MOVE THE WORLD FORWARD

MITSUBISHI HEAVY INDUSTRIES GROUP

Challenges and Issues of Electric Vehicle-Oriented Society

February 22, 2017

MITSUBISHI HEAVY INDUSTRIES, LTD.

About MHI Group

Ever since our foundation in 1884, Mitsubishi Heavy Industries (MHI) has been continuously supplying infrastructures for better society.


Energy & Environment


Commercial Aviation & Transportation Systems


Integrated Defense & Space Systems


Machinery, Equipment & Infrastructure


MLFF system (ITS)


Gas Turbine Combined Cycle power plant


LNG Carrier, Container Ship


Klang Valley MRT Project


District Chiller


Fertilizer Plant

MHI in Malaysia

MHI Group

Turnover
- US$33 Billion (MYR140B.)

No. of group companies
- 240

No. of employees
- 82,000

2015 Fiscal year

About MHI ITS

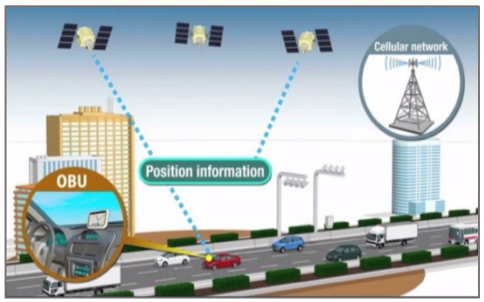
Our Major Experiences in ITS

1967	Tolling System for Japan
1980s	First Tolling System for Malaysia
1998	Electronic Road Pricing System (ERP1) for Singapore
2001	Electronic Toll Collection (ETC) system for Japan
2016	Next-generation ERP (ERP2) for Singapore awarded
2016	Multi-lane Free Flow (MLFF) POC1 for Malaysia completed
By 2020	ERP2 to be completed

Electronic Toll Collection (ETC) system In Japan

Electronic Road Pricing System in Singapore (ERP1)

MLFF POC1 In Malaysia



Next-generation Electronic Road Pricing System in Singapore (ERP2)

About MHI ITS

As one of the pioneer of ITS industries, we have been participating in various ITS Projects all over the world.

Electronic Parking System (EPS) (Singapore)

Electronic Toll Collection (India)

Electronic Vehicle Management (Spain, UAE)

Traffic Control System (Sri Lanka)

Strategic Partners

TQM Consortium	Consortium formed with Touch n' Go and Quatriz to realize advance ITS in Malaysia including MLFF (Nov. 2013)
Conduent (Former Xerox)	Signed MOU to explore, globally, on a case-by-case basis, potential joint ITS opportunities (Oct. 2015)
Sojits & Vietin Bank	Signed Memorandum for the demonstration project targeting the integration of Vietnam's expressway ETC systems. (Oct. 2015)

The history of automobiles and EVs

The first automobile invented by French man Nicolas-Joseph Cugnot in 1769 run by steam.

Photo source: Wikipedia

The history of automobiles and EVs

The Motor and battery vehicle (Electric Vehicle: EV) invented in 1830s.
This image is called “La Jamais Contente” and recorded 100 km/h in 1899.

