49th ASECAP DAYS

Decarbonizing Road Infrastructure : Challenges, Perspectives and Actions in Tough Economy

ASECAP DAYS
BRUSSELS 2022

Hotel Marriott Grand Place, Brussels

24 – 25 November 2022

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DECARBONIZING ROAD TRANSPORT WITH ERS

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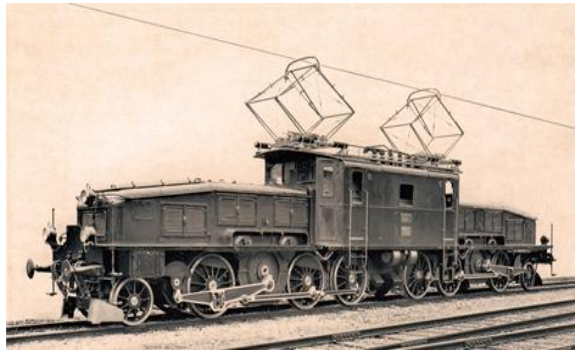
Why ERS?

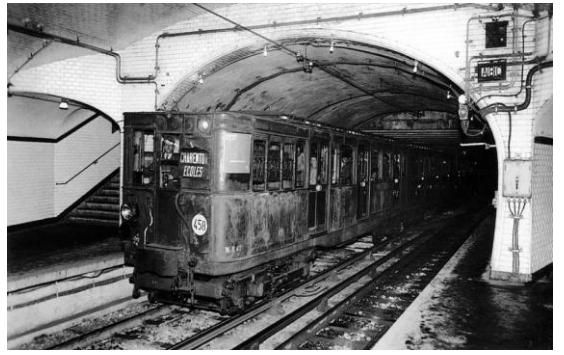
Electricity is easy to transport, but difficult to store

