The way to carbon-neutral road transport - a long-term race over three decades!

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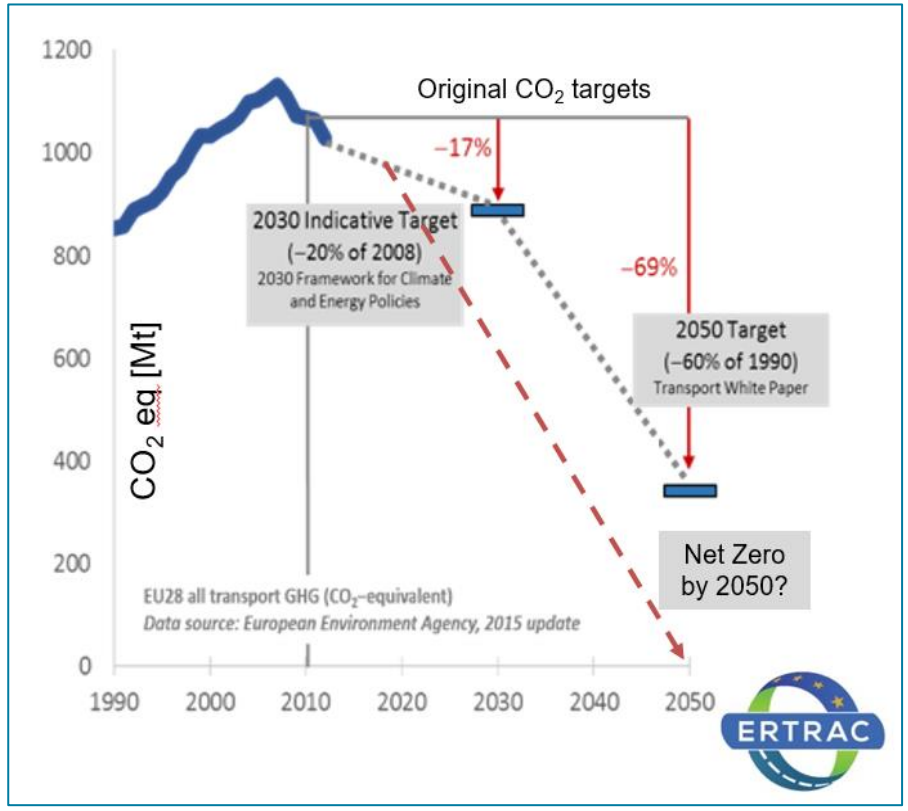
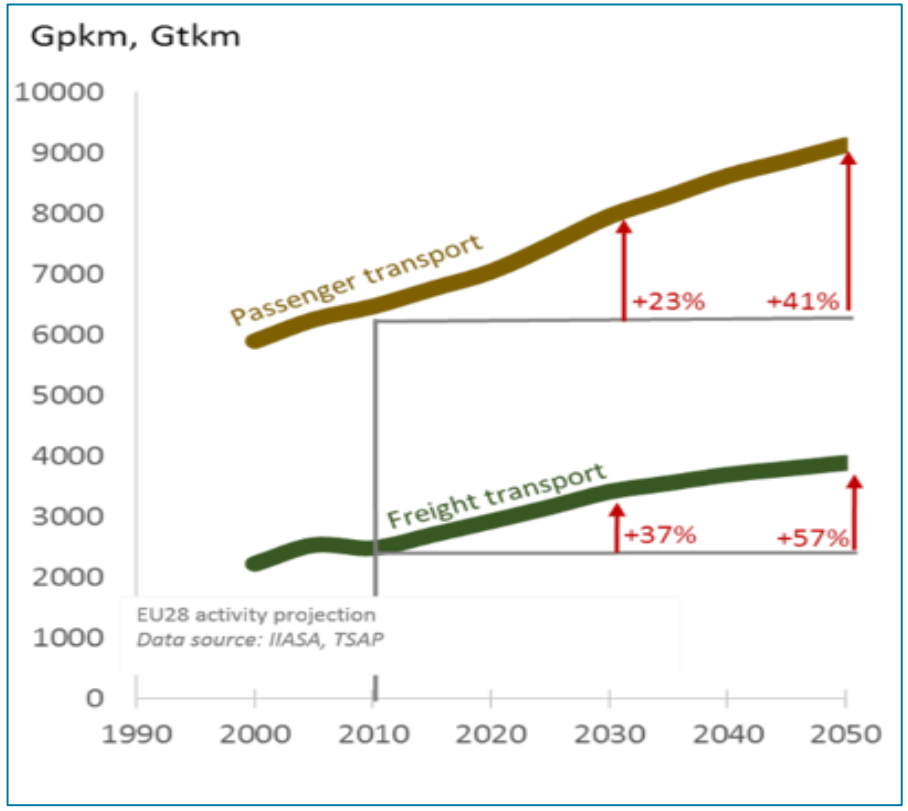
European Road Transport Research Advisory Council

