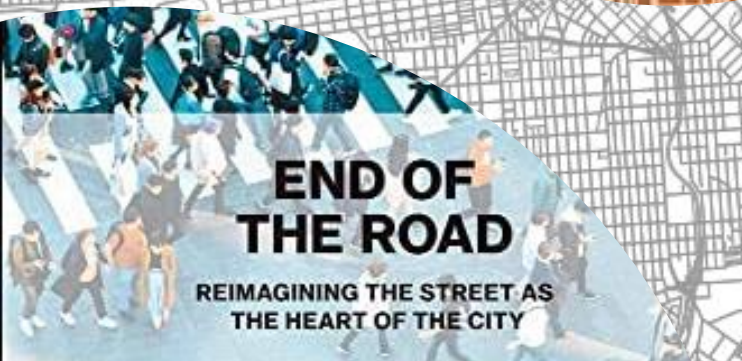
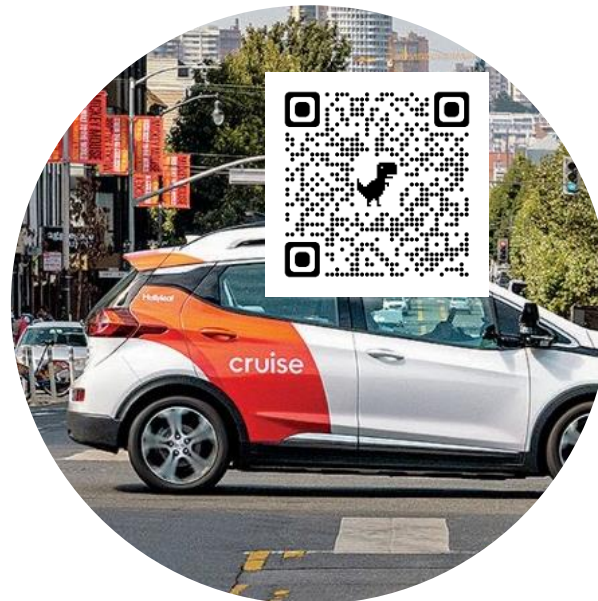


