Studies on Electric Road Systems in the Netherlands

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Background: electrification of road freight transport

Policy (EU)

- “Fit for 55” & AFIR truck charging infrastructure: public high-kW chargers at least every 100 km
- Standardized charging networks

Market

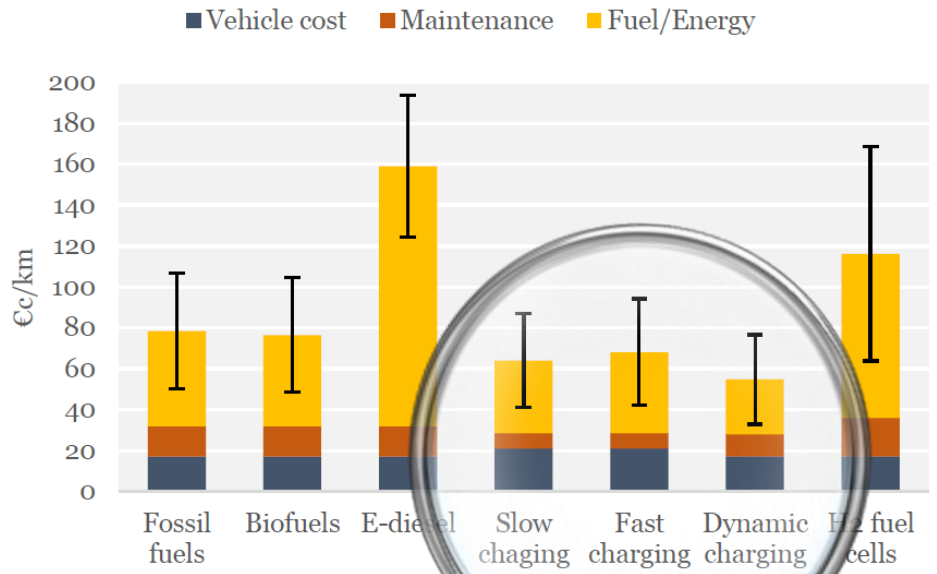
- BETs = 0.3% of total sales (EU 2022)
- But: cost parity with diesel reached in **2030**

Problems

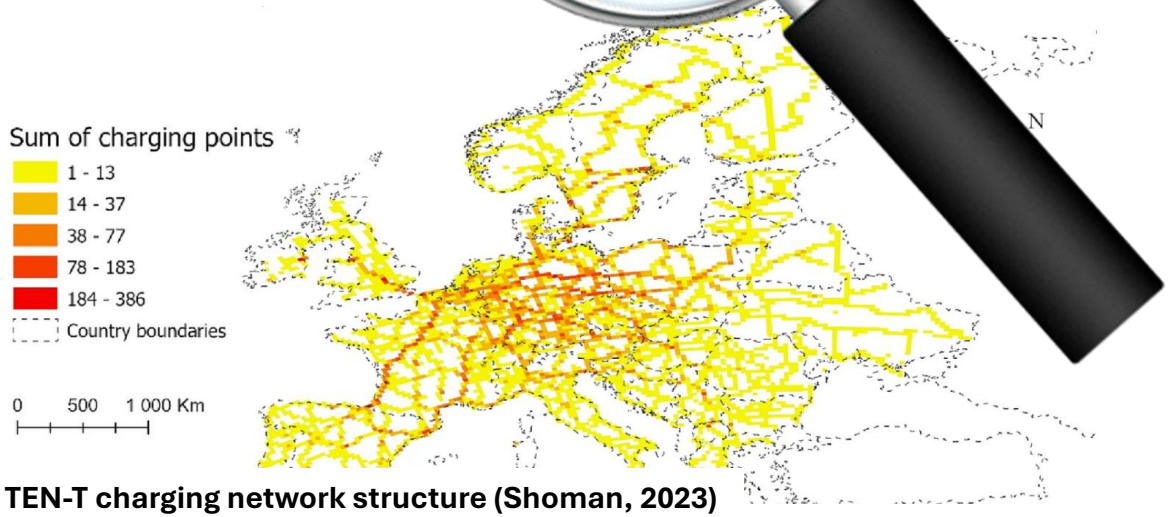
- 78.000 BETs to be charged daily in the EU in 2030 (Shoman, 2024)
- ACEA: more power needed + 40.000 overnight chargers by 2030!

