

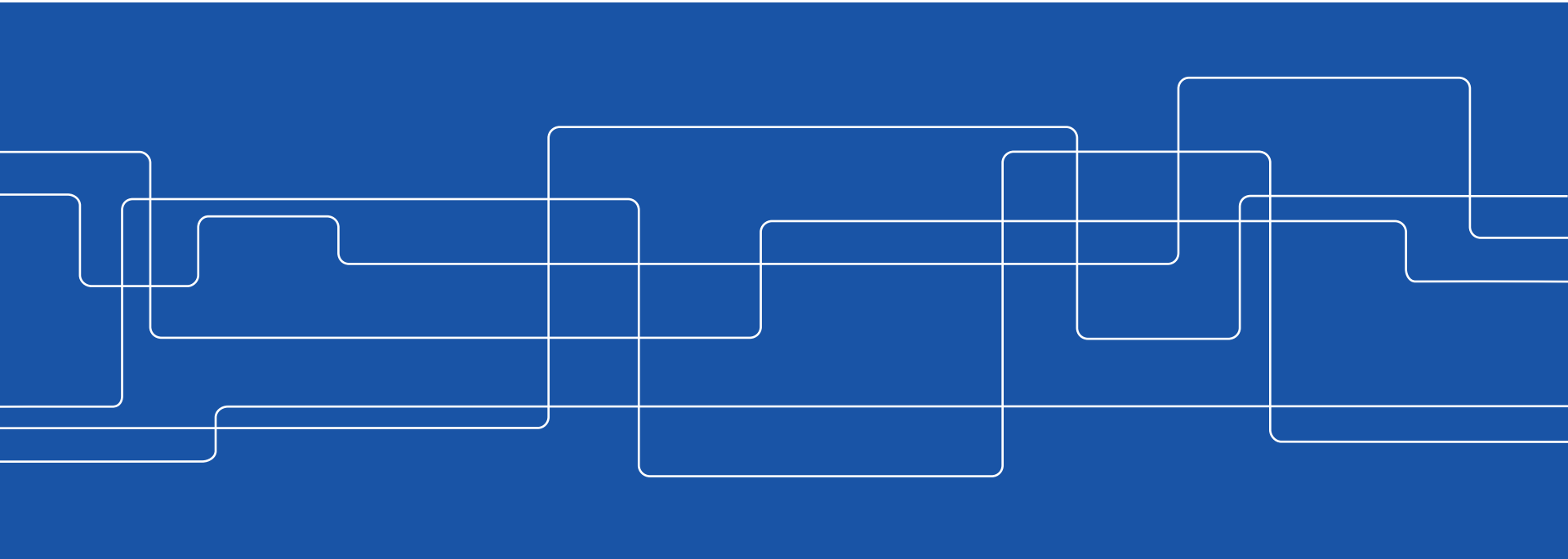


Electric road systems: Challenging the established road system and business models

Stefan Tongur, KTH Royal Institute of Technology

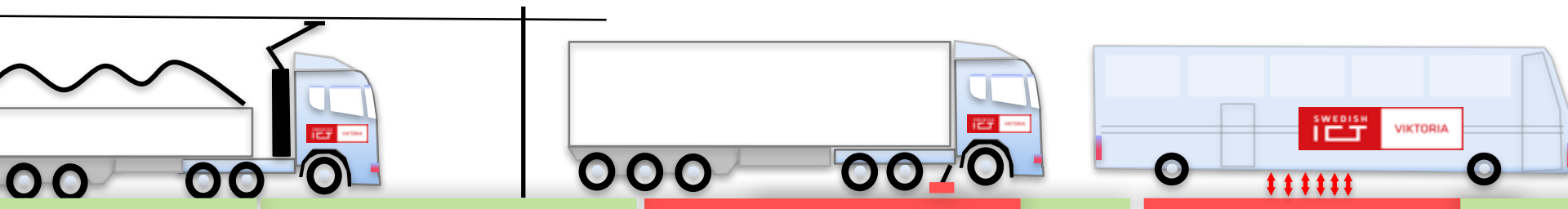
AMAA, 26 Sept 2017, Berlin.

Contact: tongur@kth.se, +46704182065



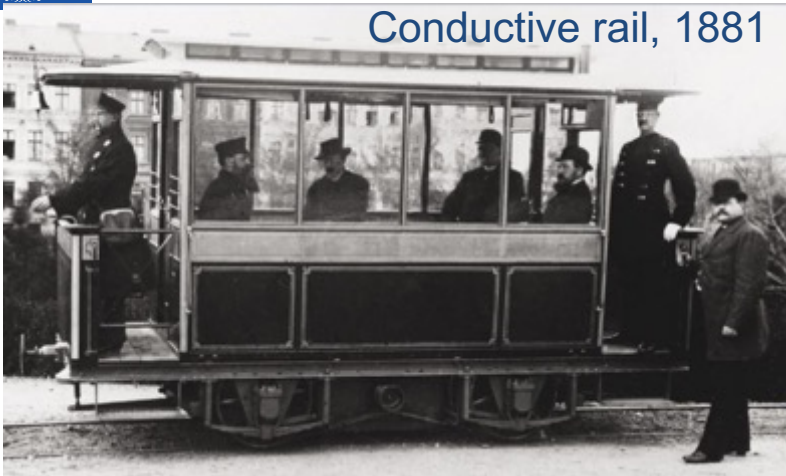
Agenda

1. **Background and definition of ERS**
2. ERS demo projects in Sweden
3. Business model challenge of ERS



