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Overhead Conductive Transmission Trucks with dynamic charging

HEC Conference on Decarbonising Long-Haul Trucking in Eastern Canada

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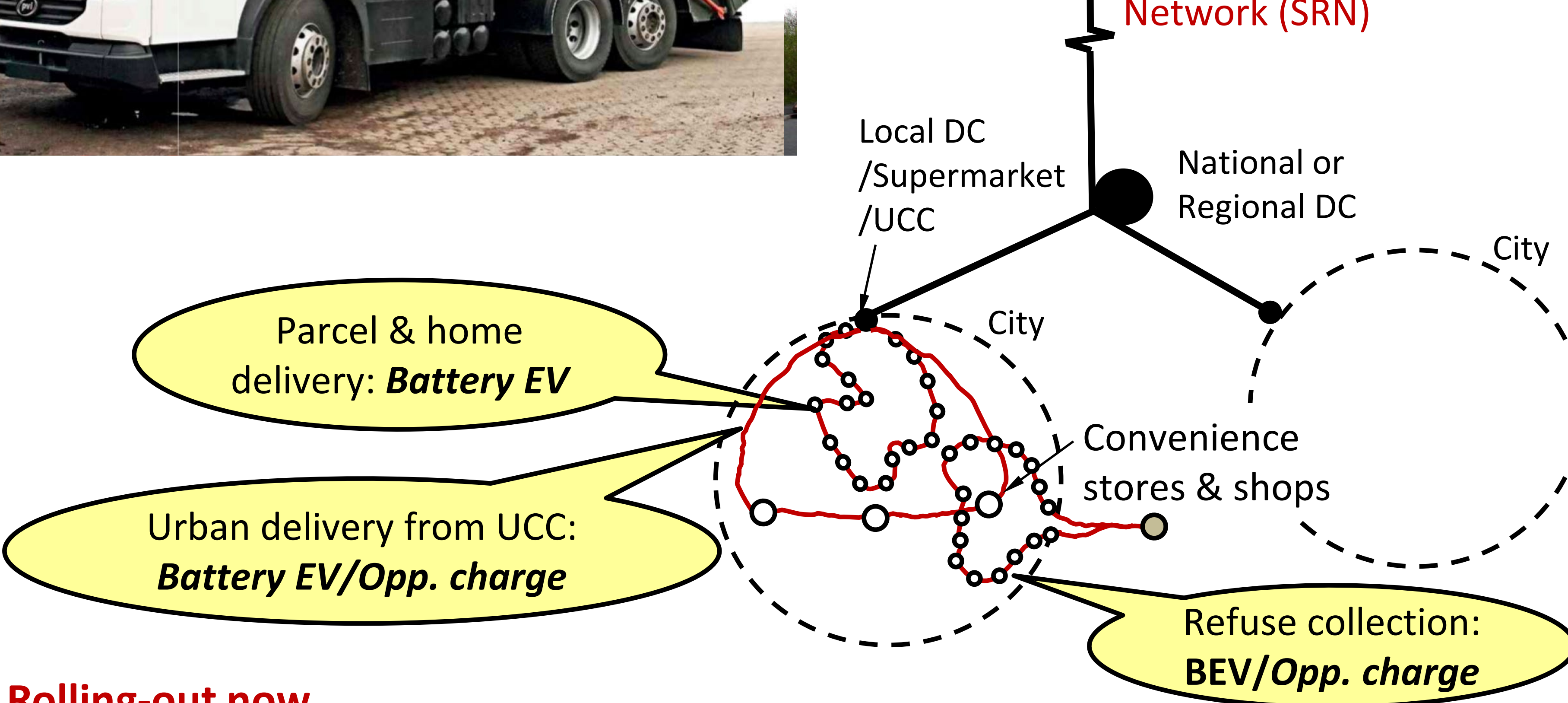
Presentation Contents

