52nd ASECAP DAYS

Challenges of Future Mobility | The Role of Road Infrastructure

Organized by ASECAP Hosted by seopan Asociación de Empresas Constructoras y Concesionarias de Infraestructuras

26 - 28 May 2025 | Madrid
www.asecapdays.com

Perspectives, benefits and conditions of deployment of Electric Road Systems on motorways

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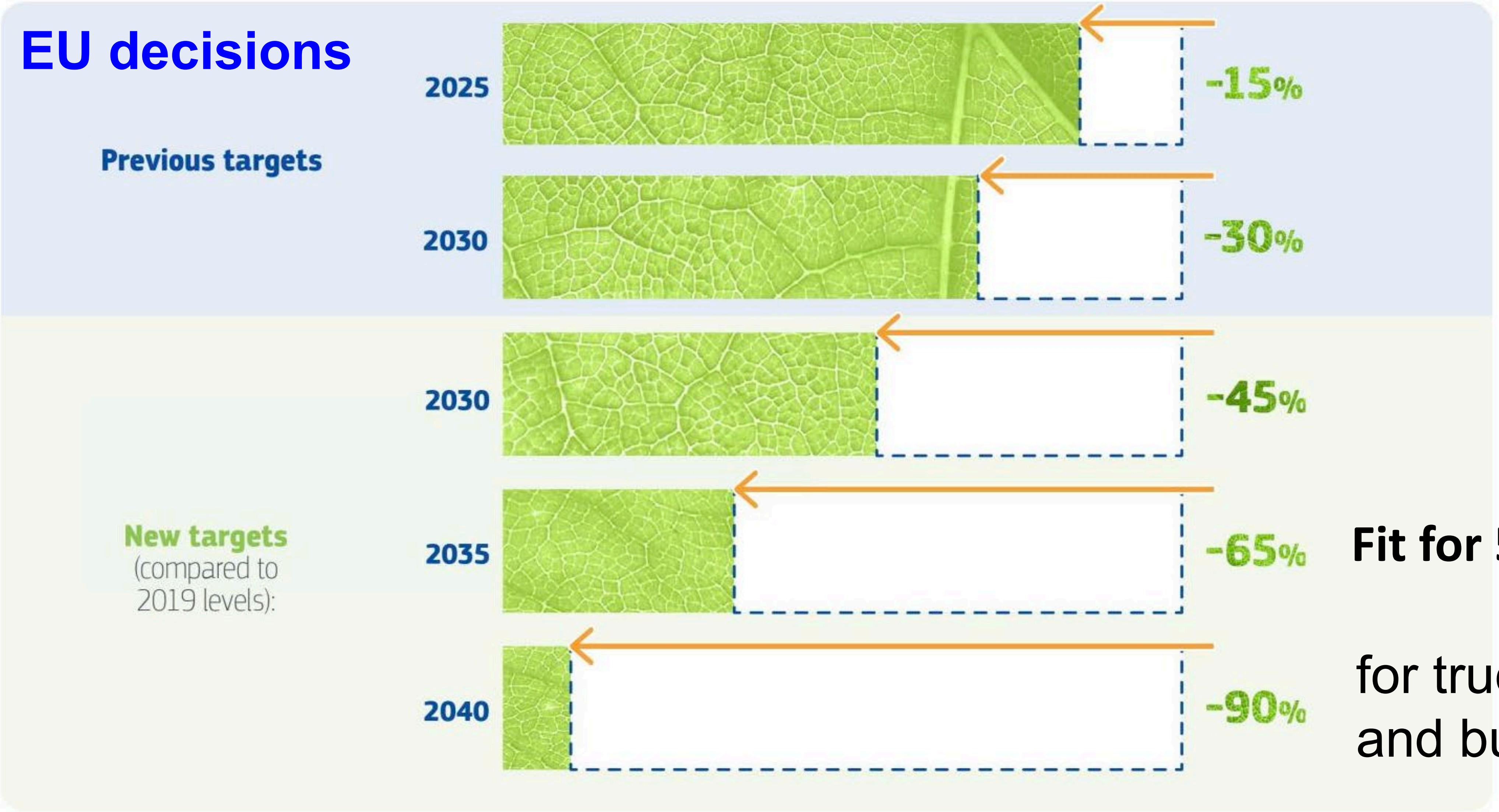
EU Challenges for decarbonizing Road Transport



- Road share: 75% - 88% EU - FR
- Road: >30% of CO2 emissions, >10% freight
- still increasing by 27% from 1990

Fit for 55

for trucks, coaches
and busses > 3.5 t

Carbon neutrality by 2050

European Commission

Climate Action

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Biofuels: limited amount of biomass and RED III constraints

- First generation biofuels save less than 65% of CO_2 (lifecycle analysis) $\Rightarrow$ do not comply with RED III (but used oils). Tolerance for existing units.
- Second generation biofuels (e.g. BioTfuelTM, IFPEN) comply with RED III but more energy required than diesel!
- Biogas complies with RED III without leaks.
- Road mobilities use 1.5 TWh of biogas (2022). The produced biogas (183 TWh) is used by electric power plants, heating, agriculture and industry. The natural gas (3420 TWh) needs to be replaced by biogas.
- The availability of biomass is the limiting factor.

