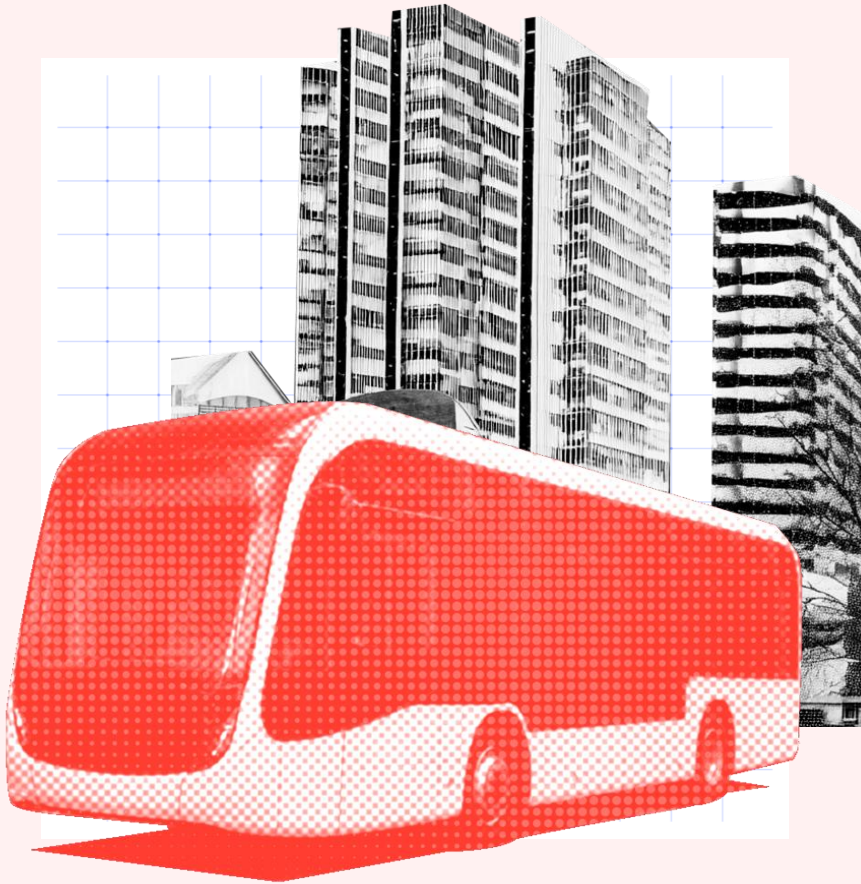
Driving Efficiency:

Five insights on cost savings and revenue potential of automated public bus transport



Automated buses: we studied the case for going driverless

Context of this publication

- The Netherlands, like many OECD countries, faces major public transport staff shortages and increased pressure to reduce costs

In 2024, 20% of bus driver positions remained unfilled[1].

- Many pilots on automated public bus transport are reaching the next phase. In this next phase, additional public and private investments are required.
- To ensure the soundness of these investments, a partnership of governments and public transport providers commissioned Rebel to develop a business case for automated public transport buses.
- This publication summarizes the main outcomes of this analysis

Content of this publication

Explanation of how we calculated the effects of automated buses on costs and revenues

Expected reduction of costs under different circumstances (routes and implementation level)

Expected impact on revenues, and the potential for intensified use of buses during non-peak hours