➔ **Infrastructure likely to be a bottleneck for adoption**

* BET = Battery Electric Truck



Alternatives in 2035 (Rise, 2023)



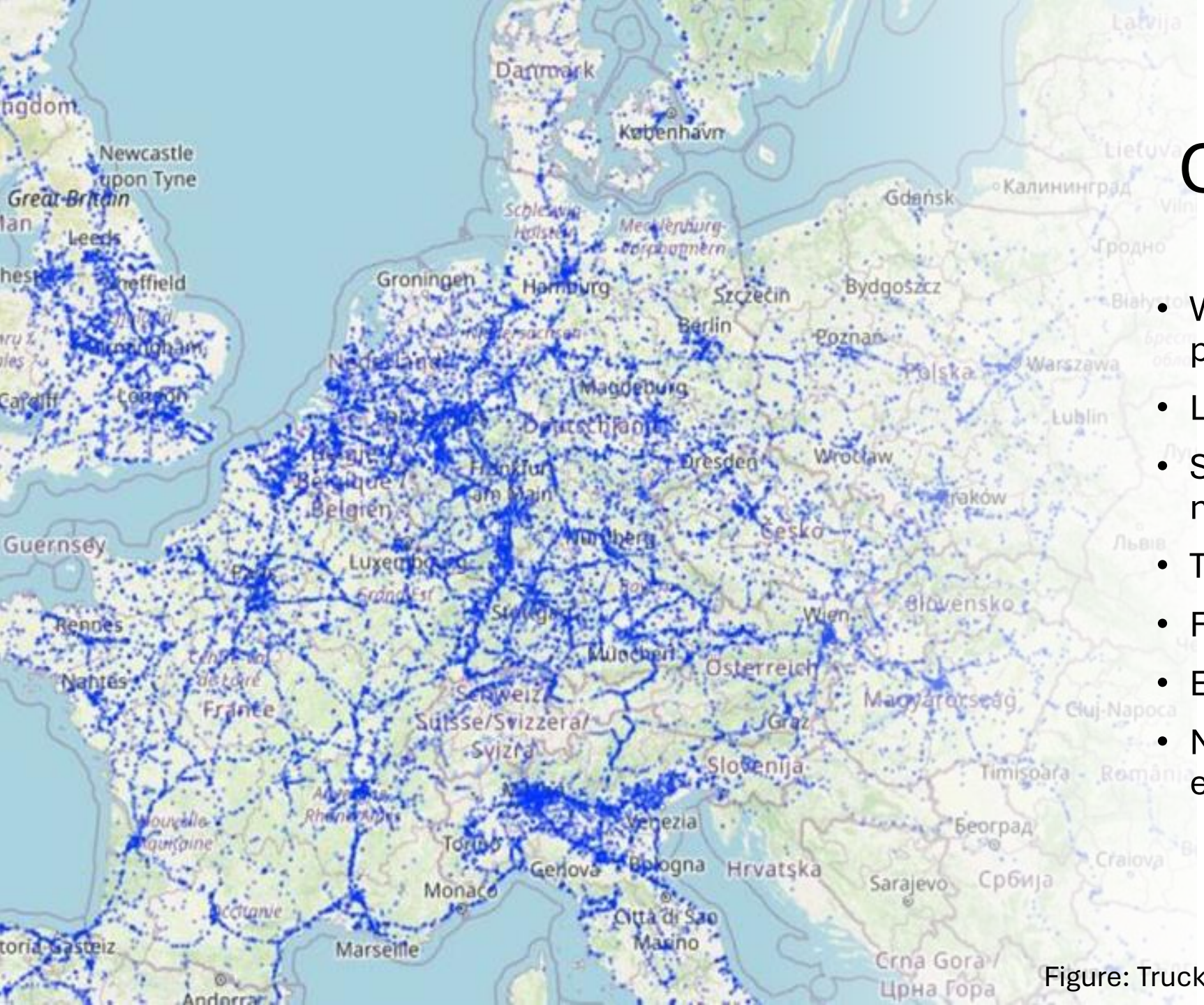
TEN-T charging network structure (Shoman, 2023)

3 Alternatives for Charging

1. **Depot (home) charging**: low-power (100kW), night-time
   - Cheap, private charging
   - Big batteries needed (long haul: 700 kWh +)
   - Electricity mix: not so green

