



# ASSURED pre-normative technology roadmap in electric bus charging

**Standardisation & Interoperability Bus-Charger Online Workshop**

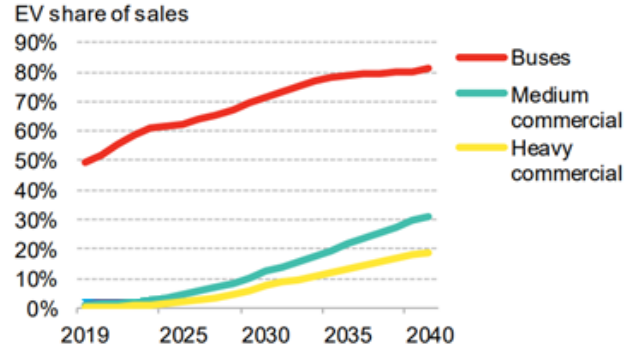
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# Introduction

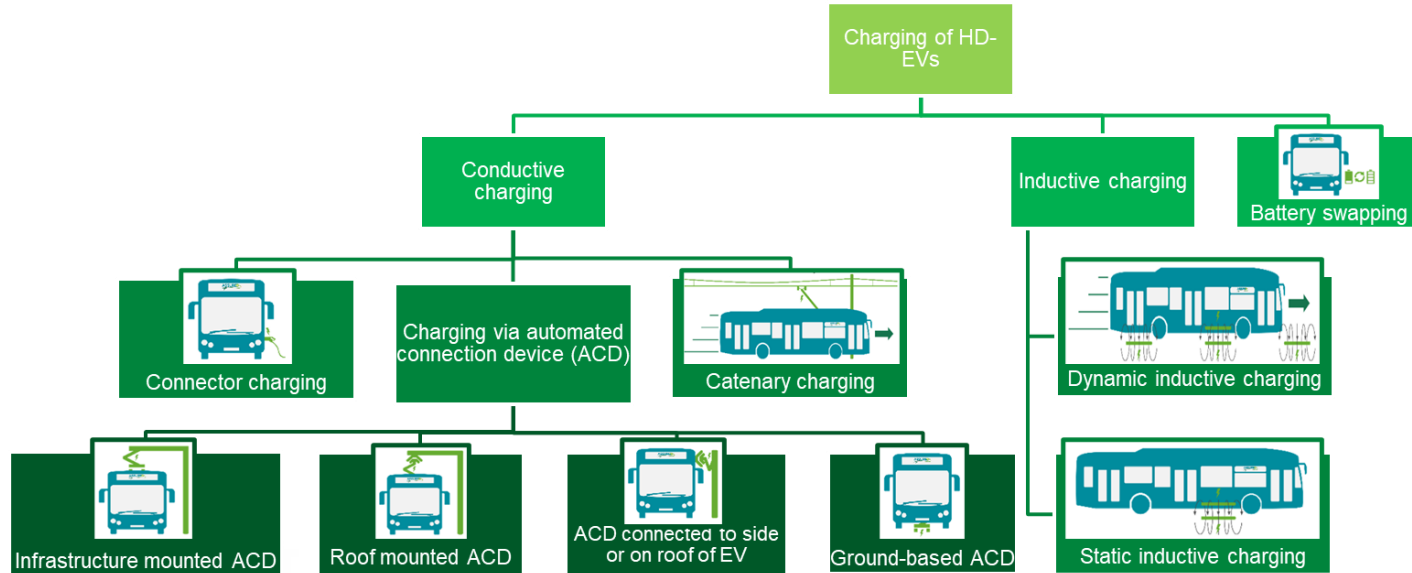
- Charging standards and policies require being future-proof and account for the upcoming charging needs.
- **Aim:** presenting a technical roadmap that projects evolution of various charging technologies aspects and their future requirements to support both standardisation efforts and end users' decision making.



EV share of annual vehicle sales by segment

Source: BloombergNEF, "Electric Vehicle Outlook 2019".  
Commercial vehicle figures include only China, Europe, and the U.S.

