
INNOCY
LIFE CYCLE MASTERS
Availability of tunnels for new energy carriers
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Services of Innocy per domain

Assetmanagement

From design to end of life, life cycle costs, RAMS-analyses, Maintenance engineering

Projectmanagement

Project, process, risk and contract management, interim management

Safety

Integral safety, social safety, working conditions and system safety, cyber security, tunnel safety & training

Industrial Automation

Industriële automatisering, testing & comissioning, projectmatig ontwerpen, MBSE, modeleren, SE

Data & Information

Data integration, Data analysis, dashboarding, tooling, monitoring

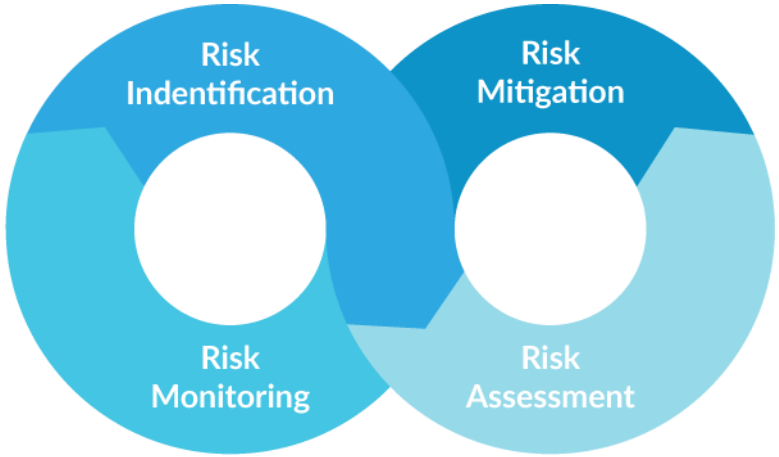
Table of content

Introduction

- Political pressure (regulations)
- Is the Dutch infrastructure prepared for a shift in the type of vehicle used for transportation?
- Quantify events that can lead to unavailability
- Design decisions for renovations and newly constructed tunnels

Main research question

What is the effect of the increasing representation new energy carriers on the availability of Dutch tunnels and how does this change in availability affect design decisions for renovations and newly constructed tunnels?



