Schnellladen mit Gleichstrom bei Elektrofahrzeugen der neuesten Generation

Leipzig, Juni 2014

Agenda

1. Die zukünftige Fahrzeug Strategie für elektrische Antriebsysteme von Mitsubishi Motors
2. Das derzeitige Mitsubishi Produkt Portfolio im Bereich der Elektromobilität
3. Das Ladesystem des Mitsubishi i-EV (i-MiEV) und des Mitsubishi Outlander PHEV
4. Das DC Ladesystem seine Funktion und Schnittstellen (CHAdeMO)
5. Bidirektionales Laden mit Hilfe der CHAdeMO Schnittstelle

MMC Strategy for Electric propulsion

Environmental Technologies in Mitsubishi

MITSUBISHI MOTORS

1. Diversification of energy resources (Energy Security)

CNG vehicle

Readiness for bio-fuel (Ethanol FFV)

Improved diesel performance

Green plastic

GREEN PLASTIC

FCV

i- MiEV

PHEV

High-efficient transmission

Catalyst technologies

low-emission vehicles

ClearTec

Restricted use of hazardous substances

Weight reduction

Variable valve engine

Variable displacement engine

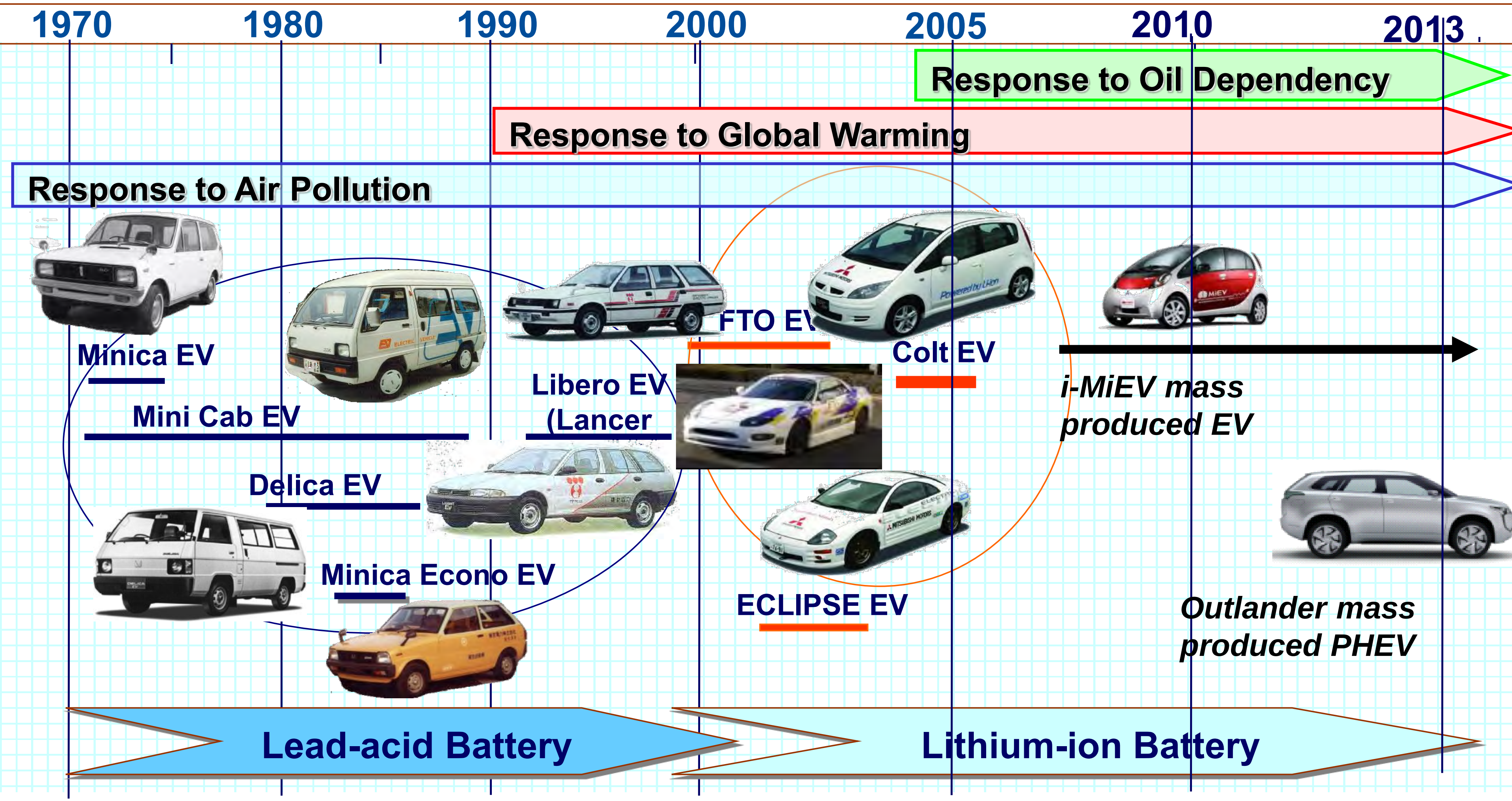
3. Reduce Pollution

2. Reduce Global Warming

The history of EV/ PHEV at Mitsubishi Motors

MITSUBISHI MOTORS

First Mitsubishi electric vehicle was built in 1971



2. Development of Next-Generation Technology (1)

Our Technology Concept

MMC Global Strategies- EV/ PHEV Targets (from investor information)

2. Development of Next-Generation Technology (2)

Leading Company in EV/PHEV Technology

Target: To Achieve 20% production ratio for EV/PHEV vehicles by 2020

Environmental Responsibility

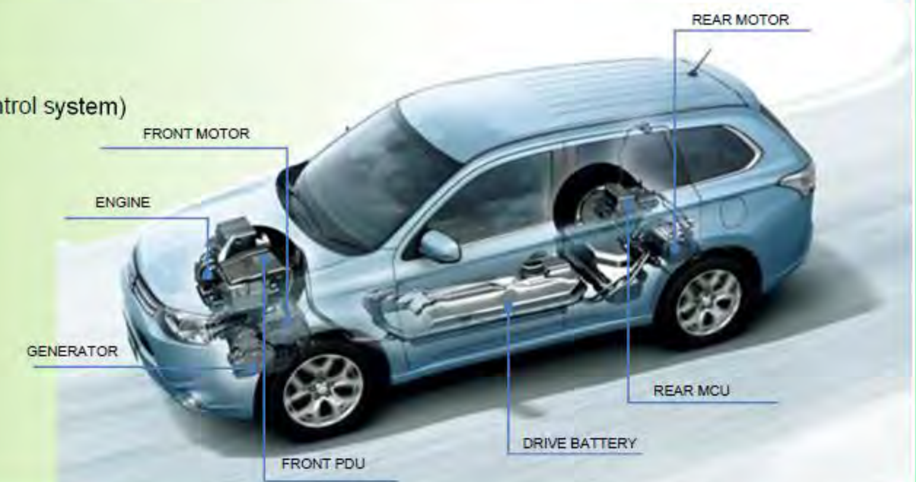
Development of next-generation EV technology

- Longer driving distance per single charge: Developing high-performance batteries and streamlining of the system
- Affordable price: Downsizing and structural streamlining of electrical components
- Expansion of charging infrastructure: Promotion of charging infrastructure expansion by four auto makers*1
- Advancement of EV technology: Wireless charging, Downsizing of components (cooling system, use of SiC*2 technology)

Development of next-generation PHEV technology

- Sophisticated integration of Driving Pleasure and PHEV: e-EVOLUTION(integration of motor drive and S-AWC*3)
- Development of high-efficiency system: Further reduction of CO_2 emission
- Increase PHEV application to SUVs

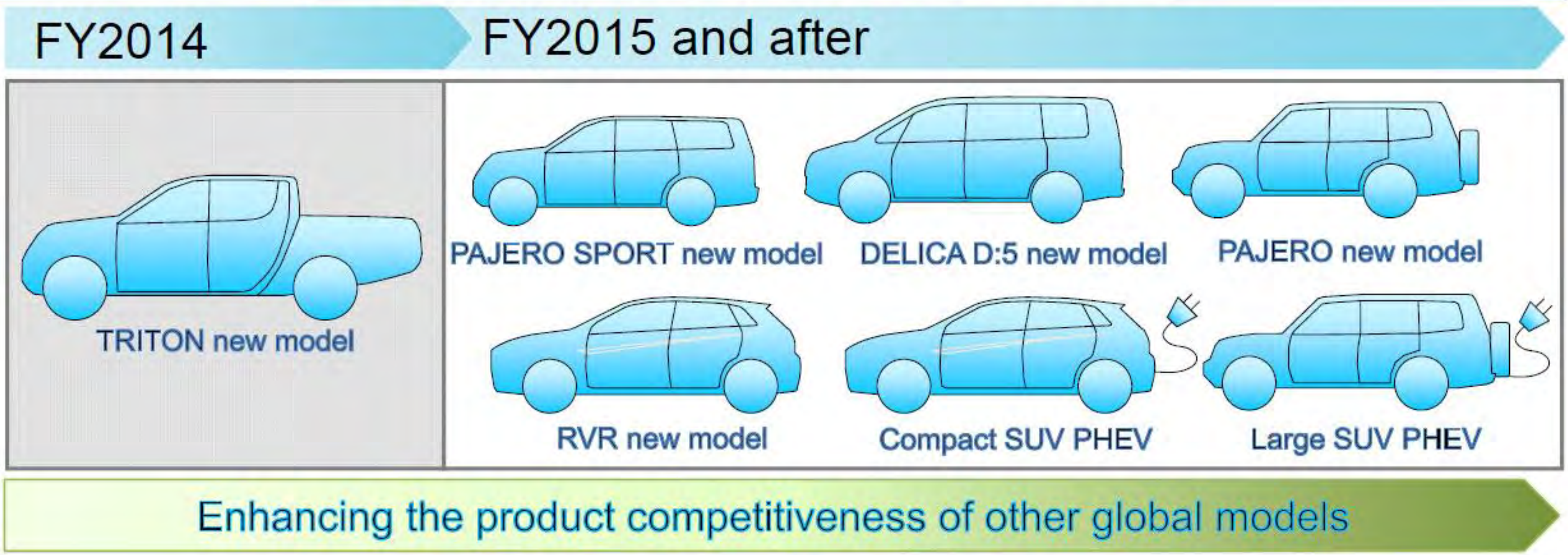
*1 Toyota, Nissan, Honda and Mitsubishi Motors
*2 Silicon Carbide
*3 Super All Wheel Control (integrated vehicle dynamics control system)



MMC Global Strategies- Roadmap (from investor information)

