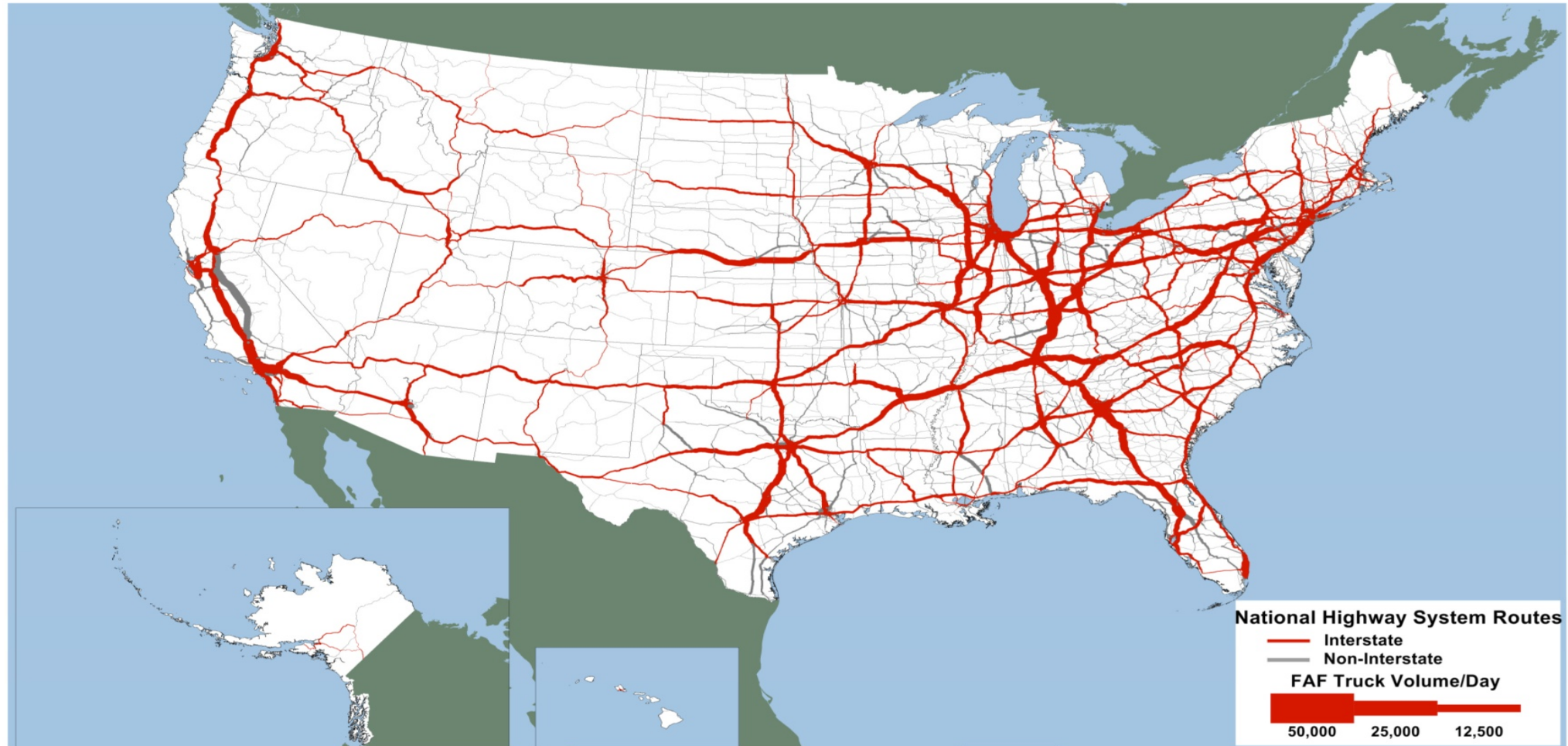


eHighway

Electrified heavy duty road transport

Long-haul Road Freight traffic daily averages (2007) shows very high numbers on main corridors



Note: Long-haul freight trucks typically serve locations at least 50 miles apart, excluding trucks that are used in movements by multiple modes and mail.
Source: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, version 3.4, 2012.