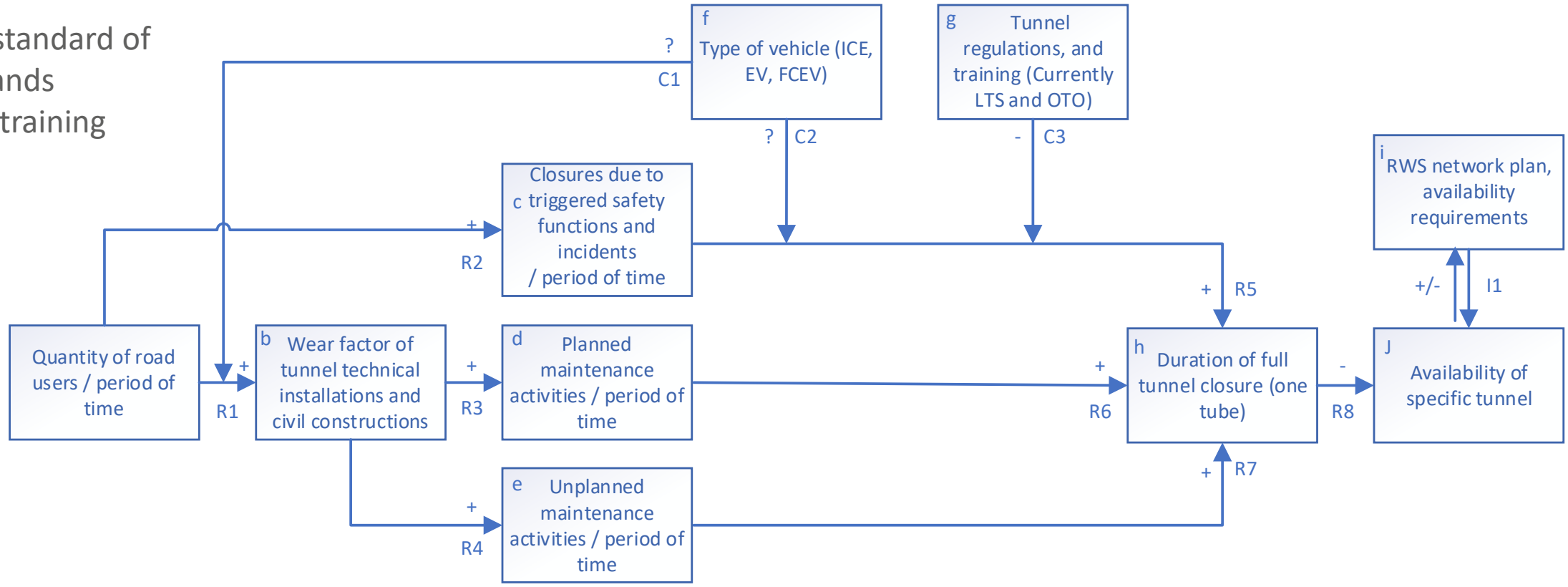
Question 1

- What events can lead to un-availabilility of a tunnel?

Approach

Legend:

LTS: Tunnel standard of the Netherlands
OTO: Safety training programme



Approach

Probability * effect

Question 2

What safety risks are influenced by vehicles that use new energy carriers?

