eHighway ELISA
Virtual Site Visit

www.siemens.com/eHighway

eHighway status as of 2021

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- Installed on two sections of the German motorways
- Used in real transport operations
- With trucks from an OEM

Agenda

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1. **Technology development**
2. Examples of integration into existing road infrastructure (field trials)
3. ELISA virtual site visit
4. Aspects of Norming and standardization ensuring interoperability in Europe
5. Virtual ride and driving experience in an overhead catenary truck

Decarbonization is a challenge in transport sector and in particular heavy long-haul transport is seen as especially difficult

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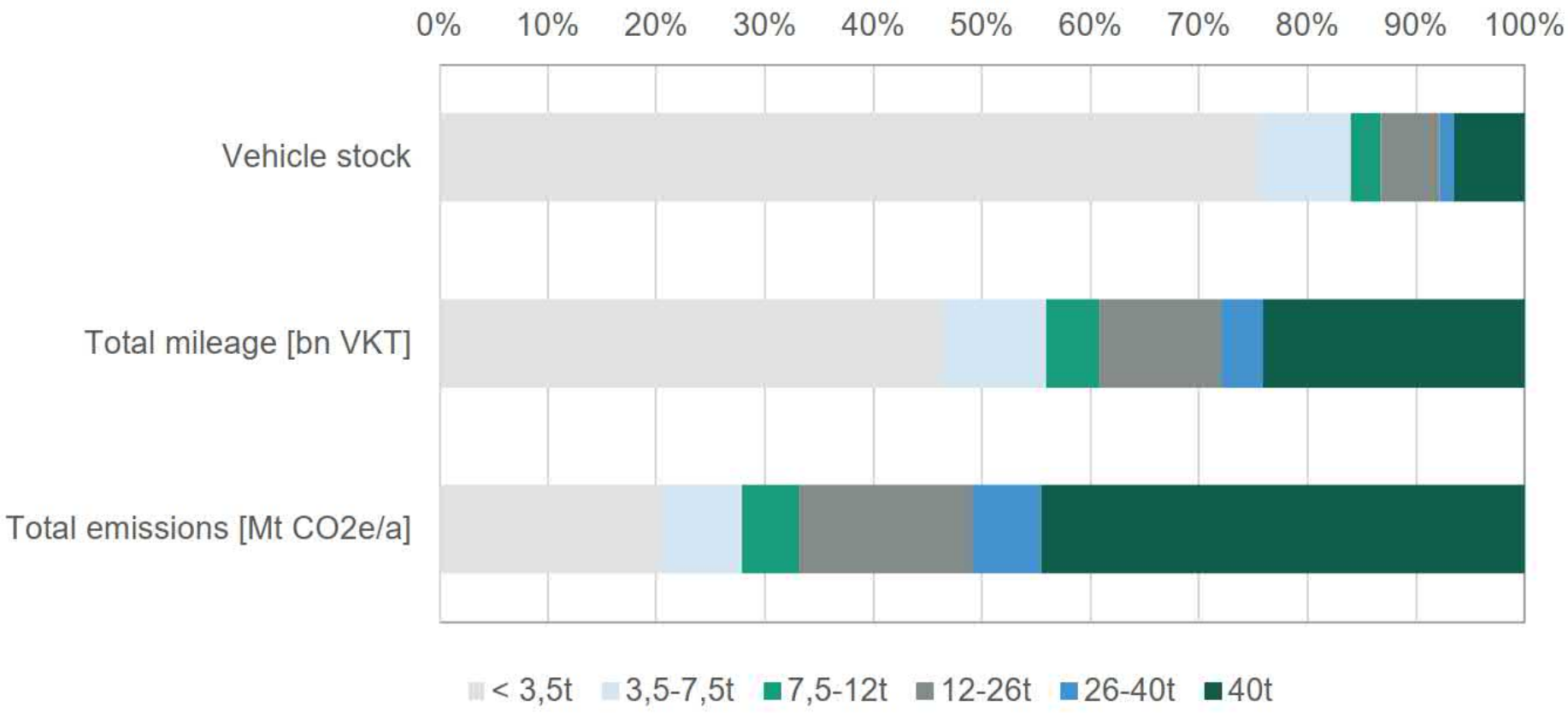
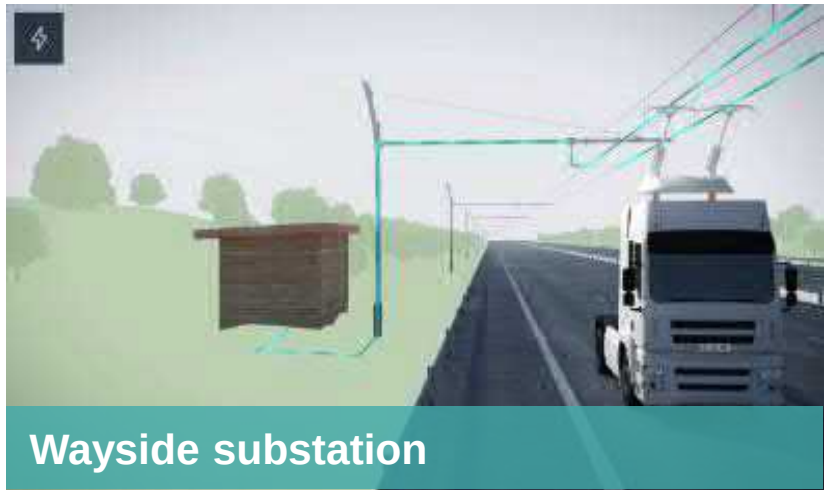
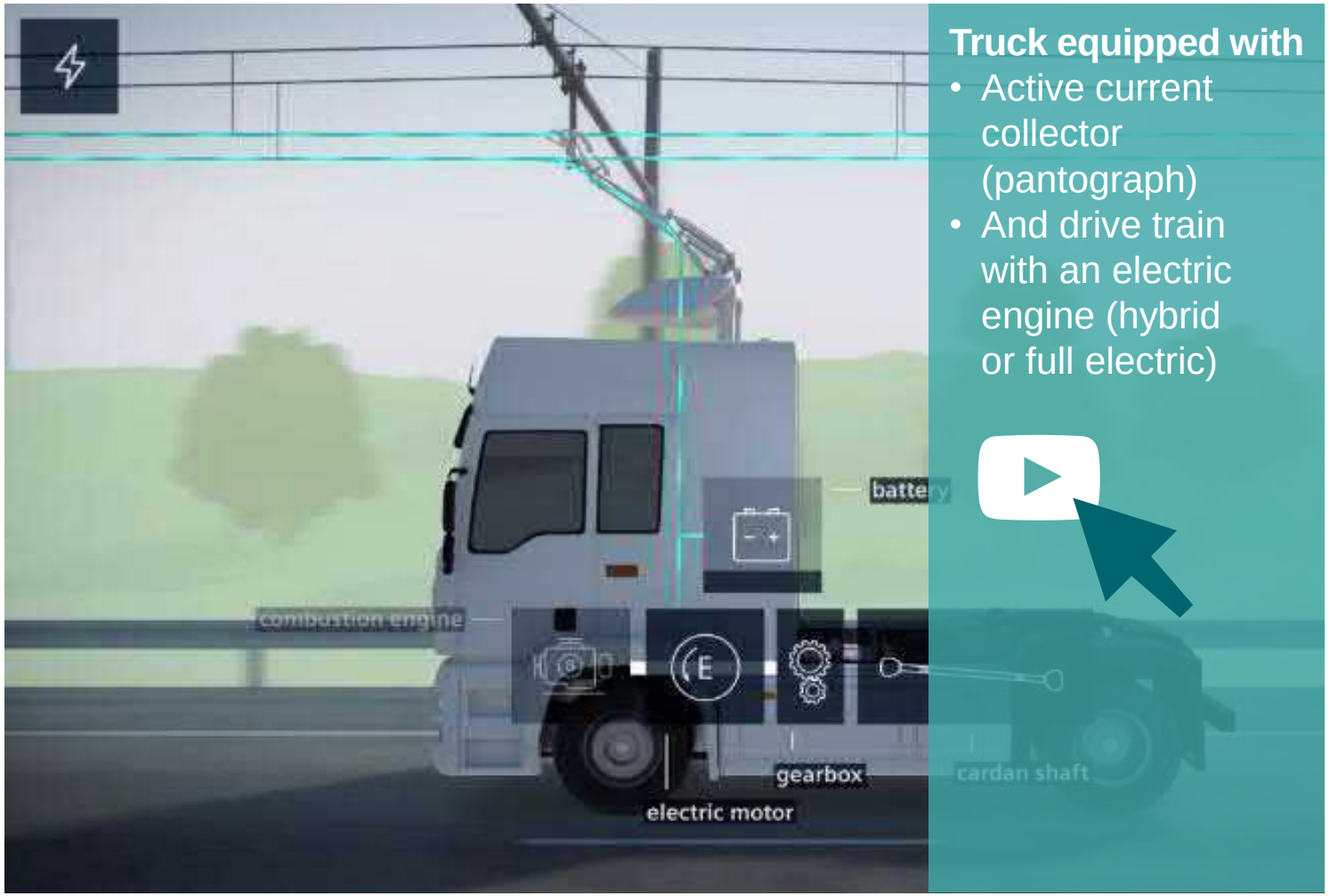
Road freight decarbonization is particularly a challenge for the few vehicles that emit the majority of CO_2



