[1] V293 – 1970/2019

[2] Göltzschtal Bridge 1856

[3] Göltzschtal Bridge 2010

- [1] hybridized diesel locomotive (from diesel hydraulic to diesel electric transmission incl. battery, after 45 yrs of use!)
- [2] & [3] electrified railway after 150 yrs of use!!! (biggest brick railway bridge worldwide in Saxony, Germany)

Sources:

- [1] Deutsch Bahn // https://www.db-fzi.com/fahrzeuginstandhaltung-de/leistungsportfolio/produkte-und-innovationen/helms-717062
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Electric Road Systems

Retrofitting and migration strategies for ERS infrastructures and vehicles

Indo-German Workshop: Innovative charging Technologies for heavy duty Vehicles (IChargeHDV)

Heidelberg, Erfurt, New Delhi - 18 February 2021

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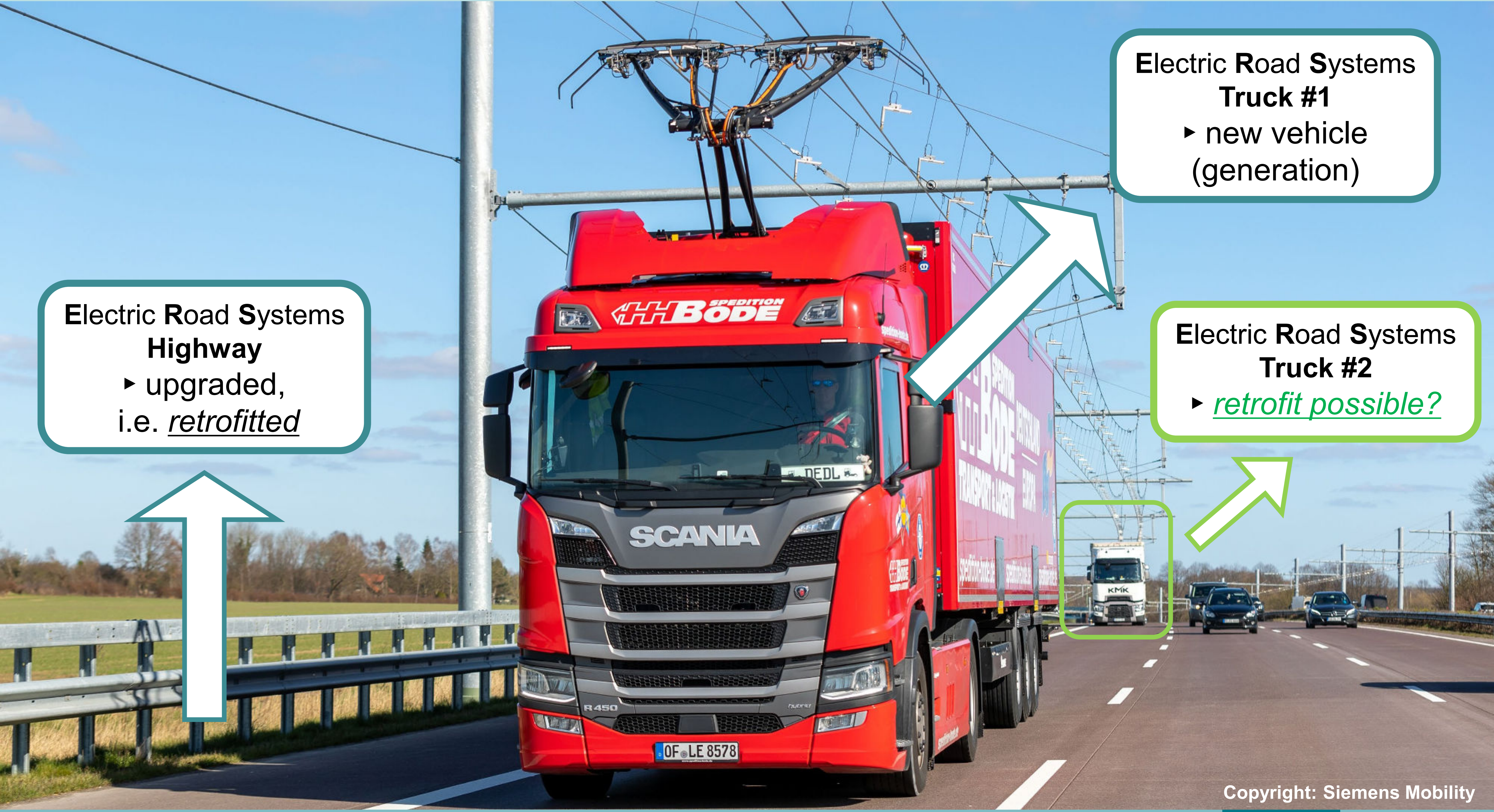
Electric Road Systems
Highway
▸ upgraded,
i.e. retrofitted
Electric Road Systems
Truck #1
▸ new vehicle
(generation)
Electric Road Systems
Truck #2
▸ retrofit possible?
SPEDITION BODE
SCANIA
OF LE 8578
KMK
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Key questions and outline