The History of ERS

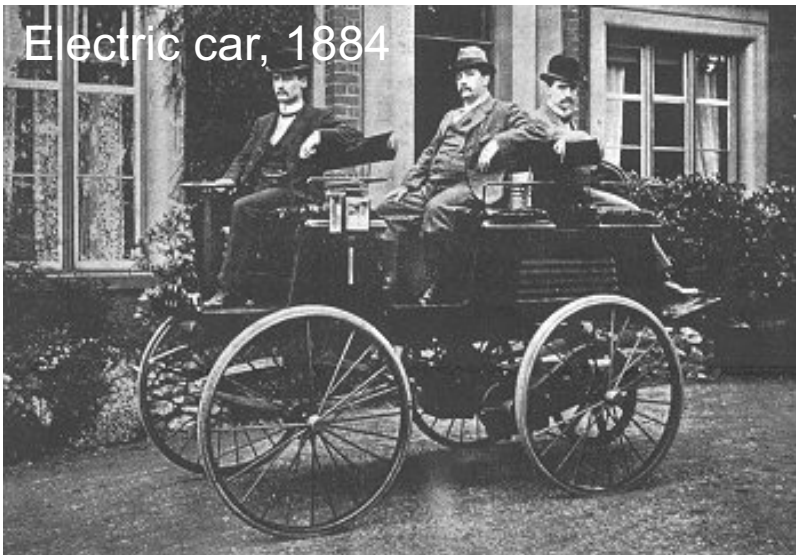
Conductive rail, 1881



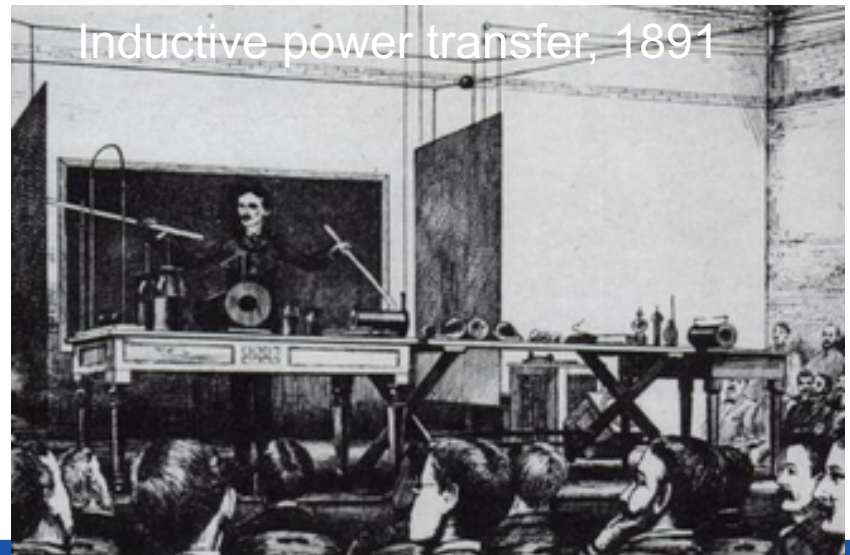
Overhead lines, 1882



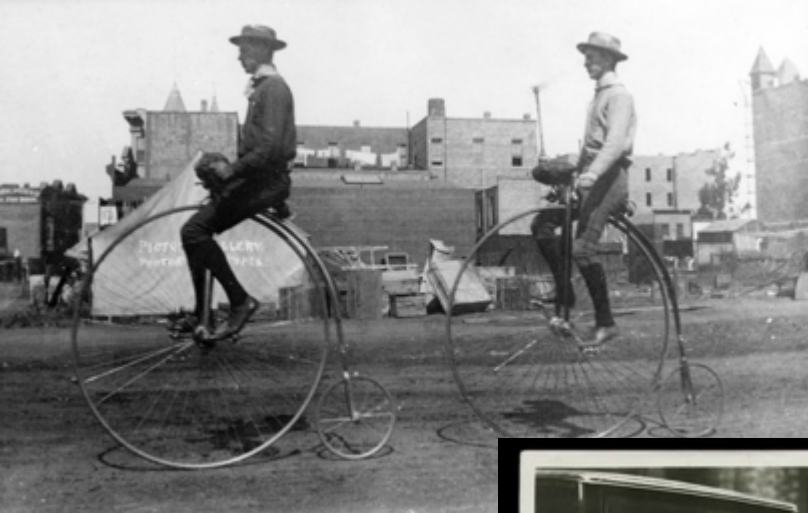
Electric car, 1884



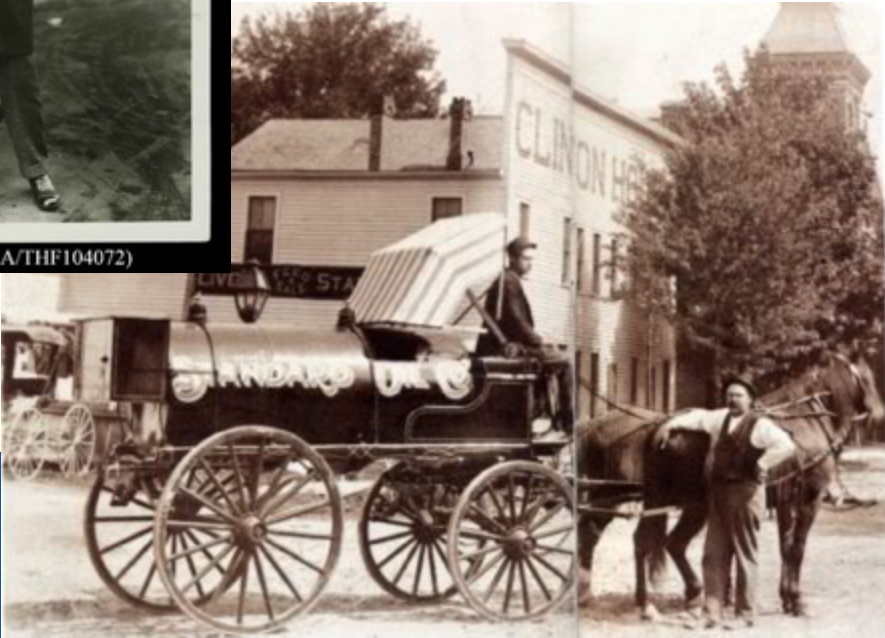
Inductive power transfer, 1891



Evolution of filling-up regime



From the collections of The Henry Ford (P.O.3015.A/THF104072)