Source: Oeko Institute, Fraunhofer ISI & IFEU – *Alternative drive trains and fuels in road freight transport – recommendations for action in Germany*

How an eHighway for heavy duty vehicles works





eHighway truck technology – From proof-of-concept to field trials

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Development of the eHighway vehicle technology

2010 — 2021

1st Generation
Proof-of-concept

2nd Generation
Swedish and US
Demonstration projects

3rd Generation
Field trials

Operations up to 100 km/h possible

Connection and disconnection to catenary in motion

Recharging of on-board energy storage while driving

No limitations for first and last mile

Catenary electrification is compatible with and complementary to other alternative fuel technologies

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The eHighway hybrid truck can be configured to suit specific applications

Truck types


Tractor truck (2 axles)


Tractor truck (3 axles)


Rigid truck (2 axles)


Rigid truck (3 axles)


Rigid truck (4 axles)

Drive system

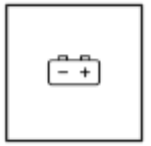

Parallel-hybrid


Serial-hybrid


Full electric

On-board source of electricity


Battery (small)


Battery (medium)


Battery (large)


Fuel cell

Combustion engine


Engine (small)


Engine (medium)

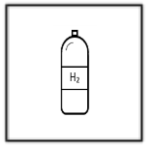

Engine (large)

Non-electrical source of energy


Diesel


Bio fuel


CNG/LNG


Hydrogen

Catenary electrification is compatible with and complementary to other alternative fuel technologies

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The eHighway hybrid truck can be configured to suit specific applications

Truck types

- Tractor truck (2 axles)
- Tractor truck (3 axles)
- Rigid truck (2 axles)
- Rigid truck (3 axles)
- Rigid truck (4 axles)