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I. Which ERS sub-systems must be considered and which railway experiences regarding retrofitting can be transferred?

II. How could ERS retrofitting strategies possibly look like?

Outline

(1) System overview and lifespan assumptions

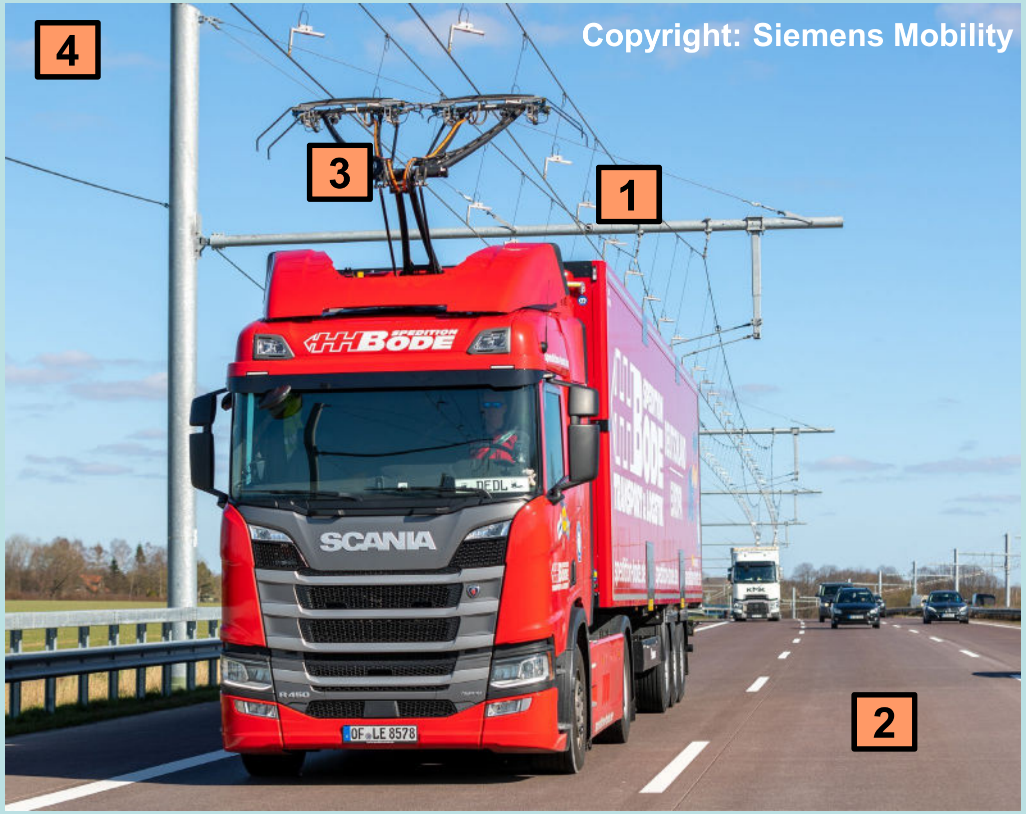
(2) Definitions: Retrofitting, upgrades, refurbishment … and purposes

