

3rd. Asia Automobile Institute Summit
2-4 December 2014, Bangkok

EV Charging in Japan: Issues and Countermeasures

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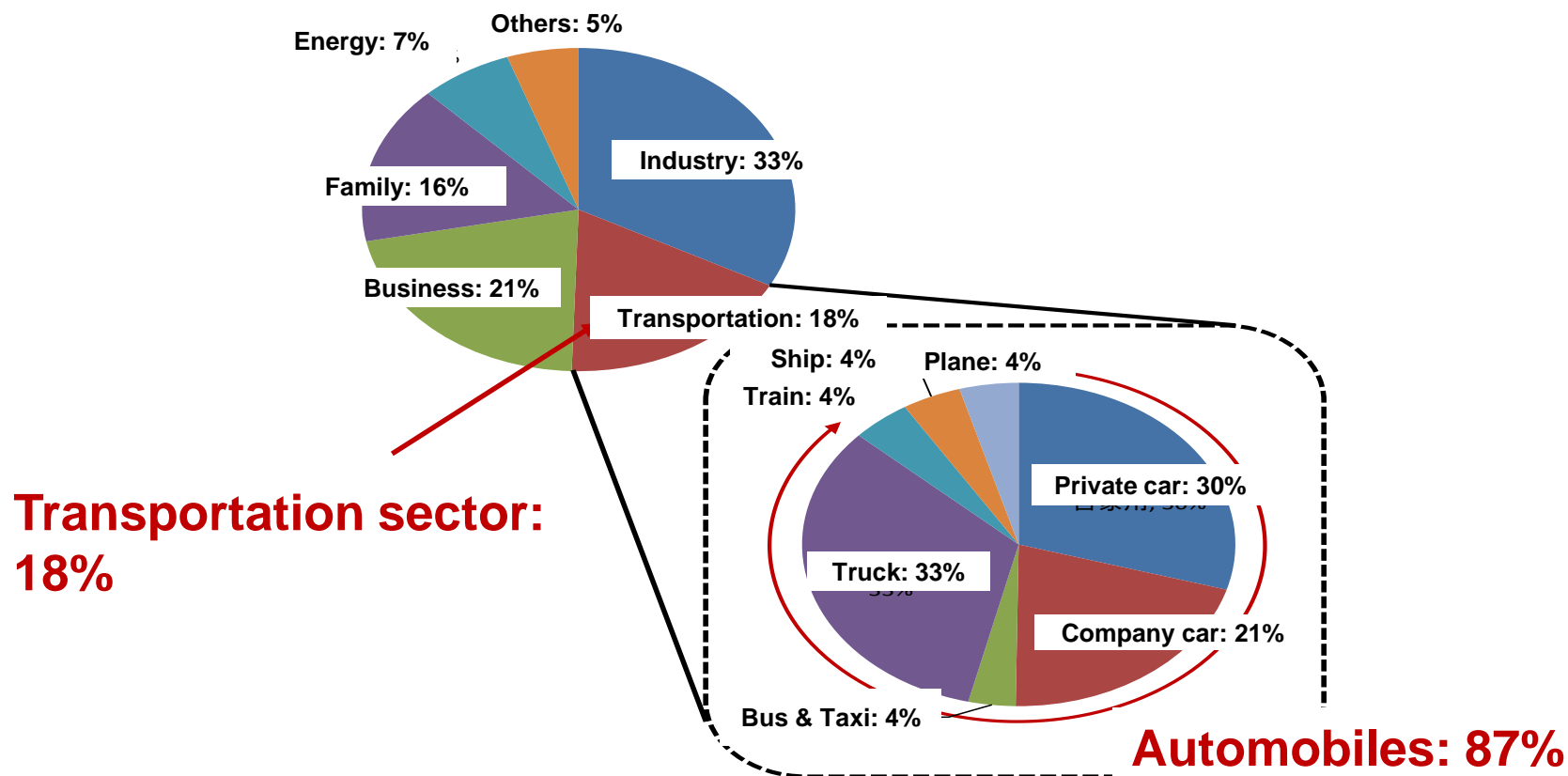
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1. Importance of EV charging infrastructure

CO2 emission volume overview in Japan

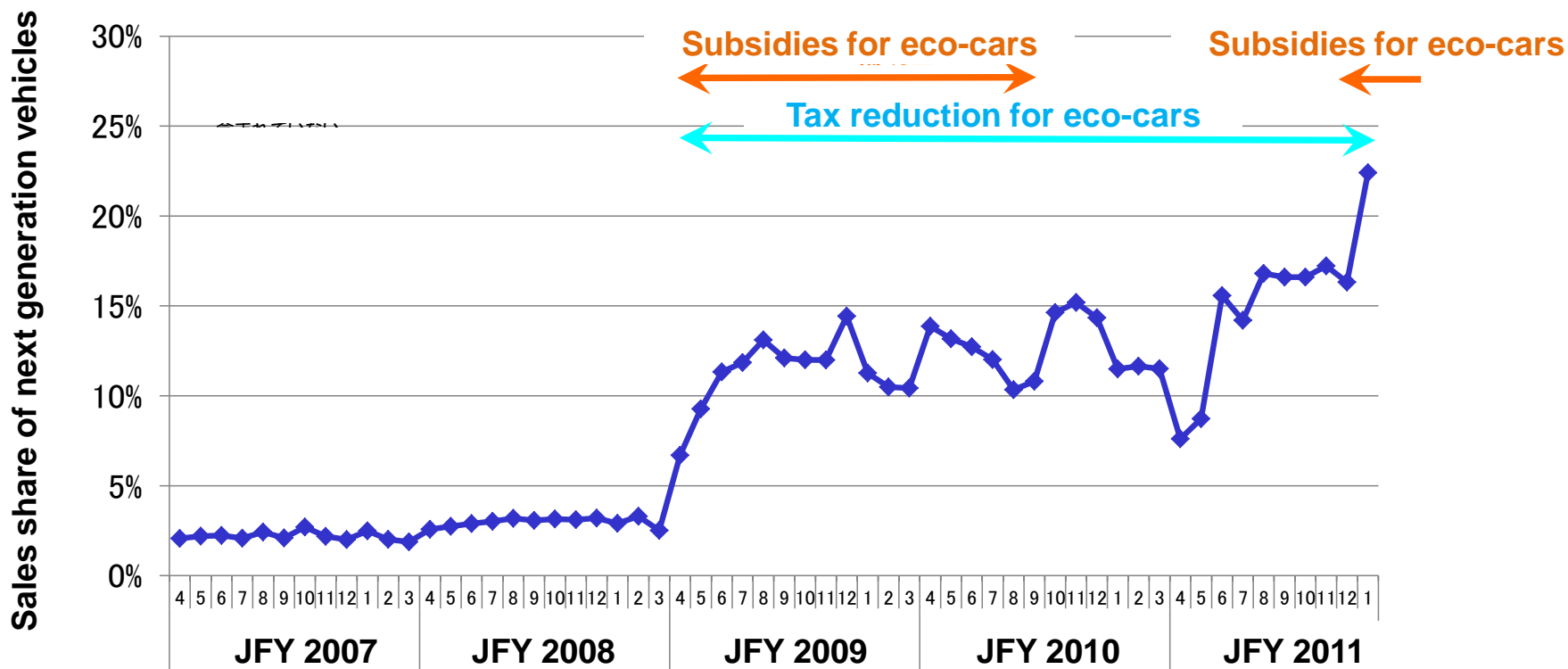
Around **20%** of CO2 emission volume comes from the transportation sector and automobile exhaust is around **90%** of that.