1. Revenue Growth by Launching Strategic Models(2)

Roadmap of Launching Strategic Models



The 43rd Tokyo Motor Show Exhibited Models

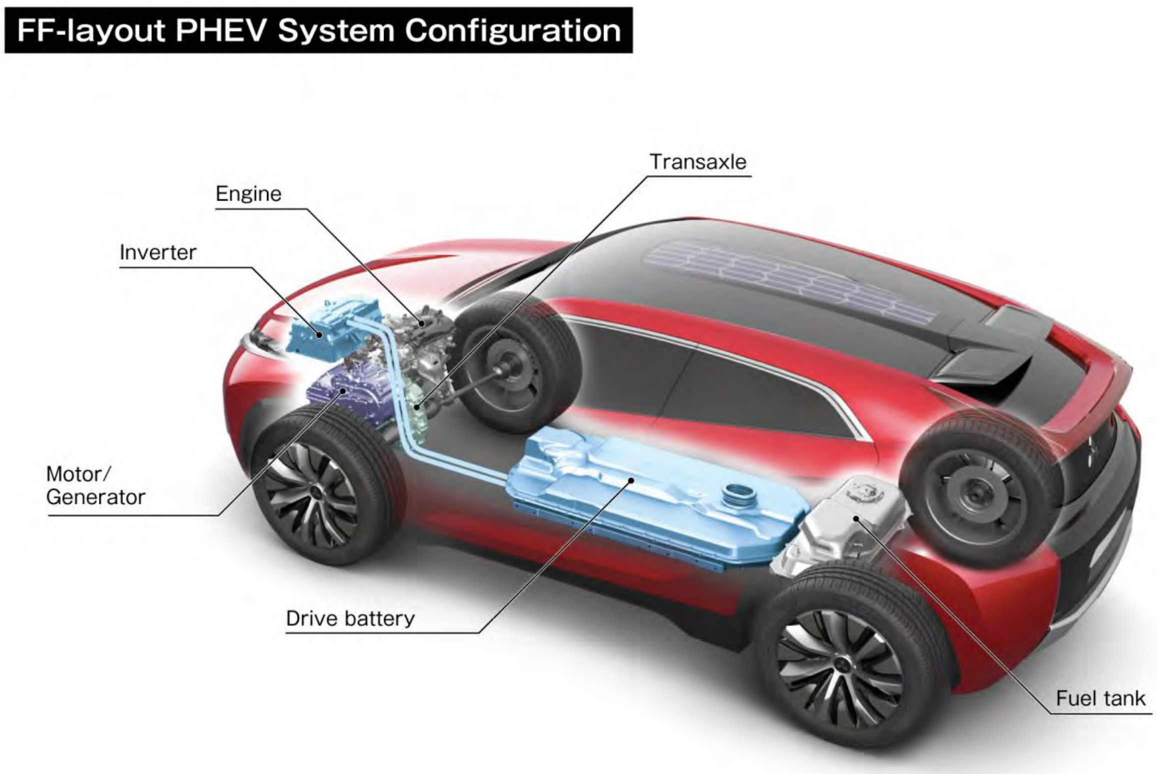
The MMC EV/ PHEV product portfolio

MMC Product portfolio EV/ PHEV in EU (2014)

The Outlander PHEV EU Production Car available since 08/2013 in Europe (Netherlands, other EU in 2014)

The i-MiEV EU Production model- available since 10/2010 (the first mass produced EV in Europe)

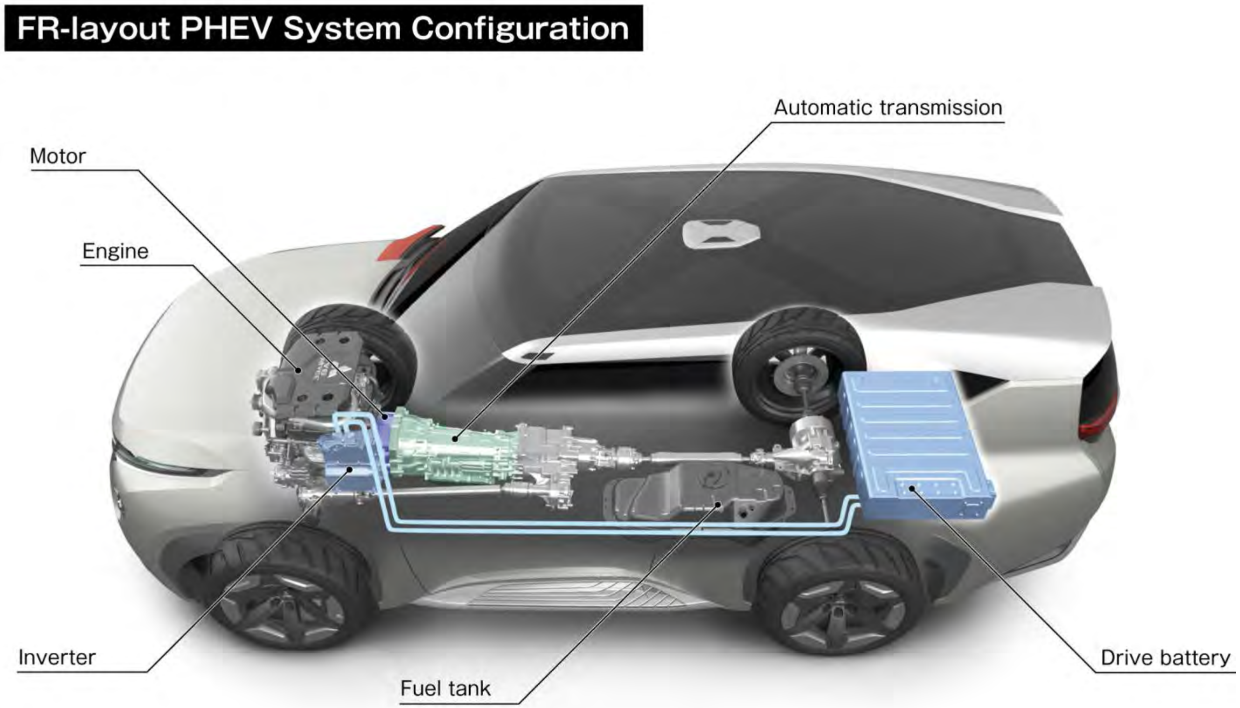
Planned MMC projects XR-PHEV- Tokyo 2013/ Geneva 2014



XR-PHEV as Compact SUV PHEV version

Base Technical Data
Dimension L x W x H:
4370 / 1870 / 1570 mm
Plug-in cruising range:
> 85 km
Engine Type:
1.1-liter in-line 3-cyl. DI MIVEC, 100 kW
E- Motor Max. output:
120 kW
Battery Capacity:
14.0 kWh
Drivetrain: 2WD, Front wheel drive

Planned MMC projects GC-PHEV- Tokyo 2013/ Geneva 2014



GC-PHEV as Large/ Luxury SUV PHEV version

Base Technical Data:
Dimension :L x W x H:
4930 / 1940 / 1980 mm
Plug-in Cruising range
> 40 km
Engine Type:
3.0-liter V6 SC MIVEC- 250kW
E- Motor Max. Output:
70 kW
Battery Capacity:
12 kWh
Drivetrain:
Full-time 4WD
Transmission:
8-AT

AC/DC Charging system

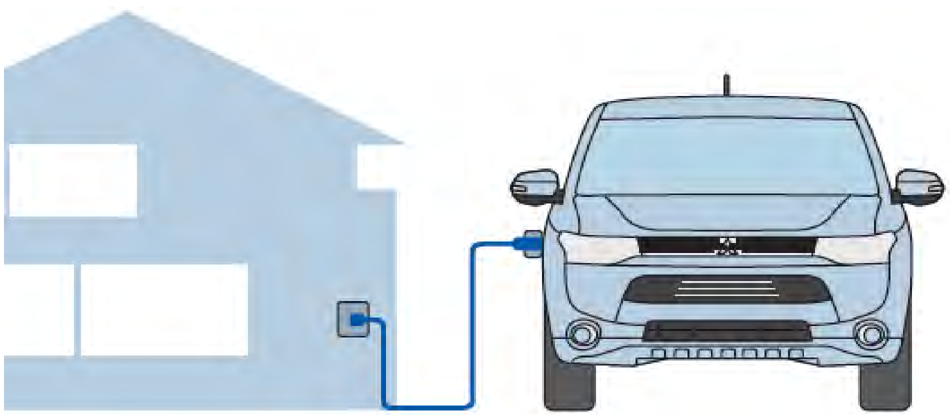
Charging system and time

Outlander PHEV offers a two way charging system as standard - beside regular AC charging, DC charging according CHAdeMO standard is possible.

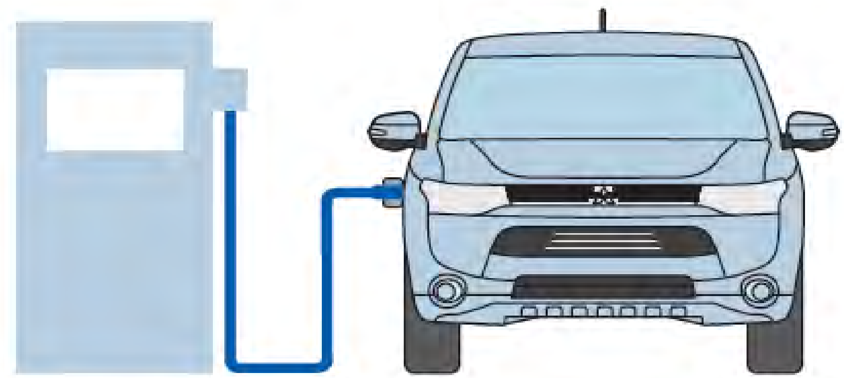
DC Quick-charging *1	Supply power	Charging time
	Max.125A and or Max.50kW	Approx. 30 minutes

***1 : 80% charged from empty.**

	Charge Mode	Supply voltage	Supply power	Charging time
AC-charging (~100%)	Mode 2	230V	10A	Approx. 5 hours
	Mode 3	230V	16A	Approx. 4 hours