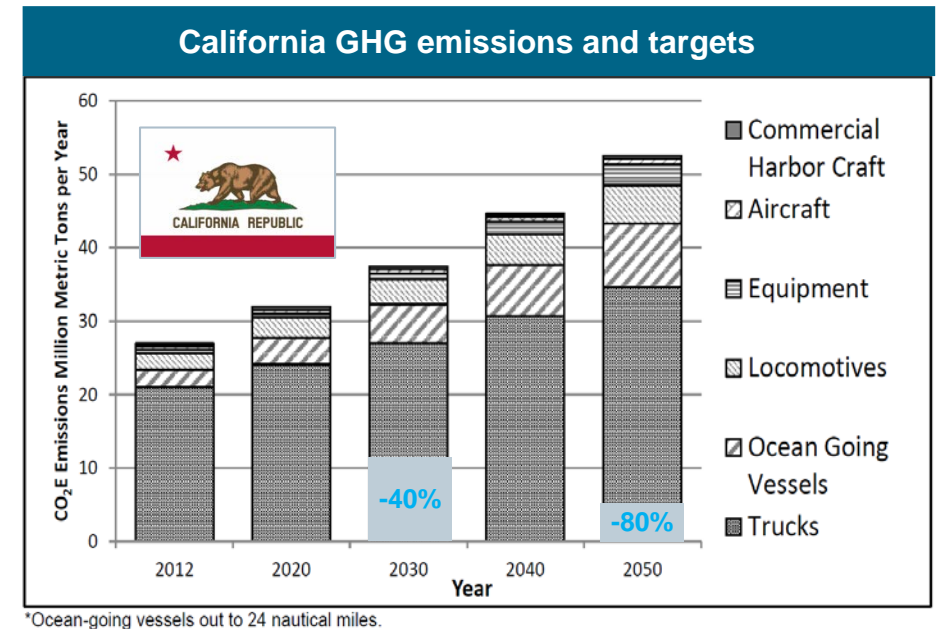
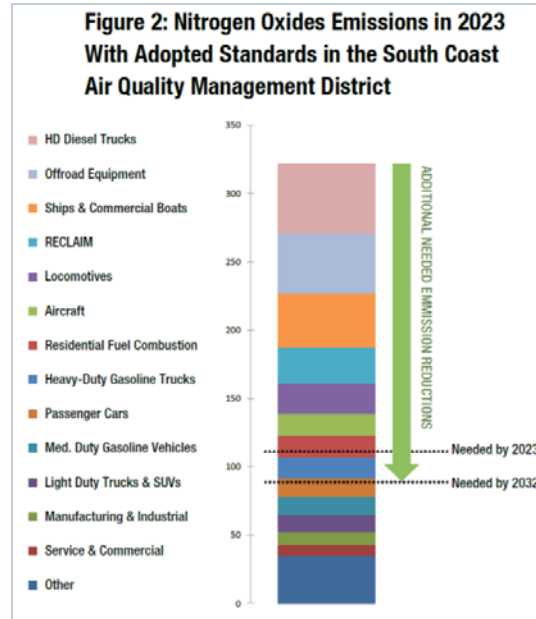
Long-haul Road Freight traffic daily averages (2040) forecast a significant rise in road freight volume



Notes: Long-haul freight trucks typically serve locations at least 50 miles apart, excluding trucks that are used in movements by multiple modes and mail. NHS mileage as of 2011, prior to MAP-21 system expansion.
Source: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, *Freight Analysis Framework*, version 3.4, 2013.