CO2 emission volume by segment, JFY 2012

Next generation vehicle sales trend in Japan

Sales share of next generation vehicles* **has been steadily increasing since 2009.** *: HEV, PHEV, BEV and Clean diesel vehicles.



Source: Japan Automobile Manufactures Association

Government policy for next generation vehicles

The Japanese government has been tackling customer demand creation, R&D support and infrastructure enhancement, targeting next generation vehicles' sales share to be **50-70% by 2030**.

Governmental target of sales share by vehicle segment

Vehicle segment	2020	2030
Current vehicles	50-80%	30-50%
Next generation vehicles	20-50%	50-70%
HEV	20-30%	30-40%
PHEV and BEV	15-20%	20-30%
FCEV	up to 1%	up to 3%
Clean diesel vehicles	up to 5%	5-10%

Source: Ministry of Economy, Trade and Industry, HP

PHEV and BEV's characteristics

To make PHEVs and BEVs more popular, it is necessary to **reduce drivers' anxiety regarding charging**. EV charging infrastructure enhancement and BEV's mileage extension are crucial.

Merits:

- ✓ High efficiency
- ✓ Good acceleration
- ✓ Possible to charge at home
- ✓ Low noise
- ✓ Zero emission (BEV)

Problems to be solved:

- ✓ Expensive vehicle price
- ✓ **Low number of charging stations**
- ✓ **Low mileage (BEV)**
- ✓ Heavy vehicle weight

Private company action toward government policy

The following actions have been started to realize Japanese government policy: "**Set 2 million units of AC chargers and 5,000 units of DC chargers up to 2020**".

JTB: The Japan Travel Bureau announced on 9. Dec. 2013:
1,000 units of AC chargers are to be set

AEON: This large supermarket chain announced on 19. Jul. 2013:
1,150 units of chargers are to be set at approximately 500 supermarkets

NEXCO: Nippon Expressway Co. and **Metropolitan Expressway Co.**
announced:
Vision of chargers' setting in service/ parking areas on expressways to be set by 20. Dec. 2013

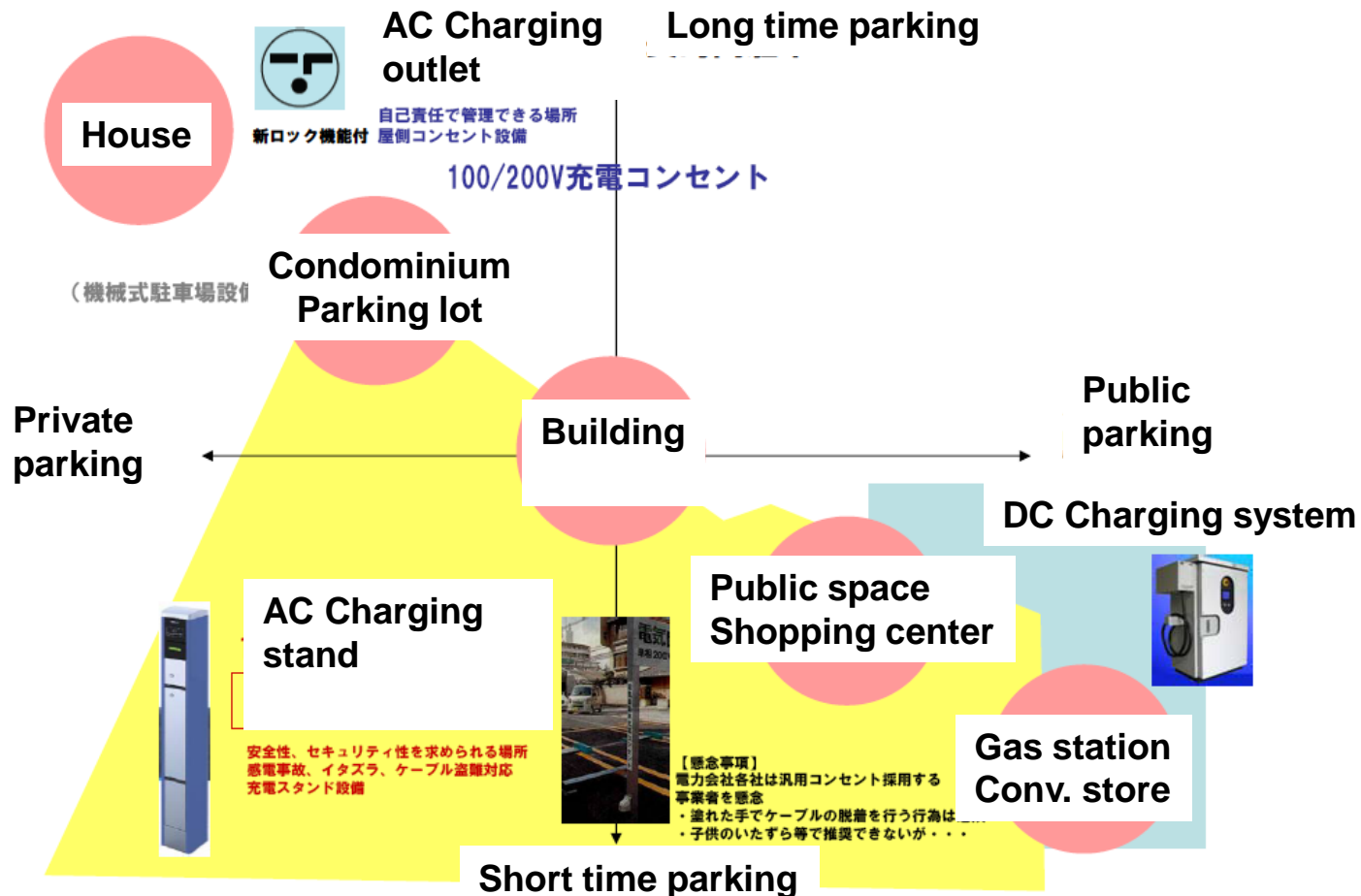
FamilyMart: This convenience store chain announced on 26. Apr. 2013:
Chargers are to be set at 500 stores