1. Background
2. Electrification of long haul
3. Big Batteries vs ERS
4. Conclusions

Urban Freight

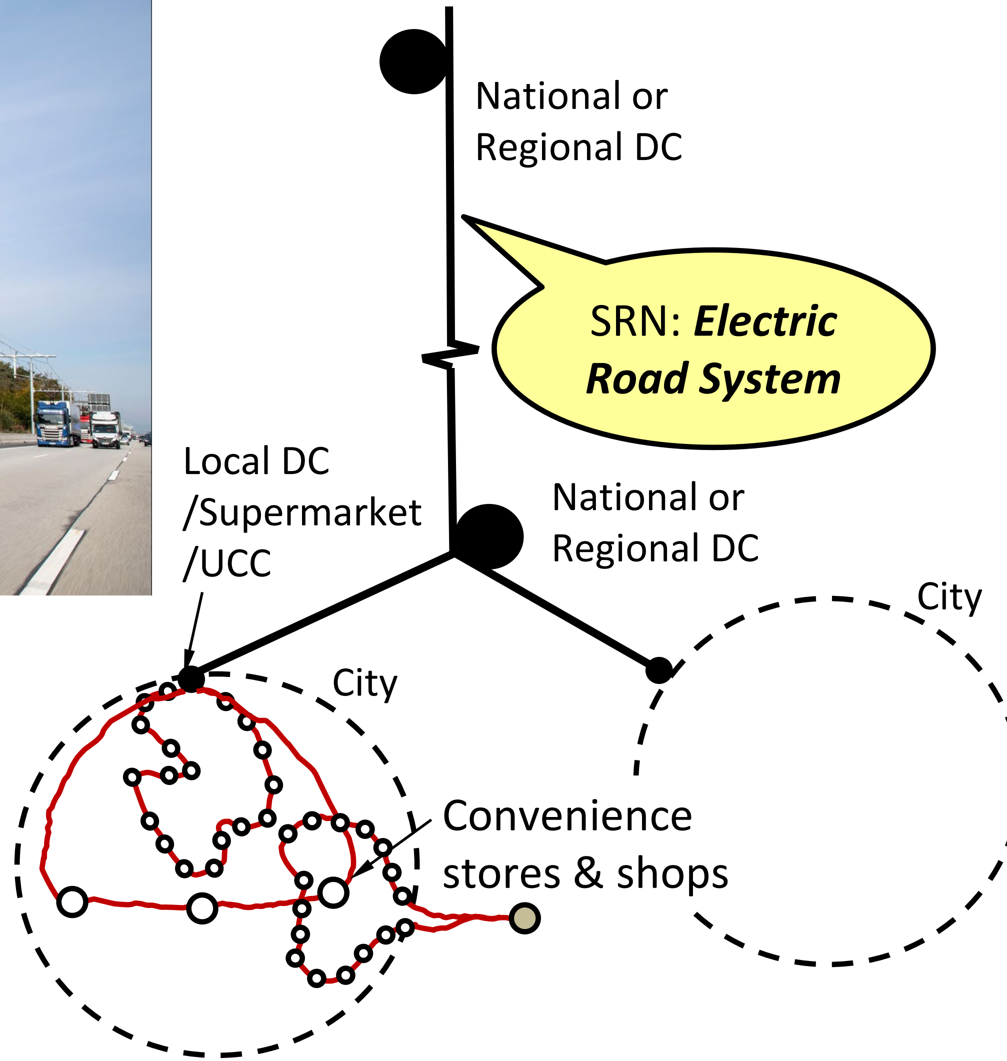


- **Rolling-out now…**
- **Building technologies and supply chains for higher capacity BEVs**