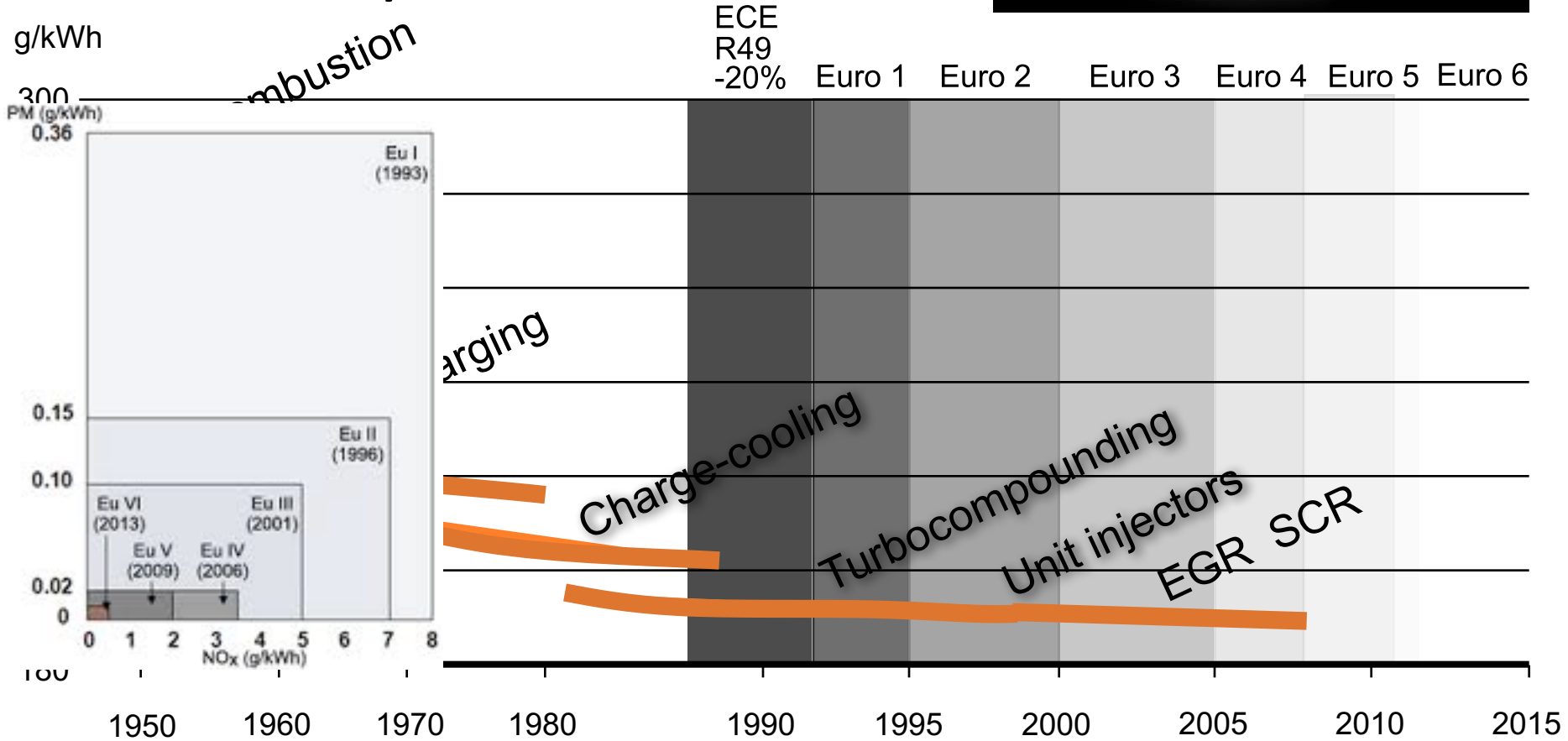




Diesel engine development

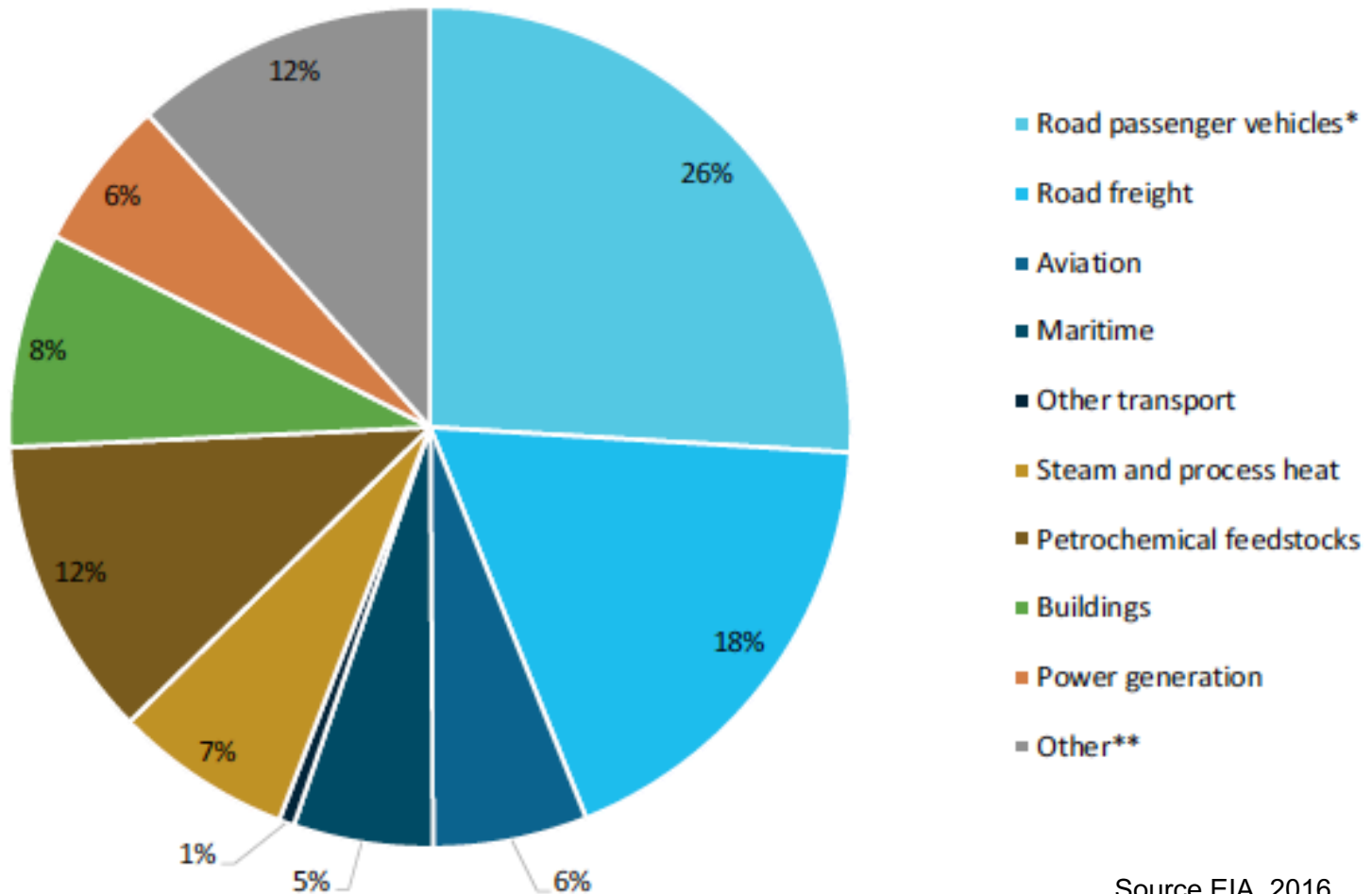


Minimum specific fuel consumption



Background for change

