light Duty
Vehicle EVSE
New
Electrical
Service &
1784 kWh
Energy Storage
for Heavy Duty
EVSE
ANG


FritoLay
Good fun!
100% electric, zero-emissi
POWERED BY
RUN
ON LESS
NACFE

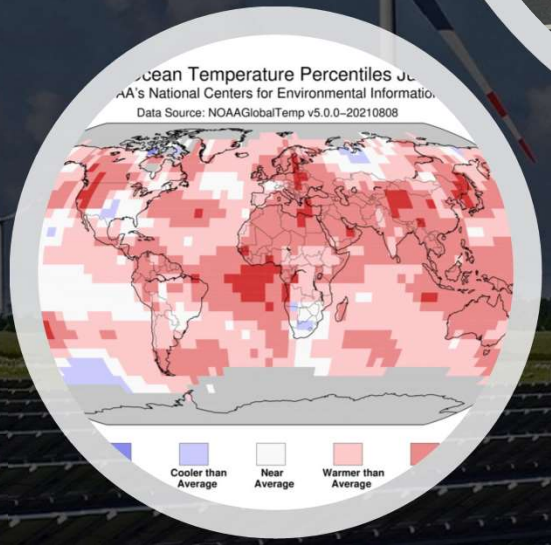
The Road Ahead



Drive to Zero 2040 Roadmap
https://globaldrivetozero.org/publication/global-roadmap-for-reaching-100-zero-emission-medium-and-heavy-duty-vehicles-by-2040/

Alignment of Urgency and Capability is Driving Regulations

- Climate impacts visible and getting worse – action cannot wait
- Zero emission solutions are real and expanding deployment now
- Manufacturers and infrastructure investors know this is the path but are waiting for a strong signal
- Regulations are coming because timing is critical
- Freight CAN carry its weight on climate – but we must work to **solutions**, not just identify barriers



ACT Research – Market Vitals
August 23, 2023

Thank you!

Questions?

Bill Van Amburg
Billva.bva@gmail.com