The Green Supply Chain

A critical assessment of a multimodal, multinational freight supply chain of a Fortune 50 retailer

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THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

Presenter

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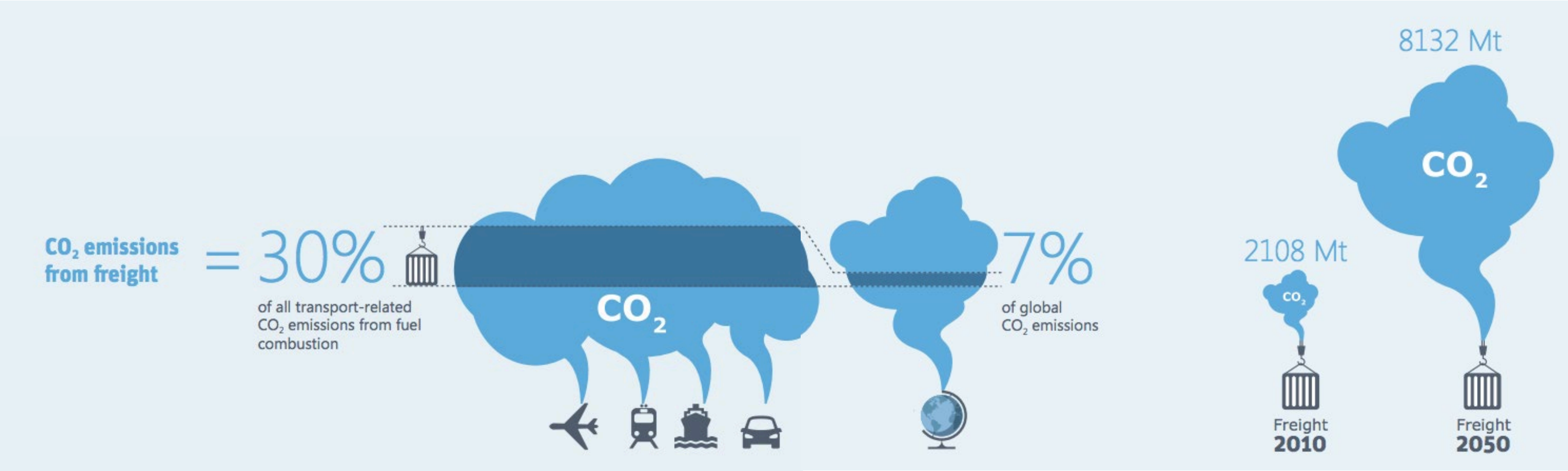
Agenda

- Background and motivation
- Project scope
- Modeling fundamentals
- Results
- Next steps

Background and motivation

The role of freight and supply chain assessment

Freight fuel consumption and GHG emissions are forecasted to grow four-fold through 2050



Source: International Transport Forum 2016

Heavy-duty vehicles contribute disproportionally to emissions, thus being an effective target for emissions control

	Percent of vehicles that are heavy-duty vehicles	Percent of vehicle carbon dioxide emissions that are from heavy-duty vehicles	Percent of vehicle particulate emissions that are from heavy-duty vehicles
China	10%	65%	83%
United States	5%	30%	36%
European Union	11%	37%	47%
Japan	19%*	43%	59%
Brazil	4%	61%	85%
India	5%	71%	74%
Russia	14%	54%	81%
Canada	15%	42%	52%
Global	11%	46%	71%

*Includes mini commercial vehicles

ICCT (2015): Policies to reduce fuel consumption, air pollution, and carbon emissions from vehicles in G20 nations

What is a supply chain?

- A supply chain involves the upstream and downstream **flow of products**, services, finances, and/or information from a **source to a customer**. (Mentzer et al., 2001)

  - Procurement
  - Manufacturing
  - Packaging
  - Warehousing
  - Transportation
  - Retail
  - End of life

Project scope

Green Supply Chain Study

Objectives

- Identify and showcase effective technologies and strategies to enhance the energy and environmental performance of global supply chains.
- Assess energy consumption and emissions savings from advanced technologies/strategies along a real-world global supply chain.
- Give visibility of actions already taken by leading shippers while providing benchmark reference for other companies.
- Identify collaboration opportunities for government, industry and other interested stakeholders.

A group of organizations participated in the conception and development of the study

