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Executive Summary (1/3)

Autonomous Vehicle (AV) Technology Overview

- The Society of Automotive Engineers defines 6 levels of automation that can be applied to all Autonomous Vehicles
- Additionally, AVs can be classified across four major categories – **passenger AVs, commercial on-road AVs, commercial off-road AVs, and delivery AVs**
- Presently, the passenger AV technology stands between L2-L3, while some players are testing L4; L5 remains several years away; AV development faces challenges from **lack of quality infrastructure, high costs, limited testing, and low customer trust**
- Within commercial off-road applications – **ports, mines, military, and agriculture** use-cases are feasible options to deploy AV technology due to their fixed driving patterns

Key Considerations for AV Rollout

- The **10 key building blocks to establish a breakthrough AV ecosystem** are – 1) R&D Capabilities, 2) Road & Urban Infrastructure, 3) IT, Cyber, & Telecom Infrastructure, 4) Tech Development & Mfg. Capacity, 5) Public Safety & Security, 6) Public Awareness & Engagement, 7) Public-Private Collaboration, 8) Organization & Governance, 9) Laws, Regulations & Incentives, and 10) Business Case Feasibility

Executive Summary (2/3)

Autonomous Vehicle Companies

- AV companies assess certain parameters before entering a market, such as **weather, business case feasibility, government support, and favorable regulations**
  - Once in the market, they invest in **Real Estate, EV Infrastructure, R&D, Human Capital, Policy Making, and Customer Outreach**
- Some of the leaders in the passenger AV market, with millions of driverless miles completed, are – **Waymo** (subsidiary of Alphabet), **Cruise** (investors incl. GM & Honda), and **Motional** (Hyundai & Aptiv JV); they have been operating in **San Francisco, Las Vegas and Phoenix**
- **TuSimple** is a leader in autonomous trucking space, targeting routes in Texas for pilot programs
- Other companies that are also prominent in this space are **Zoox, Aurora Innovation, Nuro, and Pony.ai**

OEMs Positioning in AV Market

- OEMs are currently deploying L2 at scale, while hoping to generate larger returns from L4/L5 by investing in AV operators
  - In Europe, passenger vehicle OEMs are focusing to improve L2 & L3 tech, while commercial OEMs are foraying into L4 AV technology

Autonomous Vehicle Market Readiness

- **Singapore leads AV readiness**, with San Francisco, Las Vegas, and UAE performing relatively well; Netherlands has gaps and **Poland lacks certain initiatives**

Executive Summary (3/3)

Ukraine Overview

Baseline

- Ukraine has **decent R&D and IT capabilities** but lacks **urban infrastructure**, **measures around public engagement and safety**, and currently **has no regulations or policies addressing AV testing, deployment, or commercialization**

Opportunities

- There are several opportunities within the AV space that can be implemented over the course of 5+ years, such as **Robotaxis, Demining Tractors, Farming Equipment, Military Vehicles, Cargo Trucks, Surface Ships/Boats, Testing Hubs, Port Vehicles, Urban Buses/Shuttles, AV R&D Hub, and Mining Vehicles**
  - Considering timeline & opportunity size, Ukraine will benefit most from **demining, farming, trucking, and R&D applications**

Initiatives

- There are several initiatives within the AV space that can be **implemented over short, medium, and long-term**, with a varying degree of impact and investment requirement –
  - Short-Term: Dedicated agency setup, regulation adoption, partnership development, consumer outreach survey
  - Medium-Term: Cybersecurity measures, road improvement, wireless connectivity improvement, public awareness campaigns
  - Long-Term: HD mapping, attract R&D players, strengthen AV talent pool, EV infrastructure investment

Agenda

1. Autonomous Vehicle (AV) Technology Overview
2. Key Considerations for AV Rollout
3. AV Players Overview
4. OEMs Role in AV Technology
5. Market Scorecard for AV Readiness
6. Ukraine Overview
7. Appendix

Agenda

1. **Autonomous Vehicle (AV) Technology Overview**
   - Current Status & Challenges
   - Use-Cases & Applications
     - Agriculture
     - Mining
     - Military
     - Water Vessels
2. Key Considerations for AV Rollout
3. AV Players Overview
4. OEMs Role in AV Technology
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The Society of Automotive Engineers defines 6 levels of automation that can be applied to all Autonomous Vehicles

Levels of Autonomous Driving

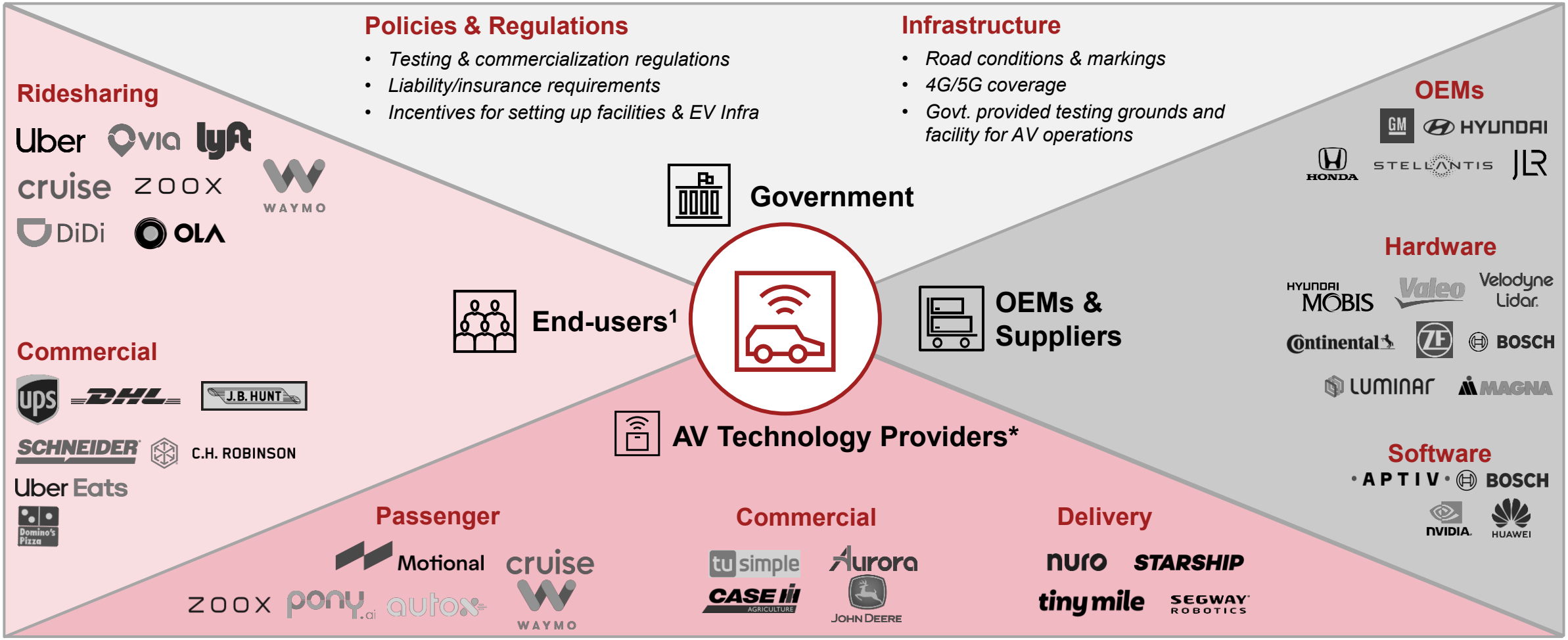
Human → ***Machine***

	Level 0	***Level 1***	***Level 2***	***Level 3***	***Level 4***	***Level 5***
Distribution of Tasks	The driver has full longitudinal and lateral control of the vehicle. Driver has full control.	The driver has longitudinal or lateral control of the vehicle. The vehicle controls the other function.	The driver is responsible for traffic monitoring. The vehicle has longitudinal and lateral control in certain situations.	The driver has to take over with a lead time. The vehicle has longitudinal and lateral control in many situations.	Driverless in certain situations. The vehicle has longitudinal and lateral control in approved situations.	The vehicles controls all tasks; steering wheel and pedals are optional.
Use Case	*Driver Information*	*Driver Support*	*Partial Automation*	*Conditional Automation*	*Driverless in Restricted ODD[1]*	*Vehicle on Demand*
Example Features	• Automatic emergency stop • Blind spot warning • Lane departure warning	• Lane centering **OR** • Adaptive cruise control	• Lane centering **AND** • Adaptive cruise control	Traffic jam chauffeur	• Local driverless taxi • Pedals/steering installation is not required	Level 4 features **+** ability to operate under <u>any condition</u>

Source(s): SAE Website, External Research

AVs are part of a wide ecosystem which involves stakeholders spanning different industry players and government bodies

Autonomous Vehicles (AVs) Ecosystem

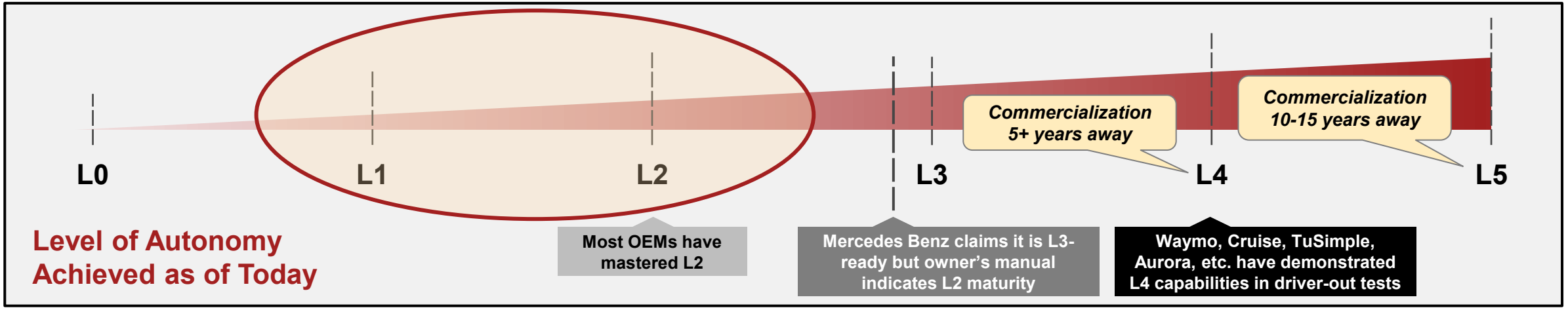


Details on select AV players and their operations are covered later

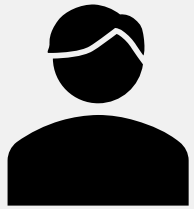
Notes: 1) AVs for private use are not currently explored
Source(s): External Research

Currently, the mass AV technology stands between L2-L3, while some players are testing L4; L5 remains several years away

Current State of AV Technology

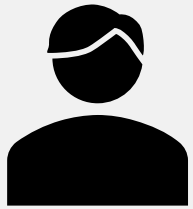


What are the Experts Saying?



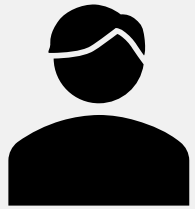
Director of Engg., Robo-taxi Developer

*"We can certainly **make L4 AVs profitable** now. All existing L4 **challenges** can be resolved in the **next 3-5 years,** but **L5 does not make an economic business case** today because **development** is too **expensive**"*



Head of Infra. & Bus. Dev. Robo-taxi Developer

*"**L4 AVs** have been **tested** in **complex urban environments** and **moderate adverse weather**, while **no tests** have been **performed on snow**…but the same difficulties found in AVs would be shared by human drivers"*



Director of Engg., Robo-taxi Developer

*"AVs need to be reliable every time, **almost perfect is not good enough**. Vehicles need to operate as independent units, until technologies such as 5G and V2X are fully reliable"*

Source(s): External Research, Expert interviews

AV technology development faces challenges from lack of quality infrastructure, high costs, limited testing, and low customer trust

Challenges to Faster AV Technology Development

1 Lack of Supporting Infrastructure and Regulations

- **Lack of high-quality roads** with relevant technical infrastructure like smart traffic management systems
- **Lack of sufficient EV charging** infrastructure, specially for fleets, impede investment in newer cities
- **Policy restrictions**, **lack of incentives**, **license suspensions**, etc. keep participants away

2 Lack of All-Weather Compatibility and Limited Testing

- Most testing today is happening in **similar-weather conditions,** delaying development of weather-agnostic AVs
- There is **limited testing in extreme-weather conditions** like snow, extreme heat, etc., due to technological challenges

3 High Development Costs

- **High equipment costs** (LiDar, radar and HD camera), and high HD mapping costs lead to high overall AV development costs
- **Significant development costs** make **L5 autonomy economically unattractive** to OEMs, though experts believe developing L4 profitably is possible

4 Shaky Customer Acceptance

- Most **customers remain wary** of AVs due to **several reported vehicle incidents** involving damage to life and property
- **Unaffordability** to end users also keeps interest of public away
- Several AV **companies have shut down** in past few years, shaking up customer confidence in this tech

Source(s): Expert interviews, External Research

Based on the use-cases attracting most investment, AVs can be classified across four major categories

On-Land Autonomous Vehicle (AV) Applications

Passengers

AVs find natural application in the passenger sector as:

- Robo-taxis
- Public shuttles

Commercial On-road

AVs are widely used within the on-road commercial space in:

- Trucking
- Buses

Commercial Off-road

AVs application are found in the commercial off-road space in:

- Agriculture
- Construction
- Mining equipment

Delivery

AVs can be used as delivery vehicles in several industries:

- Food delivery
- Package & last-mile delivery

Top players:

WAYMO Motional · ZOOX · cruise · EMBARK · kodiak · tusimple · Aurora · JOHN DEERE · ASI · CASE IH AGRICULTURE · FENDT · tiny mile · SEGWAY ROBOTICS · nuro · STARSHIP

And each different AV use-case has unique advantages

Advantages of AV technology

Shared advantages

	Passenger	Commercial On-Road	Commercial Off-Road	Delivery
Time		**Reduced** end-to-end **delivery time**	**Reduction of idle time,** increasing mine production	**Reduced delivery time** & **costs**
Cost	**Cheaper cost per ride,** technology cost offset by labor reduction	**Lower cost/mile** due to removal of human drivers		
Process	**Increased** vehicle **utilization** due to 24/7 operations **Safer roads** with a **reduction in accidents** Increased lane capacity and **reduced traffic congestion**	**Increased** vehicle **utilization** due to 24/7 operations **Safer roads** with a **reduction in accidents** Increased lane capacity and **reduced traffic congestion**	**Increased** vehicle **utilization** due to 24/7 operations	**Increased** vehicle **utilization** due to 24/7 operations **Safer roads** with a **reduction in accidents** Increased lane capacity and **reduced traffic congestion**
Process	**Improved mobility** for elderly and disabled **Parking space optimization** due to less vehicles on the road	**Reduced fuel cost & emissions** by optimizing driving practices	**Improved safety** reducing exposure to hazardous materials **Increased crop yield** due to more **efficient planting** and **harvesting**	**Contactless delivery,** ensuring **enhanced safety** of goods
Environment	**Improved car sharing accessibility, reducing** personal vehicles & emissions			**Reduced emissions** due to electric powered delivery AVs

Source(s): External Research

Due to fixed driving patterns, ports, mines, and agriculture use-cases are good options to deploy AV technology

Opportunity for AV Technology: Ports, Mines and Agriculture

	Agriculture	Construction/Mines	Military/Defense	Ports & Airports
				
AV business case factors:	• **Predictable** and repetitive **driving patterns** for **plowing** & **harvesting** • **Predictable** accessories **utilization** • **Safety concerns** around **human errors**	• **Repetitive hauling** routes **from extraction** to **processing** facility • **Productivity** driven**: cab-less trucks** allow for **greater payload** per leg • **Operator safety,** during hazardous operations	• **Safety driven: Reducing** human **exposure** to **hazards** by **reducing headcount** and **automating operations** • Set **reconnaissance**/patrol **routes**	• **Repetitive** loading **operations** on **standardized containers** • **Predictable baggage route** from aircraft to terminals • **Predictable containers movement** within the port
Use cases:	• *Autonomous tractors* • *Autonomous combines* • *Autonomous mowers*	• *Autonomous trucks* • *Autonomous dozers* • *Autonomous drills*	• *AV for container transport* • *Autonomous combat support vehicles*	• *Autonomous cranes* • *AV container trucks* • *AV baggage tractors*
Sample players:	JOHN DEERE, FENDT, SABANTO, CASE IH AGRICULTURE	VOLVO, KOMATSU, CATERPILLAR, ASI, LIEBHERR	Raytheon Technologies, OSHKOSH, RHEINMETALL, gm DEFENSE	Venti, NAVTECH RADAR, navya

Technology details on upcoming slides

Source(s): External Research

Within Agriculture, AV development includes – specialized machines, retrofit kits, and autonomous tractors

Autonomous Technology in Agriculture (1/2)

Autonomous tractors

A few players in the agricultural space are developing autonomous cab-less tractors to be deployed in a wide variety of applications.

Technology:

- **PTO** and **hydraulics** equipment to allow for compatibility with existing accessories.
- Equipped with **LiDAR**, **Ultrasonic** sensors and **Radars.**

Specialized machines

Specialized AVs are used in agriculture in weeding, sowing, seeding and spraying.

Technology:

- Each vehicle is engineered to complete a specific application, thus **cannot perform other tasks**.
- Equipped with **AI** and **cameras** to identify weed from crops, useful for both weeding and spraying.
- Accurate positioning and obstacle detection are endured by **LiDAR** and **RTK GPS** technologies.

Retrofit-kits[1]

AV players are developing kits compatible with common platforms to enable autonomous capabilities on existing vehicles.

Technology:

- Maintains **same characteristics** of **standard platform**, ensuring compatibility with existing accessories.
- Allows for **ability to manually operate the machine,** enabling road transfers.
- Path following is ensured by **cameras**, detection **sensors** and **GNSS** positioning while real time vide feed is ensured via software.

Note: 1) Technology bundle that enables autonomous capabilities on an existing vehicle platform
Source(s): External Research

There are several AV players working on agriculture, with most of them offering mature technology

Autonomous Technology in Agriculture (2/2)

Company	HQ	Equipment type	Function	Fuel	Maturity	Partnerships
efarm.pro	Ukraine	AV tractor	De-mining	-	Concept	-
AGROINTELLI	Denmark	Specialized machine	Seeding, weeding, ridging, spraying	Diesel	Commercial	-
GUSS	USA	Specialized machine	Automated sprayer	Diesel	Commercial	JV with **John Deere**
AGXEED	Netherlands	AV tractor	Cab-less tractor	Diesel	Commercial	Minority stake investment from **CLAAS**
AMOS	USA	AV tractor	Cab-less tractor	Electric	Prototype	-
BEAR FLAG ROBOTICS	USA	AV tractor	AV Retrofit kit for John Deere	Diesel	Commercial	Acquired by **John Deere** for $250M in 2021
BLUE RIVER TECHNOLOGY	USA	Specialized machine	Automated sprayer	-	Commercial	Acquired by **John Deere** for $305M in 2017
HORSCH	Germany	Specialized machine	Planter	Diesel	Prototype	-
RAVEN	USA	Specialized machine	AV Retrofit for CASE Spreader	Diesel	Prototype	-
FARMDROID	Denmark	Specialized machine	Weeding/sowing	Electric	Commercial	-
SABANTO	USA	AV tractor	AV Retrofit kit for Kubota M5	Diesel	Commercial	-
naïo Technologies	France	Specialized machine	Weeding/sowing	Electric	Commercial	-
CARRÉ	France	Specialized machine	Weeding	Electric	Commercial	Capacites (University of Nantes)

Source(s): Company Website, External Research

Within Mining, AV development focuses on autonomous hauling trucks, with cab-less concepts and OEM compatible Retrofit kits

Autonomous Technology in Mining (1/2)

Cab-less hauling trucks

- **Few players** in the mining space are **focusing** on **cab-less hauling** vehicles thanks to their optimal cargo-space utilization resulting from the cabin removal
- Even though this technology shows **significant interest** from trucking and mining OEMs, **most** of the **innovations are** at a **concept level.**

Retrofit-kits

- Most OEMs are **leveraging pre-existing platforms** to enter the autonomous mining space
- Few **AV players** in this space are **developing retrofit kits** compatible with several quarry vehicles such as hauling trucks, dozers, drills and excavators manufactured by different OEMs.

Source(s): External Research

There are several OEMs active within mining, with few pure AV players which are commercially mature

Autonomous Technology in Mining (2/2)

Company	HQ	Equipment type	Function	Fuel	Maturity	Partnerships
ASI	USA	Mining vehicles	AV Retrofit kit	-	Commercial	-
LIEBHERR	Switzerland	Hauling truck	AV Retrofit	-	Commercial	**ASI** (AV-tech): development agreement
VOLVO	Sweden	Hauling truck	Cab-less truck	Electric	Testing	**Aurora** (AV-tech): development agreement **Waabi** (AI): minority stake investment
KOMATSU	Japan	Hauling truck	AV Retrofit	-	Commercial	**Toyota**: Development agreement for ALV[1]
SafeAI	USA	Hauling truck	AV Retrofit	-	Commercial	**Siemens**: To retrofit 300 AV electric fleet for construction company Obayashi
BELAZ	Belarus	Hauling truck	AV Retrofit Cab-less truck	-	Commercial Concept	**Zyfra** (AV-tech): development agreement
SCANIA	Sweden	Hauling truck	Cab-less truck	Biofuel	Concept	**Scantinel Photonics** (LIDAR): minority stake investment
CATERPILLAR	USA	Hauling truck	AV Retrofit AV Retrofit kit	-	Commercial	-
zyfra	Finland - Russia	Mining vehicles	AV Retrofit kit	-	Commercial	-
KAMAZ	Russia	Hauling truck	Cab-less truck	-	Concept	-

Caterpillar reports selling AV retrofit kits as a **separate offering** from its core machinery.

Notes 1) Autonomous Light Vehicle for mining applications
Source(s): Company Website, External Research

Within military applications, AV development is focused in two main areas: transport trucks and combat-support vehicles

Autonomous Technology in Military Applications (1/2)

Combat-support vehicles

- **Defense contractors** and **developing** specialty vehicles for various military applications such as **mine-sweeping**, **combat support** or **reconnaissance**
- These vehicles are developed to **increase safety** for **military personnel** where even though **still needed** can be **reduced in number**.

Transport trucks

- Similar to the mining industry, most large **defense contractors** are **leveraging pre-existing platforms** to **retrofit autonomous capabilities**
- Among the current programs for autonomous transport, the **majority has** already **been deployed** or has **reached** the **testing phase.**

Source(s): External Research

Several defense contractors are developing AV for military applications, with the majority located between the US and Germany

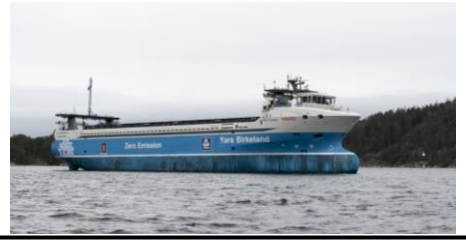
Autonomous Technology in Military Applications (2/2)

Company	HQ	Equipment type	Function	Maturity	Partnerships / Investment
OSHKOSH	USA	Mine-sweeper	De-mining	Testing	-
OSHKOSH	USA	Truck	Transport	Deployed	-
	Czech Republic	Truck	Transport	Testing	**University of Ostrava**, **Valeo**: R&D agreement
AM GENERAL MISSION READY ★ FUTURE DRIVEN	USA	Light vehicle	Passenger	Announced	-
Raytheon Technologies	USA	Combat vehicle	Combat	Announced	**Rheinmetall**: Development agreement
RHEINMETALL	Germany	UGV[1]	Infantry support	Deployed	-
gm DEFENSE	USA	Truck	Transport	Deployed	**Rheinmetall**: Development agreement
DIEHL Defence	Germany	UGV[1]	Infantry support	Testing	-
SAFRAN	France	Light vehicle		Announced	**Valeo**, **PSA:** Development agreement
kodiak	USA	Undisclosed	Reconnaissance	Announced	**$50M** from **Department of Defense** over 24 months to develop **next generation AV** for **US Army**

Notes: 1) Unmanned Ground Vehicle
Source(s): Company Website, External Research

Aside from on-land applications, autonomous vehicles are starting to break ground for water applications

Autonomous Technology in Water Vessels

	Autonomous ships	Autonomous underwater vehicle
		
General definition:	**Maritime Autonomous Surface Ships (MASS)** are **autonomous vessels** mostly **designed** for **commercial** cargo **purposes.**	**Autonomous Underwater Vehicles** (AUV) or **Unmanned Undersea Vehicles** (UUV) if used in military applications are an **evolution** of **remotely operated underwater vehicles**.
Autonomy degrees:	MASS degrees of autonomy by Int'l Maritime Organization (IMO)**:** 1. **Crewed** ship with automated processes and decision support 2. **Remotely controlled** ship **with seafarers** on board 3. **Remotely controlled** ship **without seafarers** on board 4. **Fully autonomous** ships	**Not** currently **standardized**
Use cases:	• *Autonomous bulk cargo vessels* • *Autonomous containers ships*	• *Research: reef monitoring* • *Commercial: seabed mapping*
Sample players:	• *VN Rebel (France) – autonomous merchant ship* • *Iris Leader (Japan) – autonomous vehicle carrier* • *Yara Birkeland (Norway) – autonomous cargo ship*	• Woods Hole Oceanographic Institution • ECA Group • Boeing Eco-Voyager

Besides research purposes, both applications have extremely limited commercial projects and players worldwide

Source – External Research

Agenda

1. Autonomous Vehicle (AV) Technology Overview
2. **Key Considerations for AV Rollout**
   – 10 Key pillars
3. AV Players Overview
4. OEMs Role in AV Technology
5. Market Scorecard for AV Readiness
6. Ukraine Overview
7. Appendix

Ukraine needs to consider capabilities across 10 key building blocks critical to establish a breakthrough AV ecosystem

Synchronizing the 10 building blocks is critical to establishing a breakthrough AV ecosystem

1 R&D capabilities

Invest and ensure constant innovations. Ensure local incubators are engaged in AV development

Create an environment with of tools and (IP) protections to attract leading innovators

2 Road and urban infrastructure

Develop dedicated testing infrastructure as new urban concepts are designed to support global testing reqd.

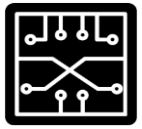
Develop areas and cities with controlled, scenario-based testing environments

3 IT, cyber and telecom infrastructure

Develop necessary IT and communication infrastructure while establishing strong cybersecurity alliances

Utilize strong IT & cyber foundations to drive development of new capabilities

4 Tech development & manufacturing capacity



Grow capacities for hardware manufacturing and software development (e.g., data collection, AI)

Develop innovation parks with cross-functional capabilities related to AV tech

5 Public safety and security

Educate the general public around safety and security elements of autonomous vehicles to accelerate adoption

Promote advanced STEM education while attracting and retaining critical talent pools

6 Public awareness and societal engagement

Increasing public awareness combined with active engagement of society in development of autonomous infrastructure

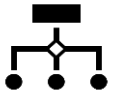
Utilize PR campaigns, mass media instruments to drive excitement for AVs

7 Public and private collaboration

Ensure public - private collaboration to innovate, develop enablers and formulate regulations

Define how to engage and attract the private sector throughout the value chain

8 Organization & governance



Develop Centers of Excellence and an unambiguous governance framework for effective decision making

Define roles and responsibilities for various public and private entities

9 Laws, regulations & incentives

Formulate the necessary laws, regulations, standards, and rules for financial incentives (e.g., funds, tax relief)

Define regulatory framework to protect, strengthen, and drive AV adoption

10 Business Case Feasibility

Workout financing mechanisms, attract global investment and steer deployment of public funds

Develop necessary relationships, tools and platforms to attract key investors

R&D Capabilities include a region's technical capabilities, indicated by presence of innovation centers, talent, patents and ongoing testing

AV Readiness Evaluation Metrics (1 of 10)

1. R&D Capabilities

Metric Elements		Description	Criticality to AV[1]
1.1	R&D Centers/ Innovation Hub	Presence of R&D centers or innovation hubs focused on AV development	2
1.2	AV-related Patents	# of AV-related patents originating from the region	1
1.3	Talent Pool	Availability of AV-trained talent, including engineers, vehicle drivers or operators, repair technicians, etc.	3
1.4	Testing / Commercial Ops In Progress	Testing / Commercial operations in progress or openness to commence	4

Key Considerations

R&D Centers/ Innovation Hub:

- Presence of local R&D centers enables faster and more complex research & testing, however, is not highly critical to drive AV adoption

AV-related Patents:

- Similar to R&D, experts don't believe companies need to grow expertise independently in target regions, hence may not plan to invest in R&D everywhere, leading to low # of patents may be filed from the region

Talent Pool:

- Availability of local talent saves costs of relocating expensive R&D talent to target countries for long periods
- It is also critical for overall AV development in region that talent pool is trained in advanced technologies like AI, ML that AVs work on
- Tie-ups between local universities and industry are a strong enabler too

Testing / Commercial Ops In Progress:

- Ongoing testing or commercial operations are an accelerator to attract more AV investments and companies
- In regions with no testing currently, indication of openness to commence testing through support commitments, regulations, etc. can invite AV cos

Note: 1) Criticality to AV indicates the extent to which the respective metric element can influence a company's decision to invest on AV development in the target region

Source: (1) Company websites, Press releases, External Research, Expert interviews

1	2	3	4
Good to have	Somewhat critical	Moderately critical	Highly critical

Road and Urban Infrastructure metrics include road quality, EV charging points and smart traffic management systems

AV Readiness Evaluation Metrics (2 of 10)

2. Road and Urban Infrastructure

Metric Elements		Description	Criticality to AV[1]
2.1	**Quality of Roads**	Indicative of road surface quality and pothole density	1
2.2	**Traffic control enablers**	Lane markings and dynamic or static traffic/road signs on the roads	1
2.3	**Real Estate Availability**	Real estate to build parking spaces for AV fleets, R&D center, office, etc.	4
2.4	**EV Charging infrastructure**	# of EV charging points per capita or per mile basis	4
2.5	**Cooperative Intelligent Transport Systems (C-ITS)** or **Smart Traffic Management Systems**	• C-ITS includes intelligent transport systems for V2X, direct and Dedicated Short-Range Communications ITS Generation 5 (DSRC/ITS-G5) technologies • C-ITS accuracy can be enhanced by Global Navigation Satellite System (GNSS), Differential GNSS (DGNSS) or real-time kinematic (RTK) positioning systems	2

Note: 1) Criticality to AV indicates the extent to which the respective metric element can influence a company's decision to invest on AV development in the target region

Source(s): Zutobi Worst and Best Roads – U.S. and International ranking 2022, Singapore Land Transport Authority – EV Vision, ChargeHub, Teletrac Worst Maintained Roads 2023, San Francisco Metropolitan Transportation Commission Intelligent Transportation Systems (ITS) website, Traffic Technology Today, Company websites, Press releases, External Research, Expert interviews

Key Considerations

Roads:

- Though no need of building new specialized roads for AV, they should be free from potholes, have even surface and consistent profile
- Road quality indices are a good indicator of such measures

