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# eHighway

## Electrified heavy duty road transport



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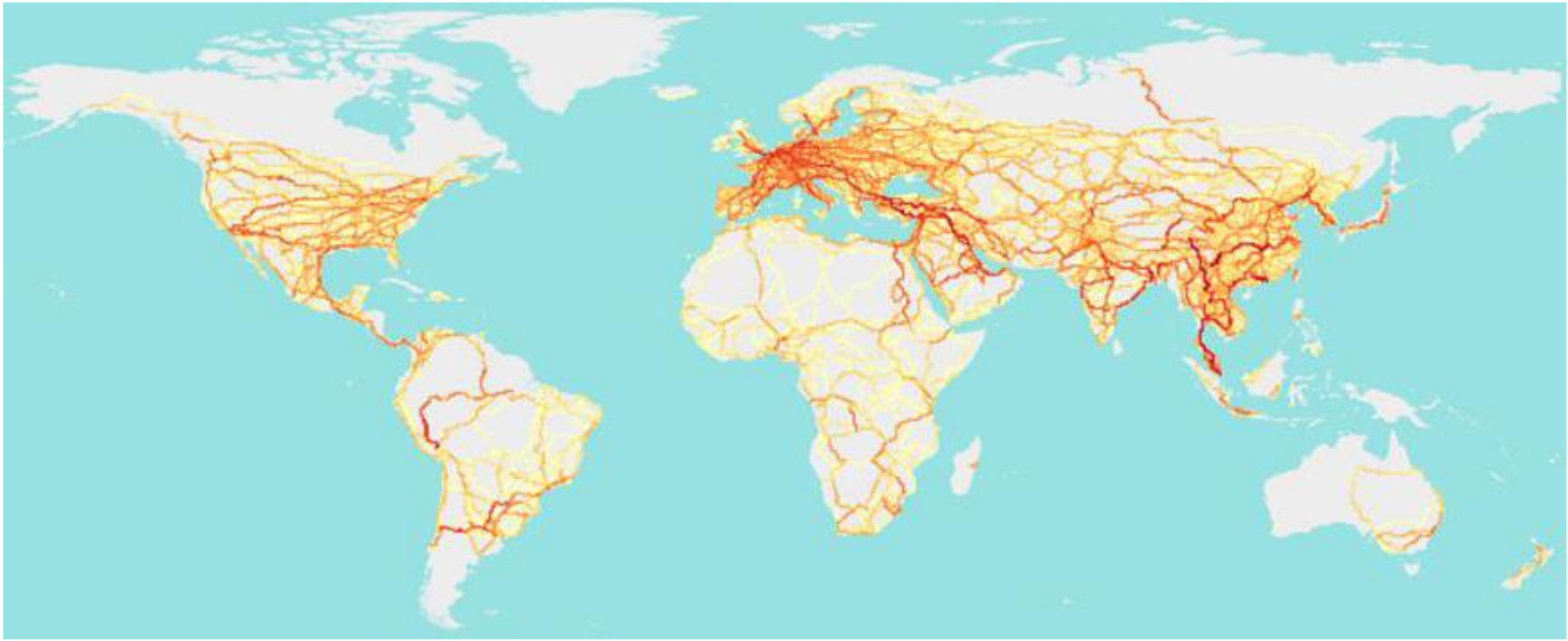
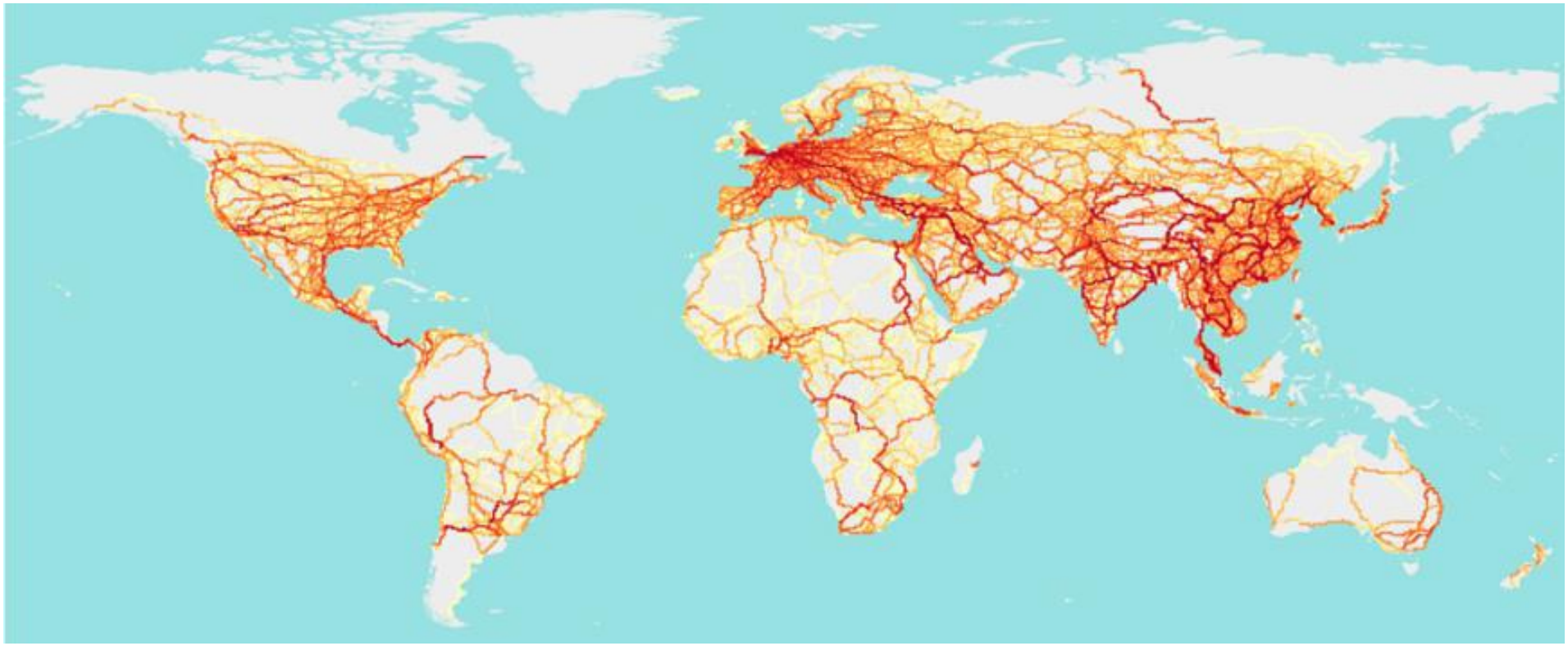
# Surface freight density: 2010