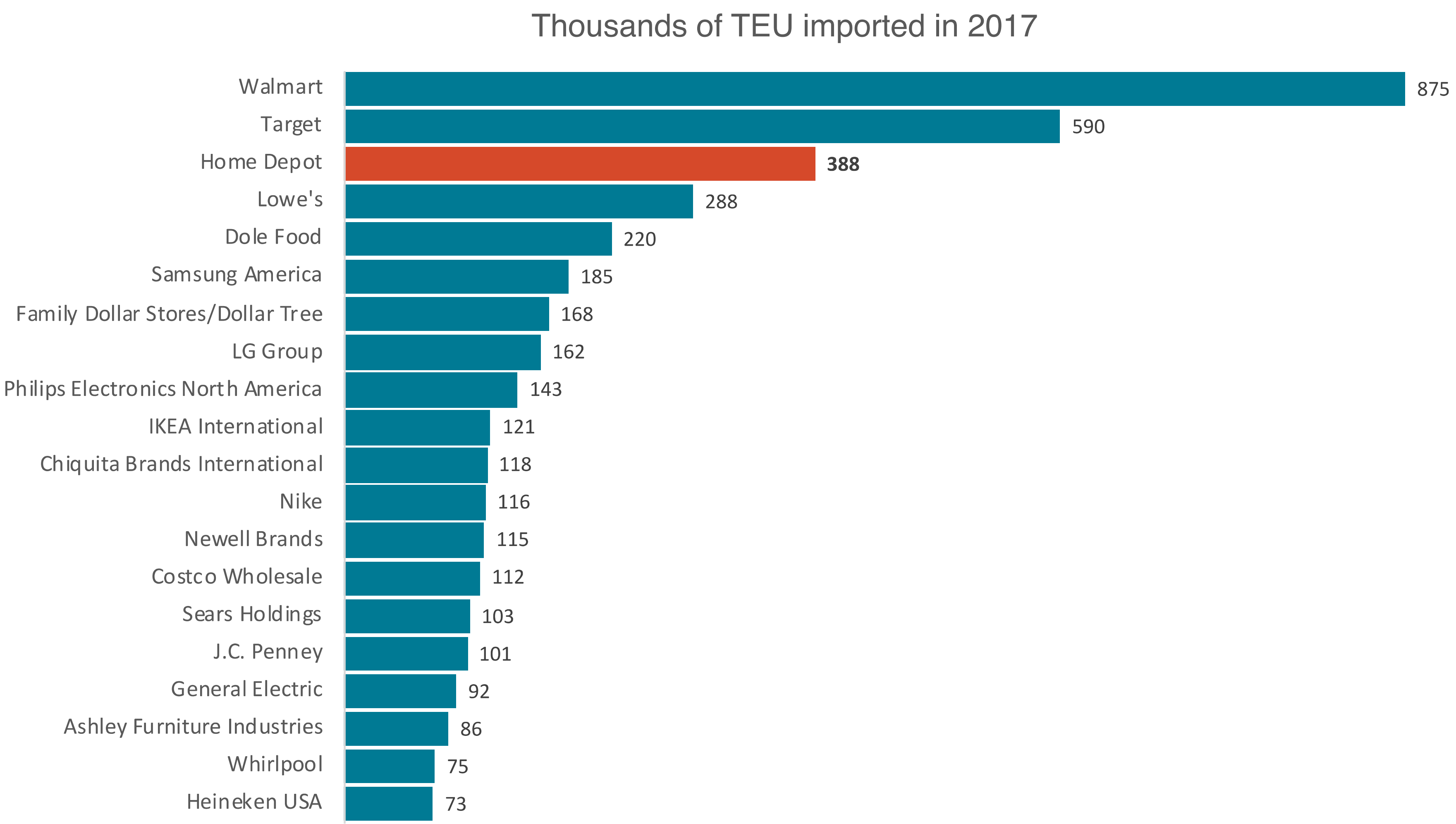
STEERING COMMITEE

ADVISORY GROUP

OTHER STAKEHOLDERS

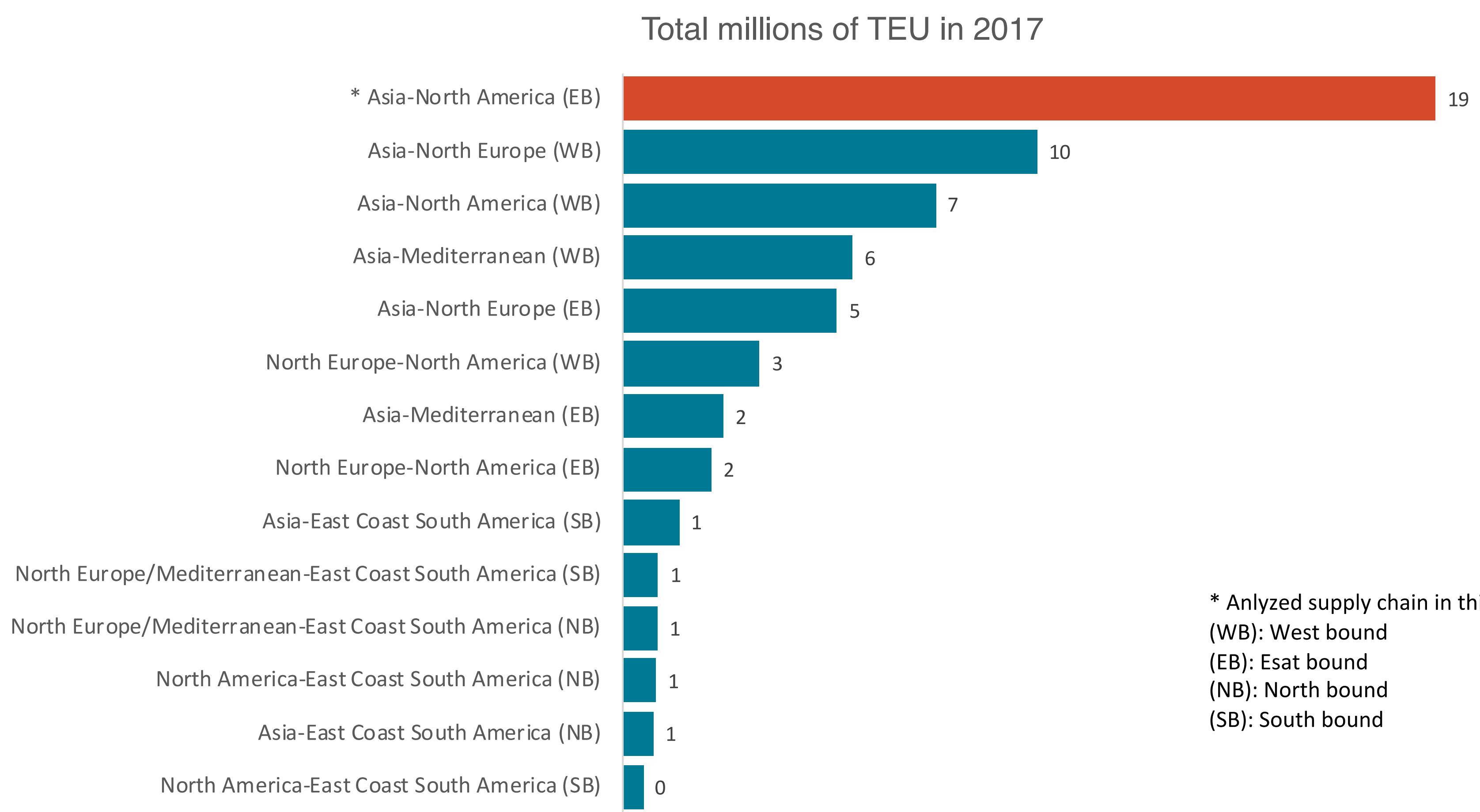
Port authorities
Local environmental agencies
Shipping lines
Trucking companies
Logistics providers

THD is the largest home improvement retailer in the U.S. and the 3rd largest container importer



The Journal of Commerce. Retrieved from: https://www.joc.com/regulation-policy/trade-data/united-states-trade-data/tariffs-trucking-top-threats-top-100-us-importers-and-exporters_20180521.html

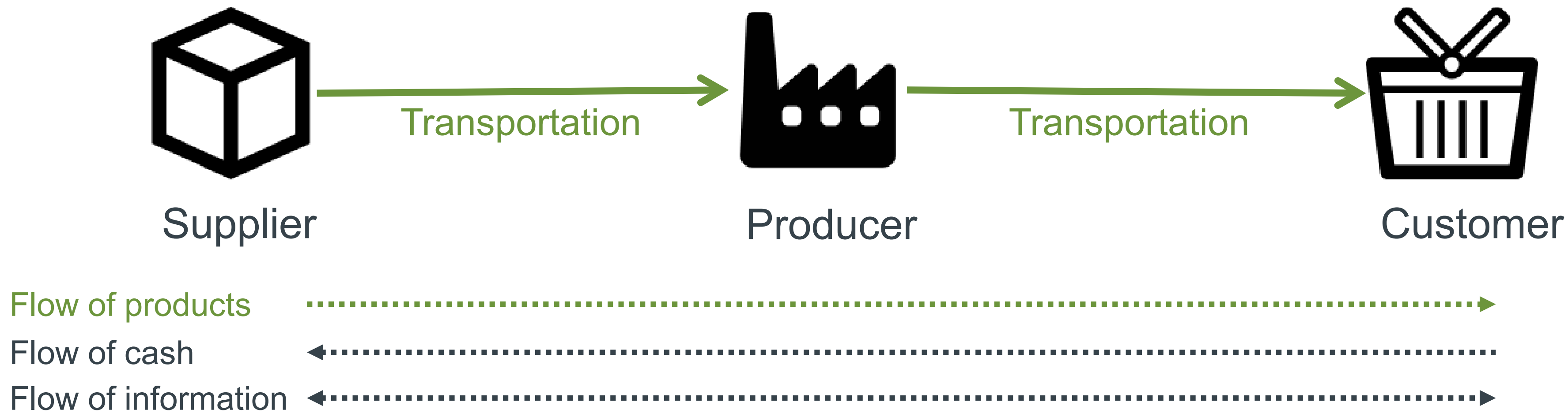
Eastbound trade route from Asia to North America had the largest container traffic in 2017