Steam locomotives and coal tender

1900

Electric locomotives, metros and tramways powered in motion





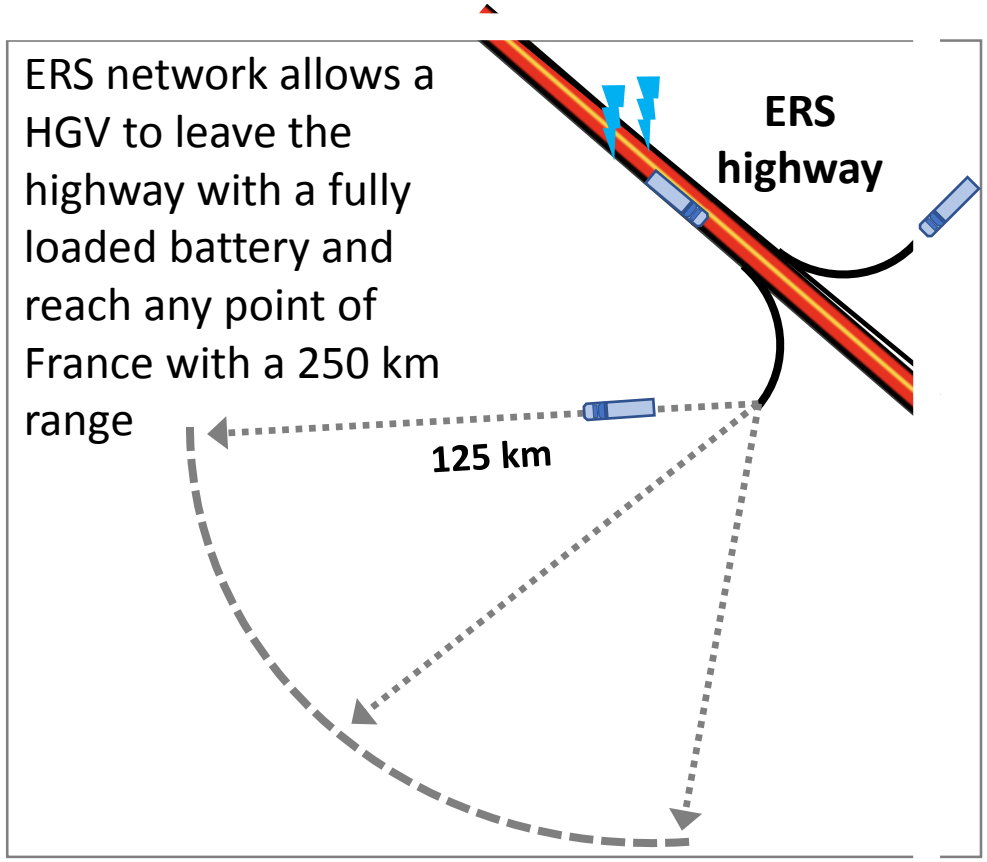
Solutions for road decarbonation

- Combustion engine with biodiesel / biogas:
  - Poor GHG net emission, 3.5% leakage cancel the benefit
  - Availability, competition with other uses
- Hydrogen: FCE (fuel cell electric)
  - Low efficiency (0.6 x 0.9 x 0.5 = 27% !)
  - Cost, competition with other uses, storage and distribution issues
- Electric with big batteries (HGVs: 750 to 1200 kWh)
  - Extra weight (4 to 7 t for a 40 t-truck, 450-750 km range)
  - High cost (80 to 130 k€), lower lifetime (-30 to 40%) and high power required on parking lots for fast charging
- **Electric Road System: ERS**

Proposed deployment in France

French data

Phase 1 : 4,900 km
Phase 2 : 3,950 km
Total : 8,850 km



Batteries reduced by 2/3 (380 kWh for a large truck)

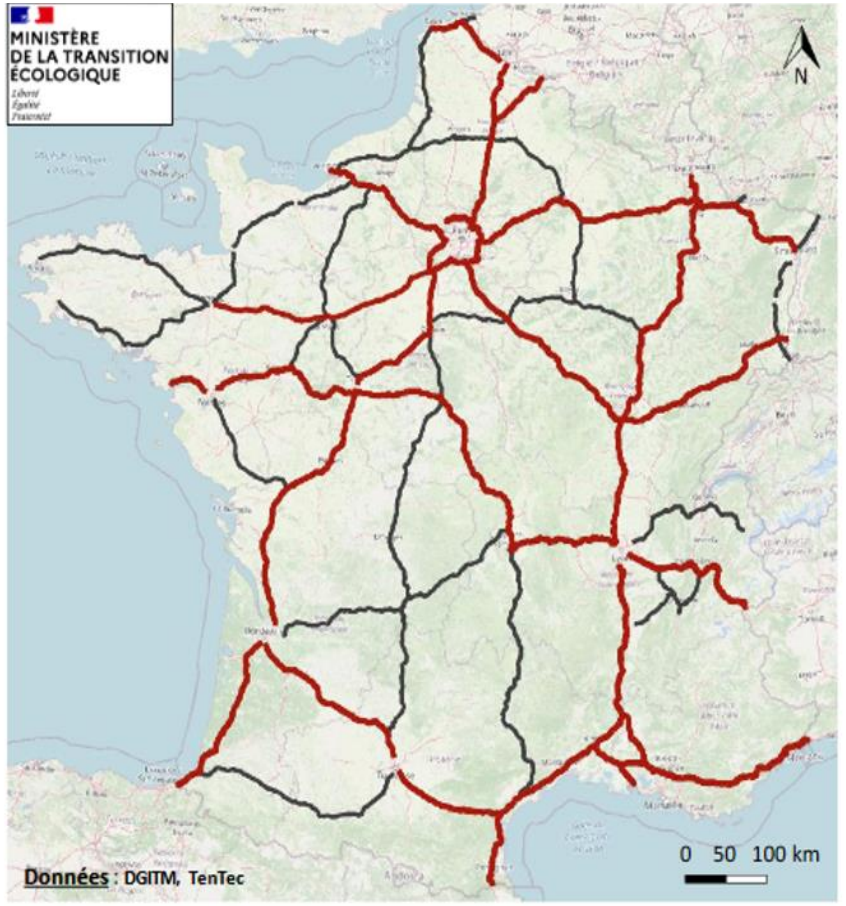
Power delivered: max 400 kW (truck)