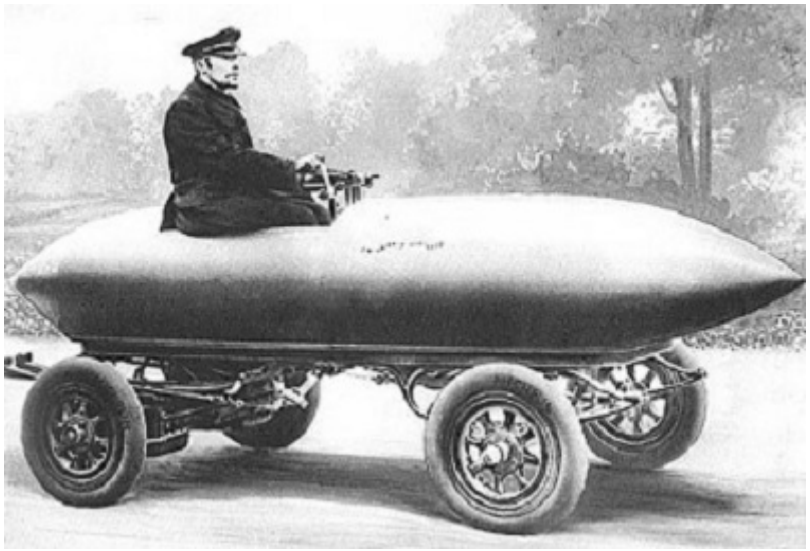
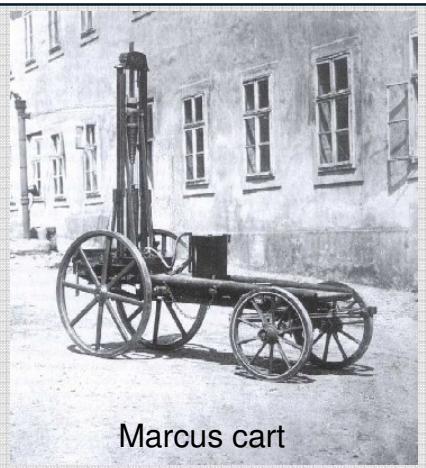


Photo source: Wikipedia

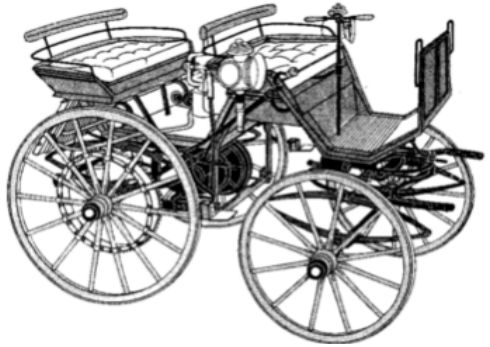
The history of automobiles and EVs

The first automobile run by gasoline invented by Siegfried Samuel Marcus in 1870. In 1885, Gottlieb Wilhelm Daimler invented internal combustion engine and completed the gasoline car.

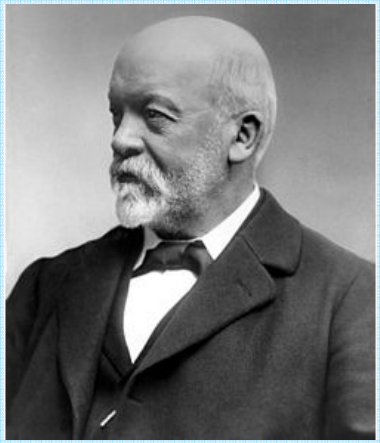


Marcus cart

Siegfried Samuel Marcus



Gasoline car made by Daimler in 1869



Gottlieb Wilhelm Daimler

Photo source: Wikipedia

The history of automobiles and EVs

Thanks to these great inventors, cars became one of the most important transportation tools for us. However, millions of cars produce serious traffic congestion as well as severe air pollution at the same time.

Photo source: Wikipedia

The history of automobiles and EVs

EVs, which emit no exhaust gas, are getting more attention as its environmental friendly aspect. Today, many companies are investing in EVs and EV related businesses.

