Automatisch fahrende Züge – Einblick in Alstoms Projektwerkstatt

Matthias Handschin

DLR-Symposium
“Der Zug zur Digitalisierung”

Braunschweig, 4. November 2020

ALSTOM
• mobility by nature •

Agenda

1. Mobilität 2030; Alstoms Vision
2. Automatisierung; Stand heute
3. Aktuelle Fragestellungen
4. Das ARTE-Projekt in Niedersachsen
5. Aktuelle ATO-Projekte in Europa

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Mobilität 2030; Alstoms Vision

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Vernetzt,…

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elektrisch,…

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automatisiert!

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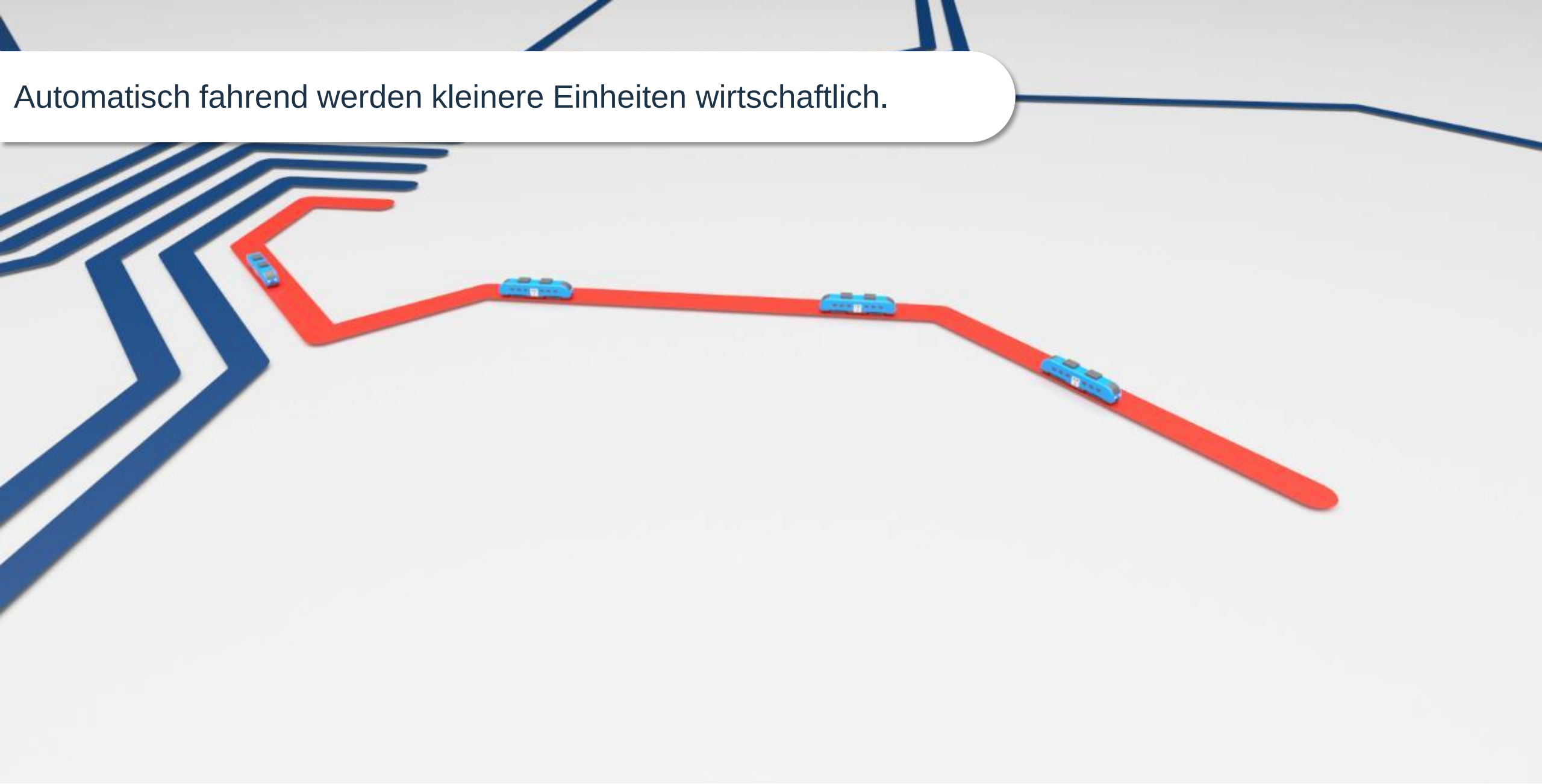
Automatisch fahrend werden kleinere Einheiten wirtschaftlich.



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Automatisierung; Stand heute

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Die Automatisierungsstufen im Bahnbetrieb

Stufe GoA	Betrieb	Türschliessung	Abfahren	Fahren und Halt im nächsten Haltebahnhof	Störfall-manager
GoA 1	mit Lokführer PZB/LZB	Lokführer	Lokführer	Lokführer	Lokführer
GoA 2	mit Lokführer PZB/LZB/ETCS	Lokführer	Lokführer	Automatik	Lokführer
			Automatik		
GoA 3	ohne Lokführer PZB/LZB/ETCS (DTO)	Zugbegleiter	Zugbegleiter	Automatik	Zugbegleiter
		Automatik	Automatik		
GoA 4	unbegleitet PZB/LZB/ETCS (UTO)	Automatik	Automatik	Automatik	Troubleshooter

GoA: grade of automation

DTO: driverless operation
UTO: unattended operation

PZB: punktförmige Zugbeeinflussung
LZB: linienförmige Zugbeeinflussung

ETCS: European Train Control System

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Was kann Automatisierung heute?

Automatischer Fahrbetrieb
(mit Fahrer **GoA2**)

- bis zu 20% mehr Kapazität
- Kürzere Reisezeiten
- Verstetigung des Betriebs
- Energieeinsparung

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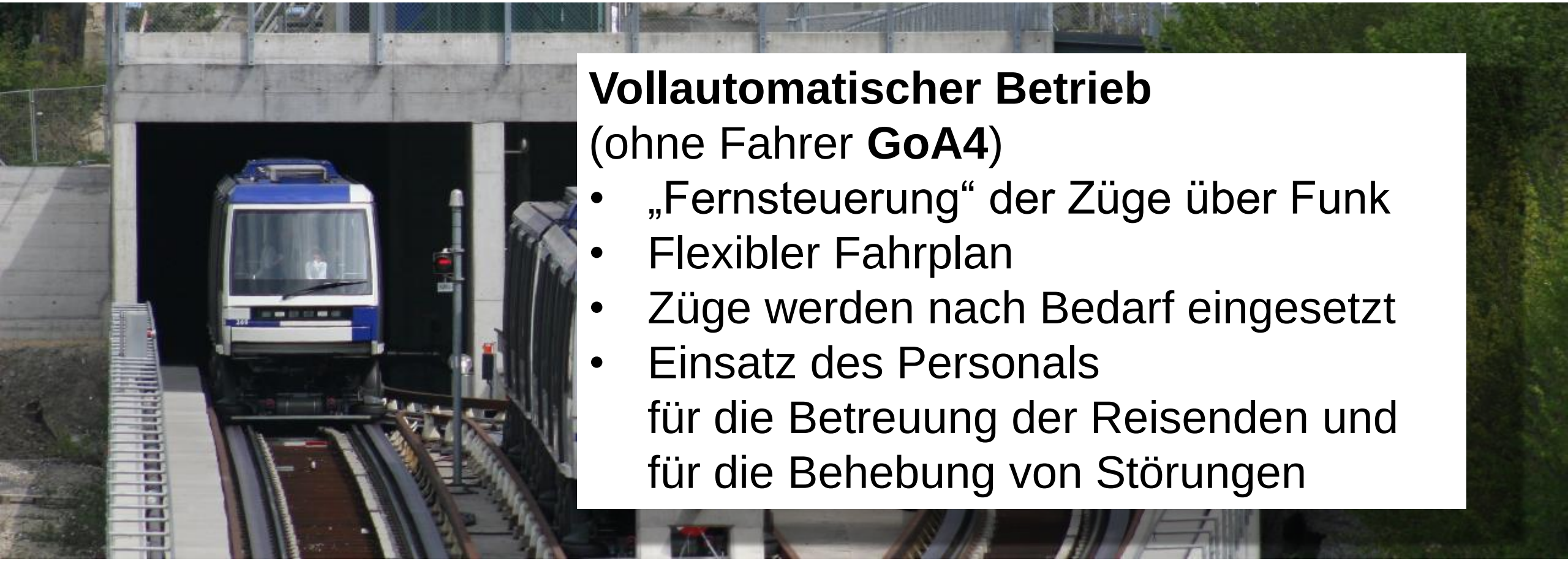
Was kann Automatisierung heute?