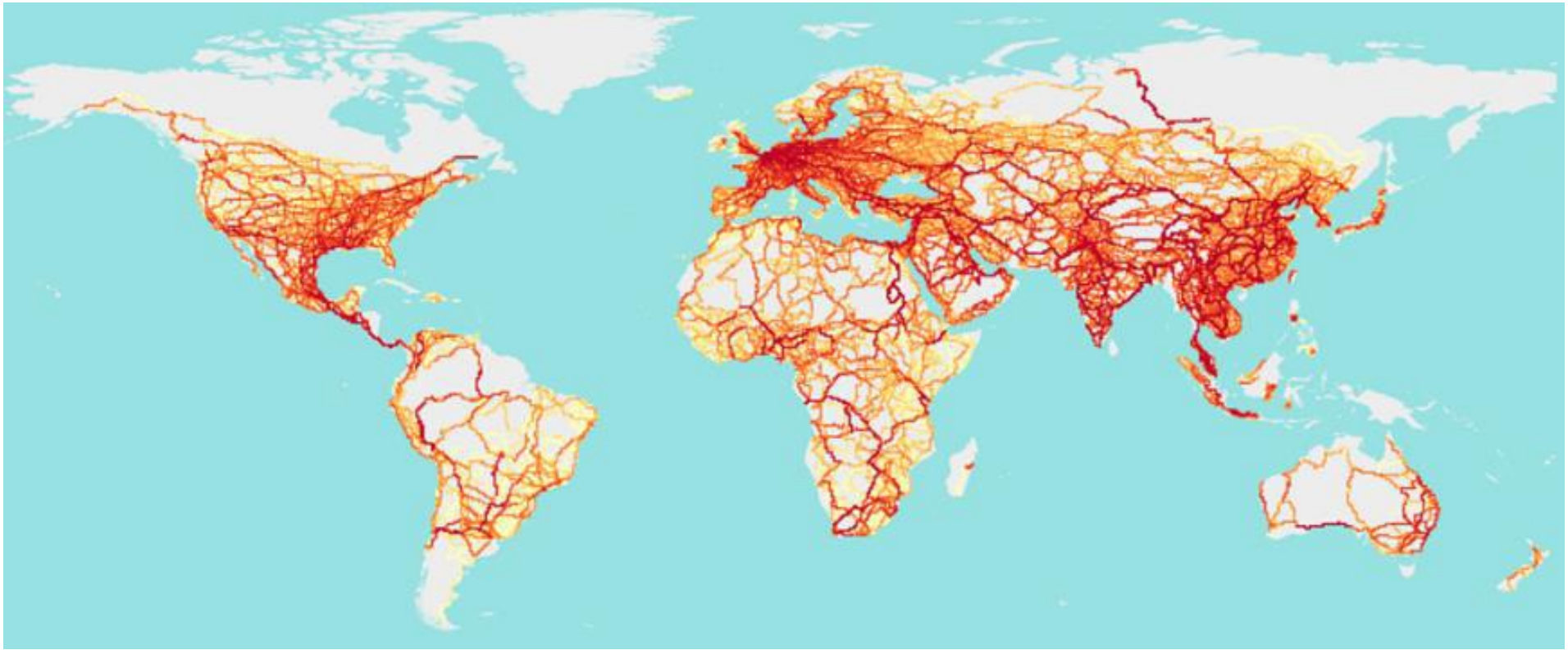
Source: ITF - Transport Infrastructure Needs for Future Trade Growth (2016)