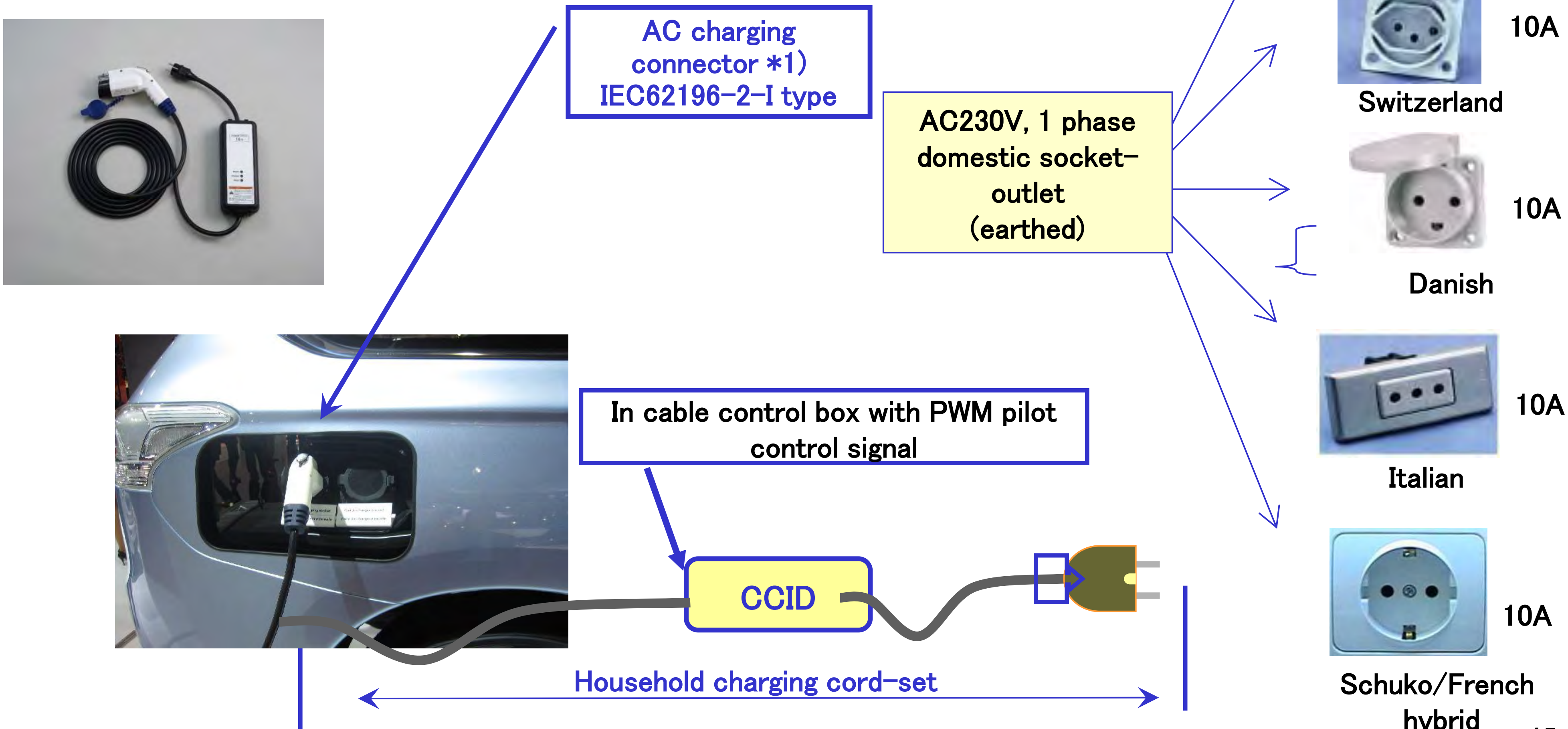
AC-Charging Mode 2/ Mode 3



DC-Charging CHAdeMO

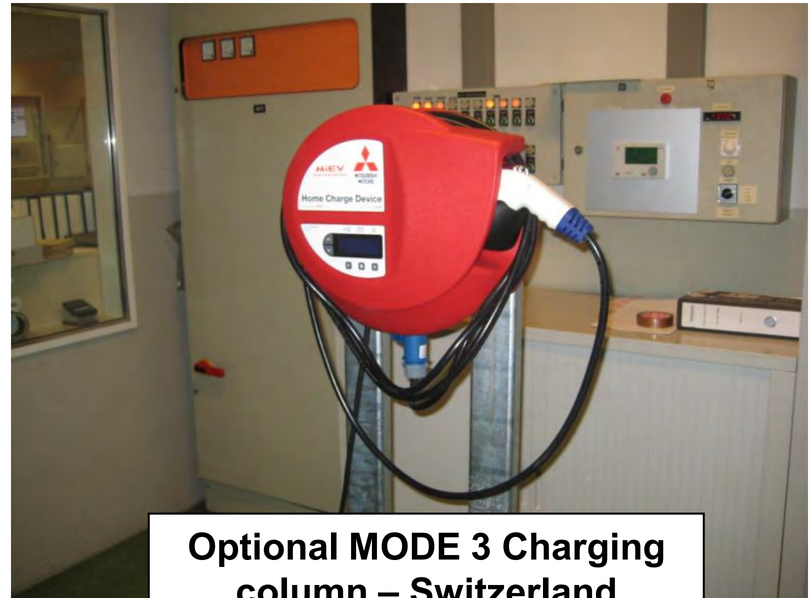
Mode 2 Charging (Household Charger)

- By an cable included in the standard equipment PHEV is plugged in domestic socket outlet AC 230V and charged through an on board charger.
- On vehicle side, a connector that is standardized according to IEC62196-2- Type 1 is adopted for easy and safe handling (so called Type 1 connector)
- Exclusive cab tire cable covered by vinyl is used. For adoption to outdoor use.
- Mode 2 –ICCB (In Cable Control Box) is adopted for highest safety for many possible use cases.



Mode 3 Charging (Designated socket or connection)

Regular charging gun. Build up under standard IEC62196-2- Type 1- (SAE/J 1772)



Optional MODE 3 Charging column – Switzerland

PHEV Mode 3 Charging

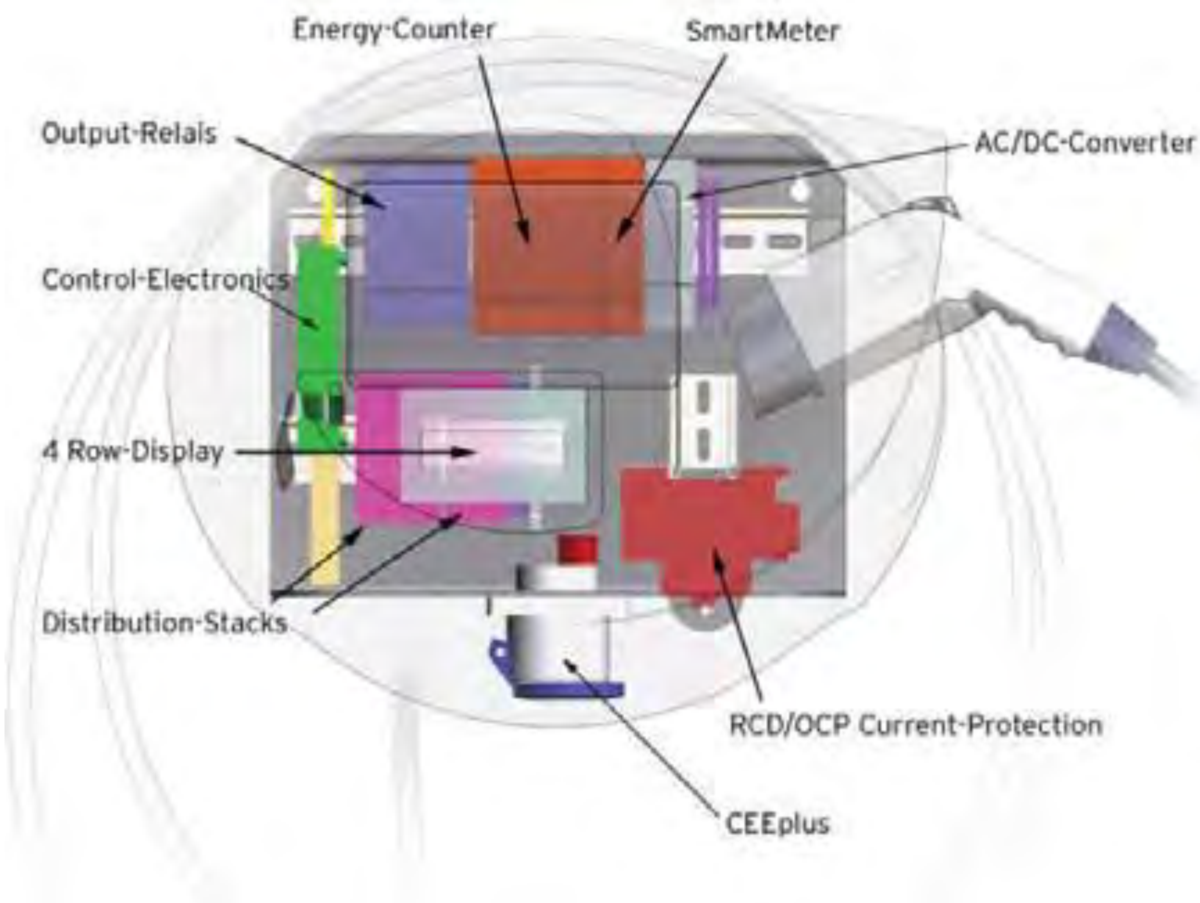
Optional Type 1 >> Type 2 Connector cable for MODE 3 charging

16

Controlled AC Charging

HCD For Controlled Charging - CH

Concept: Full controlled Charging HCD Control using Smart Meter adopted in a module.



Source: PROTOSCAR/ EVTEC

Controlled Charging by APP (Outlander) or RC (i-MiEV)

Remote APP for IOS and Android

Charging Function of the APP

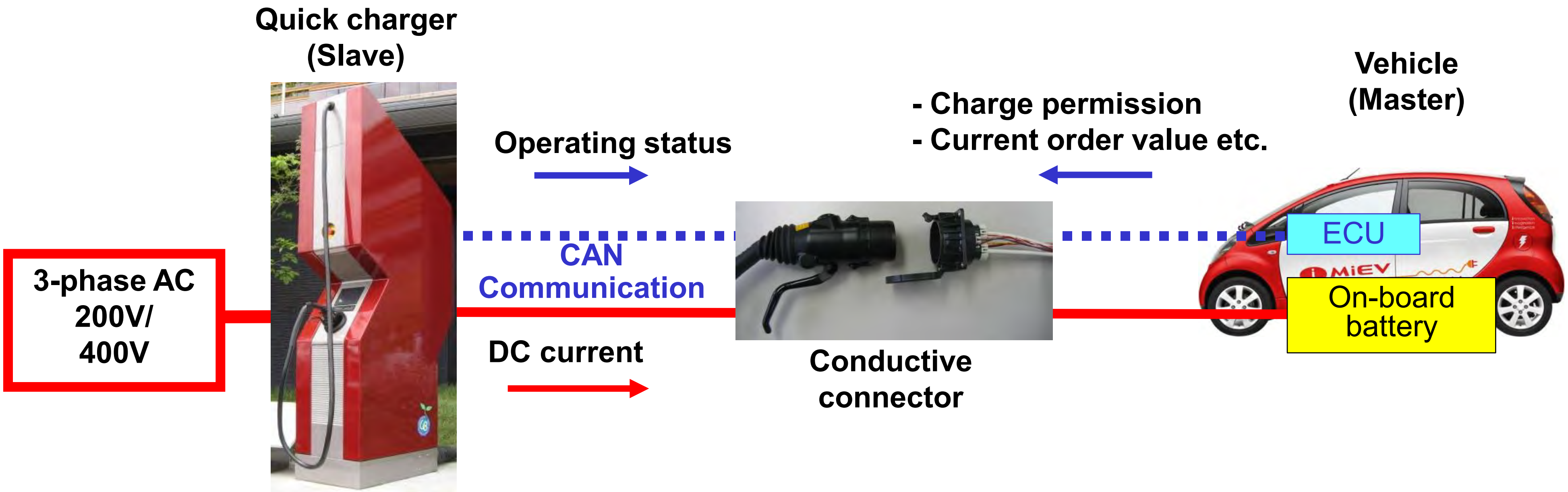
	Indicate remaining battery SOC and the charging status
	Indicate connection status when charging. Calculate time to full charge
	Timer charging function (e g. charge during less expensive night time)