DISRUPTIVE TRANSPORT

DRIVERLESS CARS, TRANSPORT INNOVATION AND THE SUSTAINABLE CITY OF TOMORROW



END OF THE ROAD

REIMAGINING THE STREET AS THE HEART OF THE CITY

WILLIAM RIGGS



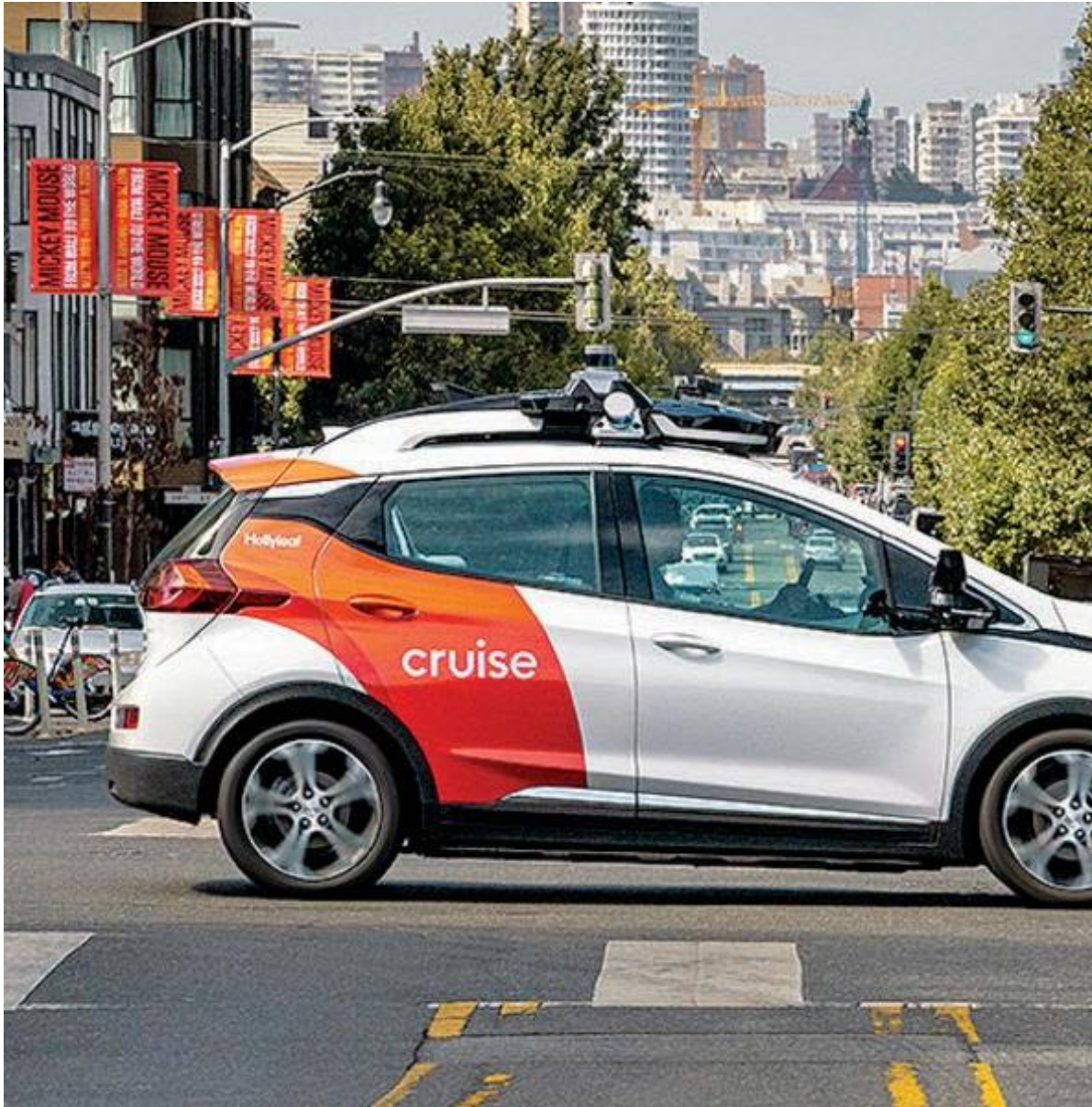
INTN.CITY SF



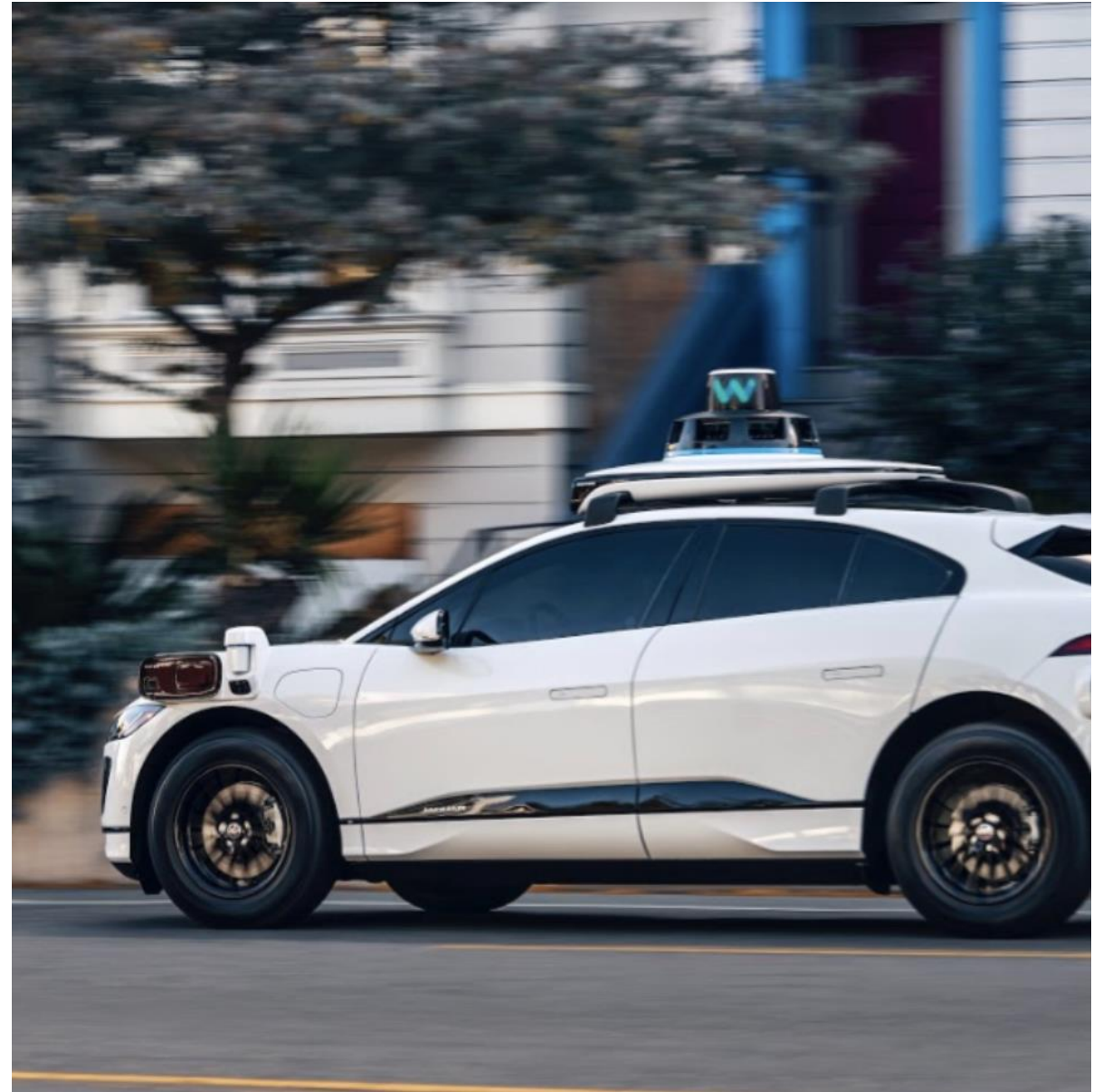
William (Billy) Riggs

Professor of Management and Engineering
Director of the Autonomous Vehicles and the City Initiative
wriggs@usfca.edu | @billyriggs





2023



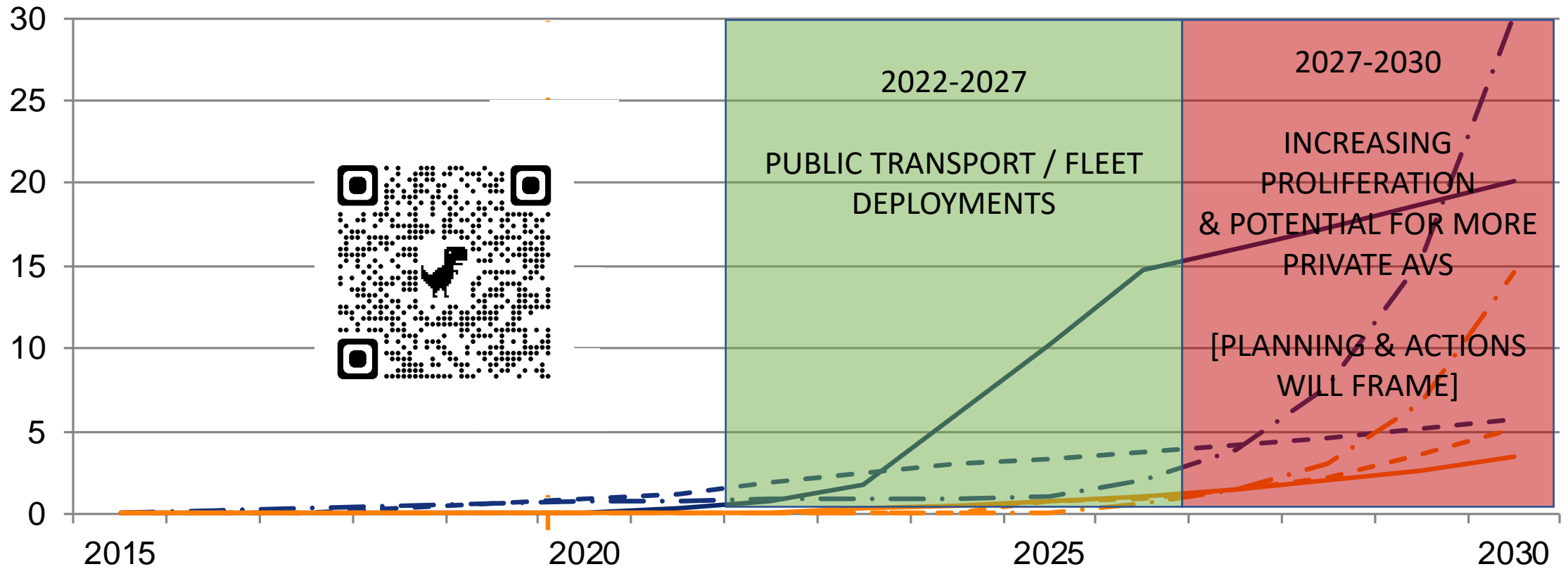
William Riggs | wriggs@usfca.edu

2

Projections for autonomous vehicle¹ new sales share as published by different analysts

Percent

— U.S. — Global



¹ autonomous (SAE L4-5)



The background image shows the interior of a vehicle, likely a taxi or ride-sharing car. Two passengers are visible: a woman in the back seat on the left wearing a grey coat and a light blue face mask, and a woman in the front passenger seat on the right wearing a red coat and a light blue face mask. The car's interior is modern, with a digital display hanging from the ceiling. The windows show a city street scene with buildings.

Network Efficiency and Reduction of Wasted Travel (VKT)

Incentive to Reduce Wasted Travel (aka “Deadheading” or “Ghost Miles”) and Maximize People Kilometers Traveled. Keep vehicles in circulation with with maximal occupancy to increase economic viability and decrease economic / environmental costs associated with wasted / inefficient Vehicle Kilometers Traveled.

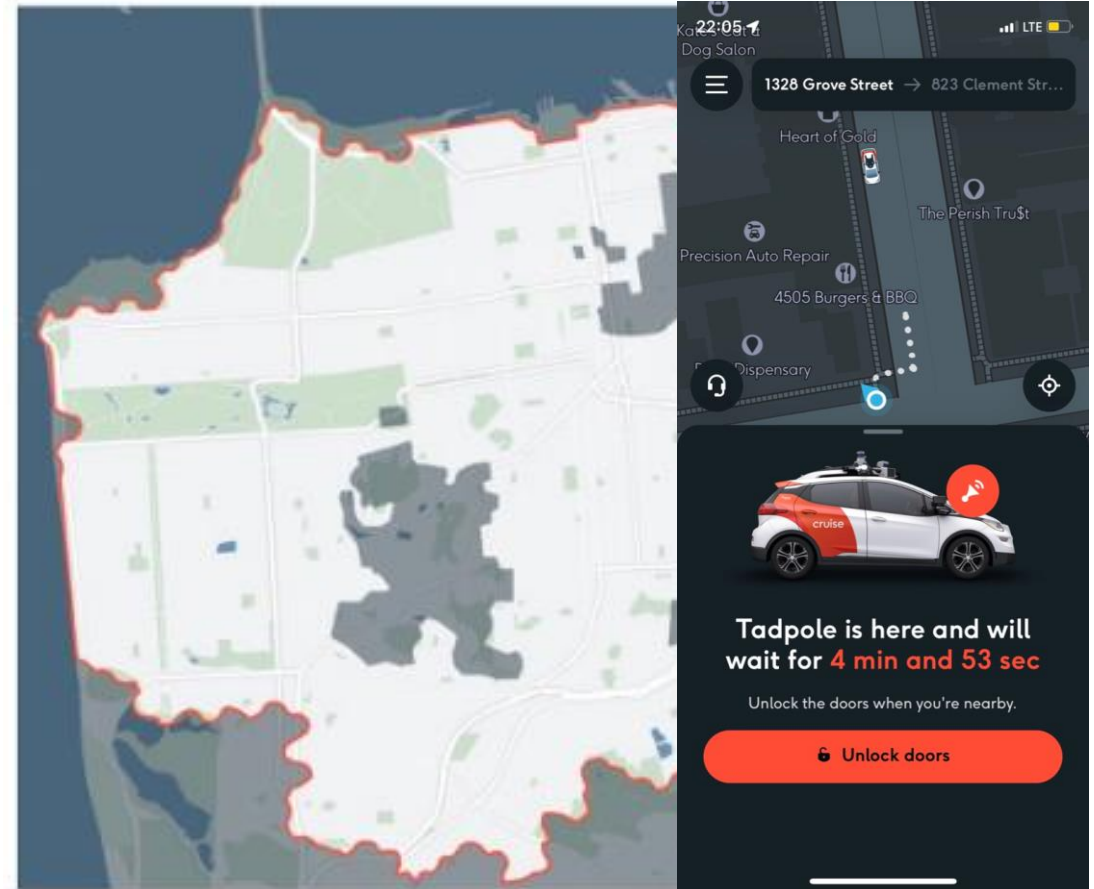
Evaluating Street Grid Networks for Surplus Travel