2. **Charging Stations**: high power (1MW), 24/7
   - Heavy battery
   - High weight & volume: up to 20% payload reduction
   - Queuing + Waiting: 63€/hour (NL)

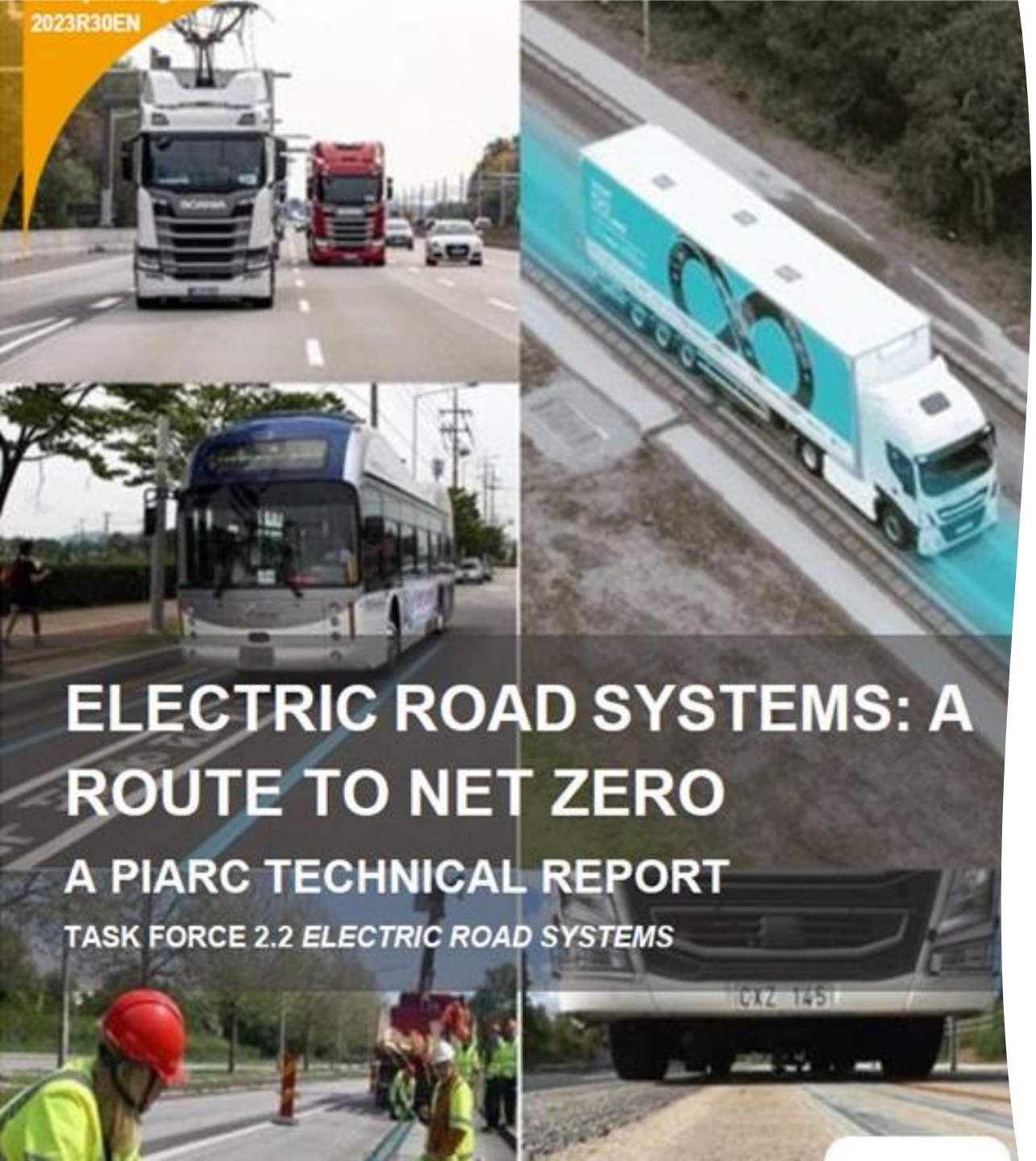
3. **Dynamic Charging**: medium power (400 kW)
   - **Electric Road System (ERS)**
   - Reduced truck costs & weight
   - Major infrastructure investment (2-3 M€/km)



Open questions

- Which charging infrastructure: private/public; static/dynamic?
- Locations of charging stations?
- Standards for international networks?
- Timing of roll-out in EU?
- Funding and subsidies? How?
- Effect on logistics?
- National competitiveness effects?