Global oil consumption per sector

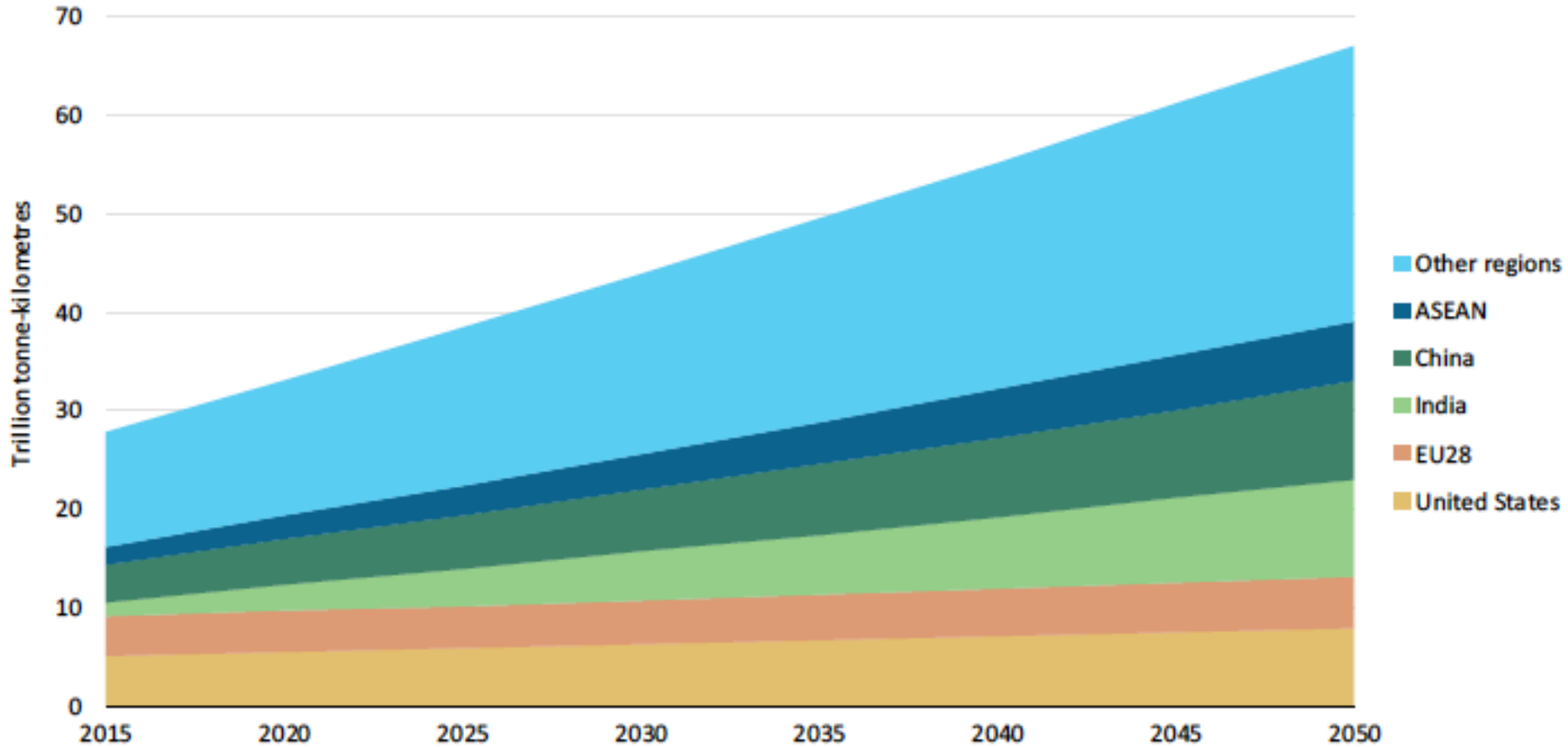


Source EIA, 2016

* Passenger vehicles include buses and two- and three-wheelers.