# Charging Technologies for HD-EVs





# Methodology for Sketching ASSURED Technology Roadmap

- **Literature review of the existing research, use cases, and roadmap**
- **Conducting surveys and interviews HD EV users and experts**

# Surveys & Interviews

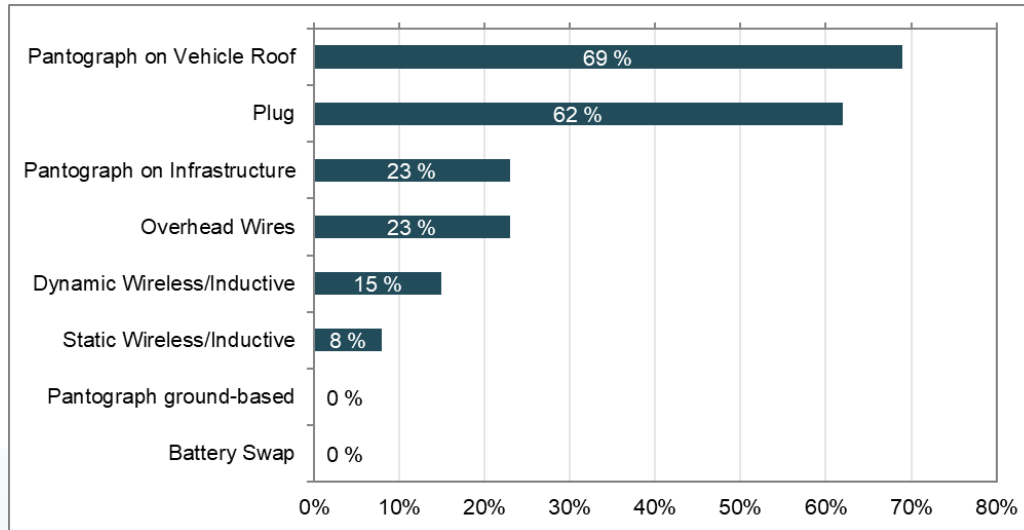
	End user survey	Technical survey
Target Participants	Owners/users or future owners/user of electric buses, trucks or other HD vehicles Examples: public transport companies, city governments, logistics companies, construction companies.	Organizations with in-depth knowledge of charging infrastructure for electric buses, trucks or other HD vehicles Examples: charger manufacturers, charging service providers, research organizations, and electric bus/truck OEM's.
Number of respondents	14	20
Respondents' target vehicle groups	Electric bus: 14 Electric truck: 0 Other HD vehicles: 0	Electric bus: 18 Electric truck: 11 Other HD vehicles: 9



7 of respondents (3 from end user survey and 4 from technical survey) to participate in a follow up interview after the survey.

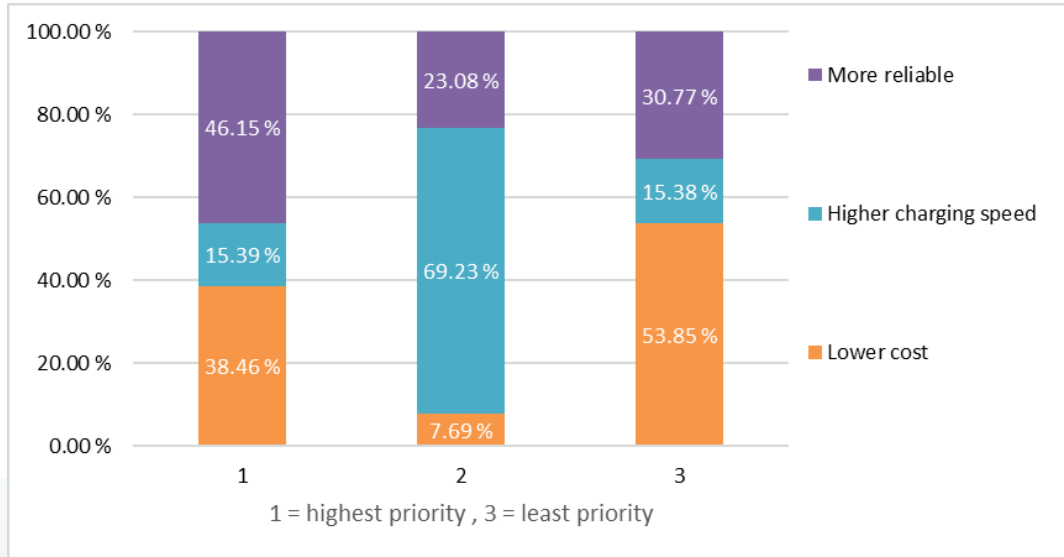
# End User Survey (I)