# Surface freight density: 2030



Source: ITF - Transport Infrastructure Needs for Future Trade Growth (2016)

# Surface freight density: 2050



Source: ITF - Transport Infrastructure Needs for Future Trade Growth (2016)

# Road freight emissions trends make it clear: Solutions for decarbonization are needed

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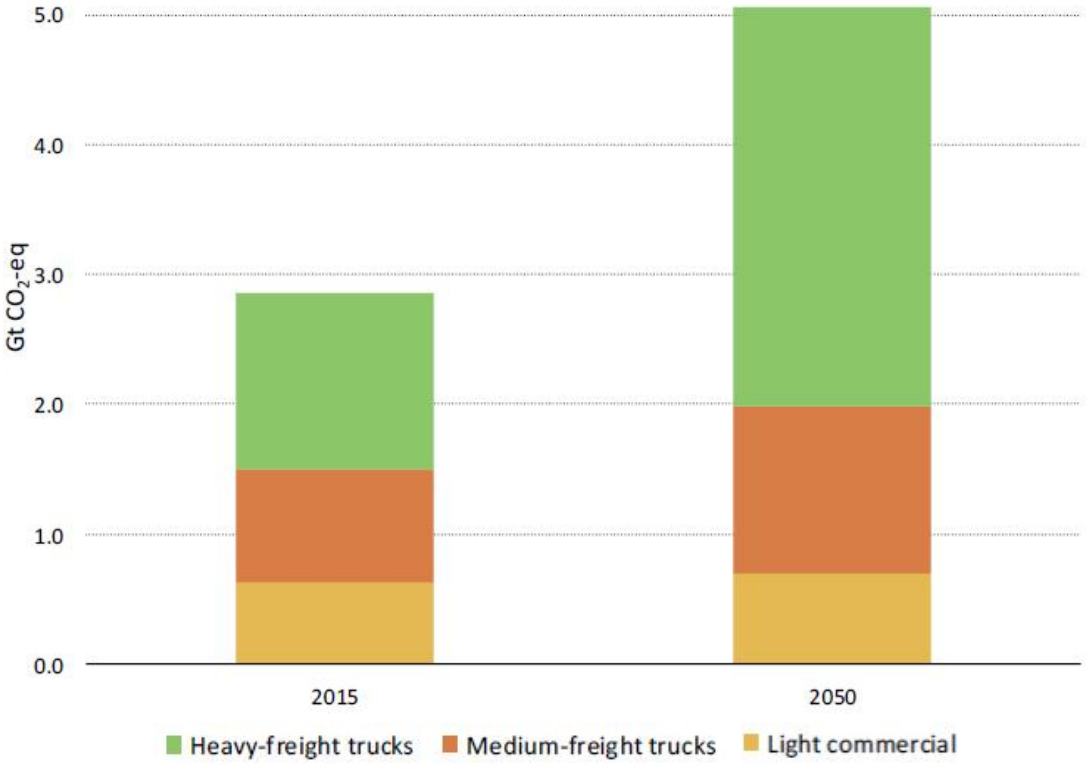
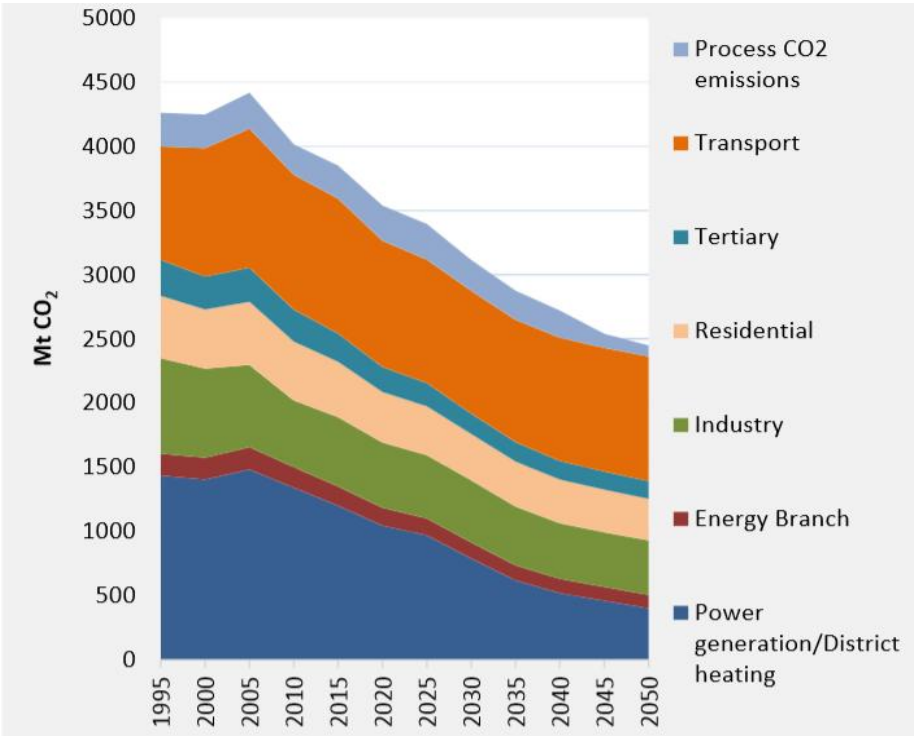
Based on latest policy announcements, **global heavy road freight** is forecast to emit 3 Gt $CO_2$ by 2050.