Drive system

- Parallel-hybrid
- Serial-hybrid
- Full electric

On-board source of electricity

- Battery (small)
- Battery (medium)
- Battery (large)
- Fuel cell

Combustion engine

- Engine (small)
- Engine (medium)
- Engine (large)

Non-electrical source of energy

- Diesel
- Bio fuel
- CNG/LNG
- Hydrogen

Showing combinations already realized in projects so far

German field trials lay the foundation for the next step in the development of the system

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Information and routing

	Federal State of Hesse Infrastructure project awarded to Siemens	Federal State of Schleswig Holstein Infrastructure project awarded to Siemens	Federal State of Baden-Wuerttemberg Infrastructure project awarded to Siemens
Track length/ amount of trucks:	5 km/ 5	5 km/ 5	2,6-3,4 km/ 5
Construction:	Apr – Nov 2018	Oct 2018 – May 2019	June 2020 – Summer 2021
Demonstration:	Official start May 7, 2019	Started in Dec 2019	Planned start: Q3 2021

Project homepage
ELISA

Project homepage
FESH

Project homepage
eWayBW

ELISA project: Delivered on time and on budget – with minimal disruption to traffic flow

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Ground investigations

Setting foundations

Erecting poles

Attaching cantilevers

Pulling the contact line

Installing the substations

Agenda

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1 Technology development

2 **Examples of integration into existing road infrastructure (field trials)**

3 ELISA virtual site visit

4 Aspects of Norming and standardization ensuring interoperability in Europe

5 Virtual ride and driving experience in an overhead catenary truck

Realisation of eHighway (field trials near Frankfurt and Lubeck)

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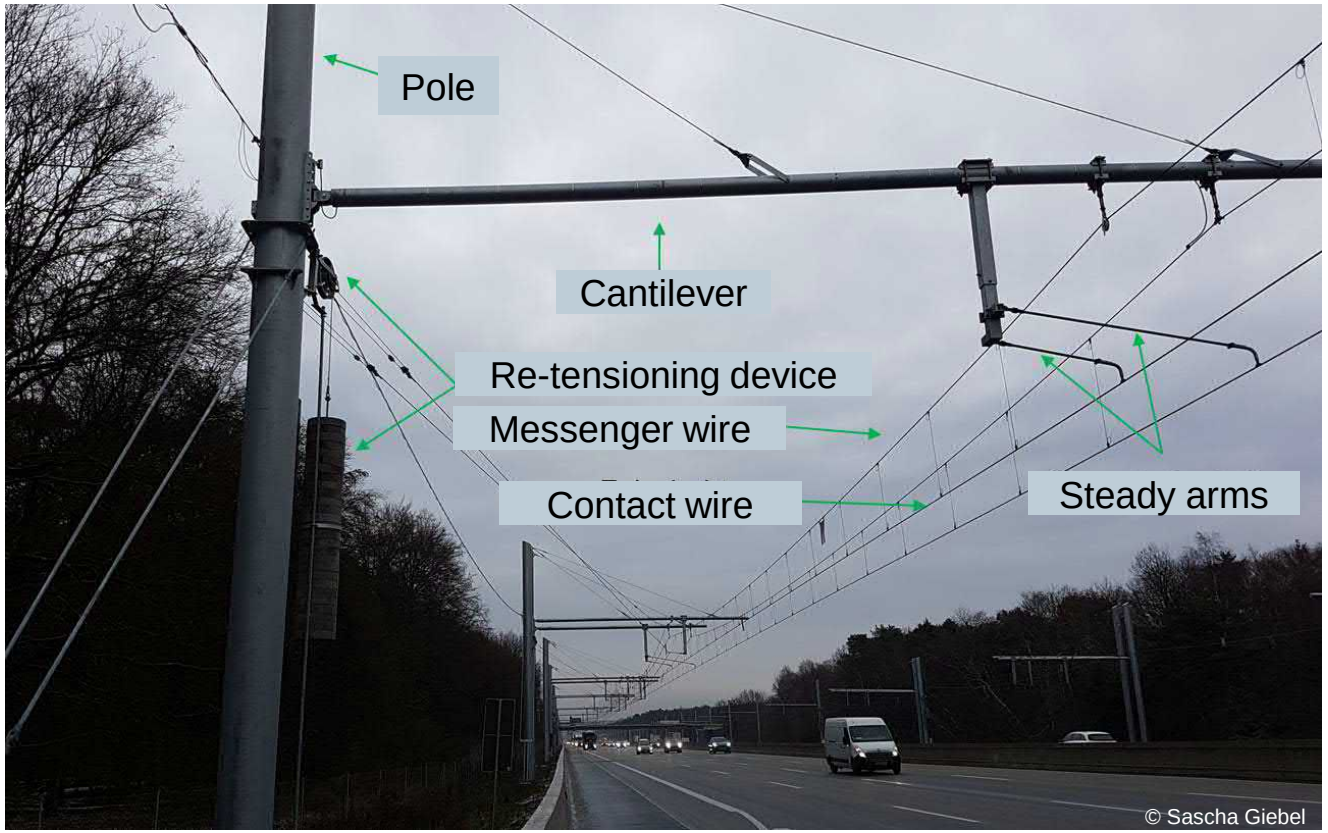
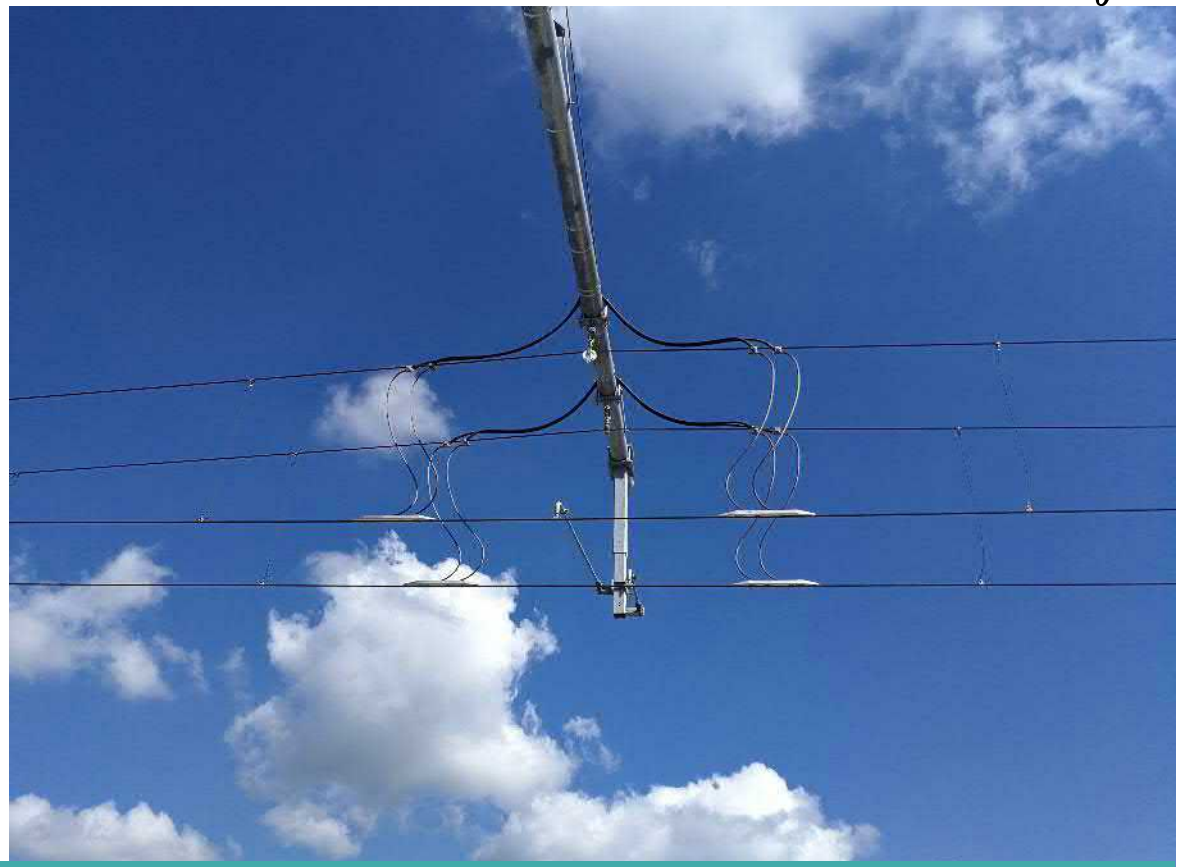
- Power distribution and supply via medium voltage network (10 kV to 30 kV)
- Substations feed the electrified sections with 670 V DC
- Infeed from the substation to the electrified section via underground cables
- Two contact lines (positive and negative) cantilever above the right lane
- Re-tensioning devices for constant tension of contact wire and suspension cable
- Supply of the track components via a suspension cable suspended from the mast
- Monitoring of the contact wire (CMS)