- Which charging technology types your organization owns/uses?



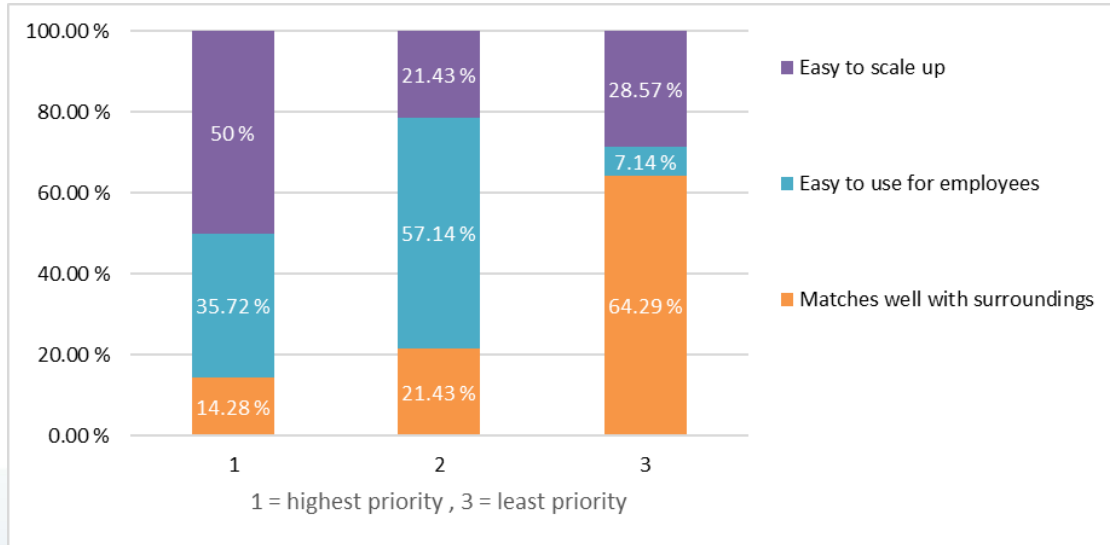
# End User Survey (II)

- Ranking the priority of the following charging infrastructure improvements for the organization.



# End User Survey (III)

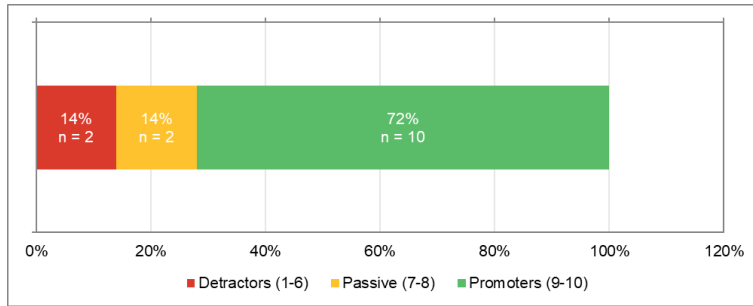
- Rank the priority of the following charging infrastructure characteristics for your organization