Early electric car, built by Thomas Parker in 1895

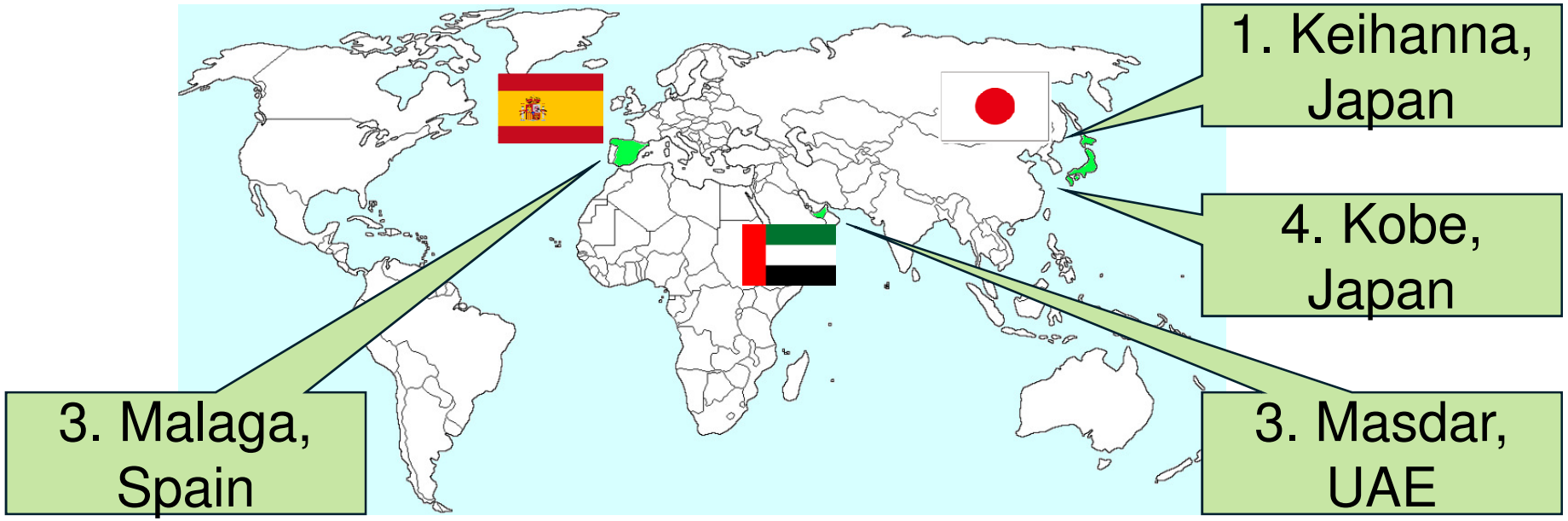
Tesla Roadster Sport 2.5 by Tesla, today

On the other hand, EVs could also be a big electronic power consumer. In order to secure stable electronic power supply for all the time, we have done Proof of Concept (POC).