Freight sector expected to grow with economic growth



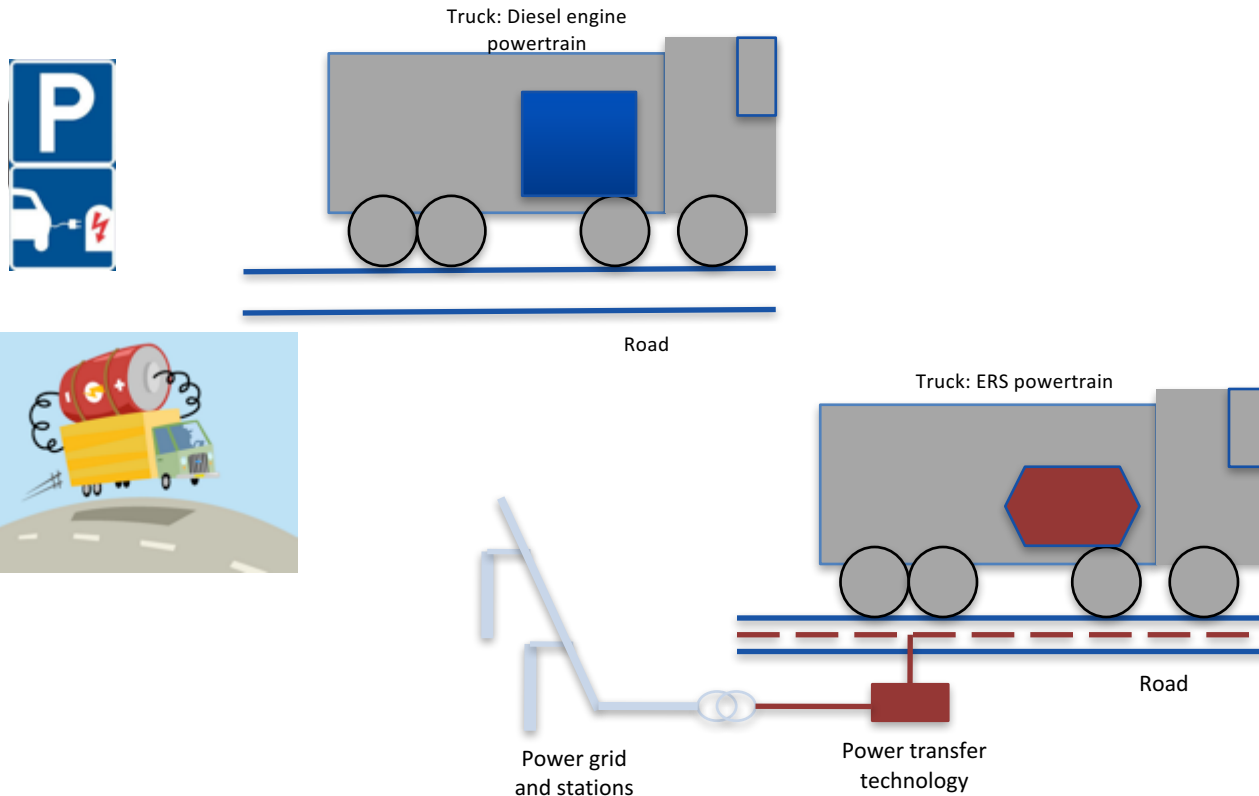
Source EIA, 2017

Impact of alternatives

| | | Energy supply diversification | Climate change | Air pollution | Key | Impact | |
|-----------------------|-------------|--|--|---------------|-----|----------|---|
| Energy efficiency | | Substantial potential to contribute indirectly (through reducing aggregate energy use) | | | | Highest | |
| Systemic improvements | | | | | | | |
| Alternative fuels | Natural gas | | 20% lower tank-to-wheel emissions offset by methane slip and leakage | | | Positive | |
| | Biofuels | | Need for low well-to-wheel emissions and minimization of land use change | | | | Assumes use of high quality drop-in fuels |
| | Electricity | | Requires low-carbon fuel supply pathways | | | | |
| | Hydrogen | | | | | | |

| Key | Impact |
|---|--------------------------|
|  | Highest |
|  | Positive |
|  | Neutral / no improvement |

Transition towards ERS The Electric Road System





Agenda

1. Background and definition of ERS
2. **ERS demo projects in Sweden**
3. Business model challenge of ERS

Two national projects awarded funding in a pre-commercial procurement

Arlanda -
Rosersberg

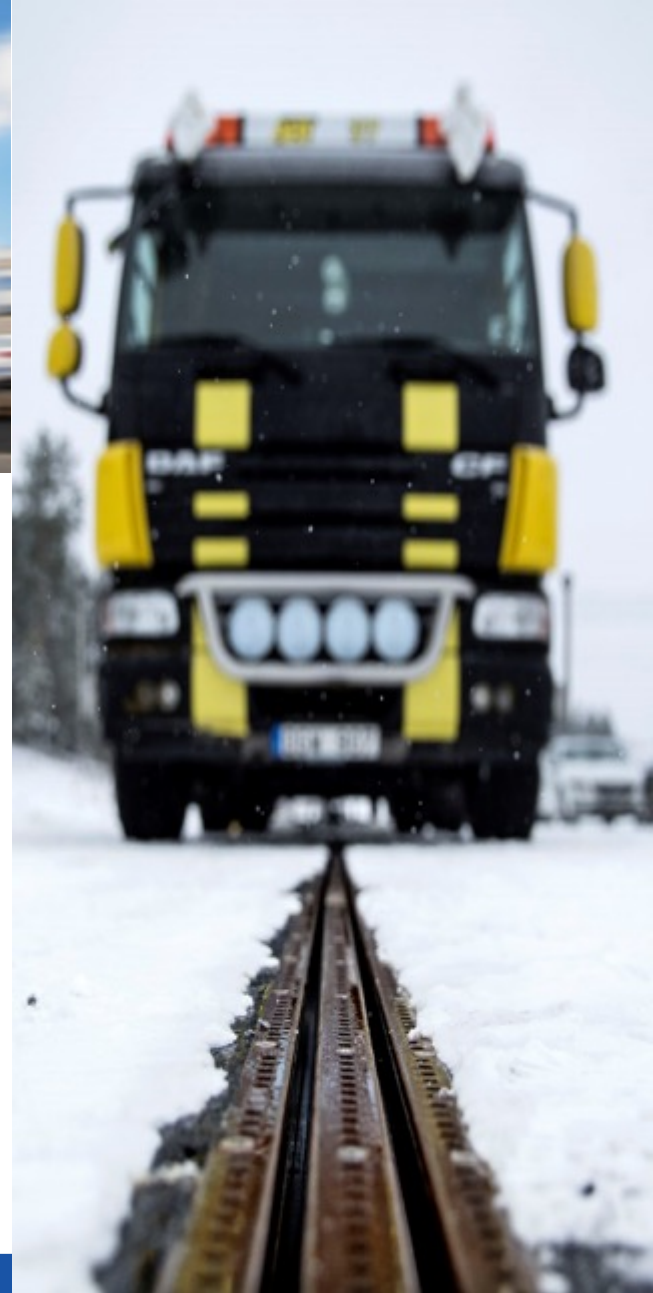


Gävleborg, Project Elvåg E16





eRoadArlanda



ELWAYS

NCC

Kilen
kryssat

ABT

BY DEL OF
AirportCity
STOCKHOLM ARLANDA

Sigtuna
kommun

swedavia
SWEDISH AIRPORTS

ARLANDASTAD
HOLDING

vti



DAF

WSP

e-Traction
revolution in motion

postnord

VATTENFALL



Bilprovningen

GÄVLE
CONTAINER
TERMINAL

training
partner



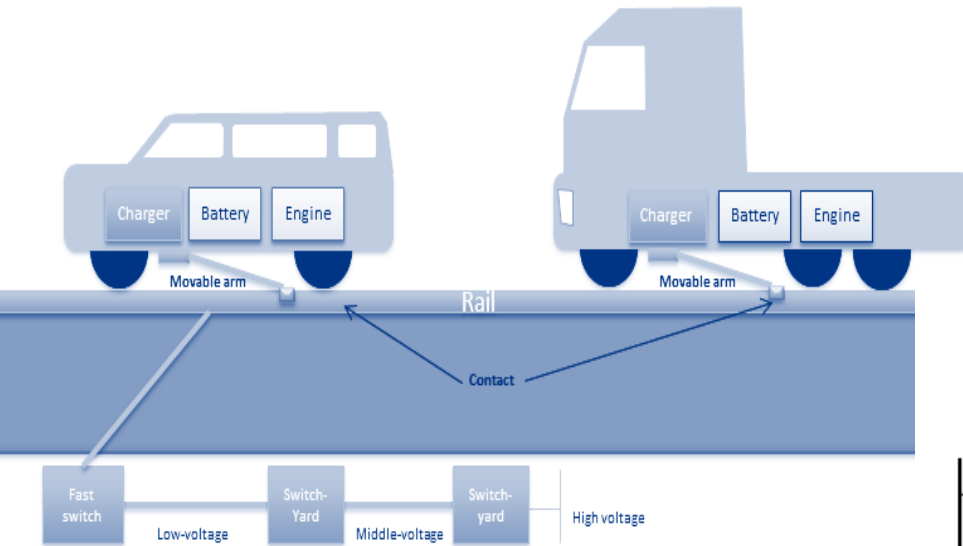
FIRST

The facility

- Existing infra of 400 m.
- Electrifying 2 km between Airport and Freight Terminal.
- Civil works beside the road finalized in Sept 2017.
- Ongoing production of rails.
- Focusing on safety and system verification.
- Waiting for "GO" to start mounting the rails into the road.