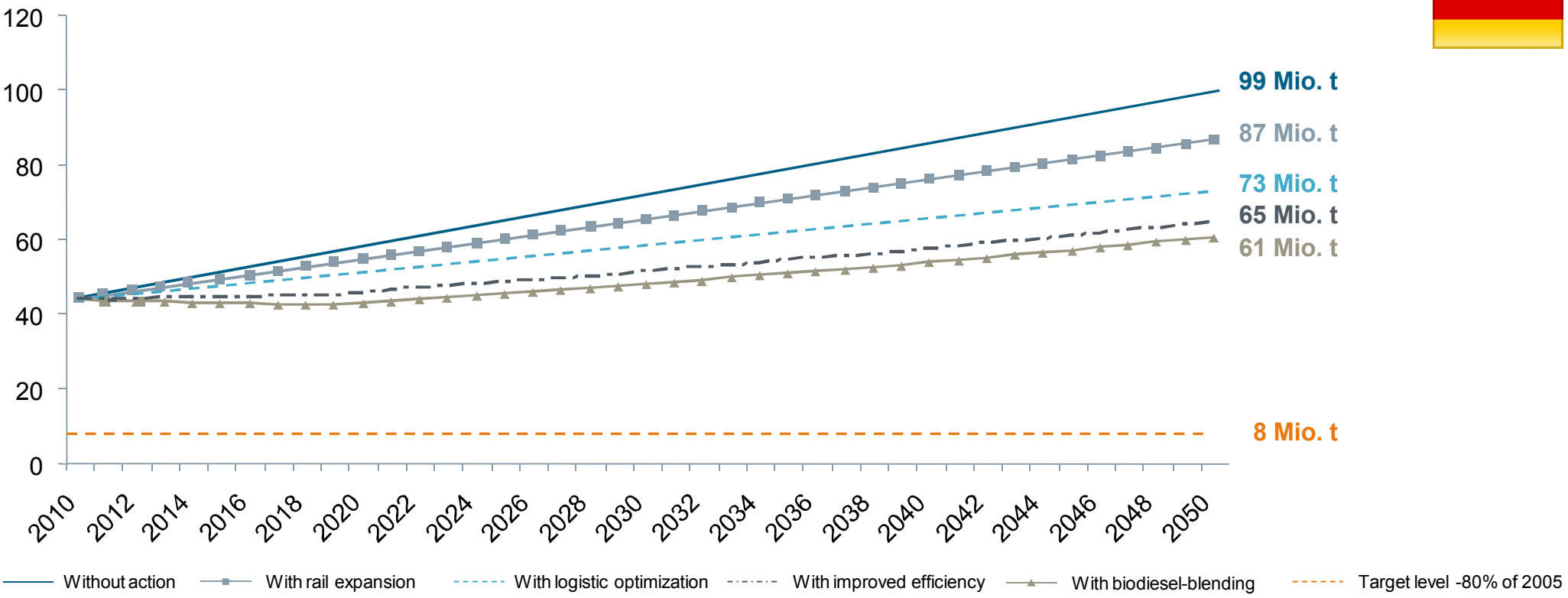

Source: IEA (2017)

Transport will increasingly be the biggest challenge for decarbonization in **Europe**.




Source: European Commission reference scenario for 2050 (2013)

# Measures to reduce road freight $CO_2$ emissions




Source: German Ministry of Environment (BMU), March 2013

# Zero emission trucks are possible with renewable energy, but efficiency varies greatly

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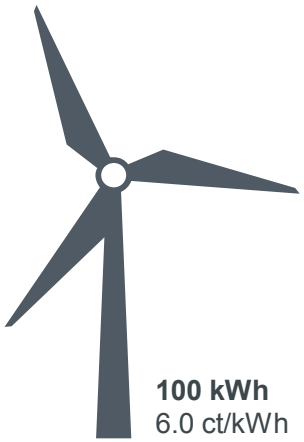
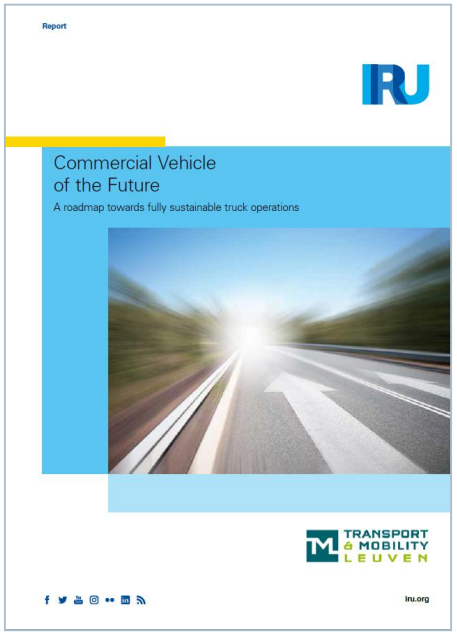



| Pathway | Range<br>Cost per km | Efficiency WTW | Example vehicle |
|---|---|---|---|
| Electric Road Systems<br>e⁻ → Grid (incl. catenary) → e⁻ → eTruck (Catenary-Hybrid)<br>96 kWh, 12 ct/kWh; 1,6 kWh/km | **60 km**<br>19 ct/km | 77% |  |
| Battery<br>e⁻ → Grid → e⁻ → eTruck (Battery)<br>96 kWh, 10 ct/kWh; 2 kWh/km | **48 km**<br>20 ct/km | 62% |  |
| Hydrogen<br>e⁻ → Electrolysis η = 70% → $H_2$ → $H_2$-network[1)] → $H_2$ → $CH_2$- fuel station → $CH_2$ → Fuel cell truck<br>2 kWh, 5 kWh<br>93 kWh; 65 kWh, 15 ct/kWh; 65 kWh, 18 ct/kWh; 65 kWh, 20 ct/kWh; 2.7 kWh/km | **24 km**<br>55 ct/km | 29% |  |
| Power-to-Gas<br>e⁻ → Electrolysis η = 70% → $H_2$ → Methanation η = 80% → $CH_4$ → NG-network[1)] → NG → CNG-fuel station → CNG → Gas-truck<br>2 kWh<br>98 kWh; 69 kWh, 15 ct/kWh; 55 kWh, 19 ct/kWh; 55 kWh, 20 ct/kWh; 55 kWh, 22 ct/kWh; 3.2 kWh/km | **17 km**<br>70 ct/km | 20% |  |