- Simulate total daily vehicle trips for each model ($n = 1,133,333$) using Dijkstra's shortest-path algorithm
- Two OD matrices of San Francisco street network (no freeways) using OpenStreetMap and OSMnx: "survey-derived" between homes and workplaces (CHTS); random "survey-derived to cover more of the city"
 - Real World Directionality (G1) real real-world "status-quo" one-way directionality
 - Bidirectional Two-Way Network (G2)
- Tests for weighting of trip length; Shortest path between the origin and destinations and free-flow travel w/out queuing model.
- **Over 20M annual surplus VKT on non-optimized network both real world and random trips (2 extra blocks traversed every trip)**



An Uber Without a Driver

- No Driver in ODD
- Fully Autonomous / No V2X Requirements
- No fixed route within ODD
- On-demand, app-based
- Door-to-door “last mile” service
- User-responsive and personalizable

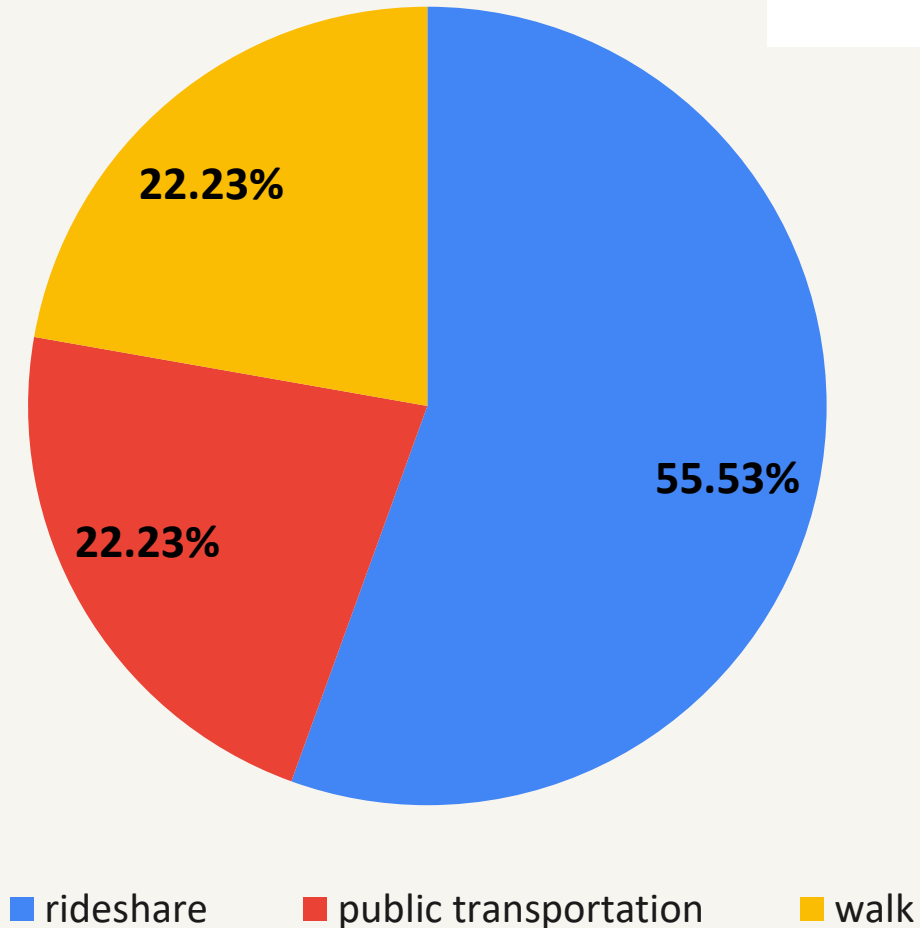


Alternative Travel for AV Riders

56% of riders would have used rideshare. Others would have walked or taken transit.

76% of riders would have made the trip via other means even if an AV were not available; existing trips not induced.

Alternative Travel Mode
(If AV was not available)



The Trip Characteristics of a Pilot
Autonomous Ve...

papers.ssrn.com



The Trip Characteristics of a Pilot
Autonomous Ve...

papers.ssrn.com

“People use my street as a racetrack and AVs have slowed down traffic.”

10

Ongoing evaluation suggests AVs meter (slow down) non-AV traffic leading to slower (and potentially safer) travel.

Importance of Incident Response & Communication

- Incident response (police / fire / ambulance) require that first first responders are trained and abide by that training.
- Need for anticipatory data to update on-board maps: Construction, Emergency Management, Etc.



We'll be back after some routine maintenance

Something happened on your trip

Blueberry is pulling over to a safe stop

- 📞 Cruise Support is calling you to help
- 🚗 Stay buckled up and wait in the car
- 👁️ If you need to, exit on the sidewalk side (check for bikes and cars)



Operational Corner Cases

future tense

Self-Driving Taxis Are Causing All Kinds of Trouble in San Francisco

They've blocked traffic, driven on the sidewalk, sped away from cops —and the city is powerless to stop them.

BY DAVID ZIPPER

DEC 08, 2022 · 11:45 AM



MANY OPERATIONAL CHALLENGES CAN RELATE TO DEFINITIONS IN ODD (STREET GRID, WEATHER, ETC.) AND CURB / PARKING POLICIES

LEGALITY OF COMMERCIAL VEHICLES TO BLOCK TRAFFIC FOR SAFE DROP OFF (CURB CUT IS ILLEGAL!)

*“...journeys were mostly smooth, though one car summoned stopped **alongside a construction site**, forcing to walk through traffic to get into the car.*”

ROUTING CHALLENGES BASED ON ODD

*“...driverless taxi went... **blocks farther than necessary**, roughly half a mile, apparently to avoid the most crowded roads....”*

An aerial, isometric view of a city street corner. The scene shows multi-story brick buildings with numerous windows. A wide sidewalk runs along the buildings. A street with double yellow lines and a red-paved 'DROP OFF LANE' is visible. A white diagonal line cuts across the image from the top right to the bottom left. A white-bordered box on the left contains text.