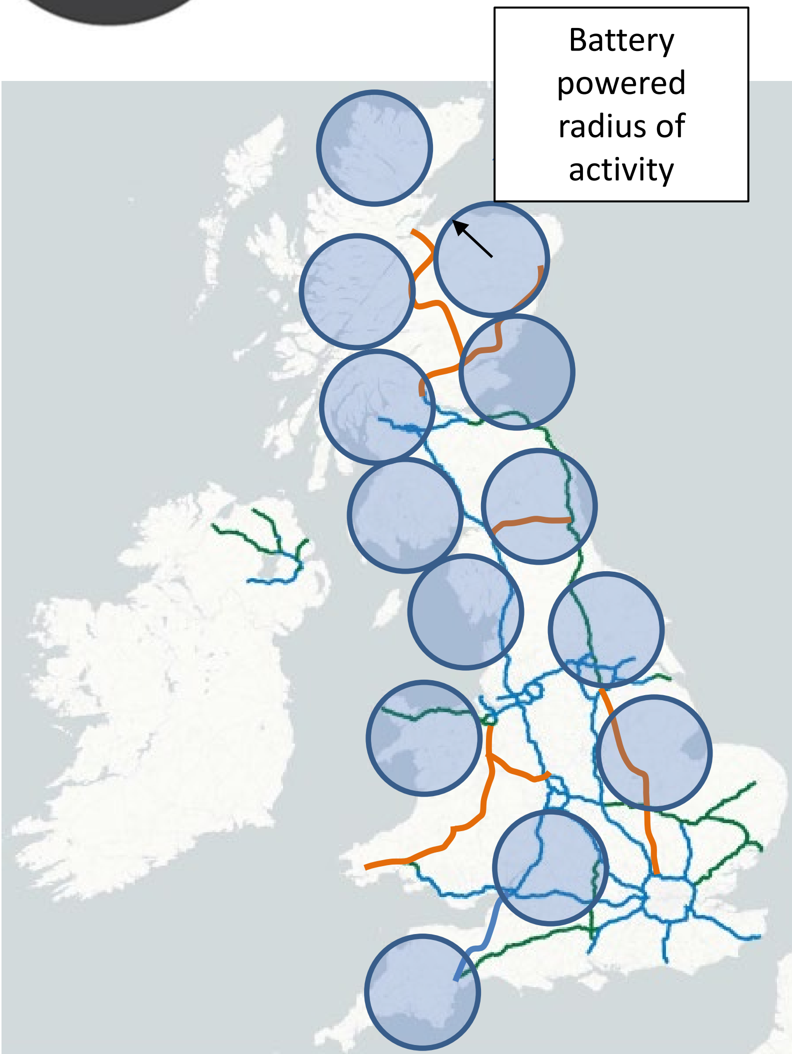
Options for Decabonising Long Haul

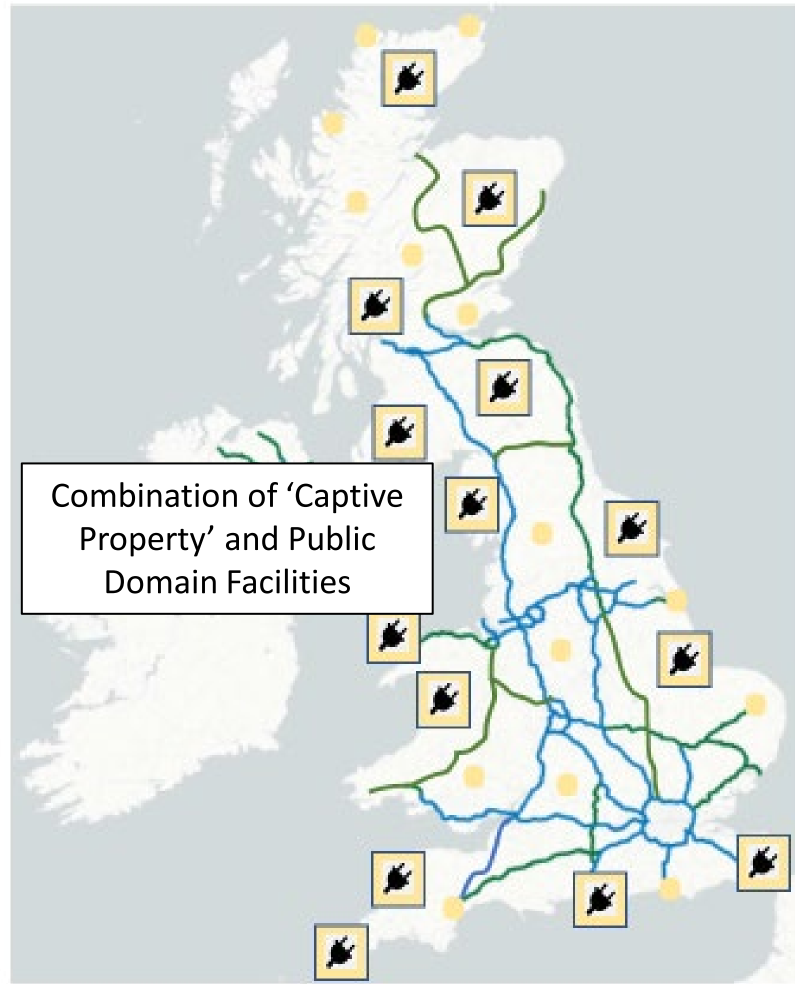
1. Big Batteries
2. Dynamic Charging (Electric Road System)
3. Hydrogen Fuel Cells
4. Battery or Tractor Swapping
5. Hybridization: Range extenders
6. (Bio-fuels)