1) Including storage
Source: German Ministry of Environment

# Industrial and political push for electrified long-haul trucking is gathering pace




IRU represents commercial road users, such as trucking companies, across the world.

Thinks 40-45% of all EU long haul road transport need to be running on electricity by 2050

Advocates near term actions to pilot and commercialize electric road systems for trucks


*"Sweden and Germany agree to … campaign at European level for the wider spread of this technology."*
*- Joint Declaration of the German and Swedish Governments in January 2017*

# Alternative concepts for climate-friendly road freight transport

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**Investigated concepts comprise external power supply and on-board storage systems**

| On-board storage | | External power supply | |
|---|---|---|---|
| **Alternative fuels** | **Electricity** | **Contactless** | **Conductive** |
| CNG / LNG | Battery | Inductive power supply | Ground-based contact line |
| Bio fuels | Capacitors | Linear s. motor concepts | Overhead contact line |
| | Fuel cell | | |

# How it works - Animation & Reality


https://www.youtube.com/watch?v=zV2yZkRFBK0&t=7s

# Compatible with and complementary to other alternative fuel technology

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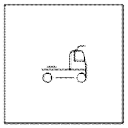
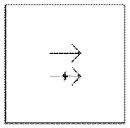
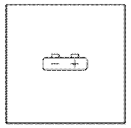
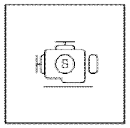
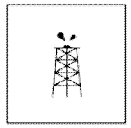
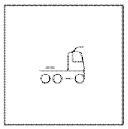
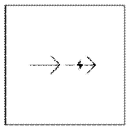
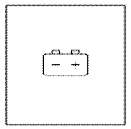
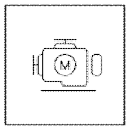
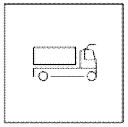
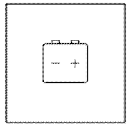
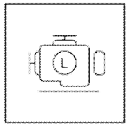
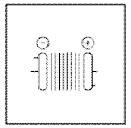
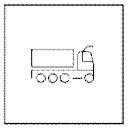
**The eHighway hybrid truck can be configured to suit specific applications**

| Truck types | Drive system | On-board source of electricity | Combustion engine | Non-electrical source of energy |
|---|---|---|---|---|
|  Tractor truck (2 axles) |  Parallel-hybrid |  Battery (small) |  Engine (small) |  Diesel |
|  Tractor truck (3 axles) |  Serial-hybrid |  Battery (medium) |  Engine (medium) |  Bio-fuel |
|  Rigid truck (2 axles) |  Full electric |  Battery (large) |  Engine (large) |  CNG/LNG |
|  Rigid truck (3 axles) | |  Fuel cell | |  $H_2$ |
|  Rigid truck (4 axles) | | | | |

# How it works - Animation & Reality


https://www.youtube.com/watch?v=4H7qM9pytYk&index=8&list=PLPlRtlVZUfnyuNDEvsaU5npEu-dEPPbW9

# eHighway is developing quickly and is ready for commercial use in near future

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## Development project

- Test track of 2.1 km with realistic highway conditions
- Cooperation with e.g. Scania and Volvo
- Technical assessment of complete system by TU Dresden & BASt (the German Federal Highway Research Institute)
- Analysis of the economic and ecological impacts by German federal ministries lead to announcement of field trials in 2017
- Several public reports have confirmed positive results: UBA (Sept 2015), Öko-Institute (Nov 2016), IRU (March 2017), IEA (June 2017 and forthcoming July 2017)
- Project-specific analysis always necessary

# Where are we now?

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## Sweden – Operation started