Traffic Control Enablers:

- Traffic rules and signs vary across geographies, so standardizing their design is key for developers to be able to design an efficient AV system

Real Estate Availability:

- AV fleets need dedicated and protected spaces to park fleets
- Developer companies are likely to setup R&D centers, offices or operating bases in target regions, requiring substantial real-estate

EV Charging:

- AV fleets require a robust EV charging network with dedicated stations that can serve fleets of large sizes without impacting local citizens

C-ITS:

- Highest levels of accuracy of V2X used by smart traffic management systems can be achieved by supplementing with technologies like DGNSS and RTK, so, must be invested in for AV adoption at scale

1	2	3	4
Good to have	Somewhat critical	Moderately critical	Highly critical

IT & Telecom Infrastructure metrics include internet speeds, cybersecurity and high-definition maps availability

AV Readiness Evaluation Metrics (3 of 10)

3. IT, Cyber and Telecom Infrastructure

Metric Elements		Description	Criticality to AV[1]
3.1	Wireless connectivity and internet speeds	4G and 5G penetration	3
3.2	Cybersecurity	Cybersecurity index ratings, indicative of quality of cybersecurity measures in place, in the country	4
3.3	HD Digital Maps	HD digital maps of highways, motorways, city streets, etc.	4

Key Considerations

Internet Connectivity and Speeds:

- Most AVs today store testing data on a hard-drive onboard, however, hi-speed internet (4G considered sufficient today) is required for real-time uploads and fast V2X communication with smart traffic systems.
- As AVs grow in volume (10+ years), higher speeds and more small cells will be required to serve the higher volume, making 5G preferred then

Cybersecurity:

- AVs being data-heavy equipment, require highest levels of data protection measures in place
- Countries must rank high on industry-wide accepted cybersecurity evaluations, for which having robust cybersecurity regulations, relevant protocols in place and a dedicated certifying or governing body are key

HD Digital Maps:

- Although creation of HD maps is expensive, AVs will heavily rely on HD maps for safe and efficient driving
- Therefore, nation-wide HD maps coverage in the long-run will be critical for higher adoption
- Enablers should be in place to update maps real-time when temporary traffic disturbances or road layout changes happen

Note: 1) Criticality to AV indicates the extent to which the respective metric element can influence a company's decision to invest on AV development in the target region
Source(s): NCSI by e-Governance Academy Foundation, nPerf Speed Test, Verizon, SingTel, Nvidia, Cyient, Orbit GT, Company websites, Press releases, External Research, Expert interviews

1	2	3	4
Good to have	Somewhat critical	Moderately critical	Highly critical

Tech development metrics for a region are assessed by penetration of new technologies, and the total AV-related R&D investments so far

AV Readiness Evaluation Metrics (4 of 10)

4. Tech Development & Manufacturing Capacity

Metric Elements		Description	Criticality to AV[1]
4.1	R&D investments by Industry	R&D investments made or committed by firms to set up R&D facilities dedicated to AV, conduct AV-related research, test or pilot AVs, hire or develop AV talent pool in the region, etc.	3
4.2	Next-gen Tech Adoption	Adoption and development of AI, Cloud and IoT tech in country	3

Key Considerations

R&D Investments by Industry:

- Experts believe it is not necessary for a company to setup fresh R&D powerhouses in all its AV-target geographies, however, their experts and testing teams must temporarily be relocated to ensure smooth roll-outs
- Overall, higher the cumulative AV-focused R&D investments announced by companies till date in a region, easier for such regions to attract more AV testing and faster adoption in the future

Next-gen Tech Adoption:

- Higher adoption of next-gen technologies like AI, ML, etc. in a region ensures better talent pool availability and higher public acceptance of applications built using such technologies
- Regions ranking higher on industry-wide accepted evaluations of such technologies' adoption indices have an opportunity to gain more
- Market sizes of these technologies in a country are also a good measure

Note: 1) Criticality to AV indicates the extent to which the respective metric element can influence a company's decision to invest on AV development in the target region

Source(s): IDC, Forrester, S&P Global, Company websites, Press releases, External Research, Expert interviews

1	2	3	4
Good to have	Somewhat critical	Moderately critical	Highly critical

Public safety and security are determined by presence of steps to ensure safety of life and property of the public

AV Readiness Evaluation Metrics (5 of 10)

5. Public Safety & Security

Metric Elements		Description	Criticality to AV[1]
5.1	Incident Liability Frameworks	Framework clearly defining who owns liability in case of accidents or serious traffic disturbances	1
5.2	Insurance Landscape	Insurance policies developed and in-use for AVs	4

Key Considerations

Incident Liability Frameworks:

- Regulatory or guidance frameworks should exist that clearly define scenario-based decisions on who are the liability-owners in which situation – the OEM, the AV software developer, the vehicle owner, or another relevant party

Insurance Landscape:

- Insurance policies clarify when the insurance-company is liable to pay for damages, versus any other party defined in the incident liability framework or otherwise
- Generally, AV developers are expected to insure against any damages caused by their vehicles, however, such requirements can vary by region
- Insurance companies are likely to tailor policies further once commercial adoption deepens

Note: 1) Criticality to AV indicates the extent to which the respective metric element can influence a company's decision to invest on AV development in the target region

Source: (1) Company websites, Press releases, External Research, Expert interviews

1	2	3	4
Good to have	Somewhat critical	Moderately critical	Highly critical

Public awareness and acceptance metrics revolve around public's awareness and potential openness to adopting AVs

AV Readiness Evaluation Metrics (6 of 10)

6. Public Awareness & Societal Engagement

Metric Elements		Description	Criticality to AV[1]
6.1	Consumer Acceptance Surveys	Govt or private-player surveys assessing public sentiment and awareness levels of AV	1
6.2	Public Awareness Campaigns	Public awareness campaigns by govt or private players	1
6.3	Public Sentiment	Consumer and local media / tech influencer sentiment on AV	2
6.4	Ride-hailing Adoption	Ride-hailing app / online taxi service booking penetration	3
6.5	Share of Population near Testing Sites	# of people living in areas where testing being done and test AV are visible to them; safety-proving demos or trials conducted for public	1

Key Considerations

Consumer Acceptance Surveys:

- Consumer surveys are early indicators of public interest and linked to business case of AVs in a region, so evidence of such surveys help cement investor and developer interest in the region

Public Awareness Campaigns:

- Awareness campaigns are key to boosting public confidence in new tech

Public Sentiment:

- Existing public sentiment can be influenced by several means, including news about incidents, social media and influencer driven perception, etc.
- Positive sentiment is important for AV business case to hold true

Ride-hailing Adoption:

- Adoption of ride-hailing services (e.g., Uber) are directly linked to success of robotaxi in a region, which are generally the first use-case of AVs to be adopted, therefore remain moderately critical

Share of Population near Testing Sites:

- Regular visibility of AVs under testing make public familiar with their presence and help boost positive public sentiment, however, remains a good-to-have as there are other stronger ways to influence sentiment

Note: 1) Criticality to AV indicates the extent to which the respective metric element can influence a company's decision to invest on AV development in the target region

Source: (1) Company websites, Press releases, External Research, Expert interviews

1	2	3	4
Good to have	Somewhat critical	Moderately critical	Highly critical

Public-private collaboration is all about industry and government coming together to jointly develop AV ecosystem

AV Readiness Evaluation Metrics (7 of 10)

7. Public & Private Collaboration

Metric Elements		Description	Criticality to AV[1]
7.1	Public & Private Collaboration	Collaboration between infrastructure operators, AV developing companies and government or institutions	2

Key Considerations

Public & Private Collaboration:

- Though not highly critical, collaboration between government authorities and industry players to formulate and publish AV standards, policies, develop infrastructure, conduct HD mapping, etc. eases financial pressure on industry players
- Such collaborations also instill stringer public confidence in the new tech
- Evident openness of governments to collaborate with private players to jointly develop AV ecosystem is important to attract more investments

Note: 1) Criticality to AV indicates the extent to which the respective metric element can influence a company's decision to invest on AV development in the target region

Source(s): Company websites, Press releases, External Research, Expert interviews

1	2	3	4
Good to have	Somewhat critical	Moderately critical	Highly critical

Dedicated government agency to govern and enable accelerated AV development, and a progressive government are important

AV Readiness Evaluation Metrics (8 of 10)

8. Organization & Governance

Metric Elements		Description	Criticality to AV[1]
8.1	Dedicated Government Agency Set-up	• Dedicated government agency setup as single PoC for all regulatory matters, policies, approvals, decisions, etc., • Clear roles and responsibilities of key personnel in the position(s) holding decision making powers defined	3
8.2	Government Readiness to Change	• A measure of how open is the government to adoption of new technologies like AV • Active interest in AV policy-making, positive opinions expressed in public commentary, AV whitepaper roll-outs, public vote gathering, etc. show readiness for change	2

Key Considerations

Dedicated Government Agency Set-up:

- AVs are expected to remain a highly regulated sector till large-scale commercial adoption picks up, which is at least a decade away
- In such a scenario, a dedicated agency that acts as single point of contact to formulate and govern the AV ecosystem is very critical
- The org structure and roles & responsibilities of all key personnel in such an agency must be clearly laid out, especially the personnel holding decision-making powers

Note: 1) Criticality to AV indicates the extent to which the respective metric element can influence a company's decision to invest on AV development in the target region

Source: Secondary Study, Company websites, Press releases, External Research, Expert interviews

1	2	3	4
Good to have	Somewhat critical	Moderately critical	Highly critical

Laws, Regulations and Incentives cover all legal instruments required to enable smooth roll-out and functioning of AVs in a region

AV Readiness Evaluation Metrics (9 of 10)

9. Laws, Regulations and Incentives

Metric Elements		Description	Criticality to AV[1]
9.1	AV regulations	Existence of AV-focused regulations guiding R&D, testing, manufacturing and use of AVs in the region	3
9.2	Govt. Grants and Incentives	• Government grants or incentives for R&D, manufacturing and sales of AV • Incentives to buyers (e.g., discounts or tax waivers)	2
9.3	Courts / Grievance redressal Tribunal setup for AV	Dedicated grievance redressal court or regulatory body for AV related matters for faster resolution	1

Key Considerations

AV Regulations:

- Comprehensive set of regulations including AV-related policies, guidelines, processes, permissions, limits, liabilities, etc. which enable and drive R&D, manufacturing, testing and adoption of AVs in the region are key to attracting AV companies to a region
- The respective country's data protection law should also contain section(s) tailored for AVs to protect consumer data generated by AV

Govt. Grants and Incentives:

- AV development is expensive, therefore, government support to developers in the form of grants, rebates or incentives are important
- In the long-run, incentives like tax rebates or govt. sponsored discounts on purchase of AVs will attract end-consumer interest

Courts or Grievance Redressal:

- AV-related accidents are expected to increase as their development and testing increase globally, and such cases are bound to be complex in nature. However, slow redressal of such cases will decelerate and, in some cases, kill chances of AV adoption in a region
- For faster and prioritized redressal, governments must setup dedicated grievance redressal tribunals or courts to handle complex AV cases

Note: 1) Criticality to AV indicates the extent to which the respective metric element can influence a company's decision to invest on AV development in the target region

Source: (1) Company websites, Press releases, External Research, Expert interviews

1	2	3	4
Good to have	Somewhat critical	Moderately critical	Highly critical

Business case metrics primarily include existing investor activity and evidence of possible returns in the foreseeable future

AV Readiness Evaluation Metrics (10 of 10)

10. Business Case Feasibility

Metric Elements		Description	Criticality to AV[1]
10.1	Feasibility studies	Past, ongoing or planned studies on AV business case for the country or region	1
10.2	Return on Investments	• Scale of returns on investment • Timeline of returns on investment turning positive	4
10.3	Existing Investor Activity	• Private Equity participation • Evidence of M&A deals in the market • Scale of existing investments on AV development	2

Key Considerations

Feasibility studies:

- Evidence of feasibility studies indicates interest of the region in exploring AV technology and stands to invite AV investments
- Government-sponsored studies assure industry players of positive regulatory environment, and are therefore beneficial, although privately funded studies can also play an important role

Return on Investments:

- Substantial market size (TAM), which depends majorly on a region's population, and a solid business case clearly proving possible scale of returns on investments, their NPV and timeline to achieve break-even are a go/no-go decision influencer
- Regional weather conditions also impact the level of testing and related costs required, impacting the business case
- Therefore, positive and multi-x returns in foreseeable future are highly critical to attract AV companies to a region

Existing Investor Activity:

- Existing interest from PE in the form of existing or announced investments and M&A deals showcase confidence of investors in the region's strength as an AV-ready market

Note: 1) Criticality to AV indicates the extent to which the respective metric element can influence a company's decision to invest on AV development in the target region

Source(s): Company websites, Press releases, External Research, Expert interviews

1	2	3	4
Good to have	Somewhat critical	Moderately critical	Highly critical

Agenda

1. Autonomous Vehicle (AV) Technology Overview
2. Key Considerations for AV Rollout
3. **AV Players Overview**
   - 3.1 Company Profiles
     - Cruise
     - Waymo
     - Motional
     - Zoox
     - TuSimple
     - Aurora
   - 3.2 Decision Factors & Investments
4. OEMs Role in AV Technology
5. Market Scorecard for AV Readiness
6. Ukraine Overview
7. Appendix

The top players in the AV industry can be divided into three categories – leaders, followers, and laggards

Industry Player Classification

Leaders	cruise, tusimple, WAYMO, Motional
Followers	nuro, EMBARK, Aurora, STARSHIP, kodiak, ZOOX
Laggards	autox, tinymile, pony.ai, EMBARK

Company profiles for highlighted players are shared on upcoming slides

Discussion

- Industry players can be classified into three categories – leaders, followers, and laggards based on the following attributes identified:
  - Total Miles Driven
  - Difficulty of Testing Cities
  - Strength of Relationships
  - Hardware and Software Expertise
  - Start of Autonomous Development
  - Pilot / Expected Commercial Launch
  - Capital Raised / Invested
  - Fleet Size
- Tesla is not included within this group as they have a unique approach to developing autonomous capabilities that relies on cameras rather than LIDAR

Cruise has already begun testing outside of US and remains one of the leading players in Autonomous Vehicles market

Company Profile – Cruise Overview

About The Company

HQ	Fleet size	Funding	Employees
San Francisco, CA	**~400** (US-only) + **5** (Dubai – testing only)	**$15.1B**	**2,943 as of 2022** (Up 29% from 2,288 in 2021)

Autonomous Technology Headway

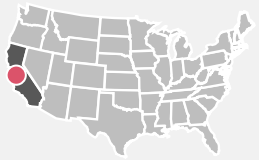
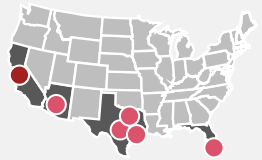
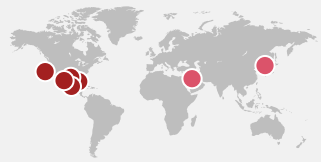
Autonomy Achieved	Driverless Miles	Patents
L4 (Driver-out AV driving)	• **3M+ miles driven** • Test miles not available	**1,084** (awarded and pending)

Relationships

Partnerships	Investors
OEM Partners: gm, HONDA **Ride-hailing Partners:**	gm, HONDA, Microsoft, Walmart + financial investors

Commercialization Plan

Commercialized | Testing

Phase 1 2013 - 2016	Phase 2 2017 - 2022	Phase 3 2023+
		
US: CA (San Francisco)	**US: CA, TX, AZ, FL** (Austin, Houston, Dallas, Phoenix, Miami)	**Global:** **Japan** (Tokyo), **UAE** (Dubai)
<100 AVs	**100-500 AVs**	**500+ AVs**

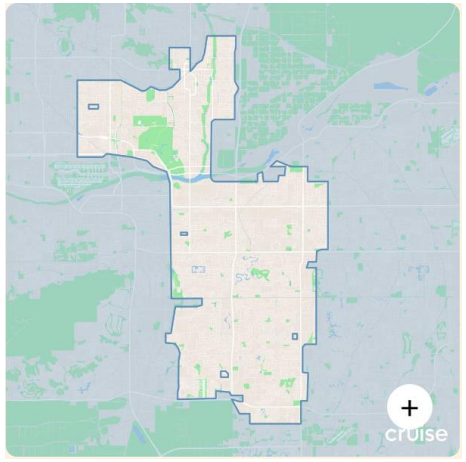
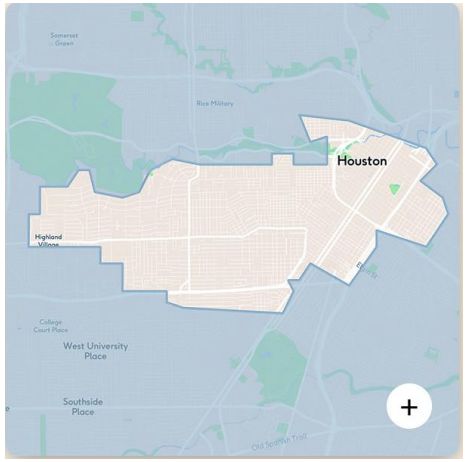
Key Milestones by Phase

Phase 1 2013 - 2016	Phase 2 2017 - 2022	Phase 3 2023+
• Founding • First AV tech retrofit to a car • Acquisition by GM in 2016	• AV testing by staff • Honda $750M + $2B commitment • Origin car unveiled • Announced in-house chip development • Launch for public in SF	• Authorized to operate publicly and monetize 24/7 in California • Origin AV to begin production at FactoryZero • Announced testing in Tokyo and Dubai

Notes: Phase-wise focus regions according to California Public Utilities Commission Resolution 09/10/23
Source(s): Cruise website, S&P Capital IQ, Crunchbase

Barring San Francisco, Cruise has restrictions on operating hours; license remains suspended in SF following an accident

Company Profile – Cruise Areas of Operation

	Austin, TX	Phoenix, AZ	Houston, TX	San Francisco, CA
Zoning restrictions				**Currently suspended**
Time restriction for monetization	9PM-5AM	9PM-5AM	9PM-6AM	24/7[1]

Notes: 1) As authorized by CPUC 08/10/23 Resolution
Source(s): Cruise website

Waymo is the pioneer and market leader in autonomous vehicles, currently running robotaxi services in US

Company Profile – Waymo Overview

About The Company

HQ	Fleet size	Funding	Employees
Mountain View, CA	**~250** (San Francisco only)	**$5.5B**	**~2,500**

Autonomous Technology Headway

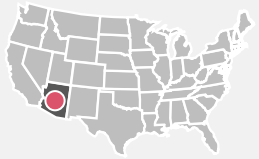
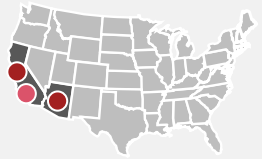
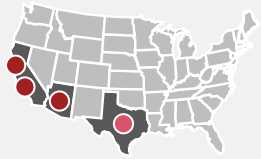
Autonomy Achieved	Driverless Miles	Patents
L4 (Driver-out AV driving)	• **1M+** miles **driven** • **20M+** miles **tested** • **20B+** miles **simulated**	**3,476** (awarded and pending)

Relationships

Partnerships	Investors
OEM Partners: JLR, Stellantis **Ride-hailing Partners:** Uber, Lyft - until 2020	Alphabet, MAGNA, AutoNation + financial investors

Commercialization Plan

Commercialized | Testing

Phase 1 2009 - 2015	Phase 2 2015 - 2022	Phase 3 2023+
		
US: AZ (Phoenix)	**US: AZ, CA** (Phoenix, San Francisco, Los Angeles)	**US: AZ, CA, TX** (Phoenix, San Francisco, Los Angeles, Austin)
<100 AVs	**100-250 AVs**	**250+ AVs**

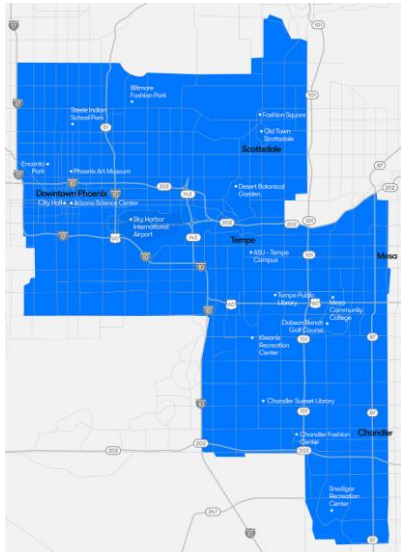
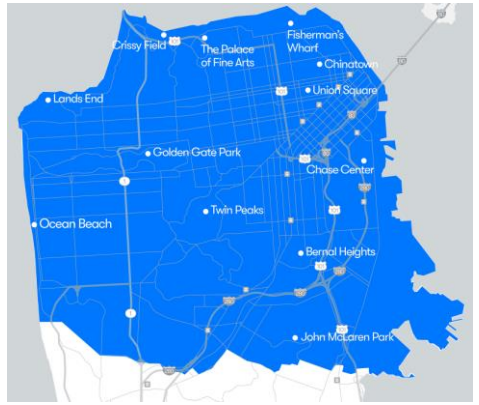
Key Milestones by Phase

Phase 1 2009 - 2015	Phase 2 2015 - 2022	Phase 3 2023+
• Founded as Google Self-Driving Car Project • First AV ride on public roads • Spun out of Google, became an independent operating entity under Alphabet	• Early Rider Program started for metro-Phoenix residents • Waymo One launched in Phoenix • Public launch of Waymo One • SF - fully autonomous service launched	• LA - fully autonomous service launched • Partnership with JLR to use EV I-Pace in fleet • Authorized to operate publicly and monetize 24/7 in California[1] • Announced launch in Austin, TX

Notes: 1) According to California Public Utilities Commission Resolution 09/10/23
Source(s): JLR statement, Waymo website, S&P Capital IQ, Crunchbase

Waymo enjoys 24/7 operations in Phoenix and SF, launching soon in Austin and LA

Company Profile – Waymo Areas of Operation

	Austin, TX	Phoenix, AZ	Los Angeles, CA	San Francisco, CA
Zoning restrictions	**Upcoming**		**Upcoming**	
Time restriction for monetization	-	24/7	-	24/7[1]

Notes: 1) Thanks to CPUC 08/10/23 Resolution
Source(s): Company Website

Motional is a JV between Hyundai and Aptiv, currently running robotaxi in US, Singapore and South Korea

Company Profile – Motional Overview

About The Company

HQ	Fleet size	Funding	Employees
Boston, MA	*Not Available*	**$19.6M** (nuTonomy) + **$454M Aptiv acq.**	**~1,400+**

Autonomous Technology Headway

Autonomy Achieved	Driverless Miles	Patents
L4 (Driver-out AV driving)	• *Miles driven not available* • **2M+** miles **tested**	*Not Available*

Relationships

Partnerships	Investors
OEM Partners: HYUNDAI **Ride-hailing Partners:** Uber, Uber Eats, lyft, VIA	HYUNDAI, APTIV

Commercialization Plan

Commercialized | Testing

Phase 1 2013 - 2017	Phase 2 2018 - 2022	Phase 3 2023+
 **Global: Singapore** (nuTonomy began testing)	 **US: NV** (Las Vegas)	 **US: PA, NV, CA** (Pittsburg, Las Vegas, Santa Monica[1], Silicon Valley); **Global: Singapore & South Korea** (Seoul)
Not available	*Not available*	*Not available*

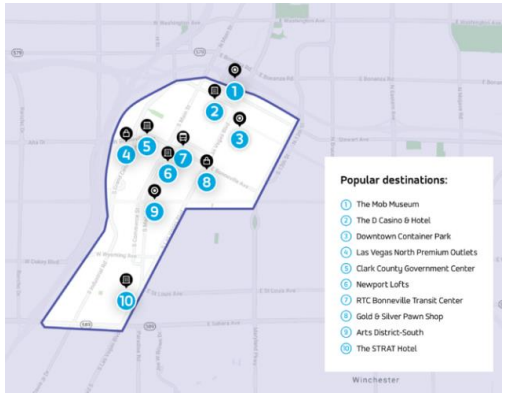
Key Milestones by Phase

Phase 1 2013 - 2017	Phase 2 2018 - 2022	Phase 3 2023+
• nuTonomy, Ottomatika founded in US • Aptiv acquired Ottomatika • Aptiv AV completed first cross-country drive • nuTonomy launched robotaxi pilot in SGP • Aptiv acquired nuTonomy	• Aptiv & Lyft launched robotaxi in Las Vegas • Aptiv & Hyundai formed Motional, a $4B JV • Motional completed 100k Lyft rides • Motional operated on public roads in LV • New IONIQ 5 robotaxi unveiled	• Expand operations in US and Singapore

Note: 1) In Santa Monica, operations are limited to Uber Eats deliveries
Source(s): Motional website, S&P Capital IQ, Crunchbase

Motional has restricted operating hours in Las Vegas, while operations in Santa Monica are limited to Uber Eats deliveries

Company Profile – Motional Areas of Operation

	Las Vegas[1], NV	Santa Monica, CA
Zoning restrictions		**Limited to Uber Eats deliveries**
Time restriction for monetization	9PM-5AM	

Notes: 1) Map shows selected destinations from Via app where customers can travel at no cost
Source(s): Company Website

Zoox, although backed by tech giant Amazon, lags behind larger players like Waymo and Cruise

Company Profile – Zoox Overview

About The Company

HQ	Fleet size	Funding	Employees
Foster City, CA	*Not available*	**$950M + $1.3B** Amazon acq.	**1,874 as of 2022** (Up 35% from 1,388 in 2021)

Autonomous Technology Headway

Autonomy Achieved	Driverless Miles	Patents
L4 (Driver-out AV driving)	• Miles driven not available • **1M+** miles **tested (L3)**[1]	**1,213** (awarded and pending)

Relationships

Partnerships	Investors
OEM Partners: *Not available* **Ride-hailing Partners:** *Not available*	amazon

Commercialization Plan

Commercialized | Testing

Phase 1 2014 – 2017	Phase 2 2018 - 2022	Phase 3 2023+
		
US: CA, NY (Foster City, San Francisco, Altamont NY test track)	**US: CA, NY, WA** (Foster City, SF, Altamont NY test track, Seattle)	**US: CA, NV** (San Francisco, Las Vegas)
Other locations: Seattle (L3), Fremont (manuf.), Altamont NY (test track), Oxfordshire, UK & Boston, MA (offices)		
Not available	*Not available*	*Not available*

Key Milestones by Phase

Phase 1 2014 – 2017	Phase 2 2018 - 2022	Phase 3 2023+
• Founding • First AV prototype • Finished first AV loop in downtown San Francisco	• Received California permit to transport passengers in AVs with safety driver • Acquired by Amazon • Unveiled AV robotaxi • Self certified vehicle against FMVS[2]	• Commercial operations in San Francisco • Commercial operation in Las Vegas

Notes: 1) With safety drivers. 2) Federal Motor Vehicle Safety Standards
Source(s): Zoox website, S&P Capital IQ, Crunchbase

TuSimple is an autonomous trucking company, it commits to commercialization plans for as early as 2024…

Company Profile – TuSimple Overview

About The Company

HQ	Fleet size	Funding	Employees
San Diego, CA	**70** (US: 35, APAC: 35)	**$648.1M**	**800 as of Sep'23** (Down 25% from 1,100 in Mar'23)

Autonomous Technology Headway

Autonomy Achieved	Driverless Miles	Patents
L4 with **1,000 meters camera visibility** (Driver-out AV driving)	• **10M+** miles (driven + tested)	**590** (awarded)

Relationships

Partnerships	Investors
OEM Partners: NAVISTAR - until Dec 2022	NAVISTAR, PORSCHE, sina 新浪网 sina.com.cn + financial investors

Commercialization Plan

Commercialized | Testing

Phase 1 2023 – 2026	Phase 2 2027 - 2029	Phase 3 2030+
		
US: Arizona (Phoenix-Tucson) launched; **Global: China**	**US: Texas Triangle** (Dallas, Houston, San Antonio, Austin); **Global: China**	**US: Sunbelt** (Tucson, El Paso, Dallas, Oklahoma City, Memphis, San Antonio); **Global: China**

R&D locations: **6** (US: 2 – San Diego, CA (HQ) and Tucson, AZ; China: 3 – Beijing, Shanghai, Tangshan; Japan: 1 – Tokyo)

<100 AVs	100-1,000 AVs	>10,000 AVs
Key Milestones by Phase		
• Develop redundant base truck AV-ready platforms • Build ADS tech further • Freeze ADS onboard S/W, and H/W for contract upfitter • Commercial launch 2024 • 'TuSimple capacity' revenue model launch	• Continued hardware maturity and optimization • Expand self-operated AV fleet • Freeze ADS onboard S/W and H/W for OEM programs	• Enable and scale production of integrated OEM produced AV trucks • **Autonomous Freight Network (AFN)** scale up • 'Carrier-owned capacity' revenue model launch

Source(s): TuSimple Investor Presentation September 2023, Annual Report FY22, Press releases, S&P Capital IQ, Crunchbase

… it struggles to keep the US operations afloat, driven by a series of recent setbacks like truck incidents and lawsuits

Company Profile – TuSimple Areas of Operation and Recent Challenges

TuSimple Route Plans – US and APAC

AFN: Autonomous Freight Network by TuSimple

TuSimple: Challenges

- **US Operations Sale:** In Jun'23, TuSimple announced it is looking to divest US ops following organizational, legal and financial troubles in last 2-3 years
- **Delisting Notice**: In May'23, received delisting notice from Nasdaq after delayed publishing of quarterly financial results
- **Espionage Charges:** As of Oct 2022, FBI and SEC were probing TuSimple for ties with Chinese firm Hydron, under the allegations of having defrauded investors by financing and transferring technology to Hydron
- **Truck Incident Leading to Investor Lawsuit**: In Aug'22, investors sued TuSimple for misrepresenting L4 capabilities, following an autonomous truck incident, sending stock prices down by 10%

Source(s): TuSimple Investor Presentation September 2023, Annual Report FY22, Press releases

Aurora Innovation is another US-based autonomous trucking company, but has plans to enter robotaxi services as well

Company Profile – Aurora Innovation Overview (1 of 2)

About The Company

HQ	Fleet size	Funding	Employees
Pittsburgh, PA	**31** trucks and **<10** Toyota Sienna minivans	**$3.7B**	**1,700+** as of Dec'22

Autonomous Technology Headway

Autonomy Achieved	Driverless Miles	Patents
L4 (Driver-out AV driving) *Note: See Autonomy Measurement box*	• **4.5M+** miles **driven** • **9B+** miles **simulated**	**1,450+** awarded and pending (**226** issued in 2022)

Relationships

Partnerships				Investors
OEM Partners: PACCAR, Volvo, Toyota	**Ride Partner:** Uber	**Fleet Maint. Partner:** Ryder	**Hardware Partner[1]:** Continental	Uber, amazon, Toyota, PACCAR, Volvo, + financial investors
Logistics Partners: FedEx, Werner Enterprises, Uber Freight, Hirschbach, U.S. Xpress, Schneider, Covenant				

Revenue Model

"Aurora Horizon" is an **autonomous trucking subscription offering** (**Driver-as-a-Service**) operating on **'fee per mile'** revenue model, and offers:

(1) ***Aurora Driver*** (L4 autonomous driving S/W, H/W, map provided to fleet owners on a fee per mile basis)

(2) ***Aurora Services*** (suite of tools and infrastructure to integrate Aurora Horizon into client business)

Operating Model: Aurora provides its technology to an external fleet owner for a fee (per mile), and bears costs like insurance, H/W and S/W maintenance, remote assistance, cloud, telecom and OEM & fleet partnership costs, by itself

Aurora's Autonomy Measurement Methodology

Commercial Autonomous Operations Readiness Measurement

(1) **'Autonomy Readiness Measure' (ARM): 84%**, shows completeness on safety requirements for the Dallas-Houston route (Aurora's 'launch lane')

(2) **Autonomy Performance Indicator (API): 98%**, shows performance to successfully operate 'Aurora Horizon' in a commercially-representative setting

API is reflected as a % of total commercially-representative miles driven over the quarter, that incorporates three components:

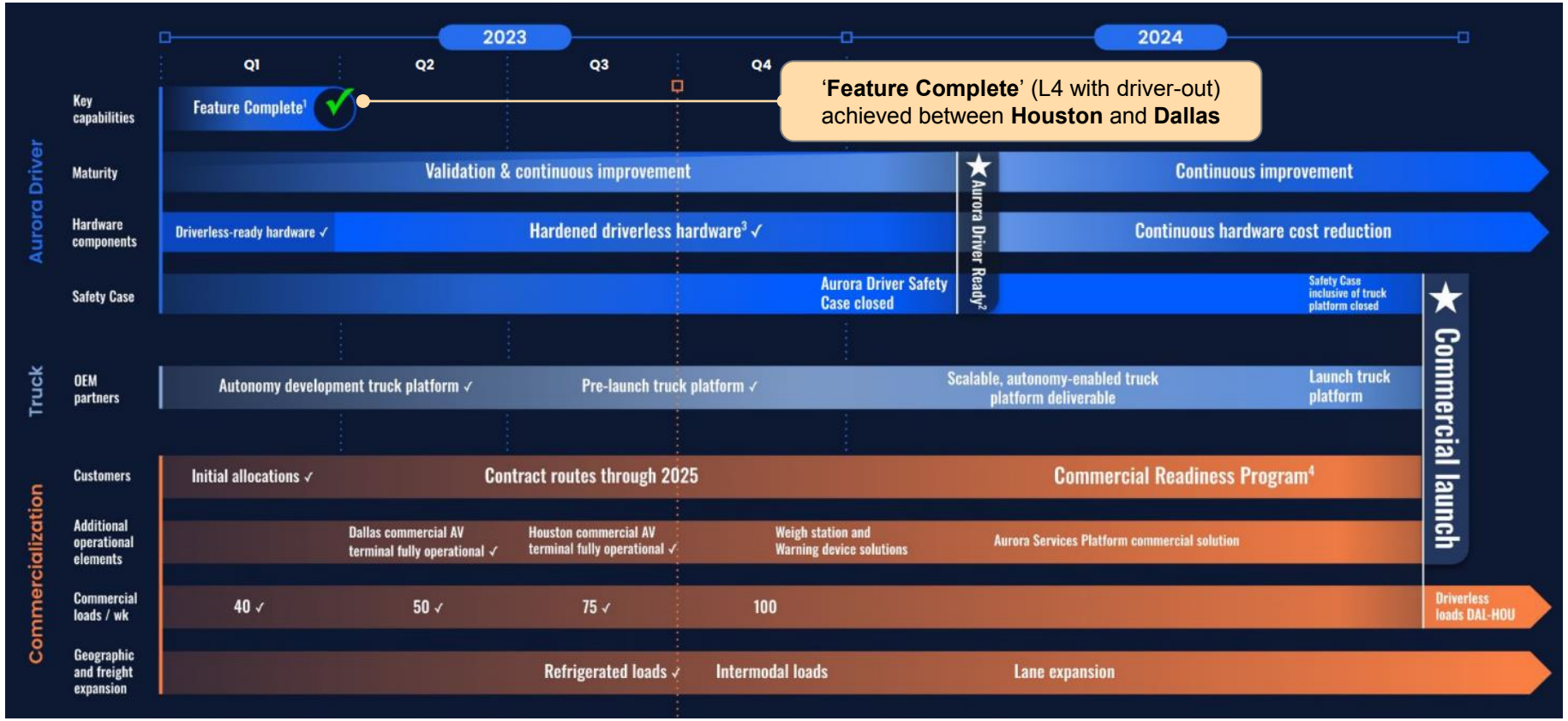
(a) Miles driven without requiring assistance from local vehicle operator or on-site
(b) Miles driven in autonomy with remote input from Aurora Services
(c) Miles where the vehicle received support but determined that the support received was not required by the Aurora Driver

Note: 1) Hardware-as-a-Service partnership
Source(s): Aurora Investor Presentation November 2023, Annual Report FY22, Press releases, S&P Capital IQ, Crunchbase

Aurora plans to commercialize autonomous trucking by 2024, then focus on passenger mobility and B2B goods delivery

Company Profile – Aurora Innovation Overview (2 of 2)

Commercialization Plan



Expansion Plans

After Aurora Horizon launch for Class 8 trucking, Aurora plans to penetrate the autonomous passenger mobility (robotaxi) and B2B local goods delivery segments too in US, followed by international expansion in Canada, Europe, Japan, Australia and New Zealand

Divestiture Plans

CEO talked about possibility of selling to Apple or Microsoft in Sep'22, but not materialized

Notes: 1) Aurora Driver 'Feature Complete' is defined as having implemented all capabilities needed for launch and all policy interventions removed; 2) Aurora 'Driver Ready' is defined as validation complete and Aurora Driver Safety Case closed; 3) Hardened driverless hardware is engineered for extreme environments and enhanced reliability; 4) Pilot customers will have the opportunity to more deeply evaluate and asses the Aurora Driver's performance as a final step to move forward with driverless operations
Source(s): Aurora Investor Presentation November 2023, Annual Report FY22

Aurora plans to first launch Aurora Horizon in TX, then cover the Sun Belt and later expand coverage northwards

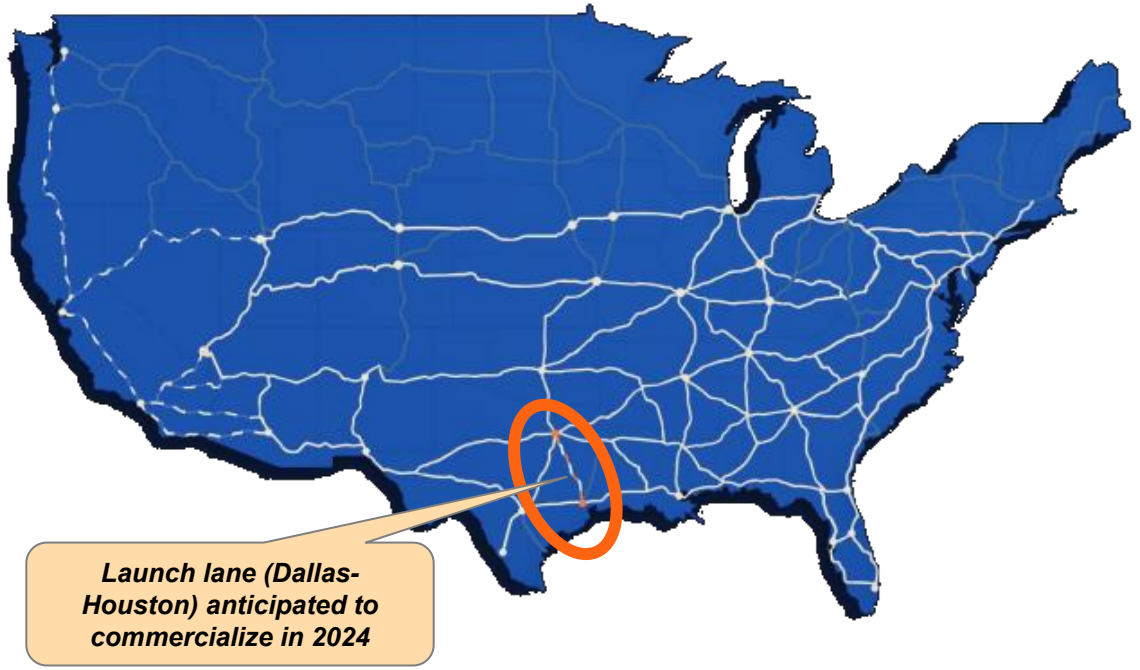
Company Profile – Aurora Areas of Operation

Current AV Routes

Aurora is currently hauling[1] freight for 5 pilot customers on 2 routes in Texas:

FedEx, WERNER ENTERPRISES, Hirschbach, SCHNEIDER, Uber Freight

Future Commercialization Plan



Aurora plans to launch Aurora Horizon in Texas and then initially expand through the interstate highway system across the Sun Belt before moving northwards

Note: 1) Pilots are operated under the supervision of vehicle operators
Source(s): Aurora Investor Presentation November 2023, Annual Report FY22

AV companies look at factors like weather, business case, regulations, customers' and govt.'s support to decide which regions to enter

Top Critical Factors Driving AV Companies' Entry to New Geographies

Factors	Description	What Industry Experts Say
Weather Conditions	• Companies prefer cities with weather similar to existing test cities • Extreme weather testing (snow, heavy fog, etc.) is currently low on priority for most companies, high preference to stable weather cities	*"Stable weather footprints allow vehicles to have experience in easier environments before entering a tougher city"* - Former Head of Tech & Infrastructure BD at an AV company

Business Case Feasibility	• It must make business sense for companies to invest in new cities
	• Key drivers influencing the business case include:
	  ○ Population density: directly proportional to market size (TAM)
	  ○ High adoption rate for ride-hailing
	  ○ Cost considerations and time to breakeven or to get positive ROI
		"We look at the market opportunity in a geography in terms of how much is ride sharing utilized there. Then there are also the logistics and operational costs" - Former Head of Tech & Infrastructure BD at an AV company

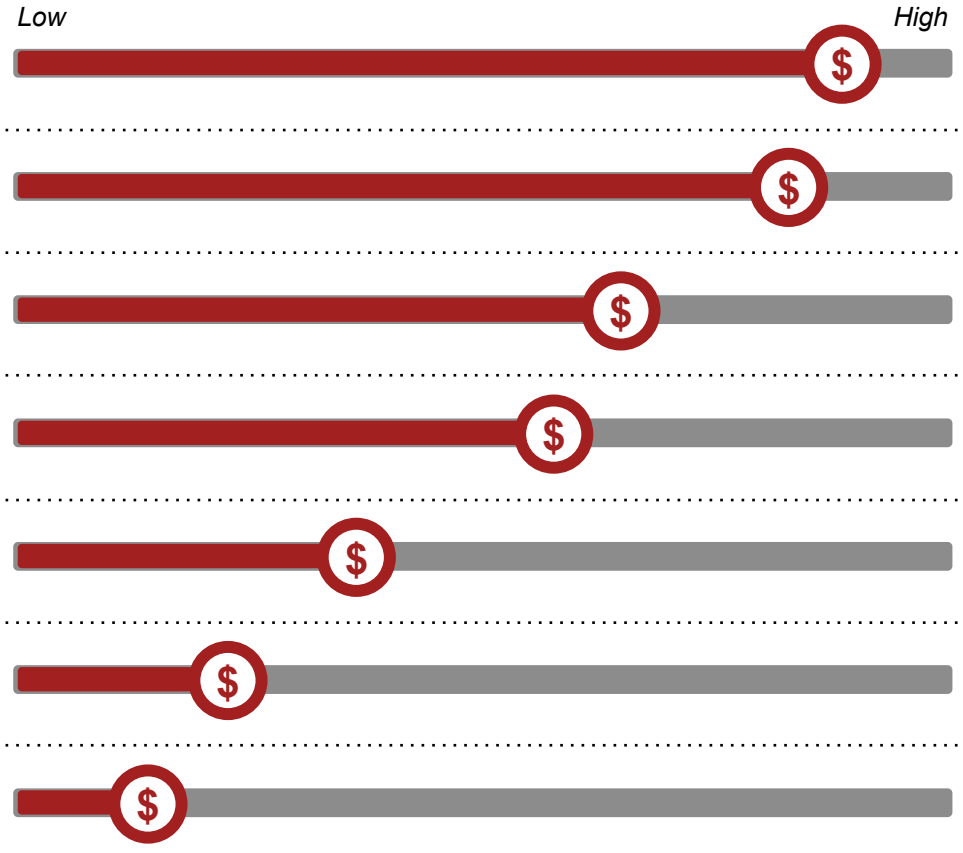
Supportive Laws and Regulations	• Regulations must exist or be under development to allow testing and deployment of AV on public roads • Commercial operation (revenue-generating services) approvals should be achievable within favorable timelines	*"In USA, it is easy to apply for license, but getting it is painful. Govts. should allow retrofit vehicles to be tested. We are fine with reporting all data, but they need to allow testing, since small companies cannot lobby govts. for license"* - Founder & CTO of a trucking AV company
Favorable Customer Sentiment	• Target customers must be aware of AVs and largely be supportive, share of population 'against' adoption of AVs is a strong deterrent • Reports from customer surveys help track sentiment, directionally	*"I believe the backlash to driverless cars is sensationalized. It is time for the public to eliminate the double standards that it has for human drivers and driverless cars"* – CEO at AV company
Government Support	• Government's openness to launch AVs is a big booster • Public announcements of support, monetary support, collaboration with industry and academia to conduct R&D, frame policies & design incentives are highly positive indicators of government support	*"In order to attract autonomous vehicle companies, govts. can offer subsidies, streamline policy and permit processes, and help identify strategic partnerships"* - Former Head of Tech & Infrastructure BD at leading AV company

Source(s): Washington Post, Expert interviews, External Research

When rolling-out in a new region, AV companies invest in real-estate, EV charging & tech infra, talent, marketing, etc. to boost deployment

Areas & Scale of Investments by AV Companies in New Regions

Investment Area	Description	Scale of Investment
Real-Estate for Running Operations	Includes costs of land acquisition, construction and maintenance of parking area for AV fleets, repair & maintenance workshop, office, etc.	
EV Charging Infrastructure	Investment to set up EV charging network covering AV parking area and well-spread charging points across the city	
Data Centers	Investment in tech infrastructure including data centers for data offload and storage, HD mapping, cybersecurity measures, etc.	
Insurance	Reserve capital as insurance fund in case of accidents involving damage to life & property; some legislations need AV companies to reserve surety bonds before giving license to operate (e.g., CA DMV)	
Human Capital	Investment in hiring, training and retaining R&D talent with expertise in AI and autonomous vehicles, and testing operators	
Consumer Influencer Programs	Marketing costs spent on consumer outreach programs, awareness campaigns, advertising, surveys, etc. to turn market sentiment positive	
Collaboration on Policy-Making	Cost of collaboration with government authorities on policy-making, feasibility studies, proof-of-concept demo, etc. with co-investments from the government, thus reducing capital burden on the company	



Source(s): Expert interviews, External Research

Agenda

1. Autonomous Vehicle (AV) Technology Overview
2. Key Considerations for AV Rollout
3. AV Players Overview
4. **OEMs Role in AV Technology**
5. Market Scorecard for AV Readiness
6. Ukraine Overview
7. Appendix

OEMs are currently deploying L2 at scale, while hoping to generate larger returns from L4/L5 by investing in AV operators

Autonomous Vehicle Technology Value Chain

Non-Exhaustive

Supplier Role

Hardware Suppliers

manufacture hardware components such as LIDAR, radar, cameras, & relevant sensors

MAGNA · APTIV · HYUNDAI MOBIS · LUMINAR · Valeo · Continental

Software Suppliers

develop software, processing units, & integrate with HW, to enable L2/L3 driving

MAGNA · APTIV · HYUNDAI MOBIS · LUMINAR · Valeo · Continental · NVIDIA

OEM Role

Deploying L2/L3 Systems

OEMs have deployed L2 autonomy (Mercedes with L3) for their vehicles, available to the public

STELLANTIS · NAVISTAR · PACCAR · TOYOTA · HONDA · Audi · GM · HYUNDAI · JLR · BMW · VW · VOLVO · Mercedes · Ford · KIA

Tesla & Rivian** develop their **own L2/L3 autonomy SW

TESLA · RIVIAN

Investing in AV Technology

OEMs have invested in Suppliers & AV operators to improve autonomy systems & position themselves for the future

GM · HONDA · Ford · VW · TOYOTA · HYUNDAI

Supplying to AV Operators

Supplying vehicles to AV operators to be retrofitted or producing vehicles with AV equipment directly on the production line (Hyundai only OEM doing the latter)

GM · STELLANTIS · HYUNDAI · JLR · VOLVO · PACCAR · NAVISTAR

AV Operators

Deploying & Testing AVs

source HW from suppliers & retrofit vehicles and integrate their proprietary software to test, train and deploy AVs

ZOOX · cruise · tusimple · Motional · kodiak · nuro · Aurora

***Waymo** uses **in-house proprietary hardware (lidars, radars, sensors, etc.)** and doesn't outsource from suppliers*

WAYMO

***Some AV operators** are developing their own Level 5 capable vehicles*

ZOOX

cruise

nuro

Source(s): External Research, Online Research, Company Websites

OEMs in Europe are investing across the AV technology value chain

AV Technology Category	Select OEMs	Collaboration with Hardware Companies *(Lidar, Radar Manufacturers)*	Collaboration with Autonomy Software Providers	Collaboration with AV Operators
Passenger Vehicles	Volkswagen	✓		
	Mercedes-Benz	✓	✓	
	BMW	✓		
	Volvo	✓	✓	
Commercial On-Road	IVECO		✓	
	SCANIA	✓		
	MAN	✓	✓	
	Volvo		✓	✓
	DAIMLER TRUCK		✓	
Commercial Off-Road	Volvo		✓	✓
	FENDT		✓	
	SCANIA	✓		
	LIEBHERR			✓

Details on relevant AV partnerships, investments, and other AV technology announcements by these OEMs are on upcoming slides

Source(s): Companies Website, Press Releases, External Research

In Europe, passenger vehicle OEMs are focusing to improve L2 & L3 tech, while commercial OEMs are foraying into L4 AV technology

Summary of European OEMs involvement in AV technology

AV Technology Category	Summary of current activities
Passenger Vehicles	• European OEMs are currently **consolidating L2 & L3 capabilities by partnering with or investing in hardware and software suppliers –** Common investments include LiDAR & chips manufacturers and autonomous software providers • For the **development** of **L4** and **L5 technologies**, **OEMs** depend on partnerships with **AV-Tech providers** such as Waymo
Commercial On-Road	**Trucks** • **Unlike passenger cars**, commercial on-road **OEMs** are showing a **significant interest towards L4 autonomous technology** • **European OEMs** are **conducting trials outside Europe** – Both Daimler and Volvo are testing their L4 technology in the US • To foster tech adoption, commercial OEMs are investing & partnering with hardware and software suppliers **Buses** • **European OEMs are active in public transport though AV buses**. Alexander Dennis and Navya (prior its bankruptcy) had running tests open to the public, while Man is targeting 2025 for its trials in Munich
Commercial Off-Road	**Mining** • There are **significant AV pilots currently running** within the mining industry with cab-less material hauling concepts being presented by Volvo, Komatsu and Scania • **European OEMs may choose to test their vehicles overseas**, in fact Liebherr and Scania are currently testing AV trucks respectively in Roy Hill and Channar, both iron ore mines located in Pilbara, Australia **Agriculture** • There is significant interest in AV technology within the agricultural sector, but **limited field testing** is currently **being performed**. • Several autonomous concepts have been presented by John Deere, Case and Fendt

Source(s): Company Websites, External Research

Passenger Vehicle OEMs are aggressively trying to master L3 autonomy, before jumping into more challenging L4/L5

European Passenger Vehicle OEMs – AV Outlook

Company	AV Level	Status	Testing Location	Partnerships	AV Investment	Other AV Announcements
	L4	Testing	Germany	**Horizon** (ADAS HW): Joint Venture	€2.4bn in Horizon in China (ADAS) - 60% of JV	By the end of 2025 planning to include AVs in MOIA ride sharing fleet in Hamburg
	L3	Commercial	Europe, US	**Luminar** (LiDAR): minority stake investment **Bosch**: Autonomous parking L4	$20M in Luminar	-
	L3	Commercial	Europe	**Innoviz** (LiDAR.): development agreement	€300M in Future Mobility Center	Developed Future Mobility Development Center in Sokolov, Czech Republic to test AV up to L4
	L3	Announced		**Zenseact** (software): acquisition **Luminar** (LiDAR): minority stake investment	-	-
	L4-5	Announced	Croatia	-	€130M for AV R&D and testing facilities in Croatia	Planned 700 robotaxi production by 2024.
	L3	Announced	Europe, China	**BMW** (as Stellantis): R&D partnership to develop STLA medium platform which will offer L3 AV capabilities	-	-
	-	Concepts	-	**TTTech Auto** (Software): minority stake investment	$57M in TTTech	-

Source(s): OEM websites, External Research

With fixed freight routes & looming driver shortage in trucking industry, commercial OEMs are testing L4 technology

European On-Road Commercial Vehicle OEMs – AV Outlook

Company	AV Level	Status	Testing Location	Partnerships	AV Investment	Other AV Announcements
IVECO	L4	Testing	Germany	**Plus** (AV-tech): development agreement	-	-
SCANIA	L4	Testing	Sweden Australia	**Scantinel Photonics** (HW): minority stake investment	€7.5M in Scantinel Photonics	-
MAN	L4	Testing	Germany	**Mobileye** (HW): development agreement	-	Roadmap to use AVs commercially by 2025 and start serial production by 2030.
ALEXANDER DENNIS	L4	Testing - Public	United Kingdom	**Fusion Processing** (HW): Partnership	-	-
VOLVO	L4	Testing	US	**Aurora** (AV-tech): development agreement **Waabi** (AI): minority stake investment	-	Volvo Autonomous Solutions open AV truck base in Texas to cover Dallas-El Paso and Dallas-Houston
DAIMLER TRUCK	L4	Testing	US	**Apex.ai** (SW): minority stake investment **Torc robotics** (SW): majority stake investment **Algolux** (SW): acquisition **Waymo** (AV-tech): development agreement	-	-
navya self-driving made real	L4	Commercial	Global	-	-	Announced partnership with BlueBus to finalize robotization and automation of EV passenger buses for serial production

Declared bankruptcy in April 2023, assets acquired by Gaussin

Source(s): OEM websites, External Research

Favored by naturally enclosed worksites, OEMs are testing AVs for construction and mining operations, with a focus on hauling tractors

European Off-Road Commercial Vehicle OEMs – AV Outlook

Company	AV Level	Status	Testing Location	Partnerships	AV Investment	Other AV Announcements
VOLVO	L4	Testing	Sweden	**Aurora** (AV-tech): development agreement **Waabi** (AI): minority stake investment	-	Volvo Construction Equipment to invest in a new 66,000 m^2 innovation zone in Sweden for autonomous transport solutions
FENDT	-	Prototype - testing	-	**Apex.ai** (software): development agreement	-	-
SCANIA	L4	Testing	Sweden Australia	**Scantinel Photonics** (LIDAR): minority stake investment	€7.5M in Scantinel Photonics	Testing autonomous vehicles at demo center at Gläntan circuit in Södertälje, Sweden
LIEBHERR	-	Testing	Australia	**ASI** (AV-tech): development agreement	-	-
BELAZ	-	Testing	Belarus	**Zyfra** (AV-tech): development agreement	-	-
KAMAZ	-	Announced	-	-	-	-

Notes
Source(s): OEM websites, External Research

Agenda

1. Autonomous Vehicle (AV) Technology Overview
2. Key Considerations for AV Rollout
3. AV Players Overview
4. OEMs Role in AV Technology
5. **Market Scorecard for AV Readiness**
   - San Francisco
   - Las Vegas
   - Singapore
   - Netherlands
   - UAE
   - Poland
6. Ukraine Overview
7. Appendix

Singapore leads AV readiness, with SF, Vegas, & UAE performing relatively well; Netherlands has gaps and Poland also lacks initiatives

Rating Legend: Poor | Average | Good | Very Good | Market Leading

AV Markets	Considerations for AV Rollout (10 pillars)										
	R&D Capabilities	Road & Urban Infrastructure	IT, Cyber and Telecom Infrastructure	Tech Dev. & Mfg. Capacity	Public Safety & Security	Public Awareness & Societal Engagement	Public & Private Collaboration	Organization & Governance	Laws, Regulations & Incentives	Business Case Feasibility	Overall Readiness Score
San Francisco											
Las Vegas											
Singapore											
Netherlands											
UAE											
Poland											

Profiles on each market & rationale behind the score is on upcoming slides

San Francisco is one of the most preferred cities globally for AV development and testing

Location Profile: San Francisco (1 of 2)

San Francisco

Rating Legend	Poor	Average	Good	Very Good	Market Leading

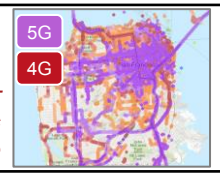
	Metrics	Rating	Readiness Initiatives
1	R&D Capabilities	■■■■■	• University of California, Stanford, etc. offer dedicated courses on self-driving & automation • Origins of Waymo include hiring CMU and Stanford engineers from DARPA[1] Grand Challenge • Availability of vast talent pool including S/W, AI/ML, computer vision, etc. engineers, from tech, H/W, semiconductor, H/W, academics, lidar/radar, etc. • Automakers test AVs at GoMentum Station in Concord, a former navy munitions depot whose grid of roads and clusters of empty buildings can simulate a city or a stretch of highway • 1,550+ AV-related patents have originated from San Francisco so far, potentially the highest in US • Waymo, Cruise, etc. already operating AVs in SF, although Cruise's license is currently suspended
2	Road and Urban Infrastructure	■■□□□	• >70% of SF roads in very poor condition (Teletrac) • SF known for lack of sufficient road markings • Very expensive real estate, but however, prices have begun falling, expected to fall 40-45% by 2025 • 1,000+ public EV charging ports (~1.3 ports per 1,000 people) and growing • Bay Area ITS website provides a blueprint for SF ITS project coordination and integration
3	IT, Cyber and Telecom Infrastructure	■■■■■	• 5G available extensively from multiple providers like AT&T, T-Mobile, etc. • 300 Mbps, and upto 1 Gbps in select locations, across networks • US ranked 46th globally on National Cybersecurity Index (NCSI) • Private players like Waymo and Cruise building city's HD maps
4	Tech Development & Manufacturing Capacity	■■■■■	• US saw $45B+ VC funding to AV startups between 2017-2023 (Crunchbase) • $14M committed by GM in 2017 to setup Cruise R&D facility in SF and add 1,100 jobs • SF is considered the center of AV universe, fueled by robotaxi approvals
5	Public Safety & Security	■■■■□	• California Vehicle Code Section 38750 has the AV regulations, but doesn't define a liability framework • AV companies wanting to test AV in CA (including SF) need to submit proof of insurance, self-insurance or a bond that can cover damages of up to $5M

GoMentum Station, an AV testing zone in SF

SF's bad road conditions

SF falling real-estate prices

SF EV charging infra growing rapidly



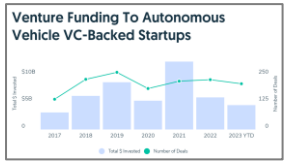
SF AT&T 4G-5G coverage

Verizon 5G expansion in SF

US Cybersecurity performance

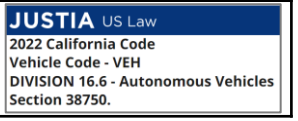
Waymo SF HD Map

US AV investments



GM AV investment in SF

SF emerges as a key AV development hub



Note: 1) DARPA is Defense Advanced Research Projects Agency, the deep research wing of the U.S. military that conducted DARPA Grand Challenge where participants designed vehicles that could drive themselves across more than 100 miles of desert terrain

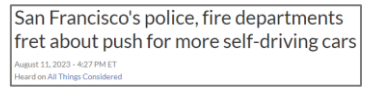
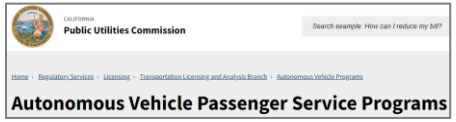
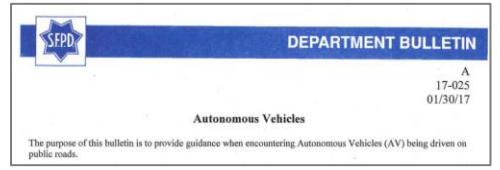
Source(s): GovTech, WSJ, SFCTA, SF Police, USPTO, Zutobi Worst and Best Roads, ChargeHub, Teletrac Worst Maintained Roads 2023, San Francisco Metropolitan Transport Commission Intelligent Transportation Systems (ITS) website, Traffic Technology Today, Company websites, Press releases, Expert interviews

San Francisco is one of the most preferred cities globally for AV development and testing

Location Profile: San Francisco (2 of 2)

San Francisco

Rating Legend	Poor	Average	Good	Very Good	Market Leading

	Metrics	Rating	Readiness Initiatives
6	Public Awareness & Societal Engagement		• 62% public in SF was open to AV per a survey conducted by Waymo LTAD[1] in 2020 • However, significantly negative sentiment ensued following a Cruise AV accident in Oct'23 • Public is aware and familiar with AV testing on roads, however, several activists, citizens, cops, firefighters, etc. are against further AV adoption • JD Power's 2023 U.S. Mobility Confidence Index showed just 37% Americans are confident of AV capabilities, however, this share of residents was higher among SF and Phoenix residents   *The limited public acceptance of AV in SF, catapulted further negative after the Cruise crash* 
7	Public & Private Collaboration		• University of SF's 'Autonomous Vehicles and The City' initiative brings together businesses, policy makers, and academia to discuss future of AV • SF Country Transportation Authority works with the SFMTA and partners from the public and private sector to better plan AV adoption in SF *Public-private collaboration for AVs in SF*  
8	Organization & Governance		• California DMV administers the Autonomous Vehicles Program and issues permits to companies that test and deploy AVs on California public roads • California Public Utilities Commission (CPUC) issues approvals to run commercial services in California as part of its Commission's AV Passenger Service pilot programs • To be eligible to participate in the CPUC programs, companies must first get relevant permit from DMV   *DMV and CPUC govern AV ops in CA*
9	Laws, Regulations and Incentives		• California Vehicle Code 38750 (CA DMV) governs AV movement in SF and defines relevant regulation • SFPD bulletin from 2017 bulletin 17-025 provides guidance for AVs operating on SF public roads • No monetary incentives, however, CA DMV allowed 24x7 operation of robotaxi • No separate tribunal or court setup for handling AV cases or incidents, being handled by DMV & CPUC *SFPD bulletin on operating AVs in SF* 
10	Business Case Feasibility		• High population density, high ride-hailing adoption, suitable and stable climate conditions of SF, and presence of clear regulations & regulatory bodies build a strong case for AV in SF • SF roads are considered a tough environment to run AVs on, thus making SF-ready AVs fit for deployment in other similar cities in far lesser turnaround time *"SF is so complex, if your AV is proven on SF roads, it can work anywhere"* – Former Director of Engineering at a leading AV company *"Mature ride sharing market and similar weather to Phoenix make SF an ideal choice"* – Former Head of Tech and Infrastructure BD at a leading AV company