(3) ERS infrastructure considerations regarding retrofitting

(4) ERS vehicle considerations regarding retrofitting

(5) Migration strategies

(6) Summary and conclusion



sub system	lifespan assumptions
1 TPS	approx. 70 yrs, contact wires 10 – 30 yrs
2 highway	decades, pavement 8 – 20 yrs
3 truck	approx. 10 yrs, big regional variation
4 OCC	indefinite, IT technology cycles

Electric **R**oad **S**ystems - **architecture**

1 – *(continuous)* traction power supply
2 – existing highway infrastructure
3 – electric vehicle *(w current collector)*
4 – operation & control

Electric **R**oad **S**ystems – **definition**

"ERS are systems that enable dynamic power transfer from the ERS traction power supply to ERS vehicles via a current collector while they are driving. By integrating contact lines and traction power supply technology into existing road infrastructure, an electrified road will stay accessible to […] other vehicles." (TS draft 50712)

(2) Definitions - purposes - examples

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term	definition, purpose	examples
refurbishment (Cambridge)	work such as painting, repairing, and cleaning that is done to make a building look new again	*railway rolling stock with new furnishings, paint (after ~15 yrs)*
retrofitting (Cambridge)	the act of providing a machine with a part, or a place with equipment, that the machine or place did not have when it was built	*added functions*
upgrade (Cambridge)	to improve the quality or usefulness of something, or change it for something newer or of a better standard	*vague: improved components or complete new fleet*
modification (EN 13306)	combination of all technical, administrative and managerial actions intended to change one or more functions of an item	*changed use of space, SW changes to alter characteristics*
modernization (EN 13306)	modification or improvement of the item, taking into account technological advances, to meet new or changed requirements	*umbrella term, e. g. to meet new environmental requirements*
rebuilding (EN 13306)	action following the dismantling of an item and the repair or replacement of those sub-items, that are approaching the end of their useful life and/or should be regularly replaced in order to provide the item with an extended useful life	*replacing engine or drive components by different type or technology (incl. obsolescent parts)*

- **dealing with existing items to improve functionality or meet (new) requirements**

(3) ERS infrastructure considerations - principles

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equipping existing highways	planning and building new ERS highways
➢ i. e. upgrade or modernization	➢ ERS ready design
➢ key points of interest - construction: • height restrictions at crossings/tunnels • side margin including crash barriers • directing lanes at turn-outs, junctions • individual constructions, possibly short interruptions	➢ key points of interest - construction: • ERS ready planning of crossings, tunnels, bridges, … • sufficient side margins (land acquisition) • adapted design guidelines for highway and electrification
➢ planning and integration: • construction works under traffic • co-ordination with other highway works • careful planning of site states • integration into existing traffic control and safety structures	➢ planning and integration: • longer planning cycles • integrated financing incl. tolling possible • dedicated truck highways possible (similar to dedicated freight railway corridors)