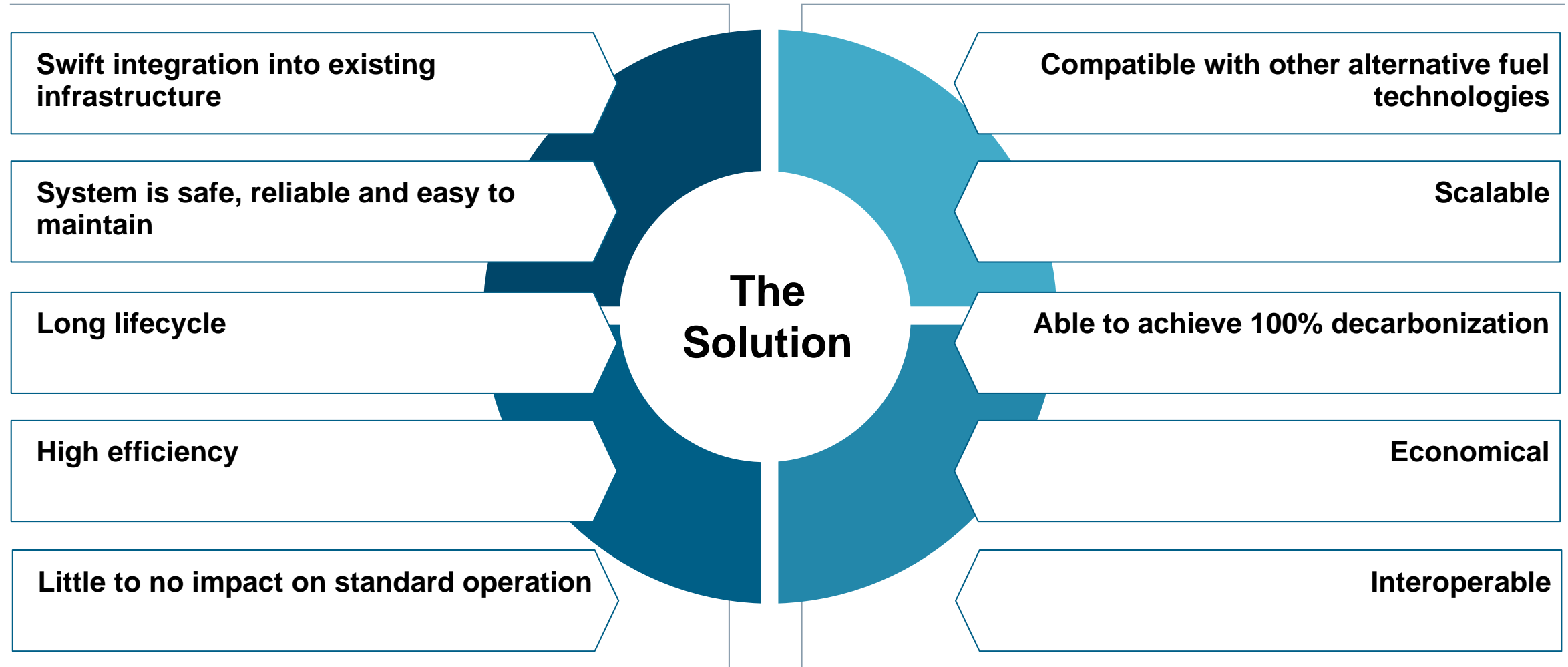
As a primary cargo center, Southern California is facing the same challenges over time – solutions for zero emissions are needed

Development of truck volume per day and emissions in the SoCal region



“By focusing on the ultimate technology endpoint (zero emissions) that satisfies all of our air quality goals and supporting needed engineering advances, we can provide the certainty businesses need for long term planning” – California Air Resources Board

Requirements for Road Freight transport decarbonization solutions



The eHighway Solution



Direct energy transmission = **efficiency**

Energy **recuperation** from braking and feed into power grid is possible


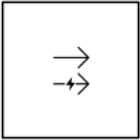

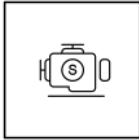
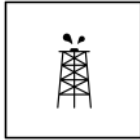

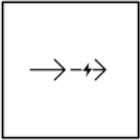
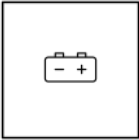
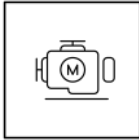



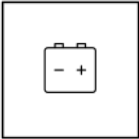
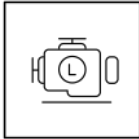


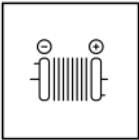


The **safety** of the catenary system has been proven in various across various applications (e.g. trolley buses, tramways)

Life-cycles and low operation and maintenance **costs** have been shown through rail and tramway operations.