Note: 1) LTAD is "Let's Talk Autonomous Driving", a Waymo community

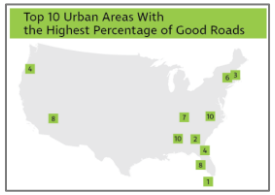
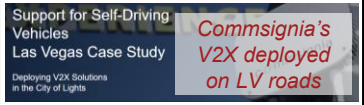
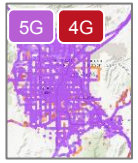
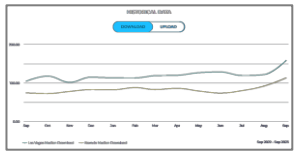
Source(s): WSJ, SFCTA, SF Police, Zutobi Worst and Best Roads – U.S. and International ranking 2022, ChargeHub, Teletrac Worst Maintained Roads 2023, San Francisco Metropolitan Transport Commission Intelligent Transportation Systems (ITS) website, Traffic Technology Today, Company websites, Press releases, Expert interviews

Las Vegas is currently one of the most sought-after cities for AV testing in US, owing to several favorable factors

Location Profile: Las Vegas (1 of 2)

Las Vegas

Rating Legend	Poor	Average	Good	Very Good	Market Leading

	Metrics	Rating	Readiness Initiatives
1	R&D Capabilities		• Nevada Center for Applied Research's (NCAR) "Nevada Autonomous" initiative (supported by Nevada Knowledge Fund though the Governor's Office of Economic Development) and aims at helping commercializing technologies like AV • NCAR's 'Intelligent Mobility' initiative aims at studying and testing transportation solutions like AV • <10 AV-related patents have originated from Las Vegas • Limited AI talent pool as US top AI talent hub reports do not cite Las Vegas among top cities • Several companies testing AVs in LV, e.g., Zoox, Motional, Cruise, Daimler, Vay, Nuro, Halo, etc. *LV not among top AI talent hubs in US*  *NCAR's AV-focused initiatives*  
2	Road and Urban Infrastructure		• LV ranks among the top 10 cities in US with high % of good urban roads with adequate markings • Not historically known for commercial real-estate, LV offers affordable prices ($300-400 / sq. ft. vs. $1,000-$1,100 for SF) and availability remains strong • ~950 public EV charging stations (~1.5 charging ports per 1,000 people) and growing • LV hosts advanced traffic management systems, including Commsignia's Cellular- V2X units at traffic intersections for sensor data exchange with AVs; Audi also trialed its V2I traffic light info system in LV *LV among top cities with 'best urban roads'*    *Commsignia's V2X deployed on LV roads*
3	IT, Cyber and Telecom Infrastructure		• City-wide 5G availability, covering >99% homes and 72%+ area of the city • 300 Mbps, and upto 1 Gbps in select locations • Las Vegas tops list of unsafe cybersecurity cities (Coronet) per a 2019 report • Private players building HD maps e.g., Motional, Zoox, etc. *LV T-Mobile 4G-5G coverage*  *LV known for poor cybersecurity (CoroNet)*  *Internet speed tests show better speeds in LC than rest of NV* 

4	Tech Development & Manufacturing Capacity		• Las Vegas is home to several big tech conferences, e.g., Ai4, MWC, CES, Gartner IT IOCS
			• Several AV companies have invested millions to test and deploy AVs in the city, e.g.,:
			  ○ Nuro invested $40M in 2021 to build a test track and factory for its delivery robots in Las Vega
			  ○ Motional is tripling its R&D and testing facility size, and initiated fresh hiring of 100 reSource(s)
			AV company investments in in LV for R&D and testing
			 
			 
			Top tech conferences in Las Vegas
			 
			 

5	Public Safety & Security		• Nevada DMV has clearly laid out AV regulations (Chapter 482A) and Liability Framework (AB 69) • AV companies wanting to test AV in NV (including LV) need to submit proof of insurance, self-insurance or a bond that can cover damages of up to $5M *Nevada AV regulations keep public safety & security in focus*  

Source(s): University of Nevada, USPTO, CSET, CBRE Artificial Intelligence: U.S. Talent Spotlight 2023, Consumer Affairs, Teletrac, Review Journal, ChargeHub, Traffic Technology Today, CoroNet, GovTech, Justia US Law, Conference websites, Company websites, Press releases, Expert interviews

Las Vegas is currently one of the most sought-after cities for AV testing in US, owing to several favorable factors

Location Profile: Las Vegas (2 of 2)

Las Vegas

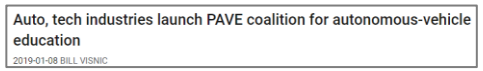
Rating Legend	Poor	Average	Good	Very Good	Market Leading

	Metrics	Rating	Readiness Initiatives
6	Public Awareness & Societal Engagement		• Pilots / surveys to find public sentiment on AVs were conducted in LV, e.g., AAA[1], RTC[2], Keolis and Las Vegas authorities piloted AV rides on a shuttle bus (2019) which improved public sentiment; and a separate AAA survey in 2021 that found 86% of drivers were afraid to drive in AVs • Several initiatives have helped keep AV awareness high in LV, e.g., demo of AV concepts at CES, launch of PAVE[3] Coalition during CES 2019 to drive AV awareness, etc. • High ride-hailing adoption as evident from pickup counts increasing from 1.03M (2016) to 2.8M (2018) • Though many companies testing AVs in LV, testing area is limited, e.g., Motional operates on the LV strip (<15k residents), while Zoox's route is a 1-mile loop around its Las Vegas HQ
7	Public & Private Collaboration		• Several public-private collaborations for AVs, e.g., Audi smart traffic lights pilot, WayCare platform to harness in-vehicle, municipal & state traffic data; Northern Nevada Intelligent Mobility Living Lab, WAZE platform to exchange notices with NDOT, Nexar Safest Driver Competition to support NDOT, etc. • NCAR partners with public & private stakeholders for its AV initiatives, e.g., DMV, Velodyne LiDAR, etc.
8	Organization & Governance		• NV requires self-certification by AV companies for testing, DMV does not test vehicles but issues a Certificate of Compliance for testing; Nevada law allows all automation levels to operate on streets • No other dedicated agency setup • NV was the first state in US to authorize AV ops by passing Assembly Bill 511 (2011), followed by AB 69 • "Smart Vegas" – LV's smart city development strategy document (2019) talks about focus on AVs

9	Laws, Regulations and Incentives		• Though no tribunal setup by Nevada, it has published and updated several regulations relative to AVs:
			  ○ Assembly Bill 511 36-6: the 1st AV bill in the state, required vehicle registration with NV DMV
			  ○ 482A mandated AVs to have a human operator with override option, and insurance worth $5M
			  ○ SB 140 made a special provision for cell phone use by human operators onboard Avs
			  ○ AB 69 established liability rules and prohibited local governments from imposing a tax/fee on AVs
			• US DoT awarded a $5.3M grant to RTC and City of Las Vegas to deploy AVs

10	Business Case Feasibility		• Nevada DoT conducted AV feasibility study in 2019 • High population density, high ride-hailing adoption, suitable and stable climate conditions of LV, and presence of clear regulations & regulatory bodies build a strong case for AV in LV • AV investments continue to grow, e.g., Germany company Vay setup new base in Las Vegas (2023), At One Ventures invested $5M in Halo.Car (2022), Nuro invested $40M to setup AV factory (2021), etc.

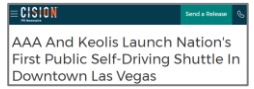
Industry coalition PAVE formed to drive AV awareness in Las Vegas



Public sentiment survey

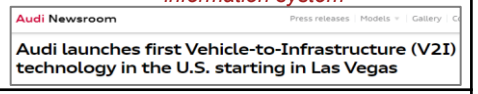
Ride-hailing market growth in LV

AV demo for public



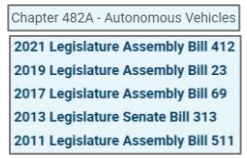
NCAR partners

Audi's V2X pilot for smart traffic light information system



'Smart Vegas' Strategy Document

NV AV Laws



US DoT grant for AVs in Las Vegas

Investments in LV AV ecosystem

NDOT AV Feasibility Study, 2019

Note: 1) AAA: American Automobile Association; 2) RTC: Regional Transportation Commission of Southern Nevada; 3) PAVE: Partners for Automated Vehicle Education
Source(s): PAVE, AAA, Nevada DOT, RTC, Nevada DMV, GovTech, NBC News, Company websites, Press releases, Expert interviews

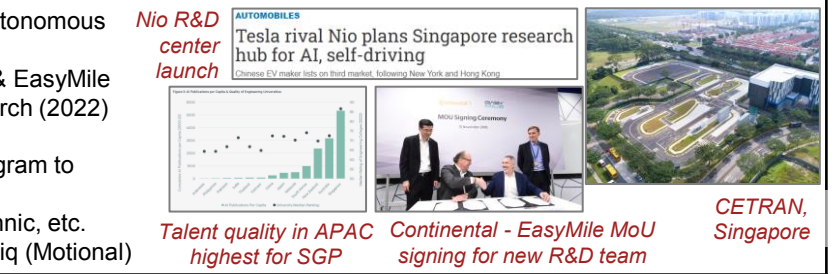
Singapore is an ideal test-bed for autonomous vehicles due to its strong infrastructure, talent, and govt. support

Location Profile: Singapore (1 of 2)

Singapore

Rating Legend	Poor	Average	Good	Very Good	Market Leading

	Metrics	Rating	Readiness Initiatives
1	R&D Capabilities	■■■■■	• In 2017, LTA[1], NTU[2] and JTC[3] set up the Centre of Excellence for Testing & Research of Autonomous Vehicles (CETRAN) and a test circuit of 1.8 hectares for AV trials at CleanTech Park • Many companies have setup AV R&D, e.g., Singapore is AV test-bed for Aptiv, Continental & EasyMile joint AV R&D team since 2018, Nio (Chinese EV co.) setup an R&D hub for AV and AI research (2022) • ~150+ AV-related patents in US and Singapore originated from Singapore • One of the top AI talent hubs globally, with big AI upskilling plans, e.g., IMDA[4] AI skilling program to reskill 18,000+ by 2026, SSIA[5] 6-month program starting Aug'24 to train ~150+ by 2029 • Several AVs on trials since 2014, e.g., Volvo bus in NTU, MooVita bus in Ngee Ann Polytechnic, etc. • 43+ models approved for testing, including of Audi, BMW, Chrysler Pacifica and Hyundai Ioniq (Motional)
2	Road and Urban Infrastructure	■■■■■	• Rank 1 on 'best roads in the world'; and one of the safest (2.2 fatalities / 100,000 capita), owing to good driving discipline, adequate markings, signages, and traffic control measures, e.g., Self-explaining roads • One of the most expensive real-estate globally, easy to buy but limited availability of commercial spaces • 3,600+ EV charging stations in 2023 (~0.6 per 1,000 capita), plans to expand to 60,000 stations by 2030 • C-ITS R&D at Singapore Science Park and a S$24M test-bed at NTU for C-V2X research using M1's 5G
3	IT, Cyber and Telecom Infrastructure	■■■■■	• 95+% outdoor areas are covered by 5G (SingTel), with speed of 376.8 Mbps, one of the fastest globally • Though 31st on global National Cybersecurity Index (NCSI); it ranks way up in other studies, e.g., 10th in Comparitech's study, 4th in GCI study (Global Cybersecurity Index) by ITU[5] (UN agency for ICTs) etc. • Private companies developing HD digital maps, e.g., NavInfo (collaborated with SGP govt.), Motional
4	Tech Development & Manufacturing Capacity	■■■■□	• All public roads in western Singapore, (1,000 km or 620 miles) are now open for AV testing • Motional doubled office and garage space in 2022, and hired more tech talent • In 2020, Hyundai and Desay (electronics co) announced their new innovation centers to work on AVs • ComfortDelGro investing S$30M in AV-related R&D in Singapore, between 2022-2027 • Singapore ranks top for AI readiness (Salesforce); and leads global AI & ML investment & adoption
5	Public Safety & Security	■■■□□	• Stringent govt. testing before approving to test on public roads ensures excellent public safety • Law-firm CMS's study concludes that OEMs will not be held liable, while liability of driver would be assessed using existing statutory and common laws; as no AV-dedicated liability framework exists • Mandatory to have liability insurance for AVs, or place a security deposit with the LTA

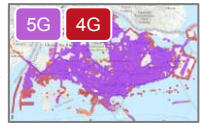


Nio R&D center launch — *Talent quality in APAC highest for SGP* — *Continental - EasyMile MoU signing for new R&D team* — *CETRAN, Singapore*

Self-explaining roads

EV infra target 2030

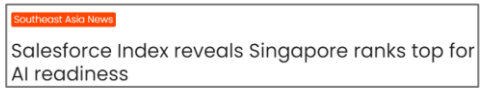
C-ITS investment



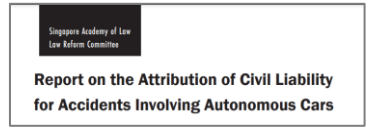
SingTel 4G-5G coverage

Cybersecurity ranking

Motional testing near expanded facility



Salesforce study on AI readiness



Evaluation of Singapore AV regulations for liability decisioning

Note: 1) LTA: Land Transport Authority; 2) NTU: Nanyang Technological University; 3) JTC: Jurong Town Corporation (Singapore); 4) IMDA: Infocomm Media Development Authority (govt. agency), 5) ITU: International Telecommunication Union

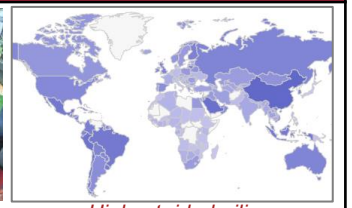
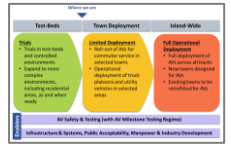
Source(s): LTA, NTU, IMDA, US PTO, CBRE Artificial Intelligence Tech Hubs: Asia Pacific Talent Spotlight, Zutobi, World Bank, Asia Property Awards, Quick Charge, NCSI, ComparitTech, ITU, NavInfo, Salesforce, SingTel, Wards Auto, SAL, Salesforce, CMS, Company websites, Press releases, Expert interviews

Singapore is an ideal test-bed for autonomous vehicles due to its strong infrastructure, talent, and govt. support

Location Profile: Singapore (2 of 2)

Singapore

Rating Legend	Poor	Average	Good	Very Good	Market Leading

	Metrics	Rating	Readiness Initiatives
6	Public Awareness & Societal Engagement	■■■■■	• Consumer acceptance studies conducted by SUTD[1] along with PTC[2] (2020), and by NTU (2018), in which public sentiment has remained moderate, and inclined towards AVs but not strongly • Govt. tries to spread public awareness and drive positive sentiment through exhibitions and dialogues, e.g., URA[3] exhibition "Reimagining Urban Mobility with Autonomous Vehicles" (2022) and SUTD "Driverless Mobility Dialogue" global dialogue participation in France (2019) • Highest ride-hailing penetration globally at 41% in 2023, to be 44% by 2027 (~2.7M users by 2027) • Initially testing was limited to a low population "One North" district (<1,000 people in 2020), but now entire Western Singapore has been opened-up for on-road testing, boosting public visibility  *AVs displayed at URA's AV exhibition*  *Highest ride-hailing penetration globally*
7	Public & Private Collaboration	■■■■■	• Strong public-private collaboration for AVs in Singapore, as evident from the most important TR68 AV regulations being prepared and reviewed by government in close collaboration with private players • Several AV trials being conducted in close collaboration between govt. and industry, e.g., CETRAN trials, NEA[4] and MOT AV sweeper truck trials in 2021, IMDA collab with industry for 5G-based AV services Singapore Standards TR 68-1:2021 TR 68-2:2021 TR 68-3:2021 *TR-68 can be purchased from Singapore Standards* *Sweeper truck trials in collaboration with private players* 
8	Organization & Governance	■■■■■	• Singapore set up of the Committee on Autonomous Road Transport for Singapore (CARTS) in 2014 to study and chart future for AV-enabled land mobility concepts in Singapore • LTA is the main approving body who sets the 'tests' (3 milestone levels of tests) conducted at CETRAN for AV approval, which is necessary for any AV trial to take place within designated zones in Singapore • Overall, Singapore has high openness to change, and adoption of AVs *LTA's 3 –milestone tests for AV approvals at CETRAN* Level 1 Assessment for Class 3 or Class 4 vehicles Milestone 1 Assessment for Class 3, Class 4 and AESV vehicles Milestone 2 Assessment for Class 3, Class 4 and AESV vehicles
9	Laws, Regulations and Incentives	■■■■□	• TR68 is a set of provisional national AV standards, published by LTA and SSC[6] in 2021, having guideline on the application of ML, S/W updates, cybersecurity principles, testing framework, etc. • AV grants have been launched in the past, e.g., the $20M grant by AI Singapore and Ministry of Defense to develop AVs in 2023; and LTA & URA's grant call for ideas on how to make SGP AV-ready (2020) • No dedicated tribunal or court for AV cases setup yet *LTA's roadmap for AV ecosystem in Singapore*  $20m grant set up to develop AI in self-driving vehicles, materials research for military, commercial uses *$20M grant setup by AI Singapore and Ministry of Defense*
10	Business Case Feasibility	■■■■■	• High population density, costly car ownership registrations, suitable climate & regulatory landscape, favorable consumer sentiment, multiple R&D investments in AVs, govt. support, etc. make a very strong business case for AVs in Singapore • Notable investments include those from SMRT Ventures (in MooVita), Yinson Holdings (to develop AV solutions), ComfortDelGro (S$30m in AV), Drive.ai ($15M from Grab et al. for new AV office space), etc. *"Singapore is important due to its suitable climate, modern infrastructure and left hand-side driving"* - Cody Kamin, Motional's Singapore Site Lead & Special Projects Director *Building an ecosystem needs public and private collaboration, legislation, cybersecurity, infrastructure, trust and socio-economic matters,"* - MooVita CEO Dilip Limbu

Note: 1) SUTD: Singapore University of Technology & Design; 2) PTC: Public Transport Council; 3) URA: Urban Redevelopment Authority; 4) NEA: National Environment Agency; 5) MOT: Ministry of Transport; 6) Singapore Standards Council

Source(s): SUTD, URA, NEA, MOT, AI Singapore, Statista, LTA, Singapore Standards, Channel News Asia, Company websites, Press releases, Expert interviews

Netherlands was once considered a front-runner for AV development but has since lagged behind

Location Profile: Netherlands (1 of 2)

Netherlands

Rating Legend	Poor	Average	Good	Very Good	Market Leading

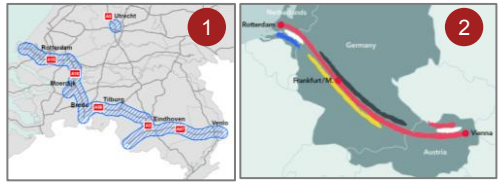
	Metrics	Rating	Readiness Initiatives
1	R&D Capabilities		• Multiple AV R&D initiatives, e.g., TomTom and University of Amsterdam's Atlas Lab for HD maps, "Roboat" 5-year program for self-driving boats by MIT and AMS[1], several Living Labs and R&D projects related to AVs at TU Delft (Delft University of Technology) like RADD[2], RAS[3], STAD[4], etc. • 450+ AV-related patents, majority registered in Netherlands, some in US • Only 6-7% of EU's AI talent resides in the Netherlands, however, ranks among the highest in Europe • Trials ongoing since 2015, including "WePod" bus trial (2016), Rotterdam AV-semi truck trial (2016), Mercedes-Benz's CityPilot AV bus trial (2019), C-ITS trials, AutoPilot trial in Brainport, etc.
2	Road and Urban Infrastructure		• 2nd best roads in the world after Singapore, and advanced motorways with electronic signalization • Very expensive commercial real estate, although prices have fallen in 2023 • Dense EV charging infra (112,000+ stations), ~6.0 stations per 1,000 capita, one of the highest globally • C-ITS Corridor being developed from Rotterdam-Vienna; NL is also part of the "C-Roads" initiative by EU member states for C-ITS, as part of which pilots running along the Dutch part of Rhine-Alpine corridor, formed by the Dutch motorway A2, A58, A16 and A15 as well as along the A2 in the city of Utrecht
3	IT, Cyber and Telecom Infrastructure		• NL has good 5G coverage, but slower speeds than global leaders • 5G speeds up to 177.6 Mbps and 4G speeds up to 91.1 Mbps • Although 20th on NSCI Cybersecurity Index; NL is a leading cybersecurity hub in Europe, home to Europe's largest security cluster of 275+ companies & govts., the Hague Security Delta (HSD) • UNECE[5] regulation for vehicle cybersecurity, the R155, has been in force since January 2021 • Mapping company TomTom working with University of Amsterdam to develop HD maps for AVs
4	Tech Development & Manufacturing Capacity		• Limited industry investments so far • Toyota created a new AV company "T-HIVE" in Netherlands, although focus is on automated guided forklifts (AGFs), automated guided vehicles (AGVs), and autonomous mobile robots (AMRs) • NL ranks 11th on Global AI Index indicating high maturity and welcomes AI and ML developments. It ranks 5th per the Eurostat statistics on the use of AI by businesses in Europe
5	Public Safety & Security		• No liability guidance exists for unmanned AVs as Art. 185 WVW (Wegenverkeerswet, Road Traffic Act) defines liabilities in case of AV crashes only when a driver is present; liability is on the owner of the car • Centraal Beheer, the car insurance unit of Achmea, was the 1st company in NL to cover shared AVs

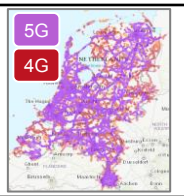

WePod AV bus


Mercedes AV Bus


Roboat, self-driving boat

(1) C-roads initiative's C-ITS pilot route in NL; and (2) C-ITS pilot route from Rotterdam to Vienna

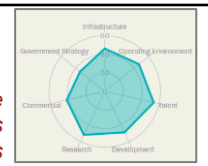





NL Cybersecurity performance

HD-mapping company sets up R&D lab in Amsterdam

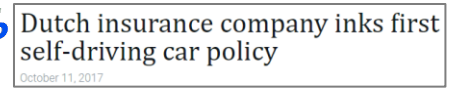
NL performance on AI Readiness parameters



Toyota setup AV company T-Hive in NL

Company offering AV insurance

Centraal Beheer



Note: 1) AMS: Amsterdam Institute for Advanced Metropolitan Solutions (AMS Institute); 2) RADD: Research lab Automated Driving Delft; 3) RAS: Research lab Autonomous Shipping Driving Delft; 4) STAD: Spatial and Transport impacts of Automated Driving; 5) UNECE: United Nations Economic Commission for Europe

Source(s): Tu Delft, AMS, US PTO, NL Patent Office, FDI Intelligence, LinkedIn AI Talent in the European Labor Market Report, C-Roads, OpenSignal, RDW, DC Velocity, Tracxn, Tortoise Media, CBI EU, Company websites, Press releases, Expert interviews

Netherlands was once considered a front-runner for AV development but has since lagged behind

Location Profile: Netherlands (2 of 2)

Netherlands

Rating Legend	Poor	Average	Good	Very Good	Market Leading

	Metrics	Rating	Readiness Initiatives
6	Public Awareness & Societal Engagement		• Witttenborg University of Applied Sciences Netherlands published a paper on "Public Opinion about Self-Driving Vehicles in the Netherlands" in 2018, based on a survey done on 100 Dutch residents, which concluded limited public awareness and excitement about AVs • No other major corporate or govt funded study evident • NL has limited ride-hailing adoption at ~13% in 2023, to be 14% by 2027 (~2.5M users by 2027) • All public roads open for testing, so likely that large chunk of population would be around test sites Public Opinion about Self-Driving Vehicles in the Netherlands — Arulanandam Jude Niranjan, Wittenborg University of Applied Sciences, Apeldoorn, the Netherlands, mathanajude@yahoo.com; Geert de Haan, Wittenborg University of Applied Sciences, Apeldoorn, the Netherlands, geert.de.haan@upcmail.nl *Consumer acceptance survey on AV in Netherlands*
7	Public & Private Collaboration		• Several public-private collaborations have happened for AV R&D and pilots, e.g., TomTom-UvA for HD maps, Dutch Integrated Test site for Cooperative Mobility (DITCM), Dutch Automated Vehicle Initiative (DAVI), AV pilot by NL-based digital mapping company AND, and Dutch government, STAD project, etc. *DITCM Test Site*  *DAVI Demo 2013* 
8	Organization & Governance		• No separate body created, the RDW[1] approves AVs for testing on public roads for which willing companies must first prove that the tests will be conducted safely and then apply for approval • CROW[2] set up a task force of road management authorities, and traffic safety experts from institutions such as the Institute for Road Safety Research (SWOV) to evaluate AV concepts and research • NL govt. was the 1st mover in EU for AV regulation (Declaration of Amsterdam for common AV legislation in EU, 2016), showing high openness to change and AV adoption • Ministry of Infrastructure and Environment published 'Smart Mobility' brochure in 2017 which talks extensively about NL's plans to develop AV ecosystem in NL, so does 'Smart Mobility Plan 2019-2025' Smart Mobility Programme 2019-2025 — *NL Smart Mobility strategy documents* — Ministry of Infrastructure and the Environment: Smart Mobility
9	Laws, Regulations and Incentives		• RDW has developed the procedure with inputs from the Ministry of Infrastructure and Water Management, the national aerospace laboratory NLR, and Delft University of Technology • It includes 5 key steps: Intake, Desk research, Testing, Admittance and Evaluation • No grant announced, however, several govt funded trials have happened and continue to happen, alongside several funded studies by NL universities *RDW AV Testing Guidelines* — RDW: Admittance procedure Connected automated vehicle
10	Business Case Feasibility		• Business case feasibility in NL is evolving as limited ride-hailing but high population density keeps market size open to debate and climate remains difficult during winters, while factors like regulations, consumer sentiment, R&D, infrastructure, etc. remain favorable • 14 AV startups in NL including HERE, TomTom, 2getthere, Yado-VR, Ibeo Automotive Eindhoven, etc. having investors like Bosch, SMRT, Intel Capital, TMI Investments, etc. *Funded AV startups in NL* — here, ibeo automotive, 2getthere, innoluce, TOMTOM, FieldBee, AIM, WEpods

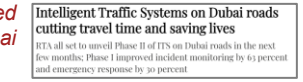
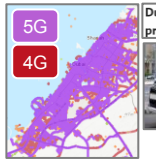
Note: 1) RDW: Netherlands Vehicle Authority; 2) CROW: Information and Technology Centre for Transport and Infrastructure
Source(s): ResearchGate, Statista, Tu Delft, Transdev, Tracxn, RDW, AI 4 Cities, Company websites, Press releases, Expert interviews

UAE's AV ecosystem development has gained pace with new AV regulations released and more testing kickoffs

Location Profile: UAE (1 of 2)

Dubai

Rating Legend	Poor	Average	Good	Very Good	Market Leading

	Metrics	Rating	Readiness Initiatives
1	R&D Capabilities		• Dubai Future Labs by Dubai Future Foundation is conducting R&D on CAVs for logistics use-cases • Dedicated zone "Smart & Autonomous Vehicles Industry" (SAVI) cluster launched in Masdar City, Abu Dhabi (UAE) for AV development, expected to add $33B to UAE economy • Dubai is emerging hotspot of AI talent in Middle-East, UAE "AI Office" plans to train 5,000+ on AI • No AV patents originating from Dubai (US PTO), nor any granted by UAE Patent Office • WeRide is 1st company to get 'national AV license' in UAE, Cruise 1st to get 'AV testing permit' in Dubai • Other companies testing in UAE include Alexander Dennis Lts. (ADL), BaseTracK (autonomous trucking) *AV last-mile delivery robot at Dubai Future Labs*   *EvoCargo AV truck in Dubai South*  *Dedicated AV zone in UAE*  *Cruise testing in Dubai*
2	Road and Urban Infrastructure		• UAE has one of the best and safest road networks globally (among Top 10 globally) per WEF • Dubai considered a more affordable destination for commercial real estate than global big cities • EV charging stations in Dubai to grow from 370 today (0.08 per 1000) to 1,000 (0.3 per 1000) by 2025 • Smart Traffic Management systems deployed but lack of evidence on C-ITS deployment • Dubai is set to host Intelligent Transport Systems (ITS) World Congress in Sep 2024  *Dubai to host ITS World Congress 2024* *ITS deployed in Dubai*  *EV charging stations to grow in Dubai* 
3	IT, Cyber and Telecom Infrastructure		• Dubai has one of the highest internet speeds globally (200+ Mbps), competes with Singapore • 89th on NCSI cybersecurity ranking, but 5th on Global Cybersecurity Index by Int'l. Telecom Union • Both public and private funded HD mapping in progress in Dubai as Dubai Municipality's Geographic Information Systems (GIS) Centre has begun building digital maps for AVs while Cruise also HD maps the city for its robo-taxis to operate commercially   *HD mapping* *UAE cybersecurity performance* 
4	Tech Development & Manufacturing Capacity		• Limited industry investments so far to setup AV R&D base in UAE, current ones include BaseTrack AV truck R&D and testing at Ras Al Khaimah Economic Zone and EvoCargo AV trials in Dubai South • UAE's deep focus on emerging tech like AI, IoT, EV, etc. is evident from having a dedicated Office for AI and appointment of a Minister of State for AI • Dubai R&D program launched with 4 strategic priorities including smart built infrastructure • 1.3% of GDP as R&D expenditure; $1.1B allocated for R&D by UAE govt.  *BaseTracK AV truck testing in UAE* *H.E.Omar Sultan Al Olama, Minister of State for AI, AI Office*  *UAE AI Office*
5	Public Safety & Security		• AV licensing criteria in Dubai include AV needs to be insured by a UAE insurer • UAE's new law to regulate AVs, "Law No. 9 of 2023 Regulating the Operation of Autonomous Vehicles in the Emirate of Dubai" fixes liability for damage by AVs on the "operator" of the vehicle, which can be the owner of the vehicle or others authorized to undertake activities related to their use, making them liable for compensation for damages to persons or property caused by the vehicle *UAE's new AV law holds "operator" liable for damages done by AV* 

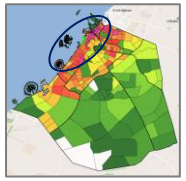
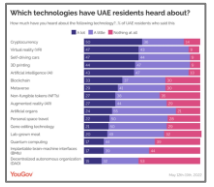
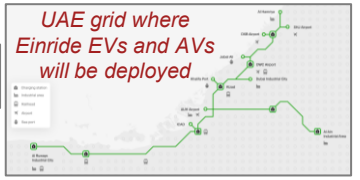
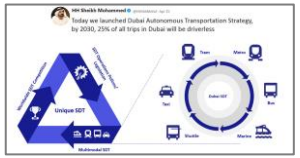
Source(s): UAE Ministry of Economy, SAVI, Dubai Future Foundation, WEF Travel & Tourism Competitiveness Reports, Statista, Dubai Electricity and Water Authority, NCSI, International Telecommunications Union (ITU), Govt. of Dubai Media Office, CNN, Wired, Company websites, Press releases, Expert interviews