Photo source: Wikipedia

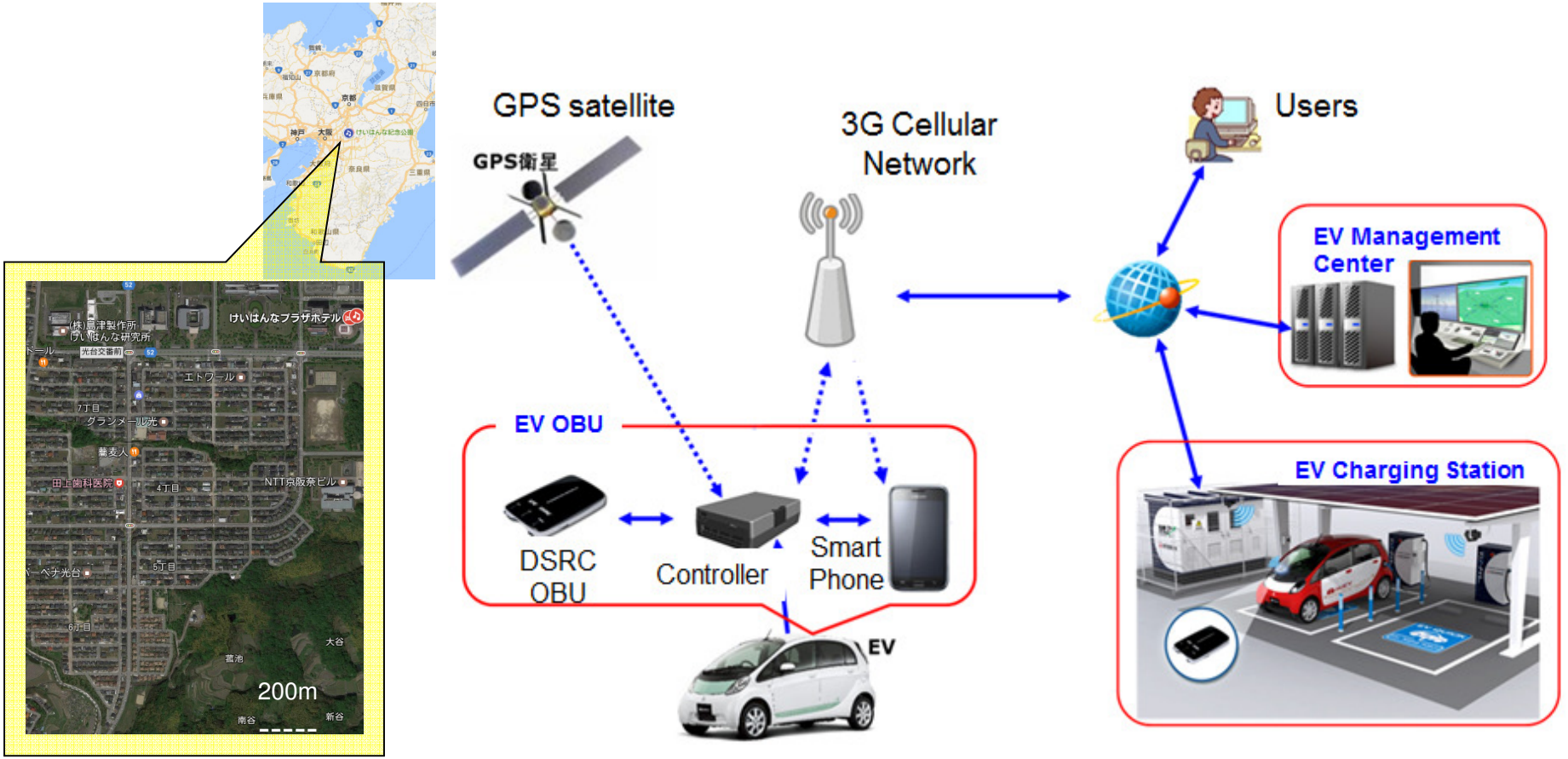
Overview of POCs for EVs

	Project Name	Country	Location	Period	POC of;	Feature	Vehicles	Power charging
1	Keihanna Eco-City Next Generation Energy Society System Inspection Project	Japan	Keihanna (Kyoto)	2012/3 ~ 2014/12	EV charger management system	・EV only	Single model 100 units	Car station 35 locations + Quick charge station 1 point
2	Masdar Pilot	UAE	Masdar	2011/1 ~ 2015/1	Fleet control system	・EV only ・Desert heat environment	Single model 12 units	Quick charge station Points
3	Smart Mobility Project	Spain	Malaga	2013/5 ~ 2015/12	Fleet control system	・EV only ・Multiple usages: owner, leasing, car sharing and rent-a-car ・Multiple vehicle models	2 models Total 200 units + owners car	Wall box for each users' house + Public quick charge station 9 points
4	SEA:MO	Japan	Kobe	2015/8 ~ 2016/3	One way type car sharing	・EV only ・One way car sharing ・Multiple vehicle models	3 models Total 20 units	Car station 16 points



POC in Keihanna, Japan

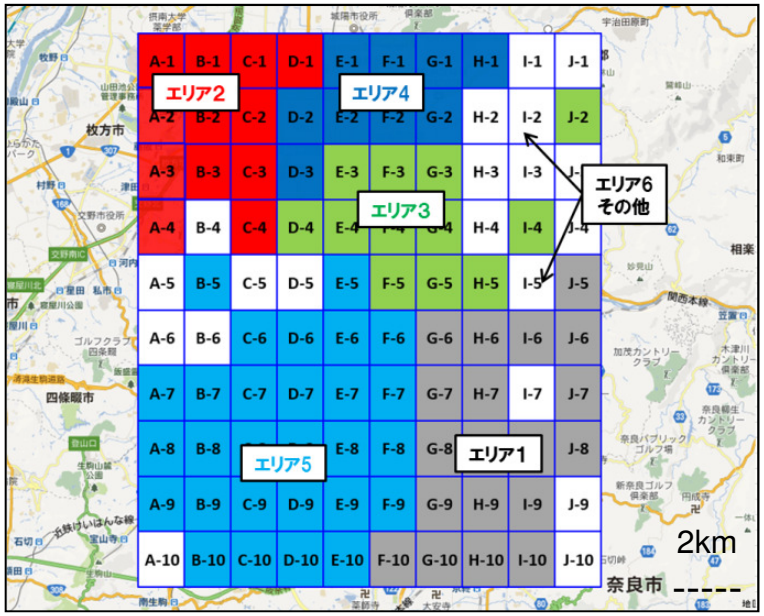
	Project Name	Country	Location	Period	POC of;	Feature	Vehicles	Power charging
1	Keihanna Project	Japan	Keihanna	2012/3 ~ 2014/12	EV charger management system	・EV only	Single model 100 units	Car station 35 locations + Quick charge station 1 point