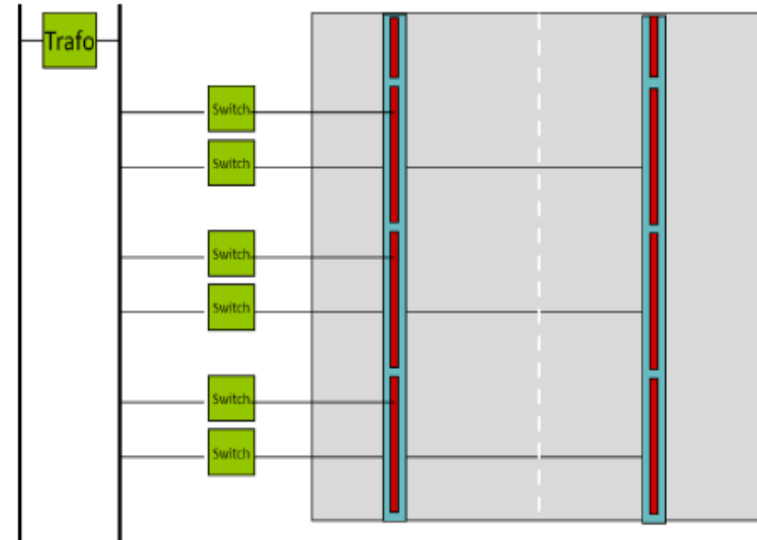


Technical solution of Elways



View from above

High voltage cable Low voltage cable



Sections are energized one by one as the car passes



The Truck

Brand: DAF

Converted by: E-traction

Motors: Two motors built into the rear axle.
Total power of 226 kilowatts (300 hp). They weigh 500 kilo each.

Battery: 80 kWh, weight 600 kilos. (Battery Tesla Model 6 close to 550 Kg.)

What does not weigh: Engine, power train and a full diesel tank

Weight: 18 tons

Load: 6.5 tons

Emissions: –



Electric Road – E16 Sandviken





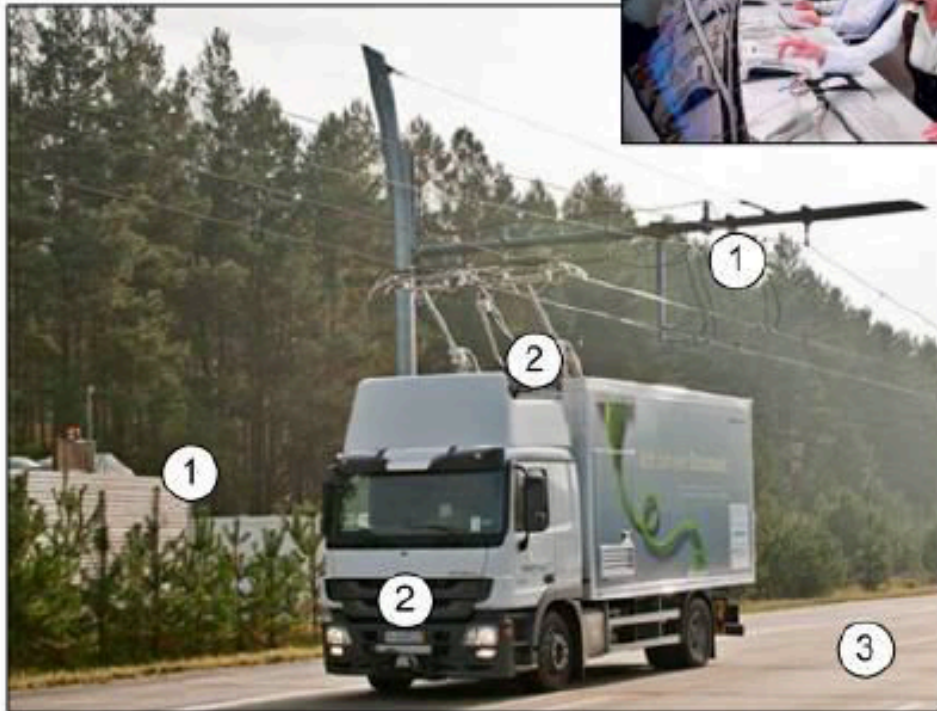
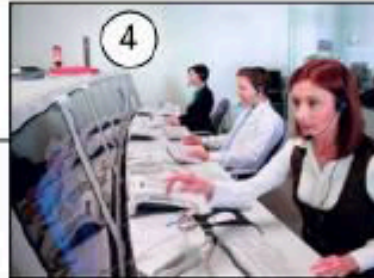
The Facility

- 2 km long facility on the E16
- Region Gävleborg is project owner and builder
- Infrastructure/facility owner Siemens
- Catenary system – Built without legal dispensations
- Siemens innovative pantograph
- Power supply Sandviken Energi
- 10 kV AC
- After conversion 650-800V DC

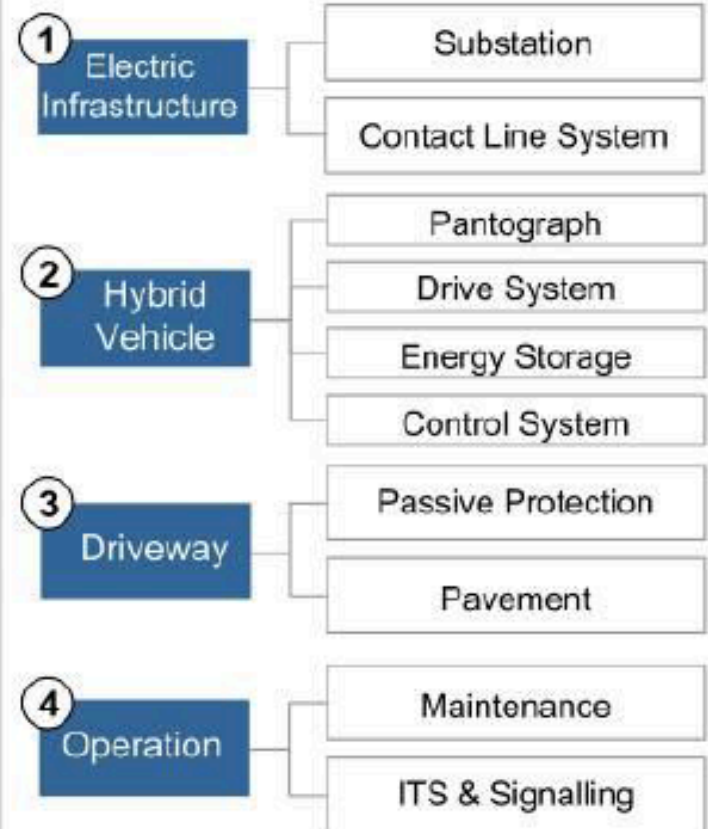


The technical solution

The complete system ...