UAE's AV ecosystem development has gained pace with new AV regulations released and more testing kickoffs

Location Profile: UAE (2 of 2)

Dubai

Rating Legend	Poor	Average	Good	Very Good	Market Leading

	Metrics	Rating	Readiness Initiatives
6	Public Awareness & Societal Engagement		• YouGov's AV survey in 2020 showed 46% public positive on AVs, while 27% felt AVs are unsafe, which had pivoted more positivity by YouGov 2022 survey on emerging technologies including AVs • Dubai RTA[1] organizes Dubai World Congress for Autonomous Vehicles (3rd edition completed in Sep 2023) to invite ideas & developments on AV tech, also helps spread AV awareness among Dubai public • High penetration of e-hailing cabs in UAE with a projected penetration of 40.5% by 2027 • <1% population resides in Jumeira 1 (Cruise's testing region), but is densely populated due to small area *Cruise is testing AVs in densely populated area Jumeira 1 of Dubai*  *YouGov survey results show positive sentiment for AVs in Dubai* 
7	Public & Private Collaboration		• Strong public-private collaboration evident from Cruise's partnership agreement with RTA for robo-taxis, under which Cruise remains the "exclusive provider" for robo-taxis in Dubai till 2029 • Dubai South and Evocargo have signed MoU to conduct UAE's first AV trials for cargo logistics • Einride signed MoU with the UAE Ministry of Energy and Infrastructure (MOEI) to deploy 2,000 EVs, 200 AVs and 8 charging stations along a 550 km freight mobility grid across Abu Dhabi, Dubai, and Sharjah • To further attract AV firms to UAE, government plans to hand out data to AV startups  *Public-private partnership for AV truck trials* *UAE grid where Einride EVs and AVs will be deployed* 
8	Organization & Governance		• Dubai Autonomous Transportation Strategy was developed to transform 25% of total transportation to autonomous by 2030 leading to a saving of AED 22Bn in annual economic revenue • RTA is the dedicated governing and licensing agency which also monitors compliance by operators • AV establishments to operate only after signing a contract with RTA • Dubai Police & Ambulance services to support the test runs and assess the results of the testing stage *Announcement of Dubai Autonomous Transportation Strategy on Twitter (now X)* 
9	Laws, Regulations and Incentives		• Dedicated law for AVs issued in 2023: "Law No. 9 of 2023 Regulating the Operation of Autonomous Vehicles in the Emirate of Dubai", sets out provisions to govern the licensing and regulatory framework, as well as operational standards for autonomous • Types of AV, areas of operation, licensing, permissions etc. to be managed by RTA • RTA awarded winners of 'Dubai World Challenge for Self-Driving Transport' $2.3M ($2M to Industry Leaders category and $300k to the Local Academia category), incentivizing further R&D in AVs  *Winners of Dubai World Self Driving Challenge 2023: 1) King Long by AG Auto, 2) BrightDrive, and 3) Heriot-Watt University of Dubai*
10	Business Case Feasibility		• Dubai ruler's vision of turning 25% transport into autonomous mode by 2030 is a big boost to AV • RTA has been instrumental in enabling data collection and supporting testing by Cruise • Favorable government support, high population density, investment in R&D and world- class road and urban infrastructure make a strong business case for AV market in Dubai *"Data collection and testing is a crucial phase in Dubai's quest for excellence in smart mobility. The work being done will ensure Cruise's advanced generalizable AI and autonomous driving systems safely adapt to Dubai traffic conditions"* - CEO of the Public Transport Agency at RTA

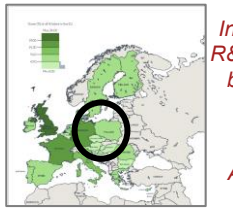
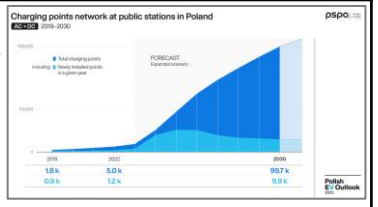
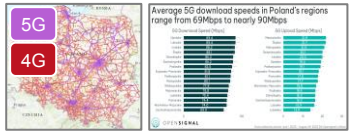
Note: 1) RTA: Roads and Transport Authority, Dubai
Source(s): YouGov, Statista, RTA, Dubai Government, Reuters, Company websites, Press releases, Expert interviews

Poland is pushing for AV ecosystem but weak performance across pillars make for average business case

Location Profile: Poland (1 of 2)

Poland

Rating Legend	Poor	Average	Good	Very Good	Market Leading

	Metrics	Rating	Readiness Initiatives
1	R&D Capabilities		• Intel's Gdansk R&D facility, its biggest in EU, focuses on tech like AV, AI, data security, etc. • Aptiv's one of the most advanced and AV-focused R&D centers is in Krakow, along with a special test track (SmarTrack), which is also the 1st test track for AVs in Poland • Only ~3% of EU AI talent is in Poland, however, many companies like Aptiv, Intel, Volvo, etc. growing R&D investments in the region is a positive indicator for growing tech talent in the region • Only 5 US patents have people from Polish origins; no AV patents in Poland Patent office database • Testing of AV buses carried out in Katowice (Oct-Nov 2023) and Gdansk (Sep 2019) *% of AI Talent in EU by country*  *Intel's Gdansk R&D center, its biggest in EU*  *Aptiv's SmarTrack AV test track, Krakow* 
2	Road and Urban Infrastructure		• Average road quality (57 out of 141 per WEF), with inadequate lane markings & road signages • 75% European real estate investment firms consider Poland "extremely desirable" for investment • Kraków and Wroclaw, the biggest office markets in Poland constitute 2.7M+ sq. mt. 'office spaces' • Poland also an attractive warehousing market, with 4M+ sq. mt. warehousing space up for grabs (2020) • EV charging points to grow from ~5k today to ~100k by 2030 (from 0.12 to >2 per 1,000 capita) • No C-ITS trials or deployments, but ITS investments on eTOLL (toll collection) and CANARD (connected photoradars), while ITS Polska public-private partnership established for smart city tech implementation  *Quality of Roads EU ranking* *EV charging points growth in Poland 2019-2030* 
3	IT, Cyber and Telecom Infrastructure		• Limited 5G penetration, barring in big cities, although growing rapidly; slow 5G speeds (upto 89 Mbps) • One of the world leaders in cybersecurity (11th on NCSI rankings) • Government authorities conducting HD mapping, e.g., City of Jawornzo has mapped streets and their surroundings to create a 3D digital map to support AVs  *5G Speeds in Poland* *Poland cybersecurity performance* 
4	Tech Development & Manufacturing Capacity		• Intel investing €72M to expand Gdansk R&D facility to boost AV development; Aptiv's Krakow R&D center is heavily invested in AVs, and Robotec.ai (Warsaw) develops AV software • Volvo opening new "tech hub" in Krakow, Poland to develop future EV software in-house • In Oct 2022, the SDCM[1] organized the "XVII Automotive Industry and Market Congress", where one of the panels was devoted to automation of transport and other technological challenges and Polish law • Otherwise, limited industry investments on AV R&D *Intel's investment in Gdansk*  *SDCM's Auto Conference*  *Aptiv's R&D center, Krakow* 
5	Public Safety & Security		• AV testing approvals mandate a civil liability insurance to compensate for any damage caused by AVs • Currently no liability rules specific to AVs are available, general liability regime is applicable which holds vehicle possessor (or driver) responsible, while OEMs held responsible only when structural flaws found • AV testing approvals are only given after residents and local police certify they have no objections *"There are many legal, infrastructural and technological challenges to be solved, for example, the law, in many cases, does not keep pace with technical development" - Head of the Motor Transport Institute's Connected and Autonomous Vehicles Competence Center*

Note: 1) SDCM: Polish Association of Automotive Parts Distributors and Manufacturers
Source(s): USPTO, WEF, NCSI, MIT Technology Review, OpenSignal, Electrek, Voice of Europe, Viborc, PSPA, Dentons, Company websites, Press releases, Experts

Poland is pushing for AV ecosystem but weak performance across pillars make for average business case

Location Profile: Poland (2 of 2)

Poland

Rating Legend	Poor	Average	Good	Very Good	Market Leading

	Metrics	Rating	Readiness Initiatives
6	Public Awareness & Societal Engagement		• Drive 2 The Future Warsaw AV pilot team surveyed Poland residents, sentiment was largely positive • 2014 study named Poland among the most AV-friendly countries in EU, only 35% residents against AVs • In June 2022, the Polish Motor Transport Institute organized an international conference "AV-POLAND Autonomous Future of the Road Transport", the biggest AV-related event of the year in Poland • Ride hailing: # of users to grow to ~10M by 2027, taking penetration from 21% (2023) to 25% (2027) • <5% population near AV test sites (Warsaw, Gdansk), keeping public awareness levels low *"AV-POLAND Autonomous Future of the Road Transport"" international conference on AVs conducted in Warsaw, Poland* 
7	Public & Private Collaboration		• Several AV pilots have been conducted in public private partnership, e.g., Sohjoa Baltic project (2019), AV tram testing in Krakow (2020) by Krakow University of Technology, Newag, Cybid, Medcom., etc. • AV Working Group established in Gdańsk (2020), consisting the region's Governor, AV companies and scientists, to create the conditions for the development and sale of AV and related products & services • In July 2019, the Mayor of Rzeszów signed an LoI with telecom, cybersecurity and network infrastructure companies for 5G deployment to support the introduction of autonomous buses in the city *AV tram tested in Krakow*  *AV minibuses testing as part of Sohjoa Baltic project* 
8	Organization & Governance		• No dedicated body governs approvals; testing applications are responded to by local traffic authority responsible for management of the road on which the testing is planned, who consults residents and local police before approving AV testing applications • Poland government is open to AVs as evident from initiatives taken so far, e.g., conferences, pilots, etc. *AV regulation summary by CMS* 
9	Laws, Regulations and Incentives		• Act on Electromobility and Alternative Fuels (2018) allowed conditional AV testing on public roads • In 2019, "Strategy for Sustainable Development in Transport until 2030" was adopted by govt., pledging support to AV adoption and defining the rules for AV testing • Ministry of Infrastructure launched "Poland's Road to Transport Automation" (AV-PL-ROAD) project for AV adoption which led to establishment of the Autonomous and Connected Vehicles Competence Center (CK: PAP) to support government administration in the efficient and safe implementation of AVs • Flipside: Strict testing regulations are a big roadblock, e.g., requirements of residents' approvals, driver presence, special license plate (obtainable on 1st registration only so new car purchase needed), etc.  *Launch of Competence Centre for Autonomous and Connected Vehicles at AV-POLAND 2021 Conference*  *Strategy for Sustainable Development in Transport until 2030*
10	Business Case Feasibility		• Though Poland has unfavorable weather conditions compared to other leading AV test markets globally, however, good population density in its largest cities, favorable public sentiment, evolving regulations & government support and growing R&D investments in the region by auto companies build a good case for AV ecosystem development in the long run *"There are problems with organizing testing. Changes to the infrastructure also seem to be urgent in Poland as it is not always in a good condition, and sometimes it does not meet the requirements of autonomous vehicles"* - President of the Polish Automobile and Motorcycle Federation

Source(s): ScienceDirect, Dentons Global Guide to Autonomous Vehicles 2023, connectedautomateddriving.eu, Poland Government website, Notes from Poland (news portal), Statista, Drive 2 The Future, Company websites, Press releases, Expert interviews

Agenda

1. Autonomous Vehicle (AV) Technology Overview
2. Key Considerations for AV Rollout
3. AV Players Overview
4. OEMs Role in AV Technology
5. Market Scorecard for AV Readiness
6. **Ukraine Overview**
   - Baseline
   - Opportunities
   - Initiative Development (Short, Medium, and Long-Term)
     - Example Organizations
7. Appendix

6.1 Ukraine Baseline

Ukraine has decent R&D & IT capabilities but lacks urban infra., measures around public engagement and safety and AV regulations

Rating Legend: Poor | Average | Good | Very Good | Market Leading

Key Pillars to Deploy AVs	Current Ukraine Status	Description
R&D Capabilities		• There are 7 active tech hubs with R&D centers for companies like Google & Samsung, however, Ukraine **lacks research in AV technology** • Several engineers & technicians are working in auto industry, but **they have been drafted for war**
Road & Urban Infrastructure		• Road infrastructure **quality is lacking**, however, real estate prices are reasonable with specific investment areas to attract tenants being identified • Although there are 3,200 charging stations, however **only 25% of them are faster than 22 kW**
IT, Cyber, and Telecom		• 4G connectivity is offered by 3 operators, while there is **a lack of licenses to roll out 5G** • **HD map of cities/country isn't available** • Some cybersecurity measures have been taken & **UA has gained ranking in Worldwide Cybersecurity Index**
Tech Development & Manufacturing Capacity		• Tech firms such as **Google, Samsung, & Lyft have invested in R&D centers** & M&A with local players • Both **government backed IoT programs and related university-level courses** are currently in place
Public Safety & Security		• There is **no clearly defined liability** for an accident involving autonomous vehicles in Ukraine • There are **no AV specific insurance policies** in Ukraine
Public Awareness & Societal Engagement		• There are currently **no AV testing sites in Ukraine**, and **public awareness on AVs is limited** • Although UA sees 100 million rides annually, it **still lags major markets** (Singapore sees >200M taxi rides annually, SF alone sees ~50M rides annually) where AV deployment is starting to ramp
Public & Private Collaboration		• While there is **no AV-specific public-private collaborations**, the government encourages AV/tech players' further development **by creating favorable tax conditions under Diia.city**
Organization & Governance		• The government is **open towards AVs** and aims to create competitive conditions for its R&D market • Additionally, **a special legal and tax regime for IT players** is provided through Diia.City
Laws, regulations & Incentives		• Currently there are **no dedicated gov. bodies dealing with AVs**, and no specific regulations are in place • Current incentives on innovation & foreign investment that apply to EVs could be extended to AVs
Business Case Feasibility		• **VCs invested $1bn in IT companies in 2022**, favoring web3, mil-tech, and artificial intelligence areas • Currently, only 6 out of 18 PE funds operating for more than a year keep operating despite the war

Details of Ukraine's status across each pillar are on upcoming slides

R&D Capabilities include a region's technical capabilities, indicated by presence of innovation centers, talent, patents and ongoing testing

Current Ukraine Status (Pillar 1 of 10)

1. R&D Capabilities

Rating Legend: Poor | Average | Good | Very Good | Market Leading

Metric Elements		Description	Criticality to AV[1]	Current Ukraine Status	Existing Initiatives
1.1	R&D Centers/ Innovation Hub	Presence of R&D centers or innovation hubs focused on AV development	2		• Ukraine has 7 tech hubs in big cities: Kyiv, Odesa, Dnipro, Lviv, Kharkiv, Mariupol (non-active), Chernihiv (1) • In Kyiv there is the UNIT.City Innovation Park aiming to become the biggest innovation district in Europe. (1) • There is also the National IP&Innovations Hub supported by Department of Innovation Development and is a powerful center for innovation that supports research, development, commercialization of IP rights and technology transfer that encourages investment in Ukraine's economy and promotes job creation (1) • Global tech companies, such as Google and Samsung have their R&D centers in Ukraine.
1.2	AV-related Patents	# of AV-related patents originating from the region	1		• There are 2 AV-related patents in Ukraine, none of which is active; - Intelligent control system for AV using a transport portal and GPS-system by Kharkiv National Automobile And Highway University, Oleg Nikonov (1). - A method of controlling the intelligent system of an AV using a transport portal and a GPS-system by Kharkiv National Automobile And Highway University, Oleg Nikonov (1).
1.3	Talent Pool	Availability of AV-trained talent, including engineers, vehicle drivers or operators, repair technicians, etc.	3		• There are 16 Ukrainian software development companies, which already providing AV-related services to the leading global automotive companies (1) (2). According to various estimates, about 2,000 engineers are working on automotive projects in Ukraine, of which about 800 are GlobalLogic specialists (4). The team of Ukrainian engineers creates the Highway Pilot function, which allows autonomous driving of a part of daily trips on highways, the Collision Avoidance function for emergency braking, acceleration and maneuvering, the Driver support function for controlled automated driving, and the Connected Roadview function for assessing road conditions, which helps plan routes and share information about road conditions with other cars in real time (5). • There is a great demand for vehicle drivers or operators, repair technicians, etc. on the labor market of Ukraine, but a large number of such specialists have already been mobilized into the Armed Forces of Ukraine (3).
1.4	Testing / Commercial Ops In Progress	Testing / Commercial operations in progress or openness to commence	4		• There are several initiatives for developing test sites for autonomous technologies, for example test site for the military or a mixed-use vehicles by cluster for the development of Defense Tech in Ukraine named Brave1 (1) and test site for autonomous vehicles in the Zakarpattia region by Zakarpattia Automotive Cluster (2). • In 2021, Nissan ProPilot 2.0 autonomous driving system has already been tested on Ukrainian roads. (1). • Since 2019, AV already exist and are being tested by INFOCOM Ltd. especially for military and civilian transportation purposes (1): - AV based on KRAZ called "Spartan" with purpose to protection, patrolling, cargo delivery, evacuation etc. - Autonomous trucks based on BelAZ for use in difficult mining conditions: they move in autopilot on a given route in a convoy and transport goods without downtime. - Autonomous passenger cars based on the Jeep and Lanos (future taxis or private cars) with "autopilot" system.

Note: 1) Criticality to AV indicates the extent to which the respective metric element can influence a company's decision to invest on AV development in the target region
Source(s): Company websites, Press releases, External Research, Expert interviews

1	2	3	4
Good to have	Somewhat critical	Moderately critical	Highly critical

Road and Urban Infrastructure metrics include road quality, EV charging points and smart traffic management systems

Current Ukraine Status (Pillar 2 of 10)

2. Road & Urban Infrastructure

Rating Legend: Poor | Average | Good | Very Good | Market Leading

Metric Elements		Description	Criticality to AV[1]	Current Ukraine Status	Existing Initiatives
2.1	**Quality of Roads**	Indicative of road surface quality and pothole density	1		• Ukraine ranked 114th out of the 141 countries in the Global Competitiveness Index 2019 ranking by quality of road infrastructure.
2.2	**Traffic control enablers**	Lane markings and dynamic or static traffic/road signs on the roads	1		• Ukraine ranked 114th out of the 141 countries in the Global Competitiveness Index 2019 ranking by quality of road infrastructure. • In Ukraine, LED road signs with variable information are used, which are developed in accordance with the requirements of EN 12966-1: 2005.
2.3	**Real Estate Availability**	Real estate to build parking spaces for AV fleets, R&D center, office, etc.	4		• Unit.City is an innovation district located in Kyiv, which is one of the key R&D and startup centers in Ukraine. The approximate rental price per 1 square meter starts at $50. • Real estate for car storage can be located both on the territory of warehouses and on specially designated car parking areas. The approximate rental price per 1 square meter starts at $5 for both places in Kyiv. • The Industrial Park "Solomonovo" is a technologically advanced zone in the field of mechanical engineering designed for establishing new automobile components manufacturing units. A free investment site covering 41 hectares has been designated for the establishment of production facilities for prospective tenants.
2.4	**EV Charging infrastructure**	# of EV charging points per capita or per mile basis	4		• In Ukraine there are approximately 3,200 public charging stations, with approximately 11,000 connectors (for 172,400 km (107,100 mi)). Often such charging stations are not located at regular gas stations, but in hard-to-reach places (1). Only about 25% of them are equipped with fast charging ports over 22 kW. The information is based on 15 charging station operators and six providers (2).
2.5	**Cooperative Intelligent Transport Systems (C-ITS)** or **Smart Traffic Management Systems**	• C-ITS includes intelligent transport systems for V2X, direct and Dedicated Short-Range Communications ITS Generation 5 (DSRC/ITS-G5) technologies • C-ITS accuracy can be enhanced by Global Navigation Satellite System (GNSS), Differential GNSS (DGNSS) or real-time kinematic (RTK) positioning systems	2		• Ukraine has adopted the national standard DSTU: 16157 which is an accurate translation of EN 16157-3:2018 Intelligent transport systems – DATEX II data exchange specifications for traffic management and information – Part 3: Situation Publication. • In 2021, Kyiv also planned to introduce an intelligent transportation system that would save up to 20% of road users' time. For this purpose, it was planned to use up to 6,000 CCTV cameras to monitor traffic flows in Kyiv.

Note: 1) Criticality to AV indicates the extent to which the respective metric element can influence a company's decision to invest on AV development in the target region
Source(s): Company websites, Press releases, External Research, Expert interviews

1	2	3	4
Good to have	Somewhat critical	Moderately critical	Highly critical

IT & Telecom Infrastructure metrics include internet speeds, cybersecurity and high-definition maps availability

Current Ukraine Status (Pillar 3 of 10)

3. IT, Cyber and Telecom Infrastructure

Rating Legend: Poor | Average | Good | Very Good | Market Leading

Metric Elements		Description	Criticality to AV[1]	Current Ukraine Status	Existing Initiatives
3.1	**Wireless connectivity and internet speeds**	4G and 5G penetration	3		• There are three mobile operators in Ukraine that provide 4G services. None of them, or other non-4G operators, have 5G coverage due to the lack of licenses to roll out 5G technology. • As for the coverage, 99% of the cities and 95% of the villages has 4G coverage (1)
3.2	**Cybersecurity**	Cybersecurity index ratings, indicative of quality of cybersecurity measures in place, in the country	4		• The International Telecommunication Union has published the 2020 Global Cybersecurity Index study of 194 countries. Ukraine ranked 78th in the global ranking. • Also, Ukraine ranked 25th out of 160 countries in the new version of the National Cyber Security Index 2020 (NCSI), published by the e-Governance Academy of Estonia. The following indicators have been considered: cybersecurity legislation in force, national-level cyber threats, cybersecurity education, ensuring the protection of services, including electronic, electronic identification and trust services, protection of personal data, measures to respond to cyberattacks and cyber incidents, fight against cybercrime.
3.3	**HD Digital Maps**	HD digital maps of highways, motorways, city streets, etc.	4		• Digital maps of city streets and roads are provided by Google Maps, Waze, Apple Maps, OpenStreetMap etc. • Google's latest Street View was updated in 2015.

Note: 1) Criticality to AV indicates the extent to which the respective metric element can influence a company's decision to invest on AV development in the target region
Source(s): Company websites, Press releases, External Research, Expert interviews

1	2	3	4
Good to have	Somewhat critical	Moderately critical	Highly critical

Tech development metrics for a region are assessed by penetration of new technologies, and the total AV-related R&D investments so far

Current Ukraine Status (Pillar 4 of 10)

4. Tech Development & Mfg. Capacity

Rating Legend: Poor | Average | Good | Very Good | Market Leading

Metric Elements		Description	Criticality to AV[1]	Current Ukraine Status	Existing Initiatives
4.1	**R&D investments by Industry**	R&D investments made or committed by firms to set up R&D facilities dedicated to AV, conduct AV-related research, test or pilot AVs, hire or develop AV talent pool in the region, etc.	3		• Samsung invested $365 million in the Ukrainian R&D center in 2009 (1). The R&D center employs more than 600 people, including 450 R&D engineers. The focus of Samsung's Kyiv center is math- and algorithm-intensive software and hardware research, computer vision, as well as cybersecurity, AI and realistic graphics. Since its foundation, the R&D center has filed 232 patents. Based on the open hiring process we can assume that the R&D center is active (2) despite the damage caused by the missile attack (3). • In November 2019, Google bought CloudSimple with an office in Kyiv, and in January 2020, the employees of CloudSimple's Kyiv office became employees of Google's Kyiv office (1). At the time of opening, the office was the 3rd of 8 Google offices in the CEE region with an R&D center. In the autumn of 2022, Google also acquired cybersecurity company Mandiant, whose Ukrainian employees joined the company's the R&D center (2). • Lyft, America-based ride-sharing company, opened the R&D center in Kyiv in 2021 (1). The R&D center focuses on collecting and maintaining the most up-to-date and accurate mapping data; developing algorithms, models and platform services to provide the basis for Lyft's current and future offerings. • It-Jim is an R&D company that provides consulting services focused on the intellectual processing of visual information and technical solutions in computer vision, image and signal processing, machine and deep learning, augmented and mixed reality (1). Portfolio of It-Jim includes Object Recognition in Radar Images, Road Detector and People Tracker (2). In 2023 the company announced an opening of the R&D center in Kharkiv (3).
4.2	**Next-gen Tech Adoption**	Adoption and development of AI, Cloud and IoT tech in country	3		• In 2022 the Kyiv City Administration has implemented a project to build a municipal backbone network and infrastructure for the implementation of the Internet of Things (1). • In 2019, mobile operator Vodafone Ukraine, together with the State University of Telecommunications, developed the first educational programme on the Internet of Things in Ukraine (1). • In 2020, the Ministry of Digital Transformation of Ukraine published a public discussion of the Concept for the Development of Artificial Intelligence in Ukraine till 2030 (1).

Note: 1) Criticality to AV indicates the extent to which the respective metric element can influence a company's decision to invest on AV development in the target region
Source(s): Company websites, Press releases, External Research, Expert interviews

1	2	3	4
Good to have	Somewhat critical	Moderately critical	Highly critical

Public safety and security are determined by presence of steps to ensure safety of life and property of the public

Current Ukraine Status (Pillar 5 of 10)

5. Public Safety & Security

Rating Legend: Poor | Average | Good | Very Good | Market Leading

Metric Elements		Description	Criticality to AV[1]	Current Ukraine Status	Existing Initiatives
5.1	**Incident Liability Frameworks**	Framework clearly defining who owns liability in case of accidents or serious traffic disturbances	1		There is no clearly defined liability for an accident involving autonomous vehicles in Ukraine.
5.2	**Insurance Landscape**	Insurance policies developed and in-use for AVs	4		There are no such insurance policies in Ukraine.

Note: 1) Criticality to AV indicates the extent to which the respective metric element can influence a company's decision to invest on AV development in the target region
Source(s): Company websites, Press releases, External Research, Expert interviews

1	2	3	4
Good to have	Somewhat critical	Moderately critical	Highly critical

Public awareness and acceptance metrics revolve around public's awareness and potential openness to adopting AVs

Current Ukraine Status (Pillar 6 of 10)

6. Public Awareness & Societal Engagement

Rating Legend: Poor | Average | Good | Very Good | Market Leading

Metric Elements		Description	Criticality to AV[1]	Current Ukraine Status	Existing Initiatives
6.1	**Consumer Acceptance Surveys**	Govt or private-player surveys assessing public sentiment and awareness levels of AV	1		Not available
6.2	**Public Awareness Campaigns**	Public awareness campaigns by govt or private players	1		Not available
6.3	**Public Sentiment**	Consumer and local media / tech influencer sentiment on AV	2		Articles from the media about what autonomous vehicles are, what companies are producing them, what the future holds for them, etc. YouTube reviews on why autonomous cars are good / bad, which car has the best autopilot, when we are going to move to fully autonomous cars, etc.
6.4	**Ride-hailing Adoption**	Ride-hailing app / online taxi service booking penetration	3		100 million rides in Uber, Bolt, Uklon, and others. This is about 20% of the total volume of passenger transportation in the country
6.5	**Share of Population near Testing Sites**	# of people living in areas where testing being done and test AV are visible to them; safety-proving demos or trials conducted for public	1		As of now there are no AV testing sites in Ukraine.

Note: 1) Criticality to AV indicates the extent to which the respective metric element can influence a company's decision to invest on AV development in the target region
Source(s): Company websites, Press releases, External Research, Expert interviews

1	2	3	4
Good to have	Somewhat critical	Moderately critical	Highly critical

Public-private collaboration is about industry and government coming together to jointly develop AV ecosystem

Current Ukraine Status (Pillar 7 of 10)

7. Public & Private Collaboration

Rating Legend: Poor | Average | Good | Very Good | Market Leading

Metric Elements		Description	Criticality to AV[1]	Current Ukraine Status	Existing Initiatives
7.1	Public & Private Collaboration	Any collaboration between infrastructure operators, AV developing companies, and government or institutions	2		There is no AV-specific Public & Private collaborations. Meanwhile, the government encourages infrastructure operators and AV/tech developing companies for their further development by creating best tax conditions under Diia.city (1). Recently, the decision of the Cabinet of Ministers will allow companies engaged in the design of drones, maintenance, repair of ships and their components, as well as training of drone operators, to join Diia.city (1).

Note: 1) Criticality to AV indicates the extent to which the respective metric element can influence a company's decision to invest on AV development in the target region
Source(s): Company websites, Press releases, External Research, Expert interviews

1	2	3	4
Good to have	Somewhat critical	Moderately critical	Highly critical

Dedicated government agency to govern and enable accelerated AV development, and a progressive government are important

Current Ukraine Status (Pillar 8 of 10)

8. Organization & Governance

Rating Legend: Poor | Average | Good | Very Good | Market Leading

Metric Elements		Description	Criticality to AV[1]	Current Ukraine Status	Existing Initiatives
8.1	**Dedicated Government Agency Set-up**	• Dedicated government agency setup as single PoC for all regulatory matters, policies, approvals, decisions, etc., • Clear roles and responsibilities of key personnel in the position(s) holding decision making powers defined	3		• The State Regulatory Service of Ukraine is a central executive body, whose activities are directed and coordinated by the Cabinet of Ministers of Ukraine, which implements the state regulatory policy and policy in the field of supervision (control) in the field of economic activity, is a specially authorized body for licensing and permitting system in the field of economic activity and coordinates actions on simplification of the regulatory framework and deregulation of economic activity (1) (2).
8.2	**Government Readiness to Change**	• A measure of how open is the government to adoption of new technologies like AV • Active interest in AV policy-making, positive opinions expressed in public commentary, AV whitepaper roll-outs, public vote gathering, etc. show readiness for change	2		• The Ukrainian government is open to the introduction of new technologies, such as AV and aims to create highly competitive conditions for the R&D market for such technologies in Ukraine. • Additionally, the government provides a special legal regime for IT businesses through Diia.City, which provides a favorable legal and tax regime for IT companies. IT companies engaged in research and development in the IT and telecommunications sectors can become Diia.City residents (1) (2).