European CO_2 targets for transport



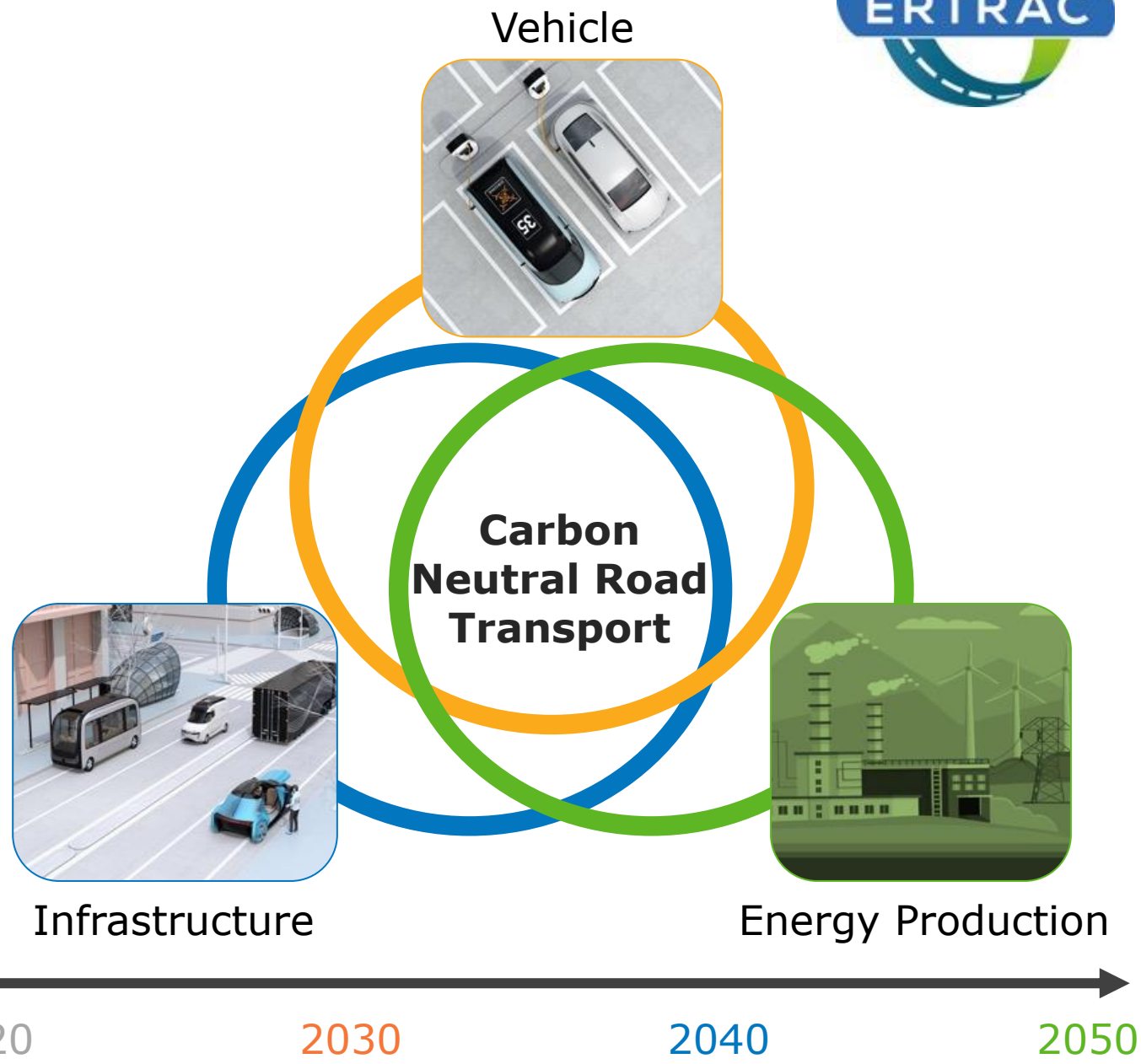


To reach the overall European CO_2 targets for transport,
a systems approach is needed:

Vehicle technologies, Infrastructure & Energy Generation

Carbon-neutral Road Transport:

- Intertwined between vehicle, infrastructure and energy production
- Long-term race over three decades!



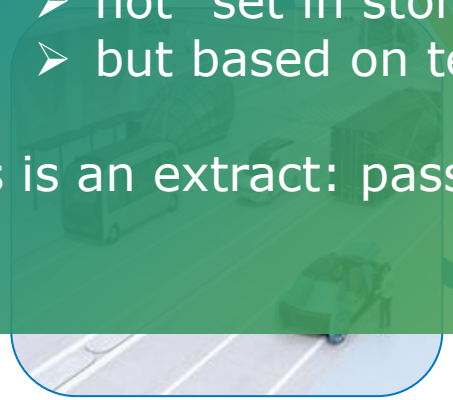
On-going discussion:

"What could the transformation look like?"

The following charts will suggest a possible timeline:

- not "set in stone"
- but based on technical neutrality

This is an extract: passenger cars are included but not shown here



2020 2030 2040 2050

Carbon Neutrality in Road Transport

The decade 2020-2030

Carbon Neutrality in Road Transport

Commercial Vehicle – Medium Duty

- **Internal Combustion Engines (ICE):**
  - Prevalent prime-mover for extra urban use
- **BEV and PHEV:**
  - Increase of New Vehicle Registrations based on local regulations