* Anlyzed supply chain in this trade route
(WB): West bound
(EB): Esat bound
(NB): North bound
(SB): South bound

World Shipping Council. Retrieved from:
http://www.worldshipping.org/about-the-industry/global-trade/trade-routes

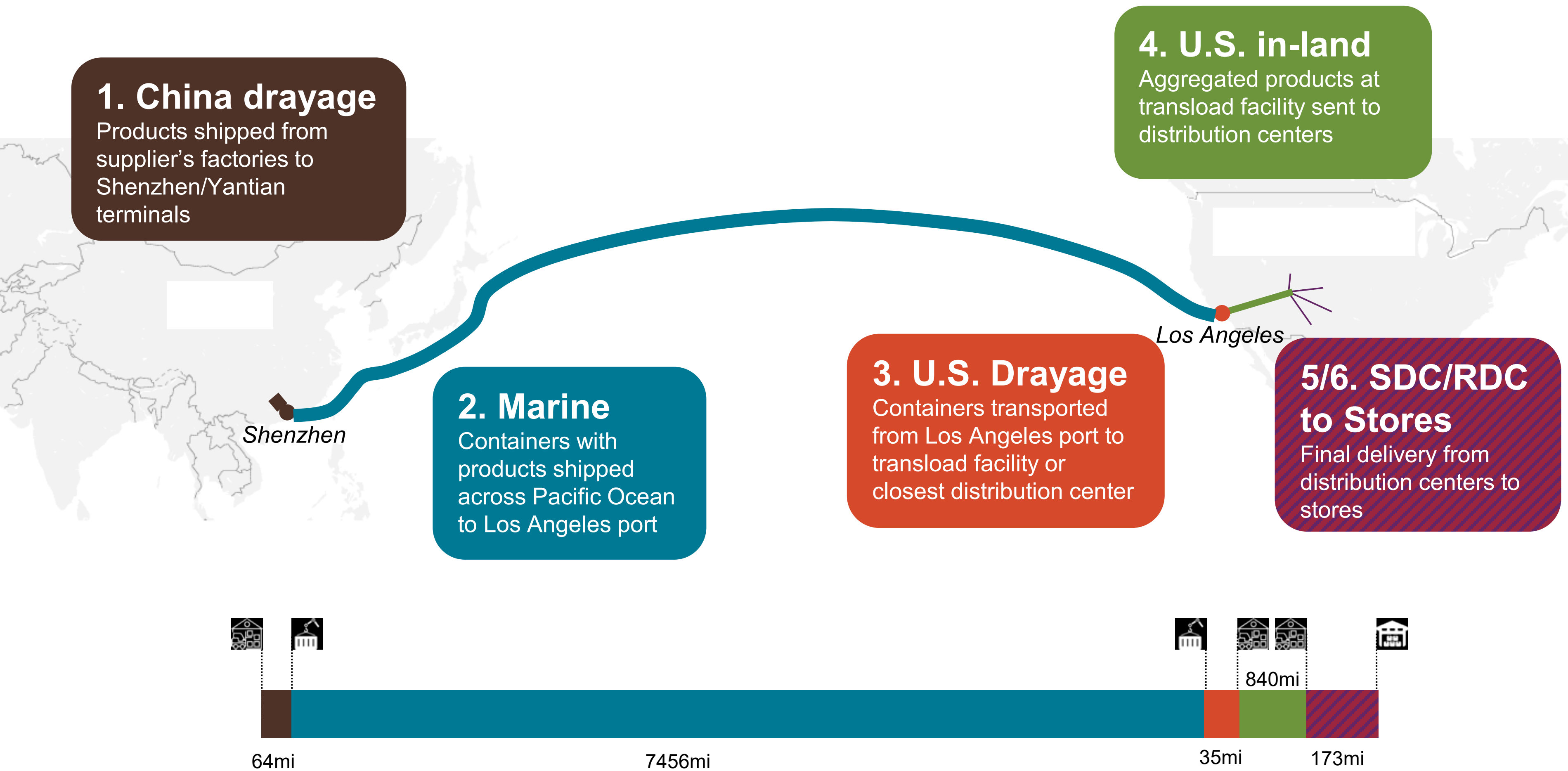
Although the study boundary is limited to transportation, understanding the supply chain is critical to effectively influence the freight sector



- Basic supply chain:
  - Source components
  - Make product
  - Move product ← Policy Target and Study Boundary
  - Sell product

Transportation a key component of supply chain management

The analysis evaluates each supply chain link based on real-world data



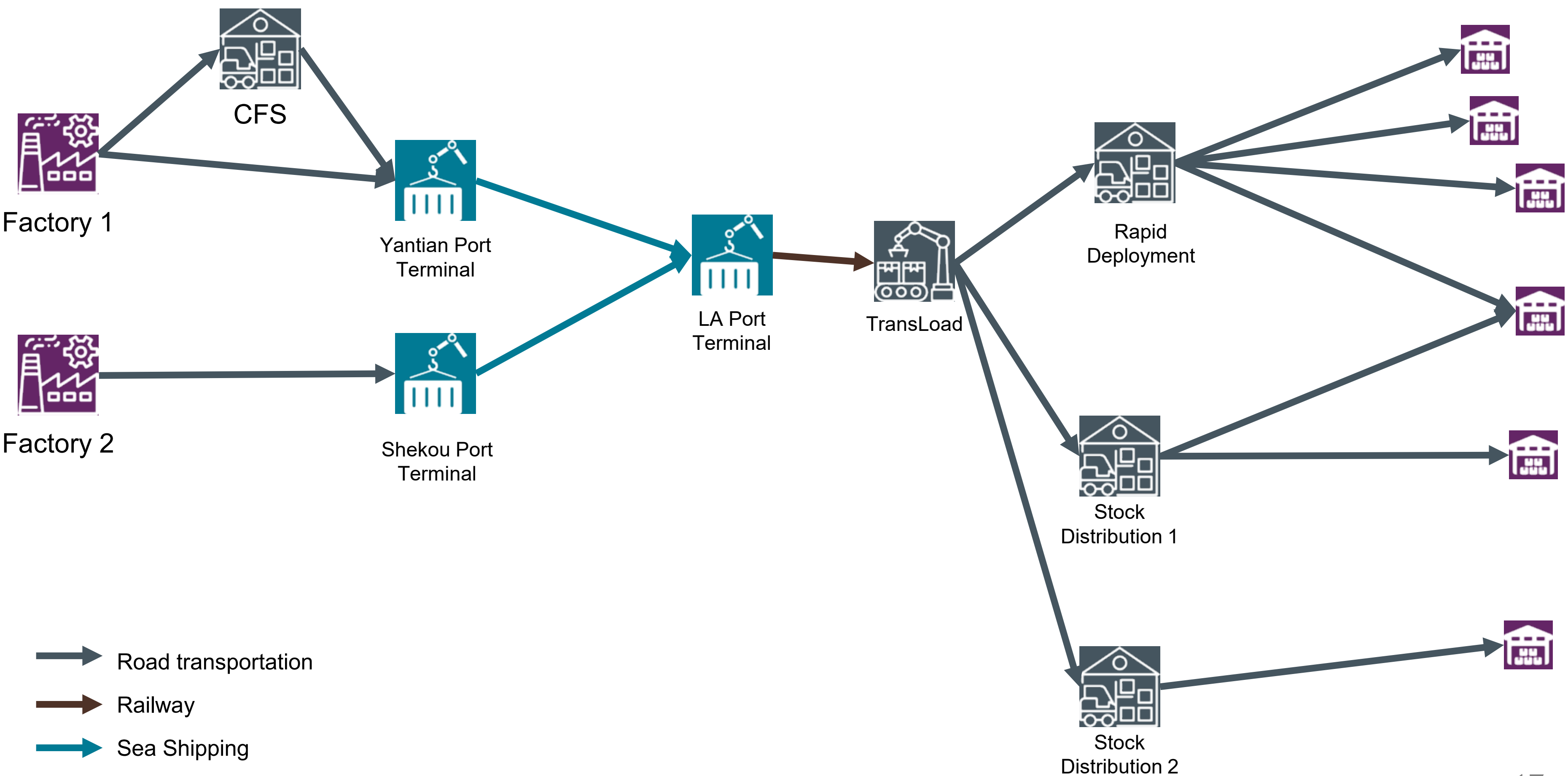
The analysis considers three scenarios to evaluate emission reduction strategies