Toyota, Nissan, Honda and Mitsubishi announced:
Support private companies to set charging infrastructure

Source: Ministry of Economy, Trade and Industry, HP

Charging system's positioning

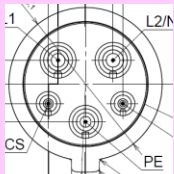


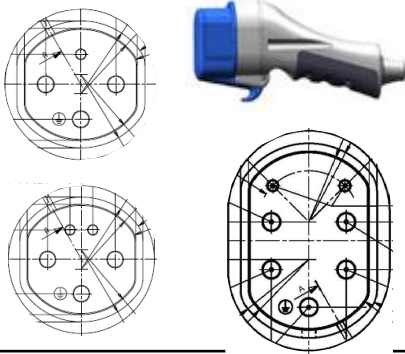
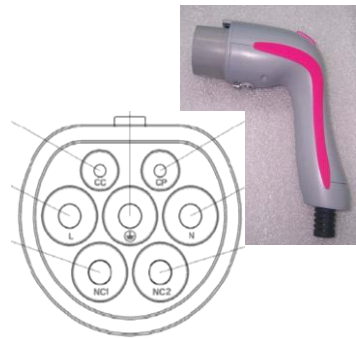
Both AC and DC charging systems are being set in Japan to meet EV drivers' charging needs.



Source: Panasonic, HP

2. EV charging system review

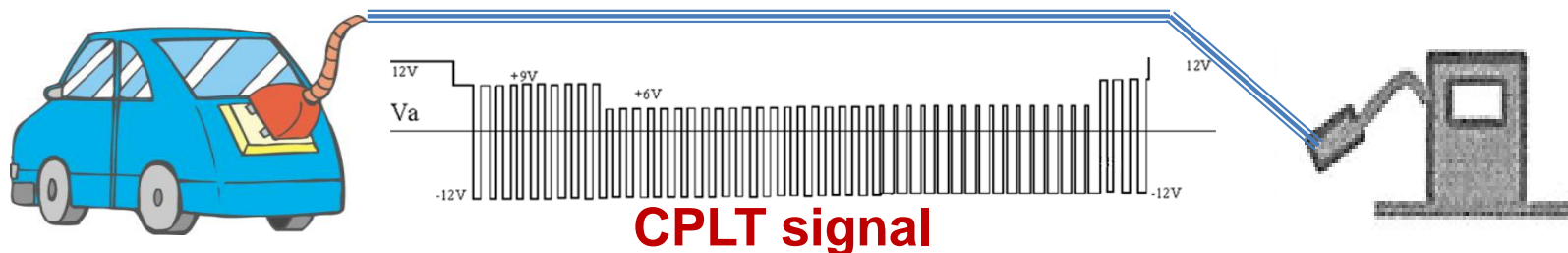
AC charging system standard

	IEC 62196-2			China
	Type 1 (Japan)	Type 2 (Germany)	Type 3 (Italy)	
Phase	Single	Single/Three	Single/Three	Single/Three
Rated Current	32A (single phase) 80A (single, US only)	70A (single phase) /63A (three phase)	32A→63A ? (single/three phase)	70A (single phase) /63A (three phase)
Rated Voltage	250V (300V US only)	480V	250V	220V (single phase)/ 380V (three phase)
# of pins	5	7	4 or 5 (single phase) / 7 (three phase)	7
Scope	Coupler	Coupler, Plug & Socket	Coupler, Plug & Socket	Coupler, Plug & Socket
Compatibility	SAE J1772	—	—	—
Connector Design	 $\Phi 43.8$	  $\Phi 56.0$		
Locking	Option	Yes	Yes	Yes
Shutter	No	No	Yes	No

AC charging system standard: CPLT function

AC charging is secured by **CPLT - Control pilot function*** which makes **communication between the EV and AC charger.**

* Check the connection, and not to pass current without request from the EV.