Vollautomatischer Betrieb
(ohne Fahrer **GoA4**)

- „Fernsteuerung“ der Züge über Funk
- Flexibler Fahrplan
- Züge werden nach Bedarf eingesetzt
- Einsatz des Personals
  für die Betreuung der Reisenden und
  für die Behebung von Störungen

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Was kann Automatisierung heute?

Autonomer Rangierbetrieb
(ohne Fahrer **GoA4**)

- Fahrzeuge fahren autonom im nicht öffentlichen Raum
- Hindernisse werden erkannt und Kollisionen verhindert

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Aktuelle Fragestellungen

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Kann ein Zug auch ohne ETCS automatisch fahren?

JA – mit optischer Signalerkennung und **NEIN – der sichere ETCS-Rechner wird benötigt.**

- Das System ist zur Zeit bei Alstom in der Entwicklung.
- Für die Entwicklung werden reale Videodaten benötigt.
- Ein ICE-Triebkopf wurde dazu mit einer Kamera und einem Datenrekorder ausgerüstet. .

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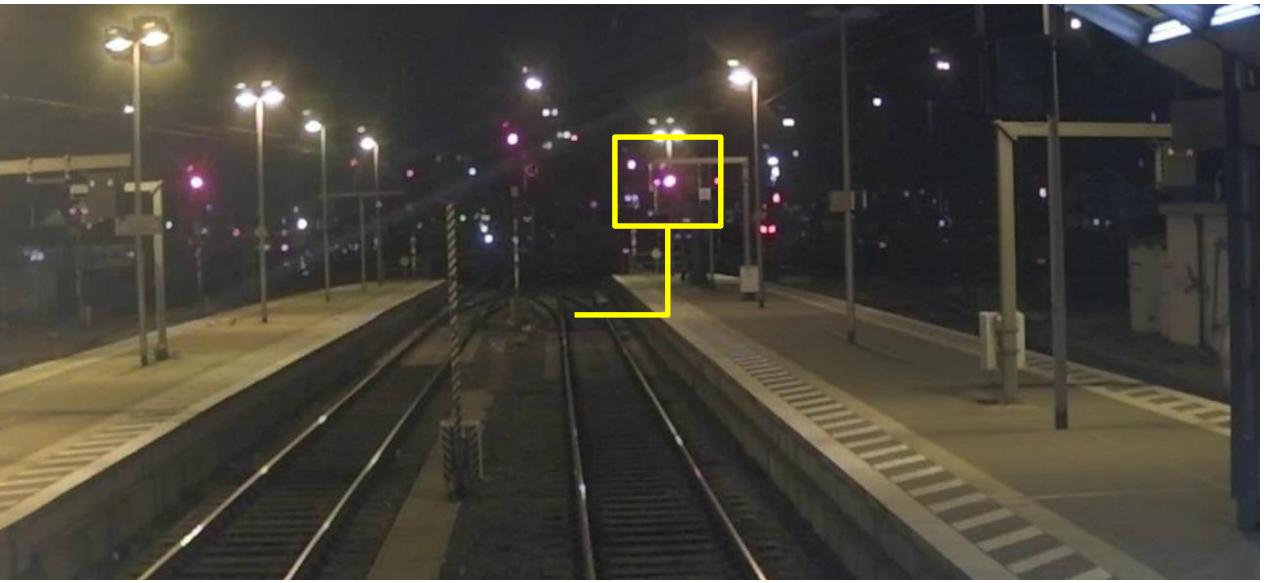
Was für Herausforderungen gibt es dabei?

- Die Signale müssen auch unter allen Bedingungen (Tag/Nacht, Regen/Nebel, Gegenlicht) sicher erkannt werden.
- Bei parallelen Gleisen oder gestaffelter Aufstellung von Signalen müssen die Signale richtig zugeordnet werden.



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Wie verändert sich der Betrieb mit dem automatischen Fahren?

	funktionale Anforderung		detaillierte funktionale Anforderung	Bedienhandlung Supporter	ATO-System	Handlung Infrastruktur
4.1	Einschalten von ATO-Goa4	4.1.01	Zug gesichert im ATO-Standbymodus			
		4.1.02	Zug ferngesteuert aufwecken	Supporter weckt Zug über Mobilkommunikation/ Fernsteuerung		
		4.1.03	Zug von ATO-Standbymodus auf ATO GoA4 umstellen	Fernsteuerung		
		4.1.04	Selbsttest ATO/RTO		Selbsttest	
		4.1.05	Meldung an Stellwerk/BLZ: genauer Standort Zug und ATO bereit	Supporter ruft Weichenwärter/Fdl an		nimmt Bestätigung Standort und Funktionstüchtigkeit Zug entgegen
		4.1.06	Zug gesichert; ATO Goa4 "EIN"			
4.2	in Gleisfeldern mit Rangiersignalen kann ein Zug selbständig als Rangierfahrt im Modus GoA4 vom Abstellort an einen Bahnsteig oder einen anderen Abstellort fahren	4.2.01	Zug gesichert; ATO GoA4 "EIN"			
		4.2.02	(bleibt frei)			
		4.2.03	Rangierroute mit Start und Ziel erhalten	Supporter gibt geplante Rangierfahrten in ATO-System ein.	ATO-AT	Weichenwärter/Fdl bespricht Rangierfahrten "Ziel, Zweck, Besonderheiten" mit Supporter
		4.2.04	Fahrrichtung wählen; Zugspitze und Zugschluss beleuchten; Kameras in Fahrrichtung einschalten		ATO und TCMS	
		4.2.05	Fahrbefehl vom Rangiersignal erhalten		SCV	
		4.2.06	Zug auf korrekte Geschwindigkeit beschleunigen (maximale Rangiergeschwindigkeit)		ATO-AV	
		4.2.07	Zug mit korrekter Geschwindigkeit		ATO-AV	

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Systemmodell ATO

- Funktionale Anforderungen der Betreiber fliessen in des System-modell von Shft2Rail ein.
- Shift to Rail vereint Bahnen und Industrie
- Shift to Rail muss Interoperabilität zwischen den Bahnen und den verschiedenen Industriepartnern sicherstellen.