Realisation of eHighway (field trials near Frankfurt and Lubeck)



Example of a feed-in pole

Realisation of eHighway using the example of the field trial near Frankfurt (project ELISA)

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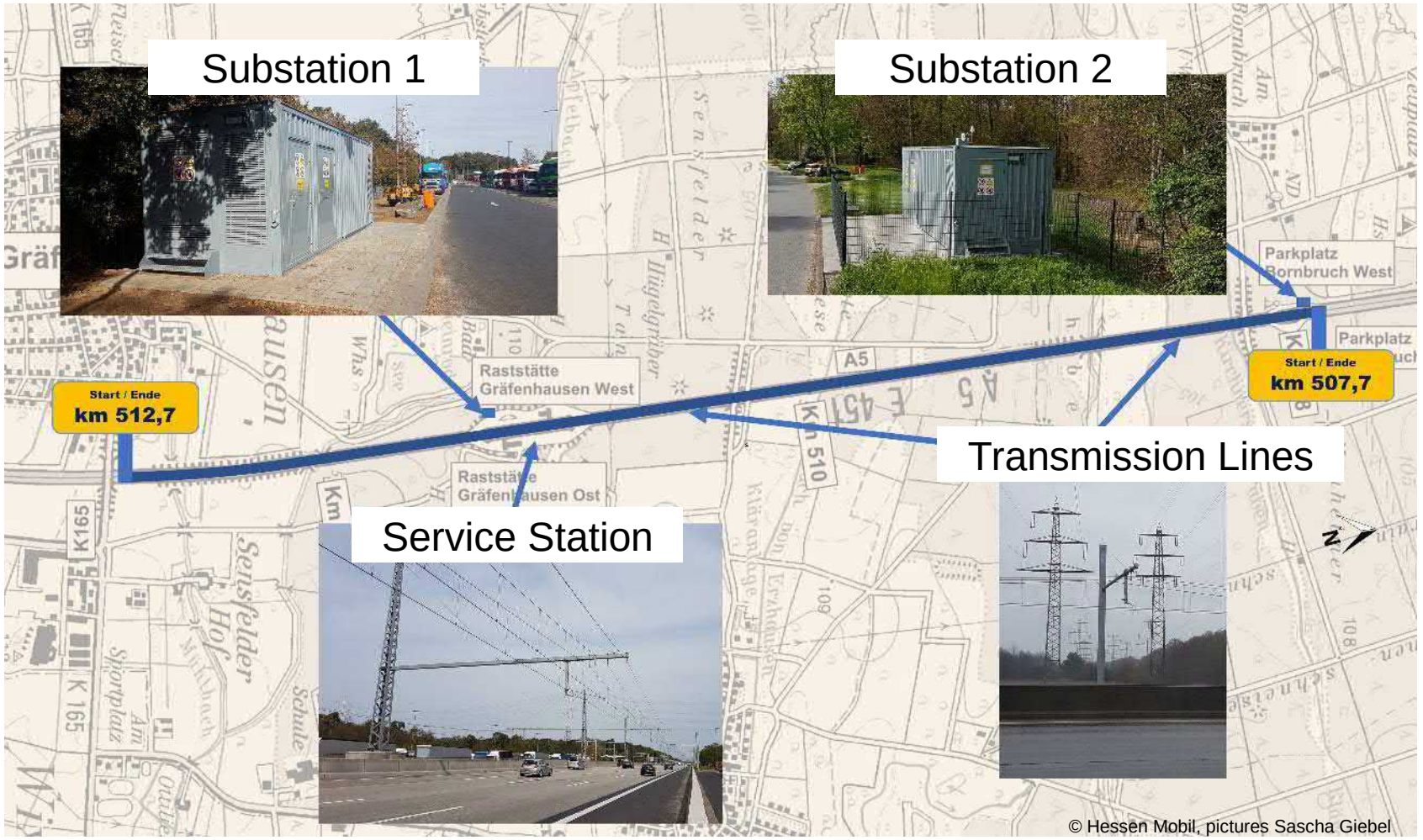
Parameter	Project ELISA
Medium Voltage 3AC	20 kV
Nominal Voltage DC	670 V
Nominal Power per Substation	1,000 kVA
Number of Substations	2
Length of Electrical section in each driving direction	5 km
Number of poles	223 + 6 Poles in Middle strip