(4) ERS vehicle considerations – principles

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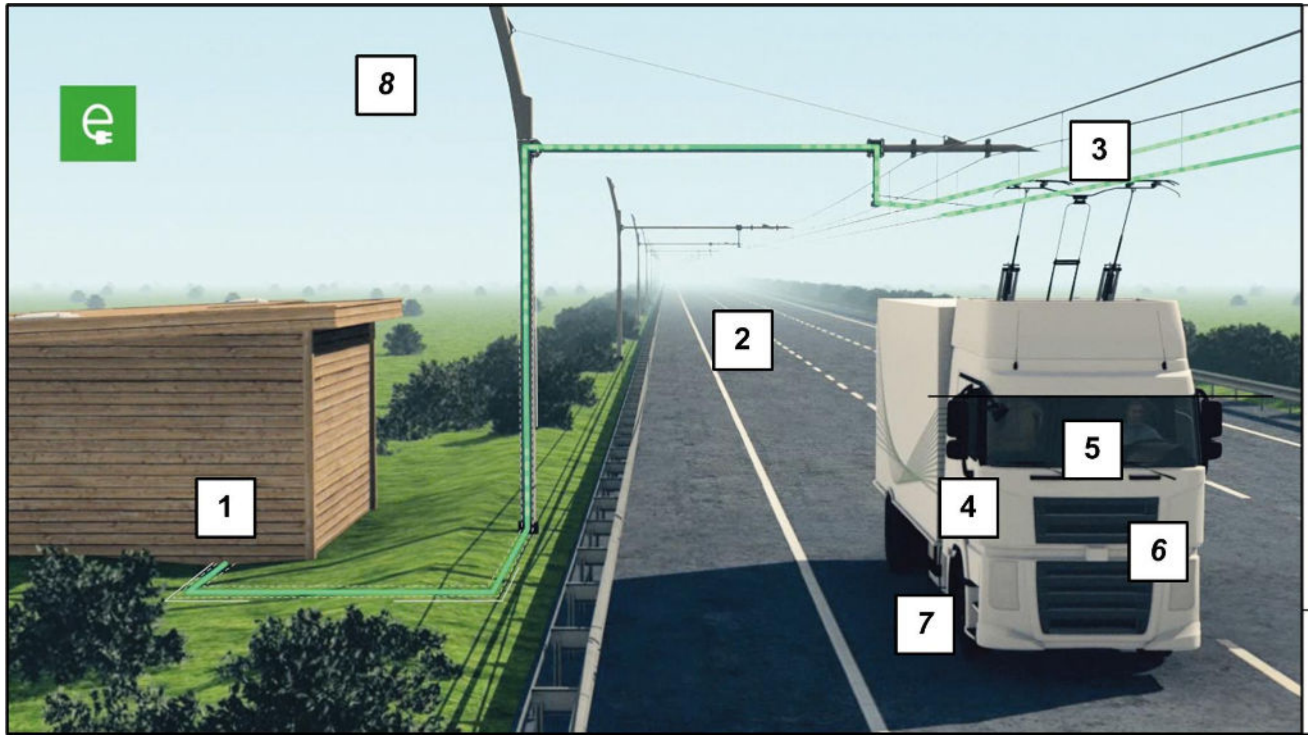
- **the railway (rolling stock) case:**
  - vehicles designed to last at least 30 yrs (often longer)
  - main overhaul/maintenance works every 6-8 yrs (depending on mileage)
  - often combined with change of items, modernization etc.
  - sometimes change of ownership or use case (contracts …)

heavy duty truck case #1 - Europe	heavy duty truck case #2 - India
➢ average lifetime ~ 10 yrs • change of owner or use case after 3-4 yrs • second and even third markets	➢ average lifetime ~ ?? yrs • impressions vs. statistics • mandatory retirement?
➢ **refurbishing** strategies: • growing affinity to monitoring and telematics in second market (keep) • interior renovation (refurbish) • technical robustness incl. adaption to lower diesel quality (2^{nd} & 3^{rd} market)	➢ considerations: • independent market • relevance of second markets? • mandatory retirement may be suspended after **rebuilding** of drive train

(4) ERS vehicle considerations – ERS readiness



#	interface
1	substation to overhead contact line (i. e. power supply to transfer)
2	contact line to road (power transfer to driveway)
3	contact line to panto-graph (power transfer to vehicle pick-up)
4	pantograph to electric drive (vehicle pick-up to hybrid base vehicle)
5	pantograph to driver/ truck cabin (vehicle pick-up to operation)
6	*vehicle to hybrid drive*
7	*vehicle to road*
8	*vehicle to OCC*

ERS sub-systems and interfaces (© M. Lehmann, ERS Conference 2017)

- ERS vehicles feature a number of internal and external interfaces
- a retrofit requires anticipation of interfaces to avoid rebuilding
- a retrofit after x yrs differs largely depending on the base vehicle (battery electric vs. conventional diesel truck)
- unused equipment causes costs, weight, maintenance …

ERS readiness check:

- ☐ base vehicle (diesel, battery, hybrid)
- ☐ base frame for later pantograph installation
- ☐ sufficient axle distance
- ☐ prepared control systems (CAN)
- ☐ electric protection concept: incl. cabling, shielding, isolation monitoring, galvanic separation …