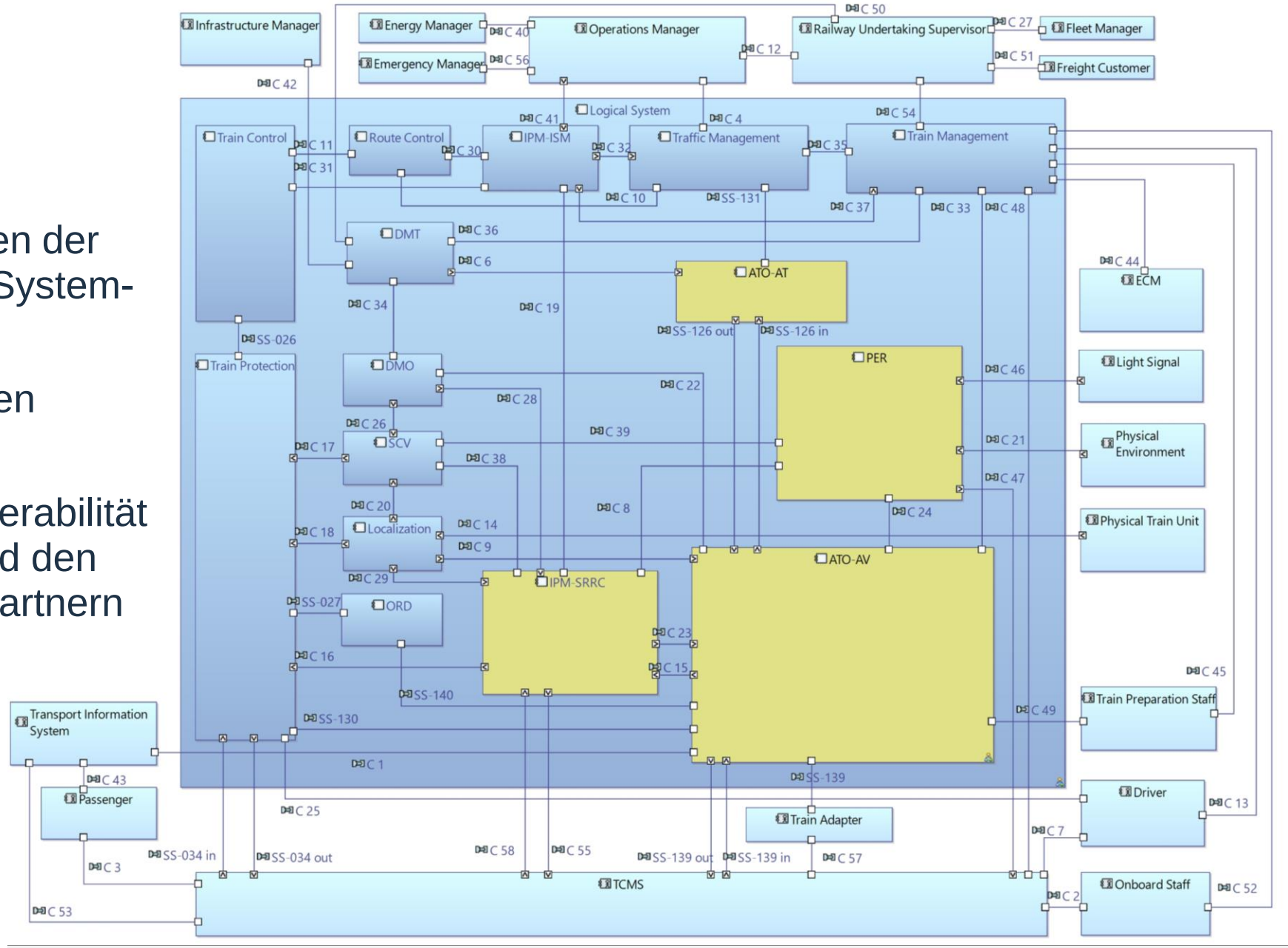

Bild: Shift2Rail

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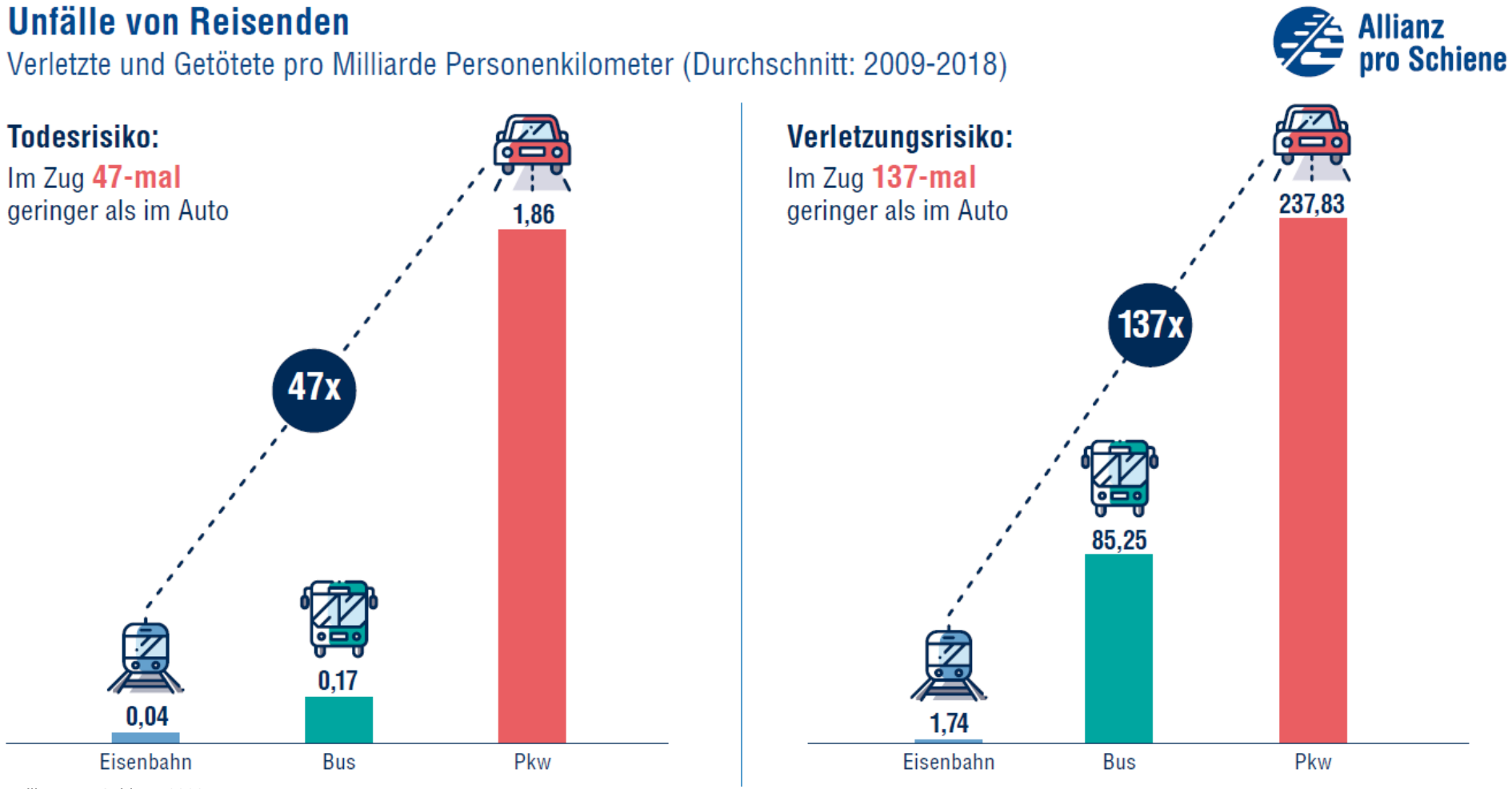
Ist das automatische Fahren sicher?



Quelle: Allianz pro Schiene 2020

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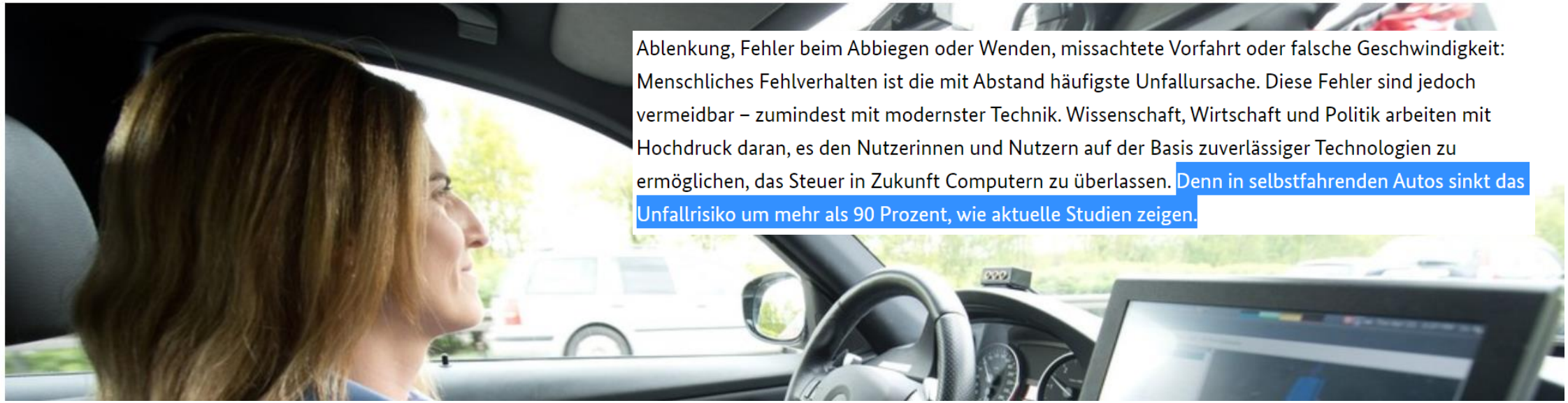
Der Automobilsektor ist davon überzeugt!