Realisation of eHighway - project FeSH on motorway A1 near Luebeck, Schleswig-Holstein

Implementation under a railway bridge with rigid catenary

Project eWayBW – National Road B462 near Gaggenau, Baden-Wurttemberg

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Agenda

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1 Technology development

2 Examples of integration into existing road infrastructure (field trials)

3 **ELISA virtual site visit**

4 Aspects of Norming and standardization ensuring interoperability in Europe

5 Virtual ride and driving experience in an overhead catenary truck

Let’s start our ELISA virtual site on motorway A5 near Frankfurt!

Agenda

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1 Technology development

2 Examples of integration into existing road infrastructure (field trials)

3 ELISA virtual site visit

4 **Aspects of Norming and standardization ensuring interoperability in Europe**

5 Virtual ride and driving experience in an overhead catenary truck

Status of standardization

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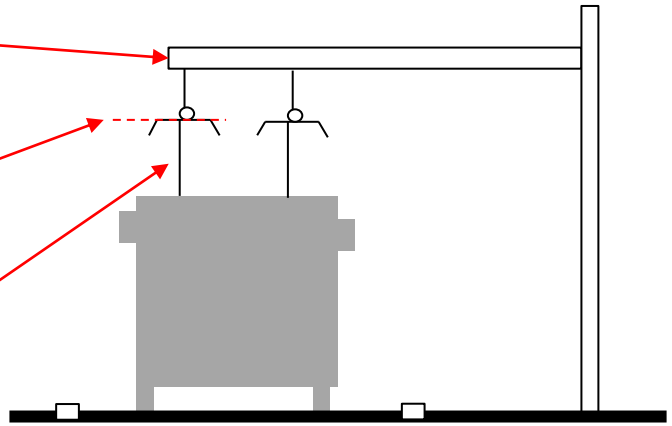
Rail industry

EN50119 – Electric traction overhead contact lines

EN50367 – Technical criteria for the interaction between pantograph and overhead line

EN50206 – Pantographs

…and further (e.g. EN50405 carbon strips)



eHighway

EN50119 incl. informative annex C – Overhead contact line for electric trucks

TC9x – interaction between pantograph and overhead contact lines on electrified roads

EN50119 incl. informative annex C – Overhead contact line for electric trucks

In the last update (released April 2020) an Annex (informative) on infrastructure requirements for overhead contact lines for electric trucks on roads was already integrated.

TC9x – Interaction between pantograph and overhead contact lines on electrified roads

The standardization of the eHighway pantograph and the interaction towards the contact lines is in implementation within the European CENELEC working group WG27. The finalization and international review of a technical specification as initial step of a technical standard is expected by end of the year.

eHighway pantograph used in current field trials

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Development view

Pantograph
- Arms & Collector head
- Main frame
- 650 VDC / 24 VDC system
- Sensor system
- Pneumatics
- Isolation system
- Drive & Control

HTE (Hybrid truck Equipment)
- Base frame
- Control
- Switches
- Choke
- DC/DC

Truck adapter

Realization

European interoperability for electrical road freight transport
Basic design criteria to be standardized