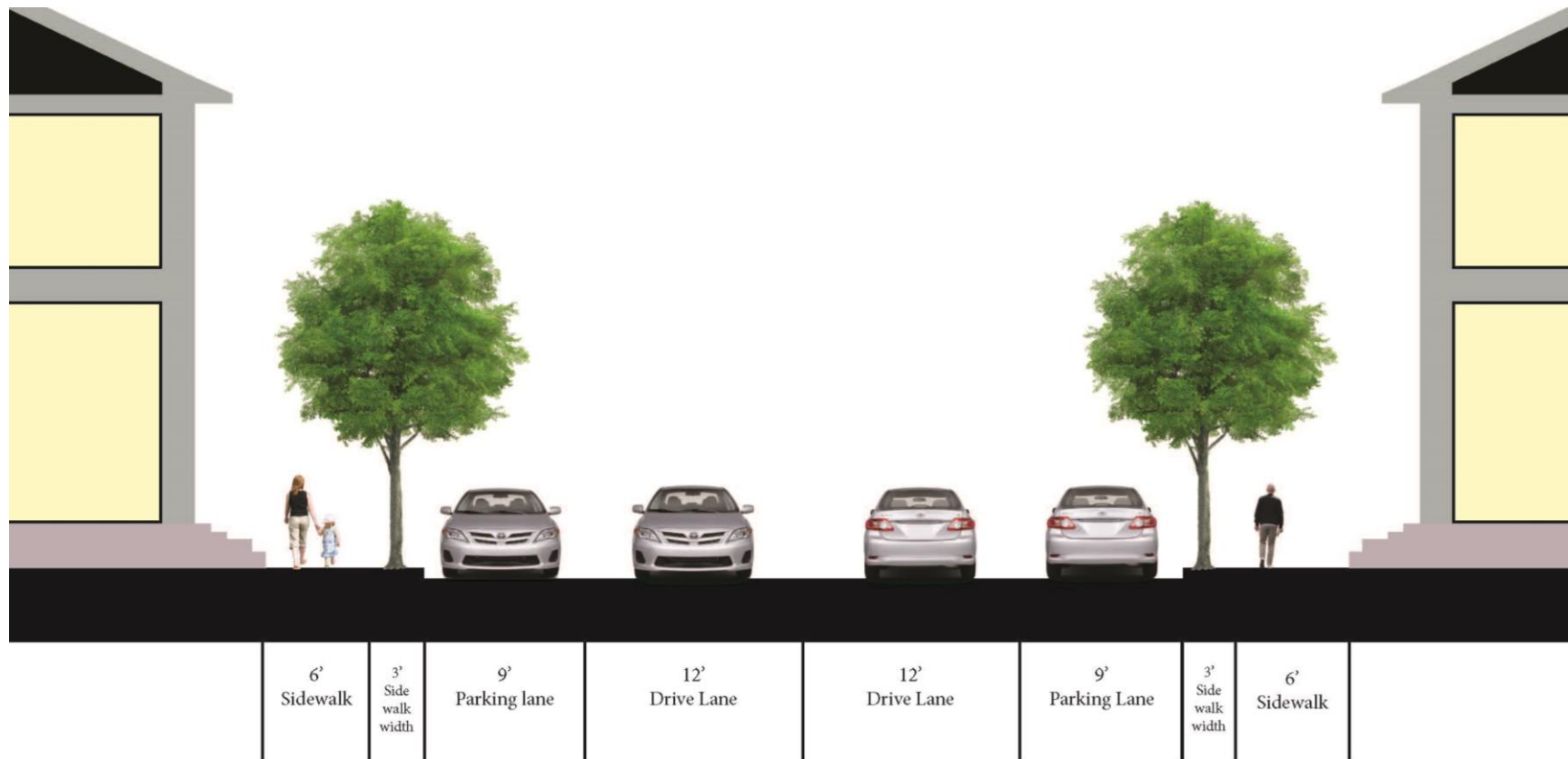
Curb Tension

Underutilization
Lack of Sharing
Infra Opportunities
Real Estate Opportunities
Move to Curb Maximization

Maximized Curbs Are ROW Opportunities

Thin Lanes | Remove Parking | Think Shared

Help cities “End the Road” and rethink what our streets are and can be.



Lessons / Opportunities for OEMs, PTOs, & Cities



Rider Data Consideration / Still Potential for Sharing

Off-peak trips may not increase total travel / VMT; capture latent travel



Infrastructure Opportunities

Signs, lines and potholes; lane / roadway prioritization (create network / operational efficiency)

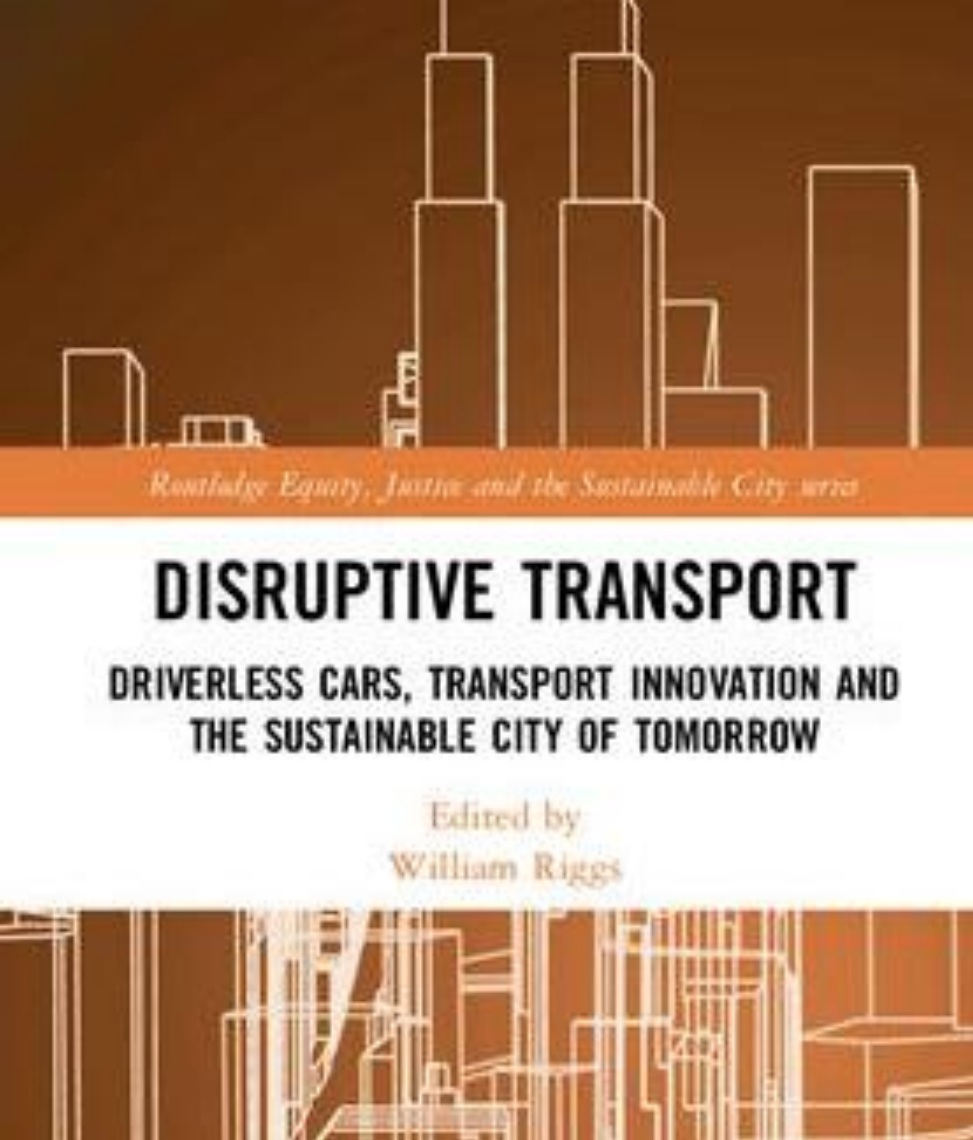
Pick and drop off / curb availability / potential use of transit stops

Leveraged digital / 3D mapping; challenge for some deployments



Business Model Partnerships

Refinement and partnership likely needed for sustainable business model alongside an emphasis on last mile / shared mobility services