FORSCHUNG

Das Auto von morgen: autonom, sicher, effizient

Mit rund 100 Millionen Euro fördert das Bundesforschungsministerium Projekte zum automatisierten und vernetzten Fahren. Dank der exzellenten Forschungslandschaft ist Deutschland für die intelligente Mobilität gut aufgestellt.



Ablenkung, Fehler beim Abbiegen oder Wenden, missachtete Vorfahrt oder falsche Geschwindigkeit: Menschliches Fehlverhalten ist die mit Abstand häufigste Unfallursache. Diese Fehler sind jedoch vermeidbar – zumindest mit modernster Technik. Wissenschaft, Wirtschaft und Politik arbeiten mit Hochdruck daran, es den Nutzerinnen und Nutzern auf der Basis zuverlässiger Technologien zu ermöglichen, das Steuer in Zukunft Computern zu überlassen. Denn in selbstfahrenden Autos sinkt das Unfallrisiko um mehr als 90 Prozent, wie aktuelle Studien zeigen.

Quelle: www.bmbf.de

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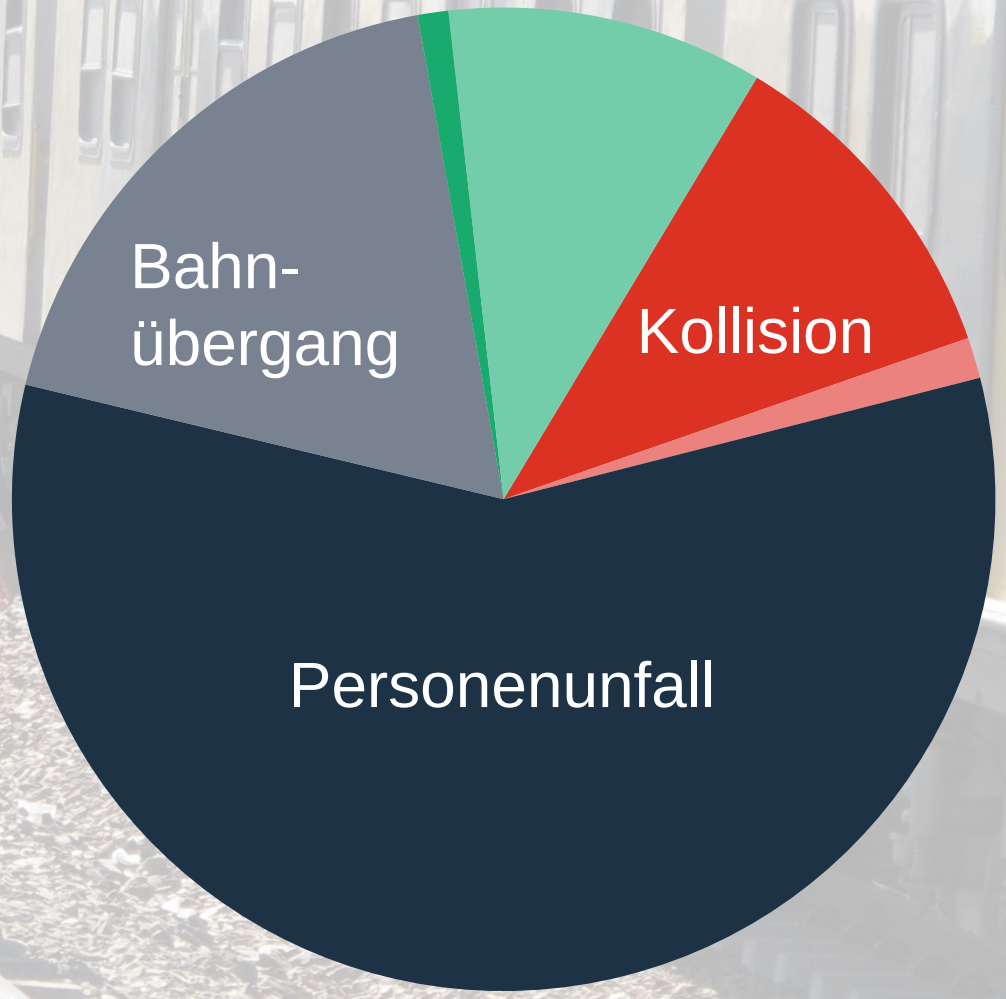
Unfälle

- Kollision
- Entgleisung
- Personenunfall
- Bahnübergang
- Fahrzeugbrand
- Sonstiges



Quelle: Sicherheitsbericht 2019 des Eisenbahnbundesamtes

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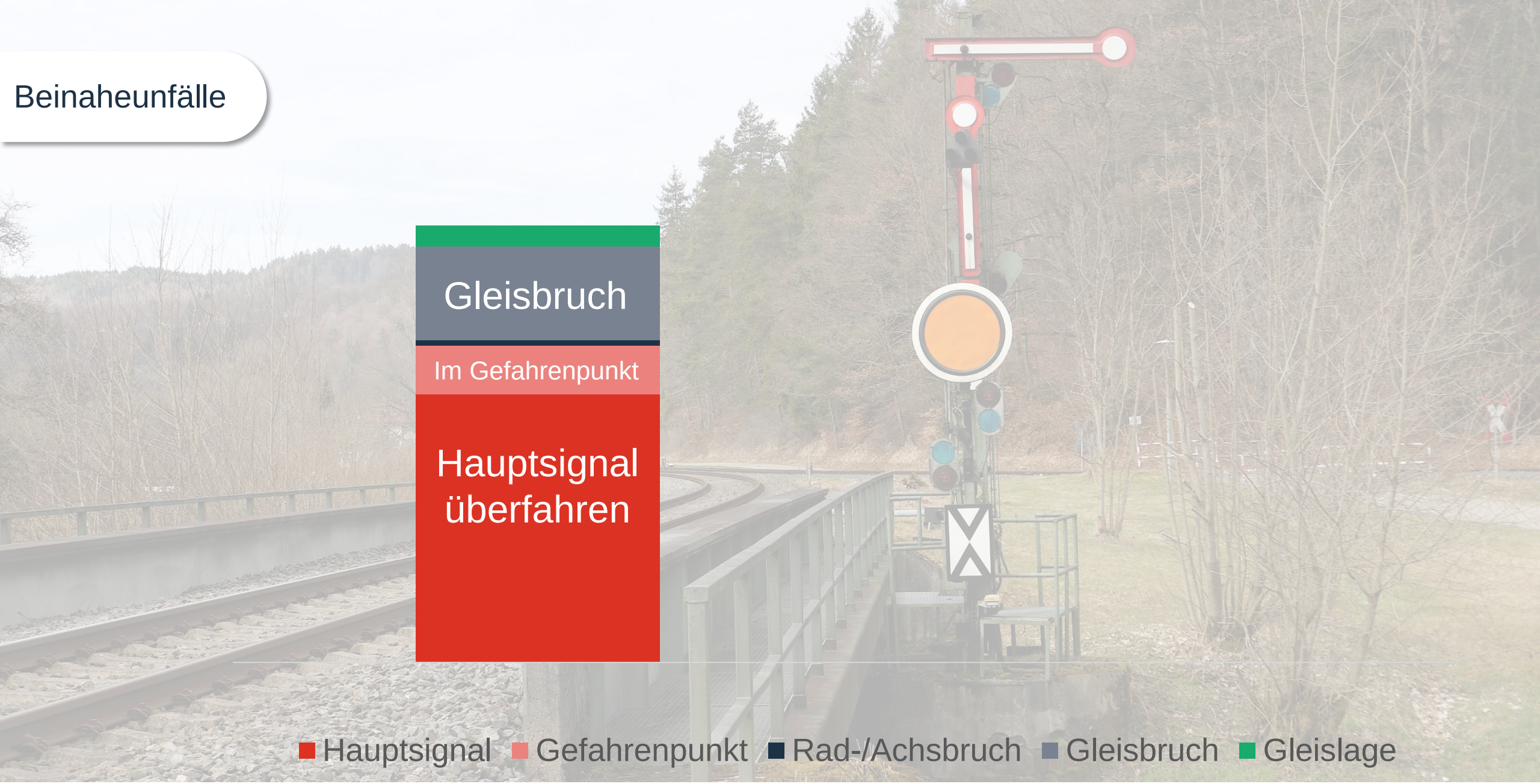
Beinaheunfälle