Vehicle type comparison

1. Combustion engine
2. High density fuel
3. 2000 moving parts

1. E-motor
2. Heavy battery packs
3. 20 moving parts

1. Both forms of propulsion
2. Heavy battery packs
3. More components

1. E-motor
2. Fuel cell
3. Pressurised hydrogen

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Specific vehicle risks

1. Fuel leakage

1. Thermal runaway
2. Single gear (torque)
3. Smoke composition

1. Risks of both ICE and EV

1. Explosion/ BLEVE risk
2. Exhaust of H2O

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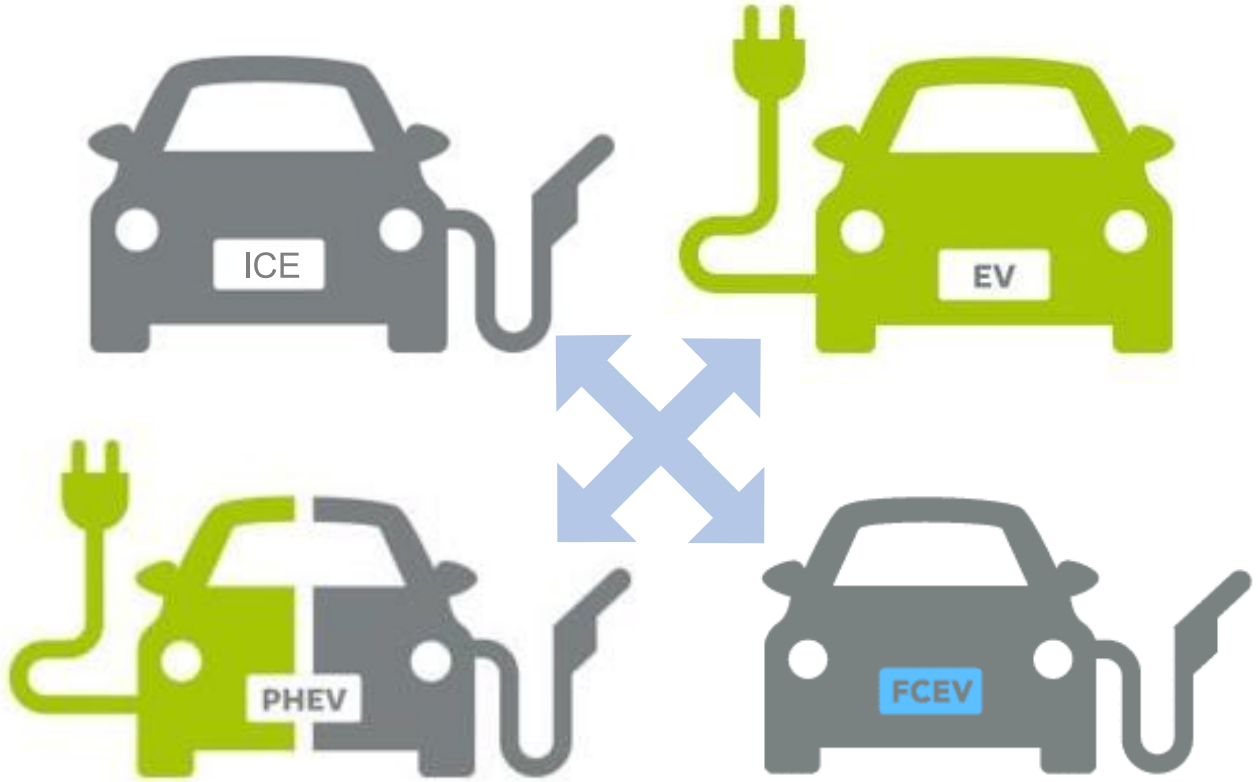
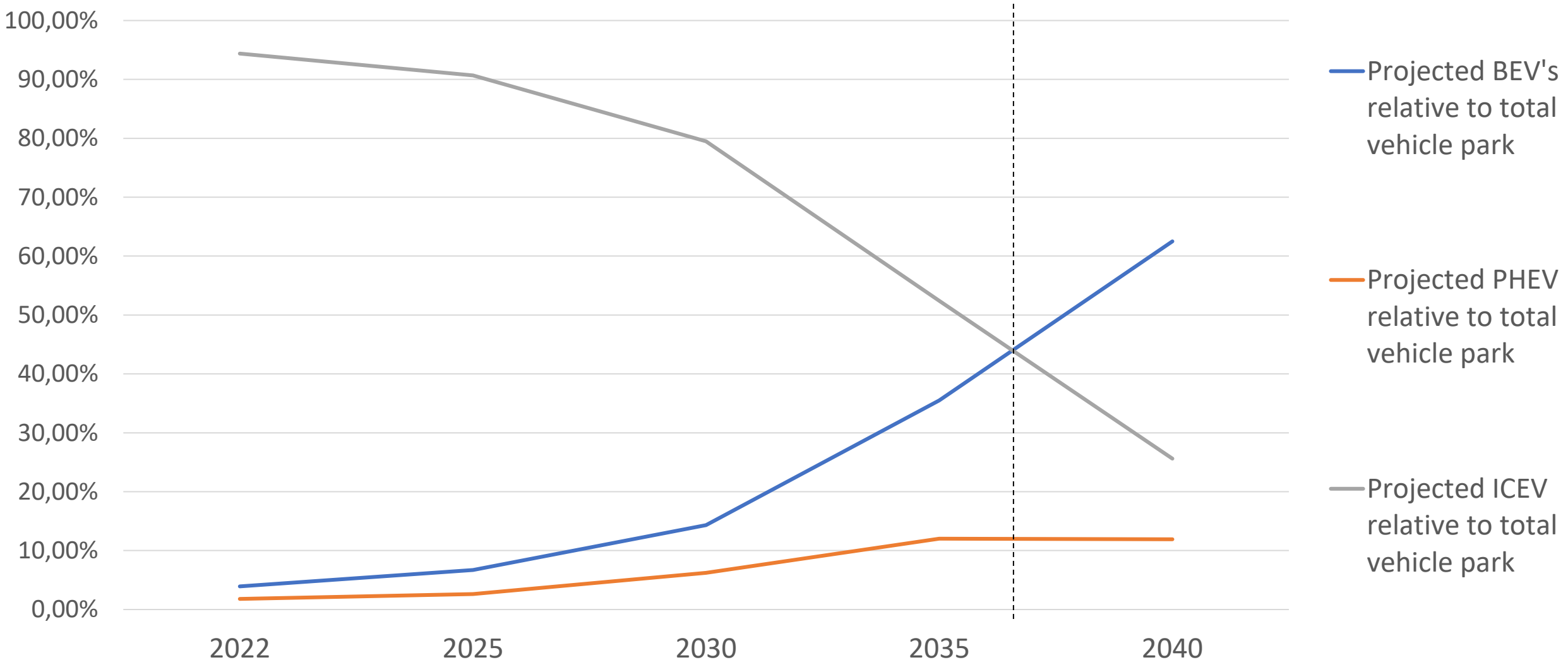
General vehicle risks