- **Conventional Scenario:** Basic supply chain without strategies considered in the green scenario, instead those strategies are replaced by basic technology and operational practices.
- **Green Scenario:** Current supply chain considering improvements already adopted (green strategies).
- **Green Plus Scenario:** Future supply chain with additional improvements to those already implemented in the green scenario. To consider implementation timeframe, we divide this scenario into:
  - Short-term (2020)
  - Medium-term (2025)
  - Long-term (2030)

Modeling fundamentals

Data, scenarios, strategies and modeling approach

We first developed a detailed model of the considered supply chain…



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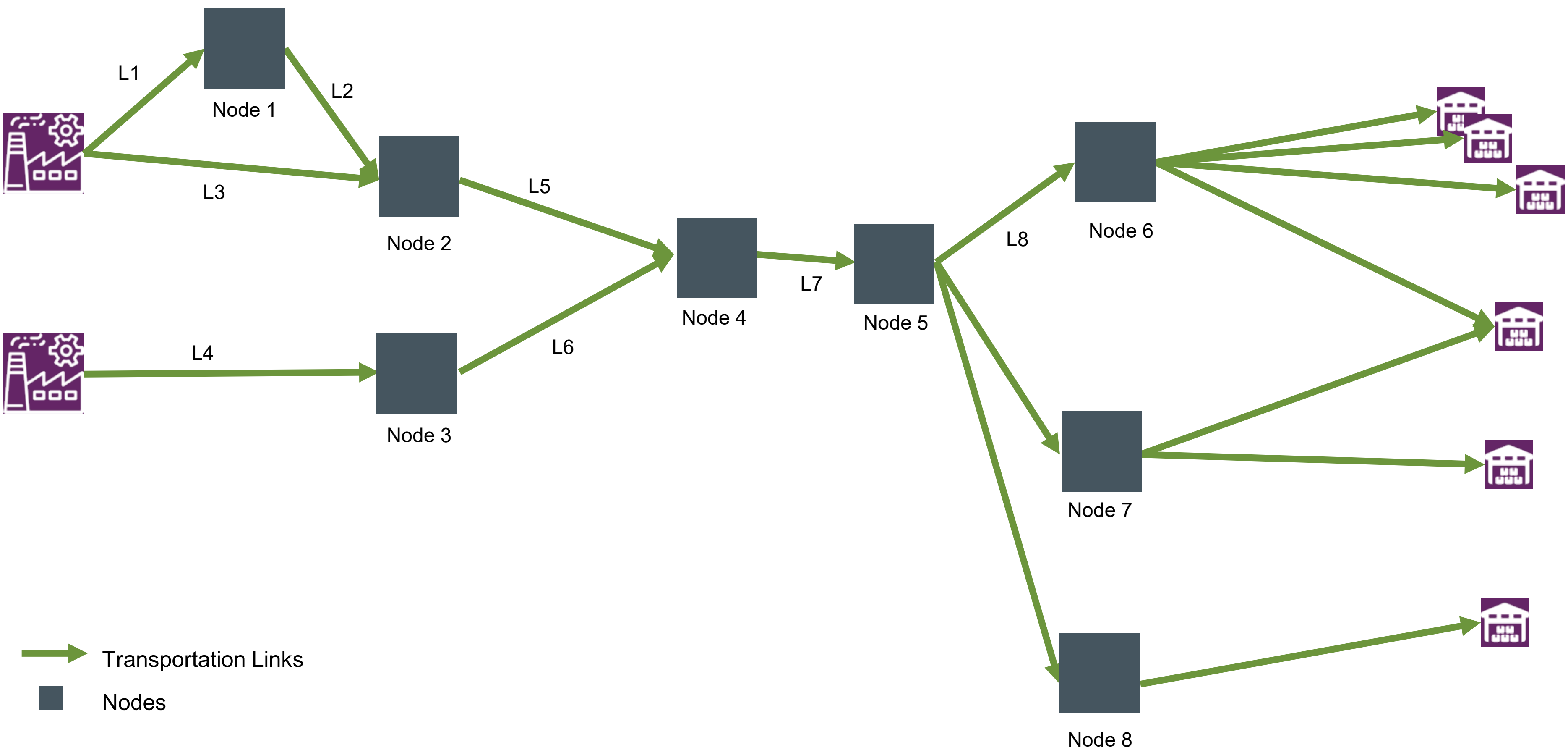
… and parametrized it based on a network of links and nodes