Electrification of Long Haul

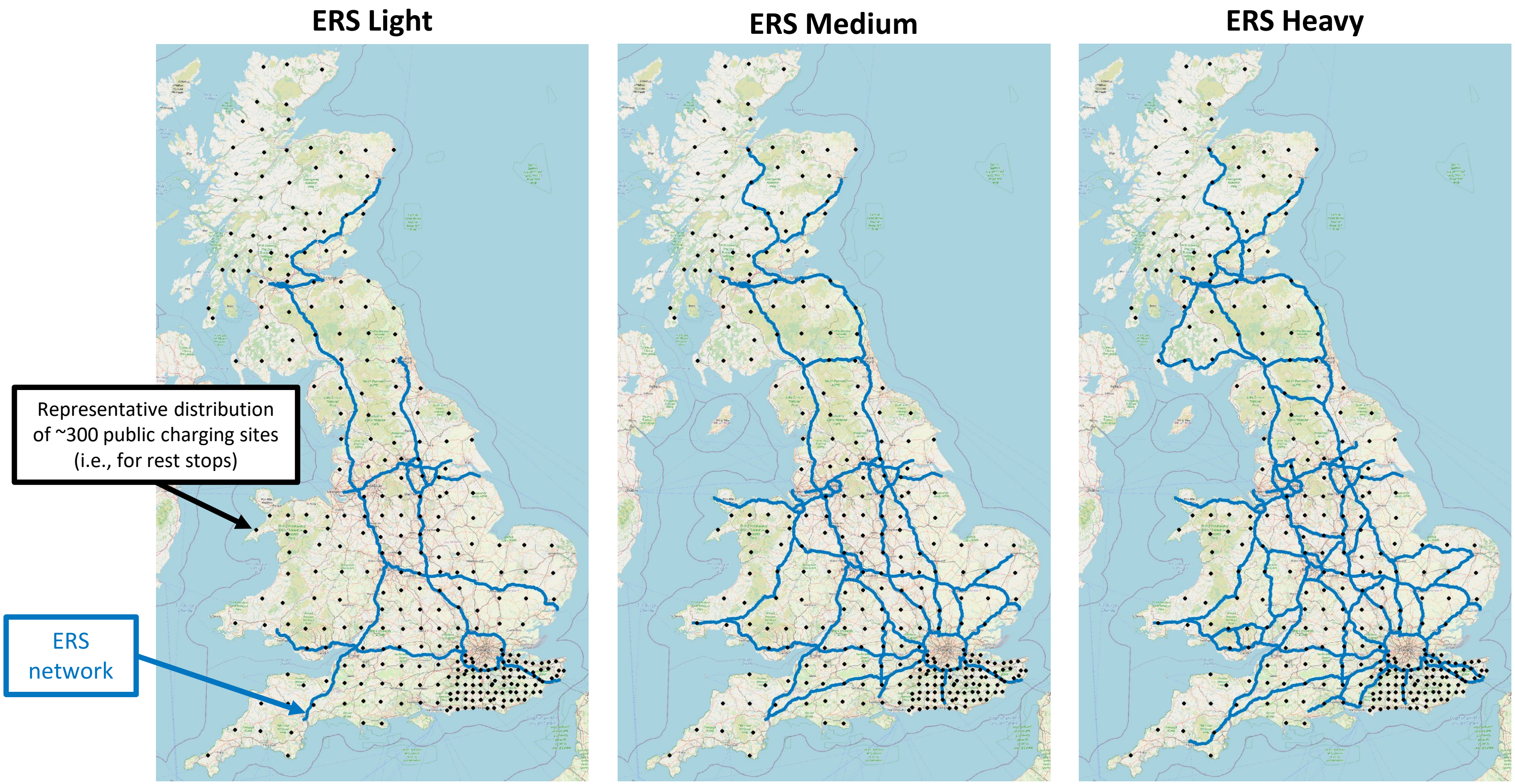


The Network Design Challenge





ERS scenarios

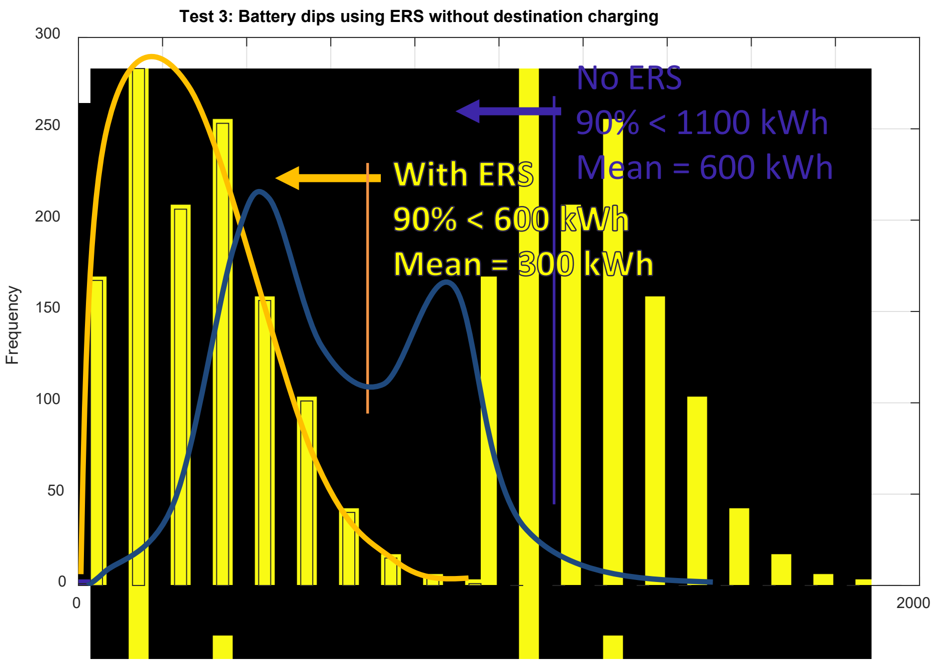


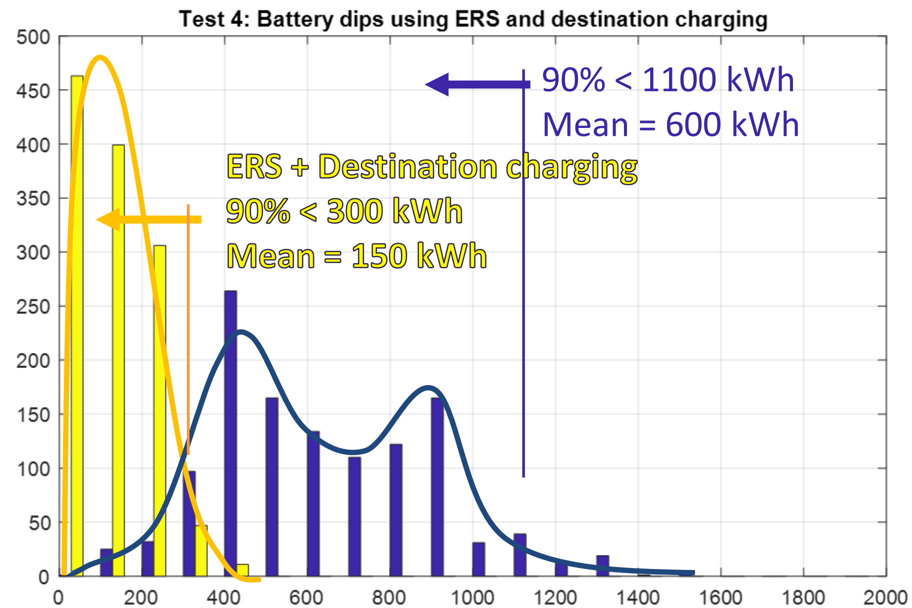
Logistics journey simulations

Operator H	Required battery capacity (kWh)			
	ERS topography			
	None	Lite	Medium	Heavy
No static charging	1666			
Charge at drop-off sites (600 kW)	397			
Charge at public rest stops (600 kW)	794			
Charge at both drop-offs/rest stops	388			