... and its subsystems.



The Truck

Scania, Euro6 Class
Parallel hybrid power train
264kW diesel, 139kW electric
engine, 100kW battery
Still a test vehicle





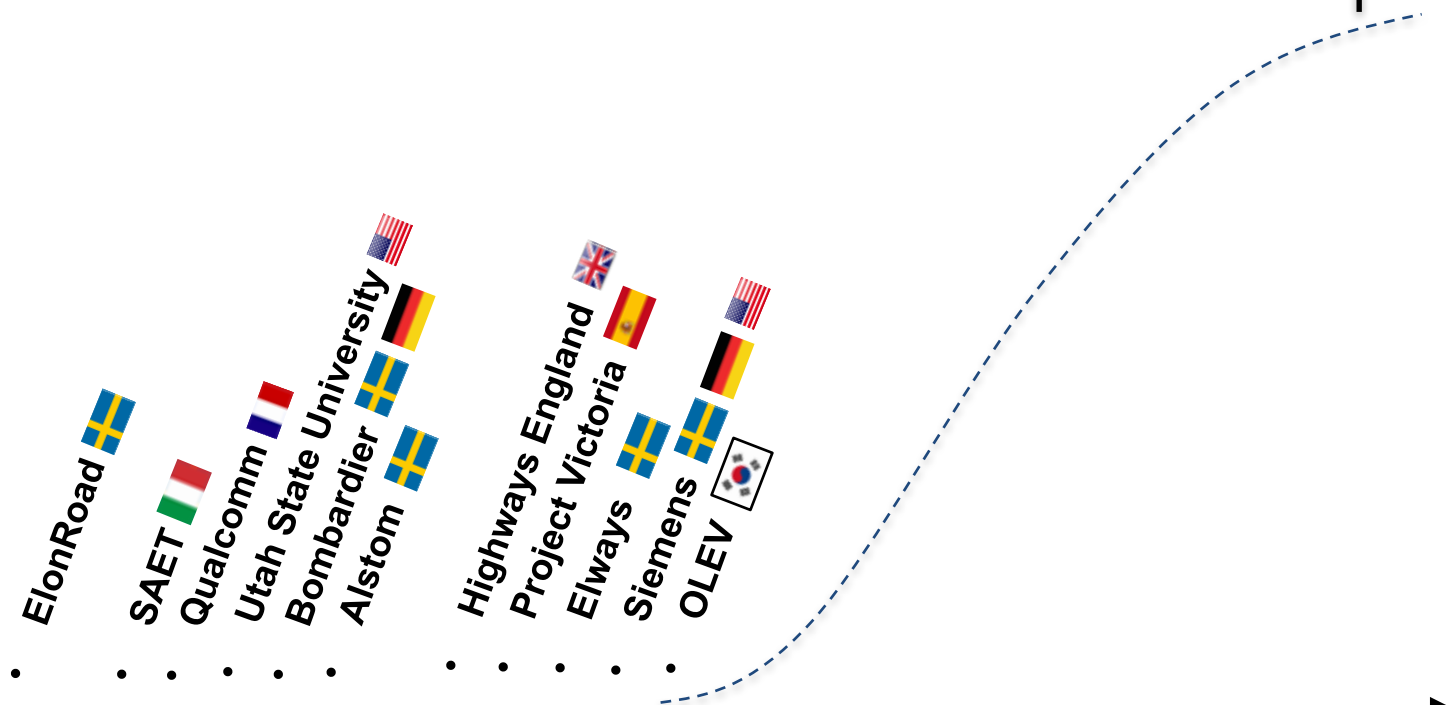
Agenda

1. Background and definition of ERS
2. ERS demo projects in Sweden
3. **Business model challenge of ERS**

ERS State of the art



Extent of use



R&D

Demonstration projects

Technological niche

Niche and mass market



“Not a technology problem, a business model challenge”

What we know:

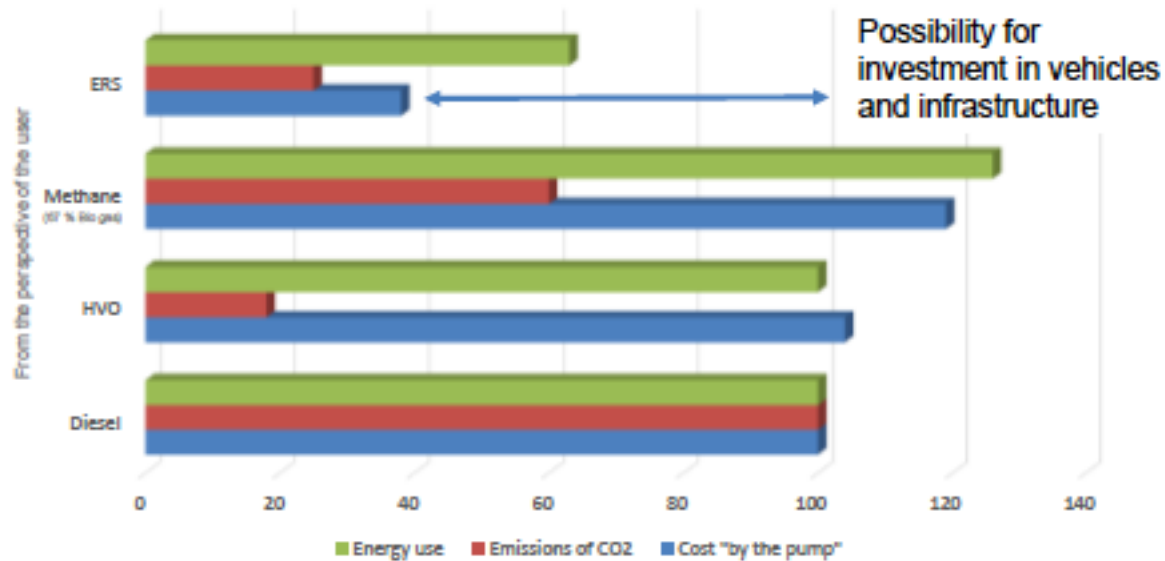
- New business models are needed to commercialize sustainable technologies; a firm-user relationship

What we don't know:

- The “right” business models for new socio-technical systems

A business model opportunity?