Recommended actions for governments to enable implementation

1 International Road Transport Union, driver shortage report. 2023

Five key insights on the business case of automated buses

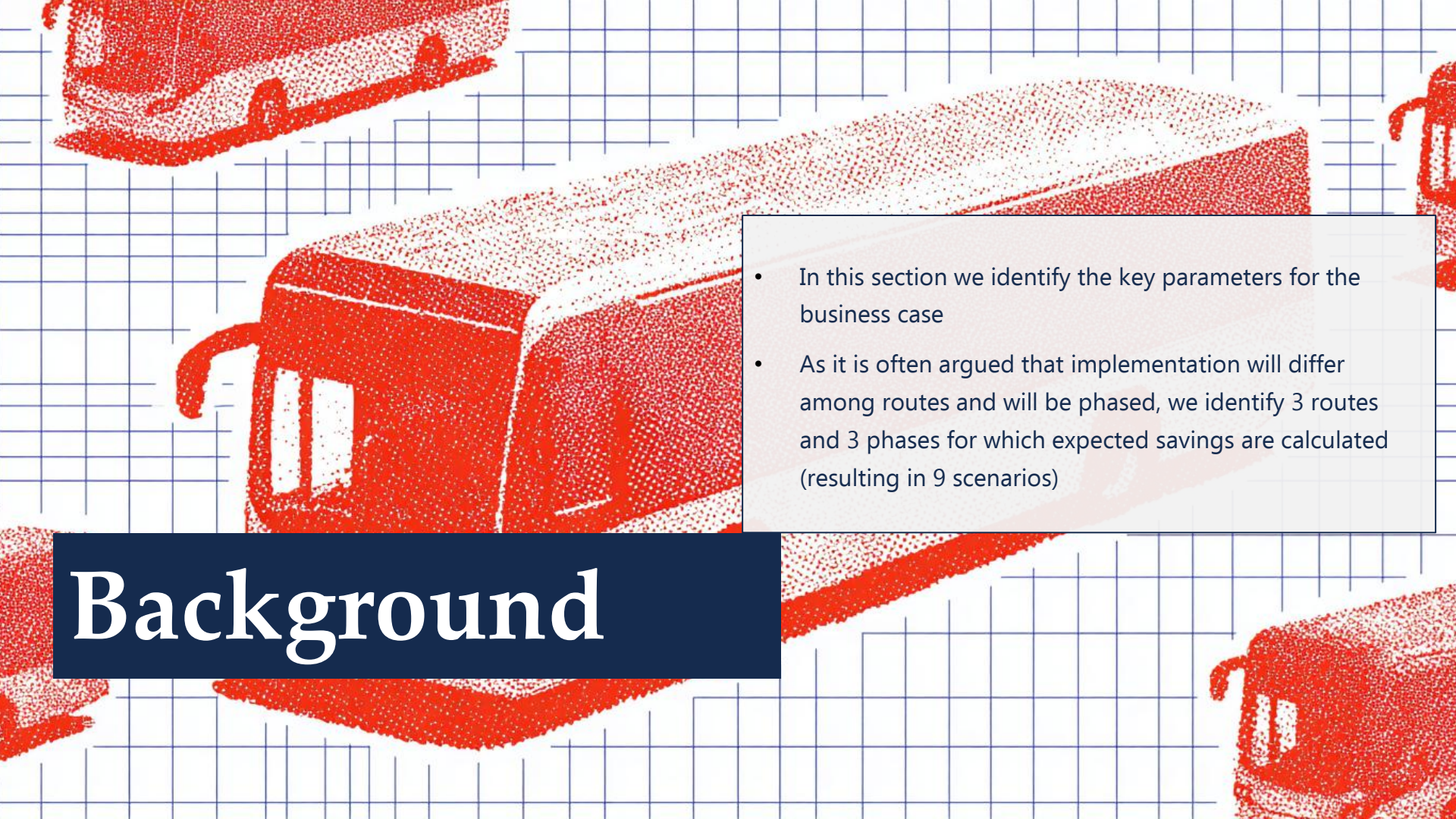
1. Operational cost savings between 25–35% are realistic with fully automated driving. Personnel costs average 60% of current costs and additional costs are ~30%.

2. When routes are partially automated, cost savings are uncertain. The main driver is the number of points where drivers enter and exit the vehicle. Routes with only one entry point for a driver were estimated to save 10%, while routes with more than one entry point see costs increases up to 15%.

3. Even if buses are operated with safety drivers for some years the business case is positive. Fully automated service commencing after more than 3.5 years of manual driving renders the investment unprofitable.

4. Revenue losses are unlikely to outweigh operational savings. Losses up to a maximum of 10% are realistic without additional interventions. Given the usual cost recovery of public transport, savings will outweigh revenue reduction by a factor of 5-7.

5. Governments have a crucial role in enabling automated public transport. They can act as a market maker, embed the technology in concession processes, cooperate with public transport providers, and commit to updating laws and regulations.



Background

- In this section we identify the key parameters for the business case
- As it is often argued that implementation will differ among routes and will be phased, we identify 3 routes and 3 phases for which expected savings are calculated (resulting in 9 scenarios)

Implementation assumed to occur over three phases

Phases	Technology	Legislation	Certification	Calendar	Presence of safety drivers	
					Simple - Average	Complex
1 Experimental	SAE2	Experimental	Limited	Now		
2 Automated driving on specific ODDs	SAE3/4	Regular	Complete / or specific for simple environment	2019		
3 Automated driving in all situations	SAE4	Regular	Complete	Uncertain / 2034		

How has 'new cost' been calculated

The base indicator used in this study is the cost per vehicle service hour (€/bus-hour)