Carbon Neutrality in Road Transport

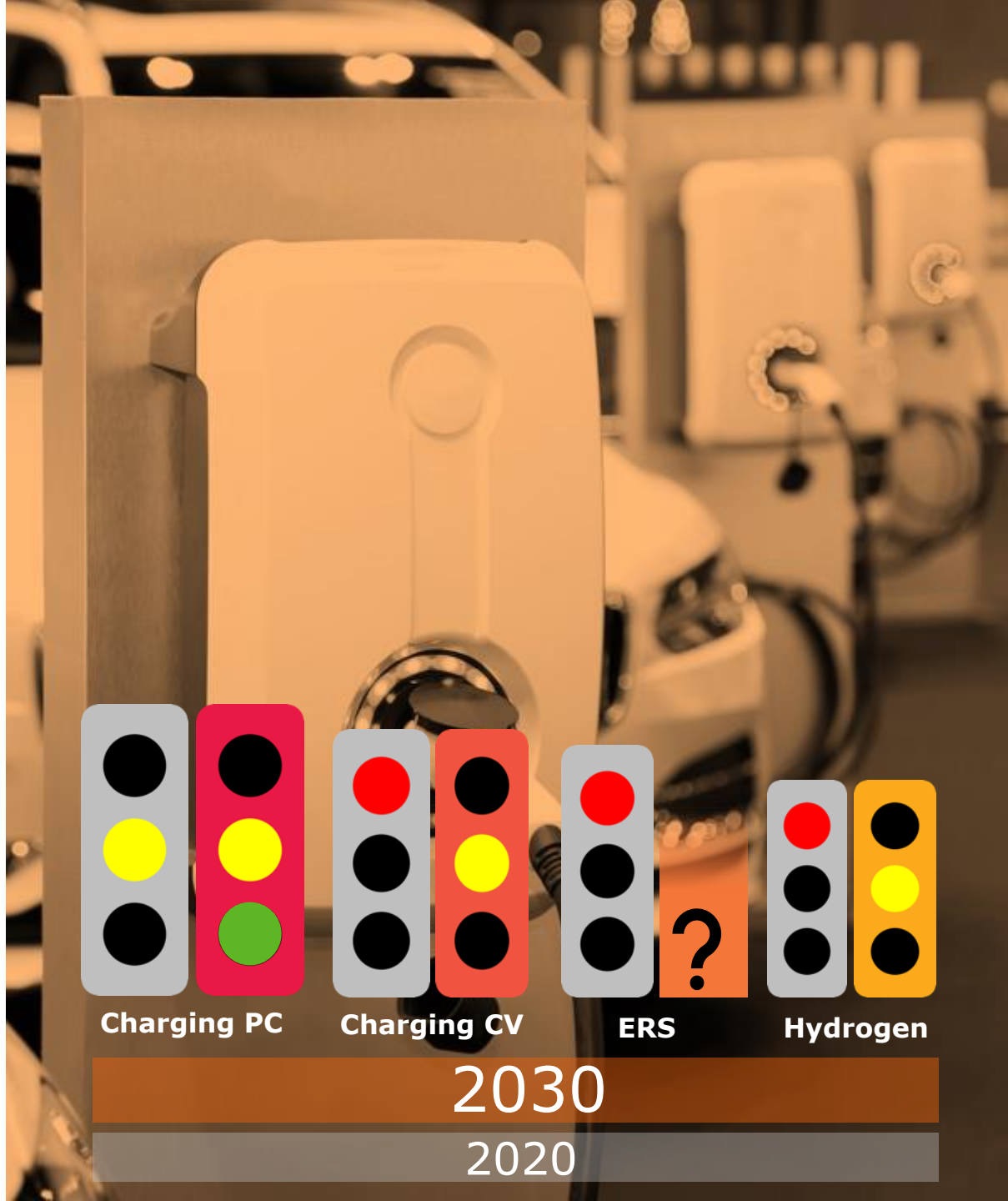
Commercial Vehicle – Heavy Duty

- **Internal Combustion Engines (ICE):**
  - Most prevalent prime-mover
  - Efficiency improvements
  - Mild-hybridization
  - Natural Gas is an alternative to conventional fuel in some corridors
- **BEV:**
  - Finding niche market applications
- **Electrified Road Systems (ERS):**
  - Only on specifically selected routes (testing and evaluation)
- **Fuel Cell Electric Vehicles (FCEV):**
  - First applications available

Carbon Neutrality in Road Transport

Infrastructure

- **Charging infrastructure for Passenger Cars** (PC) available
- **Charging infrastructure for Commercial Vehicles** (CV) insufficient
- **Electrified Road Systems (ERS)** are present on publicly funded test routes: decisions for long-term investment in ERS have yet to be made
- **Hydrogen** is available at specific filling stations
- **"Zero emission zones"** in European cities: BEV, FCEV, PHEV each in e-mode