Comparing energy use, emissions and costs



Including taxes and subsidies Based on average data and specification of fuels sold in Sweden

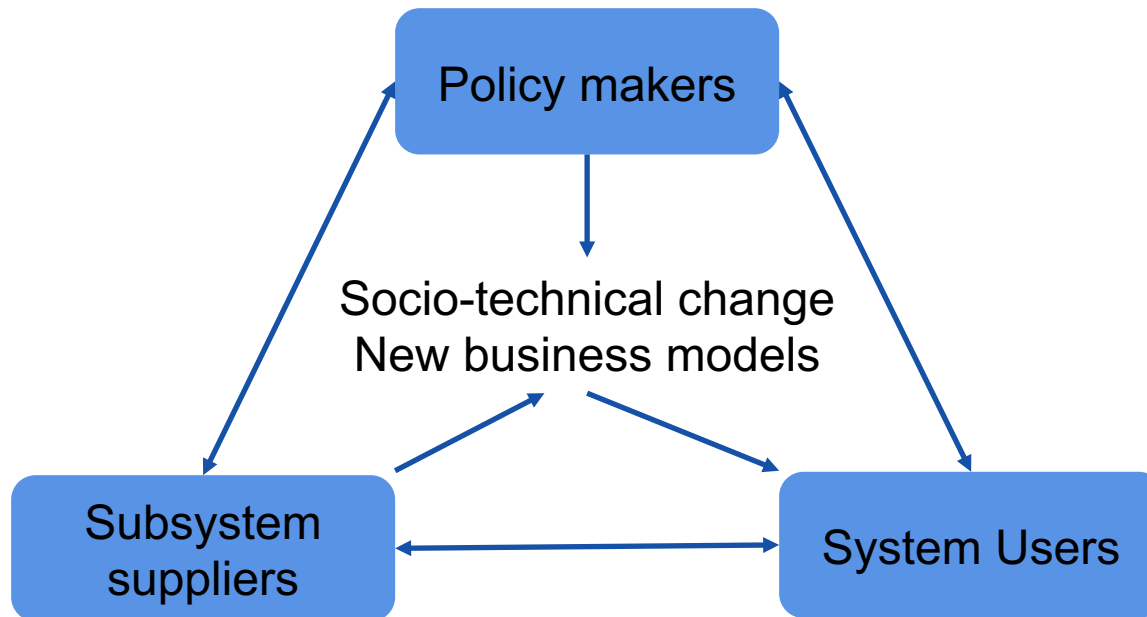
Utility of the new infrastructure is critical

DESTINATIONER - ELVÄG E16



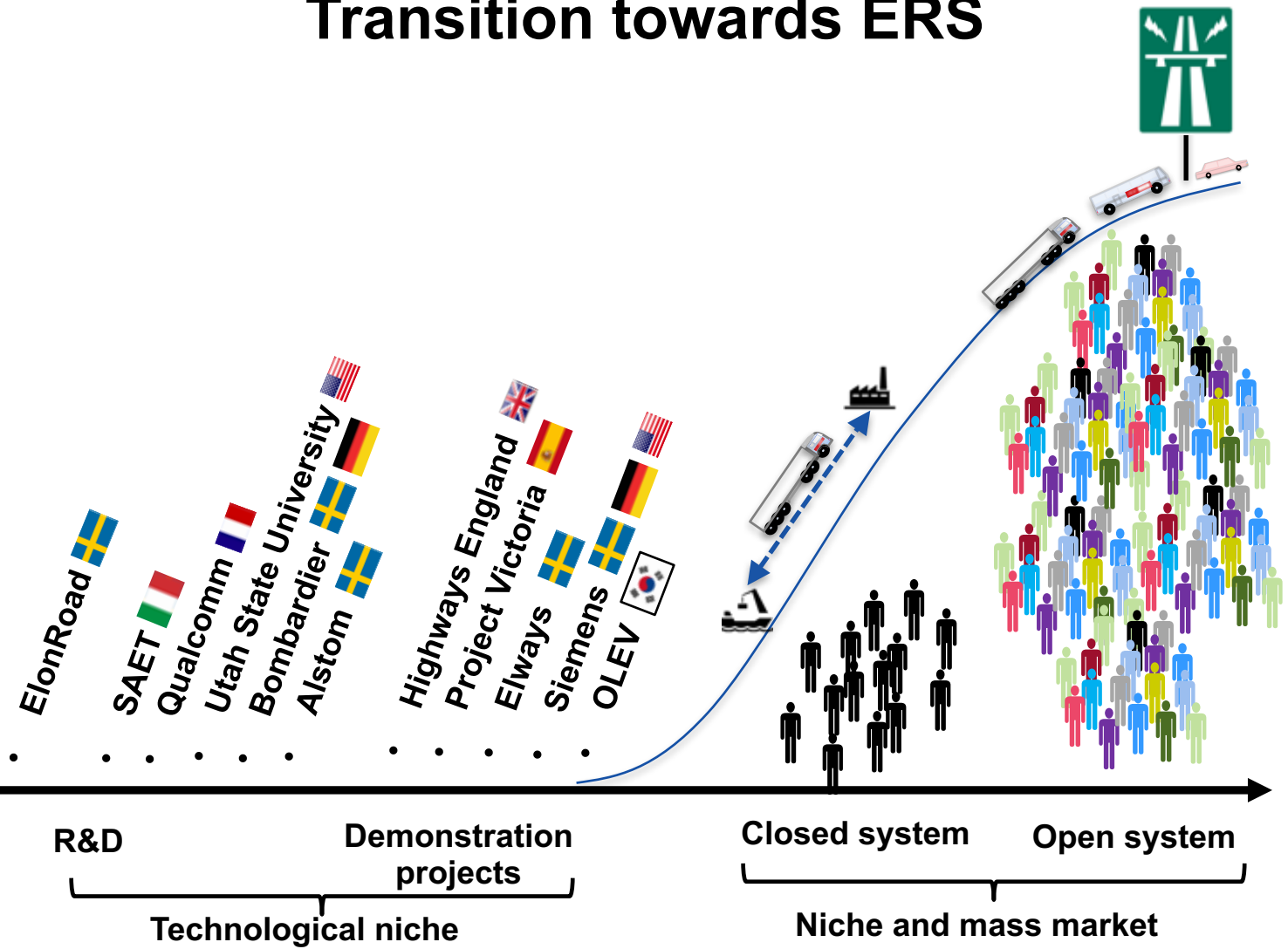


Analyzing the emergent phase of transition through a BM perspective



Transition towards ERS

Extent of use



Thank you! Questions?