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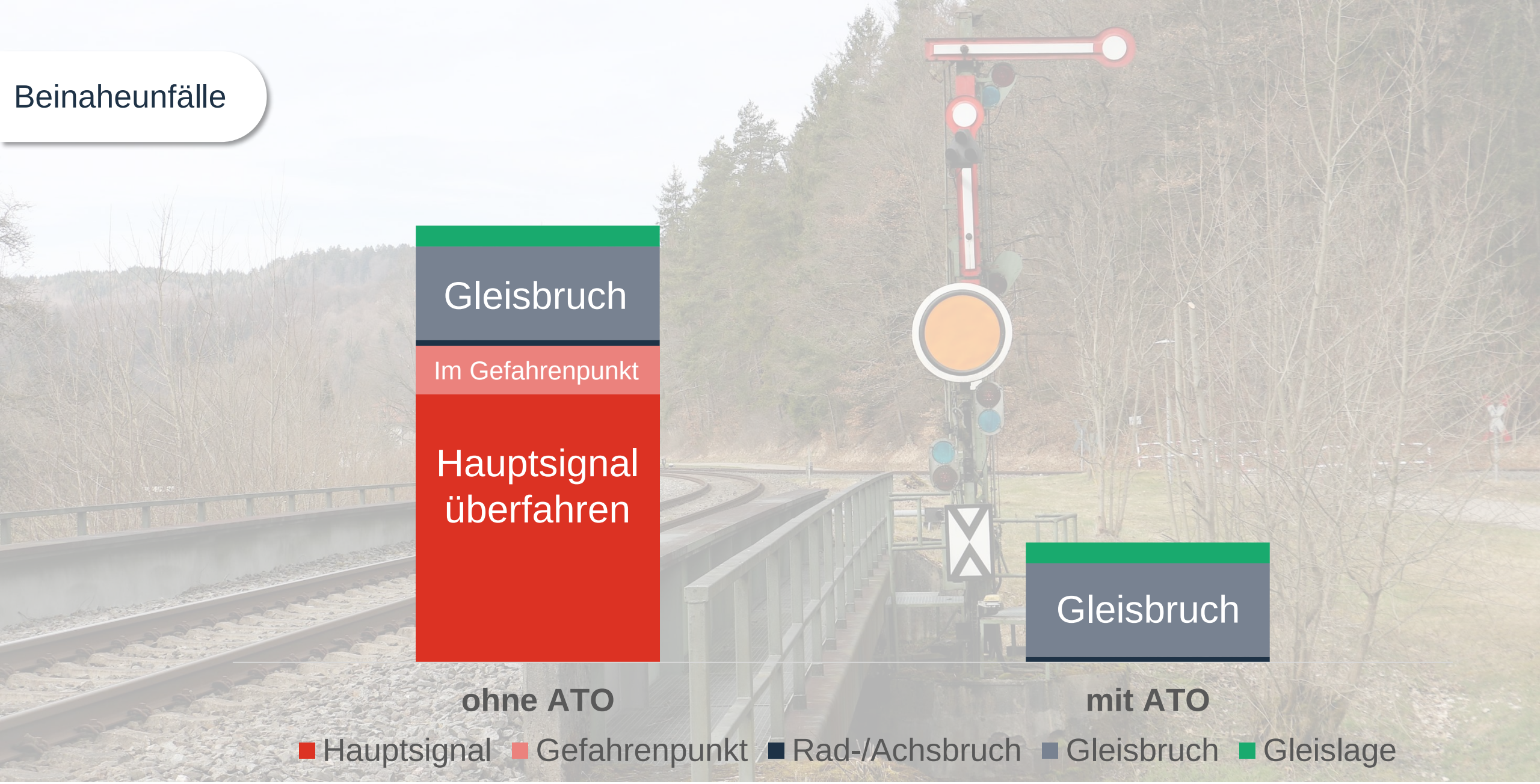
Beinaheunfälle



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Lohnt sich das automatische Fahren?

Lokführer fahren zu selten Zug

EXKLUSIV

von Christian Schlesiger
12. Juli 2019

Zugfahrten 35%

Sonstiges 65%

- Technische Kontrollen
- Rangieren
- Zugvorbereitung
- Bremsprobe
- …

Quelle; Wirtschaftswoche, 12. Juli 2019

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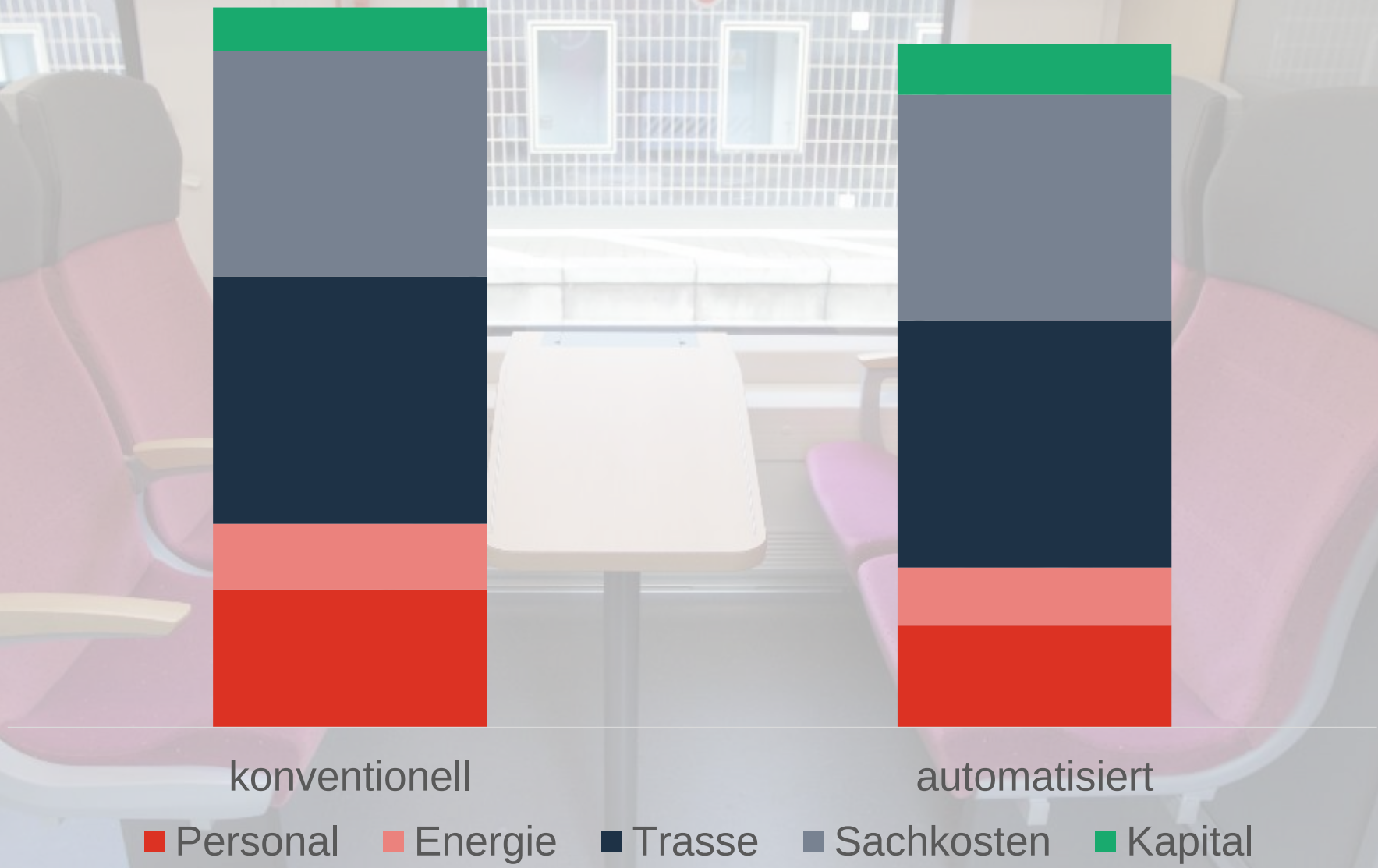
Kosten SPNV