- Vehicle fire
- Extinguishing fires
- Wear of asphalt
- Cleaning of tunnel (technical installations)



Vehicle distribution (Scenario Low)



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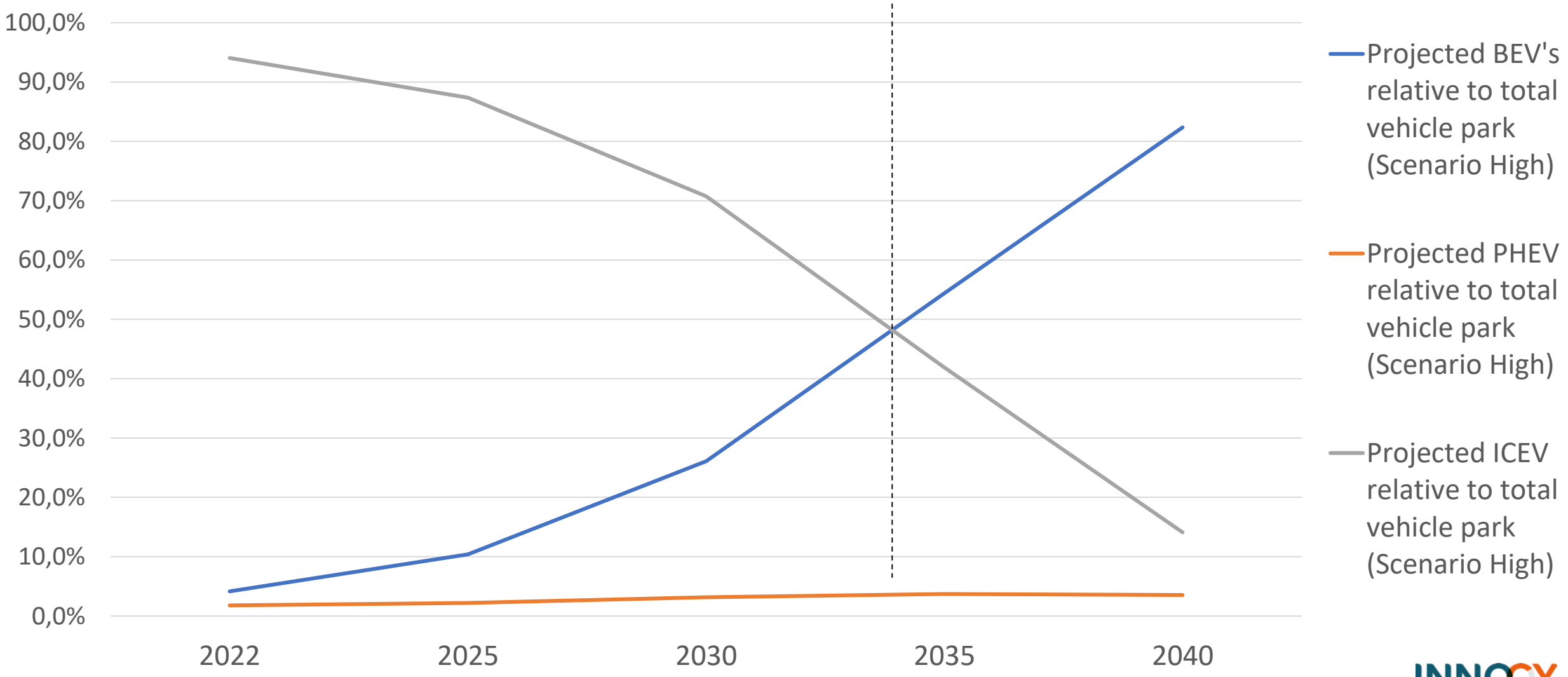
Vehicle distribution (Scenario High)