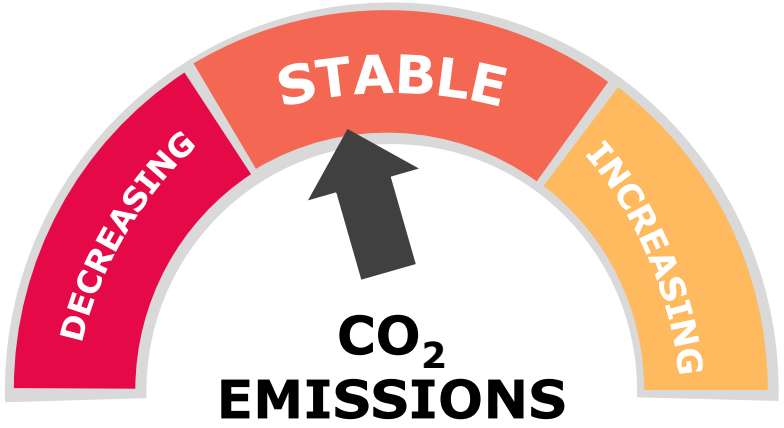
Carbon Neutrality in Road Transport

Energy Production

- **Fuels** mainly fossil based
- Less than 20% **"renewables"** in EU, on average
- **Electricity** becoming "greener" but still not climate-neutral
- Passenger Cars' electricity demand is increasing
- Electricity production **capacity** is not a problem
- **Local distribution infrastructures** face issues

Milestone 2030

- **Emissions:** Climate relevant emissions from road transport are decreasing but slowly, due to the low rate of vehicle stock turnover yet growing road transport, and the levels of investment in the energy and infrastructure aspects that are needed
- **Air quality** limits related to road transport are achieved, as far as possible, all across Europe (even in hotspots)
- **Alternative technologies** for CO_2 reduction (Well to Wheel) are pushing strongly into the market