We used detailed 2017 data on purchase orders from three suppliers

Purchase Order (PO) Number →

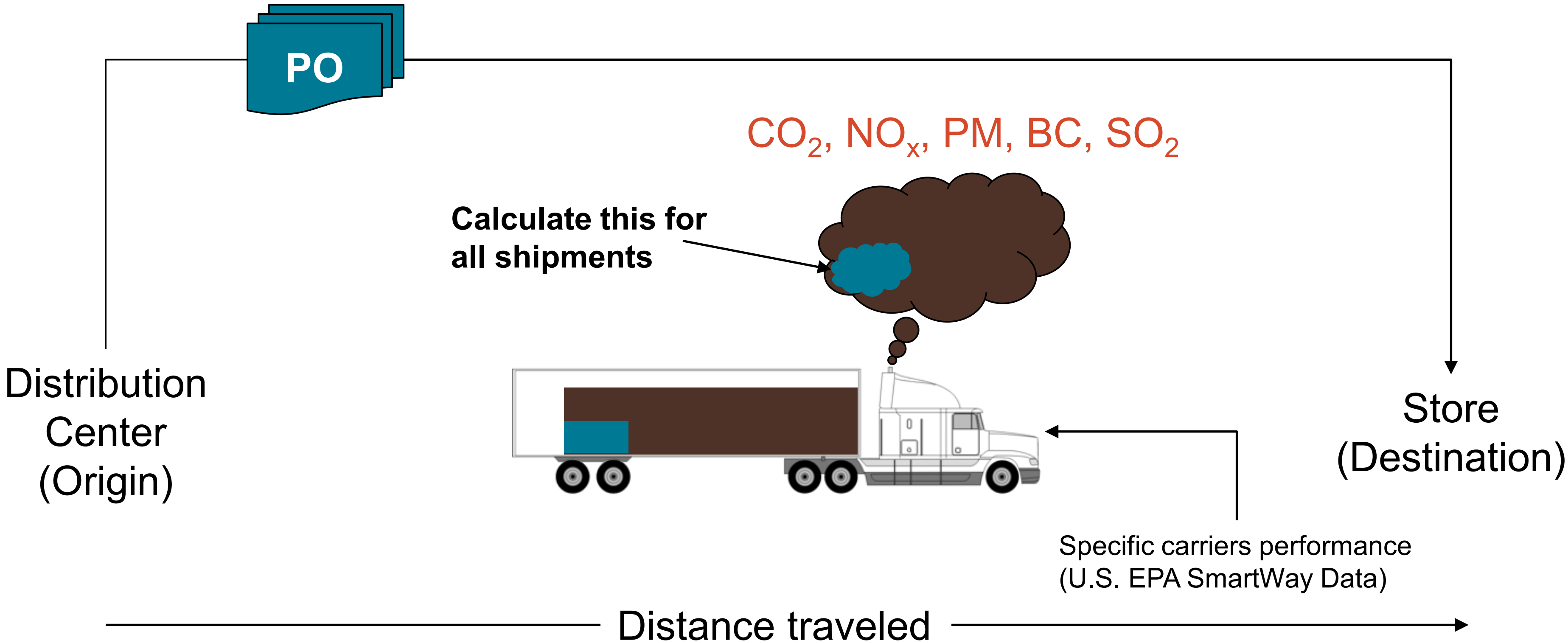
Item 3 (60” ceiling fan)

Item 2 (50” ceiling fan)

Item 1 (42” ceiling fan)

- Quantity
- Volume
- Weight
- Factory of origin
- Port terminal of origin
- Port terminal of destination
- Inbound/Outbound Distribution center
- Final store destination
- Size of container
- Marine vessel
- Trucking carrier
- …

Basic modeling approach: aggregate PO data into shipments and characterize that shipment



Freight of analyzed suppliers
Total freight

The study categorize strategies in three groups

Clean & Efficient Logistics

Strategies to improve supply chain efficiency through reduction of vehicle activity.

Clean & Efficient Modes

Strategies to leverage the use of the cleanest and most energy efficient modes.

Clean & Efficient Equipment

Strategies to improve truck/rail/vessel efficiency through technologies or eco-driving.

We evaluated a number of strategies applied to specific segments under different scenarios

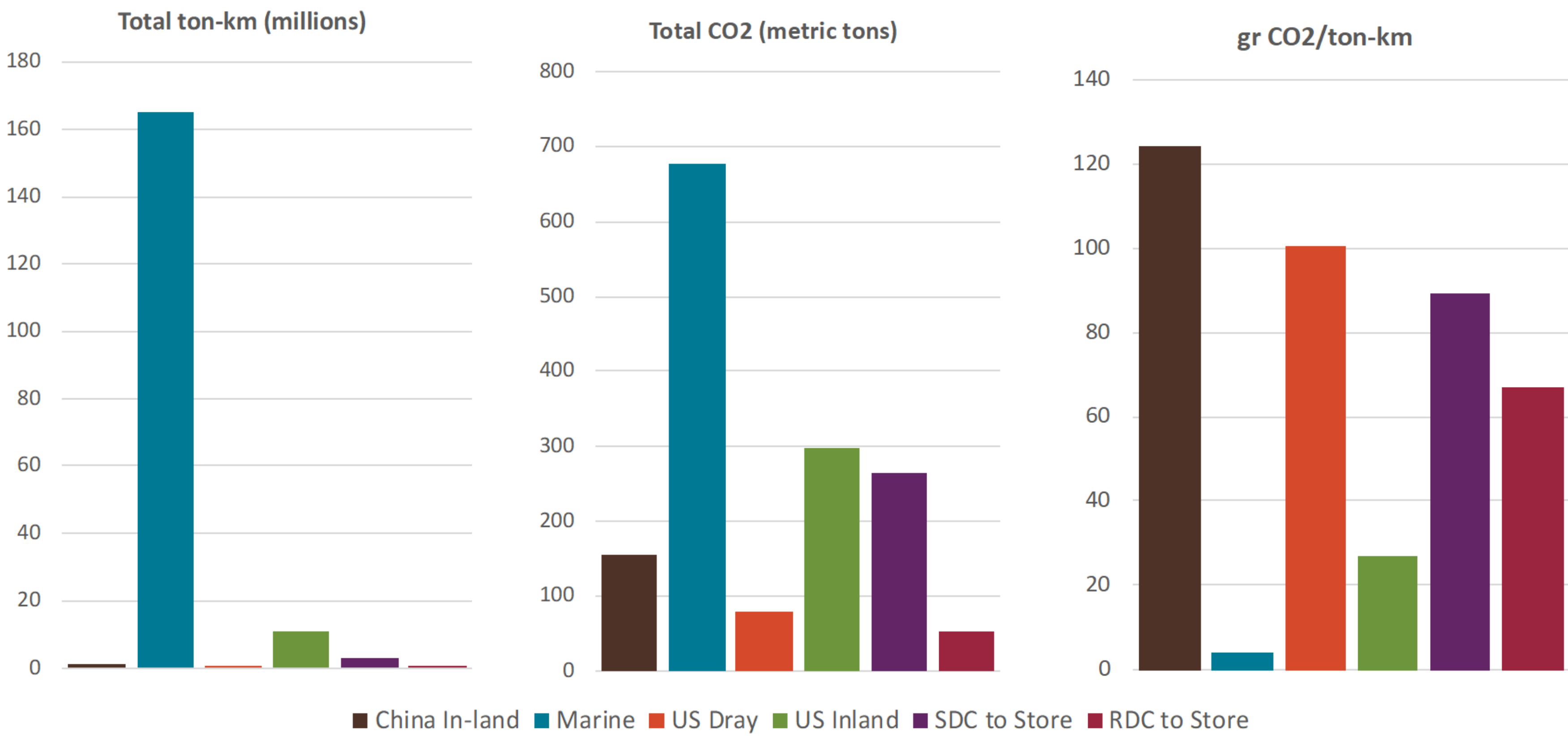
Strategy Type	Strategy	Supply chain Link					
		China drayage	Marine	US drayage	US inland	SDC to Store	RDC to Store
Clean and efficient logistics	Cargo consolidation (Consolidated Freight Station)	🟢		🟢			
	Cube optimization	🟢	🟢	🟢	🟢	🟢	🟢
	Transloading (network reconfiguration)			🟢🔵	🟢🔵		
	Floor loading	🟢	🟢	🟢	🟢	🟢	🟢
	Direct routing + Short sea shipping		🟢🔵				
	Schedule optimization (port and ship)		🟢🔵				
Clean and efficient modes	Truck to rail				🟢🔵		
	Transloading (container switch)				🟢🔵		
	Move to larger ships (Tripple E etc.)		🟢🔵				
Clean and efficient equipment	Shore power		🟢🔵				
	Slow steaming		🟢🔵				
	Vessel technology		🟢🔵				
	Vessel operations		🟢🔵				
	Truck technology	🟢🔵		🟢🔵	🟢🔵	🟢🔵	🟢🔵
	Truck electrification	🔵		🔵	🔵	🔵	🔵
	Rail technology	🔵		🔵	🔵	🔵	🔵
	Driver training	🟢🔵		🟢🔵	🟢🔵	🟢🔵	🟢🔵