No ERS

Batteries for challenging journeys

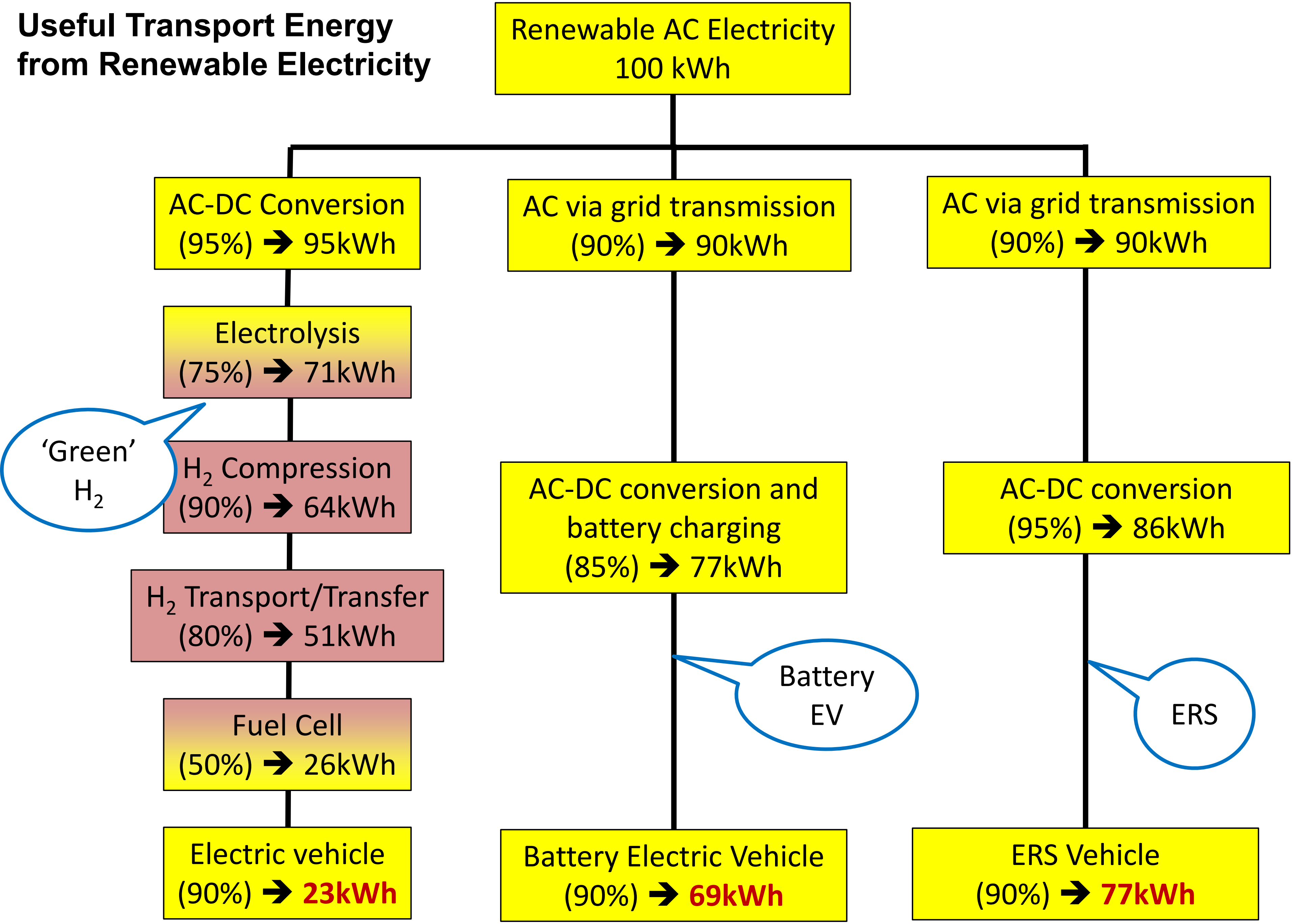




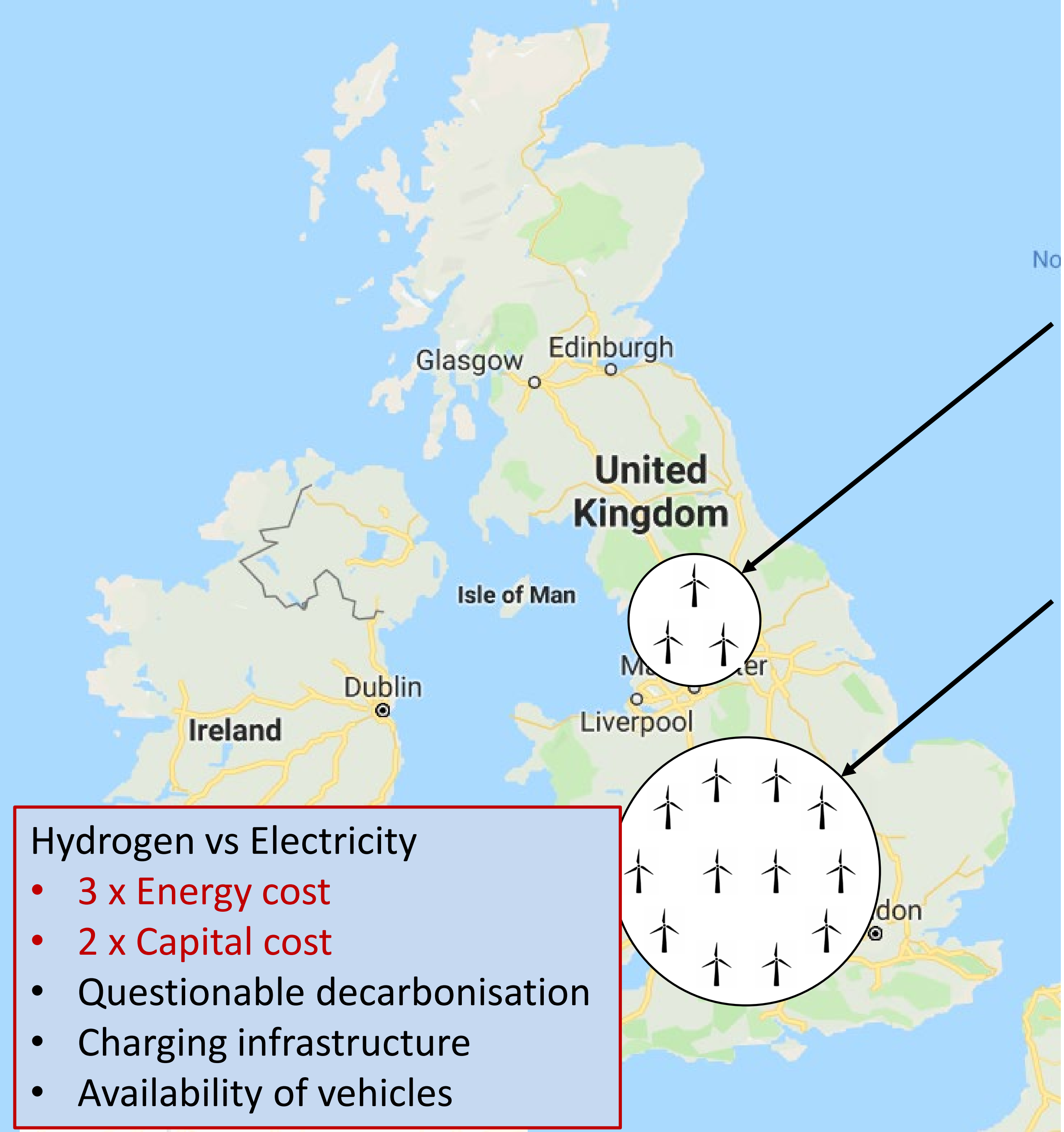
Battery size with and without 'Light' ERS

Battery sizes with 'Light' ERS and destination charging

