Decarbonizing Freight Transport: *Possible Lessons from Europe*

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Visit by President Alvarado of Costa Rica and Delegation
Kühne Logistics University
Hamburg
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Meeting EU 2011 Transport White Paper target for cutting CO$_2$ emissions from transport

Source: European Environment Agency
Meeting EU 2011 Transport White Paper target for cutting CO$_2$ emissions from transport.

- Actual trend:
  - Million tonnes CO$_{2e}$
  - 1990: 900
  - 2050: 300
  - -60% reduction by 2050 compared to 1990

Source: European Environment Agency
Need to cut CO₂ emissions globally by 50% by 2030 and end them by 2050


Need to stay within tight carbon budgets to limit temperature rise to 1.5-2.0°C

Transport = around 21% of energy-related CO₂ emissions (World Bank)

‘In a scenario where current and announced mitigation policies are implemented, worldwide transport CO₂ emissions are projected to grow by 60%.’

Growth due mainly to ‘increased demand for freight and non-urban passenger transport’

Logistics Share of Global CO₂ Emissions

• Freight transport around 8% of energy-related CO₂ emissions
• Logistics 10% (including warehousing, materials handling, IT)

very hard sector to decarbonise

Heavy dependence on fossil fuel

High forecast growth rate
High ambition scenario for CO₂ reduction:

Average carbon intensity cut from 24 to 9 gCO₂ / tonne-km

More than offset by 3-fold growth in total tonne-kms

Total freight emissions still rise 21% between 2015 and 2050

Need ‘disruptive transformations’ to fully decarbonise freight transport by 2050
EU 2011 CO\textsubscript{2} Reduction Target for Transport: \textit{60\% reduction between 1990 and 2050}

Reduction in carbon intensity need to achieve target in freight transport sector

\[\text{CO}_2\text{ emissions freight transport in EU}\]

- \text{CO}_2 reference trend assuming equal “CO\textsubscript{2} productivity” relative to 2015
- \text{2030}: 20\% reduction relative to 2008
- \text{2050}: 60\% reduction relative to 1990

\text{FACTOR 6}

83\% reduction in \text{CO}_2 / \text{tonne-km}

Source: Smokers et al. (2017). \textit{Decarbonising Commercial Road Transport}. Delft: TNO.
Leveraging freight decarbonisation parameters to achieve a 6-fold reduction by 2050

- 30% modal shift road to rail
  - Rail improves energy efficiency by 50% and reduces carbon intensity of energy by 50%
- 20% improvement in routing efficiency
- 30% increase in loading of laden vehicles
- 30% reduction in empty running
- 50% increase in truck energy efficiency
- 50% drop in carbon intensity of truck energy

\[ \text{80\% reduction in carbon intensity} \]

achievable even in 30 years?

may not be able meet the absolute CO$_2$ reduction target without restraining the growth in freight movement
CO₂ emission reduction profiles for European freight transport

**Cumulative emissions 2015-2050:** 34% lower

- Peak 2015: more gradual decline
- 60% reduction

- Peak 2030: steep decline
- 60% reduction

Both meet 2011 Transport White Paper CO₂ reduction target

Source: McKinnon (2018) *Decarbonizing Logistics*
Developing a Decarbonisation Strategy for Logistics

10 C approach

Corporate / governmental motivation
Organizations promoting the Greening of Freight Transport

Costa Rica one of the founding members

source: Smart Freight Centre
Developing a Decarbonisation Strategy for Logistics

10 C approach

Corporate / governmental motivation → Calculate emissions

System boundaries (SB) around CO₂ calculation:

- **SB5**: Administration, IT, personnel
- **SB4**: Manufacture and scrappage of freight vehicles, Construction and modification of transport infrastructure
- **SB3**: Maintenance and servicing of freight vehicles, Maintaining transport infrastructure
- **SB2**: Energy supply chain (well to wheel)
- **SB1**: Vehicle operation (tank to wheel)

adapted from NTM
Developing a Decarbonisation Strategy for Logistics

10 C approach

Corporate / governmental motivation

Calculate emissions

Commit to targets

Corporate targets to reduce CARBON INTENSITY of logistics - offset by growth of logistical activity

Deutsche Post DHL Group commits to zero emissions logistics by 2050

- Ambitious interim goals for carbon efficiency, local emissions, green customer solutions and employee engagement by 2025
- Previous climate protection target achieved ahead of schedule
- Frank Appel: “The decisions we make today will determine how our children live 30 years down the line.”