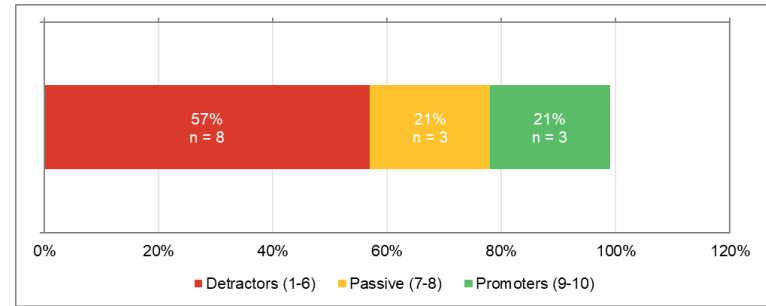


# End User Survey (IV)

- Importance of interoperability



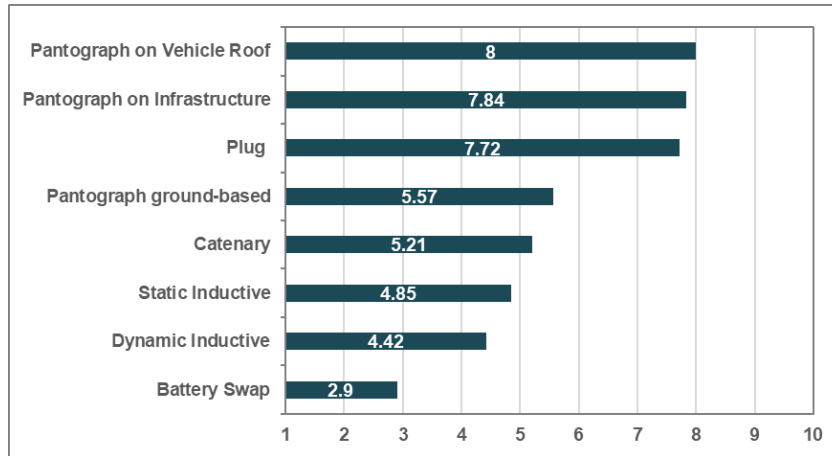
Interoperability between chargers and EVs of different brand



Interoperability between chargers and EVs of different types (e.g., buses and trucks)

# Technical Survey (I)

- Rate the potential of charging technologies



1 = Low potential and 10 = High potential



# Technical Survey (II)

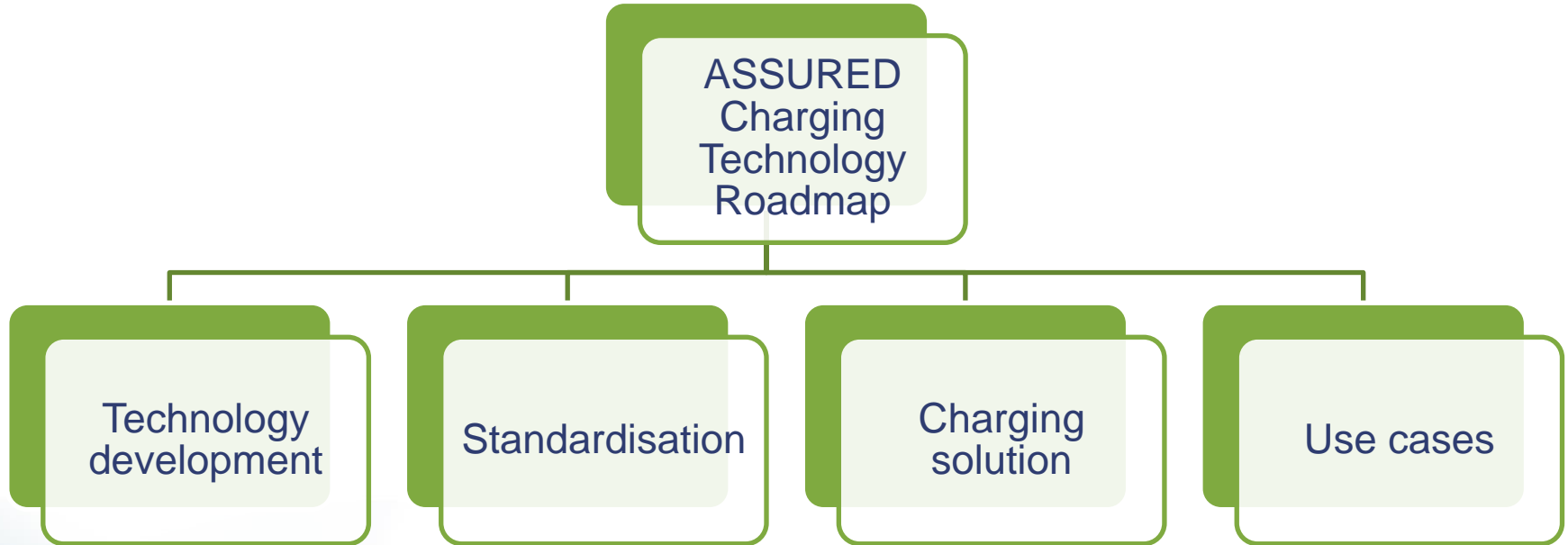
- **Challenges in today's charging technologies:**
  - Providing power needed by grid,
  - Interoperability,
  - Standardization,
  - Batteries: capacity, cost, BMS (battery management system), aging,
  - Installation (permitting, grid connection, space requirement),
  - Fleet management, demand response and its complexity