Massive decarbona-tion: -85%

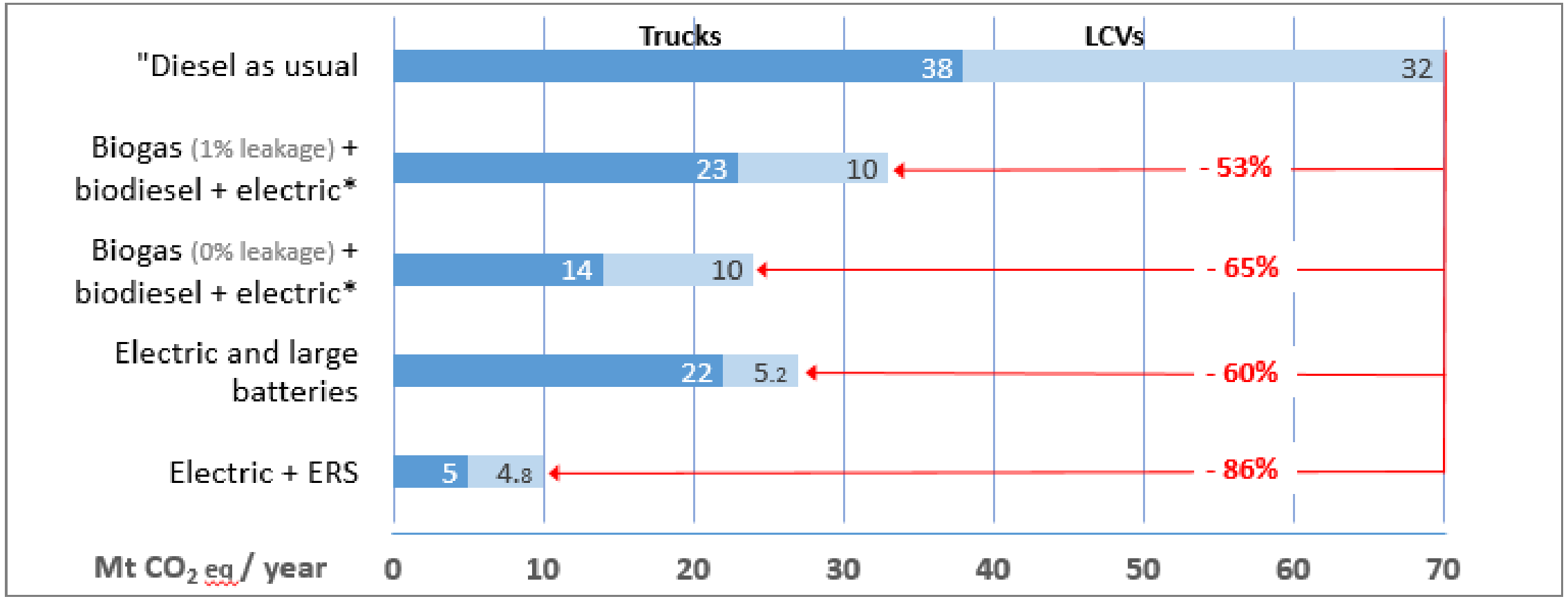
TCO ≈ diesel

Total investment: 30 to 40 b€ (concession)

ERS perimeters: 2030 (red) and 2035 (black)