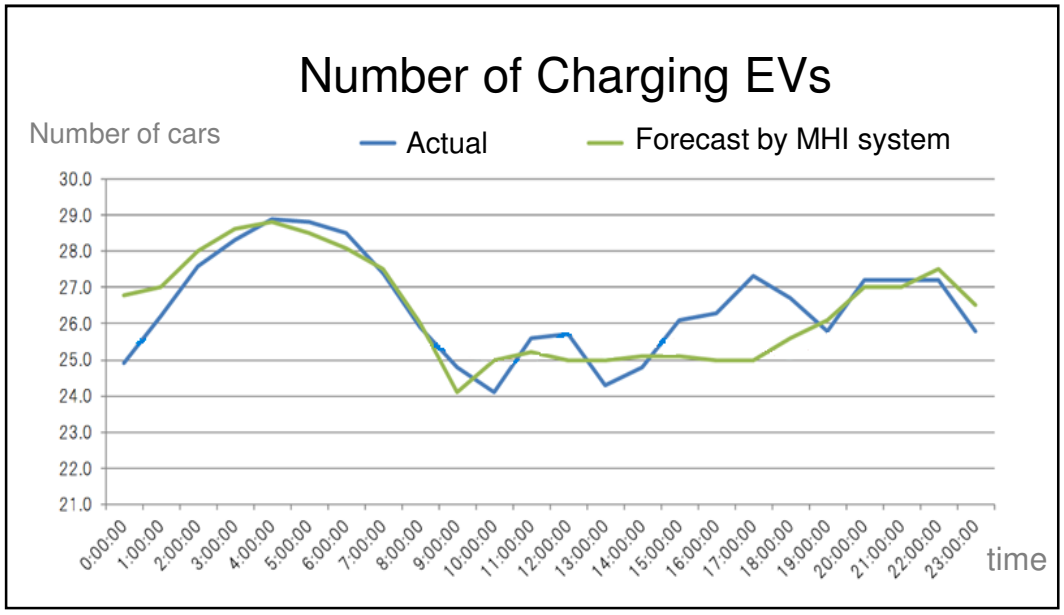
POC in Keihanna, Japan

■ Conclusion

We have proved that the power charging demand forecast has the good reliability by monitoring EV's battery status and the demand control is also possible.



Clustering by area



POC in Masdar, UAE

	Project Name	Country	Location	Period	POC of;	Feature	Vehicles	Power charging
2	Masdar Pilot	UAE	Masdar	2011/1 ~ 2015/1	Fleet control system	・EV only ・Desert heat environment	Single model 12 units	Quick charge station ?? Points

- Aimed to create reliable public transportation system by our EV management system with the existing transportation infrastructures.

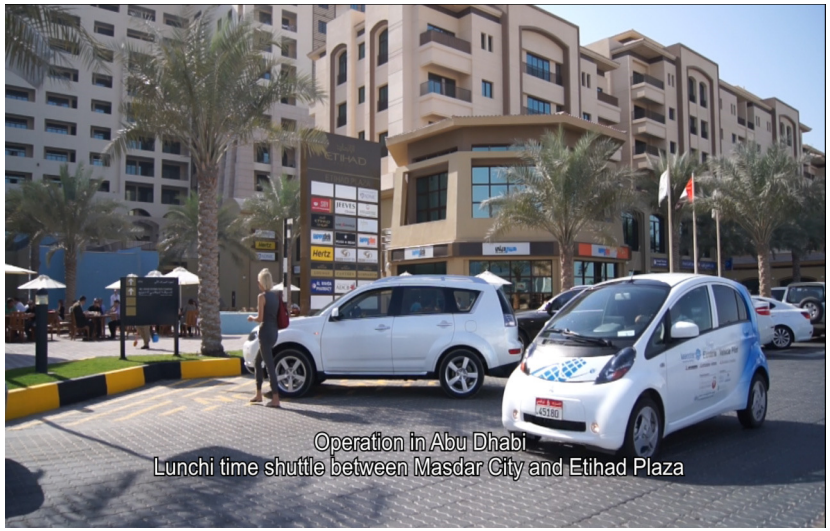
- Provided EVs and quick charger systems