Figure: Truck stops in Europe - source: Fraunhofer, 2021



Comparing ERS to charging stations

Financial impacts of ERS

- Truck costs lower due to lighter battery
- Charging not needed during breaks
- Direct electric driving => longer battery lifetime
- Centralized investment & maintenance

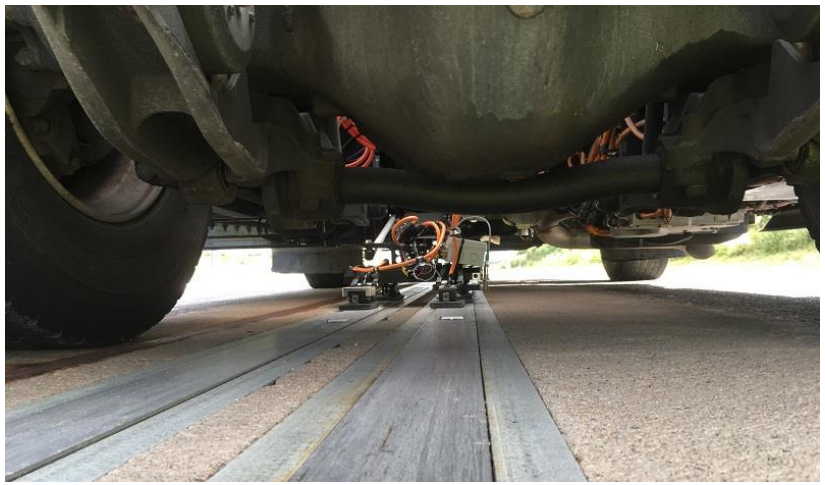
Strategic impacts of ERS

- Fewer charging stations
- More parking space
- Faster roll-out
- Vehicle-to-Grid reduces grid pressure
- Less reliance on batteries

Comparison of ERS technologies: choices ahead

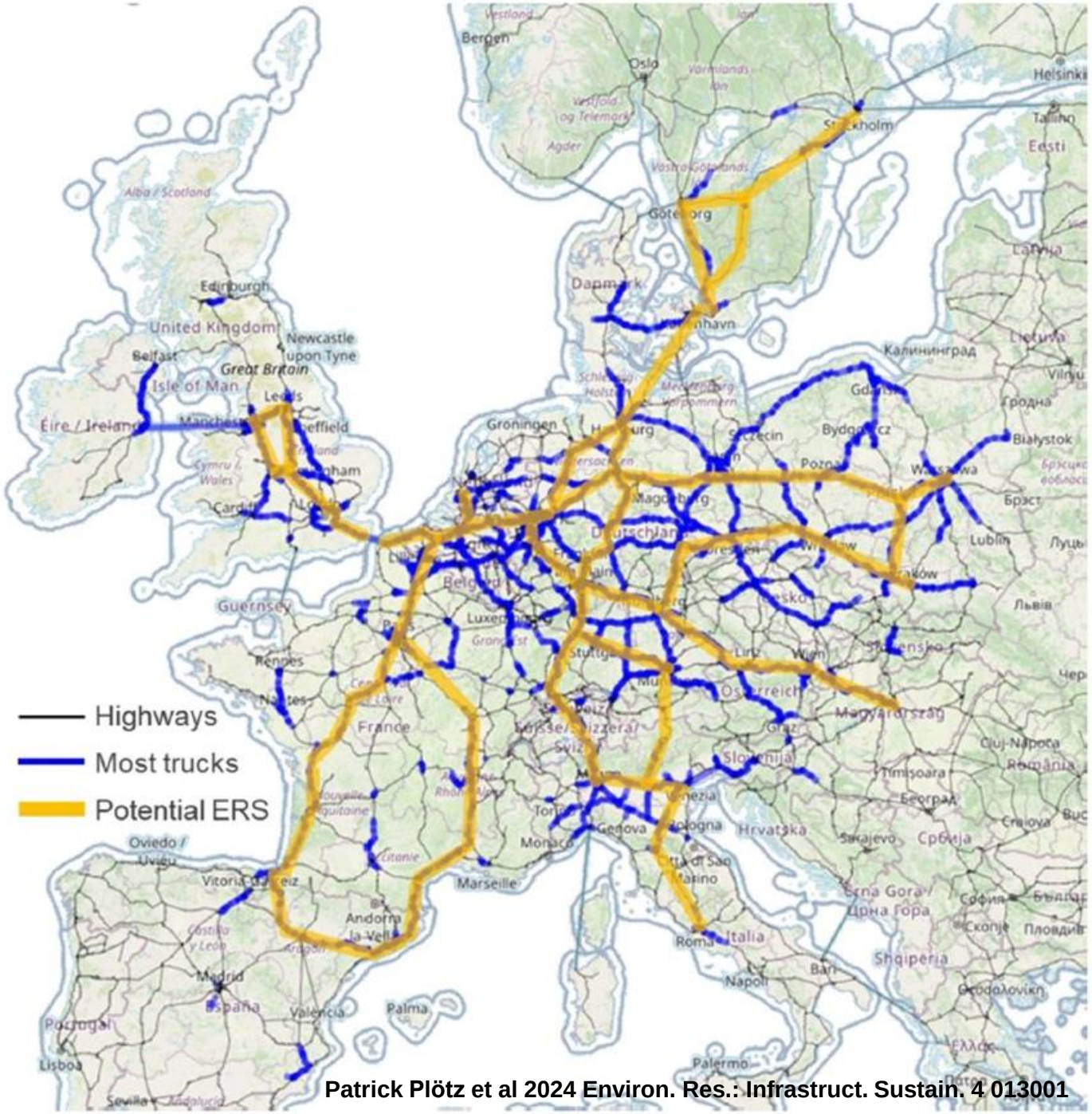
	Overhead lines	In-road systems
Years to deployment	+	-
Extreme weather risk	-	+
Energy demand	+	-
Investment costs	+	-
Maintenance costs	-	+
Hindrance	-	+