For i-MiEV a RC-solution is offered

Charging System DC

Base characteristics of the CHAdeMO protocol

MITSUBISHI MOTORS



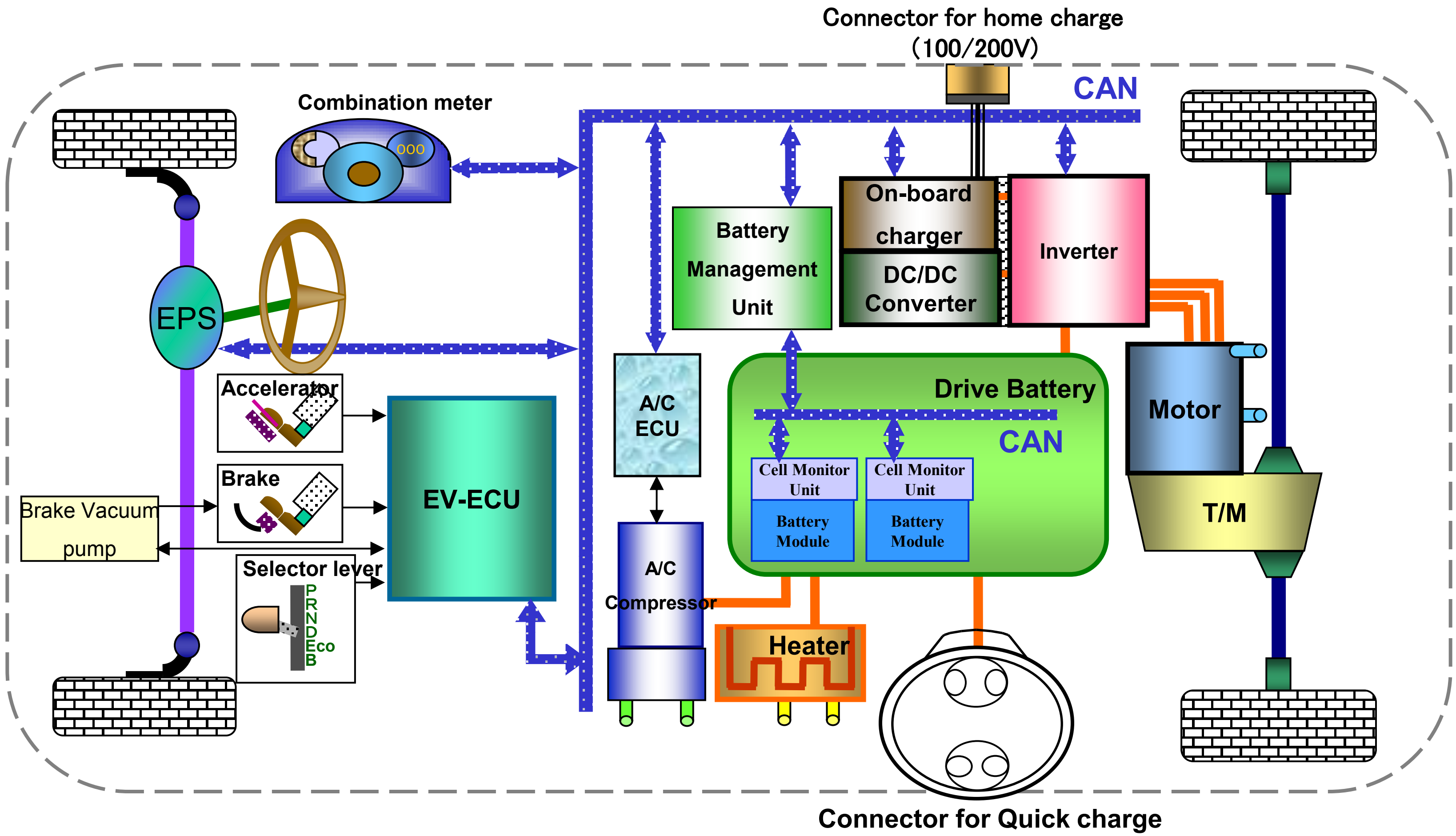
Problem

- ✓ Optimal charging pattern depends on battery characteristics and conditions.
- ✓ Standardization of charging system is essential in public use.
- ✓ Excessive standardization may disturb battery improvement.

Solution

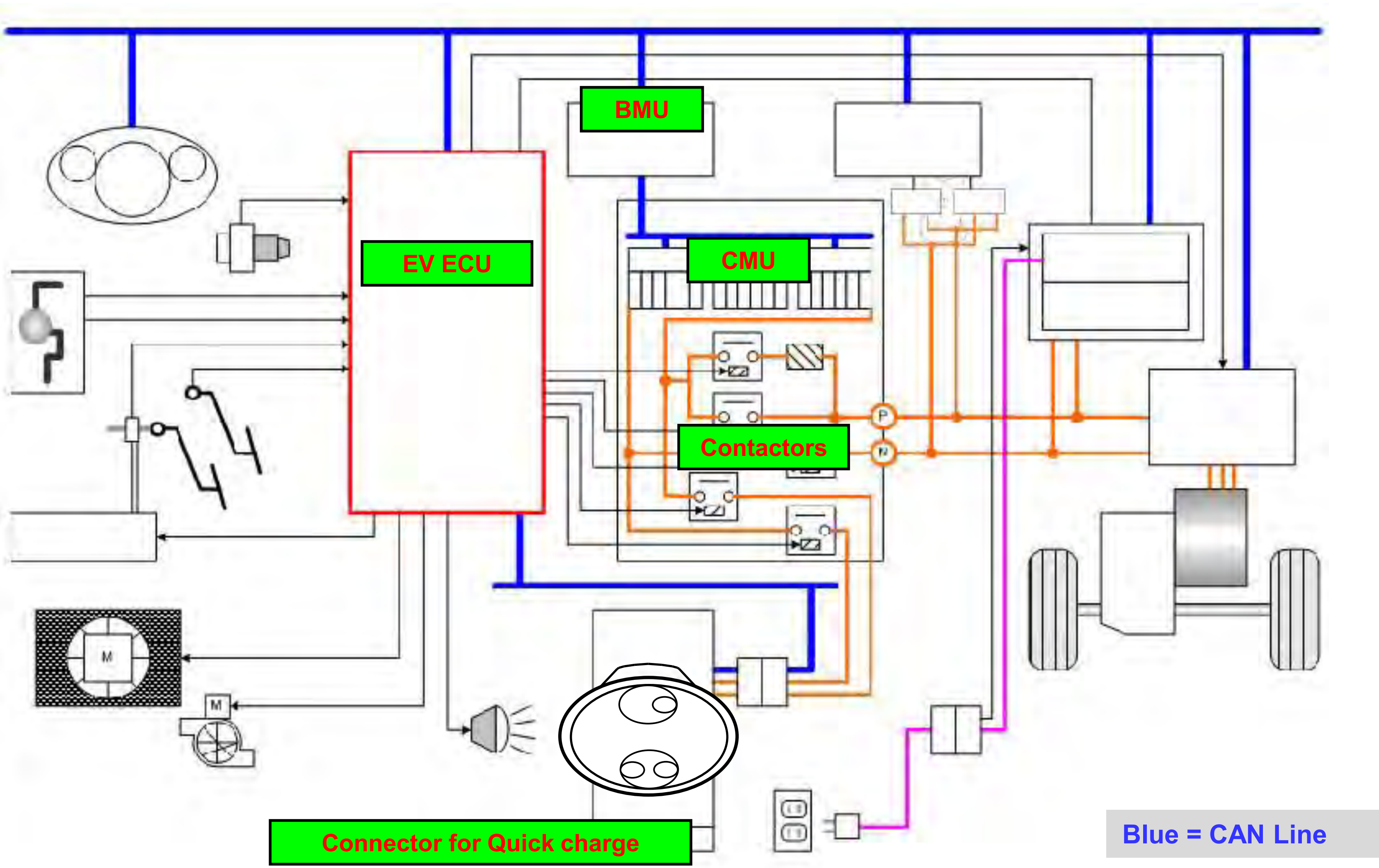
- ✓ ECU decides optimal charging current based on its battery conditions.
- ✓ Charger supplies DC current following order from ECU.

i-MiEV Overall System Schema



Overall System Schema- quick charging connection/ use of CAN communication

MITSUBISHI MOTORS

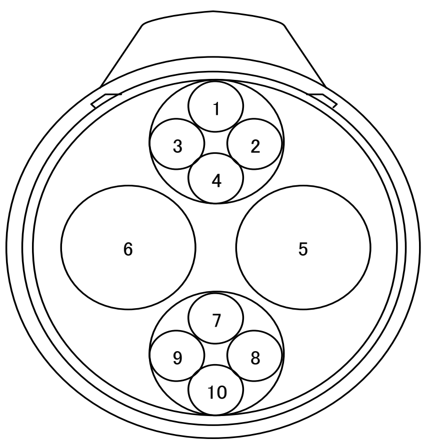


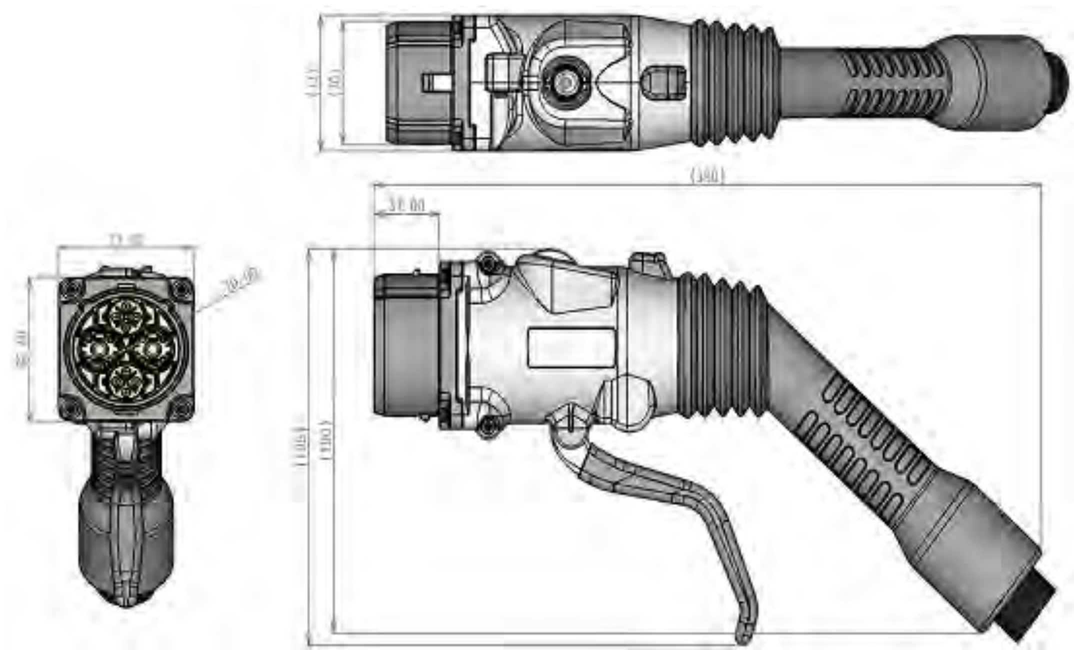
CHAdeMO compatible charging connector

Standard: JEVS G105

✓ Maximum current: DC125A
✓ Connector has independent communication signal pins and safety measure.
✓ Some makers supply improved products.