🟢 Strategy applied to Green scenario
🔵 Strategy applied to Green plus scenario

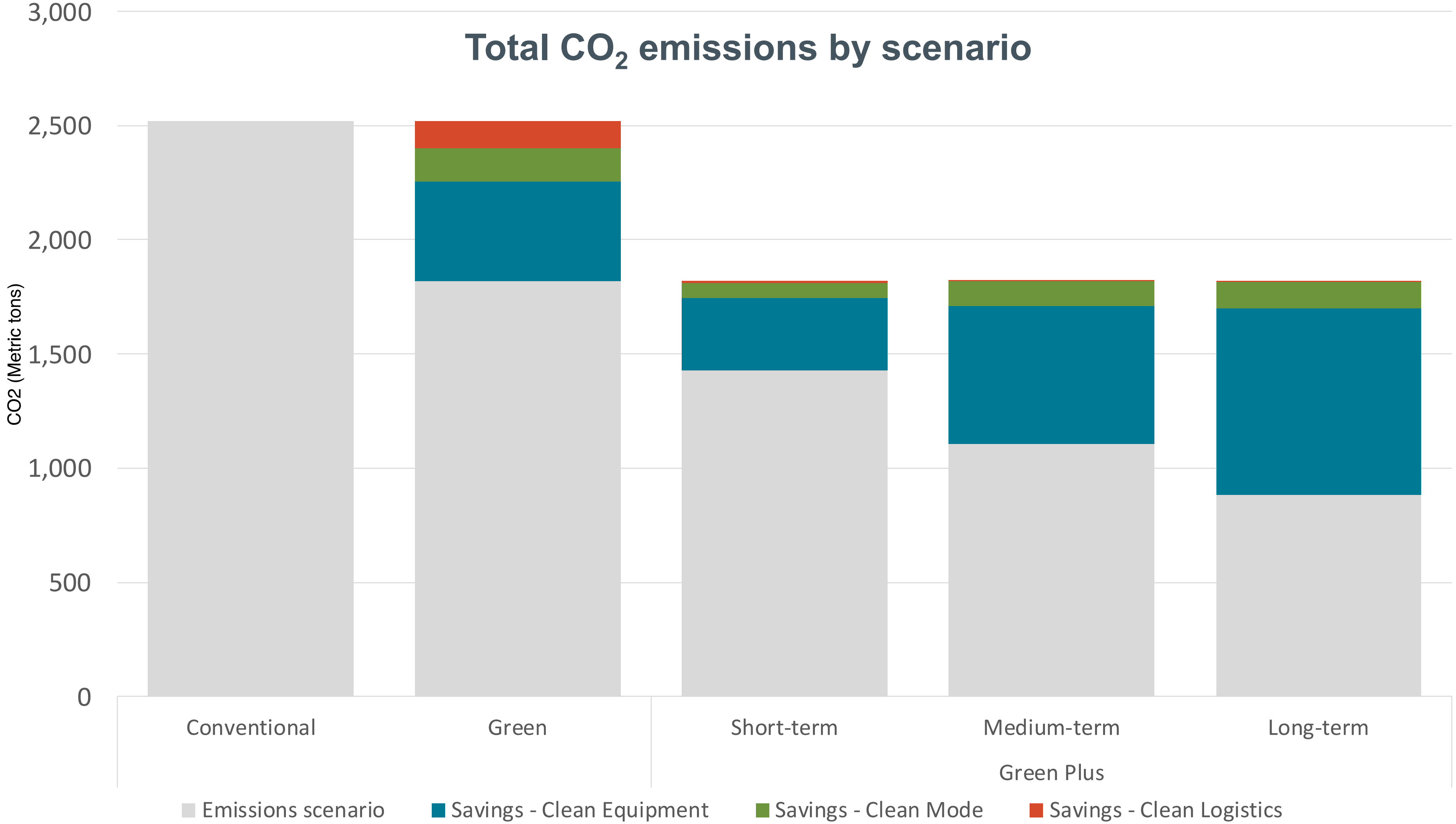
Results

Overview of supply chain emissions

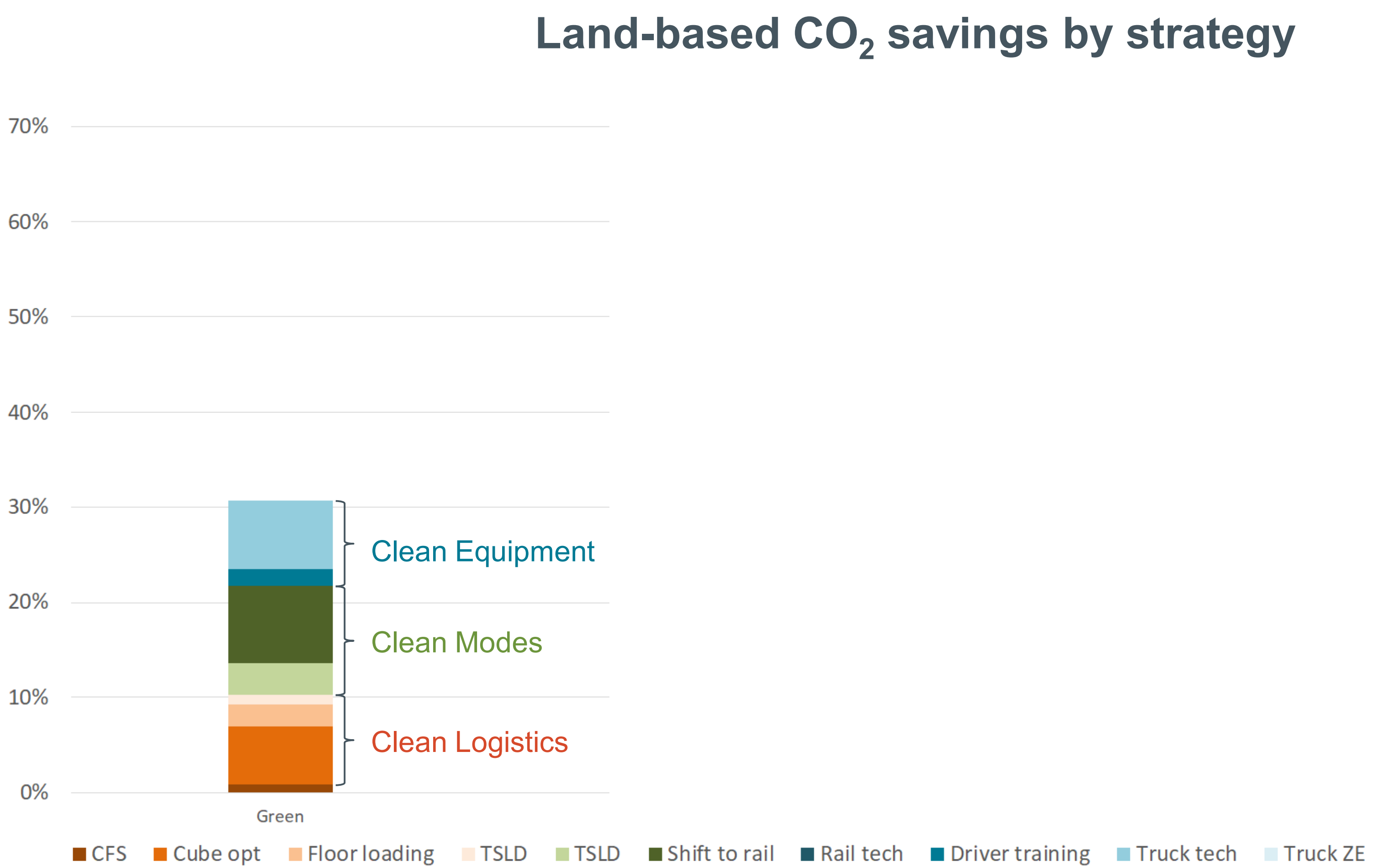
180 million ton-km | **1,500 metric tons** | **8.4 gCO_2/km**