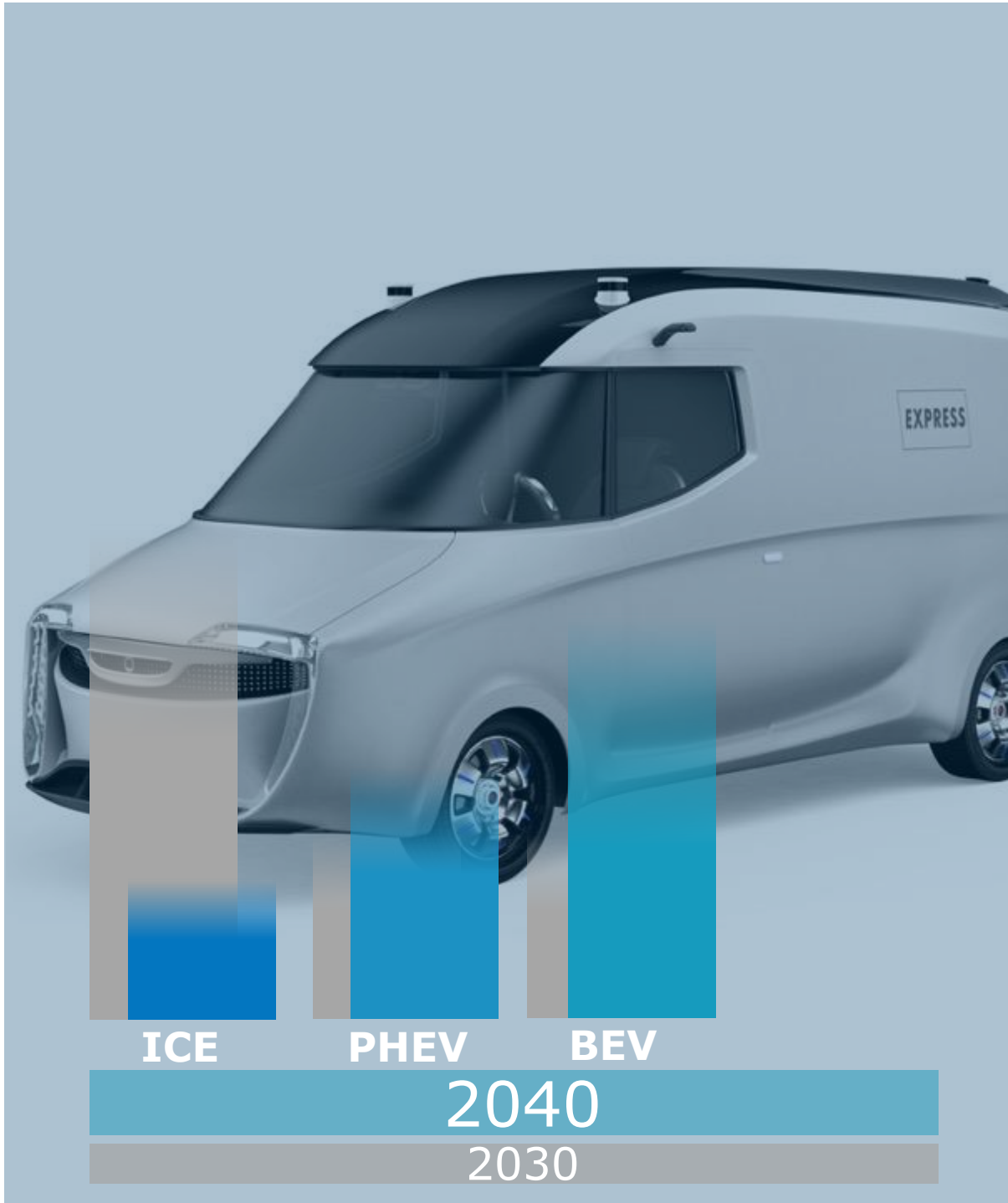
Carbon Neutrality in Road Transport

The Decade 2030-2040

Carbon Neutrality in Road Transport

Commercial Vehicle – Medium Duty

- **Most powertrains are hybridised or purely electric**
- **BEV & PHEV:** used for urban operations mostly
- **ICE:** only used for extra-regional activities