Terminal #	Terminal name
1	Ground terminal
2	Charge sequence signal 1
3	(no terminal)
4	Vehicle charge permission
5	Power supply (–)
6	Power supply (+)
7	Connector proximity detection
8	CAN–H terminal
9	CAN–L terminal
10	Charge sequence signal 2





Sample: Connector from Yazaki

Commercially available

CHAdeMO DC Fast Charge and E-Mobility in Europe

CHAdeMO Association

May 2014

CHAdeMO and standards legislation

- The IEC DC charging system catalog standards were published in March 2014
- CHAdeMO is the only technology with world-wide presence with proven record

IEC DC Charging Systems

	System A	System B	System C	
	CHAdeMO (Japan)	GB/T (PRC)	COMBO1 (US)	COMBO2 (DE)
Connector				
Vehicle Inlet				
Communication Protocol	CAN		PLC	

Note: TC69 61851-23, TC69 61851-24, SC23H 62196-3; Published on the IEC website:
http://www.iec.ch/dyn/www/f?p=103:22:0::::FSP_ORG_ID,FSP_LANG_ID:1255,25%3Cbr%20/%3E

CHAdeMO organisation

General Assembly

Executive Board

General CHAdeMO strategy decision making

Secretariat
Main Office (Tokyo)
EU Office (Paris)

Technical Work Group
Protocol development and evolution
Certification process definition

Infrastructure Work Group
Infrastructure deployment experience sharing

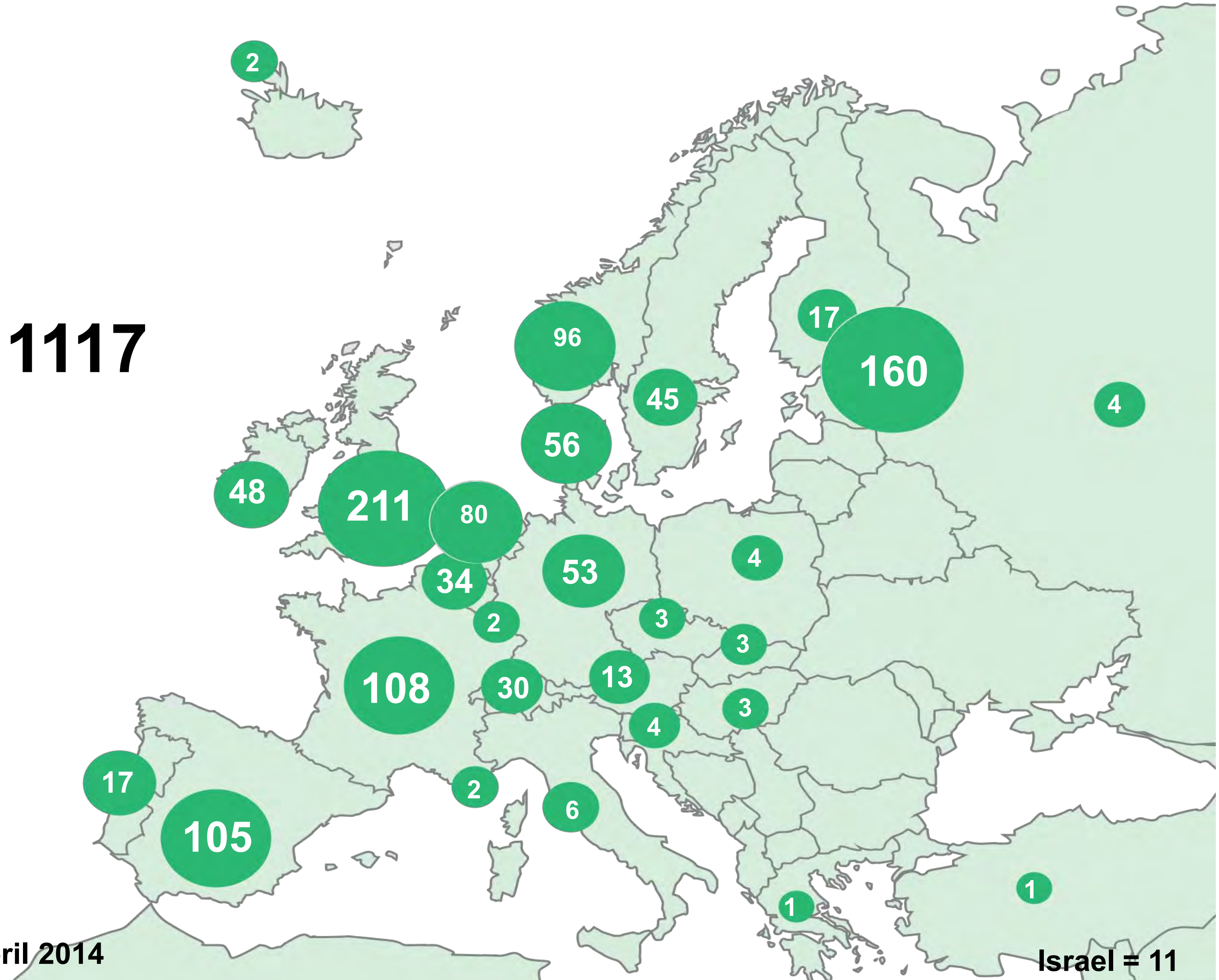
CHAdeMO Europe SC
CHAdeMO's European strategy definition

CHAdeMO members in Europe

- **CHAdeMO is an international association with 400 members in the world**
- **There are 70 entities from 18 European countries**

Note: This represents a selection of CHAdeMO members

CHAdeMO chargers in Europe



EUROPE = 1117

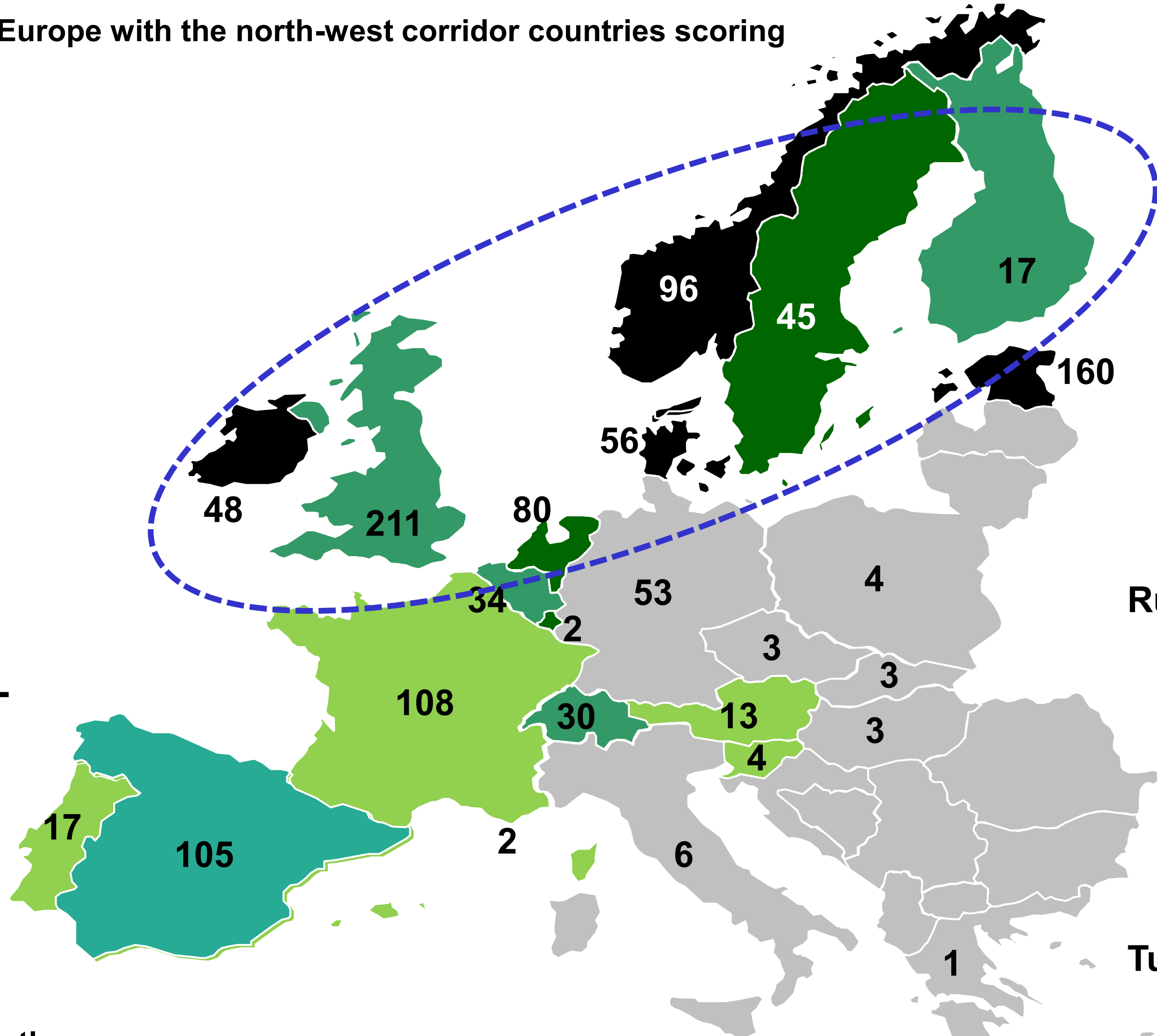
World = 3688

Note: Data as of April 2014

Israel = 11

CHAdeMO Installation in Europe

Over 1100 chargers installed in Europe with the north-west corridor countries scoring high on the charger density



Russia = 4

Turkey = 1

Israel = 11

DC fast charger density

- < 1 charger / 1 m people
- < 2 charger / 1 m people
- < 3 charger / 1 m people
- < 4 charger / 1 m people
- < 5 charger / 1 m people
- >= 5 charger / 1 m people

Note: Missing Iceland (2) from the map.
Total number of installations as of April 2014 = 1117

CHAdeMO Compatible EV`s

- **136,000 CHAdeMO compatible EVs are already on the road globally, accounting for 2/3 of all EVs available.**