Current Cost + Higher Cost + Additional Cost - Cost Savings = New Cost

Business case was made for three routes

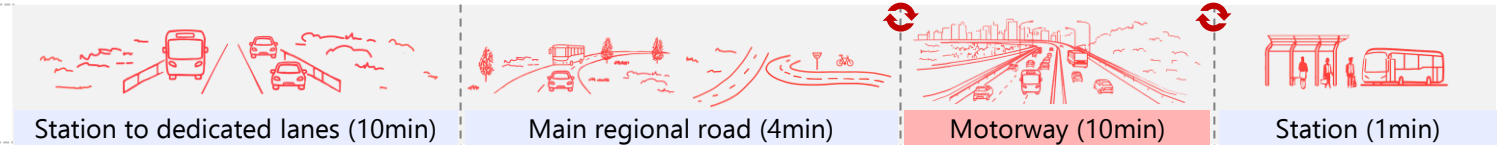
Explanation

- From a range of typical bus route combinations of Operational Design Domains (ODDs) we came to three realistic routes that are expected to differ significantly in terms of business case.
- For these routes we developed the business case for the three phases (phase 1 being automated with safety driver, phase 2 partially automated, and phase 3 fully automated).

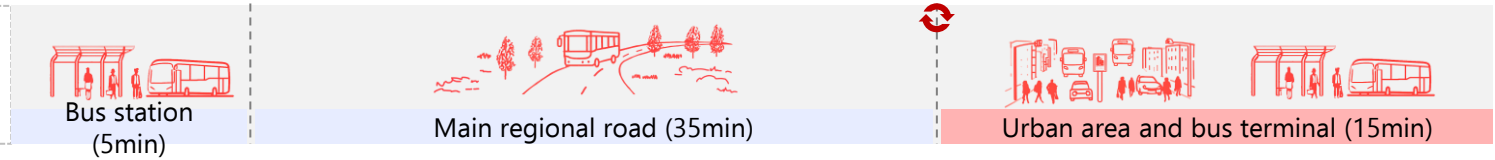
Legend

- Simple / average (automated phase 2)
- Complex (automated phase 3)
- Point where driver enters / exits

