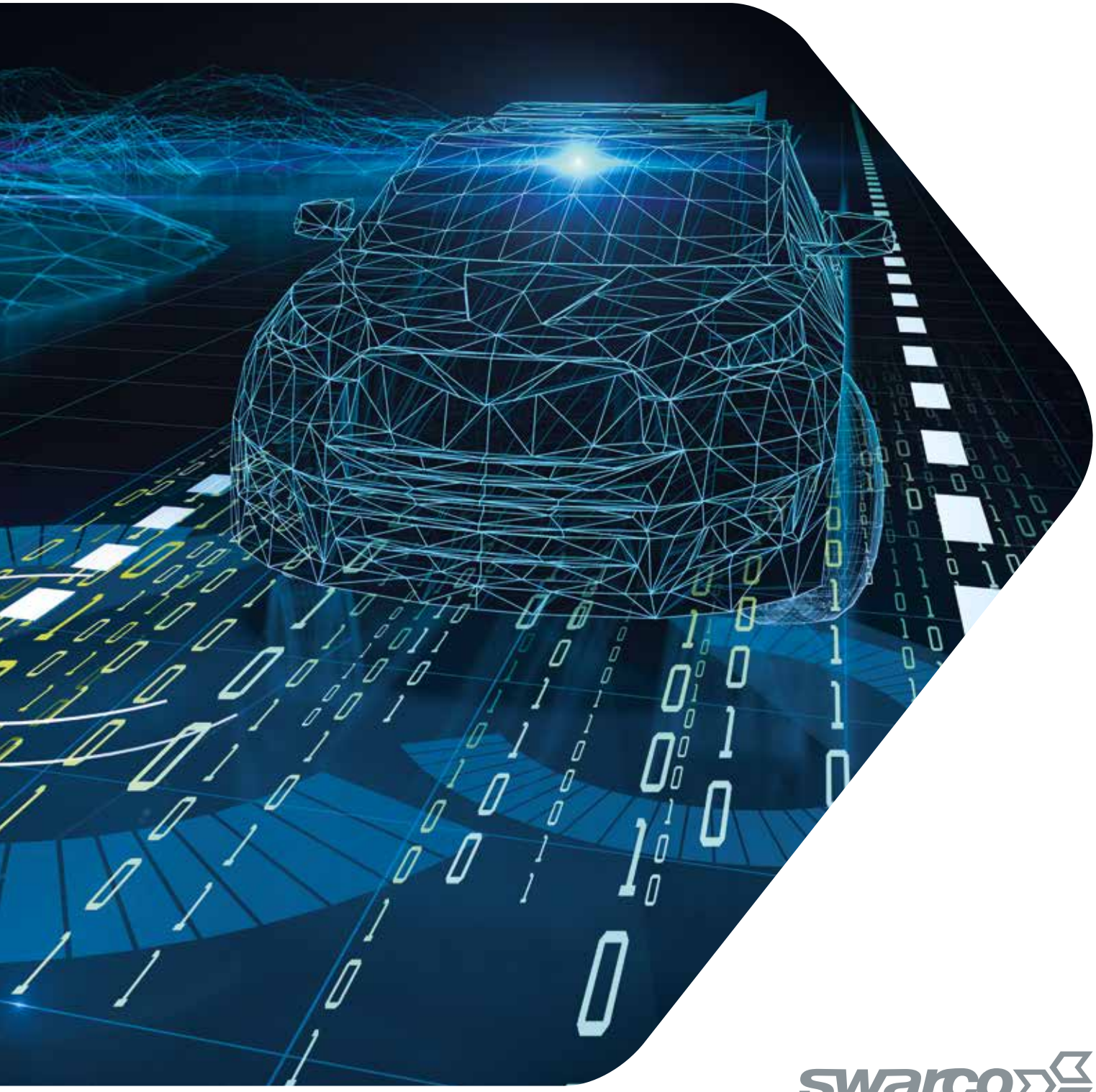
SAFE ADVANCED GUIDANCE

MOBILITY OF THE FUTURE



SWARCO | The Better Way. Every Day.