Commercial Vehicle – Heavy Duty

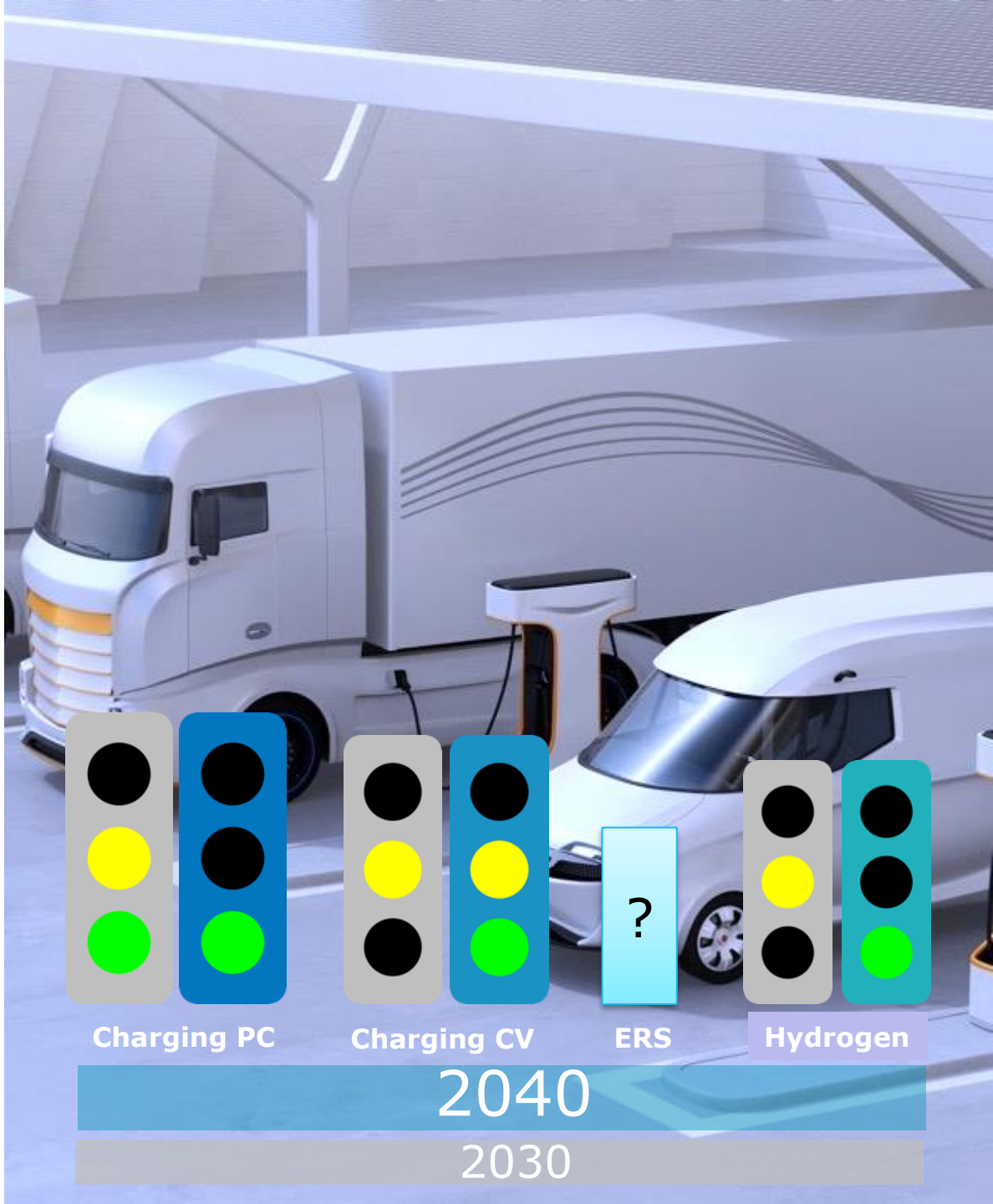
Competition between BEV, FCEV & H_2 ICE

- **Internal Combustion Engines (ICE):**
  - Prime-mover, yet in highly-electrified powertrains
  - Further efficiency improvements continue
  - "Drop-in renewable fuels"
- **BEV & PHEV:**
  - Become relevant for regional transport
- **Fuel Cell Electric Vehicles (FCEV):**
  - Alternative to IC engined vehicles
  - Main corridors with H_2 refuelling infrastructure
- **Electrified Road Systems (ERS):**
  - Depending on previous infrastructure investments
  - ERS in specific use-cases

Carbon Neutrality in Road Transport

Infrastructure

- **Charging infrastructure** for Passenger Cars (PC) applications established in urban and most other areas