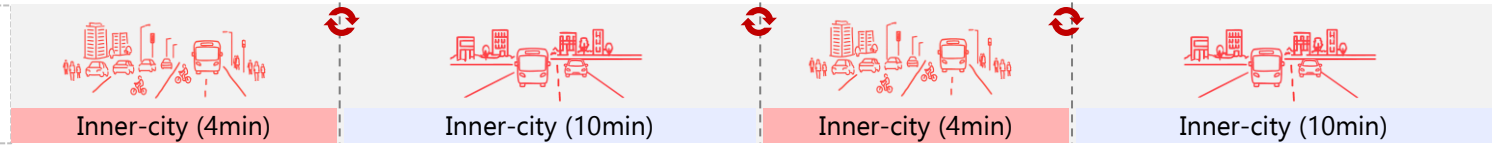
A Route with partly dedicated lanes

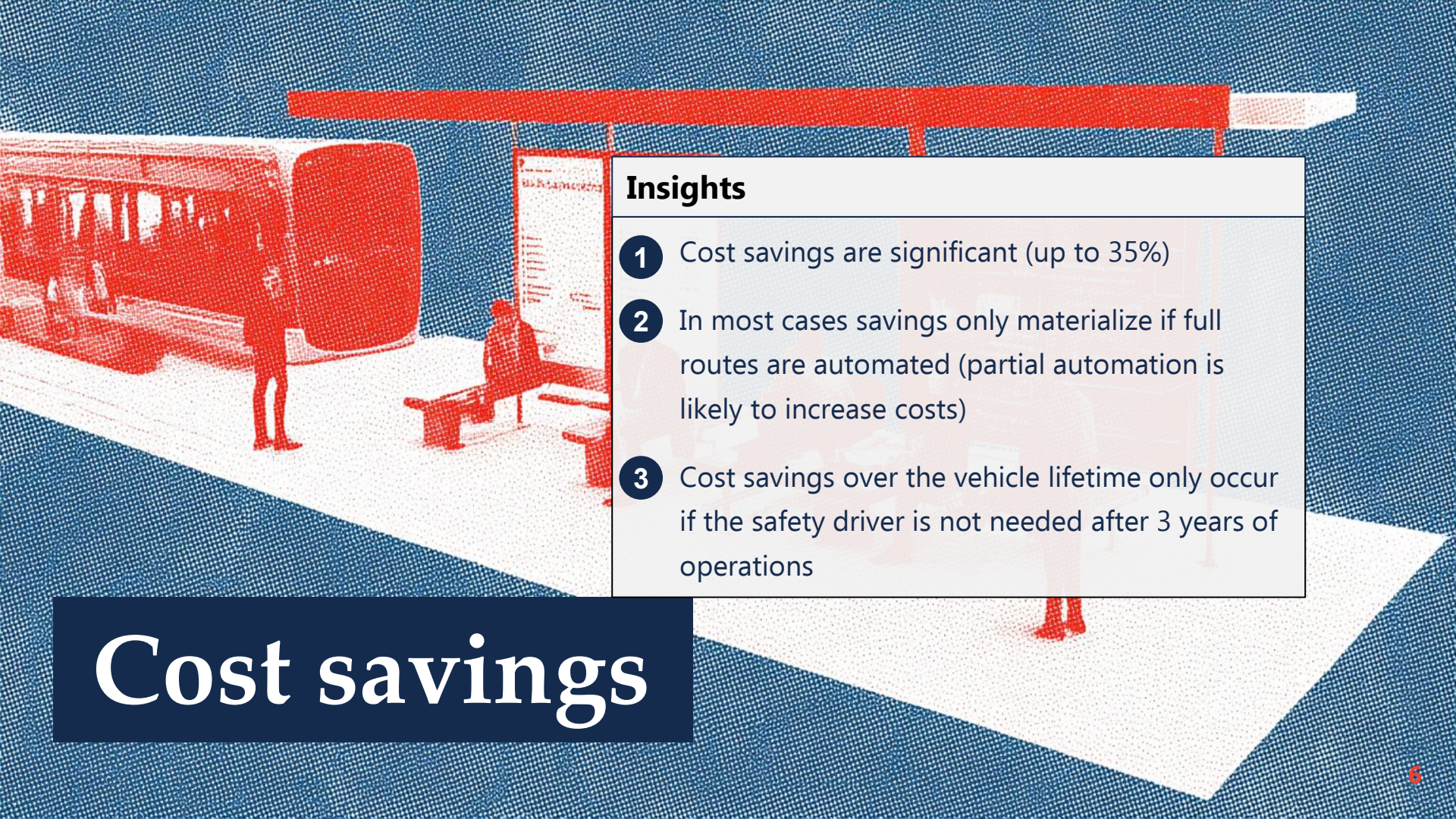


B Bus connection between 2 cities



C Fully inner-city





Cost savings

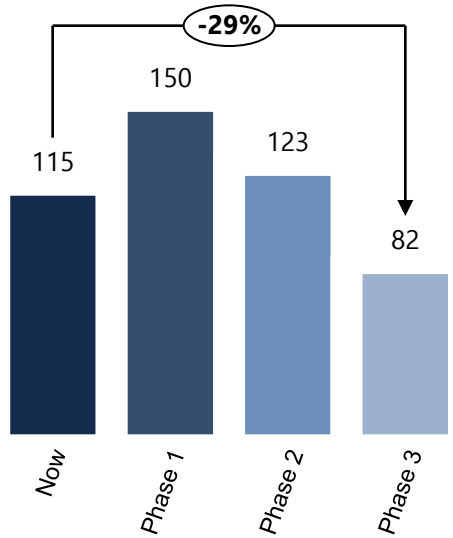
Insights

1. Cost savings are significant (up to 35%)
2. In most cases savings only materialize if full routes are automated (partial automation is likely to increase costs)
3. Cost savings over the vehicle lifetime only occur if the safety driver is not needed after 3 years of operations

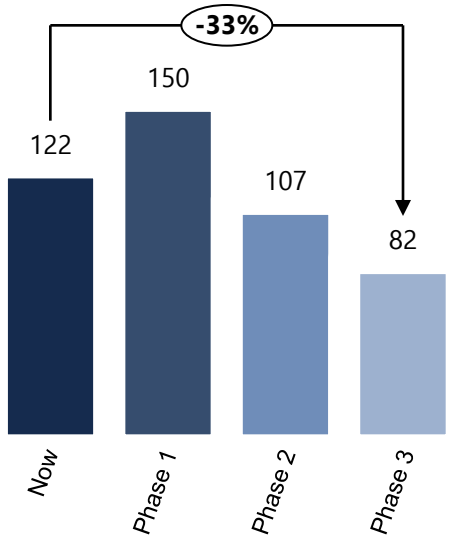
Full automation can yield cost savings of 25–33%, savings for partial automation (phase 2) dependent on ODD

Overview of costs for different routes for each development phase, EUR / bus-hour, based on standardized cost of services