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Road Marking Systems

GUIDING THE WAY

for humans and machines

Modern lane markings improve road safety significantly, saving human lives. SWARCO Road Marking Systems pursues this goal with a clear philosophy, and provides people with optimal orientation in every situation thanks to innovative markings.

OUR PHILOSOPHY

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OUR GUIDING PRINCIPLE

We make mobility safe for humans and machines.

OUR VISION

SWARCO Road Marking Systems is the recognized standard for indoor and outdoor markings.

OUR VALUES

Safety, Trust, Reliability

OUR MOTTO

Safe Advanced Guidance

INDIVIDUAL MOBILITY

The benefits of automated mobility

23–29 percent
reduction in fuel consumption
on motorways

56 minutes
gained every day

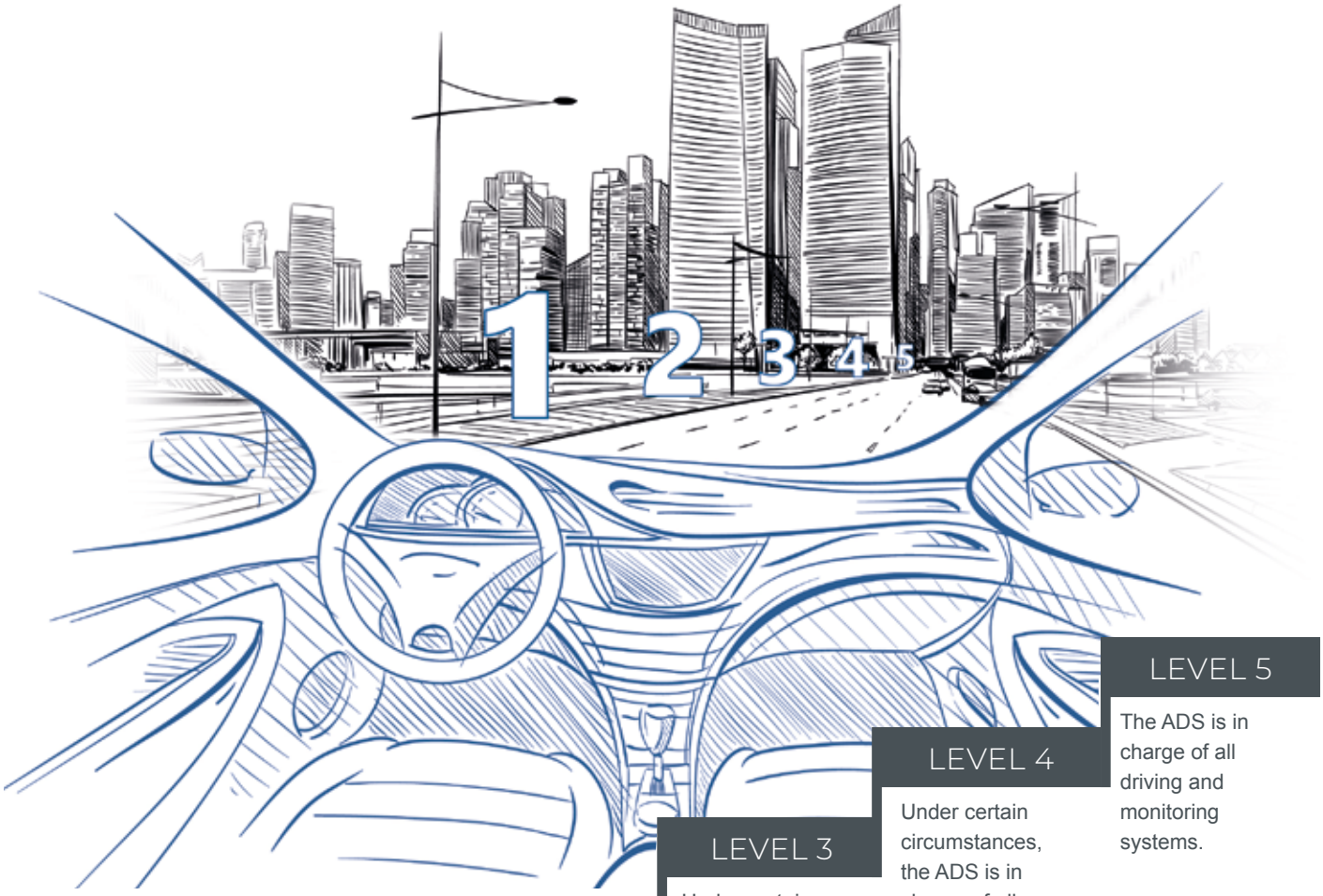
80 percent
traffic flow improvement

Driver assistance systems have become a must-have feature in modern vehicles. In the future, humans will gradually become passengers in their own car, which means more time and freedom for other activities during each drive. The implementation of intelligent control systems in cars also reduces fuel consumption and emissions, making transport cleaner. And it increases road safety, reduces the risk of accidents, and improves traffic flow.

Modern technology offers insecure drivers and elderly road users access to individual mobility. Smart roads serve as guidance systems for safe transport, in all weather conditions, day and night. Furthermore, the development of new technology in private transport gives rise to innovative projects and creates new jobs.

With its lane markings, SWARCO Road Marking Systems is part of this development towards a new mobility of the future for humankind.

AUTOMATION STEP BY STEP



LEVEL 0

The driver is responsible for all driving tasks.

LEVEL 1

An Advanced Driver Assistance System (ADAS) assists the driver, who is still required to monitor and coordinate the situation.

LEVEL 2

The ADAS assists steering and braking. In case of an emergency, the vehicle supplements the driver's braking or steering manoeuvres. The driver is still in charge of monitoring and controlling the vehicle.