Quelle: 7. Bericht der Bundesregierung über die Entwicklung der Kostendeckung im ÖPNV; BMVI 2016; Abb. 16 und eigene Berechnungen

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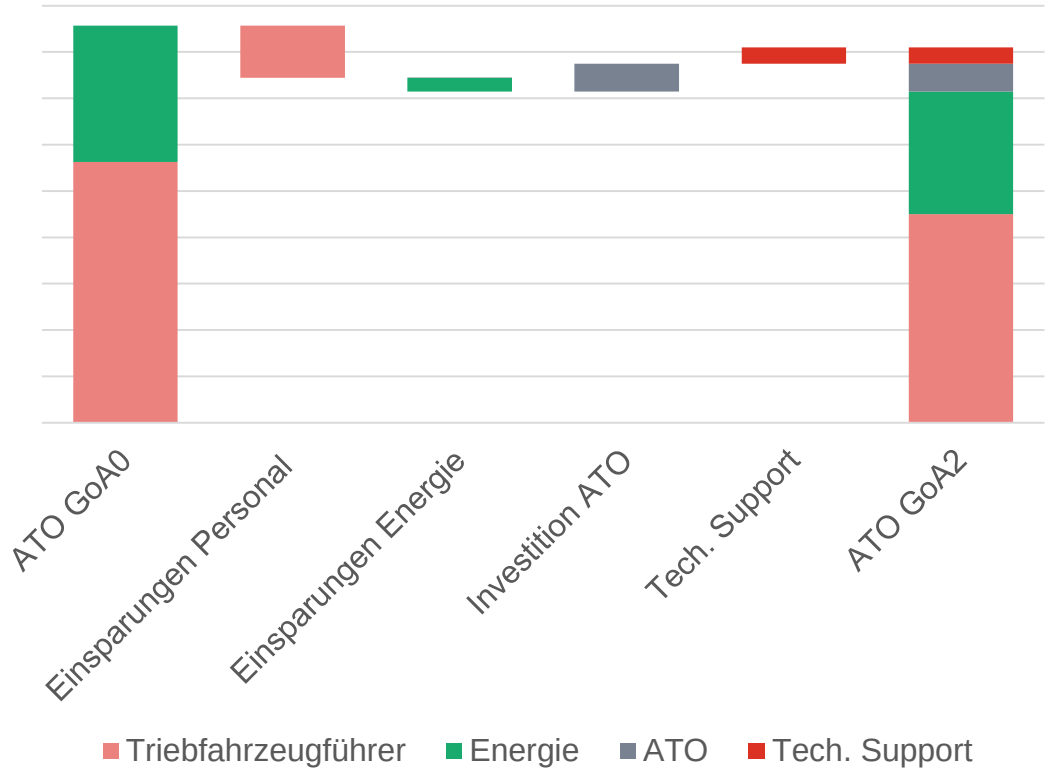
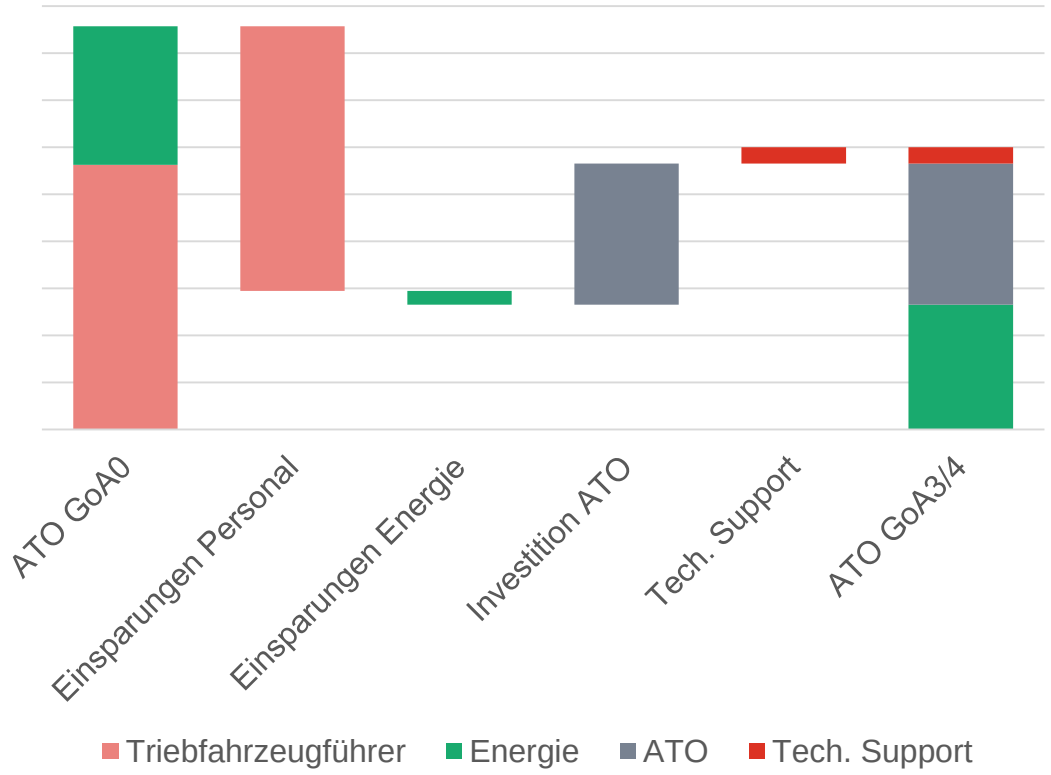
Wirtschaftlicher Vergleich GoA2 mit GoA3/4





GoA2 hat für die Betreiber nur einen begrenzten Nutzen.

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4

Das ARTE-Projekt in Niedersachsen

Automatisierter Regional Triebzug ENNO

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Das Projekt wurde durch das Land Niedersachsen angeregt.