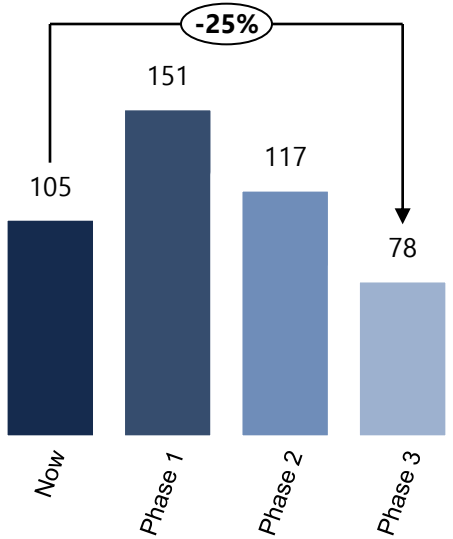
A **Route with partly dedicated lanes**



B **Bus connection between 2 cities**

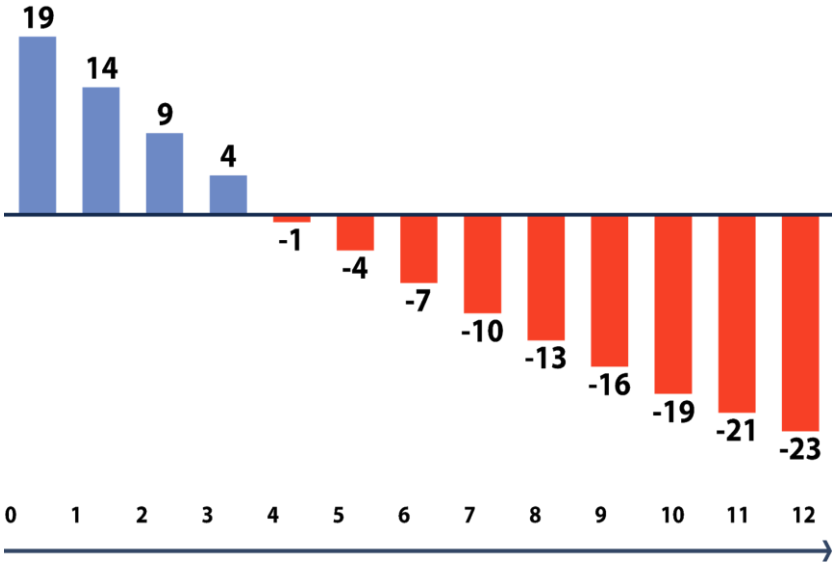


C **Fully inner-city**



The timing of automation determines investment viability

Cost savings EUR / bus-hour over lifetime, private discount rate (9%)



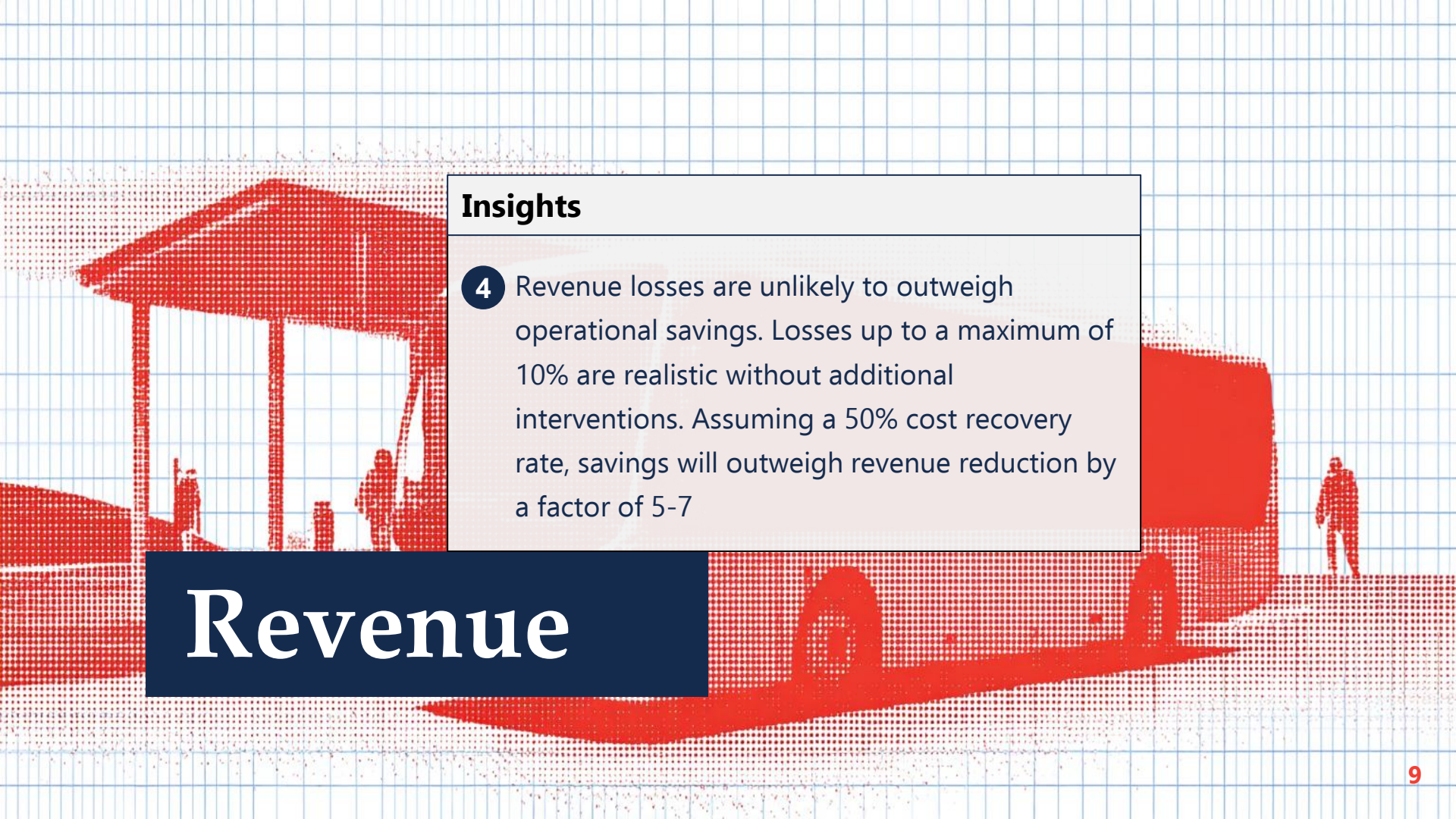
Number of years with safety driver before fully automatic driving