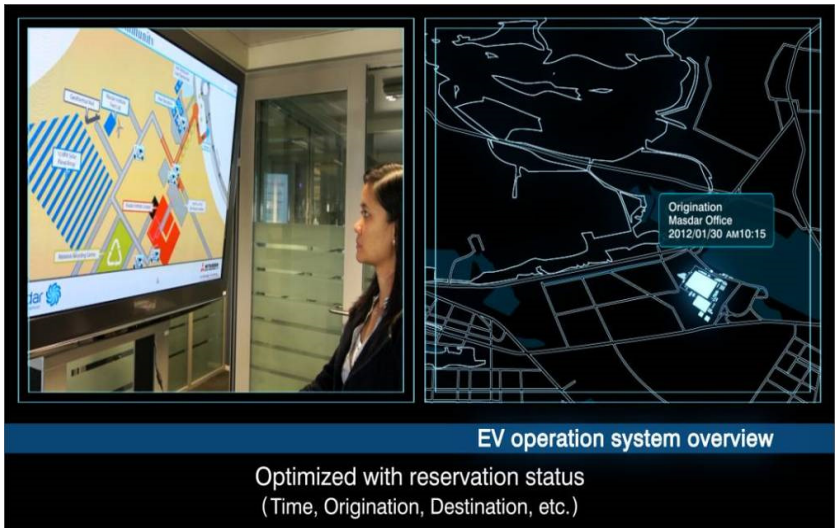
- EV management system can
  - ➢ gather positioning information and travel distance collected by OBU
  - ➢ provide various information to users
    1) when and where to charge the EV
    2) the route to the nearest charging point, etc.

POC in Masdar, UAE

■ Conclusion

- All the system including EV and components have worked as long as four years service in a very harsh desert heat environment.
- Quick charging system was successfully introduced.
- Total users: 133,000 and the reduction of CO_2 is calculated 74t





POC in Malaga, Spain

	Project Name	Country	Location	Period	POC of;	Feature	Vehicles	Power charging
3	Smart Mobility Project	Spain	Malaga	2013/5 ~ 2015/12	Fleet control system	・EV only ・Multiple usages: owner, leasing, car sharing and rent-a-car ・Multiple vehicle models	2 models Total 200 units + owners car	Wall box for each users' house + Public quick charge station 9 points

- Evaluated demand response by using multiple users and multiple vehicle models of total 200 units.

Charging locations, Malaga

POC in Masdar, Spain

Project members

i-MiEV 49

Individuals
49 EVs

i-MiEV 66

Company contract users
67 vehicles

LEAF 1

i-MiEV 45

Municipal users
45 vehicles

LEAF 30

Car share and rent-a-car
30 vehicles

Total: 191 vehicles

Project member (Charger use only)