Note: 1) Criticality to AV indicates the extent to which the respective metric element can influence a company's decision to invest on AV development in the target region
Source(s): Company websites, Press releases, External Research, Expert interviews

1	2	3	4
Good to have	Somewhat critical	Moderately critical	Highly critical

Laws, Regulations and Incentives cover all legal instruments required to enable smooth roll-out and functioning of AVs in a region

Current Ukraine Status (Pillar 9 of 10)

9. Laws, Regulations, and Incentives

Rating Legend: Poor | Average | Good | Very Good | Market Leading

Metric Elements		Description	Criticality to AV[1]	Current Ukraine Status	Existing Initiatives
9.1	**AV regulations**	Existence of AV-focused regulations guiding R&D, testing, manufacturing and use of AVs in the region	3		There is no AV-focused regulations.
9.2	**Govt. Grants and Incentives**	• Government grants or incentives for R&D, manufacturing and sales of AV • Incentives to buyers (e.g., discounts or tax waivers)	2		**Incentives for innovations and foreign investment, that can be applied to AV:** • The Law «On state support of investment projects with significant investments in Ukraine» provides state support for investment projects (exemption from certain taxes and import duties, land plot for use etc.), if such projects meet prescribed conditions; • The Law "On Public-Private Partnership" stipulates that public-private partnership is applied in the field of construction and/or operation of highways and roads. Support can be provided by state and local guarantees, construction of highways, engineering communications, etc. • The Law "On Priority Areas of Innovation Activity in Ukraine" provides that to implement the priority areas, the state takes measures to development of innovation infrastructure tax, customs and currency preferences. • The Law "On Innovative Activities" prescribes the provision of financial support to innovative activity in Ukraine. **Incentives for electric vehicles** Last October, the Ukrainian parliament made some changes and additions to the current law on the registration of electric cars. Such cars can be imported into the country without paying VAT and customs duties. VAT exemption extended until 2026. The owner of vehicles with an electric motor has to pay only excise duty. Its cost depends directly on the power of the car and amounts to EUR 1 per kWh of battery capacity (1).
9.3	**Courts / Grievance redressal Tribunal setup for AV**	Dedicated grievance redressal court or regulatory body for AV related matters for faster resolution	1		There are no special courts or bodies in Ukraine that specialize in autonomous vehicles. **The Ministry of Digital Transformation of Ukraine**, which deals with robotics, and **the Ministry for Communities, Territories and Infrastructure Development of Ukraine**, which is responsible for transport infrastructure facilities, are the most relevant authorities for AV-related matters.

Note: 1) Criticality to AV indicates the extent to which the respective metric element can influence a company's decision to invest on AV development in the target region
Source(s): Company websites, Press releases, External Research, Expert interviews

1	2	3	4
Good to have	Somewhat critical	Moderately critical	Highly critical

Business case metrics primarily include existing investor activity and evidence of possible returns in the foreseeable future

Current Ukraine Status (Pillar 10 of 10)

10. Business Case Feasibility

Rating Legend: Poor | Average | Good | Very Good | Market Leading

Metric Elements		Description	Criticality to AV[1]	Current Ukraine Status	Existing Initiatives
10.1	Feasibility studies	Past, ongoing or planned studies on AV business case for the country or region	1		• Concept of “Zakarpattia Automotive Cluster” for development of the AV testing and experimentation facilities on the basis of the Industrial Park "Solomonovo"(1).
10.2	Return on Investments	• Scale of returns on investment • Timeline of returns on investment turning positive	4		• There aren’t defined average timeline and scale of investments returns. • According to the deputy head of the Ministry of Digital Transformation, Ukrainian IT companies attracted up to $1 billion in venture capital investment in 2022, with web3, mil-tech, and artificial intelligence attracting the most interest from investors (1). • Venture capital investment in Ukraine has slowed down somewhat during the war, but has not stopped. Funds are investing in companies they already cooperate with, as well as looking for new partnerships. Ukrainian funds mainly invest at the seed round, while American and European funds invest at large rounds. The key trends are military-tech and cybersecurity developments (1),
10.3	Existing Investor Activity	• Private Equity participation • Evidence of M&A deals in the market • Scale of existing investments on AV development	2		After February 24, 2022 the Ukrainian IT market saw a decrease in the number of investments. Out of 18 active local investment funds that have been operating in Ukraine for more than a year, only 6 that continued their work despite the war. At the same time, 8 new ones were added: 3 were launched before the invasion, and 5 more in the first few months after (1). List M&A transactions in Ukraine by sector in 2021-2022 is provided here. New investment opportunities are also connected with electric vehicles and batteries, with Ukraine possessing Europe’s largest lithium reserves. This lithium advantage bodes well for the future with the growth of electric car sales globally set to make Ukraine an increasingly important player in new technology auto production.

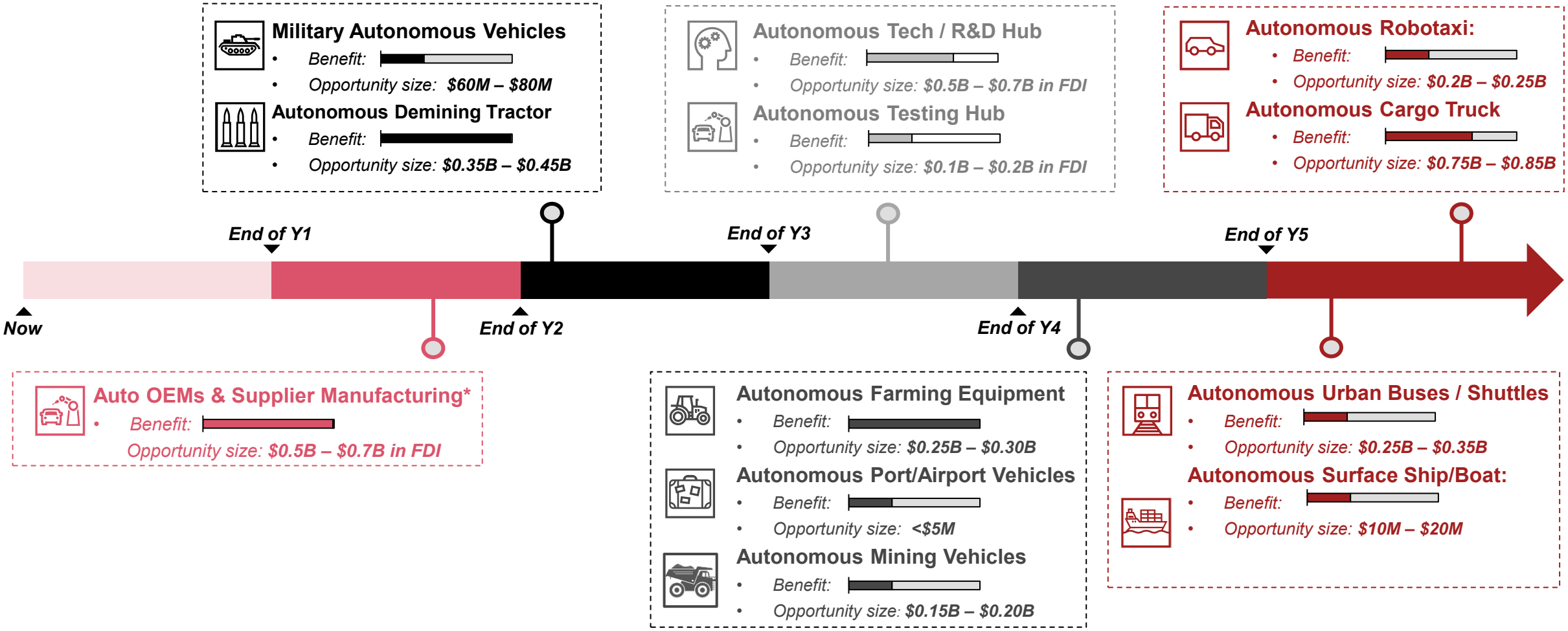
Note: 1) Criticality to AV indicates the extent to which the respective metric element can influence a company’s decision to invest on AV development in the target region
Source(s): Company websites, Press releases, External Research, Expert interviews

1	2	3	4
Good to have	Somewhat critical	Moderately critical	Highly critical

6.2 Opportunities for Ukraine

There are several opportunities within the AV space that can be implemented over the course of 5+ years

Autonomous Vehicles Opportunity Roadmap



*** Opportunity not related to AV Technology**

Source(s): External Research

Considering timeline & opportunity size, Ukraine will benefit most from demining, farming, trucking, and R&D applications

Potential Opportunities for Ukraine (1 of 2)

	Autonomous Robotaxi	Autonomous Demining Tractor	Autonomous Farming Equipment	Autonomous Military Vehicle	Autonomous Cargo Truck	Autonomous Surface Ship / Boat
Opportunity Highlights	Commercial driverless taxi services for intra-city commute	Unmanned tractor to detect & neutralize landmines on farm fields	Autonomous agro-equipment like sprayers, combines, mowers, seeders, etc.	Unmanned vehicles for mine-sweeping, reconnaissance, combat, other military activities	On-road commercial trucks, including cab-less haulers, drayage, heavy-duty truck, etc.	Crewless vessels to transport cargo or humans over navigable waters
Est. opportunity size[1] (USD)	***Benefit: $200M – $250M FDI: $500M – $700M***	***Benefit: $350M – $450M***	***Benefit: $250M – $300M***	***Benefit: $60M – $80M***	***Benefit: $750M – $850M FDI: $500M – $700M***	***Benefit: $10M – $20M***
AV Ecosystem Elements Reqd.	AV-related R&D, testing, talent, regulations, quality roads, C-ITS, 5G/4G, cybersecurity, EV charging, real-estate, HD map, ride-hailing market, sentiment	AV-related R&D, testing, talent, regulations, cybersecurity, public-private collab, govt. grants, dedicated AV-demining governing agency	AV-related R&D, testing, talent, regulations, cybersecurity, public-private collab, farmers' sentiment about AVs	AV-related R&D, testing, talent, regulations, 5G/4G, public-private collab, govt. grants, cybersecurity, dedicated AV-governing military agency	AV-related R&D, testing, talent, regulations, quality roads, C-ITS, 5G/4G, cybersecurity, EV charging, real-estate, HD map, pub.-pvt. collab, pub. sentiment	AV-related R&D, testing, talent, regulations, C-ITS, 5G/4G, navigable waterways, pub.-pvt. collab, cybersecurity, dedicated AV-governing navy agency
Rationale	• Will reduce accidents, and any resulting deaths • Will help combat driver shortage in future	• ~40% of Ukraine's farmland is contaminated with mines • AV de-mining tractors will save both lives & equipment	• UA is one of the world's top agri-producers & exporters • >55% of land area is arable • 24x7 run-times will boost agricultural output	• Enables man-less missions during potential instability over the next few years • Saves lives and expensive military equipment	• As major exporter of crops, UA is a cargo-heavy market • 24x7 cargo shipping makes it a reliable & the fastest way to transport farm produce	• With Black Sea under Russian watch, running autonomous cargo ships to nearest int'l ports would be beneficial for Ukraine
Major Roadblocks	• Low business case feasibility • Expensive to commercialize • Driver abundance in Ukraine • AI/ML talent availability • Weather conditions' stability	• Safety considerations while testing and deploying • Product efficacy • Expensive to commercialize • Post-war, long-term utility	• Tailored R&D per equipment • Tech talent availability • Expensive to commercialize • Job cuts for equipment handlers on farm fields	• Top notch cybersecurity • Safety considerations while testing and deploying • Expensive to commercialize • 5G/4G in remote, war zones	• Expensive to commercialize • Job cuts for truck drivers • Weather conditions' stability • HD mapping of highways • 5G/4G along all highways	• Network connection in Black Sea (e.g., through satellite) • Top notch cybersecurity • Safety considerations while testing and deploying
Deployment Timeline	**5+ years**	**2 – 3 years**	**3 – 5 years**	**2 – 3 years**	**5+ years**	**5+ years**
Benefit Impact on Ukraine (Opportunity size & time to scale)	**Low**	**High**	**High**	**Low**	**Medium**	**Low**

1) Parameters assessed under each opportunity are listed in Appendix and quantified benefits are only a high-level estimate

Source(s): External Research, NHTSA, UA MTU, USDA Foreign Agricultural Service

Considering timeline & opportunity size, Ukraine will benefit most from demining, farming, trucking, and R&D applications

Potential Opportunities for Ukraine (2 of 2)

	Autonomous Testing Hub	Autonomous Port / Airport Vehicles	Autonomous Urban Buses/Shuttles	Autonomous Tech R&D Hub	Autonomous Mining Vehicles	*Opportunity outside Autonomous Vehicles* Auto OEM/Supplier Manufacturing
Opportunity Highlights	Global destination for all autonomous vehicles and equipment testing	Unmanned cranes, container trucks, baggage tractors with predictable route and work output patterns	Commercial driverless public-transport shuttle services and inter-city buses	Global powerhouse of AV-related technology R&D, including availability of top-notch AV talent in the region	Unmanned haulage vehicles for mines, equipped with GPS, vehicle controllers, obstacle detection, etc.	Attracting OEMs or suppliers to setup mfg. plants
Est. opportunity size[1] (USD)	***FDI: $100 – $200M 20 – 60 jobs***	***Benefit: <$5M***	***Benefit: $250M – $350M FDI: $100M – $200M***	***FDI: $500M – $700M 800 – 1,000 jobs***	***Benefit: $150M – $200M***	***FDI: $500 – $700M 1,200 – 1700 jobs***
AV Ecosystem Elements Reqd.	Dedicated test-track recreating target conditions for simulation & testing, AV-related talent, regulations, C-ITS, 5G/4G, cybersecurity, pub.-pvt. Collab	AV-related R&D, testing, talent, regulations, cybersecurity, public-private collab, EV charging infra, C-ITS, 5G/4G	AV-related R&D, testing, talent, regulations, quality roads, C-ITS, 5G/4G, cybersecurity, EV charging, real-estate, HD map, pub.-pvt. collab, pub. sentiment	AV-related R&D, testing, talent, 5G/4G, public-private collab, govt. grants, cybersecurity, real-estate, R&D investments by industry	AV-related R&D, testing, talent, regulations, cybersecurity, pub.-pvt. collab, govt. grants, dedicated AV-governing mining agency	- -
Rationale	• All-weather testing • Revenue source as AV adoption grows over next ~50 years • Low-cost real-estate available to create simulation regions	• Easier to implement • Export of airport AVs can bring revenue • Black Sea ports face Russian threats, AVs can save lives	• Will reduce accidents, and any resulting deaths • Will help combat driver shortage in future	• Ukraine is known for a vibrant tech ecosystem with its IT expertise, so development of AV R&D hub is a natural extension	• Ukraine has world's largest titanium & iron-ore reserves, and fields of untapped lithium and massive deposits of coal	• OEMs are moving in CEE due to lower skilled labor costs & favorable incentives • EVs & ADAS driving mfg. investment
Major Roadblocks	• Attracting industry players and cracking public-private collab deals • Lack of UA's AV capabilities • Safety considerations	• Low business case feasibility • Safety considerations • Job cuts for port operations staff	• Low business case feasibility • Expensive to commercialize • Job cuts for bus drivers • HD mapping of highways • 5G/4G along all highways	• Top notch cybersecurity • Attracting industry players to invest • Safety considerations	• Expensive to commercialize • Job cuts for mining operators • Safety considerations while testing and deploying • Network in mining areas	• Instability due to war • Mfg. skilled labor shortage • Lacking raw material supply chains
Deployment Timeline	**3 – 5 years**	**3 – 5 years**	**5+ years**	**3 – 5 years**	**3 – 5 years**	**1 – 2 years**
Benefit Impact on Ukraine (Opportun. size & time to scale)	**Low**	**Low**	**Low**	**Medium**	**Low**	**High**

1) Parameters assessed under each opportunity are listed in Appendix and quantified benefits are only a high-level estimate

Source(s): External Research, NHTSA, UA MTU, USDA Foreign Agricultural Service

Robotaxis stand to gain a limited market in Ukraine, and being highly time & capital intensive to deploy, will allow it reap limited benefits

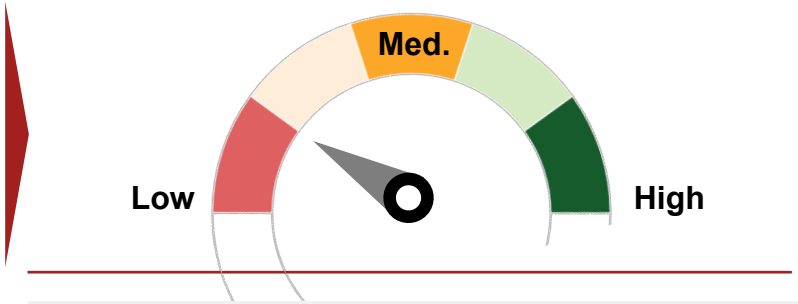
Opportunity #1 – Autonomous Robotaxi

Opportunity Definition: Commercialized driverless taxi services for intra-city commute
Estimated Time to Deploy: 5+ years

Opportunity Assessment Metrics

- Sales (incl. exports)
- Economy (GDP)
- Tech upskilling
- Emission reduction
- Human lives
- Foreign direct investments

Cumulative Scale of Benefits



Key Activities to Achieve Success

Key Activities / Initiatives	Time to Implement
Conduct customer acceptance and sentiment survey to gauge AV interest	6 months
Research and benchmark robotaxi regulations across other countries	6mos – 1yr
Draft and publish AV / robotaxi regulations, setup governance agency	1 year
Invite robotaxi companies to explore R&D setup, launch of services, etc.	1 year
Incentivize companies to setup base in Ukraine, e.g., tax incentives, R&D grants, cheaper real-estate, EV chargers, etc.)	1 – 2 years
Transform roads' quality, deploy C-ITS	2 years
HD mapping of UA, development of talent pool and AV R&D centers	2 – 3 years
Rigorous testing on roads and commercialization	3 – 5 years

Key Challenges to Scale this Opportunity

- Low popul. density & limited ride-hailing, bad road quality, adverse climate, etc. weaken business case
- Testing is time & capital intensive; commercialization without testing poses risk to life & property
- UA employs ~16,000 taxi drivers whose jobs would be at risk when robotaxi adoption matures
- Most of UA's 300,000 tech workers are IT specialists, and lack advanced AI/ML skills, making talent availability a condition for AV R&D in the region
- # of buses in UA (~75k) is over 3 times the # of taxis (23k), making robotaxi adoption difficult

Key Benefits for Ukraine:

- In 2019, UA witnessed 160k+ car accidents, injuring 32k+ and killing 3.4k+, 40% of them due to a collision with a pedestrian; robotaxi will improve road safety and drastically reduce injuries & fatalities
- UA was suffering from driver shortage in 2019, which amplified due to the migration caused by war; robotaxi will help combat such driver shortage
- Robotaxis will attract larger FDI into UA in the form of investments for R&D & testing, vehicle manufacturing, software development, etc. and provide an economic boost

Overall benefits to UA economy = **$200 – $250M**
Est. FDI = **$500M – $700M**

Source(s): OKKO Ukraine, Transport Intelligence Insight, Business Insider, Ministry for Restoration, Ministry of Infrastructure of Ukraine, External Research

Given high risk to Ukraine's economically critical agriculture sector, demining tractors can strongly boost farming output

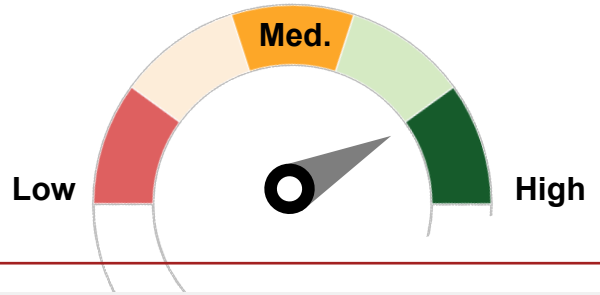
Opportunity #2 – Autonomous Demining Tractor

Opportunity Definition: Unmanned tractor to detect & neutralize landmines on farm fields
Estimated Time to Deploy: 2 – 3 years

Opportunity Assessment Metrics

- Human lives
- Farming labor availability
- Agricultural output boost
- Sales (incl. Exports)
- Crop prices
- Life of agricultural equipment

Cumulative Scale of Benefits



Key Activities to Achieve Success

Key Activities / Initiatives	Time to Implement
Research and benchmark product usage across other countries	6mos – 1yr
Draft and publish regulations around use of AV demining products, & setup governance framework & agency	1 year
Invest in UA companies already building or selling the product, and invite foreign companies for discussion	1 year
Incentivize companies to build products in Ukraine, e.g., tax incentives, R&D grants, cheaper real-estate, etc.)	1 - 2 years
Transform cybersecurity measures to ensure highest standards of sensitive data protection	1 -2 years
Deploy across farmlands / commercialize	1 -2 years

Key Challenges to Scale this Opportunity

- ❑ Difficult to build highly accurate and efficient autonomous deminers as sensors can miss mine presence in certain conditions
- ❑ Expensive to commercialize due to both price and limited target customer base
- ❑ Once war stops and farmlands are demined, the deminers will remain unutilized, plus limited user base outside Ukraine, so low resale chances
- ❑ Safety risks due to nature of the environment they are deployed in (explosion risk)

Key Benefits for Ukraine:

- ❑ ~40% of Ukraine's farmland is contaminated with mines, posing immense danger to life and property
- ❑ Autonomous de-mining tractors are built to withstand damage from mines, and thus can save both lives & agricultural equipment
- ❑ Lives saved will directly help reduce labor shortage and boost agricultural output
- ❑ Ukraine being an agriculture-heavy country, higher yield will fetch higher agricultural revenues
- ❑ Resultant better availability of crops will bring down prices and help stabilize economy

Overall benefits to UA economy = **$350 – $450M**

Source(s): Forbes, Company websites, Expert interviews, External Research

Considering agriculture sector is central to Ukraine's economy, autonomous farming equipment can accelerate farming output

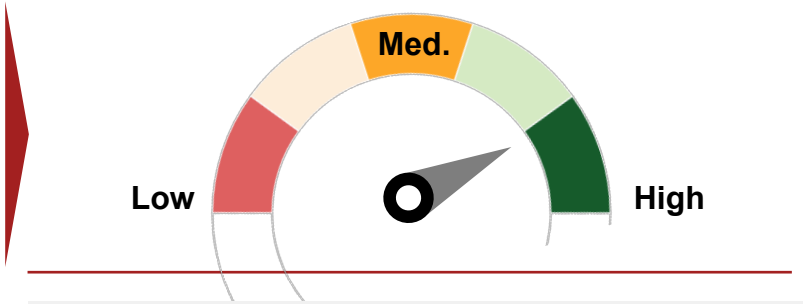
Opportunity #3 – Autonomous Farming Equipment

Opportunity Definition: Autonomous agricultural equipment like sprayers, combines, mowers, seeders, etc.
Estimated Time to Deploy: 3 – 5 years

Opportunity Assessment Metrics

- Sales (incl. exports)
- Economy (GDP)
- Agricultural output boost
- Crop prices
- Life of agricultural equipment
- Human lives

Cumulative Scale of Benefits



Key Activities to Achieve Success

Key Activities / Initiatives	Time to Implement
Conduct customer acceptance and sentiment survey to gauge farmer interest	6 months
Research and benchmark product regulations across other countries	6mos – 1yr
Conduct study to identify most critical farming equipment to invest in	6 months
Draft and publish product regulations, setup governance agency	1 year
Invest in UA companies already building or selling the product, and invite foreign companies for discussion	1 year
Incentivize companies to build products in Ukraine, e.g., tax incentives, R&D grants, cheaper real-estate, etc.)	1 – 2 years
Approve products for rigorous testing on farms and commercialization	3 – 5 years

Key Challenges to Scale this Opportunity

- Wide variety of large agri-equipment exist, all are complex machines, each would require its own tailored R&D and capital to develop AV capabilities
- Testing is time & capital intensive; commercialization without testing poses risk to life & property
- 8.3M UA households are involved in agriculture, many of them hold expertise in equipment handling and would stand to lose jobs with AV adoption
- Most of UA's 300,000 tech workers are IT specialists, and lack advanced AI/ML skills, making talent availability a condition for AV R&D in the region

Key Benefits for Ukraine:

- UA is one of the world's top agricultural producers & exporters, with over 55% of arable land area, making it a fitting destination for autonomous farming equipment
- These equipment will provide longer operating hours, thus accelerating agricultural outputs (e.g., harvest)
- If built to withstand external damage (e.g., from mines), can also save lives and boost agricultural output
- Better availability of crops will bring down prices and help stabilize economy

Overall benefits to UA economy = **$250 – $300M**

Source(s): USDA Foreign Agricultural Service, Expert interviews, External Research

Ukraine's war situation warrants benefits in terms of life & property, through use of autonomous military vehicles

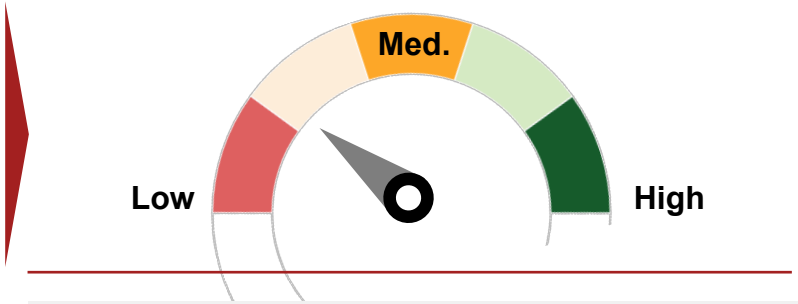
Opportunity #4 – Autonomous Military Vehicle

Opportunity Definition: Unmanned vehicles for mine-sweeping, reconnaissance, combat and more military activities
Estimated Time to Deploy: 2 – 3 years

Opportunity Assessment Metrics

- Human lives
- Cost of military equipment
- Military Effectiveness
- Sales (Exports)
- Aids military intelligence

Cumulative Scale of Benefits



Key Challenges to Scale this Opportunity

- ❑ Difficult to build highly efficient autonomous military vehicles due to harsh operating conditions and extreme off-road terrain they experience while in use
- ❑ Safety risks due to nature of the environment they are deployed in (explosion risk)
- ❑ Absolutely hack-proof cybersecurity required, which is very expensive and still chances of breach exist
- ❑ 5G/4G connectivity for such vehicles in remote areas and live war zones is difficult to deploy and maintain
- ❑ High chances of damage from explosions, leaving all investments at risk of being written off prematurely

Key Benefits for Ukraine:

- ❑ Will enable man-less missions during potential instability over the next few years, allowing huge benefit in terms of lives and expensive military equipment saved
- ❑ Good commercialization potential by selling to countries at risk of war or are invested in armament
- ❑ Will aid military intelligence teams through deployment for inspection of high-risk areas without risking lives

Key Activities to Achieve Success

Key Activities / Initiatives	Time to Implement
Research and benchmark product usage across other countries	**6mos – 1yr**
Draft and publish regulations around use of AV military products, & setup governance framework & agency	**1 year**
Invest in UA companies already building or selling the product, and invite foreign companies for discussion	**1 year**
Incentivize companies to build products in Ukraine, e.g., tax incentives, R&D grants, cheaper real-estate, etc.)	**1 – 2 years**
Transform cybersecurity measures to ensure highest standards of sensitive defense-data protection	**1 – 2 years**
Rigorous real-world testing and commercialization	**2 – 3 years**

Overall benefits to UA economy = **$60 – $80M**

Source(s): Expert interviews, External Research

As a major exporter, Ukraine is a heavy cargo-mover and can benefit from non-stop cargo movement through autonomous trucks

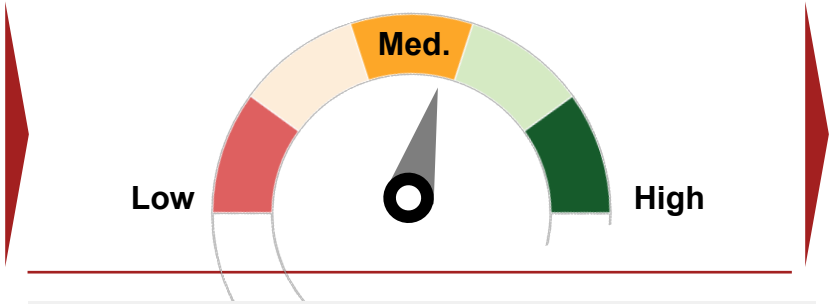
Opportunity #5 – Autonomous Cargo Truck

Opportunity Definition: Autonomous on-road commercial trucks, including cab-less haulers, drayage, heavy-duty truck, etc.
Estimated Time to Deploy: 5+ years

Opportunity Assessment Metrics

- Sales (incl. exports)
- Economy (GDP)
- Robust supply chain
- Emission reduction
- Human lives
- Foreign direct investments

Cumulative Scale of Benefits



Key Activities to Achieve Success

Key Activities / Initiatives	Time to Implement
Conduct customer acceptance and sentiment survey to gauge AV interest	6 months
Research and benchmark AV truck regulations across other countries	6mos – 1yr
Draft and publish AV truck regulations, setup governance agency	1 year
Invite AV truck companies to explore R&D setup, launch of services, etc.	1 year
Incentivize companies to setup base in Ukraine, e.g., tax incentives, R&D grants, cheaper real-estate, etc.)	1 – 2 years
Transform highway quality, deploy C-ITS	2 years
HD mapping of UA highways, talent pool development and setup AV R&D centers	3 – 5 years
Rigorous testing on roads and commercialization	5+ years

Key Challenges to Scale this Opportunity

- ❑ Bad road quality, adverse climate affect usability
- ❑ Testing is time & capital intensive; commercialization without testing poses risk to life & property
- ❑ UA has 16,000+ registered trucks, driven by 12,000+ drivers, whose jobs would be at risk from AV trucks
- ❑ Most of UA's 300,000 tech workers are IT specialists, and lack advanced AI/ML skills, making talent availability a condition for AV R&D in the region
- ❑ HD mapping of highways is critical but very expensive and time-taking
- ❑ 5G/4G, EV charger deployment along all highways

Key Benefits for Ukraine:

- ❑ In 2019, 3,400+ Ukrainians died in vehicle accidents, AV trucks can improve road safety and thus, such stats
- ❑ UA was suffering from driver shortage in 2019, which amplified due to the migration caused by war; AV trucks will help combat such driver shortage
- ❑ AV trucks will attract larger FDI into UA in the form of investments for R&D & testing, vehicle manufacturing, software development, etc. and boost UA's economy
- ❑ UA will benefit as major exporter of crops, as 24x7 cargo movement in AV trucks makes it the fastest way to transport farm produce, thus helping economy

Overall benefits to UA economy = **$750 – $850M**
Est. FDI = **$500M – $700M**

Source(s): OKKO Ukraine, Transport Intelligence Insight, Business Insider, Ministry for Restoration, Ministry of Infrastructure of Ukraine, External Research

With its coastline at high risk of foreign attacks, Ukraine can benefit by using autonomous ships for cargo movement across the Black Sea

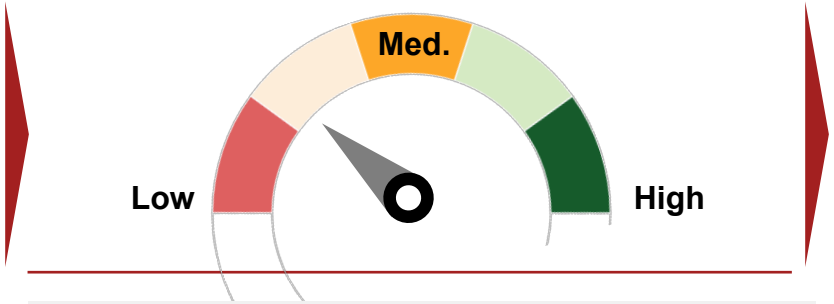
Opportunity #6 – Autonomous Surface Ship / Boat

Opportunity Definition: Crewless vessels to transport cargo or humans over navigable waters
Estimated Time to Deploy: 5+ years