Siemens: overhead, conductive



Alstom, Elonroad: in-road conductive

Electreon: in-road inductive

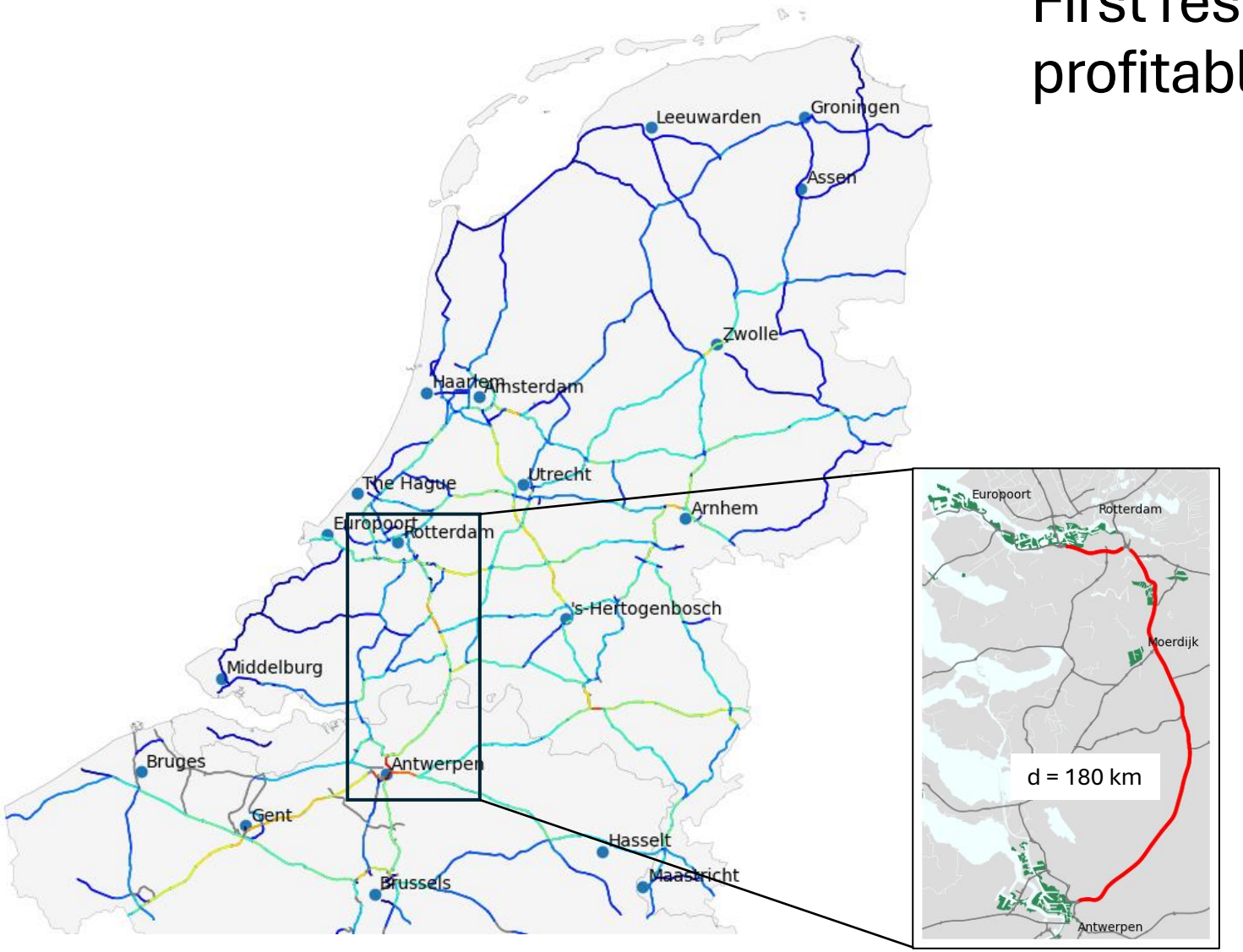


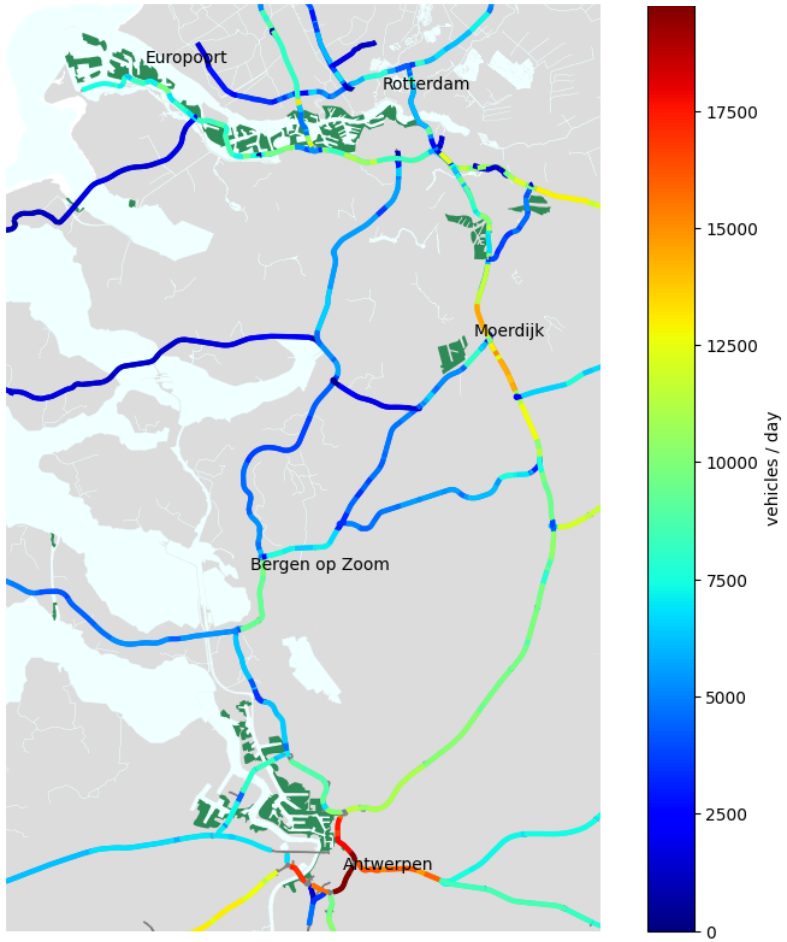
Patrick Plötz et al 2024 Environ. Res.: Infrastruct. Sustain. 4 013001

E-CORE project

- ERS Corridor Rotterdam-Budapest
- NL, D, A, H collaboration, national funding
- Project lead = Germany (IKEM)
- Hungarian project started June 2024 (KTI)
  - Corridor and user identification
  - Prerequisites for construction and operation
  - Integration Hungarian toll system & European system