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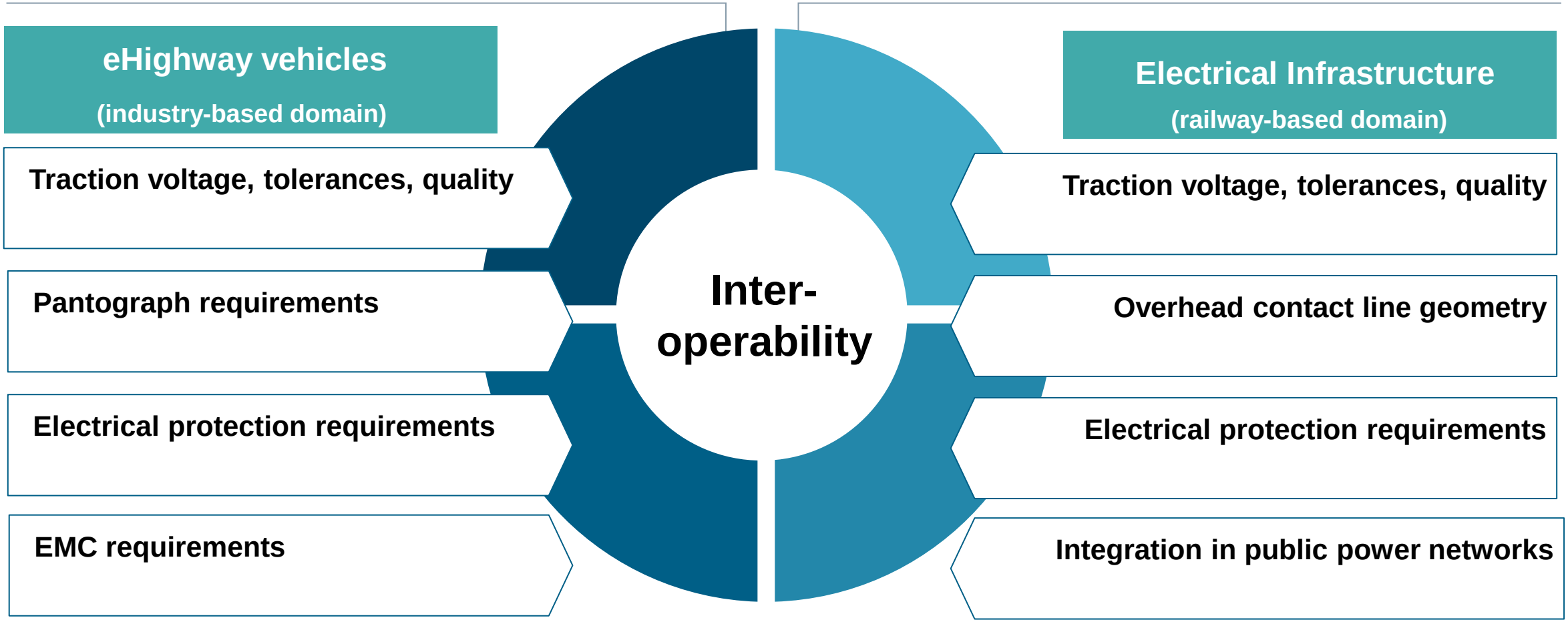

Similar criteria to be standardized for both subsystems. But in totally segregated domains.

European interoperability for electrical road freight transport
Subsystems and interfaces affected by standardization

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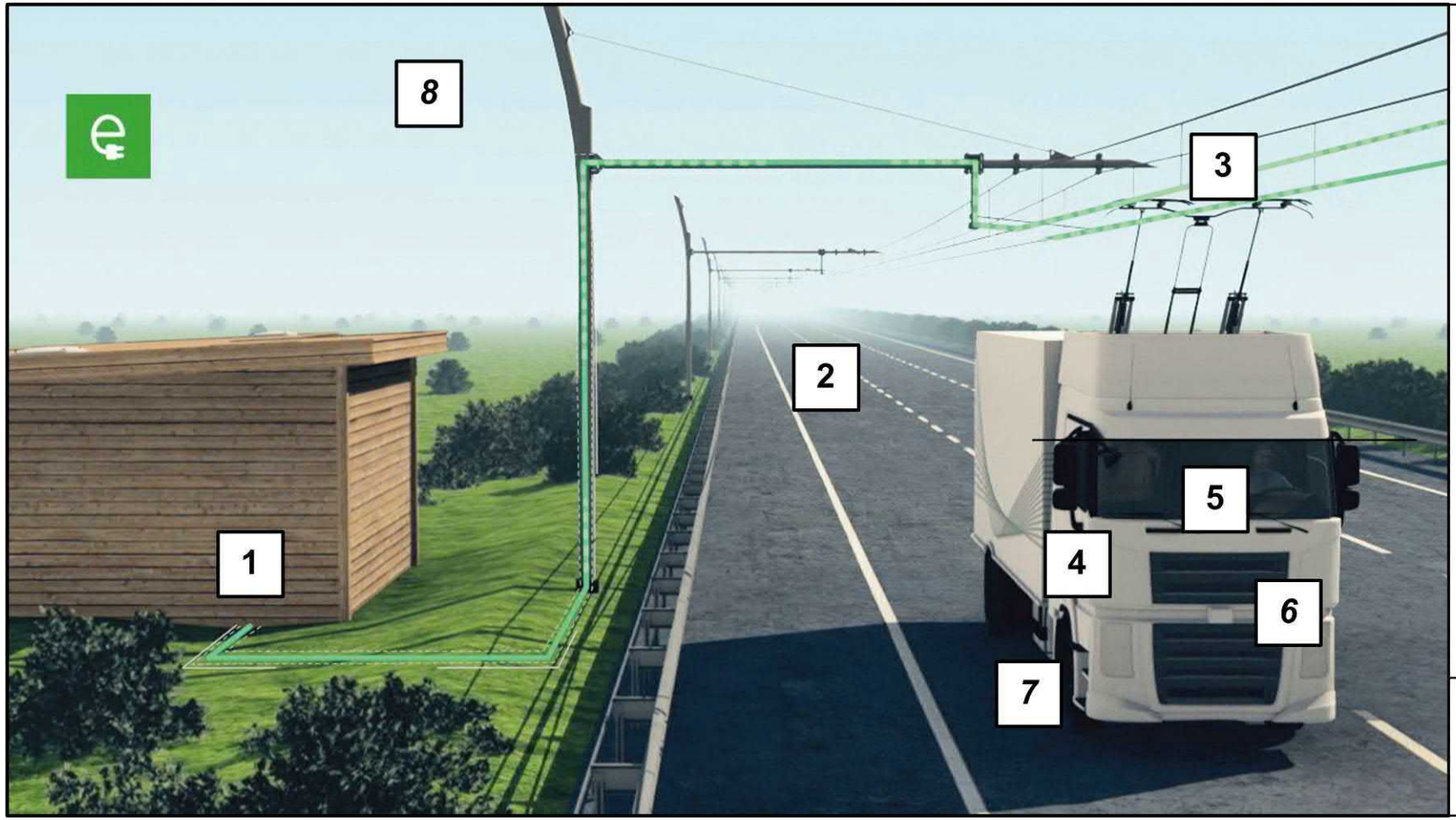