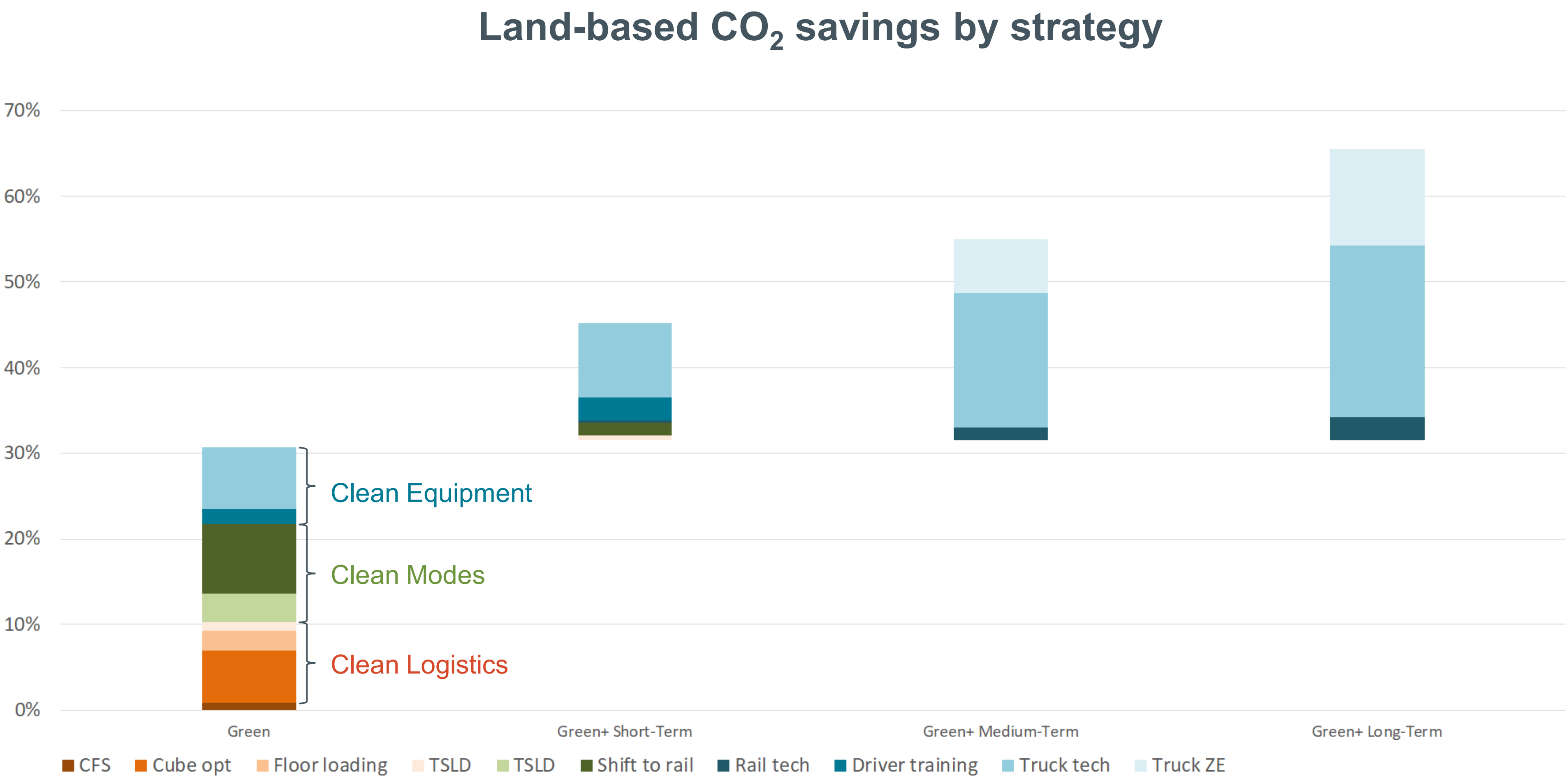
Current available technologies and strategies reduced CO_2 emissions by almost 30% with respect to the conventional supply chain. Adopting advanced strategies can further reduce CO_2 by roughly 35%.