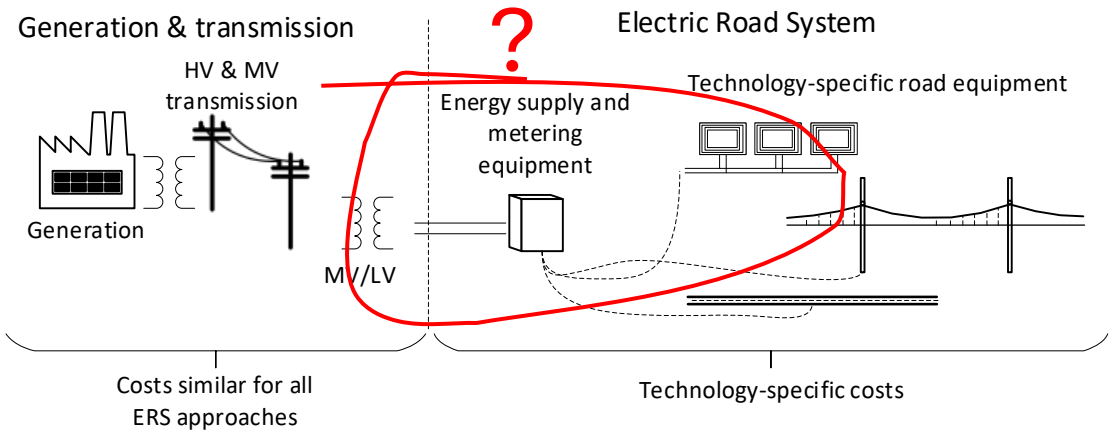
First results Rotterdam-Antwerp: profitable above 5-15% ERS share



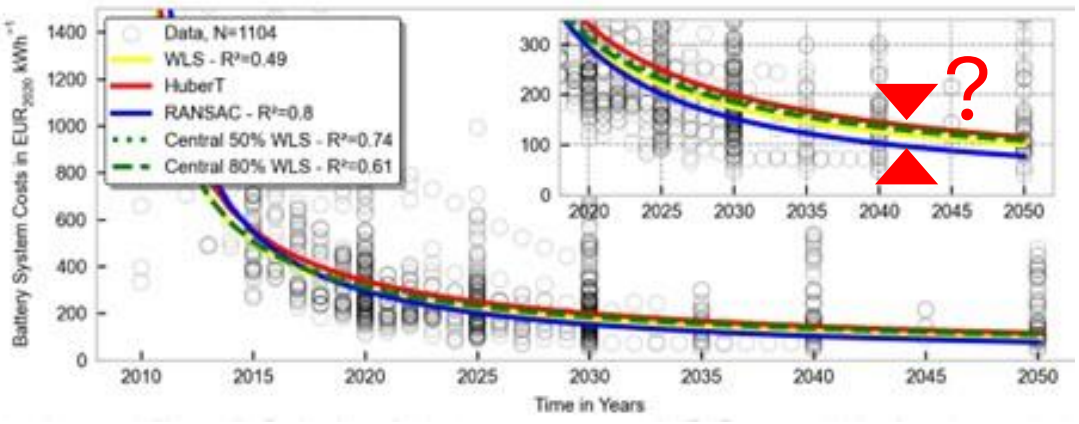


Source: University of Antwerp (2023), TNO/TUD (2024)

Path forward



Transport/Energy connections (University of Antwerp, 2024)



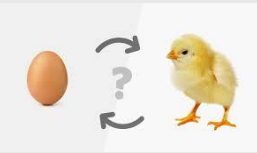
Battery prices (Link et al. 2024)

Critical innovations

- Access to charging
- Truck operations
- Electricity grid update
- Policy for BETs