→ Incomplete and transient solutions

Hydrogen: efficiency, price and availability

- The **energy efficiency** is **2.5 lower** than a BEV:
  - Electrolysis production: 55 kWh/kg 60% efficiency) or high temperature 42 kWh/kg (75%)
  - Conservative assumptions for BEVs

	EV with H_2	BEV
Electricity Transport Losses	2%	8%
Battery charge / discharge		85%
Electrolysis efficiency	55 / 42 kWh/kg	
Compression-Transport-Distribution	5 kWh/kgH_2	
Leaks H_2	? (0)	
Fuel cell efficiency	55 %	
Inverter and electric engine efficiency	90%	90%
Total	**27.0 / 34.4 %**	**70.4 %**

- Current demand of H2 (mainly from fossil materials) for fertilizers, chemistry, oil and other industries) = 9.7 Mt (330 TWh)
- Demand in 2035 for aviation and maritime = 8.5 Mt (282 TWh)
- Long distance freight transport: +11.7 Mt (390 TWh) by 2050 (≈ 50% by 2035)

→ **« niche / rich » solution**

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BEV (trucks) for long distance

It exists…

- Mercedes « eACTROS Long Haul »
- 42 t, engine: 400kW, range: 500 km, battery LFP 620 kWh
- Battery recharging 20%-80% in 30 min (at 750 kW) or ≈1h (at 400 kW)
- Battery weight < 4t ⇒2 t payload loss

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But…

Static charging of batteries on motorways

- Fast charging stations (0.75 to 1 MW) + slow charging stations (100 to 150 kW)
- Scenario
  - Start with full battery (620 kWh)
  - Driving 4.5 hrs @ 80 km/h (360 km): 430 kWh $\Rightarrow$ battery 30%
  - Pause 45 min: battery fast recharging up to 85-90%
  - Driving 4.5 hrs $\Rightarrow$ battery 15 to 20%
  - Long pause 11.5 to 12 hrs: slow battery recharging (station @ 100 kW) $\Rightarrow$ 100%

- Needs on service area – motorways
- 2035 (20% of BEVs)
  - 2000 FCS on 400 area: 5 FCS - 4 MW/area
  - \+ cars and LCVs: 6 to 10 MW/area
    $\Rightarrow$ 10 to 14 MW/area (20 kV OK)
- 2050 (80% of BEVs)
  - 6 to 8000 FCS: 25 MW/area
  - \+ cars and LCVs: 20 to 30 MW/area
    $\Rightarrow$ 45 to 55 MW/area (200 to 400 kV!)
- Requirements/locks:
  - 1 ha transformer + more parking space
  - High voltage lines…

Why ERS?

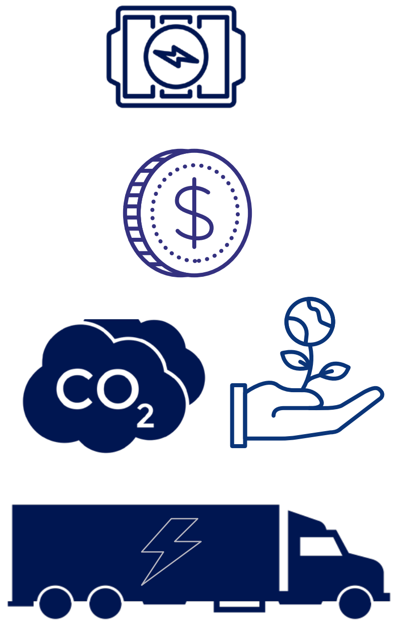
Electricity is easy and cheap to transport, but difficult to store

Liquid biofuels and biogas

Large electric batteries

Hydrogen

Electric Road Systems ✓



- Drastically reduce battery size
- Reduce vehicle cost
- Reduced carbon and material footprints
- Eliminates range and downtime limitations

- **DGITM requests** Compare ERS technologies through experiments Decide on the best solution to deploy at scale