Useful Transport Energy from Renewable Electricity



Land areas for electrification of UK Road Freight



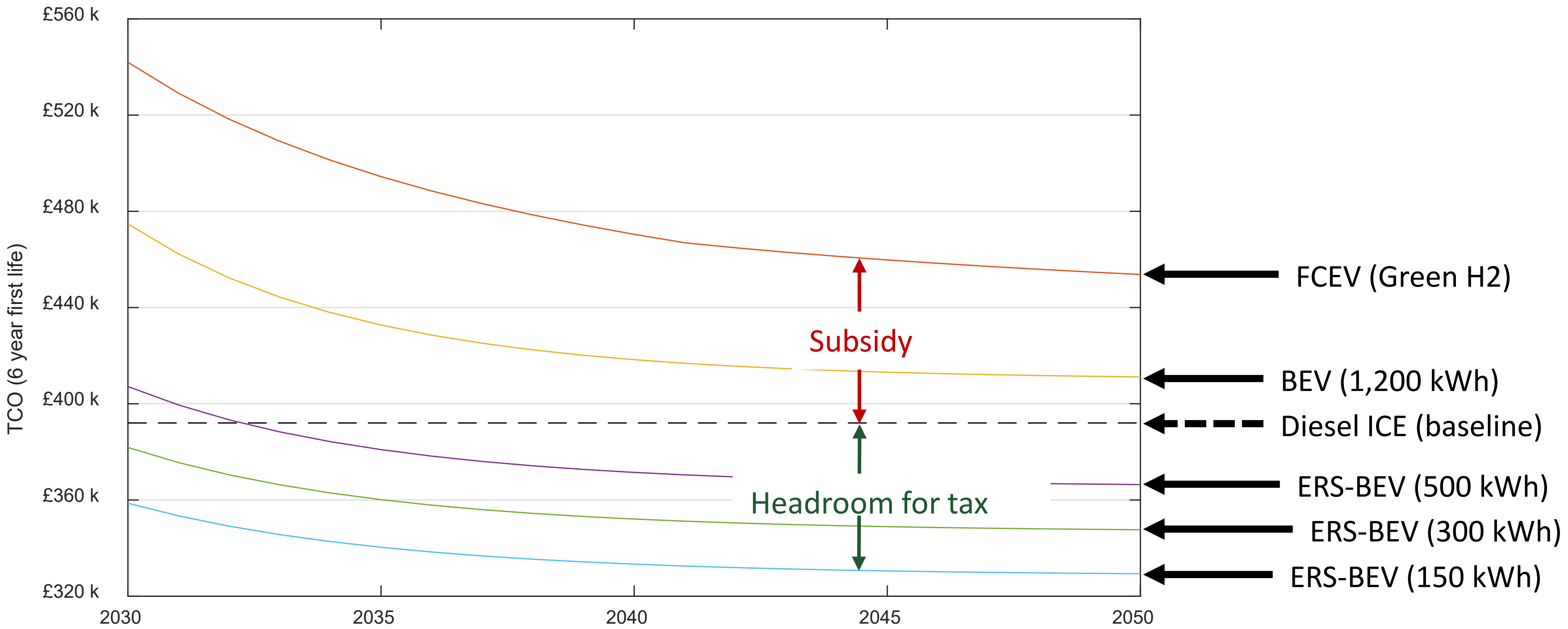
ERS:
- 10.6 GW
- 3,500 wind turbines
- Land Area=5,300 km^2