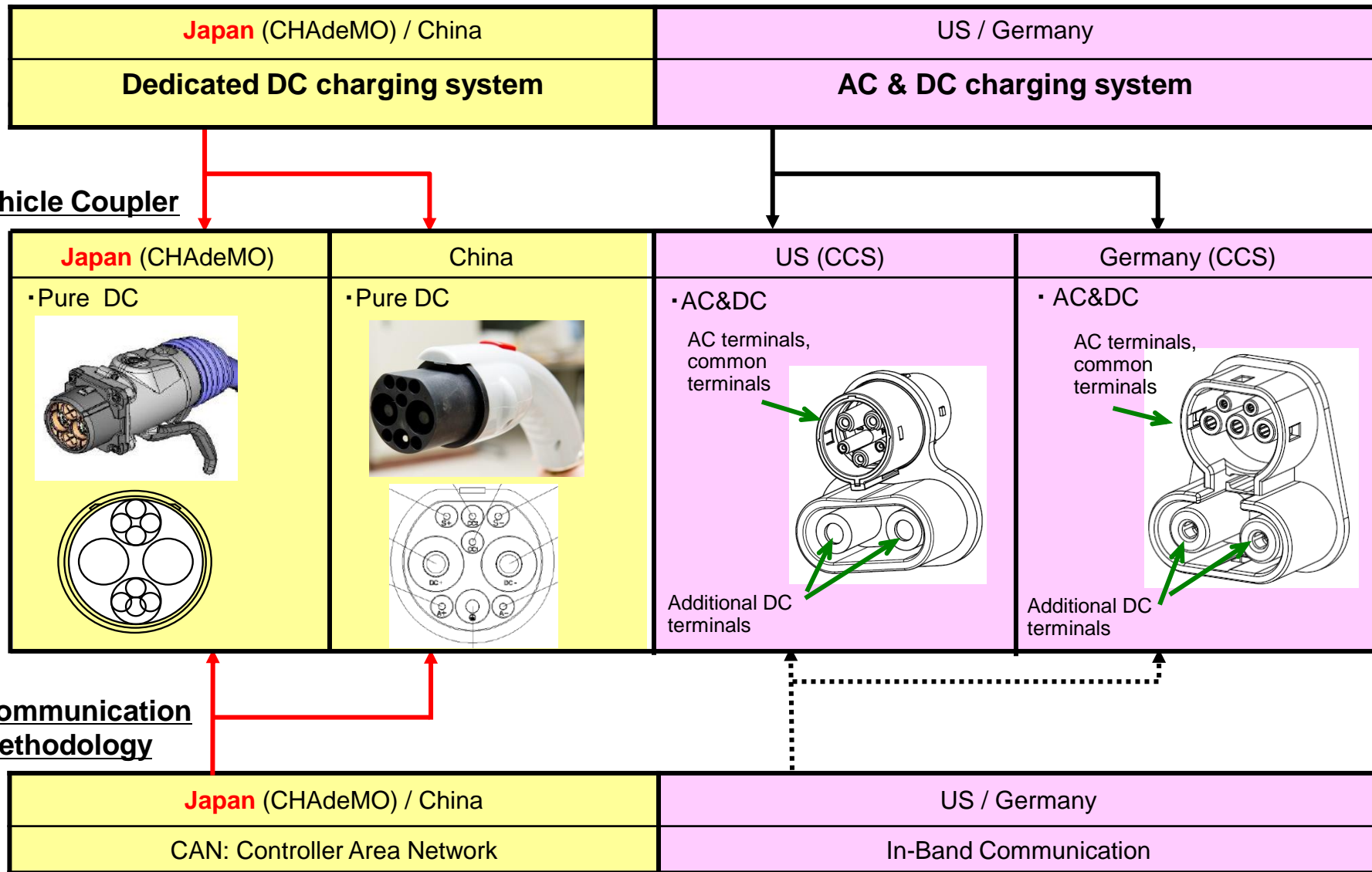
PHEV
BEV

- ✓ Status of charging cable
- ✓ Availability of current passing
- ✓ Max. current to be passed
- ✓ with or without electric source down and/or failure