Opportunity Assessment Metrics

- Ocean freight revenues
- Economy (GDP)
- Robust supply chain
- Human lives
- Foreign direct investments

Cumulative Scale of Benefits



Key Challenges to Scale this Opportunity

- ❑ Although 1,000+ autonomous surface ships operate globally, most require manned support, indicating limited maturity of the technology
- ❑ Several onboard operations require human action, autonomous ships do not eliminate their need
- ❑ Vessel control is difficult in waters, as against controllability of on-road vehicles
- ❑ Testing and commercialization will take a long time
- ❑ Network connectivity on sea routes is tricky to enable
- ❑ Defense considerations require highly sophisticated & expensive cybersecurity arrangements in place

Key Benefits for Ukraine:

- ❑ With Black Sea under Russian watch, autonomous cargo ships operating to nearest international ports would boost ocean freight revenues
- ❑ Black Sea is one of the top 10 regions globally for "total loss" of vessels, causing huge loss of life and goods, which can be minimized with autonomous ship usage
- ❑ AV ships will attract larger FDI into UA in the form of investments for R&D & testing, software development, etc. and boost UA's economy

Key Activities to Achieve Success

Key Activities / Initiatives	Time to Implement
Conduct market assessment study	6 months
Research and benchmark AV ship regulations across other countries	6mos – 1yr
Draft and publish AV ship regulations, setup governance agency	1 year
Invite AV ship companies to explore R&D setup, launch of services, etc.	1 year
Transform cybersecurity measures to ensure highest standards of sensitive navy-data protection	1 -2 years
Incentivize companies to setup base in Ukraine, e.g., tax incentives, R&D grants, cheaper real-estate, etc.)	2 - 3 years
Rigorous testing on seawaters and commercialization	5+ years

Overall benefits to UA economy = **$10 – $20M**

Source(s): The Maritime Executive, Allianz Safety and Shipping Review 2023, Expert interviews, External Research

Ability to offer all-weather conditions lends UA a unique advantage for AV testing, but overall benefits are limited

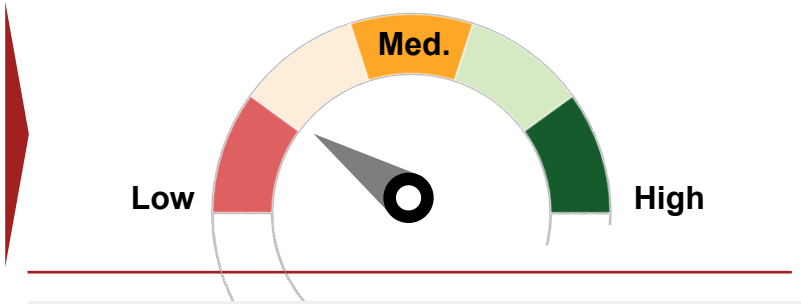
Opportunity #7 – Autonomous Testing Hub

Opportunity Definition: Global destination for all autonomous vehicles and equipment testing
Estimated Time to Deploy: 3 – 5 years

Opportunity Assessment Metrics

- Foreign direct investments
- Tech upskilling
- Economy (GDP)
- Job creation
- Revenues
- Real estate development

Cumulative Scale of Benefits



Key Activities to Achieve Success

Key Activities / Initiatives	Time to Implement
Conduct nationwide survey to identify suitable land areas for AV testing hubs	6 months
Research and benchmark AV test hubs in other countries	6mos – 1yr
Draft and publish AV test hub regulations, setup governance agency; and relax regulatory approvals to initiate testing	1 year
Invite AV & testing companies to setup base, launch AV testing services	1 - 2 years
Incentivize companies to setup base in Ukraine, e.g., tax incentives, R&D grants, cheaper real-estate, etc.)	2 – 3 years
Collaborate with industry players to co-invest in construction of testing hub(s)	2 – 3 years
Commercialize testing services	3 – 5 years

Key Challenges to Scale this Opportunity

- ❑ With no existing autonomous vehicle R&D and testing in progress, difficult to attract industry players afresh and crack public-private collaboration deals
- ❑ Perception of being a war-prone country will deter industry investments in Ukraine for several years
- ❑ Most of UA's 300,000 tech workers are IT specialists, and lack advanced AI/ML skills, making talent availability a condition for AV R&D in the region
- ❑ Safety considerations for vehicles being tested and employees on such campuses

Key Benefits for Ukraine:

- ❑ UA makes all-weather testing possible with climate varying from harsh to comfortable through the year
- ❑ AV adoption will grow significantly globally but slowly (10+ years to commercialization), therefore AV testing services will be a stable and constant source of revenue
- ❑ Low-cost real-estate available to create simulation regions that can mirror ideal city-like test conditions, which may help attract platers for testing
- ❑ Setup of such large testing hub(s) will boost real-estate market size and contribute to UA's GDP growth
- ❑ Testing hub setups will be clear and lasting FDIs

Est. FDI = **$100 – $200M**
Est. new jobs = **20 – 60**

Source(s): Expert interviews, Ministry of Infrastructure of Ukraine, External Research

While autonomous port equipment are the easiest to deploy, they have a very limited market in UA, leaving little to gain from adoption

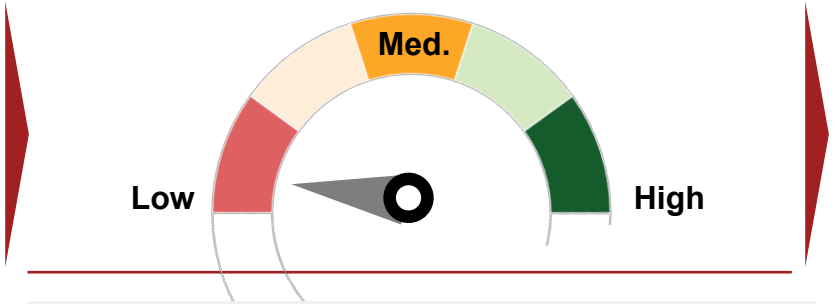
Opportunity #8 – Autonomous Port/Airport Vehicles

Opportunity Definition: Unmanned dock & airport equipment with fixed route, e.g., cranes, container trucks, baggage tractors, etc.
Estimated Time to Deploy: 3 – 5 years

Opportunity Assessment Metrics

- Life of equipment
- Fewer accidents
- TAT of port operations
- Human lives

Cumulative Scale of Benefits



Key Activities to Achieve Success

Key Activities / Initiatives	Time to Implement
Conduct market assessment study	6 months
Research and benchmark relevant regulations across other countries	6mos – 1yr
Draft and publish AV port equipment regulations, setup governance agency	1 year
Invite AV companies to assess ports and build tailored autonomous equipment	1 year
Incentivize product development for UA, e.g., tax incentives, R&D grants,, etc.)	1 – 2 years
Upgrade port infrastructure for V2X capabilities	2 years
Test and deploy across ports	3 – 5 years

Key Challenges to Scale this Opportunity

- ❑ With only 38 airports and 30 key seaports & sea terminals, limited market size exists within Ukraine
- ❑ Jobs of port equipment handlers at risk
- ❑ Safety considerations for both autonomous equipment and expensive ships and planes against damage by the autonomous equipment

Key Benefits for Ukraine:

- ❑ UA will benefit as major exporter of crops, as faster turn-around time at cargo ports will help accelerate dispatch
- ❑ Port autonomous equipment are easier to deploy due to their fixed routes and predictable, repetitive nature of operations
- ❑ Export of airport AVs can bring revenue, provided they are produced within Ukraine
- ❑ Black Sea ports face Russian threats, such autonomous equipment can save human lives impacted by the port attacks

Overall benefits to UA economy = **<$5M**

Source(s): Logistics Cluster, External Research

Autonomous buses can garner a significant market in UA given heavy reliance of public on bus transport

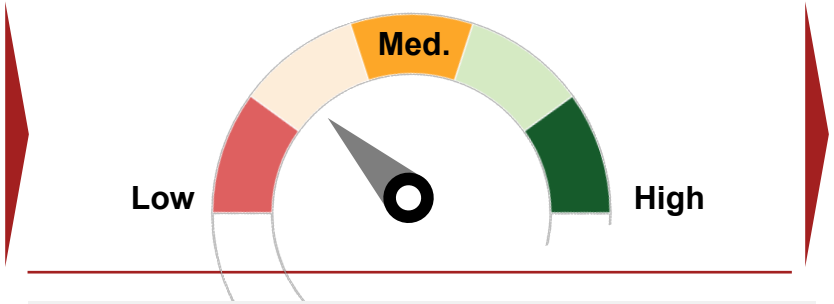
Opportunity #9 – Autonomous Urban Buses/Shuttles

Opportunity Definition: Commercialized driverless public-transport shuttle services and both intra- & inter-city buses
Estimated Time to Deploy: 5+ years

Opportunity Assessment Metrics

- Congestion reduction
- Economy (GDP)
- Emission reduction
- Labor productivity
- Human lives
- Foreign direct investments

Cumulative Scale of Benefits



Key Challenges to Scale this Opportunity

- ❑ Bad road quality, adverse climate affect usability
- ❑ Testing is time & capital intensive; commercialization without testing poses risk to life & property
- ❑ UA has 75,000+ registered buses, driven by 13,000+ drivers, whose jobs would be at risk from AV trucks
- ❑ Most of UA's 300,000 tech workers are IT specialists, and lack advanced AI/ML skills, making talent availability a condition for AV R&D in the region
- ❑ HD mapping of highways is critical but very expensive and time-taking
- ❑ 5G/4G, EV charger deployment along all highways

Key Benefits for Ukraine:

- ❑ In 2019, 3,400+ Ukrainians died in vehicle accidents, AV buses can improve road safety and thus, such stats
- ❑ UA was suffering from driver shortage in 2019, which amplified due to the migration caused by war; AV buses will help combat such driver shortage
- ❑ AV buses will attract larger FDI into UA in the form of investments for R&D & testing, vehicle manufacturing, software development, etc. and boost UA's economy
- ❑ Better driving and vehicle control of AV buses will extend longevity of roads which already suffer on quality, and extend the vehicles' usage timeline too

Key Activities to Achieve Success

Key Activities / Initiatives	Time to Implement
Conduct customer acceptance and sentiment survey to gauge AV interest	6 months
Research and benchmark AV bus regulations across other countries	6mos – 1yr
Draft and publish AV bus regulations, setup governance agency	1 year
Invite AV bus companies to explore R&D setup, launch of services, etc.	1 year
Incentivize companies to setup base in Ukraine, e.g., tax incentives, R&D grants, cheaper real-estate, EV chargers, etc.)	1 – 2 years
Transform roads' quality, deploy C-ITS	2 years
HD mapping of UA, development of talent pool and AV R&D centers	3 – 5 years
Rigorous testing on roads and commercialization	5+ years

Overall benefits to UA economy = **$250 – $350M**
Est. FDI = **$100M – $200M**

Source(s): OKKO Ukraine, Transport Intelligence Insight, Ministry for Restoration, Ministry of Infrastructure of Ukraine, External Research

Although lucrative opportunity to build itself as a global AV R&D hub, UA faces competition from other leading countries

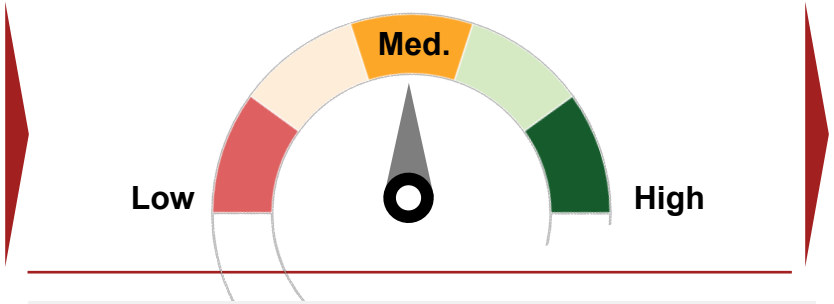
Opportunity #10 – Autonomous Tech R&D Hub

Opportunity Definition: Global powerhouse of AV-related technology R&D, including availability of high-quality AV talent in the region
Estimated Time to Deploy: 3 – 5 years

Opportunity Assessment Metrics

- Foreign direct investments
- Revenues
- Economy (GDP)
- Real-estate development
- Job creation
- Talent development

Cumulative Scale of Benefits



Key Activities to Achieve Success

Key Activities / Initiatives	Time to Implement
Research and benchmark AV R&D hubs in other countries	6mos – 1yr
Relax regulatory approvals to setup R&D base in UA	1 year
Invite AV companies to setup R&D bases, launch AV R&D services	1 – 2 years
Incentivize companies to setup R&D base in UA, e.g., tax incentives, grants, cheaper real-estate, etc.)	2 – 3 years
Conduct survey and identify most suitable locations to setup R&D hub (e.g., create special economic zone)	2 – 3 years
Collaborate with industry players to co-invest in construction of R&D hub(s)	2 – 3 years
Build and launch commercially	3 – 5 years

Key Challenges to Scale this Opportunity

- ❑ With no existing autonomous vehicle R&D and testing in progress, difficult to attract industry players afresh and crack public-private collaboration deals
- ❑ Other countries already have significant head-start
- ❑ Perception of being a war-prone country will deter industry investments in Ukraine for several years
- ❑ Most of UA's 300,000 tech workers are IT specialists, and lack advanced AI/ML skills, making talent availability a condition for AV R&D in the region
- ❑ Extremely critical for OEMs to keep their R&D IP protected, so highest cybersecurity standards needed

Key Benefits for Ukraine:

- ❑ AV adoption will grow significantly globally but slowly (10+ years to commercialization), therefore AV R&D firms will be a stable and constant source of tax revenue
- ❑ Setup of large R&D hub(s) will boost real-estate market size and contribute to UA's GDP growth
- ❑ R&D hub setups will attract a sustained flow of FDIs
- ❑ Ukraine is known for a vibrant tech ecosystem with its IT expertise, so development of AV R&D hub is a natural extension of the capabilities
- ❑ R&D centers typically employ large number of people, so hub development will generate massive employment

Est. FDI = **$500M – $700M**
Est. new jobs = **800 – 1,000**

Source(s): Expert interviews, Ministry of Infrastructure of Ukraine, External Research

Given presence of huge mining industry in UA and emerging market of autonomous vehicles in mining, there are monetizable benefits

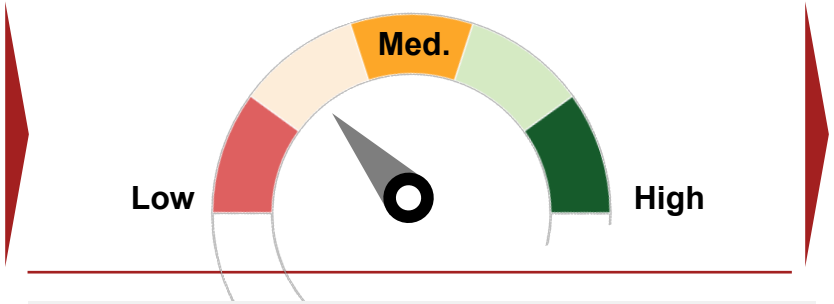
Opportunity #11 – Autonomous Mining Equipment

Opportunity Definition: Unmanned loading, mining, & haulage vehicles for mines, equipped with GPS, vehicle controllers, sensors, drills, etc.
Estimated Time to Deploy: 3 – 5 years

Opportunity Assessment Metrics

- Sales (exports)
- Economy (GDP)
- Taxes
- Mining output boost
- Metal prices
- Life of mining equipment
- Human lives

Cumulative Scale of Benefits



Key Activities to Achieve Success

Key Activities / Initiatives	Time to Implement
Research and benchmark autonomous mining regulations across other countries	6mos – 1yr
Draft and publish relevant regulations, setup governance agency	1 year
Invest in UA companies already building or selling the product, and invite foreign companies for discussion	1 year
Incentivize companies to build products in Ukraine, e.g., tax incentives, R&D grants, cheaper real-estate, etc.)	1 – 2 years
Approve products for rigorous testing in mines and commercialization	3 – 5 years

Key Challenges to Scale this Opportunity

- ❑ Expensive to commercialize AV trucks in mining
- ❑ Global market is currently small, with just over ~1,000 autonomous mining trucks deployed globally
- ❑ Mining is one of the largest employer industries in Ukraine (130k+), many of them would lose jobs when autonomous mining equipment gain adoption
- ❑ Safety considerations while testing and deploying due to harsh operating conditions in mining areas
- ❑ Stable network connectivity is difficult to achieve and sustain in mining areas

Key Benefits for Ukraine:

- ❑ UA has world's largest titanium & iron-ore reserves, untapped lithium and massive deposits of coal, making it one of the largest UA industries (5-6% of GDP)
- ❑ 24x7 operations enabled by autonomous mining equipment will boost output and thus the economy
- ❑ Built to withstand harsh mining area environment, will also save lives lost to mining's tough conditions
- ❑ Better availability of mined metals will bring down prices and help stabilize economy
- ❑ High potential to attract R&D by autonomous mining equipment makers given UA's huge mining industry

Overall benefits to UA economy = **$150 – $200M**

Source(s): Global Data, GMK Center, Expert interviews, External Research

Like other countries in CEE, there is potential for UA to attract FDI in automotive manufacturing, fostering creation of new jobs

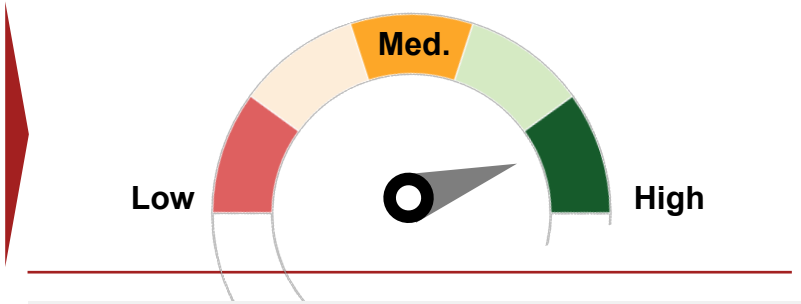
Opportunity #12 – Auto OEM/Supplier Manufacturing

Opportunity Definition: Attracting automotive OEMs or suppliers to establish manufacturing footprint in UA and FDIs and new job creation
Estimated Time to Deploy: 1 – 2 years

Opportunity Assessment Metrics

- Employment
- Economy (GDP)
- FDI
- Supply base development
- Tax revenues
- Talent development
- Vehicle prices

Cumulative Scale of Benefits



Key Activities to Achieve Success

Key Activities / Initiatives	Time to Implement
Conduct market assessment study	6 months
Invite auto companies for discussions to understand their location assessment criteria to setup plants in new countries	6 months
Review and relax new business setup regulations for auto OEMs & suppliers	1 year
Curate incentives / grants and earmark dedicated economic zone for auto companies to invest in and build plants	1 year
Invite proposals/plans from auto companies for plant setups in UA	1 – 2 years
Co-invest if needed and approve construction & commercial operations	1 – 2 years

Key Challenges to Scale this Opportunity

- ❑ Instability due to ongoing conflict situation
- ❑ Shortage of manufacturing skilled labor due to migration or enlisting in the military
- ❑ Lack of established supply chains for raw materials
- ❑ Little to no pre-existing automotive manufacturing landscape
- ❑ Investment competition from neighboring countries with established OEM presence

Key Benefits for Ukraine:

- ❑ The introduction of new manufacturing plants in UA will create new job opportunities boosting employment rates
- ❑ The introduction of cutting-edge manufacturing facilities will result in the need for workforce upskilling through dedicated trainings
- ❑ OEM & supplier investments in new facilities are driven by electrification and autonomy related technology, which will in turn propel and support UA's transition to become an automotive technological hub
- ❑ Local manufacturing will bring vehicle prices down

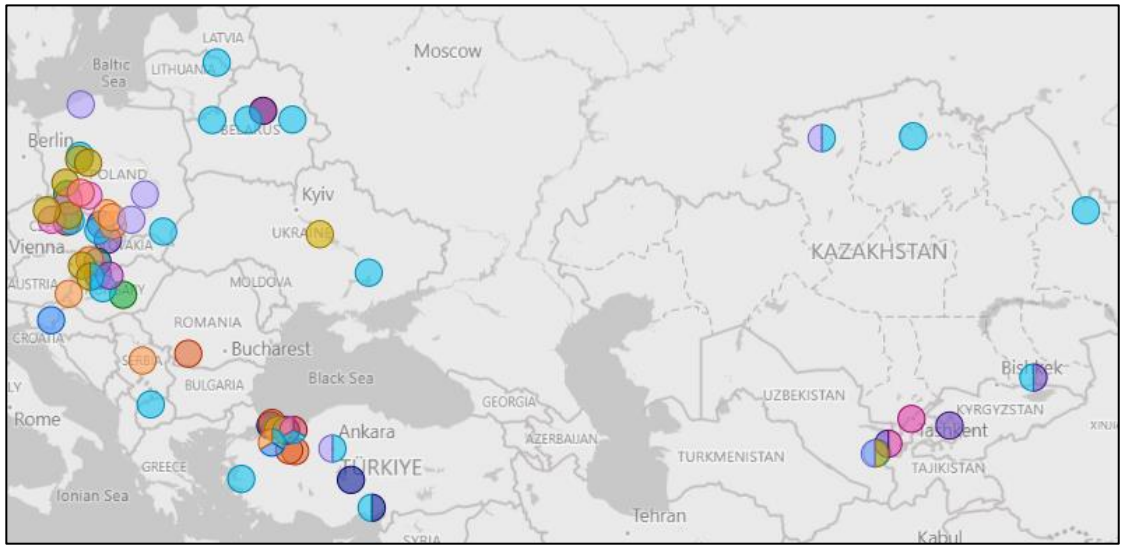
Est. FDI = **$500 – $700M**
Est. new jobs = **1,200 – 1,600**

Source(s): Expert interviews, External Research

OEMs assemble passenger and commercial vehicles across ~100 plants in the CEE region

Central & Eastern Europe (CEE) OEM Mfg. Footprint & 2022 Vehicle Production Volume

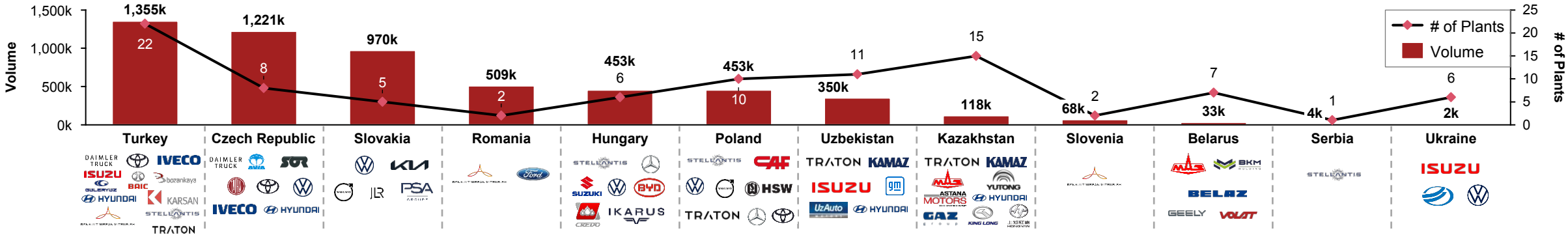
All Passenger and Commercial Vehicle OEM Vehicle Manufacturing Plants in Central & Eastern Europe



Legend[1]

- BYD
- Daimler Truck
- Ford
- Geely
- General Motors
- Hyundai
- Isuzu
- Iveco Group
- Land Rover
- Mercedes-Benz
- Others
- Renault-Nissan-Mitsubishi
- Stellantis
- Suzuki
- Toyota
- Traton
- Volkswagen
- Volvo

CEE OEM Mfg. # of Plants and Volume[2] ('000s), 2022



Note: 1) Others include regional players like Kiraca Holding, CAF, Kamaz, MAZ, Yutong Bus, etc.; 2) Stats for vehicle manufacturing plants and vehicle volumes shown, and engine and other component plants are not included; Source(s): S&P Global Mobility

Favorable cost arbitrage and well-developed infrastructure are the primary drivers of auto OEMs' continued investments in CEE region

Major Factors Driving Auto Investment in CEE

1 Lower Wages

The labor force in CEE is relatively cheap compared to Western Europe (WE), while it is highly skilled and well-educated

2 Labor Availability

There is less competition in CEE as compared to WE, given the relatively smaller presence of global engineering and IT companies in the region

3 Tax Allowance

Generally, tax rates are lower in CEE region than in Western Europe, while some countries also offer 'Special Economic Zones (SEZs) as an attractive solution

4 Well Developed Infrastructure

CEE boasts a network of easily accessible airports, relatively modern highway and rail systems, and well-developed digital infrastructure

Besides OEM plants, there are **several tech & R&D centers** and **more than 40 auto supplier plants** across CEE as well (mostly focusing on ADAS & electrification parts, among other components)

Near the CEE region, OEMs have pushed to setup majority of the plants in Kazakhstan and Uzbekistan since 2018

List of Automotive OEM Plants in CEE setup in or after 2018

Vehicle Type	Plant Type	Country	OEM	Plant Location	Launch Year	Investment	Sq. footage	Annual Production Capacity	Rationale
Light Vehicles	Vehicle Assembly	**Slovakia**	Land Rover	Nitra	**2018**	**€1.4bn 2,350 jobs**	300,000 m²	150,000	Expand global operational footprint
Light Vehicles	Vehicle Assembly	**Poland**	Stellantis	Gliwice	**2022**	**500 additional jobs**	110,000 m²	100,000	Consolidation Opel and PSA facilities
Light Vehicles	Vehicle Assembly	**Uzbekistan**	Uzavtosanoat	Jizzakh	**2020**	**-**	-	20,000	Manufacturing and sales agreement with VW Rus
Light Vehicles	Vehicle Assembly	**Uzbekistan**	Hyundai	Jizzakh (Roodell)	**2020**	**-**	-	30,000	Manufacturing agreement with Astana Motors
Light Vehicles	Vehicle Assembly	**Kazakhstan**	AllurGroup	Kostanay	**2020**	**$50-60M (estimated)**	-	100,000	JV with Chevrolet to manufacture vehicles for export
Light Vehicles & trucks	Vehicle Assembly	**Kazakhstan**	Astana Motors - Hyundai - MAZ	Almaty	**2020**	**-**	34,000 m²	45,000	JV with Hyundai to manufacture and export vehicles + Production agreement with MAZ for 2 heavy truck models
Light Vehicles	Engine Plant	**Poland**	Mercedes-Benz	Jawor	**2019**	**$750M 1,300 jobs**	44,372 m²	100,000 EV batteries	-
Bus	Vehicle Assembly	**Turkey**	Iveco Group	Sakarya	**2021**	**2,000 jobs**	552,000 m²	-	Production agreement with Otokar for production of 2 Iveco buses and a specific model for export in Africa and Eastern Europe
Bus	Vehicle Assembly	**Kazakhstan**	Yutong Bus	Saran	**2020**	**$54.9M 1,000 jobs**	-	1,700	-
Truck	Vehicle Assembly	**Kazakhstan**	Traton	Kostanay	**2018**	**-**	-	-	-
Truck	Vehicle Assembly	**Uzbekistan**	Kamaz	Jomboy	**2018**	**400 jobs**	-	5,000	-
Bus	Vehicle Assembly	**Hungary**	Kravtex-Kuehne	Gyor	**2022**	**$5.8M 550 jobs**	Additional 4000 m², for total of 20,000 m²	1,000	$1.5M grant received from government used to Acquire new machinery, expand painting area and ramp up production

Most of the automotive plants are long-established, few have opened recently

List of Automotive OEM Plants in CEE setup before 2018 (1 of 2)

Vehicle Type	Plant Type	Country	OEM	Plant Location	Launch Year
Light Vehicles	Vehicle Assembly	Turkey	Ford	Kocaeli-Otosan	2001
Light Vehicles	Vehicle Assembly	Turkey	Ford	Yenikoy	2014
Light Vehicles	Vehicle Assembly	Turkey	Stellantis	Bursa-Tofas	2010
Light Vehicles	Veh + Eng + Trans	Turkey	Renault-Nissan	Bursa (Oyak)	1999
Light Vehicles	Vehicle Assembly	Turkey	Toyota	Sakarya	1994
Light Vehicles	Vehicle Assembly	Turkey	Hyundai	Izmit	1997
Light Vehicles	Vehicle Assembly	Turkey	Karsan	Bursa-Karsan	1966
Light Vehicles	Vehicle + Engine	Czech Republic	Volkswagen	Mlada Boleslav	1905
Light Vehicles	Vehicle Assembly	Czech Republic	Volkswagen	Kvasiny	1934
Light Vehicles	Vehicle Assembly	Czech Republic	Hyundai	Ostrava	2006
Light Vehicles	Vehicle Assembly	Czech Republic	Toyota	Kolin	2005
Light Vehicles	Vehicle Assembly	Slovakia	Stellantis	Trnava	2006
Light Vehicles	Vehicle + Engine	Slovakia	Hyundai	Zilina	2004
Light Vehicles	Veh + Transm.	Slovakia	Volkswagen	Bratislava	1991
Light Vehicles	Vehicle Assembly	Slovakia	Volkswagen	Bratislava #2	1991
Light Vehicles	Veh + Eng + Trans	Romania	Renault-Nissan	Pitesti-Colibasi	1968
Light Vehicles	Vehicle + Engine	Romania	Ford	Craiova	2008
Light Vehicles	Vehicle + Engine	Hungary	Volkswagen	Gyor	1994
Light Vehicles	Vehicle Assembly	Hungary	Mercedes-Benz	Kecskemet	2012
Light Vehicles	Vehicle Assembly	Hungary	Suzuki	Esztergom	1991
Light Vehicles	Vehicle Assembly	Poland	Volkswagen	Wrzesnia	2016
Light Vehicles	Vehicle + Engine	Poland	Stellantis	Tychy	1975
Light Vehicles	Vehicle Assembly	Poland	Volkswagen	Poznan	1993
Light Vehicles	Engine Plant	Uzbekistan	General Motors	Tashkent	2011
Light Vehicles	Vehicle Assembly	Uzbekistan	Uzavtosanoat	Asaka	1996
Light Vehicles	Vehicle Assembly	Uzbekistan	Uzavtosanoat	Khorezm	2014
Light Vehicles	Vehicle Assembly	Kazakhstan	GAZ	Semey	2013
Light Vehicles	Vehicle Assembly	Slovenia	Renault-Nissan	Novo Mesto	1990
Light Vehicles	Vehicle Assembly	Belarus	Geely	Borisov	2013
Light Vehicles	Vehicle Assembly	Serbia	Stellantis	Kragujevac	2012
Light Vehicles	Vehicle Assembly	Ukraine	Eurocar	Zakarpattya	2002
Light Vehicles	Vehicle Assembly	Ukraine	AvtoZAZ	Zaporozhye	1923
Light Vehicles	Engine Plant	Hungary	Stellantis	Szentgotthard	1992
Light Vehicles	Engine Plant	Poland	Stellantis	Bielsko Biala	1992
Light Vehicles	Engine Plant	Poland	Toyota	Jelcz-Laskowice	2005
Light Vehicles	Engine + Transm.	Poland	Toyota	Walbrzych	2001
Light Vehicles	Engine Plant	Poland	Volkswagen	Polkowice	1999
Light Vehicles	Engine Plant	Turkey	Ford	Inonu	1982
Truck	Vehicle Assembly	Turkey	Daimler Truck	Adana	1968
Truck	Vehicle Assembly	Turkey	Daimler Truck	Aksaray	1986
Bus	Vehicle Assembly	Turkey	Daimler Truck	Istanbul	1995
Truck	Vehicle Assembly	Turkey	Ford	Inonu	1982
Truck + Bus	Vehicle Assembly	Turkey	Isuzu	Gebze	1999
Bus	Vehicle Assembly	Turkey	Otokar Otomotive	Sakarya	1997
Bus	Vehicle Assembly	Turkey	Traton	Ankara	1966
Bus	Vehicle Assembly	Turkey	PPF	Adana	1968