'Green' Hydrogen:
- 35.6 GW
  (31 GW = UK average)
- 12,000 wind turbines
- Land Area=18,000 km^2

Hydrogen vs Electricity
- 3 x Energy cost
- 2 x Capital cost
- Questionable decarbonisation
- Charging infrastructure
- Availability of vehicles

Assumptions:
1. UK freight: 189b t.km per year
2. 0.19 kWh/t.km (44t), LF=0.75
3. Efficiencies:
   - 0.77 ERS
   - 0.23 H_2
4. Turbine power: 3MW
5. Wind power density: 2 W/m^2

Total Cost of Ownership (TCO)



Big Batteries vs ERS

Big Batteries

Pros

- Simple, intuitive
- No government intervention needed

Cons

- High cost vehicles, loss of payload, bad for mass-limited loads
- Warehouse charging is essential – expensive grid connections
- Benefits are damaged by automation and autonomy

Dynamic Charging (ERS)

Pros

- Lowest cost vehicles, highest payload, good for mass-limited loads
- Min energy consumption, Min CO_2, Small batteries
- Benefits enhanced by automation and autonomy
- Minimal warehouse charging
- Privately financeable

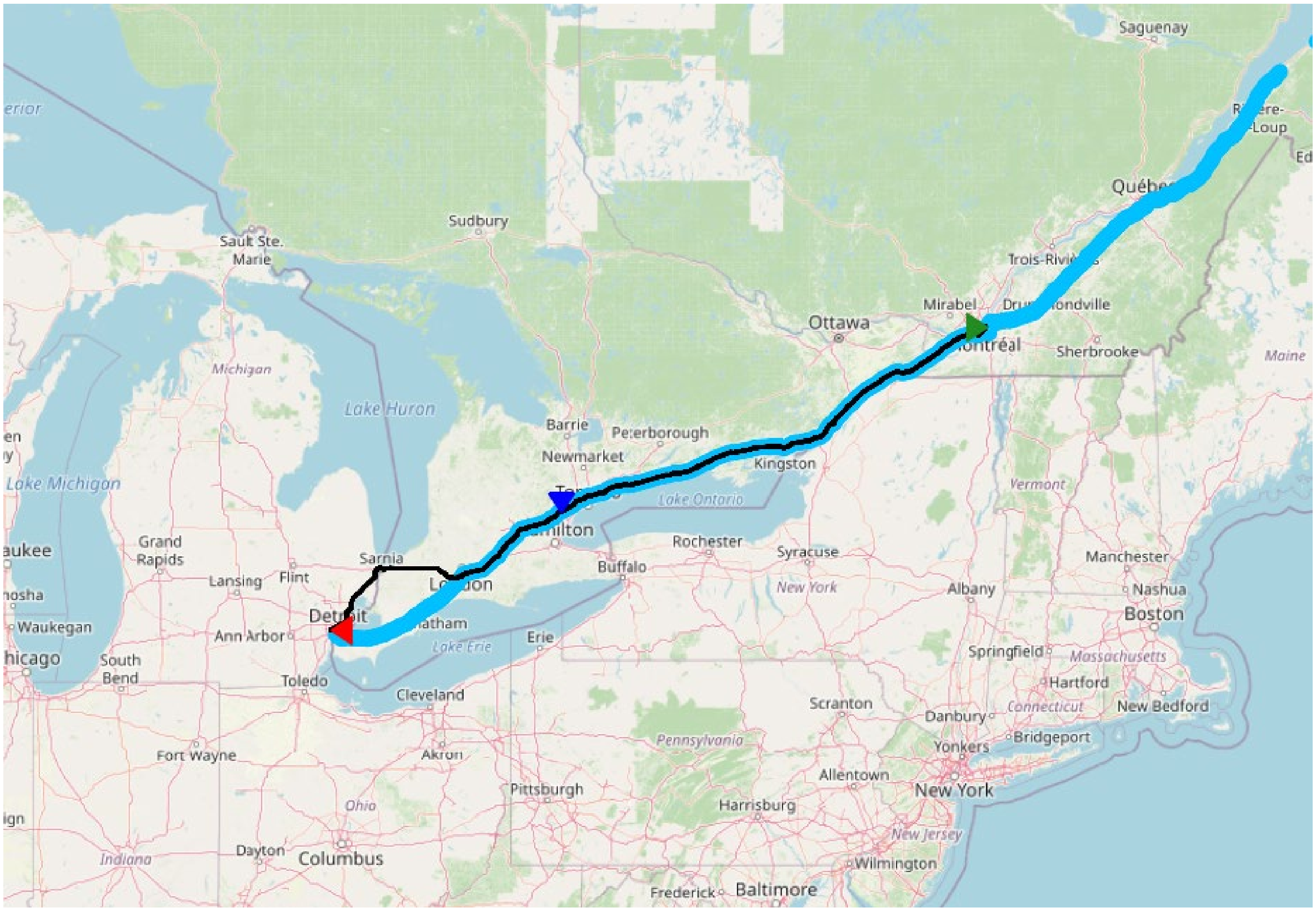
Cons

- Requires government support (not subsidies)
- Requires Highway Authorities to learn about electricity
- Doesn't look nice (to some people)!