The catenary system allows for quick **integration** into existing traffic infrastructure

Compatible with and complementary to other alternative fuel technology

The eHighway hybrid truck can be configured to suit specific applications

Truck types	Drive system	On-board source of electricity	Combustion engine	Non-electrical source of energy
<div>  <div>Tractor truck (2 axles)</div> </div>	<div>  <div>Parallel-hybrid</div> </div>	<div>  <div>Battery (small)</div> </div>	<div>  <div>Engine (small)</div> </div>	<div>  <div>Diesel</div> </div>
<div>  <div>Tractor truck (3 axles)</div> </div>	<div>  <div>Serial-hybrid</div> </div>	<div>  <div>Battery (medium)</div> </div>	<div>  <div>Engine (medium)</div> </div>	<div>  <div>Bio-fuel</div> </div>
<div>  <div>Rigid truck (2 axles)</div> </div>	<div>  <div>Full electric</div> </div>	<div>  <div>Battery (large)</div> </div>	<div>  <div>Engine (large)</div> </div>	<div>  <div>CNG/LNG</div> </div>
<div>  <div>Rigid truck (3 axles)</div> </div>		<div>  <div>Fuel cell</div> </div>		<div>  <div>H₂</div> </div>
<div>  <div>Rigid truck (4 axles)</div> </div>				

Funded research projects supplement the currently executed projects on public roads in Los Angeles and Sweden

Research Projects

- **ENUBA (Germany)**
 - First research project with BMUB
 - Duration: 05/2010 – 09/2011
- **ENUBA 2 (Germany)**
 - Second research project with BMUB
 - Duration: 05/2012 – 12/2015
- **ELANO (Germany)**
 - Third research project with BMUB
 - Duration: 01/2016 – 09/2019



Projects on Public Roads

➤ Los Angeles – Port Application



- One mile demonstration as connection to near-dock rail terminals for cargo vehicles for 6 months
- Primary goal is to promote the implementation of zero emission goods movement technologies
- Cooperation with Volvo trucks and local truck converters