LEVEL 3

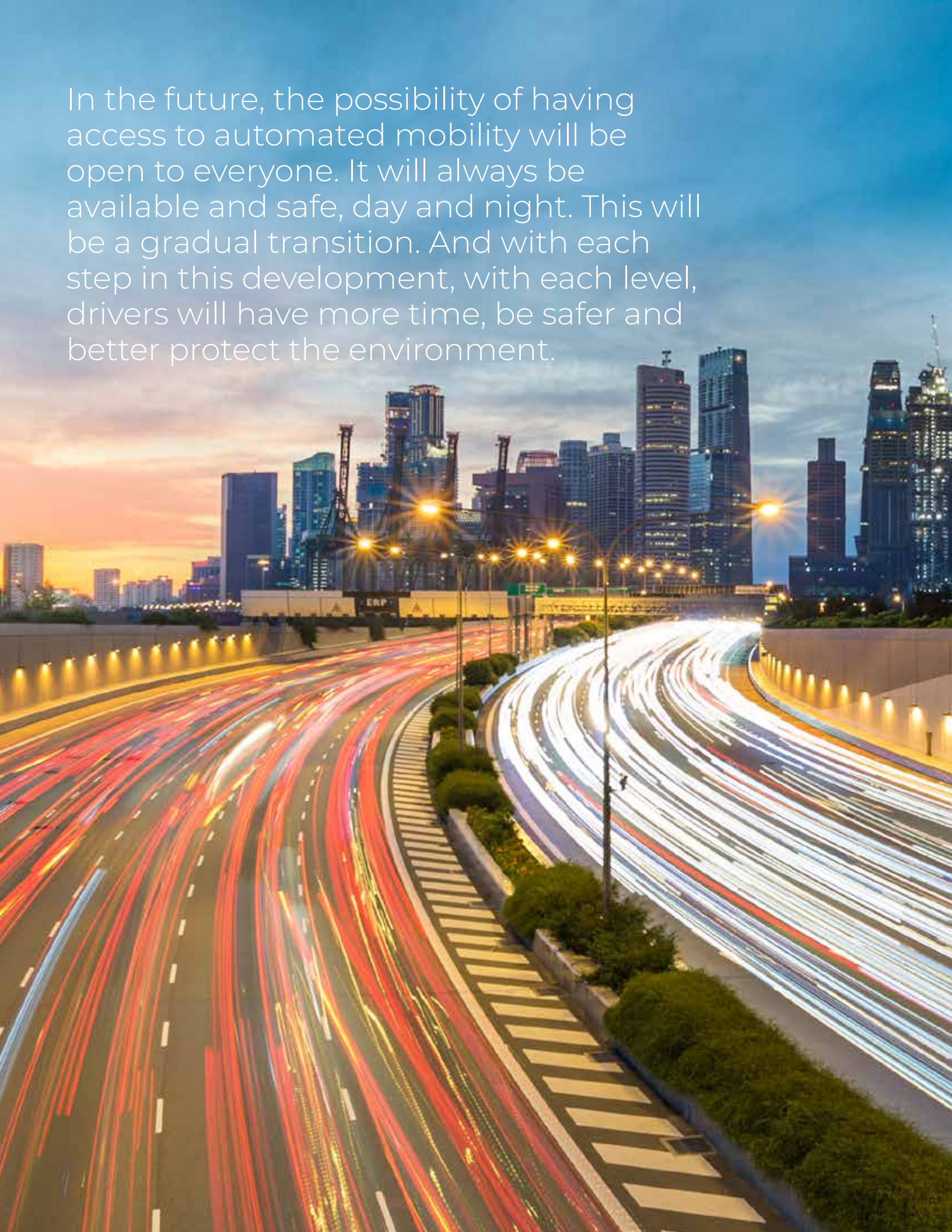
Under certain circumstances, an Automated Driving System (ADS) takes over the driving. The driver hands over the driving to the vehicle or takes it back.

LEVEL 4

Under certain circumstances, the ADS is in charge of all driving functions as well as environmental monitoring. The driver decides when the vehicle drives itself.

LEVEL 5

The ADS is in charge of all driving and monitoring systems.


In the future, the possibility of having access to automated mobility will be open to everyone. It will always be available and safe, day and night. This will be a gradual transition. And with each step in this development, with each level, drivers will have more time, be safer and better protect the environment.

RELIABLE ORIENTATION

In road traffic, orientation is a key factor for safety. To build the necessary trust, process reliability is required. All components must work together seamlessly in every situation.

For vehicles, the equivalent of the human eye is a whole array of highly sensitive sensors, which have a very specific reaction to their environment and take the necessary action. This involves many different technologies, including radar, LiDAR, GPS, video cameras and Wi-Fi. LiDAR and camera sensors detect markings and use them for orientation. By using markings with premium glass beads, SWARCO Road Marking Systems creates a world of reliable guidance systems for humans and machines. These lane markings can be detected in any weather. Like a silent usher, they guide drivers and their vehicles, on all roads, regardless of the weather, day and night.

THE 150x150 FORMULA

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a minimum of
150 mcd/m²*lx
retroreflection
dry conditions