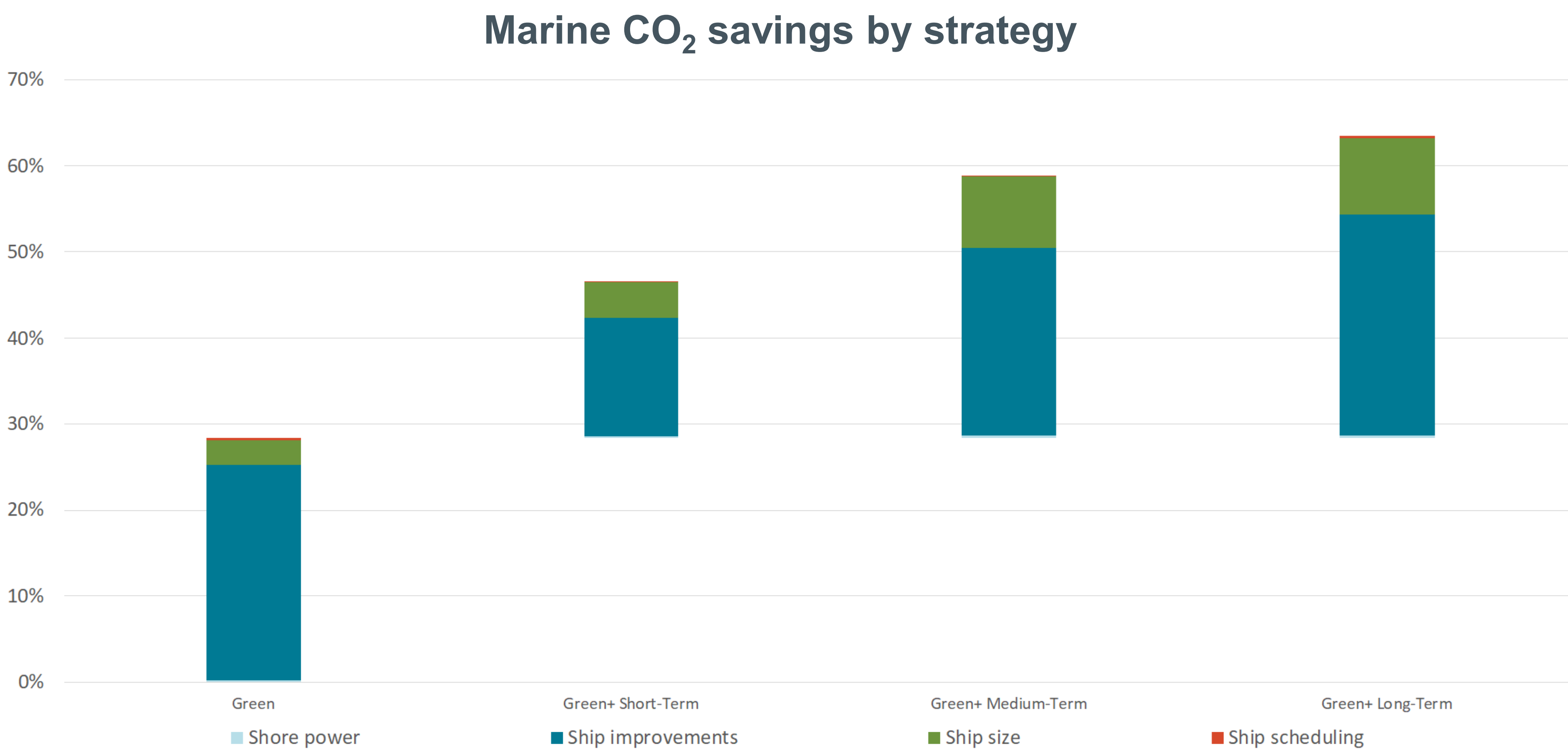
For land-based segments, adopting logistic and mode shift strategies have shown reductions as large as vehicle technology improvements



Most certain path to reduce emissions further is to promote vehicle technology not only on ICE trucks, but also zero-emission trucks and low-carbon rail technologies



Given long distances traveled by marine vessels, technology and ship size provide the largest opportunities for supply chain decarbonization



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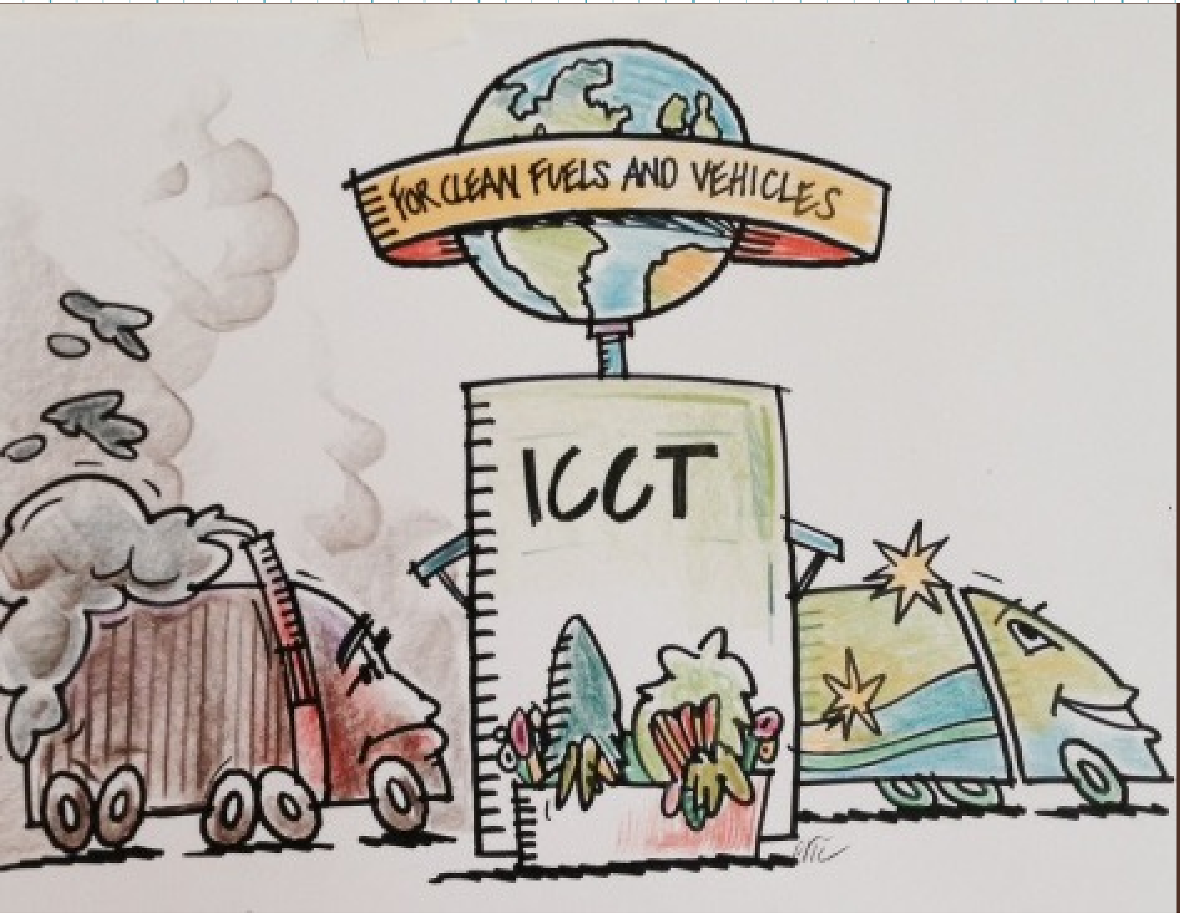
Insights on health-related results

- Study evaluated supply chain emissions of NO_x, PM, black carbon, and SO_2.
- Marine emissions account for the lion's share of local air pollutant supply chain emissions.
- Technology plays an important role in the reduction of local air pollutants.
  - For marine, technology strategies in the Green scenario have reduced air pollutants by over 20%. Future technologies could reduce air pollution by over 50% from current levels.
  - For land-based links, cleaner vehicles reduced local air pollutants by over half. Moving towards soot-free HDVs and cleaner locomotives will virtually eliminate these emissions.

Next steps

- Review process
- Publication and outreach
- Future research
  - Well-to-wheels emissions
  - Follow-up on key strategies to develop cost-benefit analysis
  - Expand the future analysis to include more complex solutions (mode and logistics)
  - Evaluate other industries and trade routes



Thank you!

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