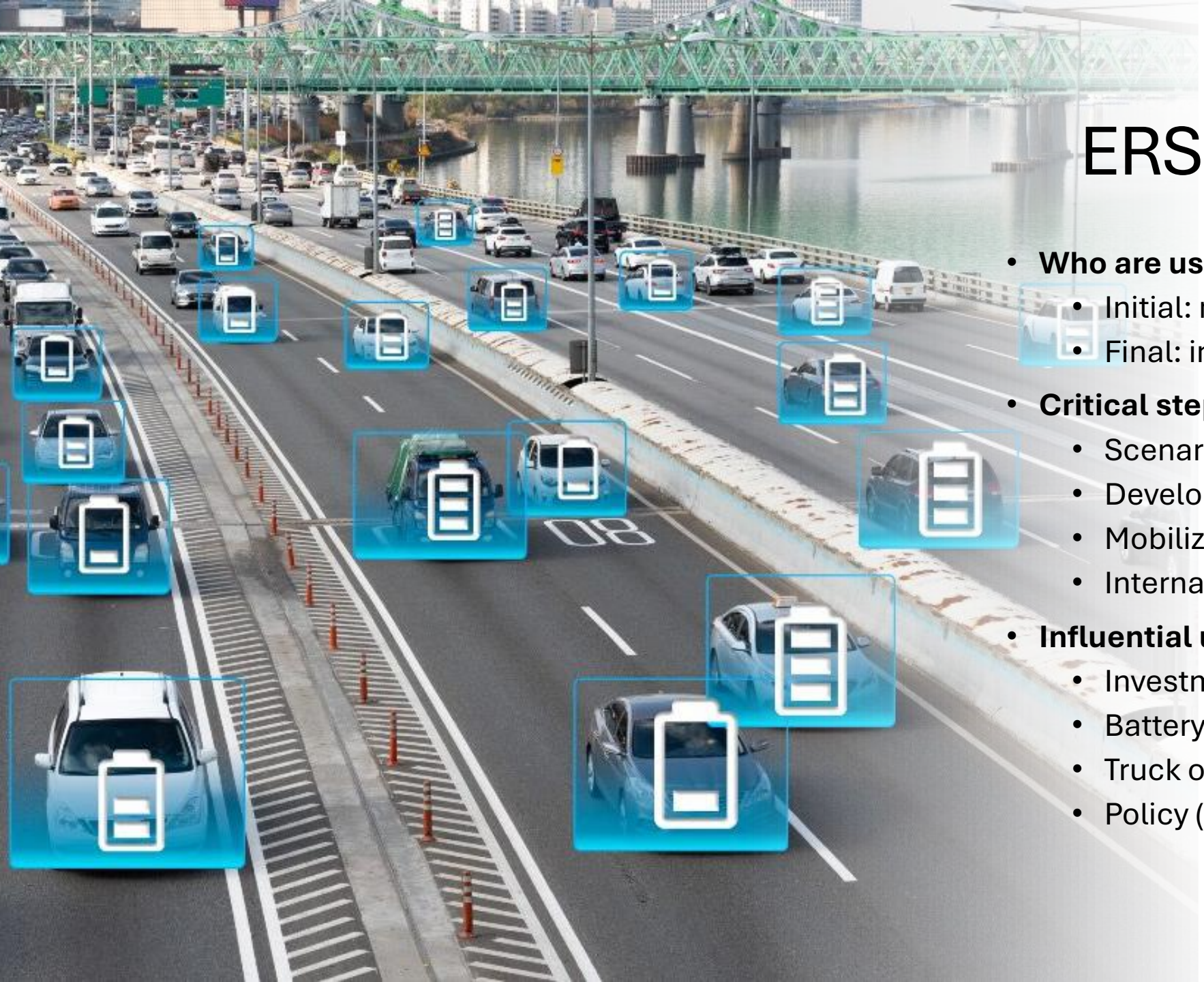
Speed of roll-out

- Charging infrastructure
- OEM and battery manufacturers
- Adoption by truck operators



Impacts

- CO_2 emissions well-to-wheel
- Total costs of electrification
- Access to electricity for SMEs



ERS lessons so far

- **Who are users?**
  - Initial: niche solution
  - Final: integrated, complementary solution
- **Critical steps**
  - Scenarios for combined charging
  - Develop V2G capability
  - Mobilize road authorities
  - International alignment
- **Influential uncertainties**
  - Investment costs (1M€-4M€/km)
  - Battery prices (70-200 €/kWh)
  - Truck operations (depot charging?)
  - Policy (government initiative)

Summary

- Battery electric trucks cheaper than diesel as of 2030
- Big change for transport operators
- Home charging will not always be possible, commercial stations expensive
- ERS could support electrification
  - Saving costs for transport operators (truck & driver)
  - Open, proven technology for trucks and infrastructure
- Action needed from public authorities