- ✓ Request of start and stop of passing current

AC
charger

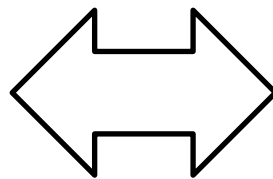
DC charging system standard



3. Issues and countermeasures

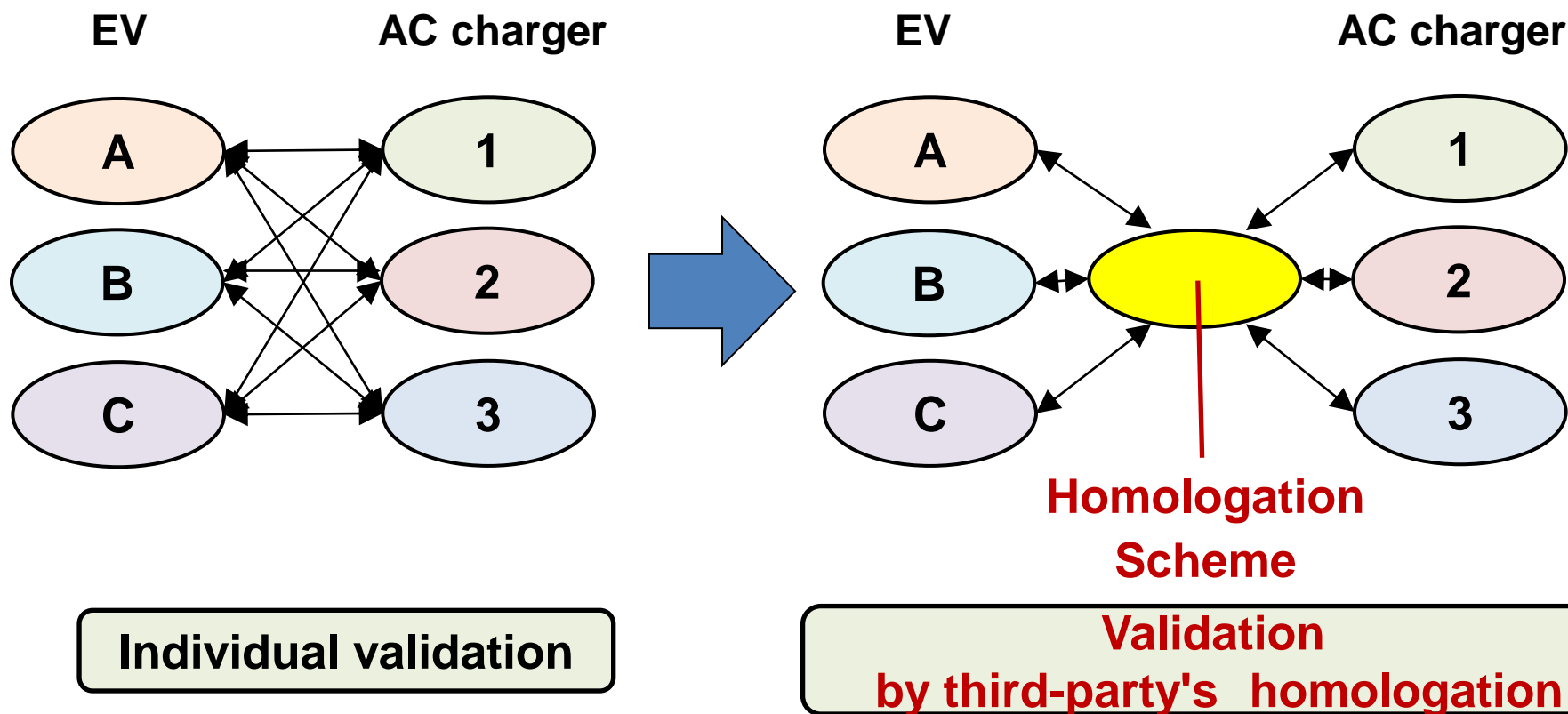
AC charging: Issues and countermeasures

Compatibility between EVs and AC chargers is necessary, to secure charging. **Many kinds of AC chargers** have been launched by various manufacturers in Japan.



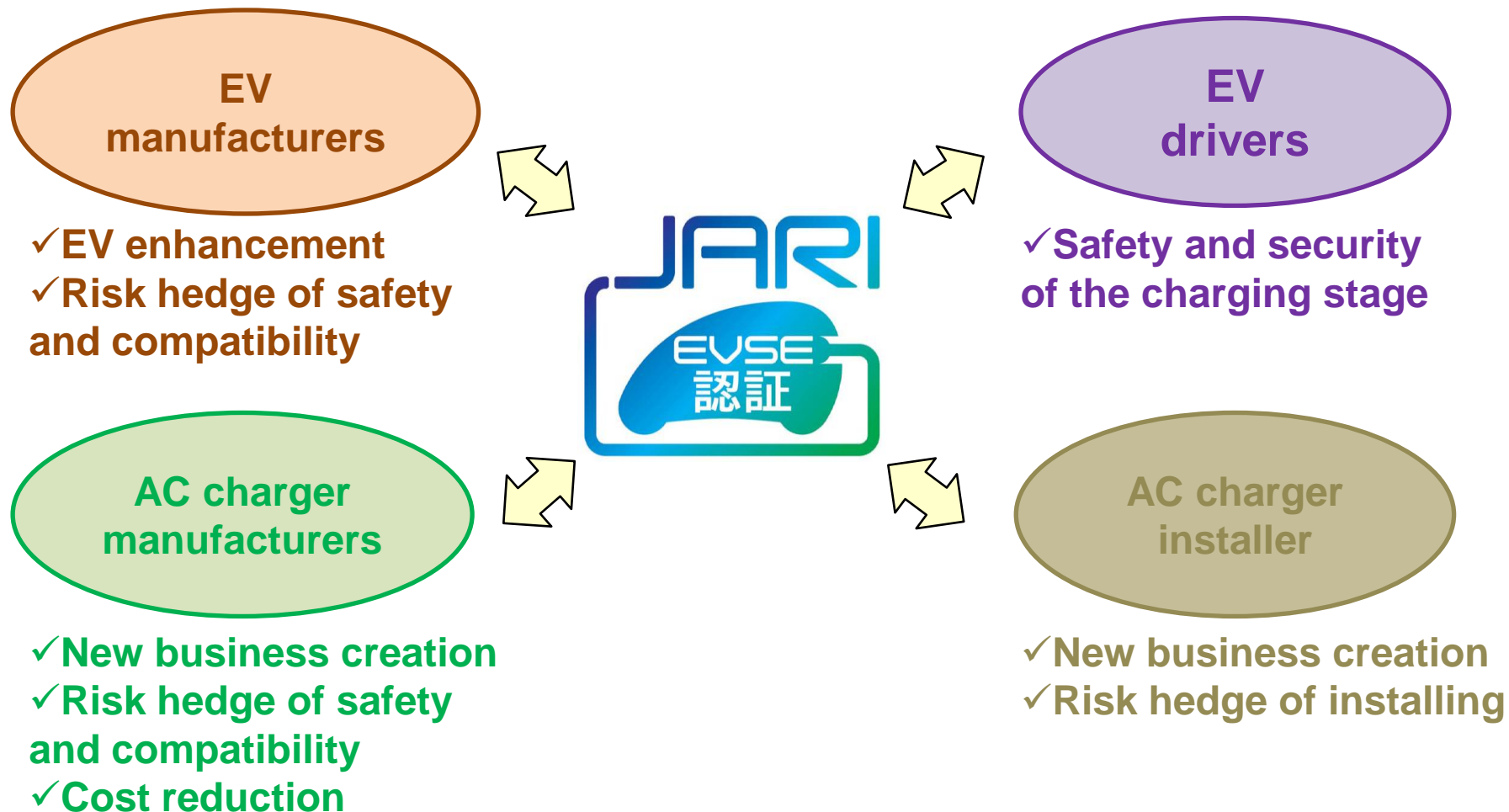
Homologation needs for compatibility

Individual validation for compatibility may cause a **lack of convenience** in various situations, considering the increase of EVs and AC chargers. **Validation by homologation** is a more effective way.