Deutsche Post DHL Group, the world’s

Setting corporate GHG reduction targets in line with evidence from climate science
Developing a Decarbonisation Strategy for Logistics

10 C approach

Corporate / governmental motivation

Calculate emissions

Consider possible options

Commit to targets

Scoping the Decarbonisation of Road Freight Transport

Logistics System Design / Supply Chain Restructuring

Freight Modal Shift

Vehicle Routing and Scheduling

Vehicle Loading

Driving

Vehicle Maintenance

Vehicle Technology

Alternative Fuels

emissions per vehicle-km

total emissions

total vehicle-kms
Developing a Decarbonisation Strategy for Logistics

10 C approach

- Corporate / governmental motivation
- Consider possible options
- Collaborate with others
- Calculate emissions
- Commit to targets

Supply Chain Collaboration

Deep decarbonisation of freight transport will require much greater sharing of logistics assets.

Nestle – Pepsico Horizontal Collaboration in Benelux

1. Separate delivery operations
2. Groupage by Logistics Provider
3. Collaborative synchronisation

<table>
<thead>
<tr>
<th></th>
<th>Kg CO2 / tonne</th>
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</thead>
<tbody>
<tr>
<td>1. Separate delivery</td>
<td>43.8</td>
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<tr>
<td>2. Groupage</td>
<td>27.3</td>
</tr>
<tr>
<td>3. Collaborative synchronisation</td>
<td>20.3</td>
</tr>
</tbody>
</table>

EU project: Source: Jacobs et al 2014
Developing a Decarbonisation Strategy for Logistics

10 C approach

- Corporate / governmental motivation
- Consider possible options
- Collaborate with others
- Calculate emissions
- Commit to targets
- Cost evaluation

3 Phases in the Economics of Logistics Decarbonisation

Adapted from Tavasszy (2014)
Developing a Decarbonisation Strategy for Logistics

10 C approach

- Corporate / governmental motivation
  - Calculate emissions
  - Commit to targets
- Consider possible options
  - Cost evaluation
  - Choose appropriate actions
- Collaborate with others
- Carbon offset?
  - Cut emissions
  - Calibrate the strategy

Five Sets of Decarbonisation Initiatives for Freight Transport

1. Reduce Demand for Freight Transport
2. Shift Freight to Lower Carbon Transport Modes
3. Optimise Vehicle Loading
4. Increase Energy Efficiency of Freight Movement
5. Reduce the Carbon Content of Freight Transport Energy
Five Sets of Decarbonisation Initiatives for Freight Transport

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Reduce Demand for Freight Transport

Dematerialisation: *reducing the amount of stuff to be moved*

- New era of sustainable consumption: *lower demand for material goods?*

**Reduction in Future Demand for Cars?**

- [Image: Venn diagram showing交汇 of Automated (connected), Electric (ZEV), Shared (pooled)]

- **PwC (2018)**
  - 40% of car travel in Europe by autonomous vehicles by 2030
  - Total European can fleet will drop from 240 to 200 million vehicles

- **Robotaxi Scenario**: in theory only 14% of current inventory of cars required to meet future demand for mobility
Reduce Demand for Freight Transport

Dematerialisation: *reducing the amount of stuff to be moved*

• New era of sustainable consumption: *lower demand for material goods?*

• Circular economy: *Increasing recycling and remanufacturing*

• Digitisation of physical products: *from consignments to electrons*

• Design products with less material: *miniaturisation, lightweighting*

• 3D Printing: *less material and wastage, eliminate supply chain links*

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Adidas mass customising soles of training shoes using 3D printing in German factory

expert opinion divided on impact of 3DP on freight transport

‘a scattered array of answers ranging from large positive impacts to large negative impacts’ (Boon and Wee, 2018)

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3D printing: a decarbonising silver bullet?

Alan McKinnon investigates the potential impacts new additive manufacturing could have on the wider industry.

Reduce Demand for Freight Transport

Restructuring of supply chains

- relocalize production / sourcing
- decentralize inventory
- reversal of key business trends
- high carbon-mitigation costs

Fossil fuel phase-out

- 41% of international seaborne trade (2016)

Building renewable energy infrastructure

- infrastructure is material- and transport-intensive

optimise vehicle routing

Yields economic and environmental benefits – ‘win – win’ option
Future drivers of demand for freight transport

carbon capture and storage

air conditioning

negative emissions / direct air capture

climate change adaptation and climate proofing

resettlement of populations

Bio-energy Carbon Capture and Storage

carbon ‘scrubbers’
Five Sets of Decarbonisation Initiatives for Freight Transport

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Average carbon intensity of freight transport modes: \( gCO_2 / \text{tonne-km} \)

<table>
<thead>
<tr>
<th>Mode</th>
<th>Carbon Intensity</th>
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<tbody>
<tr>
<td>Bulk Carrier vessel</td>
<td>300</td>
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<tr>
<td>Pipeline</td>
<td>200</td>
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<tr>
<td>Container ship</td>
<td>150</td>
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<tr>
<td>Rail</td>
<td>100</td>
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<td>RoRo ferry</td>
<td>50</td>
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<tr>
<td>Articulated truck</td>
<td>25</td>
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<tr>
<td>Rigid truck</td>
<td>10</td>
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<tr>
<td>Van</td>
<td>5</td>
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<tr>
<td>Airfreight long-haul</td>
<td>1</td>
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<tr>
<td>Airfreight short-haul</td>
<td>0.5</td>
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Data source: DEFRA (2017)

- Analysis of 158 NDCs for 185 countries
- Only 13% referred to freight transport (analysis by Sudhir Gota)

% of NDCs specifying particular green freight measures

NDC – nationally determined contribution
Prospects of a Freight Major Modal Shift in Europe?