Nissan : LEAF


Peugeot: Partner


Citroen: C-ZERO


Mistubishi Motors : i-MiEV


Toyota: eQ


Citroen: Berlingo


Mitsubishi Motors: Outlander PHEV


Mitsubishi Motors: MINICAB-MiEV


BD Otomotive: eTRAFIC


BD Otomotive : eKANGOO


Peugeot: iON


Mazda: Demio EV


Subaru : Plug-in Stella


Protoscar: LAMPO2

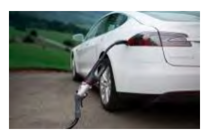

BD Otomotiv : eScudo


BD Otomotiv : e-Fiorino


Mitsubishi Motors: MINICAB-MiEV (Truck)

To be Introduced


Kia Soul


Tesla Model S with adapter

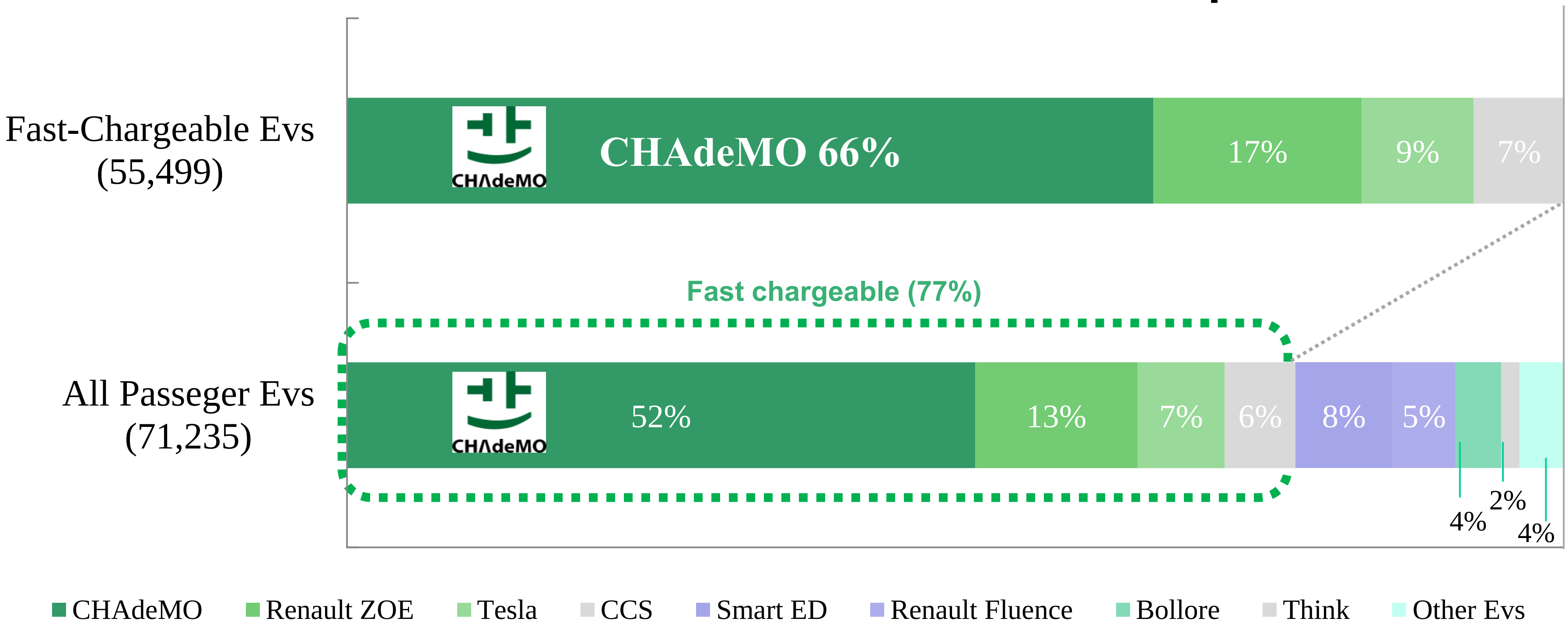

Nissan: eNV200


Nissan: Infiniti EV Sedan

Note: data as of February 2014

- **A great majority of fast-charge enabled EVs on the roads in Europe are CHAdeMO compatible**

CHAdeMO EV market share in Europe



Note: Data based on registrations from 1 January 2010 to 28 February 2014, not including electric light commercial vehicles (LCVs) or e-quadricycles.

EU Directive on the deployment of alternative fuels infrastructure

OBJECTIVE	PROCESS	RESULT

OBJECTIVE

- To provide a general direction for the development of alternative fuels in the Single European Transport Area
  - Binding targets
  - Common technical specifications

PROCESS

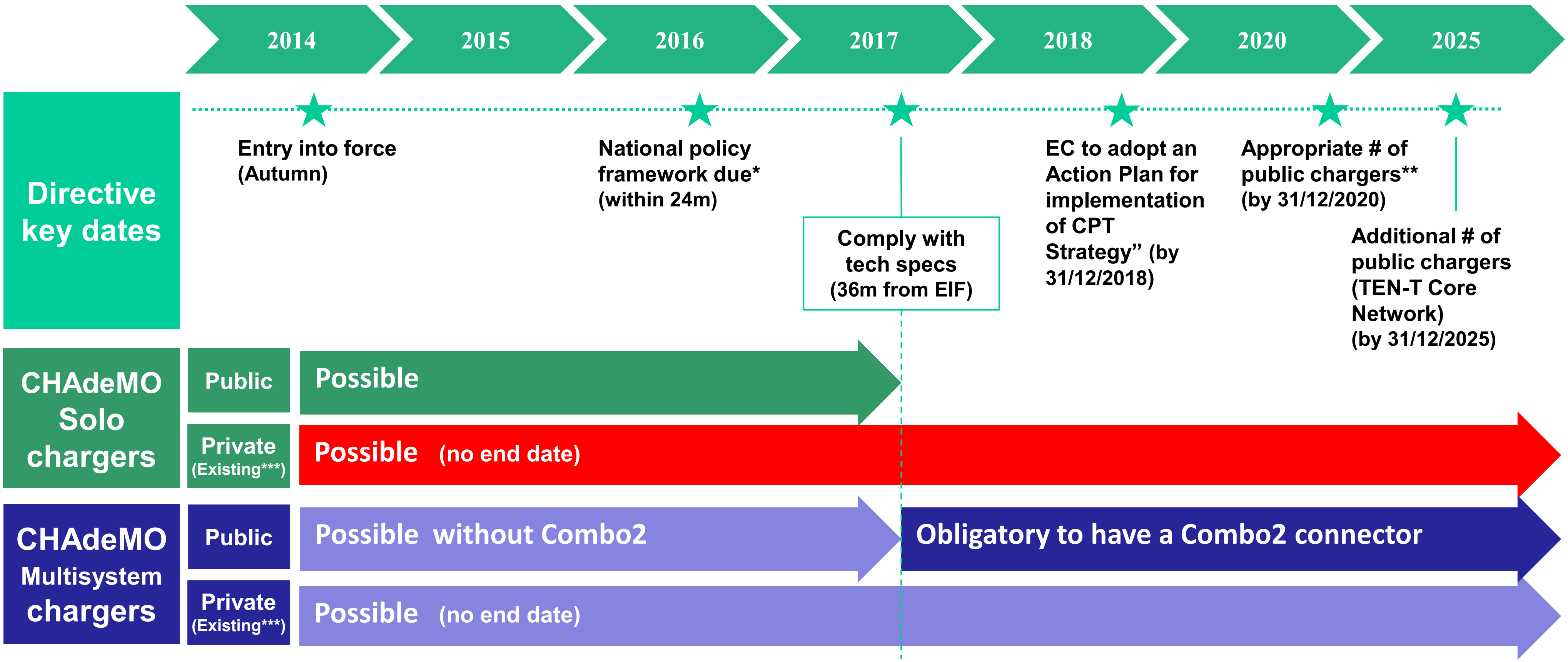
- ✓ European Commission (Proposal)
- ✓ European Parliament (Plenary vote 15 April)
- ✓ Council of Ministers

- Entry into effect (Expected Fall 2014)

RESULT

- ✗ No binding targets
- ✓ Common technical specs
- Annex III 1.1.2.
  - Direct Current (DC) high power recharging points for electric vehicles shall be equipped, for interoperability purposes, at least with connectors of Type "Combo 2" as described in standard EN62196-3

Key dates and CHAdeMO implications



Note: * this should include national targets (charge points), measures necessary to reach targets, designation of urban/suburban agglomerations, other densely populated areas and networks to be equipped with charge points. **in the designated areas. ***Existing chargers can continue operations with no need to retrofit or disinstallation.

Technical Solution Multi Chargers

EV USERS

- More charge stations for all

OPERATORS / INVESTORS

- Faster recovery of cost
- Limited incremental cost (5-10% of overall cost)

OEM'S

- Competition with cars (not with charge standards)

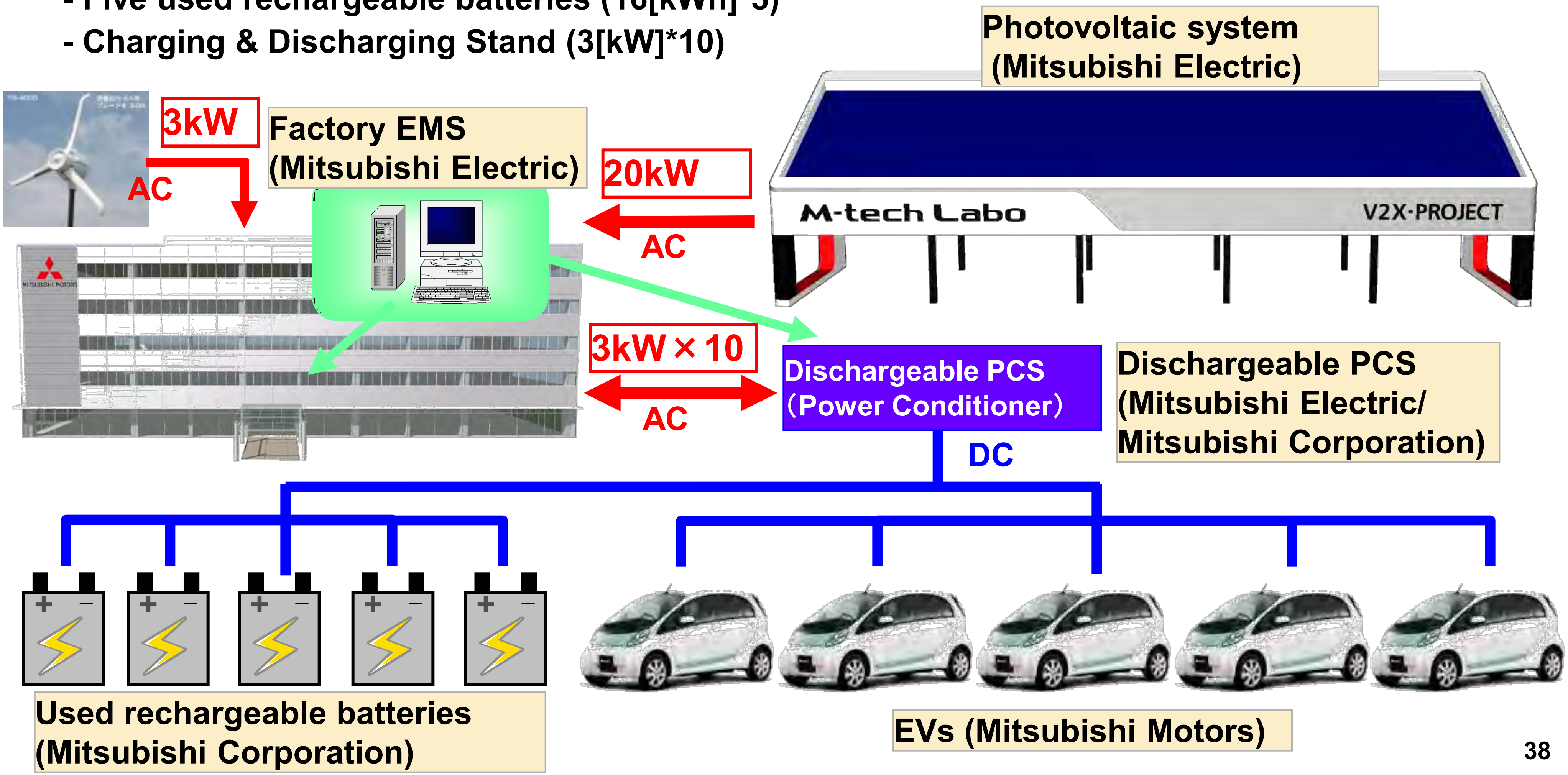
ABB	ABB, Netherlands	EV TRONIC electronic for electric vehicle	EVTRONIC, France
CIRCONTROL Movilidad y Seguridad Mobility and Security	Circontrol, Spain	GH GROUP	GH, Spain
DBT Charging Electric Vehicles	DBT, France	LAFON TECHNOLOGIES	Lafon, France
DELTA	DELTA, Taiwan	MAGNUM CAP ELECTRICAL POWER SOLUTIONS	Magnum Cap, Portugal
e8 energy. moving the future now EVTEC	E8Energy/ EVTEC, Germany, Switzer-land	SGTE Power	SGTE, France
efacec	EFACEC, Portugal		