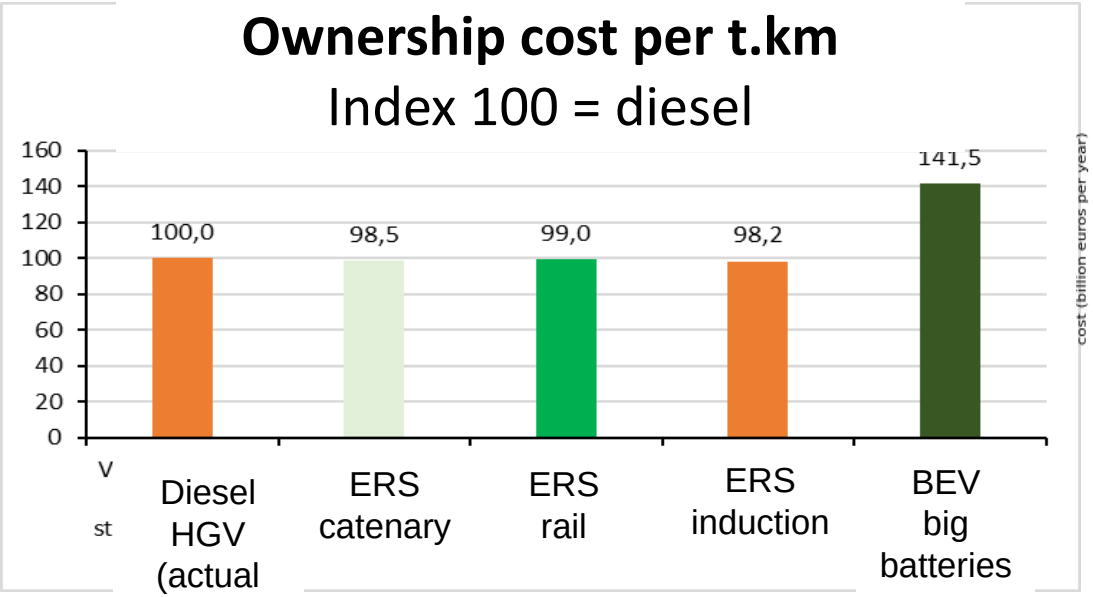
GHG emission saving (life cycle analysis by 2040)



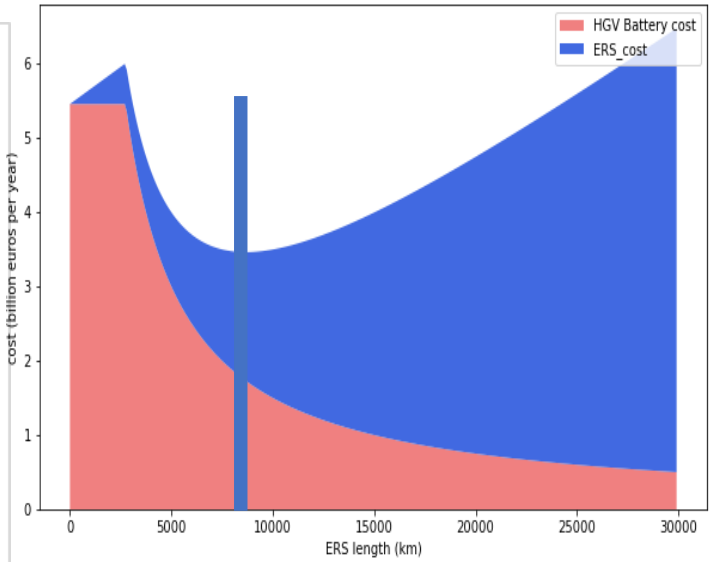
The ground conductive solution would save an additional 4 Mt CO_2 eq /year allowing 25% of cars to have a smaller battery (- 40 kWh)

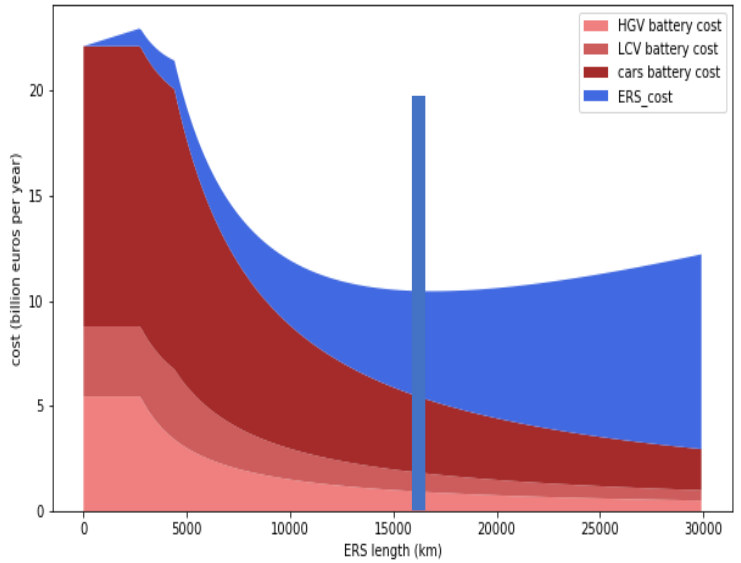
Cost analysis

TCO



Total yearly investment cost (ERS + batteries)