minimum width
150 mm

contrast
3:1 → **4:1**

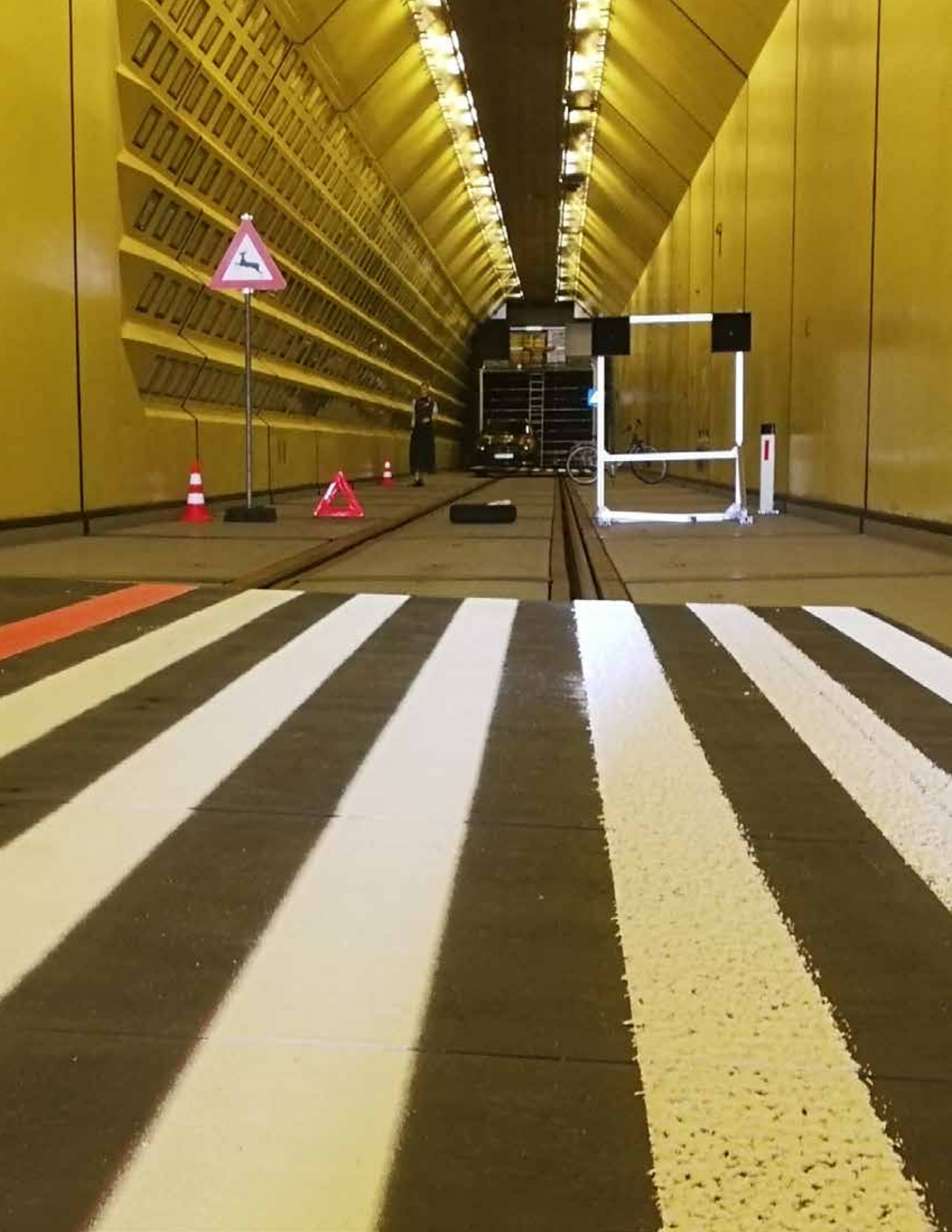
35 a minimum of
mcd/m²*lx
retroreflection
wet conditions

harmonized standards

CAV (Connected and Automated Vehicles) refers to a new phase of road transport, which enables vehicles to navigate without human intervention. This requires computers and connectivity, but also machine vision. Vehicles need road markings to determine their position. The European Commission has called for road markings and traffic signs to be designed and maintained in such a way that they can be properly recognized both by human drivers and by vehicles.

For some time, the European Union Road Federation **(ERF)** has been recommending certain minimum standards for road markings, emphasizing their width and retroreflective quality. The proposed **150 x 150 formula** plays a crucial role in sustainably increasing road safety. It recommends a line width of 150 mm and 150 mcd/m²*lx of retroreflection (in dry weather) as minimum features of markings. In wet conditions, the recommended retroreflection value is 35 mcd/m²*lx. The contrast between markings and road surface should be 3:1, or even better, 4:1, to avoid measurement errors. Furthermore, the ERF recommends harmonizing standards across different countries. The North American **MUTCD** (Manual on Uniform Traffic Control Devices) also requires a minimum width of 150 mm for road markings and the use of standardized markings.