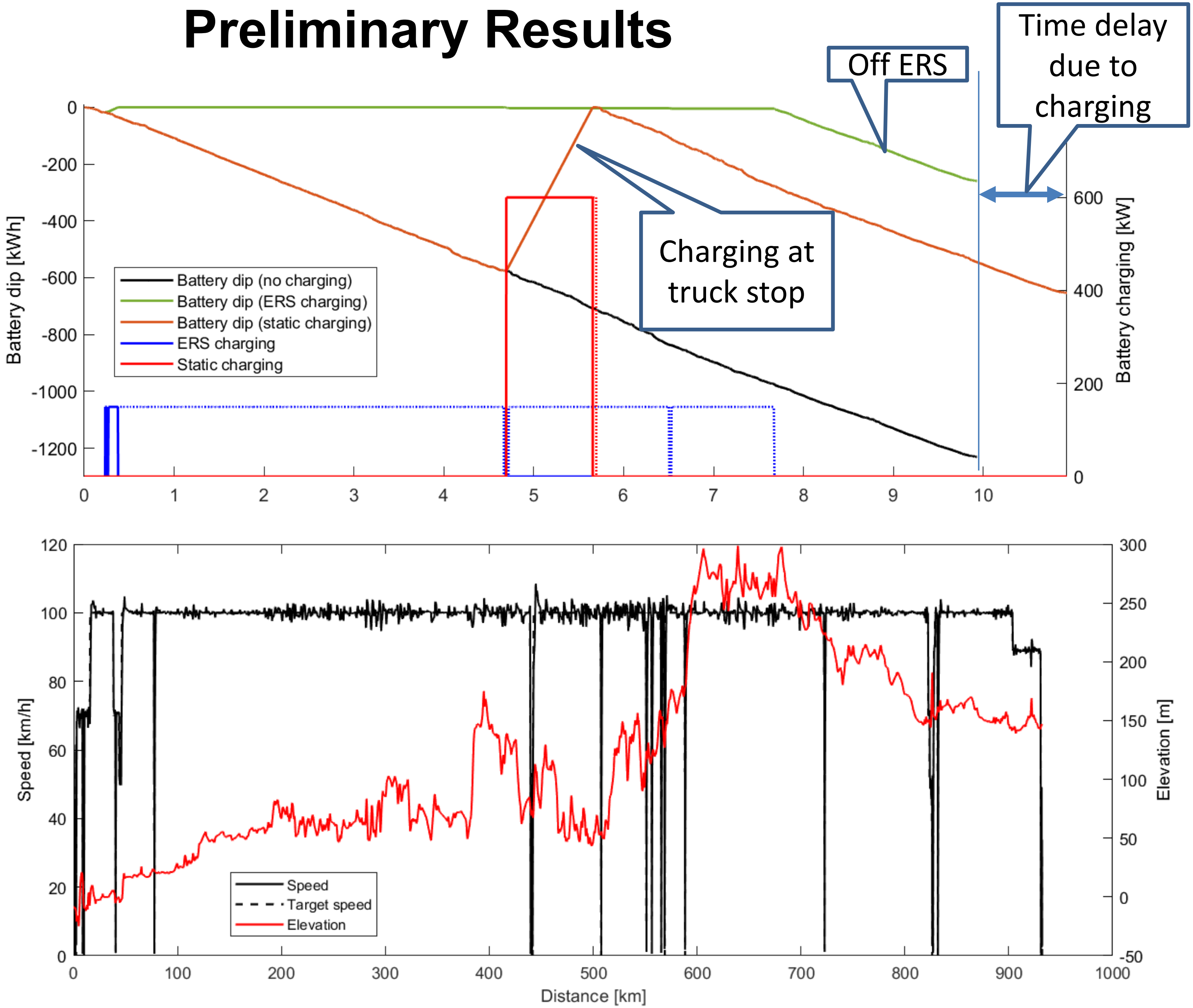
Conclusions

1. **Electrification:**
   - ..is **all about the charging** not the vehicles
   - ... fitting the charging into the **logistics** day
2. **Urban: battery EVs + opportunity charging**
3. **Automation will make charging significantly more difficult**
4. **Long-Haul: BEVs with ERS**
5. **Hydrogen: Too expensive.**
6. **Electric logistics can be made to work ➔the future!**
7. **Logistics is a system… Questionable benefit of analysing a single route in isolation!**

Preliminary Simulation of A20-H401



Preliminary Results



Preliminary Results

Charging Scenario	Required Battery Size (kWh)	Battery Weight (tonnes)	Max Payload (tonnes)
No charging	1538	8.2	16.3
Static charging	818 (built-in 850 kWh battery)	4.5 (for 850 kWh battery)	20.0 (current maximum)
ERS charging	325	1.4	22.8

Assumptions

- Vehicle: Tesla Semi, drag coefficient = 0.36
- Tractor Tare weight: 12 tonnes (850 kWh battery weighing 4.5 tonnes)
- Tractor Tare weight excluding battery: 7.5 tonnes
- Trailer Tare weight: 4 tonnes
- Energy density of Tesla Model S battery: 0.186 kWh/kg
- Gross Vehicle Weight: 36 tonnes