#	interface
1	substation to overhead contact line (i. e. power supply to transfer)
2	contact line to road (power transfer to driveway)
3	contact line to panto-graph (power transfer to vehicle pick-up)
4	pantograph to electric drive (vehicle pick-up to hybrid base vehicle)
5	pantograph to driver/ truck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

Organizations responsible for standardization / regulation eHighway to be allocated to the respective S&R-bodies

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#	interface
1	substation to overhead contact line (i. e. power supply to transfer)
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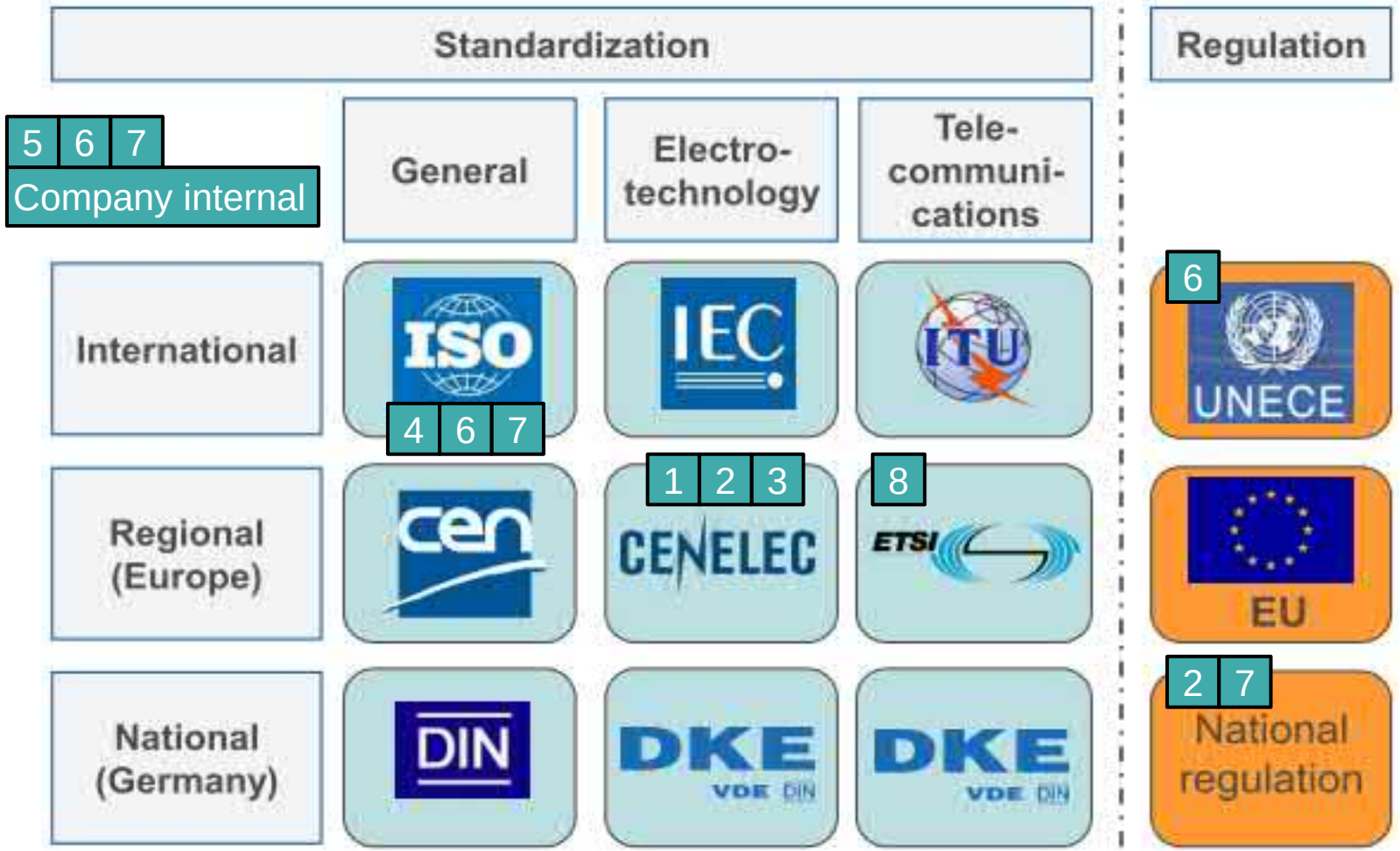
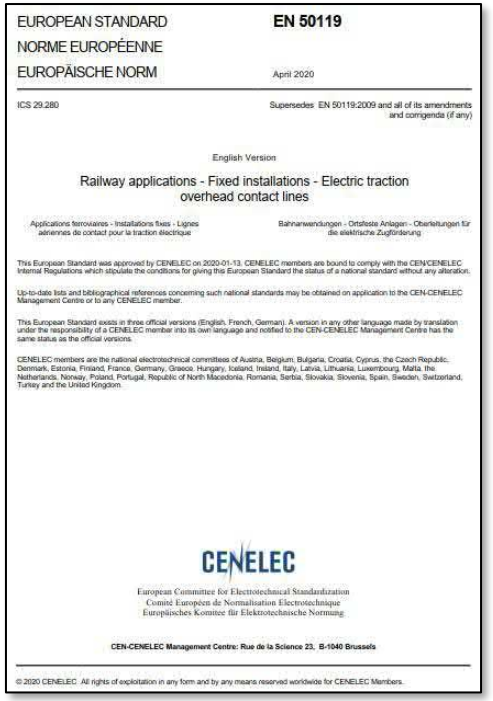