V2X/ V2G

V2G Japan: M-TECH laboratory project

The main purpose of "M-tech Labo", a smart grid demonstration system, is to level the power demand of factory facilities, which consists of the followings:

- **Photovoltaic system (Mono crystal type: 20[kW])**
- **Five electrically dischargeable EVs (16[kWh]*5)**
- **Five used rechargeable batteries (16[kWh]*5)**
- **Charging & Discharging Stand (3[kW]*10)**



V2G Japan- M-TECH laboratory project

Photovoltaic system : 105 pieces of mono crystal type panel (200[W])

Power conditioner with 20kw

Used rechargeable batteries from i-MiEV (used for 1 year - equivalent to 16kWh)

Used EV: dischargeable i-MiEV

V2G Japan: M-TECH laboratory project

Photovoltaic system : 105 pieces of mono crystal type panel (200[W])

Power Conditioner (20[kW])

EV：Dischargeable G-grade i-MiEV (16kWh) (Prototype)

Battery:
Used rechargeable batteries for i-MiEV (used for 1 year - equivalent to 16kWh) and related systems for i-MiEV

V2G Japan: M-TECH laboratory project

Charging & Discharging stand (Prototype)

Connection Status Indicator

(blue)	Disconnected (Disabled)
(red)	Power supplied to EV
(green)	Power supplied from EV

Operation Display (for authentication and connection)

Smart Community System Demonstration Project in Spain (Image)

Source: press release from NEDO as of 8 March 2011

MALAGA Smart City Scope:

•Focus on the transportation and power sectors from 2011 to 2015

•Introduction of a platform to collaborate with the Malaga Smartcity Project, which integrates information from energy management systems for renewable energy and the existing power infrastructure.

•Establishment of new infrastructure including EV management systems, EV charging facilities and information services . Build up of 6 power conditioners (V2G Device)

•Aiming improvement of the efficiency of Malaga's grid management system

MALAGA Smart City Project between:

endesa

Telefónica Sadiel

and

Mitsubishi Corporation

MITSUBISHI HEAVY INDUSTRIES, LTD. HITACHI Inspire the Next

under the Japan and Spain Innovation Program funded by NEDO and CDTI

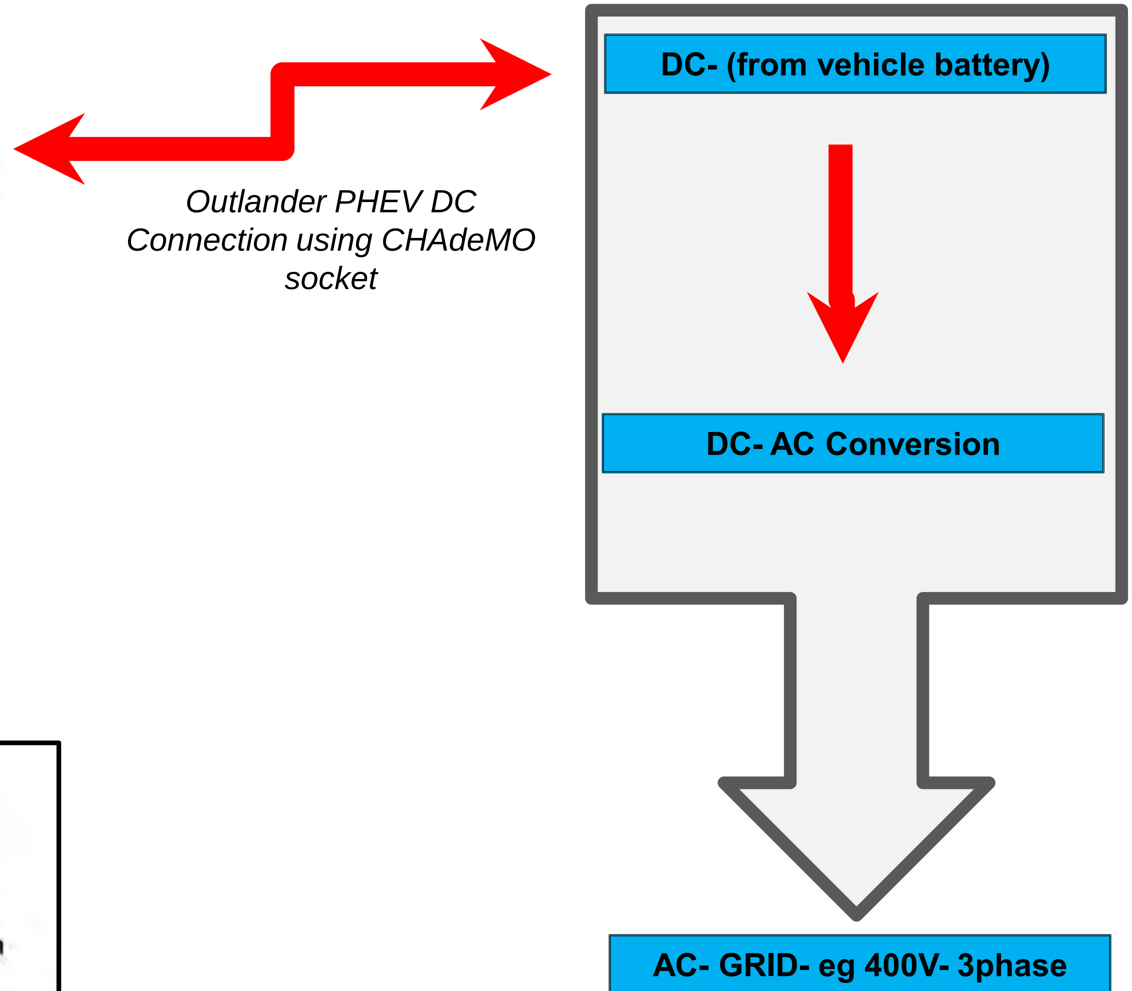
V2G Germany– Project Würzburg

Series MMC
Outlander PHEV

V2G trial Germany-
FHWS 2014

FHWS
Hochschule für angewandte Wissenschaften
Würzburg-Schweinfurt

Prototype Power Conditioner
developed by FHWS



Power conditioner build up for the German grid

Charge and discharge test at the FHWS laboratory

V2G trial Europe Germany- FHWS 2014


Drive@earth
MITSUBISHI MOTORS

Appendix

CHAdeMO- Information
Safety

Safety measures for CHAdeMO quick charger

- "Electric shock" is the highest risk hazard assumed on the operation of quick charging infrastructure.
- CHAdeMO specifications stipulate the following items to reduce the risk of electric shock.

✓ Floating DC output circuit design and ground fault detector
✓ Charging connector lock mechanism
✓ Circuit safety check before charging
✓ Program control with analog signals and digital signals

MITSUBISHI MOTORS

<Connector mating>

- ✓Connector has a locking latch on its tip top.
- ✓Connector is **<u>mechanically</u>** latched when it's fully inserted into vehicle inlet.
- ✓Connector can be unlatched when the release lever is pushed down.

Connector appearance

<Connector locking>

- ✓Connector has a solenoid pin which is operated by charger DC current.
- ✓This solenoid is energized during charging and latches the release lever with its pin **<u>electromagnetically</u>**.
- ✓Connector notify the locked status by lock indicate while solenoid is energized.

Connector can be prevented from detached with these double mechanisms:
"mechanical latch" and "electromagnetic solenoid pin"

CHAdeMO

How to use Quick Charger

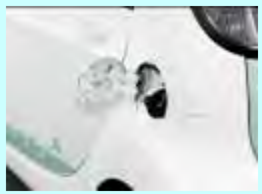
1

・Put the shift position on P
・Turn the electric motor switch off to the position of "LOCK"

2

・Pull the lid opener located under the driver's seat.
・Open the quick charging lid and quick charging opener.
.

<RHD>



3

・Insert the quick charging gun to the charging connector of the car.

4

・Check that the charging indicator is lighted.
・For 30min, 80% of charging is capable.
(if you repeat the charging, more than 80% of charging is capable)

5

・When the battery is charged 80% (or more), charging will be stopped automatically, then charging lamp will be turned off.

6

・Pull out the quick charging gun from the charging connector of the car.
・Close the quick charging opener and quick charging lid.

7

・Replace the quick charging gun to the quick charger.