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GoA3 im Linieneinsatz

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GoA4 im Rangierbetrieb

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Lokführer…

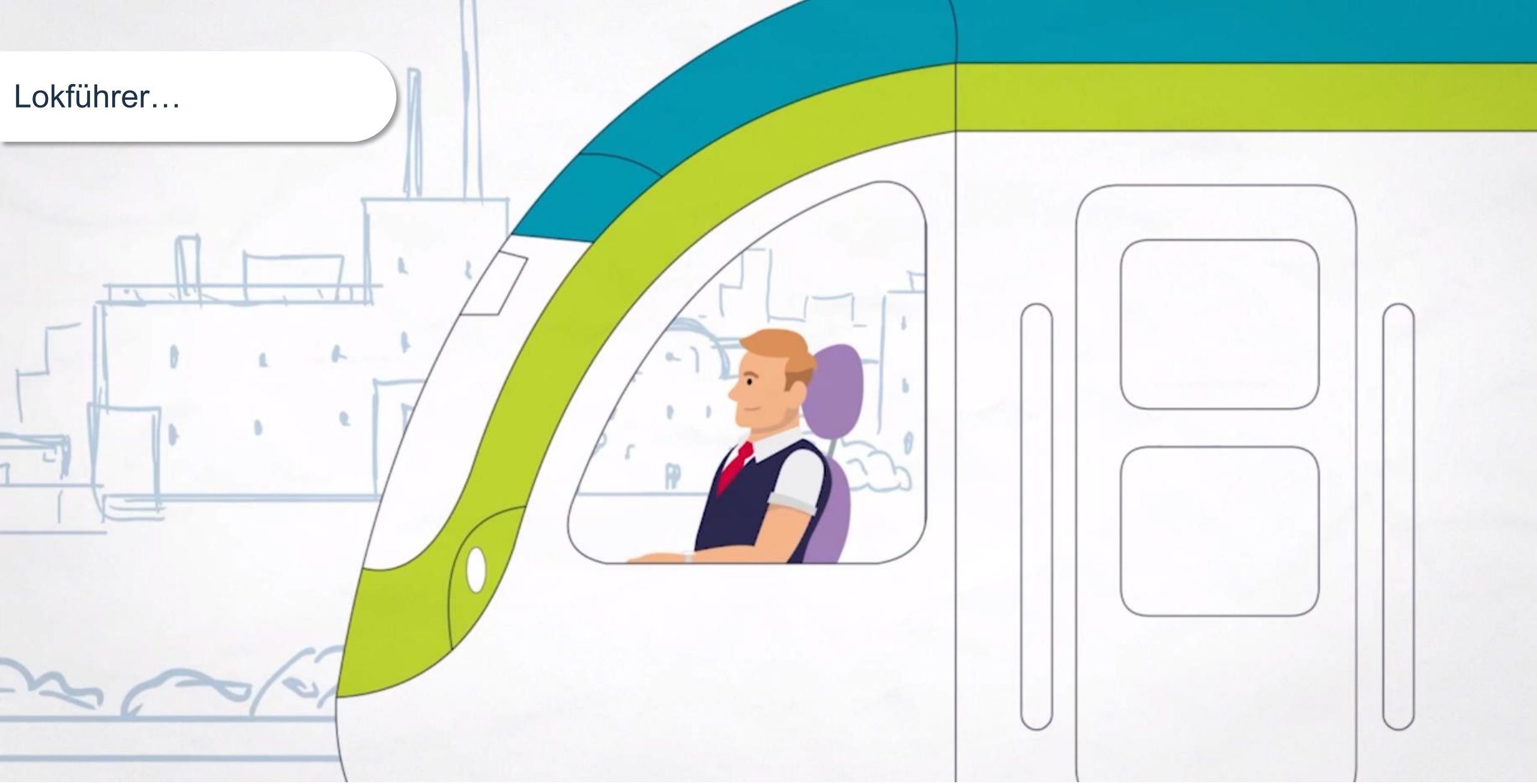

Bild: Bundesministerium für Wirtschaft und Energie, Reallabore

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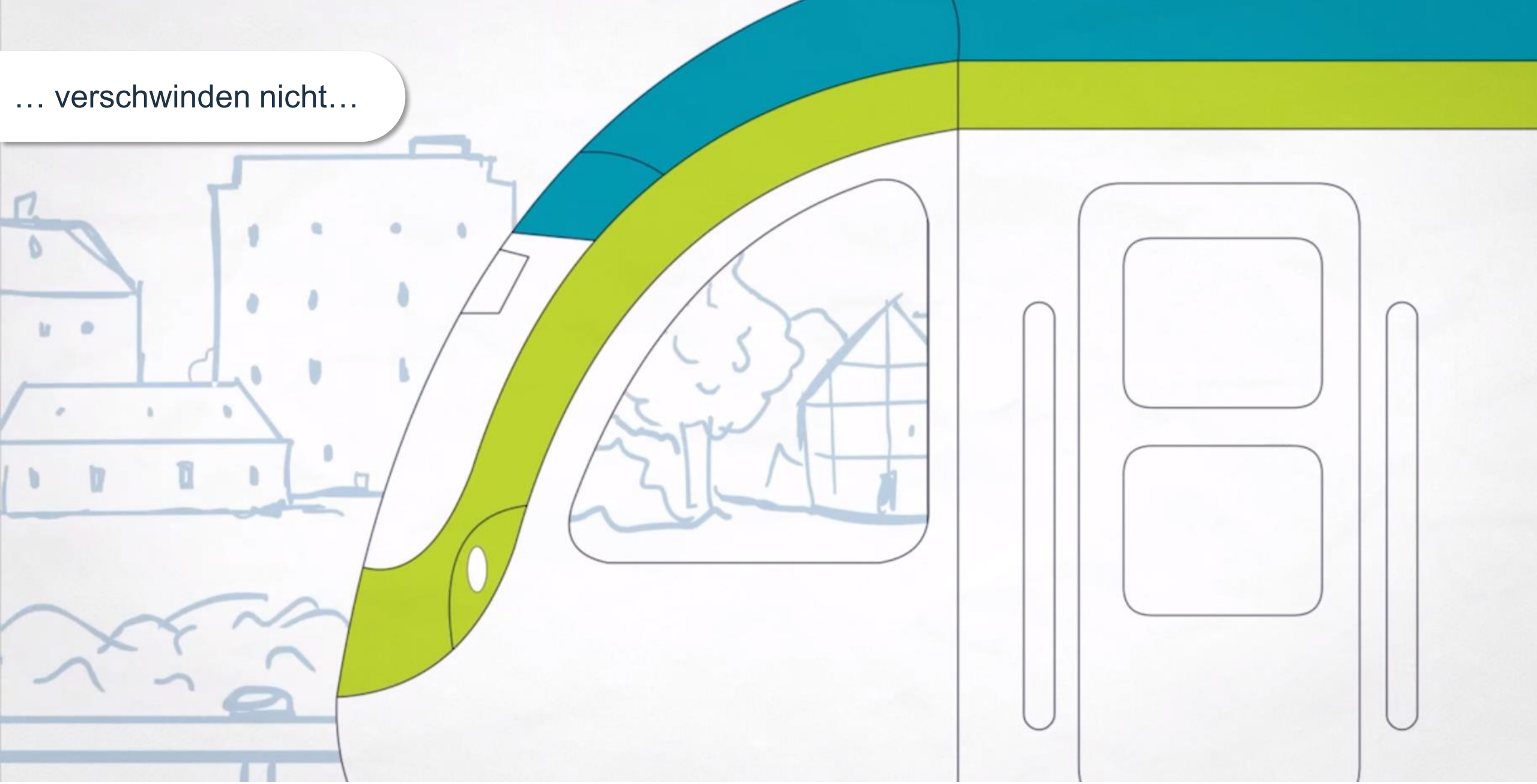
… verschwinden nicht…



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… sondern werden zu Zugbegleitern.

Bild: Bundesministerium für Wirtschaft und Energie, Reallabore

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“Idealerweise” werden sie nicht gebraucht ….

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… sind aber in schwierigen Situationen zur Stelle.

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Die Arbeitspakete und Partner des Projekts ARTE

Anforderungen ermitteln

Recht und Regelwerke

Teilsysteme entwickeln

Mitarbeitende, Öffentlichkeit

Fahrzeuge ausrüsten

Versuche auswerten

ATO-Versuchsfahrten

Zulassung vorbereiten

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Projektentwurf

Phase 1

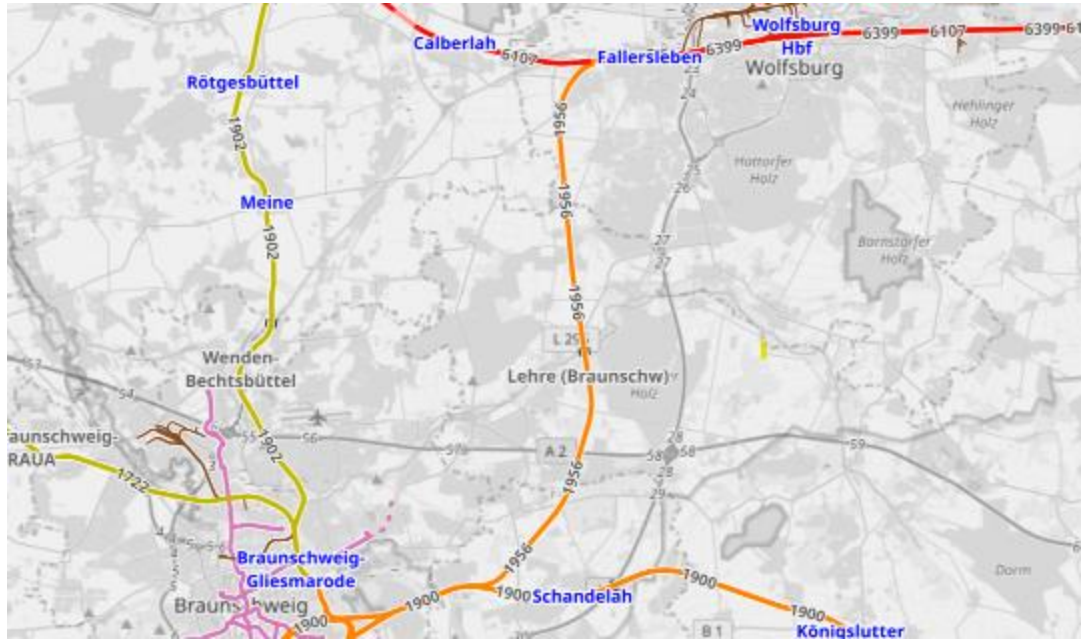
- Regulatorische Rahmenbedingungen prüfen
- betriebliches Pflichtenheft erstellen
- Versuchsträger umbauen
  (Vorschlag ENNO BR1440)