Plants established after 2010

Most of the automotive plants are long-established, few have opened recently

List of Automotive OEM Plants in CEE setup before 2018 (2 of 2)

Vehicle Type	Plant Type	Country	OEM	Plant Location	Launch Year
Truck	Vehicle Assembly	Turkey	BAIC	Sakarya	2013
Truck + Bus	Vehicle Assembly	Turkey	BMC	Izmir	1964
Bus	Vehicle Assembly	Turkey	Kiraca Holding	Bursa	1999
Bus	Vehicle Assembly	Turkey	Gueleryuez	Bursa	1990
Bus	Vehicle Assembly	Turkey	IIA	Bursa	1999
Bus	Vehicle Assembly	Turkey	Bozankaya	Ankara	2003
Truck	Vehicle Assembly	Poland	Traton	Niepolomice	2007
Bus	Vehicle Assembly	Poland	Traton	Slupsk	1993
Bus	Vehicle Assembly	Poland	Traton	Starachowice	2015
Bus	Vehicle Assembly	Poland	CAF	Bolechowo	1996
Bus	Vehicle Assembly	Poland	Volvo	Wroclaw	1996
Bus	Vehicle Assembly	Poland	Huta Stalowa W.	Sanok	1945
Truck + Bus	Vehicle Assembly	Kazakhstan	SAIC	Kostanay	2013
Truck	Vehicle Assembly	Kazakhstan	Weichai Power	Semipalatinsk	Not found
Truck + Bus	Vehicle Assembly	Kazakhstan	Kamaz	Kokshetau	2005
Bus	Vehicle Assembly	Kazakhstan	King Long	Almaty	1997
Bus	Vehicle Assembly	Kazakhstan	ZYLE Daewoo CV	Semey	Not found
Truck	Vehicle Assembly	Kazakhstan	BAIC	Semipalatinsk	Not found
Truck	Vehicle Assembly	Kazakhstan	GAZ Group	Semipalatinsk	Not found
Truck	Vehicle Assembly	Kazakhstan	OMG Group	Semipalatinsk	Not found
Bus	Vehicle Assembly	Kazakhstan	CRRC	Kostanay	Not found
Truck + Bus	Vehicle Assembly	Belarus	MAZ	Minsk	1949
Truck	Vehicle Assembly	Belarus	Belaz	Jodino	Not found

Vehicle Type	Plant Type	Country	OEM	Plant Location	Launch Year
Bus	Vehicle Assembly	Belarus	MZKT	Lida	1994
Truck	Vehicle Assembly	Belarus	MZKT	Minsk	1954
Bus	Vehicle Assembly	Belarus	BKM Holding	Minsk	1973
Truck	Vehicle Assembly	Belarus	Moaz	Mogilev	1935
Bus	Vehicle Assembly	Czech Republic	Iveco Group	Vysoke Myto	1895
Truck + Engine	Vehicle Assembly	Czech Republic	Czechoslovak	Koprivnice	1897
Bus	Vehicle Assembly	Czech Republic	SOR	Libchavy	1991
Bus	Vehicle Assembly	Czech Republic	PPF	Pilsen	Not found
Truck+Bus	Vehicle Assembly	Uzbekistan	Isuzu	Samarkand 2	1999
Truck	Vehicle Assembly	Uzbekistan	CNHTC	Samarkand	Not found
Truck+Bus	Vehicle Assembly	Uzbekistan	Traton	Samarkand	2009
Truck	Vehicle Assembly	Uzbekistan	MAZ	Tashkent	Not found
Bus	Vehicle Assembly	Hungary	BYD	Komarom	2017
Bus	Vehicle Assembly	Hungary	Ikarus	Szekesfehervar	1963
Bus	Vehicle Assembly	Macedonia	Van Hool	Skopje	2014
Truck + Bus	Vehicle Assembly	Ukraine	Isuzu	Cherkasy	1999
Truck	Vehicle Assembly	Ukraine	Dayun Group	Kremenchug	Not found
Bus	Vehicle Assembly	Ukraine	ZAZ	Zaporozhye	1863
Truck	Vehicle Assembly	Lithuania	Kamaz	Rokishkis	2012
Bus	Vehicle Assembly	Lithuania	UAB Vejo Projektai	Klaipeda	Not found
Bus	Vehicle Assembly	Slovenia	K-Bus	Murska Sobota	Not found
Truck	Engine	Belarus	Minsk Motor	Minsk	1944
Truck	Engine	Turkey	Ford	Eskisehir	1982

Plants established after 2010

6.3 Initiative Development

There are several initiatives within the AV space that can be implemented over short, medium, and long-term

Autonomous Vehicles Opportunity Roadmap

Setup dedicated government agency for AVs
- *Criticality:*
- *Scale of investment:* **$**

Adopt AV regulations
- *Criticality:*
- *Scale of investment:* **$**

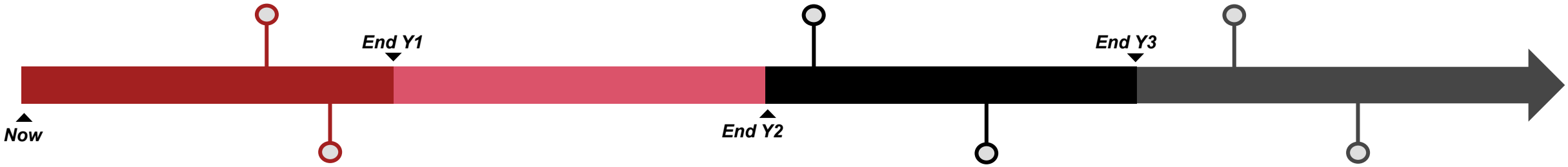
Cybersecurity (CS)
- *Criticality:*
- *Scale of investment:* **$$**

Transform quality of roads
- *Criticality:*
- *Scale of investment:* **$$$**

Deploy C-ITS
- *Criticality:*
- *Scale of investment:* **$**

HD mapping of Ukraine
- *Criticality:*
- *Scale of investment:* **$$$**

Attract and enable launch of AV R&D centers / innovation hubs
- *Criticality:*
- *Scale of investment:* **$$**



Partner with AV industry players
- *Criticality:*
- *Scale of investment:* **$$**

Conduct consumer acceptance survey
- *Criticality:*
- *Scale of investment:* **$**

Wireless connectivity and internet speeds
- *Criticality:*
- *Scale of investment:* **$**

Public awareness campaigns
- *Criticality:*
- *Scale of investment:* **$$**

Develop / attract AV talent pool
- *Criticality:*
- *Scale of investment:* **$**

Improve EV charging infrastructure
- *Criticality:*
- *Scale of investment:* **$$$**

$	$$	$$$
Low	Medium	High

Source(s): External Research

In the next 6-12 months, Ukraine can focus on understanding user sentiment and setting up a robust regulatory landscape

Short-Term Initiatives

Criticality: *High* → *Low*

Pillar	Initiatives	Key Activities	Challenges	Potential Stakeholders	Markets to Benchmark	Scale of Investment Reqd.
Organization & governance	Setup dedicated government agency for AVs	• Setup a new AV ecosystem-governing agency or create taskforce within existing agency • Hire / appoint key decision-making staff • Define key roles and responsibilities of the agency, e.g., developing AV regulations, grants, governing compliance, approvals, etc.	• Existing agencies may not have bandwidth for governance of a new vehicle category (AV) • New agency will take time to upskill and frame strong AV laws	• Ministry of Economic Development & Trade • Ministry of Digital Transformation • Ministry of Infrastructure	• Singapore • UAE • California (SF)	$
Laws, Regulations, and Incentives	Adopt AV regulations	• Benchmark leading AV regulations globally • Draft and publish AV-specific regulations clearly stating process to acquire AV license, eligibility criteria, commercial use policy, testing & insurance requirements, liability framework, grievance redressal mechanism, etc.	• No perfect AV regulations exist globally to mirror • Lack of AV expertise among lawmakers may result in easy loopholes' presence in the laws • Change management (local level)	• Ministry of Justice • Ministry of Economic Development & Trade • Ministry of Digital Transformation • Ministry of Infrastructure • AV developer companies	• UAE • Singapore • Nevada (LV)	$
Public-Private Partnership	Partner with AV industry players	• Identify avenues of investment for AVs and define target state of development • Identify leading industry players for partnering • Negotiate terms of partnership, schedule of investments, align on end-goals, KPIs, progress measurement methodology, etc.	• Securing funding for partnership • Setting contract terms mutually beneficial for both govt. & players • Attracting companies for AV investment and partnerships	• AV developer and software firms • Ministry of Economic Development & Trade • Ministry of Digital Transformation • Ministry of Infrastructure • Ministry of Strategic Industries	• UAE • Singapore • Nevada (LV)	$$
Public Awareness & Societal Engagement	Conduct consumer acceptance survey	• Identify & appoint vendor to conduct user survey among public, farmers, trucking companies, defense and govt. officials, etc. to gauge AV awareness and acceptance, and conduct the survey	• Identification of the right target groups for survey • Relevance and timing of survey • Picking out target category of AV to survey about (robotaxi, military, agricultural, mining, etc.)	• Cabinet of Ministers • Consumer survey companies • Trucking companies • All end-users including both public and govt. officials	• Singapore • UAE • California (SF)	$

$ Low $$ Medium $$$ High

Over the next 12-36 months, focus should be on public sentiment improvement and infrastructure upgrades, e.g., roads, network, etc.

Medium-Term Initiatives

Criticality: *High* → *Low*

Pillar	Initiatives	Key Activities	Challenges	Potential Stakeholders	Markets to Benchmark	Scale of Investment Reqd.
IT, Cyber and Telecom Infrastructure	**Cybersecurity** (CS)	• Audit current state of identification, prevention, response, & resolution of CS threats / incidents • Work with CS companies to attack gaps • Draft, publish and adopt strict cybersecurity and data privacy laws (e.g., GDPR)	• Strengthening CS is a gradual process, while AVs require high levels of CS from the start • Change management difficulties with new CS law implementation	• Cybersecurity service providers • Telecom companies • Ministry of Digital Transformation • Ministry of Infrastructure • Ministry of Justice	• US • Netherlands	$$
Road and Urban Infrastructure	**Transform quality of roads**	• Reconstruct or repair damaged roads, ensure smooth and consistently even road surfaces • Augment all roads with traffic control enablers like signages, markings, traffic lights, etc.	• Large-scale and capital-intensive • Unstable climate conditions affect road quality, marking visibility	• Infrastructure companies • Ministry of Economic Development & Trade • Ministry of Infrastructure	• Singapore • Netherlands • Nevada (LV)	$$$
IT, Cyber and Telecom Infrastructure	**Wireless connectivity and internet speeds**	• Auction 5G spectrum bands, allow deployment • Release higher speed bands • Review and resolve bottlenecks to high speeds	• Capital-intensive for companies, so roll-out can be slow or low-priority on their radar • Cybersecurity in newer bands	• Telecom and network infra firms • Ministry of Economic Development & Trade • Ministry of Infrastructure	• Singapore • Netherlands	$
Road and Urban Infrastructure	**Deploy C-ITS**	• Work with C-ITS vendors and auto OEMs to pilot C-ITS in major regions or highways • Refine based on pilot results and deploy throughout highways and city roads	• Applicability varies by AV type • 5G/4G availability for V2X comm. • Limited leading examples globally	• Automotive OEMs • AV developer and software firms • Local traffic authorities • Ministry of Infrastructure	• Netherlands • Nevada (LV)	$
Public Awareness & Societal Engagement	**Public awareness campaigns**	• Ideate awareness improvement options, e.g., AV conference, demos, sponsored rides, joint marketing campaigns with AV companies, etc. • Finalize and execute awareness campaigns	• User sentiment difficult to change • Accidents, if any, severely impact user sentiment, wasting such campaign investments	• Marketing vendors • AV developer and software firms • Ministry of Social Policy • Ministry of Strategic Industries	• Singapore • Netherlands • Nevada (LV)	$$

$	$$	$$$
Low	Medium	High

Source(s): External Research

On a 3+ years horizon, focus should pivot to large-scale ecosystem establishment including R&D bases, EV charging and HD mapping

Long-Term Initiatives

Criticality: *High* → *Low*

Pillar	Initiatives	Key Activities	Challenges	Potential Stakeholders	Markets to Benchmark	Scale of Investment Reqd.
IT, Cyber and Telecom Infrastructure	**HD mapping of Ukraine**	• Secure funding for HD-mapping • Work with HD mapping vendors, AV developer companies and auto OEMs to build nation-wide HD map of Ukraine	• HD mapping is capital-intensive • Real-time update of HD maps • Data storage and transfer speeds • Cybersecurity and data privacy	• HD mapping companies • AV developer and software firms • Automotive OEMs • Network infrastructure companies • Ministry of Digital Transformation • Ministry of Infrastructure	• UAE • San Francisco • Singapore	$$$
R&D Capabilities	**Attract and enable launch of AV R&D centers / innovation hubs**	• Reserve real-estate or define protected special economic zones for AV R&D companies • Announce special grants or incentives for setting up AV R&D centers in Ukraine • Collaborate with and relax permissions for early movers to launch R&D centers faster	• Identification of suitable land area • R&D setup is capital-intensive, so difficult to attract companies even with grants and incentives • Local resistance to FDI in R&D	• AV developer and software firms • Ministry of Infrastructure • Ministry of Education & Science	• California (SF) • Singapore	$$
R&D Capabilities	**Develop / attract AV talent pool**	• Collaborate with governments to source international AV talent to lay the foundations • Tie-ups of universities with AV developer companies to hire and train fresh AV talent • Incentivize AV firms to develop local talent pool	• Talent relocation is tricky • Brain drain to Western countries 'after' AV upskilling in Ukraine • Talent development is time-intensive, ROI takes even longer	• AV developer and software firms • Ministry of Economic Development & Trade • Ministry of Digital Transformation • Ministry of Education & Science	• California (SF) • Netherlands • UAE	$
Road and Urban Infrastructure	**Improve EV charging infrastructure**	• Assess current EV charging infra (availability per capita, split of fast vs slow chargers, etc.) • Work with energy and EV charging companies to strategize target state and invest to improve • Setup committee to monitor EV infra progress	• Maintenance and upkeep • Business case for EV charging stations specially in remote areas • Uncertain power supply	• Automotive OEMs • Energy companies • Ministry of Infrastructure • Ministry of Energy	• Netherlands • California (SF)	$$$

$ Low $$ Medium $$$ High

Meanwhile in the US and California, the regulatory framework is diversified among federal and state legislations

US – California AV Regulation Structure

Stakeholders & Details

Employees:

- US DoT: 55,000
- US FHWA: 2,700
- US NHTSA: 626
- CalSTA: 42,000
- CPUC: ~1000
- CA DMV: 9,000

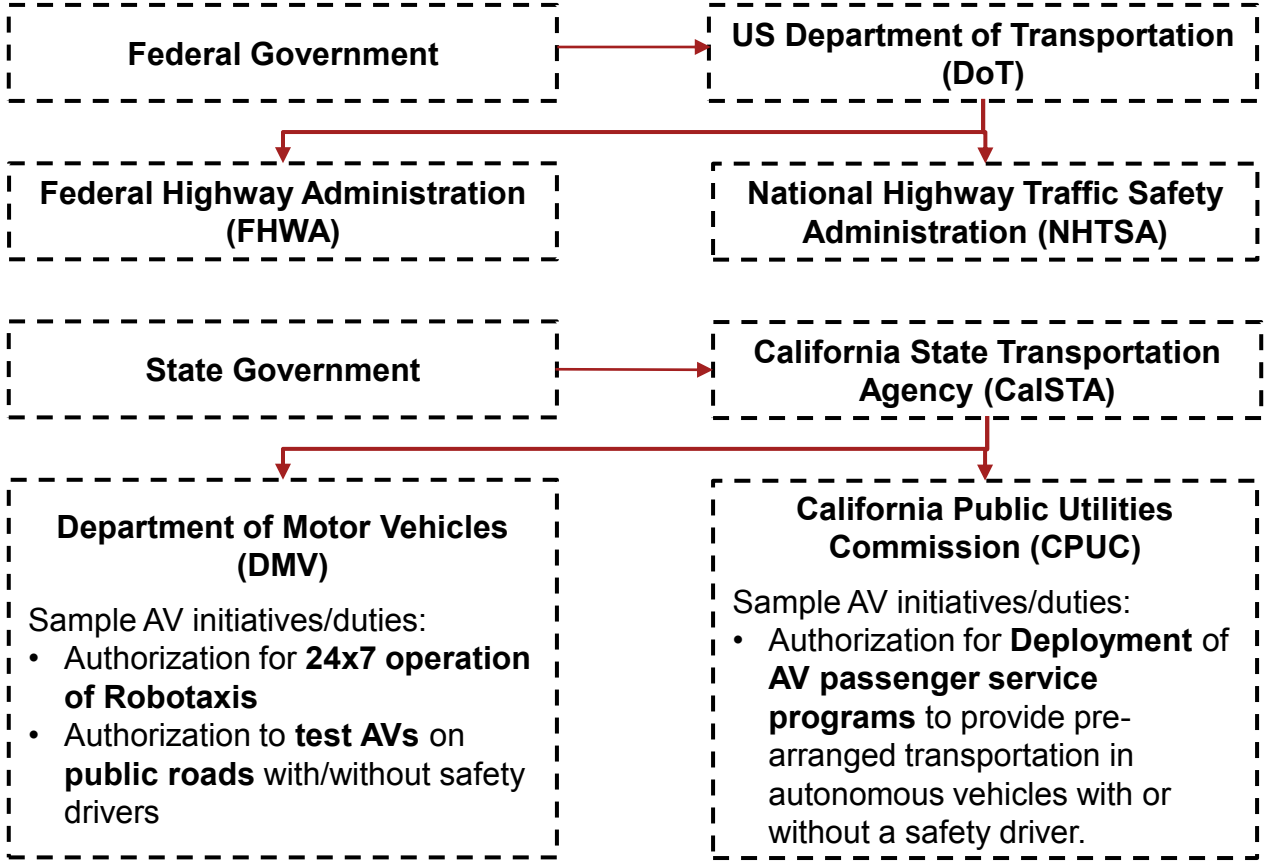
Objective & Responsibilities:

- **CalSTA**: develops and coordinates the policies and programs of the state's transportation entities to achieve the state's mobility, safety and air quality objectives from its transportation system.
- **CPUC**: regulates private electric, natural gas, telecommunications, water, railroad, rail transit, and passenger transportation companies, in addition to authorizing video franchises.
- **CA DMV**: responsible for licensing drivers and registering residents' vehicles. License and regulate vehicle manufacturers, transporters, dealers, distributors, vehicle salespeople, and dismantlers.

Profiles:

- **CalSTA** executive staff: 16 members, with 2 general counsels
- **CPUC**: 5 commissioners appointed by the Governor and confirmed by the Senate
- **CA DMV** executive leadership: 15 members

Structure



Sources: California Public Utilities Commission, US DoT, Strategy& Research

One leading example of AV-related agency is the Committee on Autonomous Road Transport for Singapore (CARTS)

Singapore – CARTS Structure

Stakeholders & Details

Creation:
Founded in 2014 and announced at the "*Autonomous Transport: Paving the Road for Future Mobility" conference."*

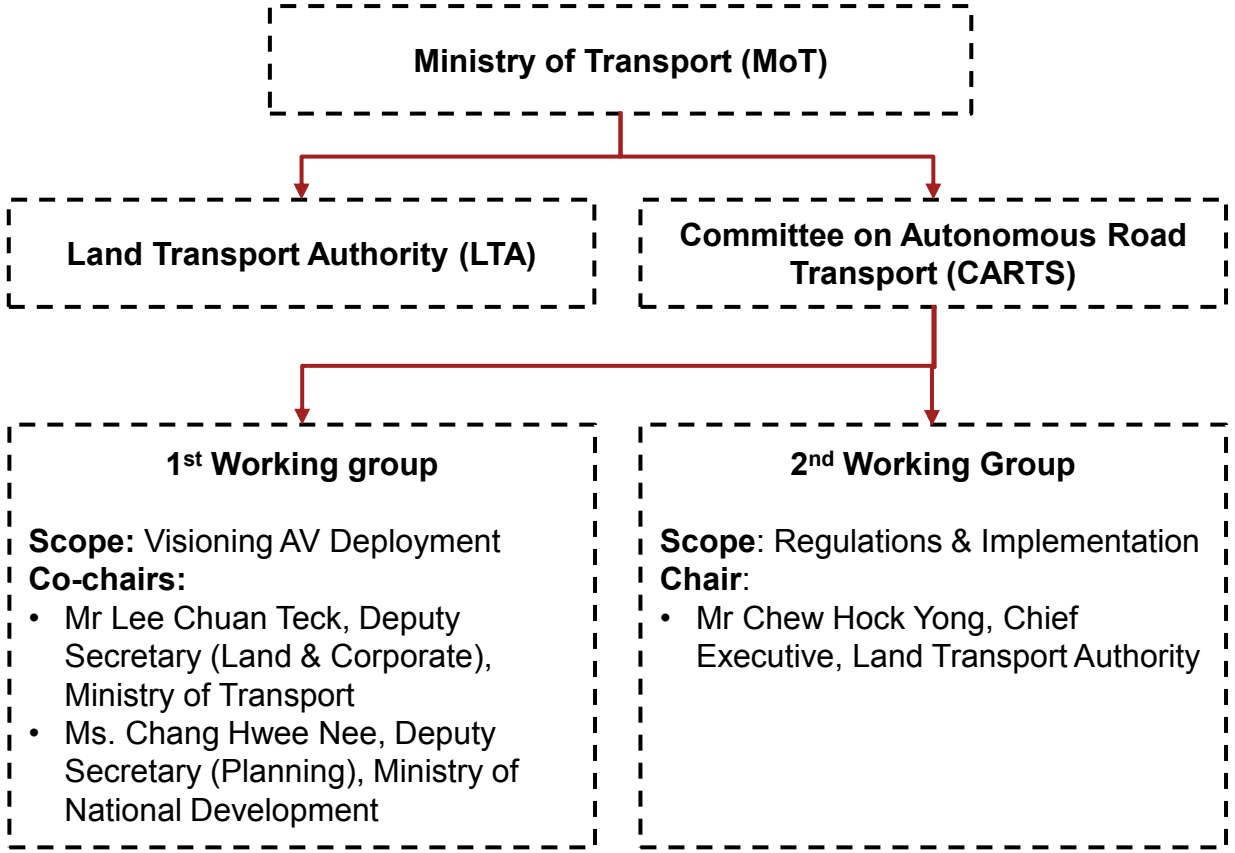
Chairman:
Mr. Pang Kin Keong, Permanent Secretary Ministry of Transport

Objectives:
"Provide thought leadership and **guidance on** the research, development and deployment of **AV technology** and **AV-enabled mobility concepts** for Singapore; and Study the associated **opportunities** and **challenges**. "

Responsibilities:
Publish guidelines to steer direction of AV technology in Singapore

Profiles:
17 members, including members of the **public sector** from relevant planning agencies, **international experts**, **academics**, and **industry leaders**. Committee members were appointed based on skills and experience around AV technology, urban planning, new business models and transport solutions.
Out of 17, 8 seats are taken by government members, 5 from academics and 4 from industry leaders.

Structure



Sources: National Archives Singapore, Strategy& research

While other examples of AV-related agencies are the Integrated Transport Center (ITC) and the Road Transport Authority in UAE

UAE – RTA & ITC Structure

Stakeholders & Details

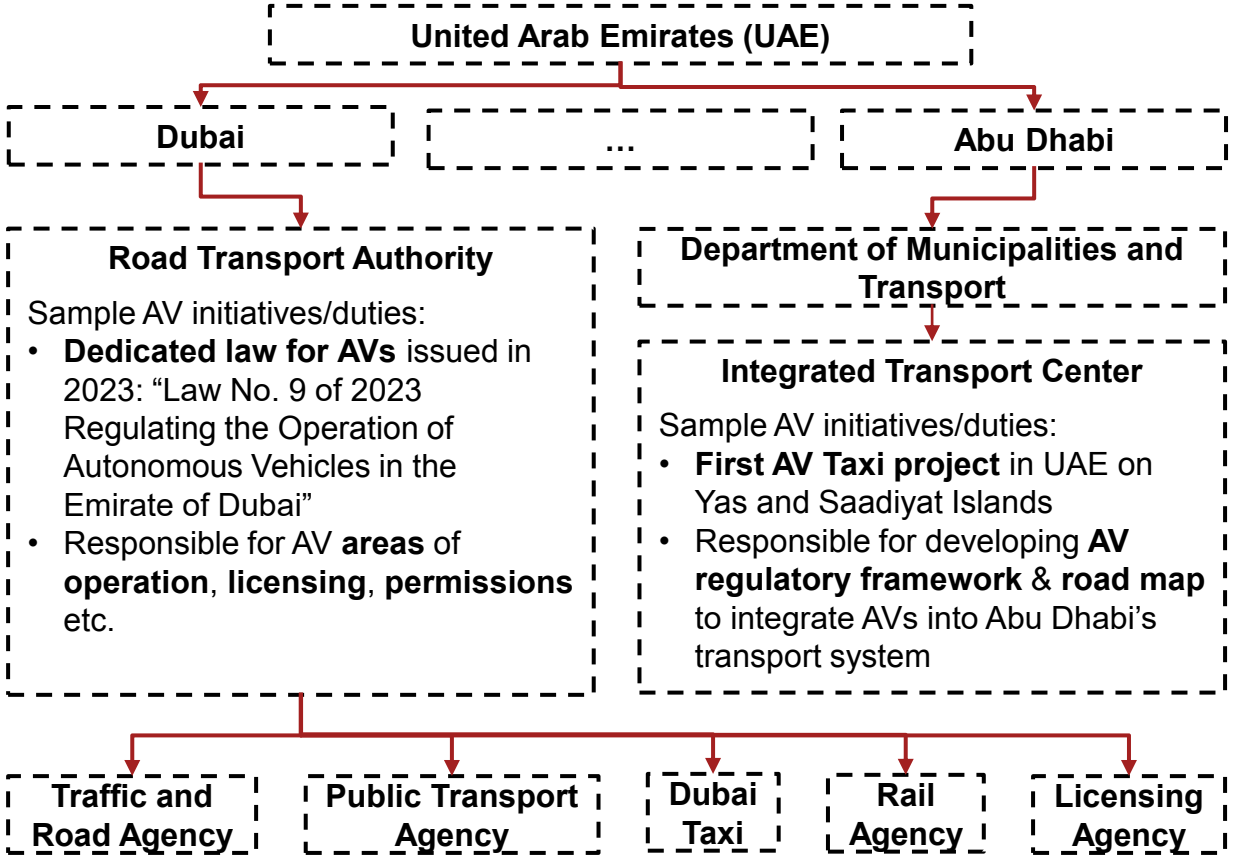
Creation:
- RTA – established with Law No. 17-2005 by the Emir of Dubai
- ITC – established with Law No. 19-2016 by the ruler of Abu Dhabi

Objective & Responsibilities:
- **RTA**: responsible for planning and providing the requirements of transport, roads & traffic in the Emirate of Dubai, and between Dubai and other UAE Emirates and neighboring countries.
- **ITC:** responsible for operating public transport and managing parking spaces, traffic monitoring centers, axle weights stations, logistical facilities of freight surface transport and roads sector according to the approved transport plans.

Leadership:
- Chairman RTA: HE Mattar Al Tayer
- Director general ITC: Abdulla Al Marzouqi

Profiles:
- **RTA**: Overseen by an 11-member Board of Executive Directors appointed by decrees from the Executive Council of the Emirate
- **ITC**: depends from Department of Municipalities and Transport

Structure



Sources: Digital Dubai Office Website, ITC Abu Dhabi Website, International Trade Administration Strategy& research

Thank you

Agenda

1. Autonomous Vehicle (AV) Technology Overview
2. Key Considerations for AV Rollout
3. AV Players Overview
4. OEMs Role in AV Technology
5. Market Scorecard for AV Readiness
6. Ukraine Overview
7. **Appendix**

Appendix – Opportunity Parameters

Depending on opportunity, we looked at different assessment parameters to quantify the potential benefit for Ukraine (1/2)

Opportunity	Opportunity Size Assessment Parameters (High – Level Estimate)	
Autonomous Robotaxi*	• Increased GDP contribution (reducing fatalities & injuries) • Reduced healthcare & infrastructure spending (fatalities & injuries avoided)	• Tax losses on fuel due to EV penetration • Job losses due to AV introduction
Autonomous Demining Tractor	• Reduction in healthcare spending (fatalities & injuries avoided) • Increase in available agricultural land	• Reduction in farming equipment losses
Autonomous Farming Equipment	• Increase in farming yields with timely & accurate sowing and tilling • Reduction in crop/harvest losses occurring due to weather, pests, mishandling, and storage issues	
Autonomous Military Vehicles	• Increase in military logistics/transportation efficiency • Reduced healthcare spending (fatalities & injuries avoided)	
Autonomous Cargo Truck*	• Increased GDP contribution (reducing fatalities & injuries) • Reduced healthcare & infrastructure spending (fatalities & injuries avoided)	• Increased supply chain & logistics output (improved trucking efficiency) • Job losses due to AV introduction
Autonomous Surface Ship / Boat	• Increased supply chain & logistics output (improved shipping efficiency)	

Impact on opportunity benefits
Positive Impact ***Negative Impact***

*** Also separately included estimated FDI for R&D & commercialization requirements**

Depending on opportunity, we looked at different assessment parameters to quantify the potential benefit for Ukraine (2/2)

Opportunity	Opportunity Size Assessment Parameters (High – Level Estimate)
Autonomous Testing Hub	• New jobs creation • Foreign Direct Investments
Autonomous Port / Airport Vehicles	• Estimated to generate limited benefit with regards to improved material handling at seaports & airports
Autonomous Urban Buses / Shuttles*	• Increased GDP contribution (reducing fatalities & injuries) • Reduced healthcare & infrastructure spending (fatalities & injuries avoided) • Job losses due to AV introduction
Autonomous Tech R&D Hub	• New jobs creation • Foreign Direct Investments
Autonomous Mining Vehicles	• Increased mining throughput leading to more exports and higher GDP contribution (improved mining efficiency)
Auto OEM/Supplier Manufacturing	• New jobs creation • Foreign Direct Investments

Impact on opportunity benefits
Positive Impact ***Negative Impact***

*** Also separately included estimated FDI for R&D & commercialization requirements**