JARI's homologation concept

To **establish safety and security** of the charging stage through an open validation process **with a global standard**.



JARI's homologation overview

Started in April 2012 to **establish safety and security of EV society**

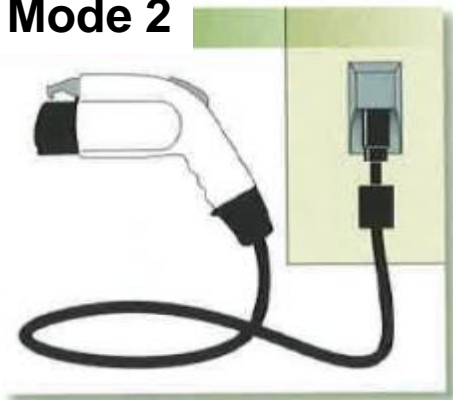
- ✓ AC chargers' enhancement, securing safety and compatibility
- ✓ Reliability offered for AC charger trade and usage

Homologation standard items

- ✓ Safe from electrification, fire and injury
- ✓ Compatibility to secure charging for PHEV and EV
- ✓ Quality control
- ✓ Delivery inspection

Products subject to homologation

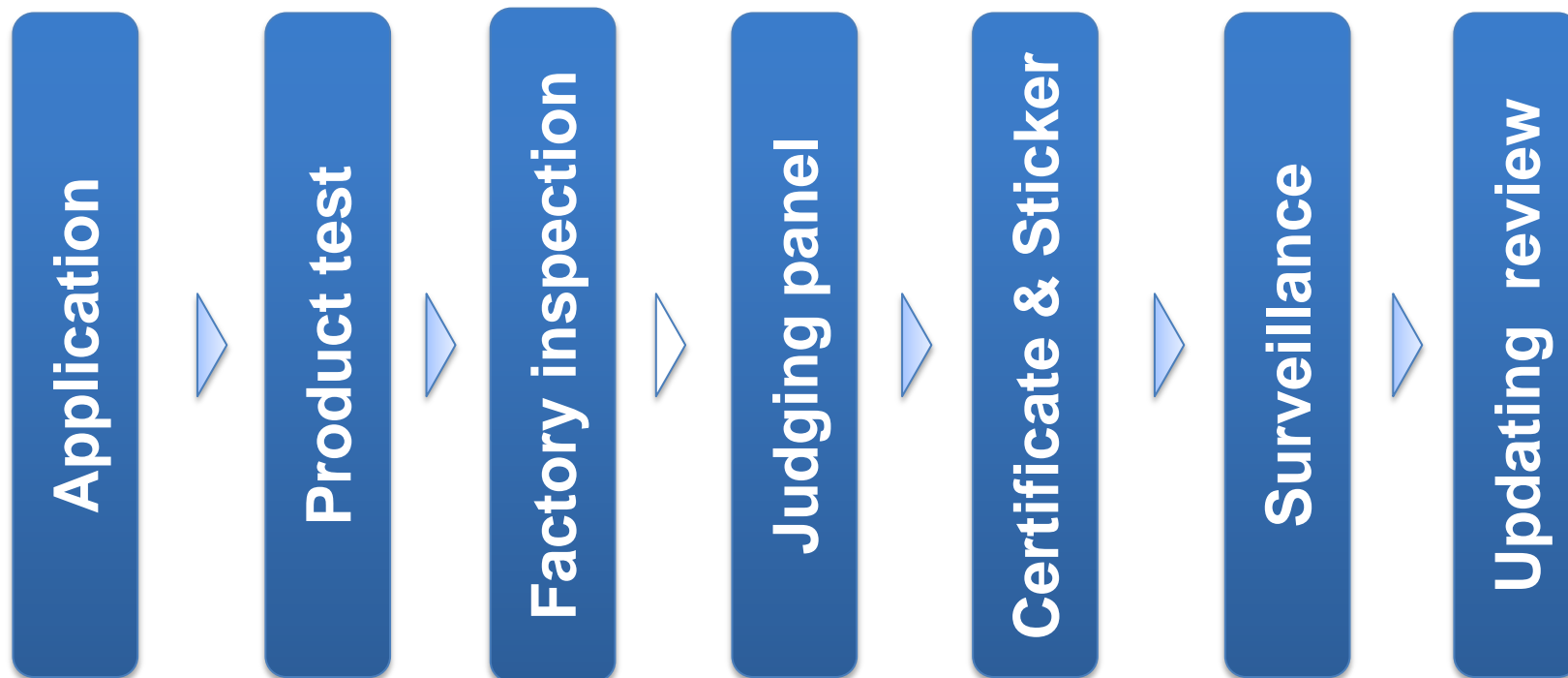
Mode 2



Mode 3



JARI's homologation process



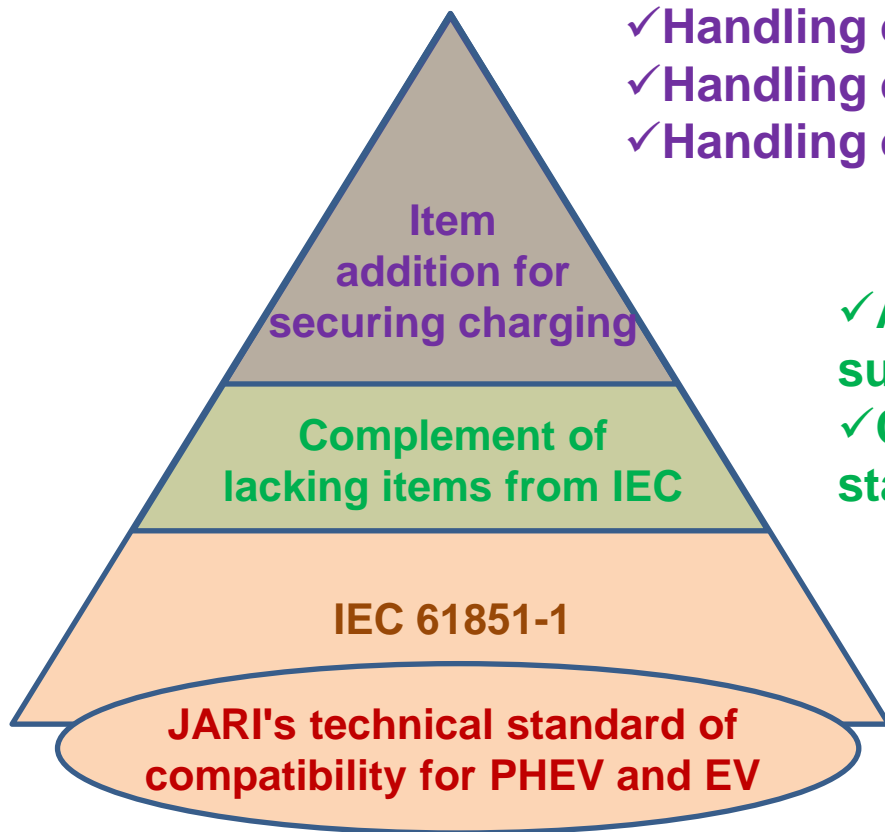
Product test: Compatibility and safety

Factory inspection: QMS and delivery inspection

Surveillance frequency: Once a year

Period of validity: 3 years

AC charging: Points for Compatibility



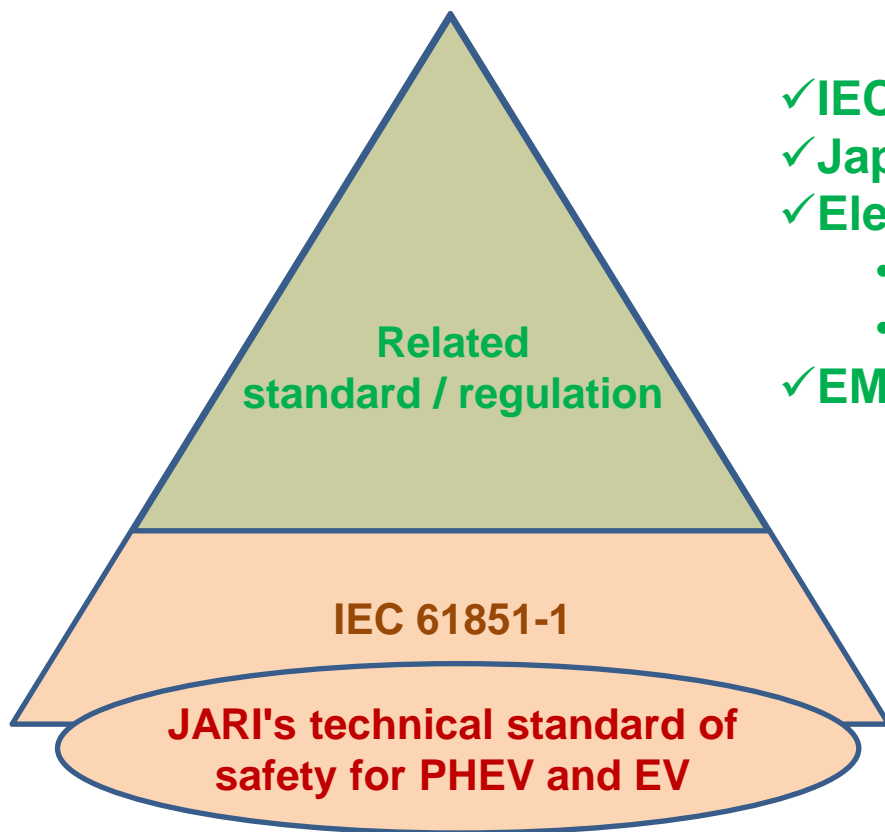
- ✓ Handling of predictable improper use
- ✓ Handling of foolish operation
- ✓ Handling of breakdown and/or abnormal state

- ✓ Adequacy of reaction time for transition such as charging, current cutoff ... etc.
- ✓ Clarification of test method and judging standards for the above