Results

- Fault Tree Analysis
- RWS availability budget is 90 hours unavailability for incidents or emergencies
- RWS availability budget is 75 hours unavailability are budgeted for planned maintenance

Scenario Low

Year	Hours planned unavailable by asphalt replacement	Hours unplanned unavailable by fire
2022	4,266	0,15
2025	4,284	0,14
2030	4,348	0,13
2035	4,502	0,12
2040	4,652	0,10

Scenario High

Year	Hours planned unavailable by asphalt replacement	Hours unplanned unavailable by fire
2022	4,266	0,19
2025	4,301	0,19
2030	4,398	0,19
2035	4,564	0,17
2040	4,722	0,15

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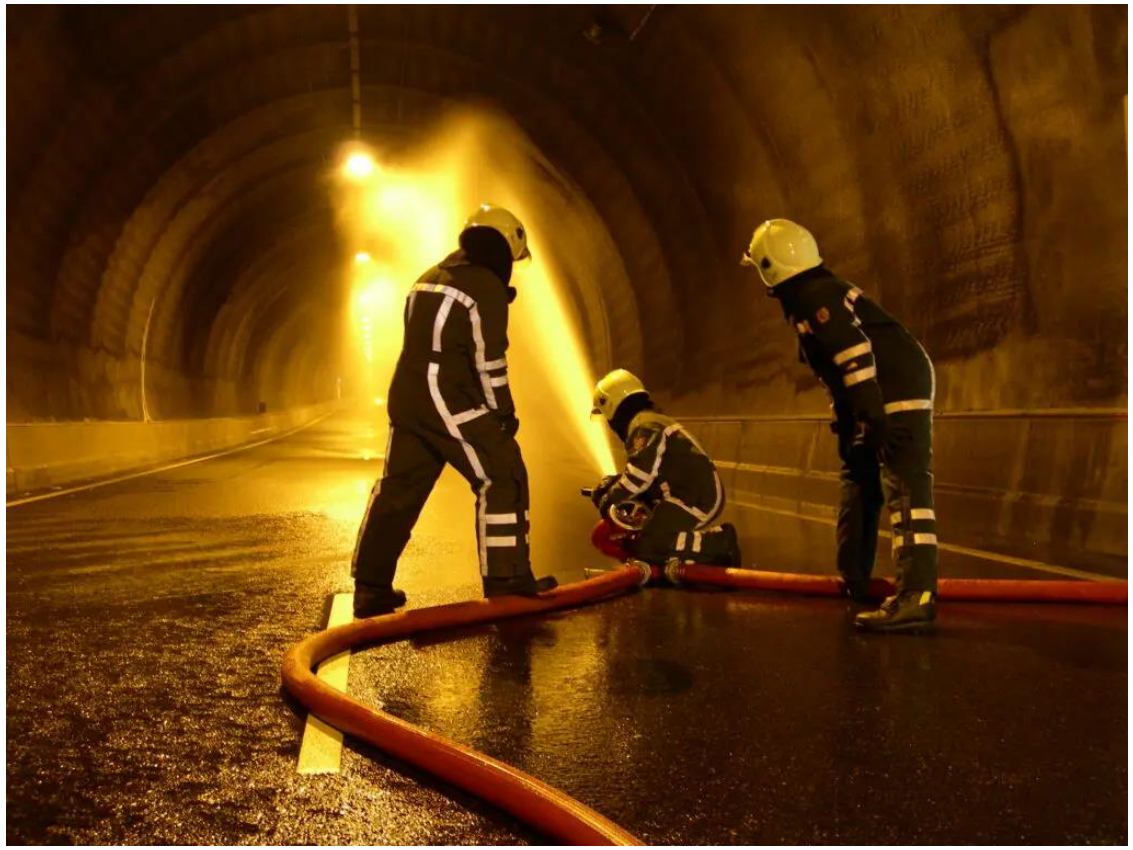
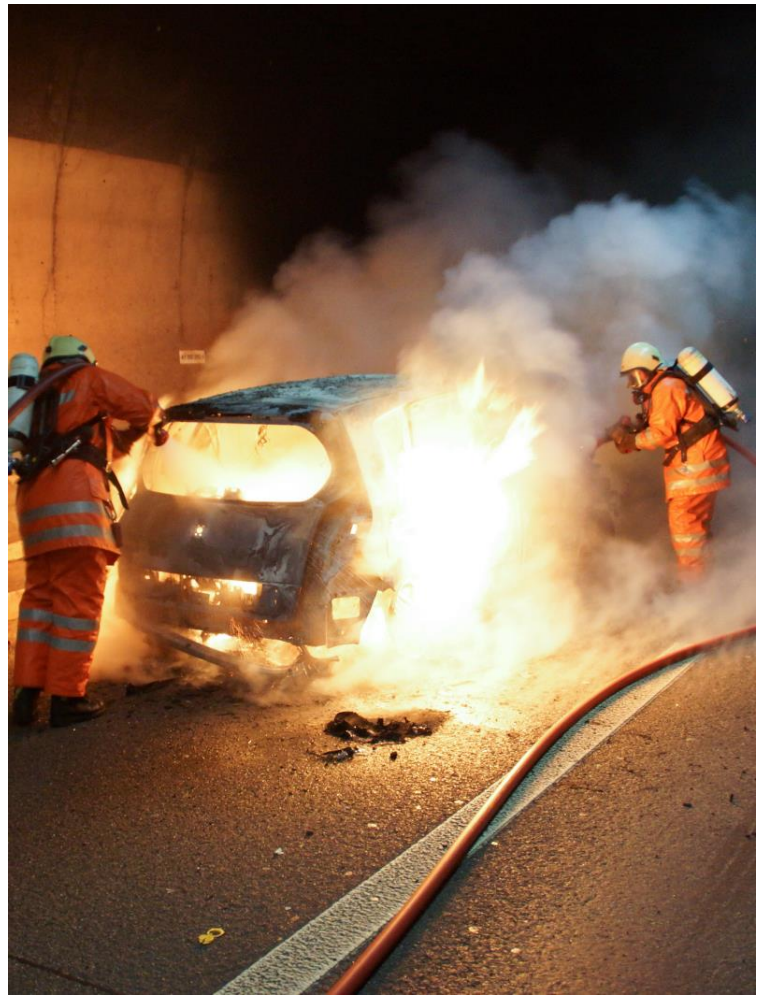
Conclusions (Fire)

- Increased MTTR
- Reduced probability
- Extinguishing methods



In depth Fire

Vehicle type	Fire rate as a result of a collision	Mean time to recovery (without functional testing and release)	Chance of reignition during towing
ICEV	3,17%	30 minutes	
PHEV (incl. hybrids)	2,21%	55,5 minutes	+- 5%
BEV	2,00%	68 minutes	+- 5%



Conclusions (Cleaning)

- Cleaning
- Emissions
- Chemical composition

Conclusions (Degeneration of asphalt)

- Wear particles of asphalt & axle load degeneration models
- 12,9% increase in wear
- Costly
- Real life testing

Type of asphalt	Life expectancy	Old degeneration model	New degeneration model	New life expectancy
Closed concrete asphalt (DAB)	17	1/17 or 0,059% per year	0,066%	15,0 years
Porous asphalt (ZOAB)	12	1/12 or 0,083% per year	0,094%	10,6 years