Phase 2

- Versuche vorbereiten
- Versuche auf dem Netz des ENNO
- Demonstration der Machbarkeit
  des automatisierten Regionalverkehrs

Phase 3

- Vorbereitung der generischen Zulassung des
  automatisierten Regionalverkehrs



Karte: openrailwaymap.org

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Terminplan

Phase 1 Regulatorische Rahmenbedingungen prüfen; betriebliches Pflichtenheft erstellen
Versuchsträger (Vorschlag ENNO BR1440) umbauen

Phase 2 Versuche vorbereiten; Versuche auf dem Netz des ENNO
Demonstration der Machbarkeit des automatisierten Regionalverkehrs

Phase 3 Vorbereitung der generischen Zulassung des automatisierten Regionalverkehrs

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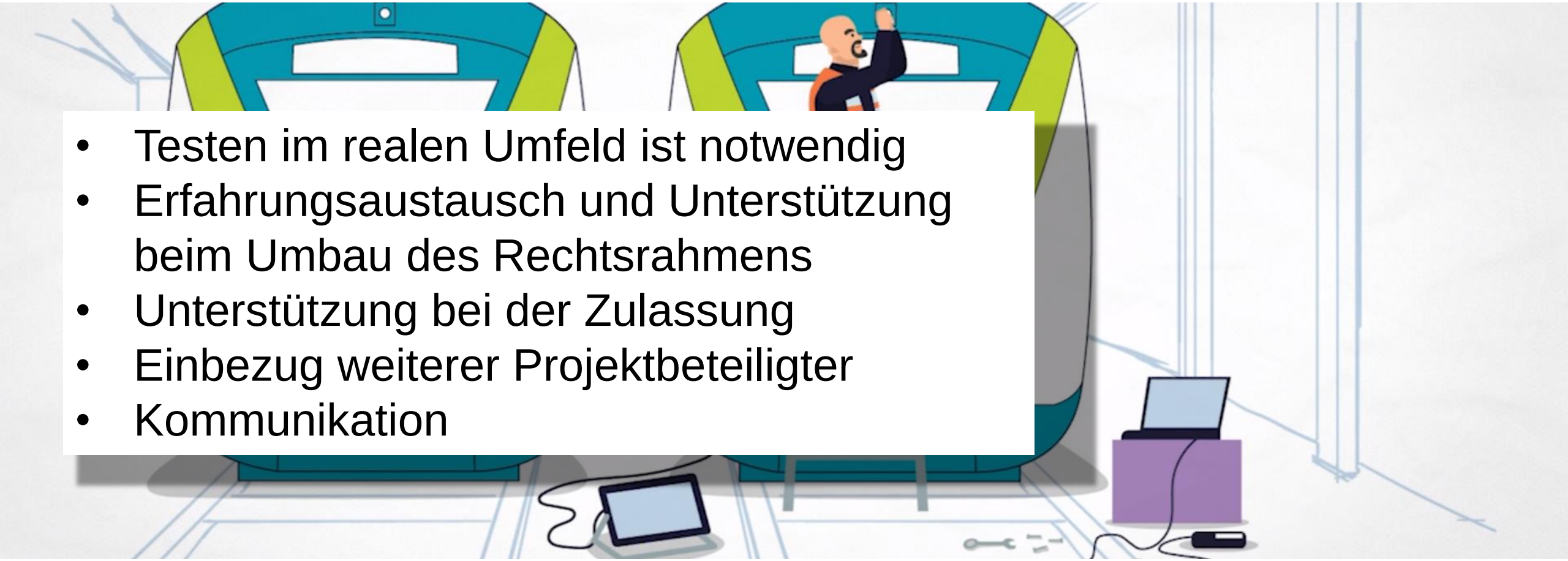
Warum haben wir uns beim Innovationspreis «Reallabore» beworben?



- Testen im realen Umfeld ist notwendig
- Erfahrungsaustausch und Unterstützung beim Umbau des Rechtsrahmens
- Unterstützung bei der Zulassung
- Einbezug weiterer Projektbeteiligter
- Kommunikation

Bild: Bundesministerium für Wirtschaft und Energie, Reallabore

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Grosse Resonanz intern und extern sowie im In- uns Ausland

TEAMS FLASH

ALSTOM · mobility by nature ·

02.06.2020 • DEUTSCHLAND; ÖSTERREICH & SCHWEIZ

Weltneuheit: Automatischer Zugbetrieb für Regionalverkehrszüge soll in Deutschland getestet werden

Das Bundeswirtschaftsministerium hat

Braunschweiger Zeitung vom 13.06.2020

BRAUNSCHWEIGER ZEITUNG
UNABHÄNGIG | NICHT PARTEIGEBUNDEN

Seite:	7	**Jahrgang:**	2020
Ressort:	Wirtschaft	**Nummer:**	0
Ausgabe:	Hauptausgabe	**Auflage:**	30.825 (gedruckt) [1] 32.021 (verkauft) [1] 32.226 (verbreitet) [1]
Mediengattung:	Tageszeitung	**Reichweite:**	0,090 (in Mio.) [2]

[1] von PMG gewichtet 4/2020

[2] von PMG gewichtet 7/2019

„Keine Angst vor selbstfahrenden Zügen“

Alstom-Manager Sprotte erklärt die Pläne, die Technik zwischen Braunschweig und Wolfsburg

hallo Salzgitter wochenende vom 30.05.2020

hallo SALZGITTER wochenende

egleiter fahren, der die Fahrgäste unter-
tützen und bei Störungen eingreifen
ann.
Wie wird dabei die Sicherheit der
ahrgäste und Mitarbeiter gewährlei-
tet? Bei einem voll besetzten Regio-
alzug könnte ein technischer Fehler
ine Katastrophe mit zahlreichen
odesopfern bedeuten ...

Autor:	roland weiterer [tmt6pq63auz5rr1hozr1k8o]	**Mediengattung:**	Anzeigenblatt
Seite:	17	**Auflage:**	63.945 (verbreitet) [1]
Ressort:	Lokales		

[1] Verlag 10/2019

Innovationspreis für Alstom

Automatischer Zugbetrieb für Regionalverkehrszüge

UITP

Bild: Alstom und diverse Zeitungsausschnitte

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Ergänzende Informationen zum Innovationspreis «Reallabore»

Bild: Bundesministerium für Wirtschaft und Energie, Reallabore

BMWi-Information

Alstom Presseinformation

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Automatisierungsprojekte in Europa

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Laufende Entwicklungsprogramme

Shift2Rail

- Alstom leitet die Projektgruppe «autonomes Fahren»
- Ziel aller Shift2Rail-Programme ist es die Bahn zu stärken und deren Modalsplit zu erhöhen.

Train fret autonome (automatischer Güterzug)

- Alstom ist beteiligt am Entwicklungsprogramm der SNCF
- Erste Versuche beginnen 2020.
- Der vollständig automatische Güterzug soll 2023 fahren.

Bild: wikipedia – N. Silva [CC BY-SA 3.0 (http://creativecommons.org/licenses/by-sa/3.0/)]

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Aktuelle Projekte und Ideen zur automatisierten Bahn

SNCF – TFA «train fret autonome»

- Goa4

2019 – 2023

ProRail - LINEAS

- Goa4 (Rangierbetrieb)

2020 – 2021

Regionalverband Grossraum Braunschweig – DLR – TU Berlin

- Goa4 (Rangierfahrten); GoA3 (Zugfahrten)

2021 – 2023

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Ihre Fragen? – Meine Kontaktdaten!

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