Specifications of CHAdeMO quick charger

Sample model

CHAdeMO

Specifications

Type: Switching type
constant current power supply

- **Input: 3-phase 200V (200~430V)**
- **Output power: 50kW (10~100kW)**
- **Maximum DC output Voltage: 500V**
- **Output current: 125A (20~200A)**

Target charging time

5 minutes for 40km driving range
10 minutes for 60km driving range

Program control with analog and digital signals

MITSUBISHI MOTORS

Quick charger	Vehicle
Signal the start-of-charging setup ('d1' on) →	Start CAN communication ('f' on)
	Transmit battery parameters: Target charge voltage, battery capacity, maximum charging time etc.
Compatibility check ←	
Transmit charger parameters: Available output voltage/current, Error thresholds etc. →	Compatibility check
Receive charging permission signal ('j' on) ←	Signal the completion of vehicle setup ('k' on)
Lock the connector and perform insulation test **Signal the completion of charger setup ('d2' on)** →	Receive charging start signal ('g' on) Turn on EV main relays

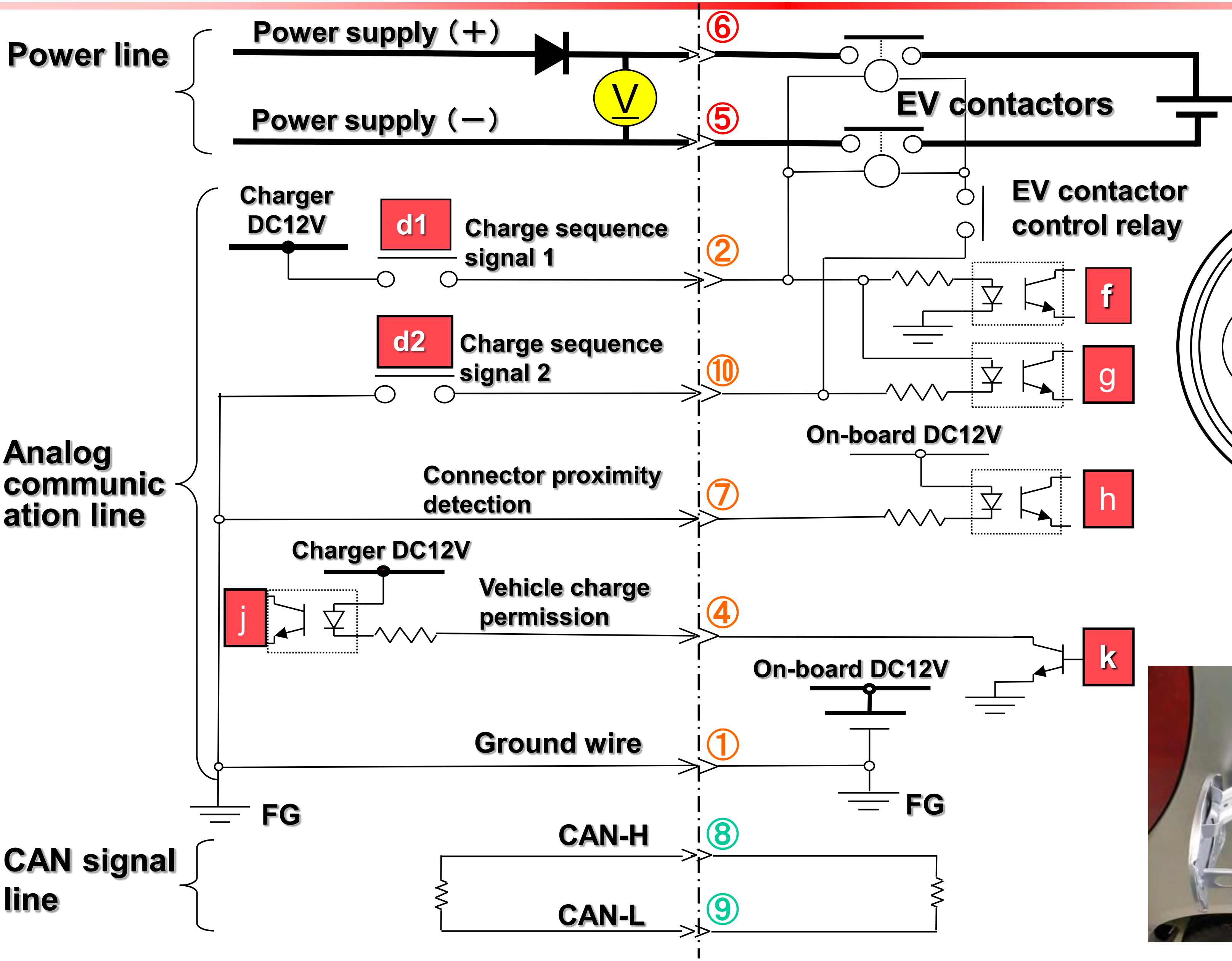
Charging current control

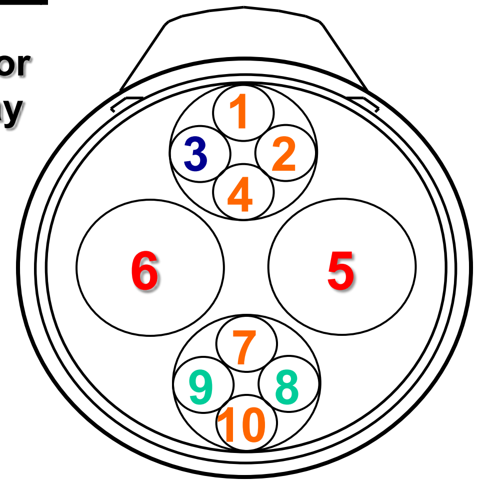
Quick charger	Vehicle
Control output current **Monitor charging errors and charging timer** ←	Calculate optimal current based on battery condition Transmit current order value (every 100msec) Monitor supplied current and judge whether error has occurred
	Battery energy has reached the threshold value
Terminate outputting current ←	Signal the completion of battery charging
Receive charging termination signal ('j' off) Terminate charging session ('d1', 'd2' off) Unlock the connector ←	Confirm that DC current on main circuit is below 5A Turn off EV main relays Terminate charging session ('k' off)

CHAdeMO

Analog signal, Digital signal (CAN)

Pin layout on charging connector





Pin layout

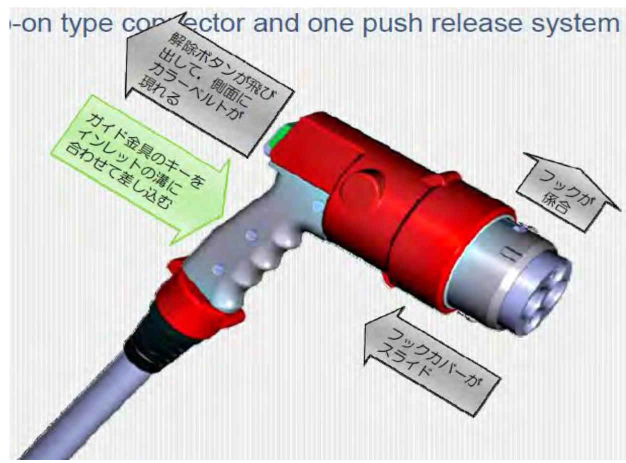
CHAdeMO compatible charging connector

Yazaki- commercial available

Sumitomo Electric Industries

Fujikura

Japan Aviation Electronics



Dyden

EU embraces multi standard chargers, aligning legislation with the market reality

Recital

- 15a
  - Interface to charge electric vehicles could include several sockets outlets or vehicle connectors as far as one of them complies with Annex III.1.1 and 1.2, so as to allow **multistandard recharging.**
  - However, the choice for the EU **common** Type 2 and Combo 2 connectors for electric vehicles should not be detrimental to Members States having already invested in the deployment of other standardized technologies for recharging points and should not affect existing recharging points deployed before the entry into force of this Directive.
  - Electric vehicles already in circulation before the entry into force of this Directive should be able to recharge, even if they were designed to recharge at recharging points that do not comply with the technical specifications set out in this Directive.

Articles and Annexes

- Article 4
  - Member States shall ensure that high power recharging points* for electric vehicles, excluding wireless or inductive units, **deployed or renewed as from [36 months from the date of entry into force of this Directive]** comply **at least** with the technical specifications set out in Annex III.1.2.
- Annex III 1.1.2.
  - Direct Current (DC) high power recharging points for electric vehicles shall be equipped, for interoperability purposes, **at least** with connectors of Type "Combo 2" as described in standard **EN62196-3**

Note: * high power recharging point : more than 22KW

Excursion: Inner vehicle charging

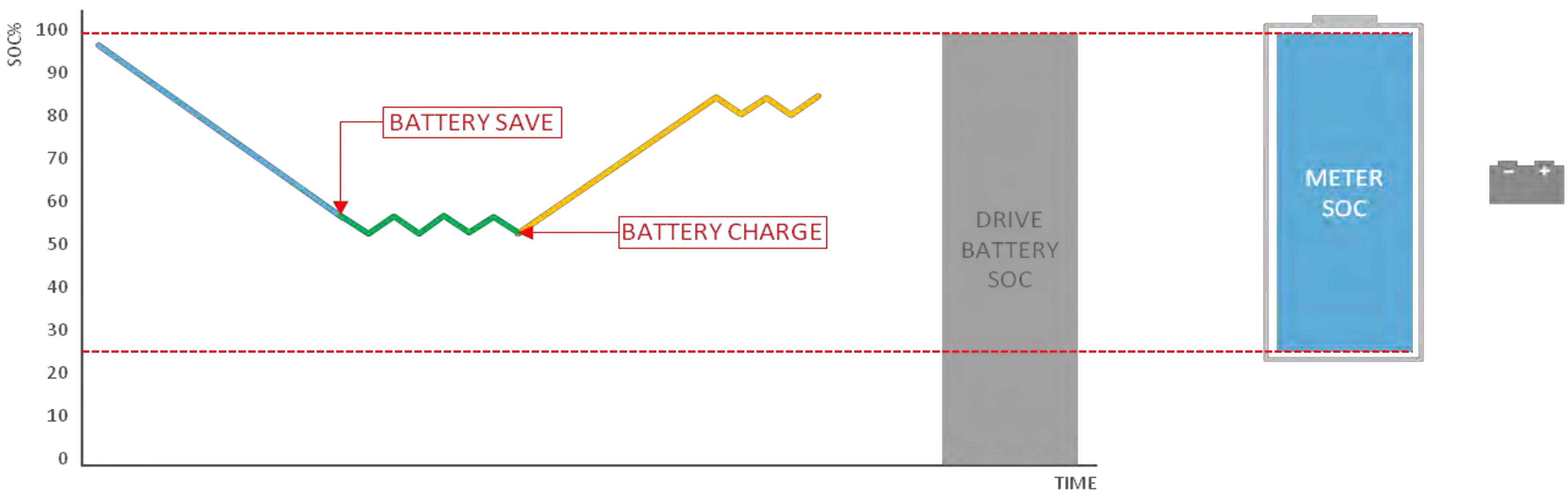
HMI- Electric drive functions- Charge and save mode

BATTERY CHARGE MODE

DRIVER-ACTIVATED CHARGING THROUGH ICE AND GENERATOR 80% SOC IN 40 min

BATTERY SAVE MODE

DRIVER-ACTIVATED MAINTAINS BATTERY SOC LEVEL



Regenerative Braking

- The kinetic energy of the vehicle is used to charge the battery
- The front and the rear motor will be used as a generator
- The regeneration strength can be can be controlled by the driver using shift paddels.

Use Cases:
- **City driving**
- **Downhill driving**