ERS for HGVs only	8,666 km (network length)	254 km (range)
ERS for all vehicles	16,882 km	130 km

Technologies of ERS

- 3 families and 4 main suppliers:

+ Ground conduction by Elways/Evia + lateral conduction by Honda
+ Induction by IPT/Primove & by WiPowerOne/KAIST

Technologies Assessment

Stakeholders

- WG1 – Public authorities and regulators
- WG2 – Road builders and operators, concessionaires (ASFA)
- WG3 – OEMs
- WG4 – Carriers and shippers
- WG5 – Energy sector
- WG transverse : researchers & consultants

Criteria (63 into 13 families)

A - Interoperability, use's domain, technological maturity
B - Potential of decarbonation
C – Effectiveness and energy efficiency
D - Costs : investment, maintenance and operation
E - Intrusiveness (infrastructure, environment)
F - Integrability in the vehicles
G - Impact on health
H - Impact on road safety
I - Security
J - Durability and resilience
K – Technological and systemic risk
L – Environmental and social acceptability
M - Others

Summarized results

- WG1 (Road builders, concessionaires and operators)

Most detailed and complete answers — rating on 10

Induction	Ground conduction	Overhead conduction
Electreon: 7.6 WiPowerOne: 7.2	Alstom: 6.8 Elonroad: 6.2 Elways/Evias: 5.5	Siemens: 6.0
Low intrusiveness after installation	Medium intrusiveness	Many concerns: safety, durability, constraints for road operation

- WG5 (Energy suppliers)

Ground conduction	Overhead conduction	Induction
8.0	6.5	4.0 to 5.0
High energy efficiency, saving materials, cost and deployment	Good energy efficiency, but heavy infrastructure, no interoperability with cars	Not mature enough Not enough power for trucks Low energy efficiency

Overhead Conduction

Pros

- The most mature technology, benefits of the railway experience
- Several demos on open roads
- Not intrusive for the pavements

Cons (cont'n)

- Not compatible with cars and vans
- Safety concerns (pylons), for vehicles and catenaries (in case of a collision against a pylon), or accidental crane deployment (shock on the catenaries)

Cons (cont'n)

- Safety concerns in case of accident: no access by helicopter, difficult side access (protection walls), difficult to operate a crane (rollover truck) or dump truck (works)
- Durability and resilience: 100 times more pantographs runs/day than on railways, vertical motion 10 times higher, exposed to extreme climatic events (wind, ice…)
- Bridge crossing, drag force of pantographs
- Visual acceptability not proved

Ground Conduction

***Elways/Evias**: not adapted for highly trafficked motorways and high speed. Risk in case of quick lateral manoeuver, issue with the drainage*

Pros

- All vehicles can be powered
- Intermediate maturity (between overhead conduction and induction)
- No major locks vs the essential criteria
- Almost no limit of power
- The easiest to install
- The best material balance (no critical material)

Cons

- Lack of demos on open roads and motorways
- Specific devices to be developed for pavement surface replacement without dismantling the rail
- Complementary investigations on the long term mechanical reliability, and in case of fall of conductive objects/substance

Induction

Pros

- All vehicles can be powered
- No intrusiveness after installation
- No mechanical contact between vehicle and infrastructure
- Road operation “as usual”

Cons

- Lack of maturity, higher cost
- Not enough efficiency to power AND reload batteries of heavy trucks, quick loss of efficiency with lateral wandering
- Very intrusive installation (removing the pavement surface)
- Uncertainties on the durability and resilience, above all for asphalt pavements, water intrusion, and in case of pavement rehabilitation
- The worst material balance (Cupper x2-3)
- Uncertainties for road users’ health (above all for high power)

Final recommendations

- Induction for urban area and static fast charging, needs more maturity and efficiency on motorways
- Ground conduction (flat rail in the pavement) is the most appropriate (interoperability, medium intrusiveness, low impact on road safety, high energy efficiency, good material balance, high expected durability), needs large scale tests on open roads
- Overhead conduction can make the job if both other technos are'nt ready to scale, high operation constraints, not interoperable for cars and LCVs

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THANK YOU FOR YOUR ATTENTION

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