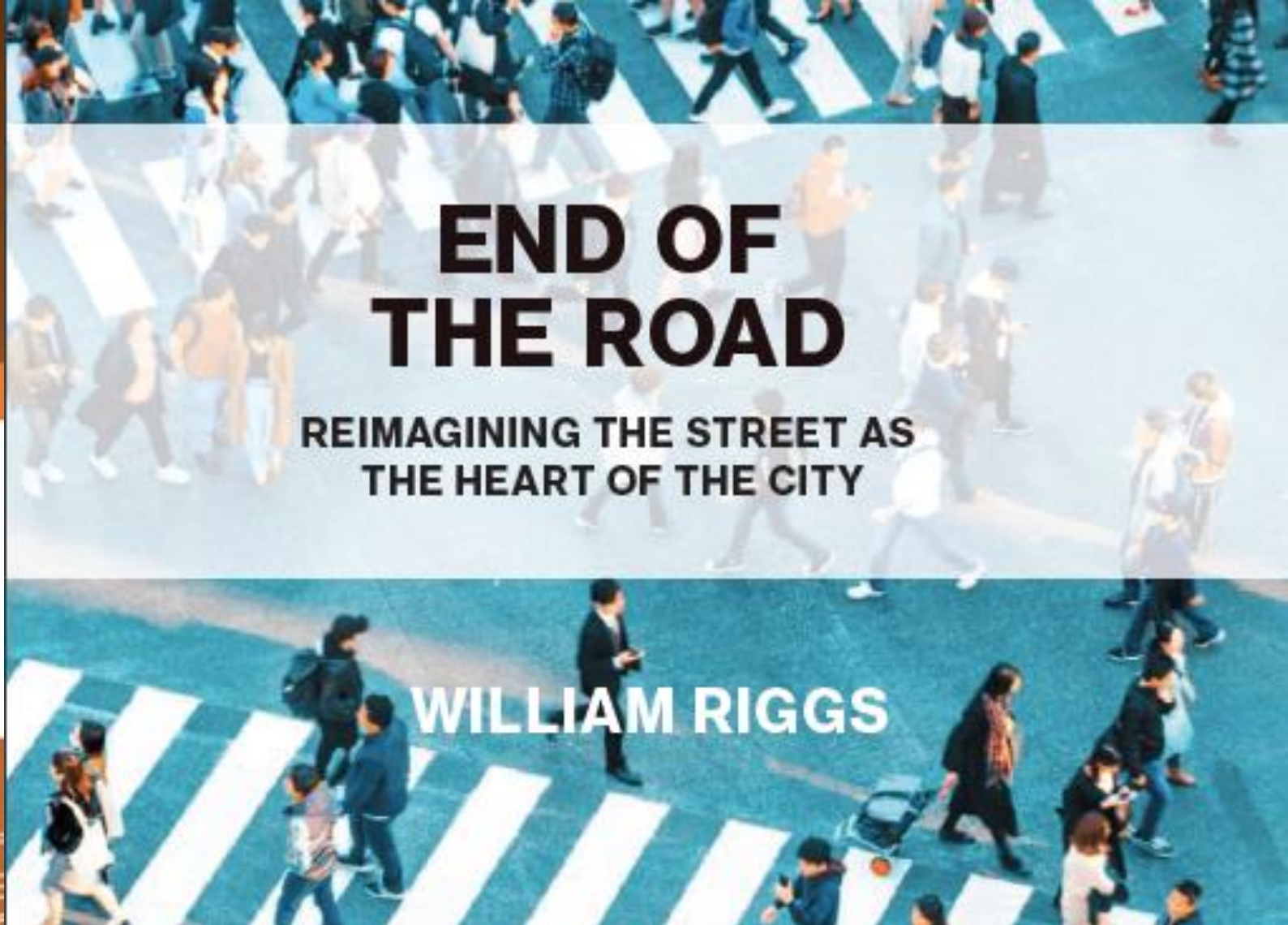


Routledge Equity, Justice and the Sustainable City series

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WILLIAM RIGGS



Disruptive Transport: Driverless Cars,
Transport Innovation and the Sustainable
City of Tomorrow
Available from Routledge:
<http://bit.ly/disruptivetransport>



End of the Road: Reimagining the
Street as the Heart of the City.
Available for preorder now:
<https://bristoluniversitypress.co.uk/end-of-the-road>



ansdev
obility company



TRANSDEV AUTONOMOUS MOBILITY

TRANSDEV EXPERTISE

2024

AUTONOMOUS MOBILITY WILL CONTRIBUTE TO MAKE CITIES MORE LIVEABLE

“We believe that Autonomous mobility will change the way people move, reducing the number of private cars on the roads while increasing road safety.

As a leading mobility company, Transdev aims at paving the way to new modes of sustainable transportations while guarantying the same level of safety, passenger experience and quality of service.”



Virginie Fernandes

Head of Strategy and Transformation,
Transdev Group

Autonomous Vehicles will deliver benefits for all :

→ Extended time and geographical transport offer

When scaling up, the lower total cost of ownership of operating AVs (lower than driven services) will allow PTAs and PTOs to increase public transport and raid-hailing attractivity with additional services both for time and geographical coverage.

→ Accelerate energy transition with integration to sustainable public transport

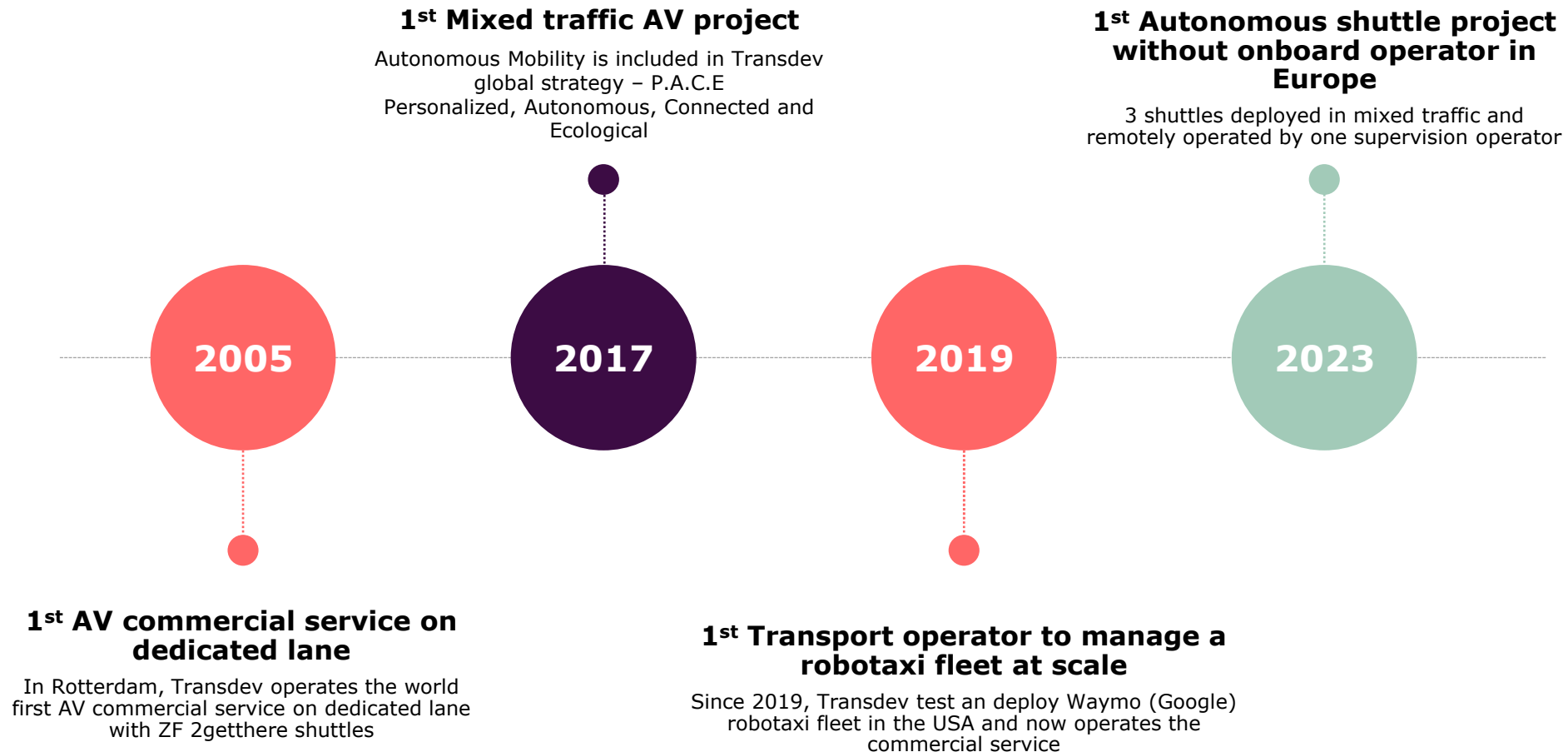
Electric autonomous vehicles will enable door-to-door transport service (1st mile / Last mile) with less noise and pollution while triggering Modal shift.