(5) Migration strategies …

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Railway examples
#1 – implementation of advanced train control systems leads to a variety of interoperability specifications and long transition phases (multi system vehicles required; infrastructure converted line by line with than limited usability for non-interoperable vehicles)
#2 – change of key parameters (e. g. nominal voltage) requires multi system infrastructures **and** vehicles to ultimately benefit of switch-over

- useful, but only for long lifespans
- requires infrastructure and fleet managers to co-operate closely
- share of benefits, long duration of contracts/traffics

ERS options

- infrastructure growing line by line (alternatives regarding regional networks vs. mayor routes)

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i. **vehicles *pre-equipped***
ii. **vehicles *prepared***
iii. **vehicles *exchanged***

variables:

- duration of contracts
- fleet sizes and specialization
- variability regarding areas, frequencies
- *sunken* costs of un-used equipment
- second/third market

→ **certainty** / **variability**

(6) Summary & conclusion

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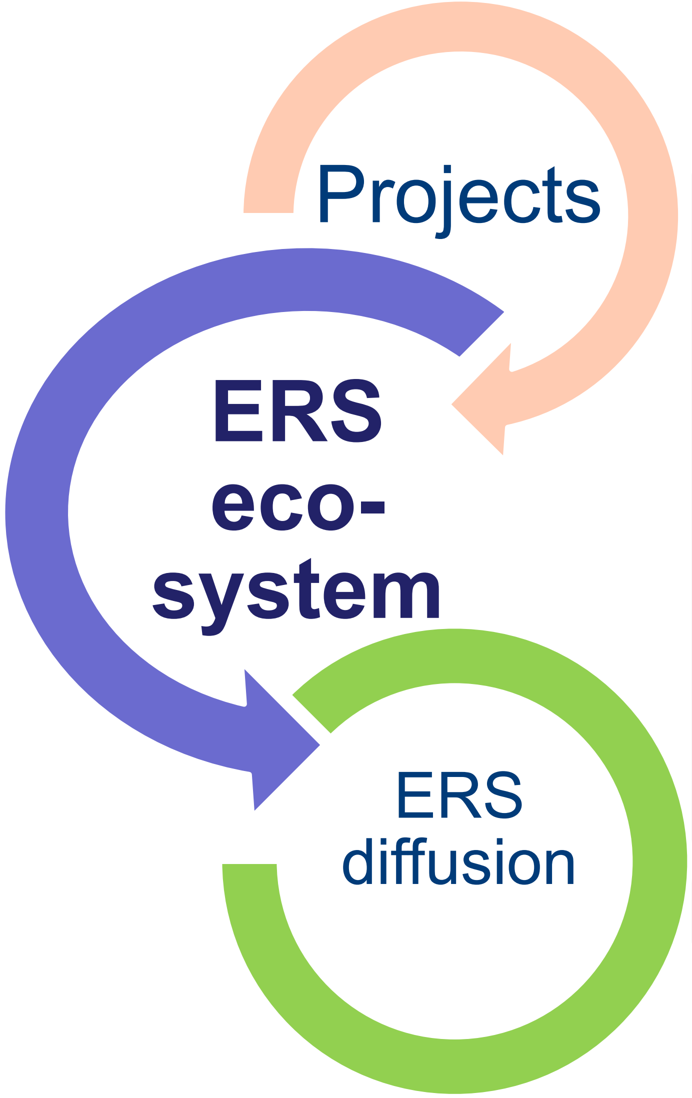
▸ **Start: Greenfield projects**

- dedicated applications
- in parallel set-up of ERS infrastructure **and** vehicles
- learn about all ERS lifecycle phases

time

▸▸ **infrastructure roll-out**

- ERS infrastructure implementation plan
- 1…2 decades, growth according regional needs
- increasing benefits of ERS vehicles



electric vehicle strategy

- plan for BEV and ERS vehicles (with respect to components like cabling, batteries, electronics)
- consider ERS-readiness in heavy duty vehicles depending on application
- compare fleet changes among applications against retrofitting in same application
- retrofitting of vehicles is one of many solutions

Thank you for your attention!

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Decarbonising road freight with ERS – **Moving forward!**

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ERS – basic literature

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