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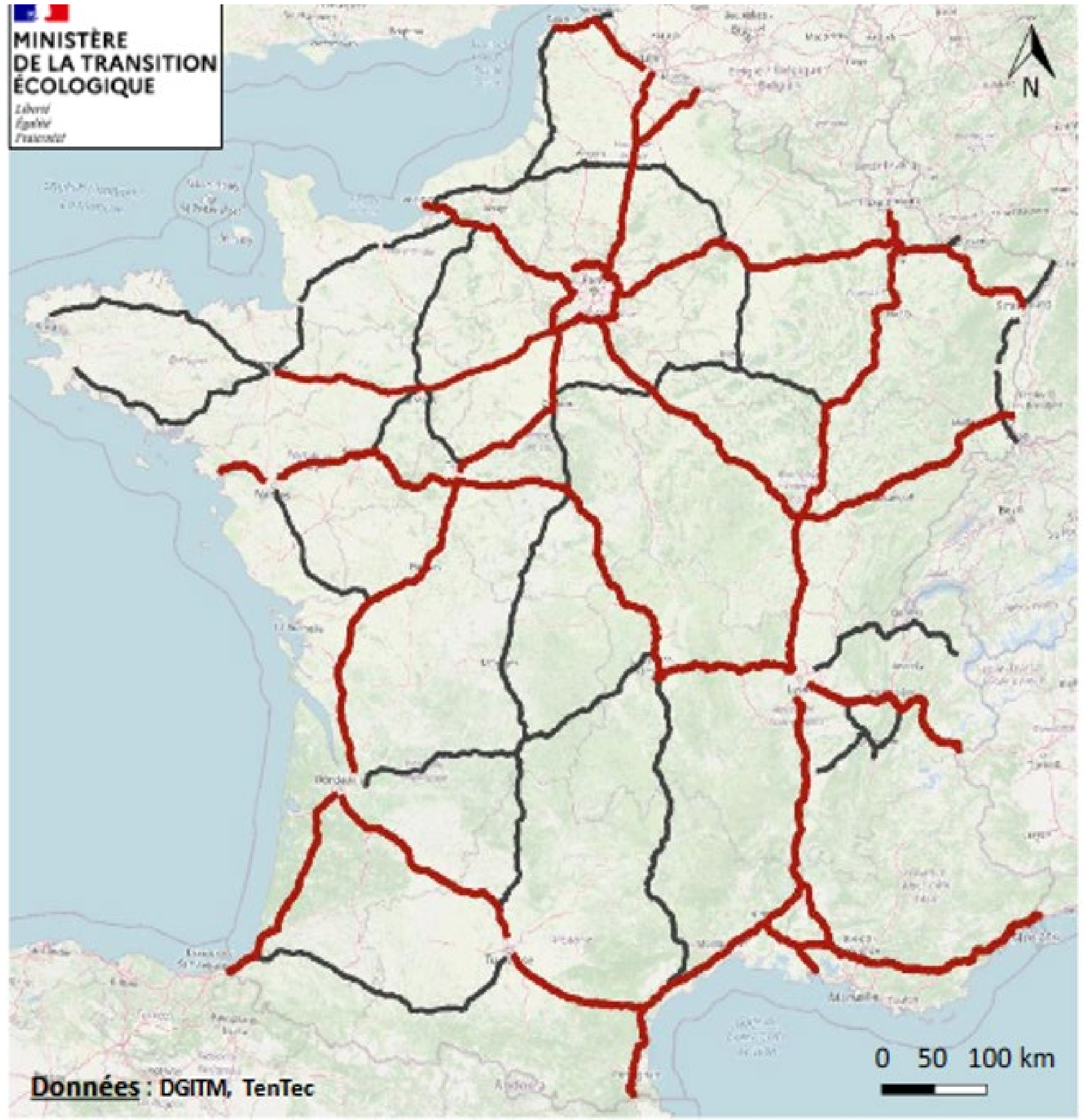
Potential ERS deployment in France

ERS perimeter phase 1 (red) and phase 2 (black)



- ≈ 9000 km of motorways (TEN-T)
- Battery of 380 kWh (range 250 km)
- Max. 350 kW/truck (44 t fridge + charging)

- Phase 1 : 4900 km, phase 2 : 3950 km
- GHG: -87% vs -72% with BEVs & FCS
- Business model
  - Investment 40 Bn € - maintenance 2%/yr - lifetime 35 yrs
  - Cost of electricity: 75 €/MWh (intensive), sold at 220 €/MWh (26 TWh/an)
  - **ROI: ≈6,5%**
  - Concessions + incentives, TCO maintained
- Saving compared to a full network of FCS (-50% ??)

Experimentations of ERS in France

Two main projects, funded by BPI France:

Charge As You Drive
Less Battery. More Range. For All

VINCI AUTOROUTES · VINCI CONSTRUCTION · electreon · HUTCHINSON · ELONROAD · Université Gustave Eiffel

Objectives

- Experiment 2 dynamic charging technologies on motorway
- In operational conditions

eRoadMontBlanc

ATMB · PRONERGY · Université Gustave Eiffel · ALSTOM mobility by nature · greenmot

Objectives

- Experiment 1 dynamic charging technology in Transpolis / RN205
- In operational/alpine conditions

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Thank You

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