2030 modal shares if EU 2011 White Paper target is achieved*

European experience shows difficulty of shifting freight to rail and water

Decline in coal and oil demand – deprives rail of core traffic

European Court of Auditors (2016):

Rail fails to increase its share of EU freight market, despite €28 billion financial support between 2007-2013

Combining road and rail on route to Port of Limon could cut pineapple transport emissions by 25%
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Optimise Vehicle Utilisation

**under-loading**

**over-loading**

<table>
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<th>% of truck-km run empty</th>
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<tr>
<td>EU (2016)</td>
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<td>US (2016)</td>
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<td>Latin American 30-50%</td>
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<td>Costa Rica 10% ?</td>
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Online freight exchanges: *matching loads with available capacity*

Mature, well-established market in Europe and North America

Diversification of UBER into the freight market
May cut transport-related CO₂ emissions, BUT....

Wider corporate CO₂ savings from JIT replenishment

Need comprehensive assessment of the CO₂ impact of JIT
Increasing truck size and weight – *within infrastructural constraints*

2 truck for 3 substitution: load consolidation → reduced energy use and emissions per tonne-km

Vehicle level analysis

% reduction in carbon intensity against baseline vehicle

- 25.5 m LHV – variable maximum weight limit

System level analysis

Net effect on CO₂ depends on:
- vehicle adoption rate
- induced traffic
- circuitous routing
- vehicle load factor
- freight modal shift

European studies of high capacity transport

Increasing truck size and weight – *within infrastructural constraints*
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Improve Energy Efficiency in the Freight Transport Sector

Vehicle technology: new build + retrofits
- upgraded drive-trains
- light-weighting
- low-rolling resistance tyres
- improved aerodynamics

Fuel economy standards for heavy duty vehicles:

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<tr>
<td>Japan</td>
<td>Phase 1</td>
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15% less CO₂ by 2025 30% by 2030

Vehicle operation: IT, training, monitoring
- eco-driver training
- platooning
- automation

Business practice: e.g. lower vehicle speed

- upgraded drive-trains
- lightweighting
- low-rolling resistance tyres
- improved aerodynamics

Fuel Consumption (U/100km)

Source: ICCT (2015)
Five Sets of Decarbonisation Initiatives for Freight Transport

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Switch to Cleaner, Low Carbon Energy

WTW CO₂e emissions

Life-cycle GHG emissions relative to diesel fuel

biofuel fuels: slow uptake

- limited supply of sustainable biofuels
- lack of refuelling infrastructure for gas
- methane leakage problem
- uncertainty about net impact on GHG emissions

2015 – EU Renewable Energy Directive: ‘to be considered sustainable, biofuels must achieve greenhouse gas savings of at least 35% in comparison to fossil fuels’,
Powering logistics with low carbon electricity

decarbonisation of electricity generation

Carbon intensity of electricity generation (gCO₂ / kWh)

Local delivery operations
- recharging infrastructure
- future battery performance
- E-vehicle price differential

Long-haul trucking
- battery weight & size?
- maximum payload?
- cost?

Hydrogen as the carrier of low carbon electricity

Highway electrification: *the e-Highway*

**Electrified roads: Trials in Sweden, Germany and the US**

BDI / Boston Consulting Group / Prognos study:
Recommends that 4000-8000 km of German autobahn network be electrified (out of 13000 km)

Capital cost of highway electrification: €1.5 – 2.0 million per km
Uncertainty over most cost-effective energy decarbonisation pathways for trucking

What are the most cost-effective alternative energies for each type of road freight operation?

Optimum mix of decarbonisation pathways likely to vary by country
Decarbonizing Logistics at the Urban Level: *low carbon city logistics*

- Build bypasses to minimize through-traffic
- Consolidate of urban deliveries
- Permit / promote night-time delivery
- Encourage cleaner freight vehicles
- Create low emission zones
- Facilitate multi-stakeholder collaboration
- Shift to greener transport modes (e.g. cargo cycles)
- Accredit cleaner carriers
- Droids
- Robovan
- Drones
- Drone-truck
Professor Alan McKinnon

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