- **Smart and fast** charging facilities
  - Charging infrastructure for Commercial Vehicles (CV) is still limited
- The main corridors equipped with sufficient **H_2 filling stations**
- Depending on investments, **ERS** will be established in some publicly funded corridors
- Zero emission zones in cities are standard



Carbon Neutrality in Road Transport

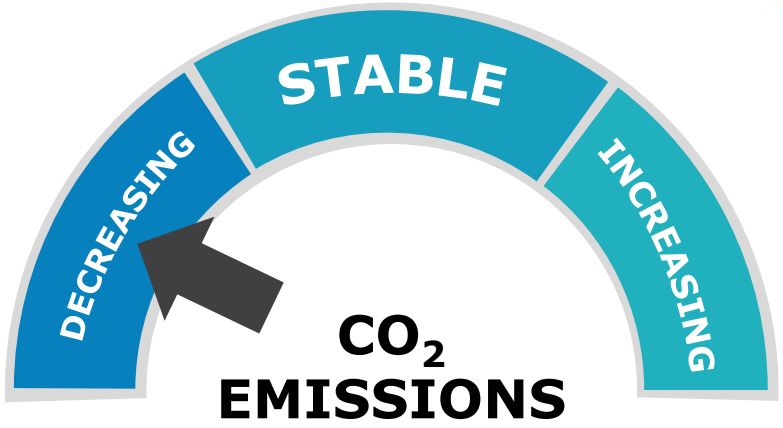
Energy Production

- **Defossilised fuels:** production is increasing
  - Rate of renewables ≤ 50% drop-in
- **Hydrogen:** mostly produced in a renewable, carbon-free way
- **Electricity:** predominantly produced in a carbon-neutral way
- **Electricity consumption** by road transport is growing significantly
- **Peaks in energy demand** may cause issues
- **Smart Charging** is being established