→ Increase road safety

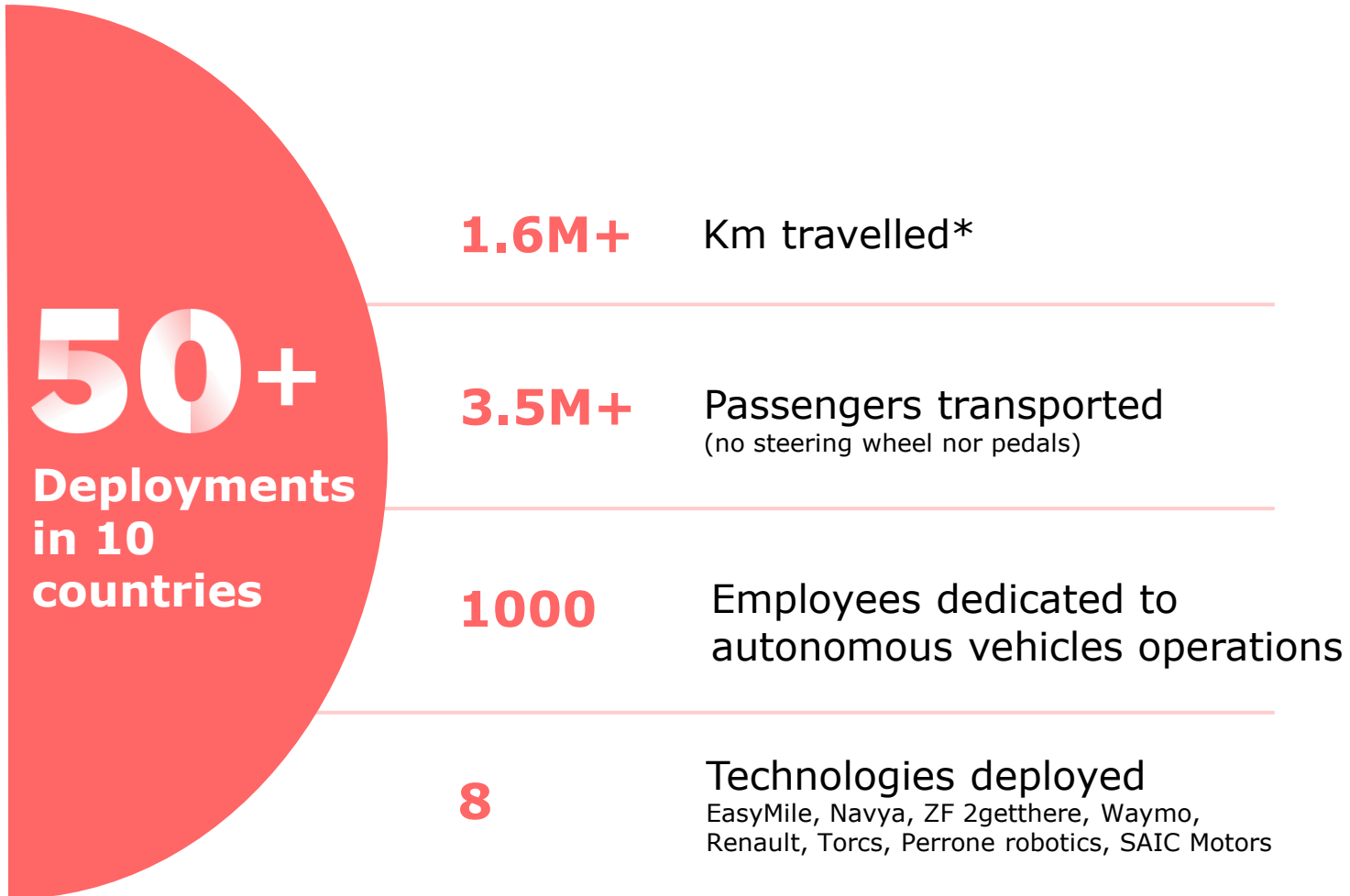
When mature, autonomous vehicles will reduce road accidents as 90% of road accidents are caused by human mistakes.



A PIONEER IN AV OPERATIONS



A LEADER IN AV OPERATIONS



TRANSDEV AUTONOMOUS MOBILITY ACTIVITIES

Transdev is paving the way for autonomous mobility services through 2 main activities

Public Transport Authorities

Helping PTAs to test, launch and operate autonomous mobility service

ATS providers

Helping Technology providers to test, validate and deploy autonomous vehicles



A NEW PULL FOR MOBILITY TRANSITION:

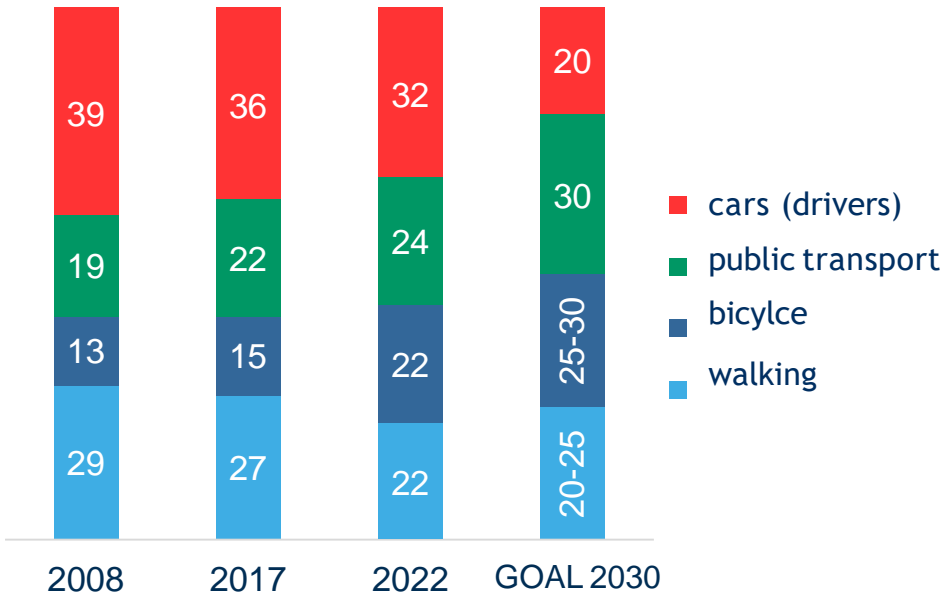
**INTEGRATING AUTONOMOUS ON-DEMAND
SHUTTLES INTO PUBLIC TRANSPORT**

Minister Dr. Anjes Tjarks
Ministry of Transport and Mobility Transition

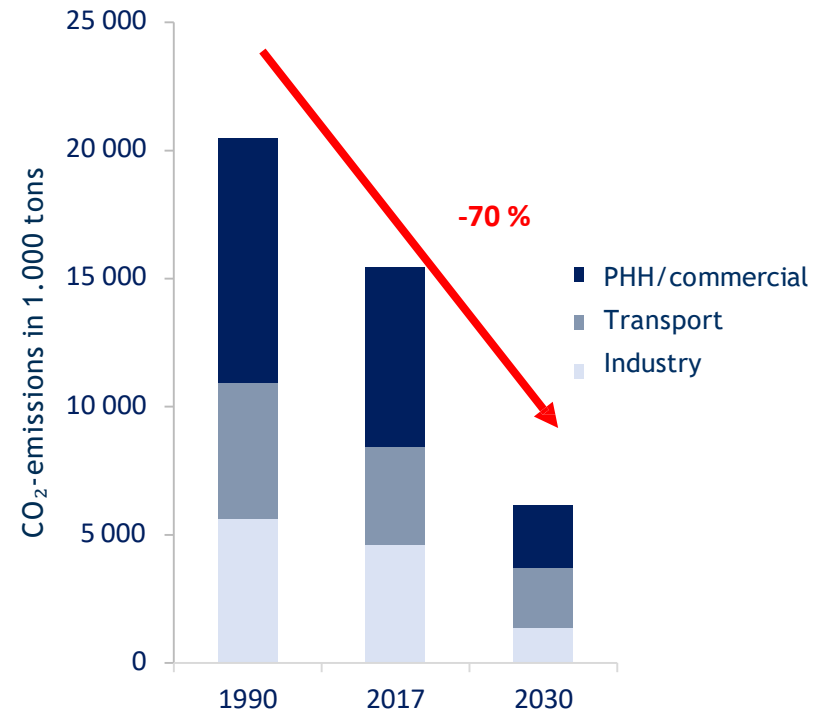
CLIMATE AND MOBILITY DEVELOPMENT GOALS

Modal Shift until 2030

Share of all trips made by Hamburg residents per day in %



CO₂ Reduction until 2030



Source: infas, MID Hamburg 2017

“DEUTSCHLANDTICKET” (GERMANY TICKET)