Substantial progress has been made on standardization and regulation aspects (Europe)

- Basic Design Criteria
  - *Definition of relevant parameters and design criteria for construction and operation of eHighway system*
- Standard and Regulations Roadmap
  - *Set of applicable standards for the eHighway system (CENELEC, ISO, OEM, other)*
- CENELEC TC9X working group:
  - *Technical Criteria for the interaction between pantograph and overhead contact lines on electrified roads*
- EN50119_2020:
  - *Annex C describes specifications for overhead contact lines for electric trucks*


EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 50119

April 2020

ICS 29.280

Supersedes EN 50119:2009 and all of its amendments and corrigenda (if any)

English Version

Railway applications - Fixed installations - Electric traction overhead contact lines

Applications ferroviaires - Installations fixes - Lignes aériennes de contact pour la traction électrique

Bahnanwendungen - Ortsfeste Anlagen - Oberleitungen für die elektrische Zugförderung

This European Standard was approved by CENELEC on 2020-01-13. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Key features of the eHighway pantograph

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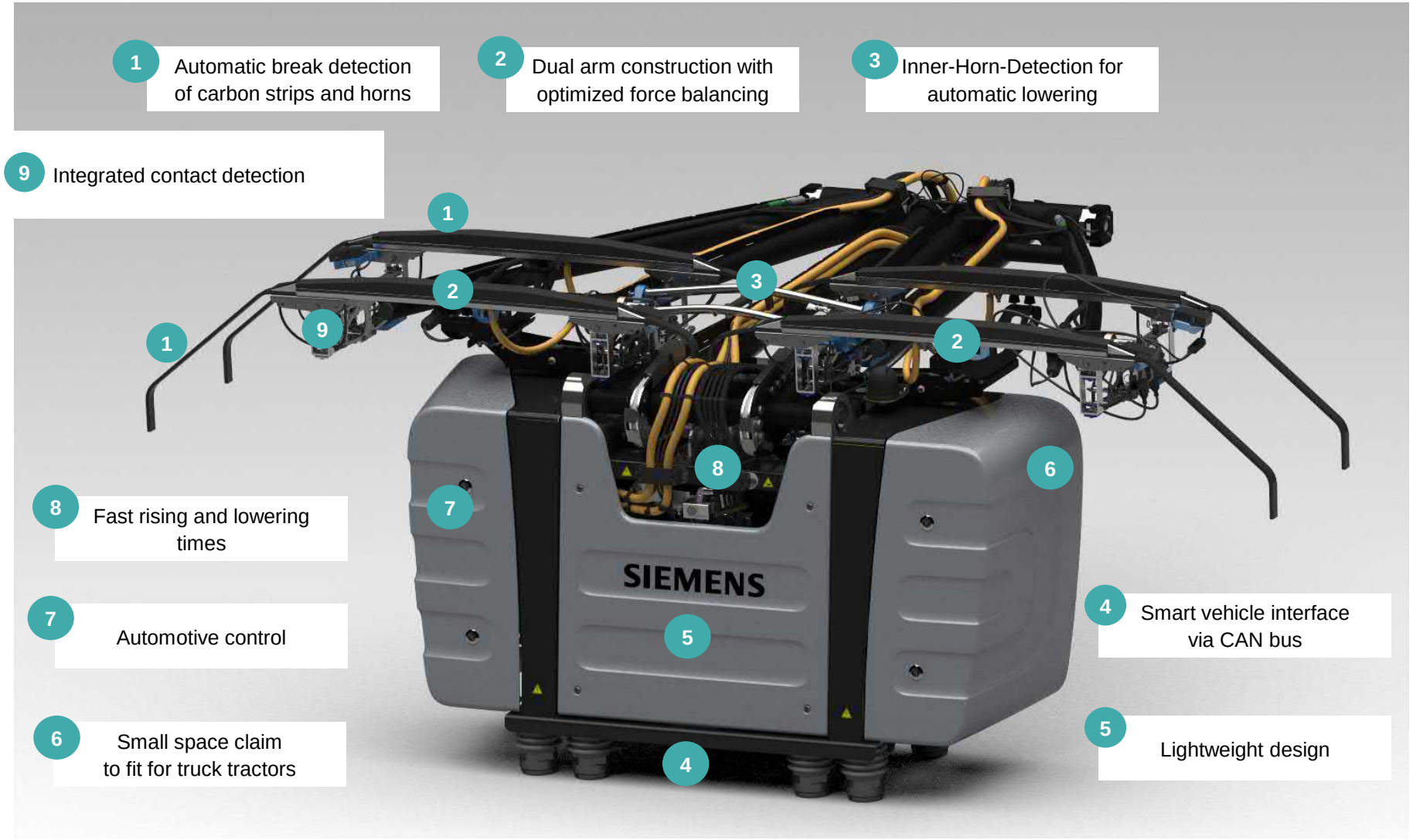

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Virtual ride and driving experience in an overhead catenary truck


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Questions, comments?

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