Carbon Neutrality in Road Transport

Milestone 2040

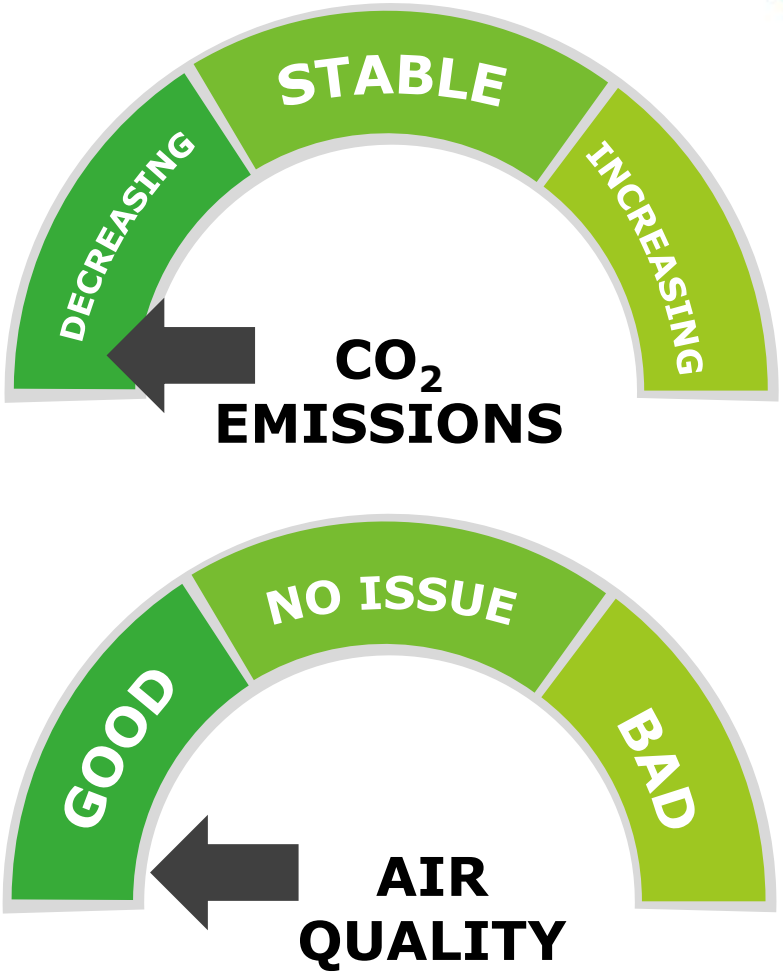
- **Air Quality:** Since the vehicle stock is renewed, air quality relevant emissions from road transport are no longer an issue
- **Emissions:** Whilst the mobility of people and goods continues to grow, climate change relevant emissions (CO_2 etc.) from road transport are decreasing rapidly



Carbon Neutrality in Road Transport

Milestone 2050

- All of road transport, throughout Europe is climate-neutral (Well to Wheel)
- Air-quality is not affected by powertrain emissions anymore



Summary:

- **Achieving carbon-neutral Road Transport** will be a decades-long race
- **Strongly linked** between vehicles, energy and infrastructure technologies
- The **technologies and their rate of change vary** in the different vehicle segments
- Existing technologies need to **be improved** and new technologies need to **be developed**
- **Huge investments** in Research & Innovation are **needed …**
  … in all three sectors

Carbonneutral energy