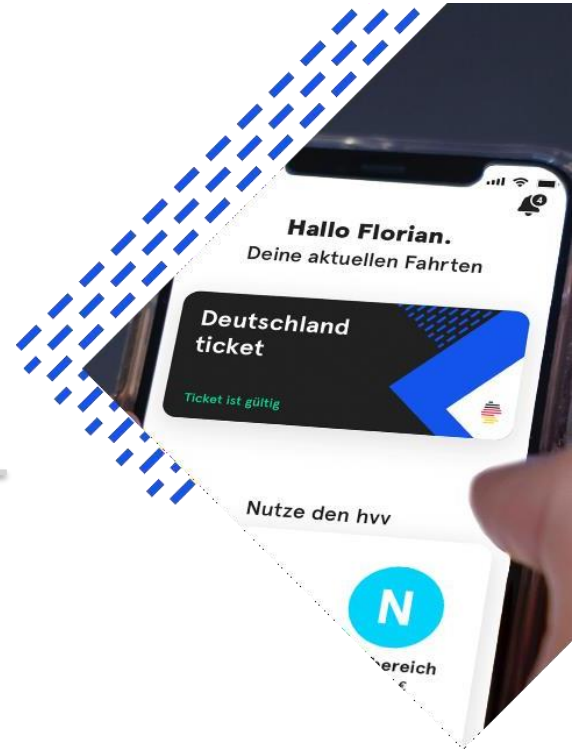
Valid on local services all over Germany!

Not valid on tourist transport (museum railways etc.); can also be valid on cross-border services if local transport areas/fare systems include it



Issued per calendar month – from 2024 flexible validity

Valid per calendar month in 2023 – starter ticket as onboarding option.
From 2024 valid for a one-month period – flexible times like online subscriptions as in Netflix, Spotify & Co.



A fully digital product

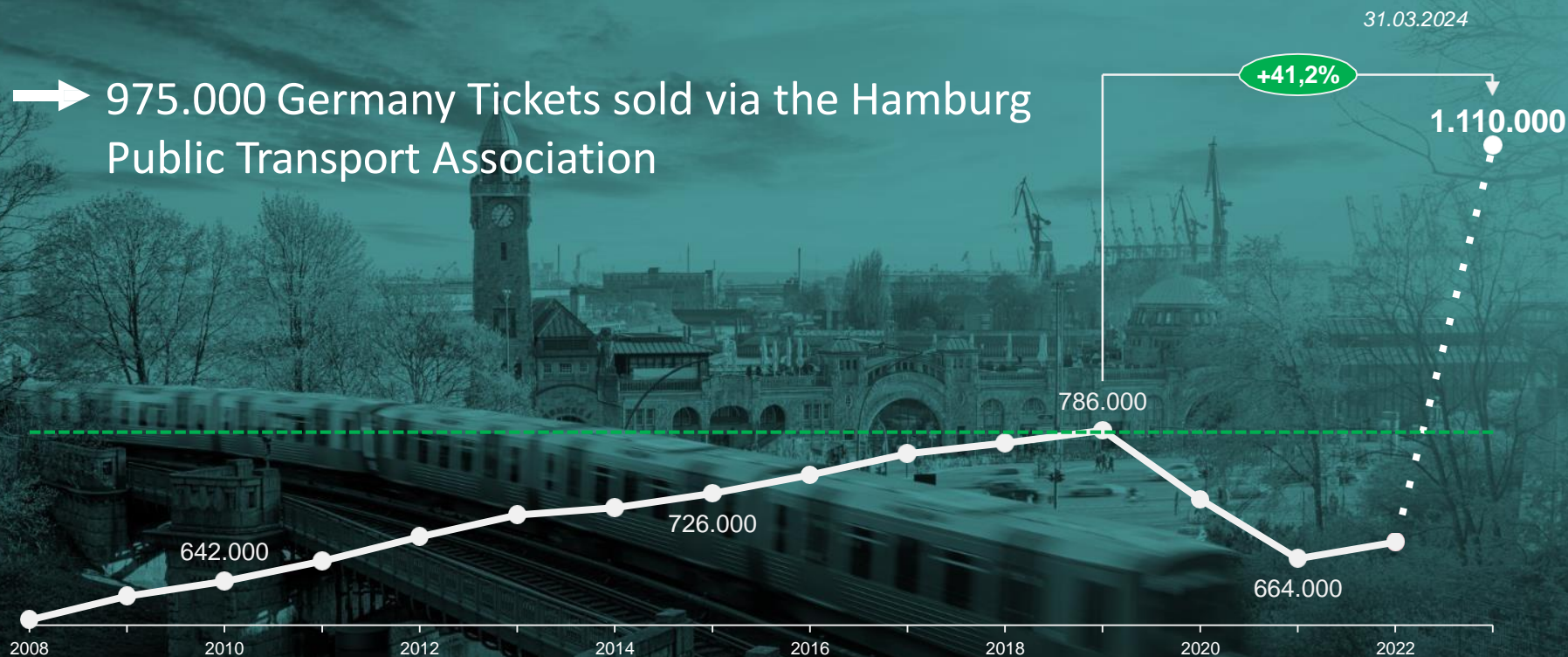
Issued on paper only for a transitional period till chipcard sent by post
Paper tickets permitted till end of 2023