- ✓ Confirmation of basic actions such as connector connection, charging preparation, charging ... etc.
- ✓ Adequacy of pilot signals such as voltage, frequency, pulse width ... etc.

IEC 61851-1: Electric vehicle conductive charging system – Part 1: General requirements

AC charging: Points for safety



- ✓ IEC 62196: Connector
- ✓ Japanese regulation for electrical safety
- ✓ Electrical shock, fire hazard
 - Direct/indirect contact, insulation
 - Requirement for parts
- ✓ EMC

✓ General requirements

IEC 61851-1: Electric vehicle conductive charging system – Part 1: General requirements

AC charging: Workshop for Compatibility

Secure **compatibility and safety** for many manufacturers' products, by holding a **workshop**.

Host: EVPOSSA (Electric Vehicle Power Supply System Association)

Assent: JAMA (Japan Automobile Manufacturers Association), **JARI**

Attendees:

4 manufacturers of 5 PHEV & BEV

15 manufacturers of 15 types of AC chargers

Checked items:

- ✓ IEC61851-1 items
- ✓ Additional functions
(Charging timer ... etc.)
- ✓ Foolish operation items
(Longer push of unlock lever ... etc.)
- ✓ Abnormal state items
(Blackout ... etc.)
- ✓ Attendees' requested items
(Control logic, functional assessment)