# Technical Survey (III)

- **Different accepts to consider in long term (2030) charging technology goals:**
  - Vehicle-charger interoperability
  - Interoperable charging between different vehicle types
  - Automated charging without human involvement
  - Cyber security
  - High power opportunity charging
  - V2Xcharging, fleet & grid management, local storage
  - Increased battery capacity with lower price

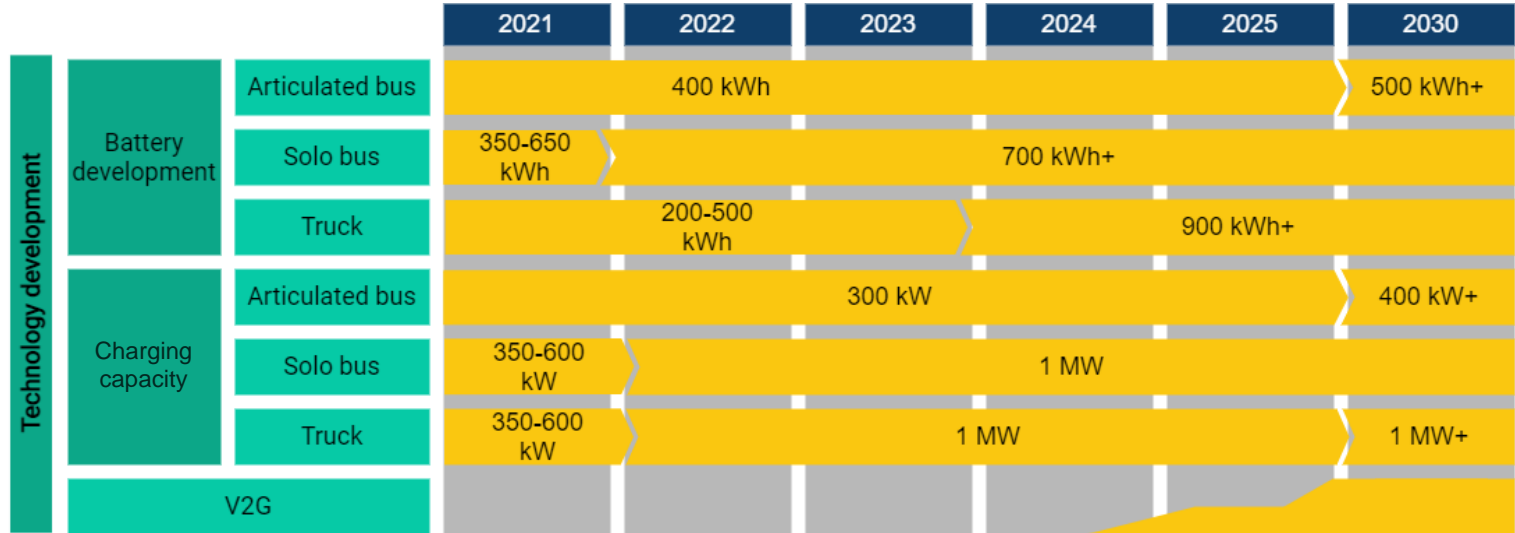


# ASSURED Pre-normative Charging Technology Roadmap





# ASSURED Charging Technology Roadmap (I)



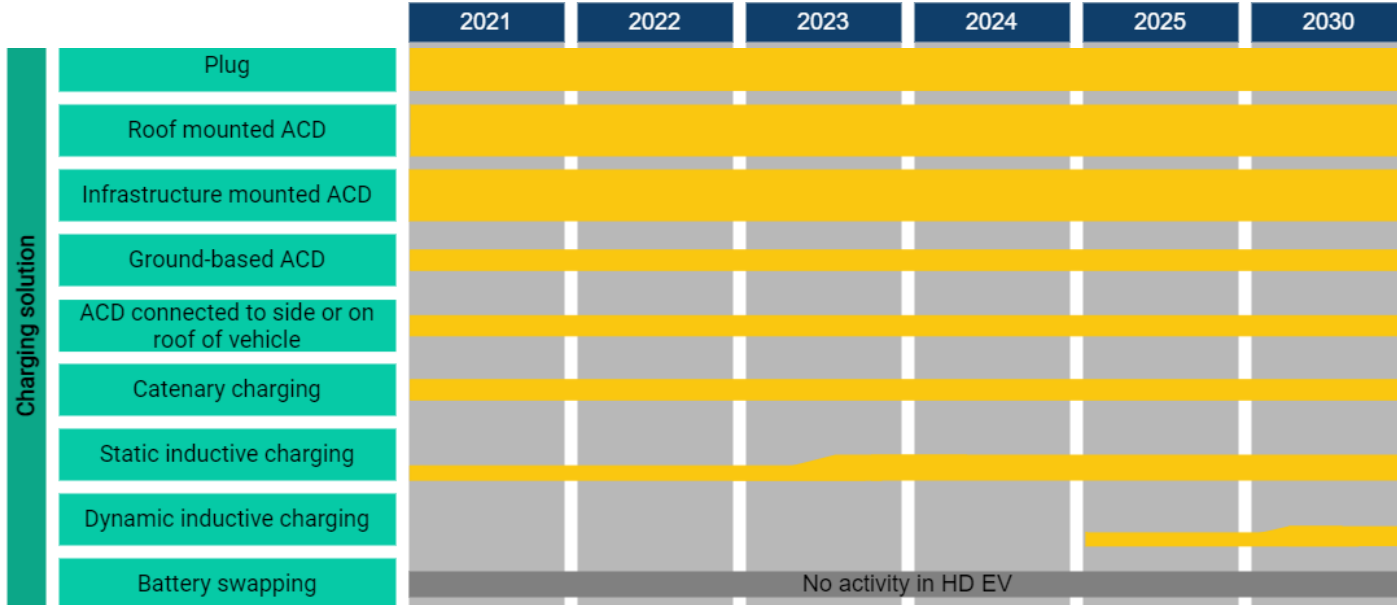


# ASSURED Charging Technology Roadmap (II)

		2021	2022	2023	2024	2025	2030
Standardisation	Static inductive charging						
	Dynamic inductive charging						
	Dynamic conductive charging	No known activity in standardisation					
	AC charging w/onboard charger	No known activity in standardisation					
	Charger-vehicle interoperability						
	Interoperable charging between different vehicle types						
	Cyber security						



# ASSURED Charging Technology Roadmap (III)







# ASSURED Charging Technology Roadmap (IV)

			2021	2022	2023	2024	2025	2030
Use cases	Feeder lines	Depot charging	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
		Opportunity charging	Yellow	Yellow	Yellow	Yellow	Grey	Grey
	Trunk lines	Depot charging	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
		Opportunity charging	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
	BRT	Depot charging	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
		Opportunity charging	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow

# Conclusion

- **ASSURED technology roadmap supports:**
  - future standardisation effort by providing the evolvement of various charging technologies aspects and their future requirements
  - end users in selecting their charging technologies by familiarising them with the charging technologies and concepts, and their perceived potential.



# Thank you!

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