i-MiEV 3 | OUTLANDER 1

Individuals
15 vehicles

LEAF 10 | E-NV200 1

C-Zero 1

Company contract user
3 vehicles

LEAF 2

Total: 18 vehicles

Breakdown of the vehicles

i-MiEV : 163

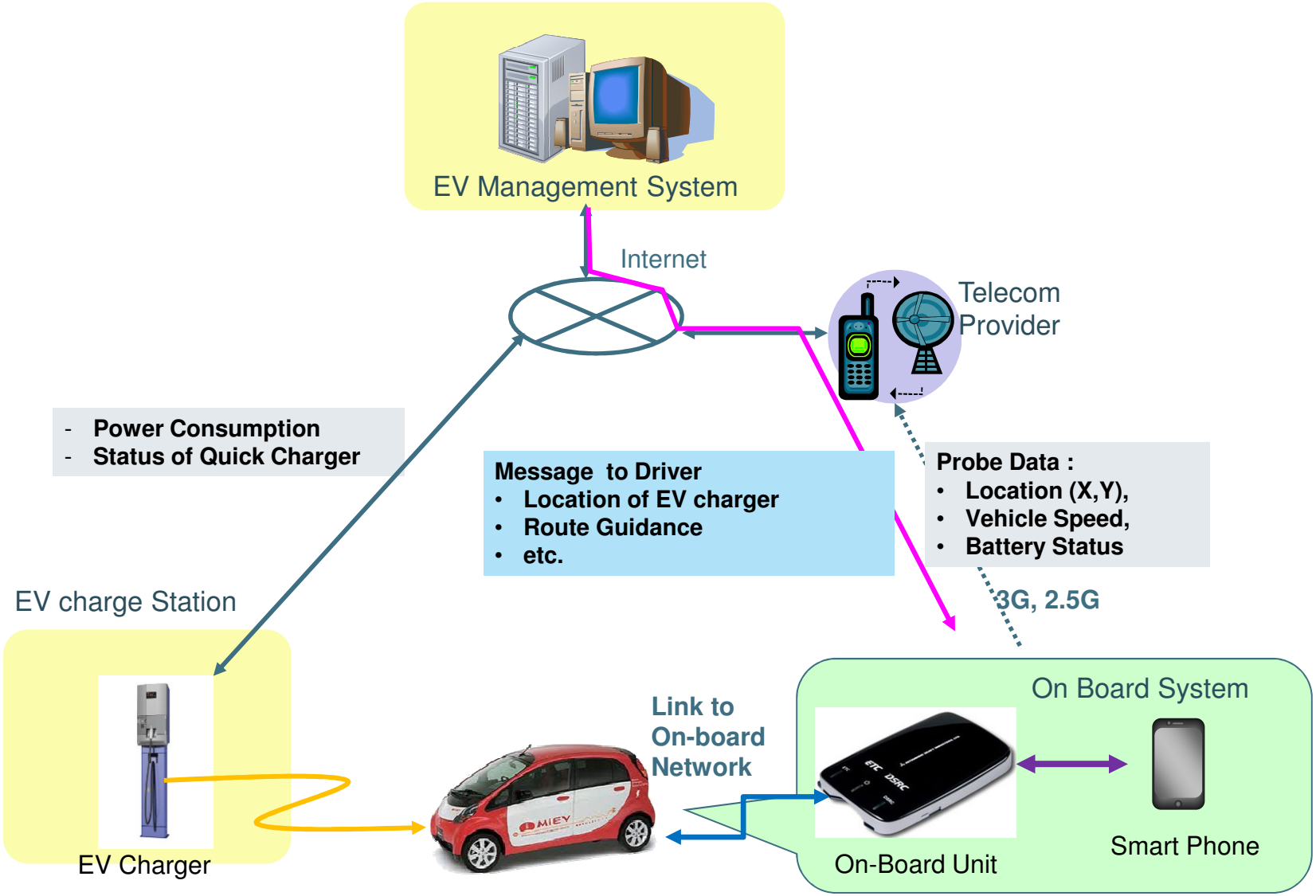
OUTLANDER : 1

LEAF : 43

E-NV200 : 1

C-Zero : 1

POC in Masdar, Spain



POC in Masdar, Spain

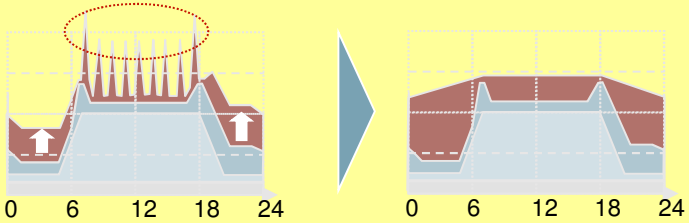
Step 1 : Collecting information
-Charging Reservation
-EV position
-Ev users' characteristic