* Determined based on currently known costs and expected trends as calculated in a private sector view business case

Investment analysis should use a private sector discount rate which reflects true and non-diversified cost of risk **independently of market organization or ownership of the project.** It provides better insight because it reflects the specific risks and returns of the business case.

The chosen 9% private sector discount rate is an indicator of presumed efficient **risk pricing** of a private sector company in public transport. It shows an investment today in the total roadmap (through phases 1-2-3) is viable only if driverless service is achived within 3-4 years.

That is why it is recommended that for any automated bus investment undertaken today, **full SAE4 technology and regulatory approvals be in place within about 3 years.** This requirment includes project development, regulations, and certification.



Insights

4 Revenue losses are unlikely to outweigh operational savings. Losses up to a maximum of 10% are realistic without additional interventions. Assuming a 50% cost recovery rate, savings will outweigh revenue reduction by a factor of 5-7

Revenue

Revenue losses are unlikely to outweigh savings

Uncertain income effects: Automation may lead to more non-paying passengers **(5–15%)** due to the absence of a driver, and some travelers might avoid buses because of perceived insecurity, especially during quiet hours or in certain areas.

Control measures and monitoring: Automated buses can be monitored remotely **(assumed 1 operator per 5 buses, but ratios of 1 to 10 are feasible),** which also allows for fare and safety checks. The financial impact of fare evasion depends on income structure and effectiveness of such control measures.

Relative scale of impact: Potential income losses range from **€2.2–13.4/bus-hour** depending on cost recovery ratios, compared to expected cost savings of **€28–41/bus-hour** from automation. Therefore, losses are not expected to outweigh savings.

Revenue as % of costs	Revenue (€/bus-hour)	Revenue loss				
		5.00%	10.00%	15.00%	20.00%	25.00%
20%	22.3	-1.1	-2.2	-3.3	-4.5	-5.6
30%	33.4	-1.7	-3.3	-5	-6.7	-8.4
40%	44.6	-2.2	-4.5	-6.7	-8.9	-11.1
50%	55.7	-2.8	-5.6	-8.4	-11.1	-13.9
60%	66.9	-3.3	-6.7	-10	-13.4	-16.7
70%	78.0	-3.9	-7.8	-11.7	-15.6	-19.5
80%	89.2	-4.5	-8.9	-13.4	-17.8	-22.3

With an 80% cost recovery ratio and 10% income loss, the net impact is –€8.9 per bus-hour. Expected savings in phase 3 range from €26–40 per bus-hour.

Automation enables a better service during non peak hours for limited additional costs

Cost structure & Automation: Personnel costs make up **55–75%** of operations, while mileage-related costs (energy + maintenance) are **only 10–15%.** Removing driver costs through automated operations allows buses to run longer and more frequently with only limited extra expense. It also helps to address staff shortage issues.