Road markings by SWARCO Road Marking Systems already reach retroreflection values of up to 1000 mcd/m²*lx, and higher values in wet conditions. With their high resistance against mechanical impacts, they are guaranteed to have a long service life.



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ZKW

SENSORS TO DETECT MARKINGS

Studies have shown that using LiDAR and cameras together achieves the best marking detection results.

The company ZKW Group GmbH, based in Wieselburg, Austria, carried out comprehensive tests with sensors for automated driving in the world's largest climatic wind tunnel, located in Vienna.

The tunnel belonging to Rail Tec Arsenal was fitted with a set of marking systems by SWARCO Road Marking Systems, and their detectability was thoroughly examined, even in the most adverse weather conditions.

Based on the preliminary results from this study, clear conclusions can be drawn. Retroreflective lane markings can be detected by LiDAR, with highly retroreflective systems increasing LiDAR detectability significantly. For cameras, too, higher retroreflectivity yields markedly better detectability in the dark. Adequate contrast ratios are another particularly important factor for camera systems.

LiDAR and cameras complement each other very well. When it comes to detecting retroreflective lane markings, combining these two systems achieves the best results.

3
cameras
from different manufacturers

8
road marking systems
of low to top quality

10
LiDAR sensors
from different manufacturers

24
weather simulations

144
test scenarios at Rail Tec Arsenal Wien

It is home to the largest climatic wind tunnel in the world.

(Test section length: 100 metres, temperature range: -45 °C to +60 °C, max. wind speed: 300 km/h, relative humidity at >10 °C, 10 to 98 %) sun, rain, snow and icing simulation