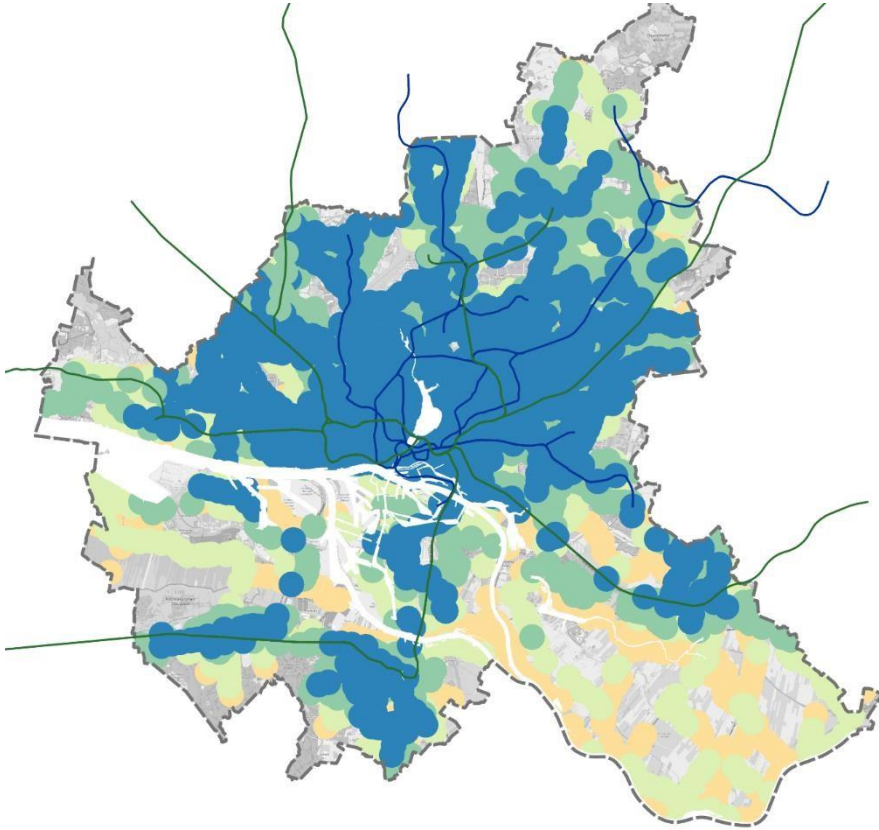
cancellable monthly

Total subscriptions

➔ 975.000 Germany Tickets sold via the Hamburg Public Transport Association



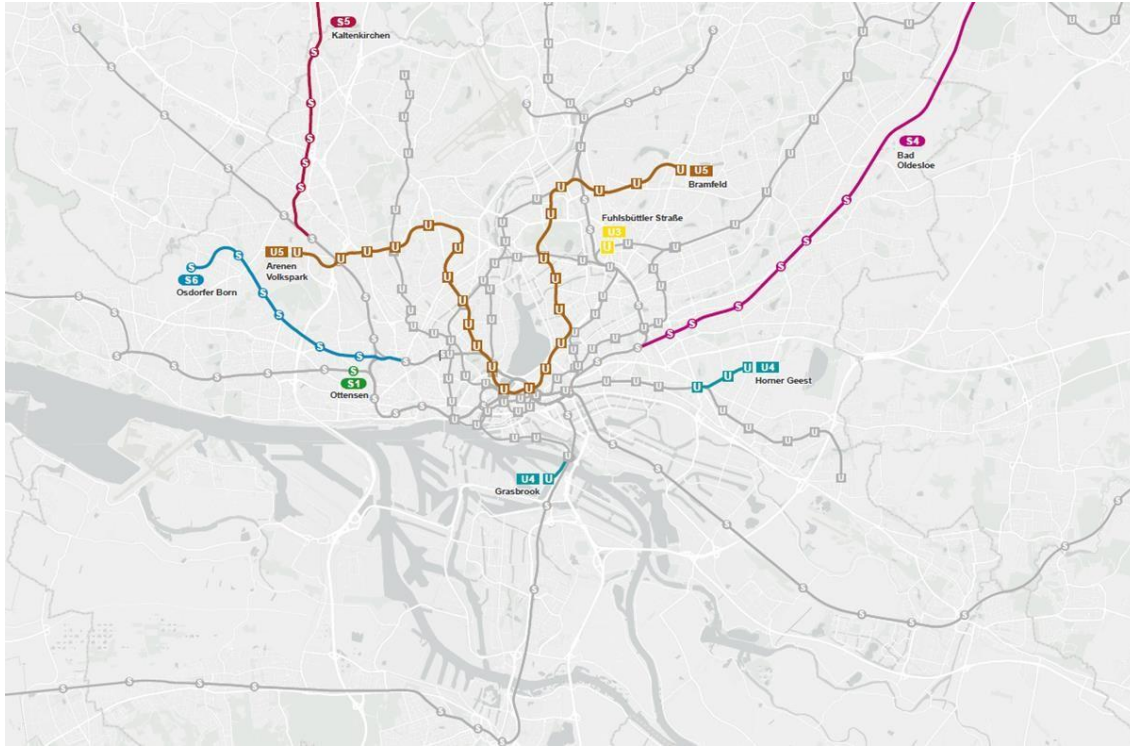
“HAMBURG TAKT” = HAMBURG FREQUENCY



The expansion of the classic public transport network will give appr. **85 % of Hamburg's population** a service every 5 minutes within a walking distance of 5 minutes.

- The remaining 15 % could complete 2/3 of their rides via **on-demand shuttles** to existing public transport stations while the rest uses on-demand direct connections.
- The „Hamburg-Takt“ in the entire city is only possible with an intelligently operated on-demand service that is fully integrated in the public transport system.

RAPID TRANSIT EXPANSION (UNTIL 2030)



Goal: expansion of regional rapid transit system to reduce private motorized transport, especially commuting

- New suburban trains, longer trains, larger buses, denser intervals
- Capacity expansion
- Increased frequency on S-Bahn and U-Bahn trains at peak times
- New Expressbus, Metrobus and neighborhood bus lines
- Night bus network to be relaunched

Further expansion plans beyond 2030:
38 new stations until 2040

HAMBURG DEVELOPS A NEW URBAN MOBILITY SYSTEM

Classic public transport is combined with autonomous on-demand traffic



Automated, digital and interconnected mobility system of the future
for a sustainable mobility transition with noticeably less car traffic

This is today

MOIA's current non-AD ridepooling service in a 270 km² service area

Scenario **1** 2 3 4 5

Costs **1.2** €/km

Vehicles **250** non-AD

Public policies

Biking 	Individual Car 	Public Transport 
14.5%	34%	23.9
Pedestrian 	Acceptance Rate	Modal Split 
26.5%	88%	0.1%

⏪ || ⏩ 0 6 12 18 24 20:14

Mobility revolution

Sustainable and comfortable mobility for everyone

Scenario 1 2 3 4 5

Costs 40 ct/km Vehicles 10k AD Public policies

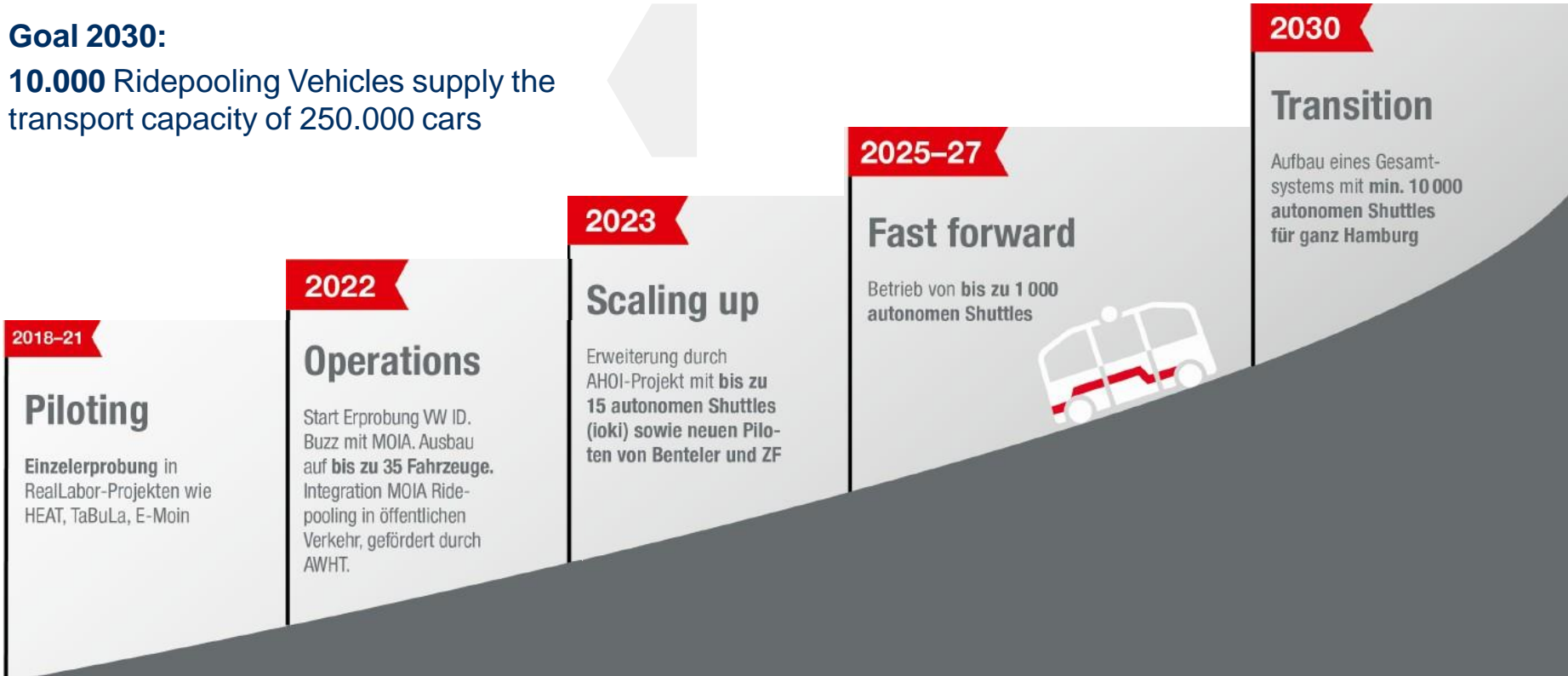
Biking	Individual Car	Public Transport
14.9% ↑ 14.5	18.1% ↓ 34	31.4% ↑ 23.9

Pedestrians		
27% ↑ 26.5	↑	↑

AUTONOMOUS ON-DEMAND TRAFFIC IN HAMBURG

Goal 2030:

10.000 Ridepooling Vehicles supply the transport capacity of 250.000 cars



UITP SUMMITS HAMBURG 2025 & 2027



15. - 18. June 2025

We look forward to seeing you in Hamburg!

 > **17.000** visits

 > **400** exhibitors from > **40** countries

 > **40.000 m²** of exhibition space

 > **2.800** congress delegates and approx. **250** speakers

 **43 %** female speakers at the last UITP Summit in 2023

 **250** press representatives at the last UITP Summit in 2023

 Side events throughout the city



Thank you!

Minister Dr. Anjes Tjarks
Ministry of Transport and Mobility Transition