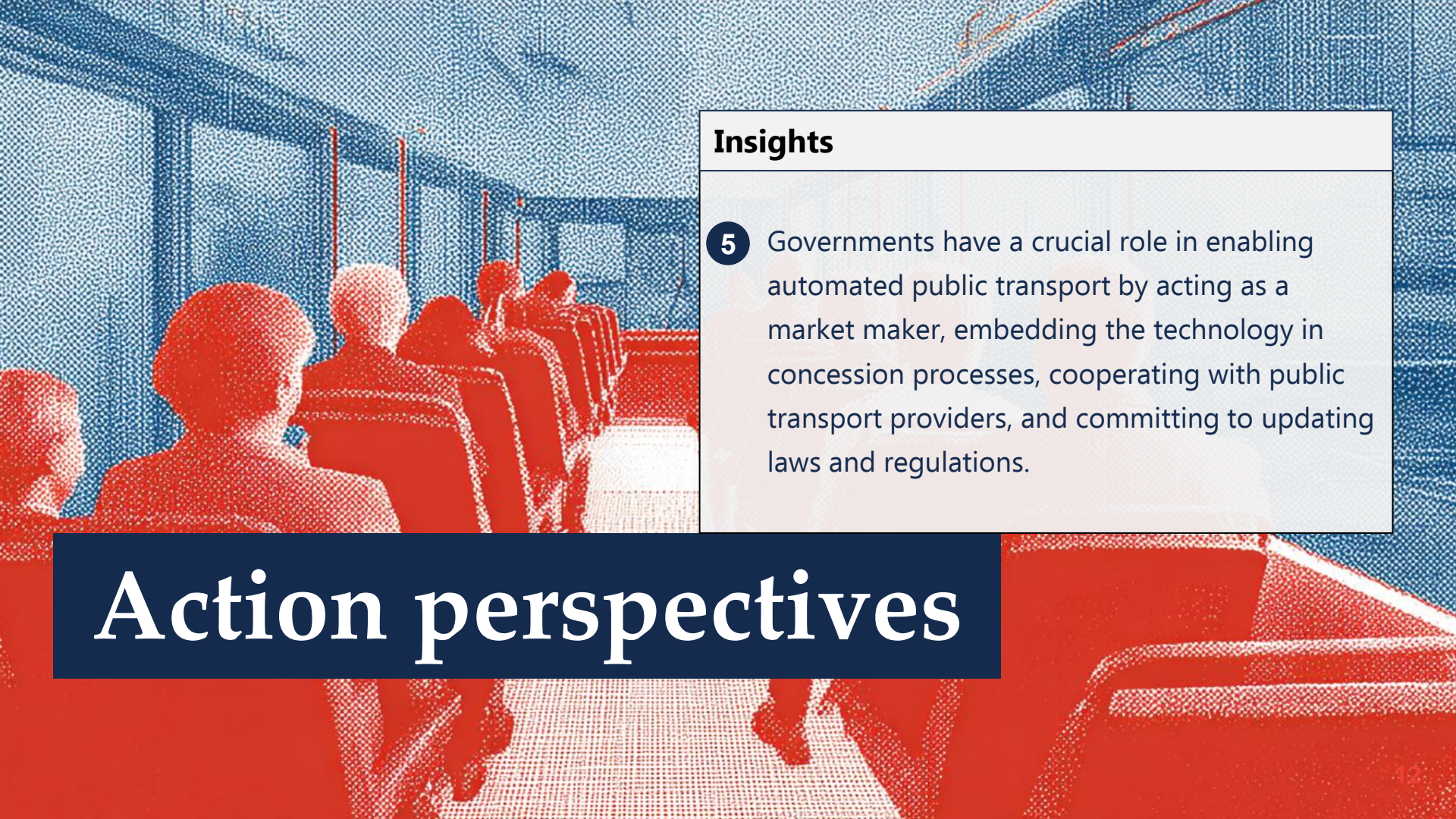
Impact on service quality and demand: More frequent timetables can attract additional passengers, with relatively limited added operational cost.

Assumptions	Conservative scenario	Optimist scenario
Share of daily services at high-frequency	40%	20%
Increase of high-frequency share outside peak hour services due to availability of idle automated fleet	50%	100%
Demand elasticity*	0.2	0.4
REVENUE INCREASE	**2%**	**24%**

Revenue potential

- Increased service could raise income due to lower waiting times during non-peak hours
- In optimistic scenarios this can be done with no additional costs. In the most conservative scenario total costs increase by 8-13%

Recommended elasticity of the Netherlands Institute for Transport Policy Analysis (KiM) from Download: Elasticities of domestic passenger mobility (2024) is 0.3



Action perspectives

Insights

5 Governments have a crucial role in enabling automated public transport by acting as a market maker, embedding the technology in concession processes, cooperating with public transport providers, and committing to updating laws and regulations.