MEASURABLE INNOVATION

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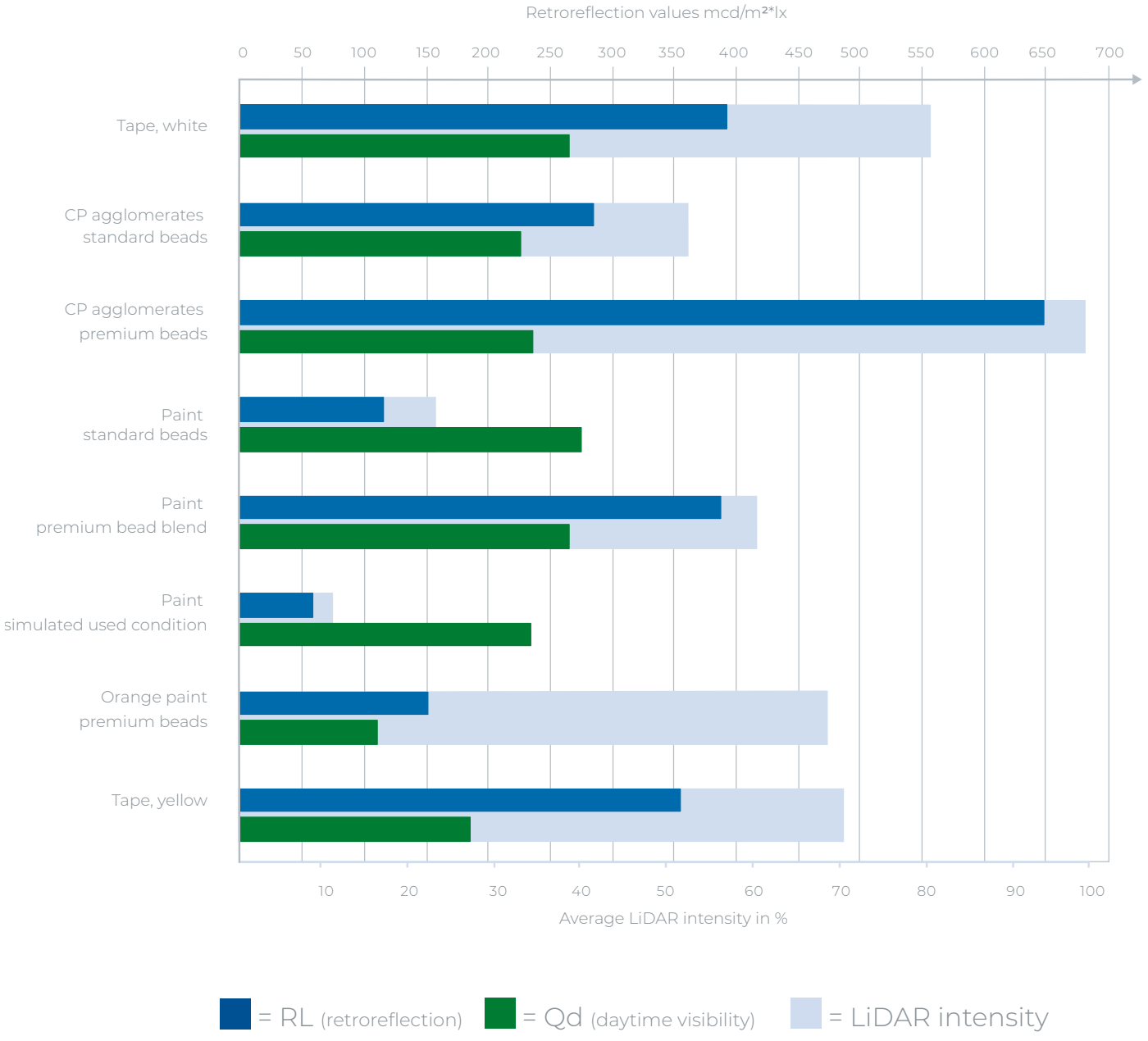
ZKW

With illumination:
RL/Qd EN 1436 and average
LiDAR intensity (wavelength 905 nm)
measuring distance 16 m, measuring angle 6.4°



"The car can´t find the lane markings! You need to paint the bloody roads here!"

Lex Kerssemakers,
Commercial Operations, Volvo Car Group

"They (self-driving car companions) actually said make sure you have really good paint lines. So, where there are lines, we have to make sure they´re really good."

Kirk Steudie,
former Director of the Michigan Department of Transportation

"Lane markings are the rails for the self-steering car."

European Road Assessment Programme (EuroRAP)
European New Car Assessment Programme (Euro NCAP)

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"Like the human eye, the technology can´t work effectively if it can´t see the road markings if they are worn out or hidden or if they are confusing."

European Road Assessment Programme (EuroRAP)
European New Car Assessment Programme (Euro NCAP)

"Road markings are the first point of reference for all users and vehicles (traditional, connected or not, autonomous or not). We need to ensure road markings provide the minimum quality standards that can be read, interpreted and understood by both the human user and the assistance systems."

Christophe Nicodème,
Director General, European Union Road Federation (ERF)

"We really need better lane markings. This is crazy."

Elon Musk,
CEO, Tesla

SWARCO | The Better Way. Every Day.

SHOWING THE WAY, WORLDWIDE

In 1969 we started out with the manufacture of tiny reflective glass beads. Today we have grown into the world's largest systems provider for road markings, making roads safer and saving lives on a daily basis. Our high quality products and services, safely direct traffic flow from A to B, every day and night. On all roads, in any weather, and all from SWARCO.

We prepare for the future by fusing knowledge with innovation at our Competence Center for Glass Technology and Marking Systems. So, even with smart and autonomous driving, we continue to blaze the trail of premium road markings to the world. Jump in and drive with us; we will be happy to help you find your ideal road marking solutions.

www.swarco.com/rms

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