➤ Sweden – Highway Application



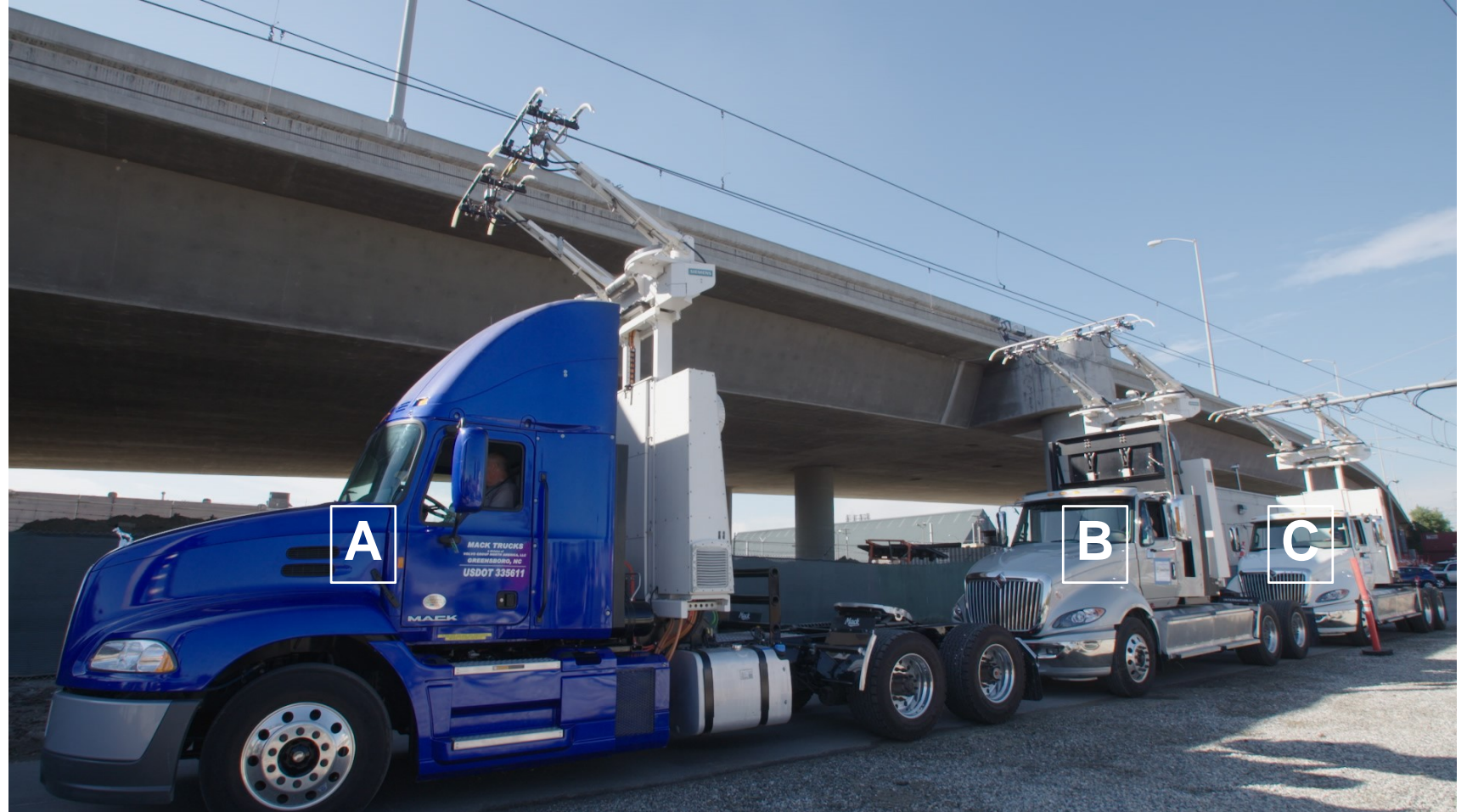
- Two kilometer demonstration on a public road between industrial area and port for 2,5 years
- Overall aim is to evaluate Electric Road System options prior to introduction on road network
- Cooperation with Scania trucks

Three different truck configurations for shuttle applications are put to the test near the Port of L.A.

SIEMENS
Ingenuity for life

Truck configurations

- **A - Volvo / Mack**
 - Parallel-hybrid
 - Independent drive: **Diesel**
 - Small buffer battery
- **B - Transpower CNG-Truck**
 - Serial-hybrid
 - Independent drive : **CNG**
 - Medium battery (< 40 km)
- **C - Transpower Battery-Truck**
 - Full electric
 - Independent drive: **Battery**
 - Large battery (> 60 km)



The potential of the eHighway technology ranges from closed shuttle applications to open highways solutions

eHighway application cases



Shuttle transport

- Solution for high frequency shuttle transport over short and medium distances (<50km), i.e. in ports or industrial areas
- Lower fuel consumption and longer lifetime
- Reduction of air and noise pollution



Electrified mine transport

- Connection of pits and mines to storage or transit locations
- Minimization of harmful emissions
- Sustainable, clean and economical mine operation



Electrified long-haul traffic

- Economical and sustainable alternative for road freight transport
- Significant reduction of CO₂ emissions
- Substantial cost savings for freight carriers

The development path of road electrification can echo that of rail electrification a century ago

Thank you for your attention



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