The public sector has a crucial role in next steps

Current barriers
Many legal obstacles remain (authorization, liability, traffic rules). Uncertainty about the timeline for SAE4 automated driving discourages manufacturers, investors, and operators from scaling up.

Need for government action
Without policy direction, market formation will not happen — there is no private market for self-driving public transport. Only governments and concession providers can create demand at scale, as seen in the transition to battery-electric buses.

The cost of opportunity of inaction
If governments do not address regulatory, certification, and implementation challenges now, automated buses will become profitable much later than in leading countries. This will delay economic benefits such as staff shortage relief, service optimization, and cost savings.

RECOMMENDED ACTIONS

Act as a market maker
Provide long-term policy, investment vision, pilots, and co-financing.

Embed automation in concession processes
Set automation requirements or incentives and clear timeline in tenders.

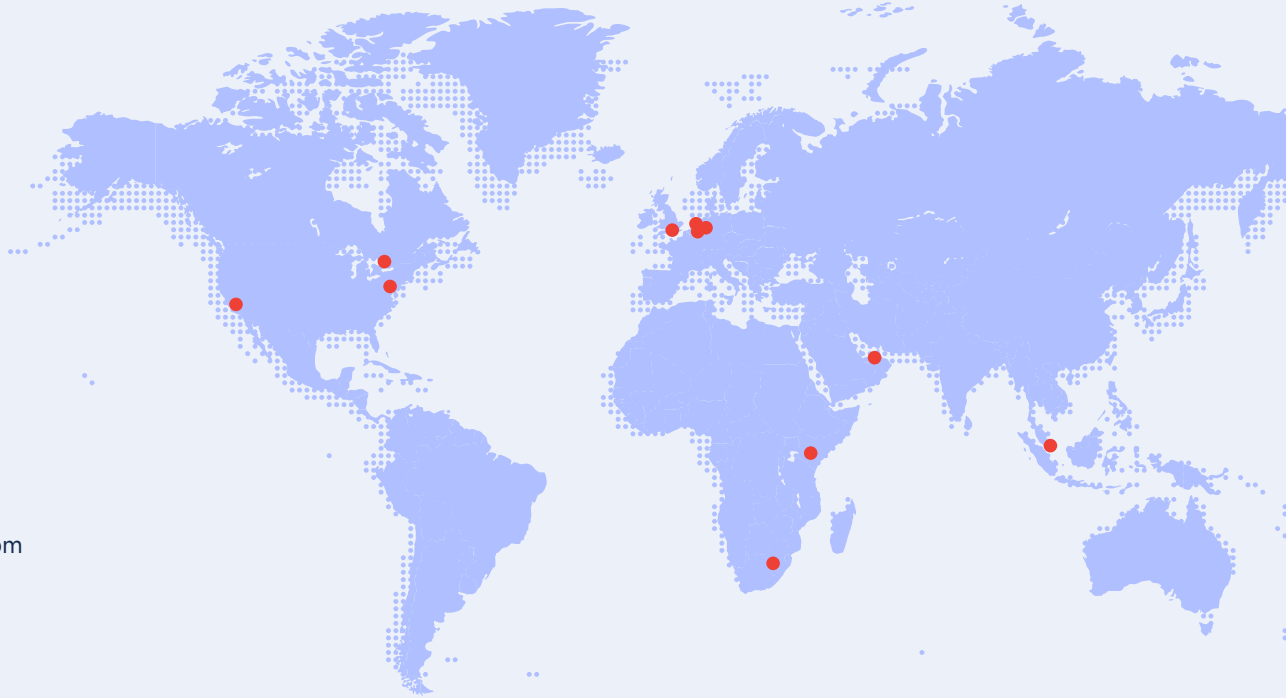
Cooperate with carriers and concessionaires
Let concessionaires identify promising routes. Ask carriers to investigate on which lines automated driving is feasible.

Commit to updating laws and regulations
Ensure that legal framework enables upscaling.

Contact

Koen van Baekel
Koen.vanbaekel@rebelgroup.com

Jan Willem Moesker
Janwillem.moesker@rebelgroup.com



Rebel offices

Rotterdam	**Düsseldorf**	**Antwerp**	**Toronto**	**Nairobi**	
London	**Washington DC**	**San Francisco**	**Johannesburg**	**Dubai**	**Singapore**

NO CHANGE WITHOUT A REBEL