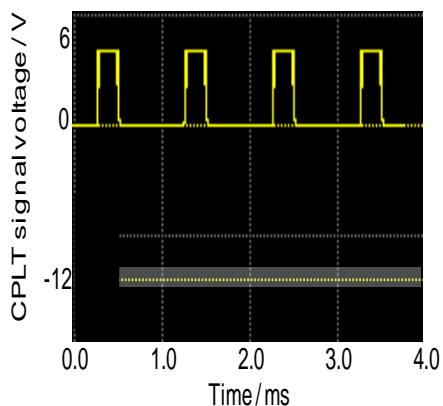


AC charging: Examples of mismatching

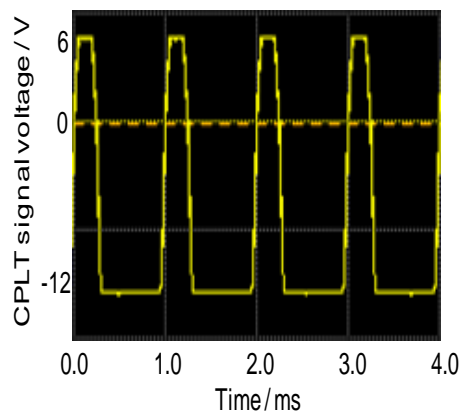
Example 1: Inappropriate control signal mode adoption, due to **specification misunderstandings**

- ✓ In original function mode added by manufacturer, occasionally detected, e.g. Sleep mode
- ✓ In particular operating conditions, occasionally detected e.g. Blackout, abnormal use by user

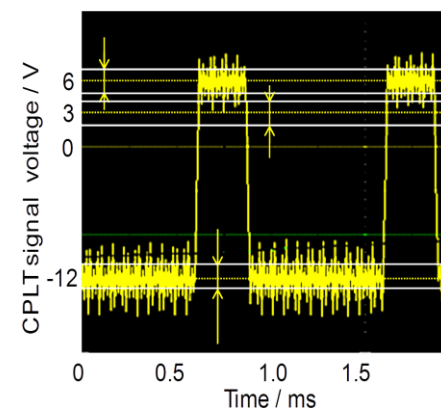
Example 2: Abnormal control signal wave such as below, due to **lack of specification study**



Abnormal Voltage Range



Abnormal Rise Time



Noise

DC charging: Points for compatibility

The **CHAdeMO** association has been conducting an compatibility testing scheme, and it has achieved **a good result for 5 years.**



CCS system team started an activity to establish compatibility in recent years.

For the Chinese system, we think that some activity regarding compatibility homologation is also progressing in China.

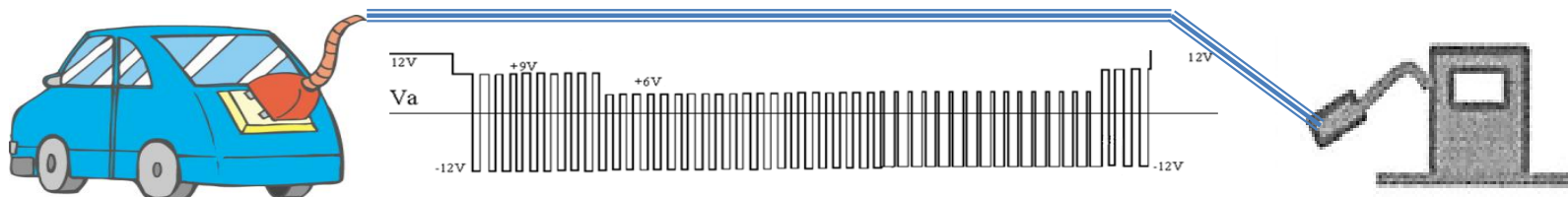
4. Summary

- ✓ For the DC charging area, **efforts to secure compatibility were already started.**

- ✓ In the AC charging area, **compatibility homologation is also important, although the system is simple.**

These homologation needs come from the situation of many more manufacturers developing AC chargers compared to DC chargers according to their simpleness.

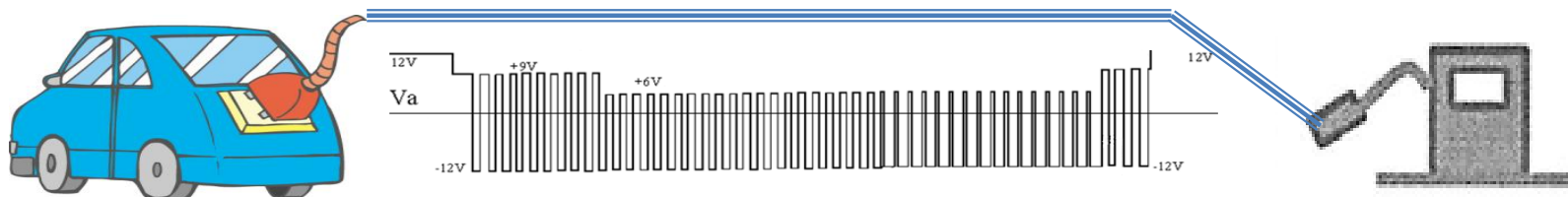
We need to tackle AC charger homologation as well.



To increase the amount of charging infrastructure, we should consider and tackle the following points:

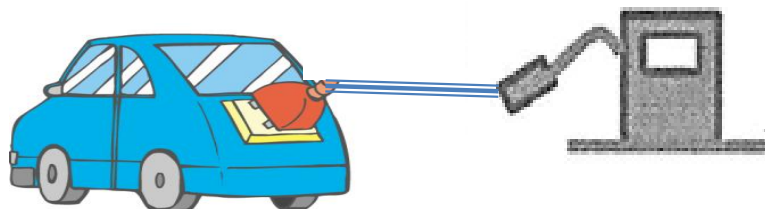
- ✓ Sometimes it is difficult to adopt compatibility to regulations, compared to safety.
But it is indispensable for EV's enhancement to **establish a comprehensive homologation process covering compatibility** in addition to safety.

- ✓ **Homologation costs need to be reasonable for various manufacturers.**



What can we do next?

- ✓ **The international community is now working toward improving international standards.**
- ✓ **For countries which are just introducing Electric Vehicles and charging stations, the key factor is developing a homologation scheme.**
- ✓ **Let's all work together to improve the usability of Electric Vehicles, toward a healthy motorized society.**



Thank you for your attention.