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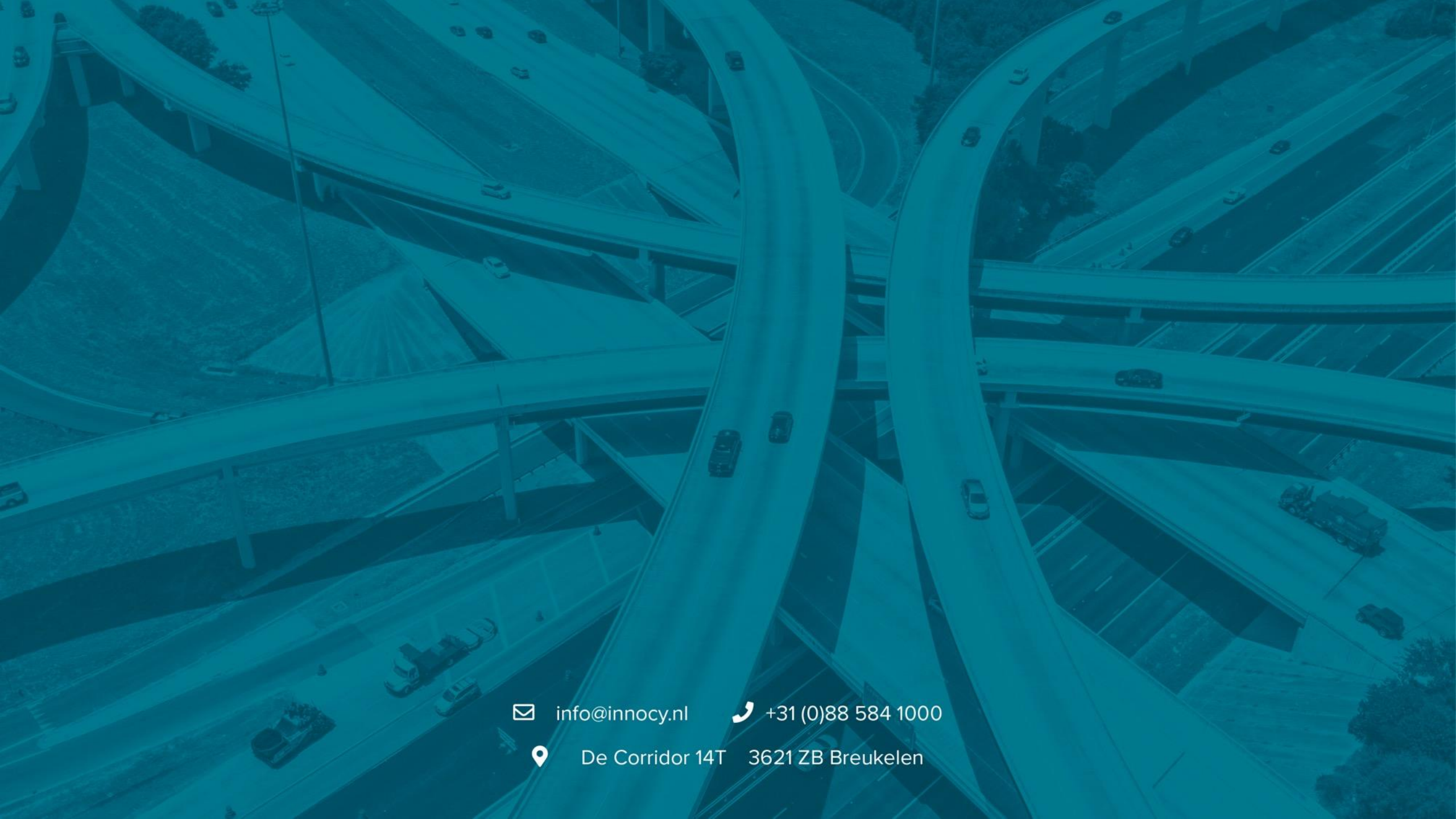

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