- **Innovation Procurement Process for demo projects by Trafikverket**
- **Field trial (2 years) started <u>June 2016</u>**
- **Overall aim:** evaluate ERS-options prior to introduction on road network
- **Scania as truck OEM**, second truck will join operation July 2017

## USA – trucks ready

- **eHighway** to reduce emissions of port links on **1-mile** infrastructure near ports in L.A. and Long Beach
- **Cooperation with Volvo Trucks** and local truck converters
- **Contract with South Coast Air Quality Management District** testing for at least 6 month in 2017

## Germany – field trials planned


- **Cabinet of the German Federal Government** – decided on field trial of eHighway ERS in call 10/2015
- Project decision for Federal States Schleswig-Holstein and Hesse
- First tender was published 03/2017
- **Construction** approx. **2017** // **field trials** approx. **2017-2019**

# The path forward focuses on the electrification of highly frequented routes

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## eHighway application fields

**Near term**

Shuttle transport

Mine transport

**Long term**


Long haul traffic

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


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Elektrisch in die Zukunft

# Thank you for your attention


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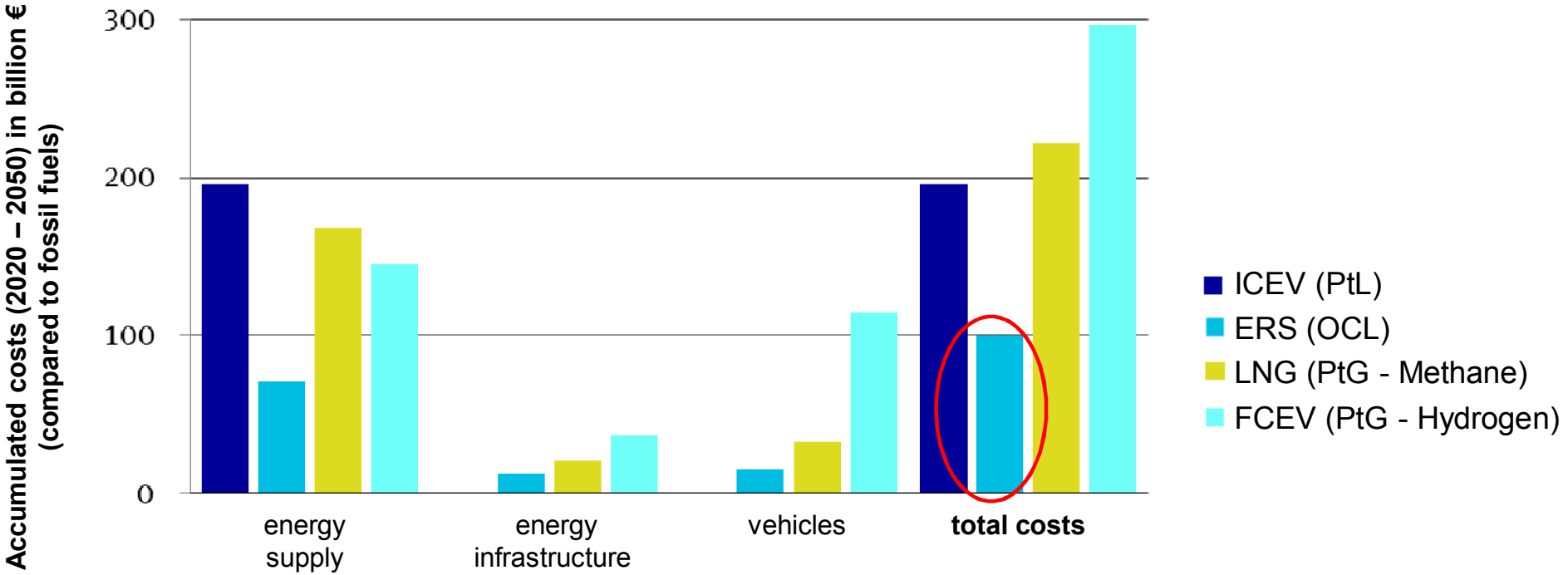
**#eHighway**

# External assessment ... ecologically and economically beneficial




**Key assumptions:**

- Length of electric network: 4,000 km; Infrastructure costs: 2.2 million €/km; Maintenance 2.5% of investment per year
- Additional vehicle costs: per today 50,000 € / truck; per 2050 19,000 € per truck; share of direct electric traction: 60% in 2050