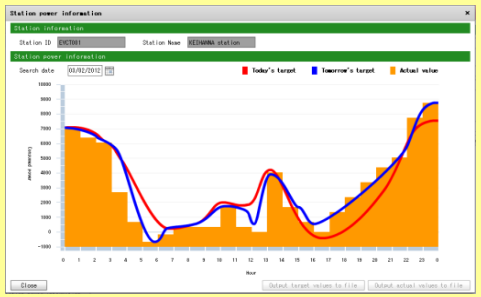
EV Management Center

Step 2 : Forecasting energy consumption
-Forecast the charging
-Forecast community energy supply and Demand by an electric company

Step 3 : Demand control trial
-Request the time and place of the charging
-Changing the price of charging

Peak cut / Peak shift

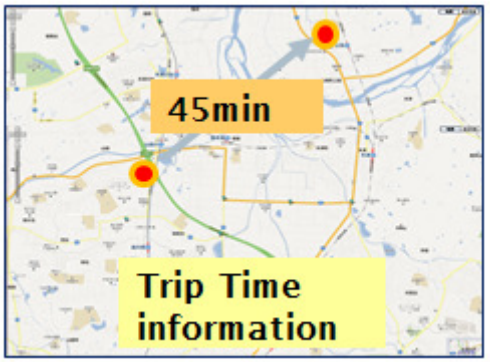


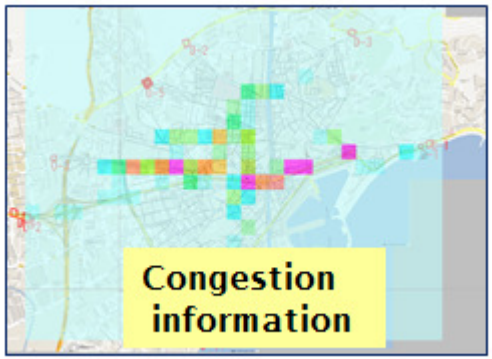


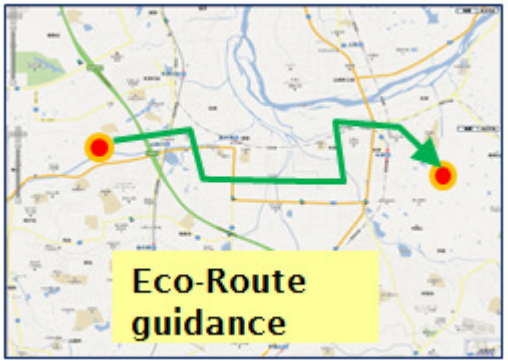
POC in Masdar, Spain

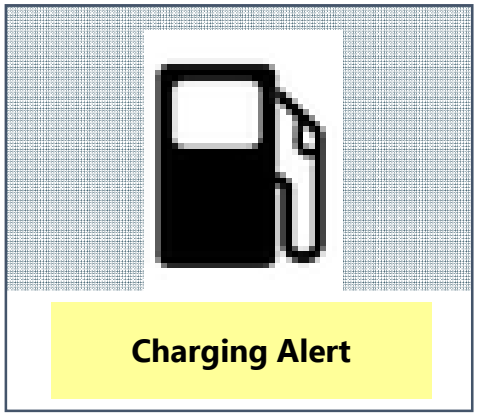
■ Available Service

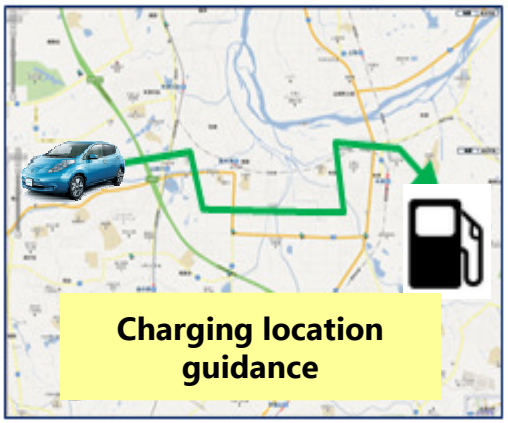
Customer services using probe data







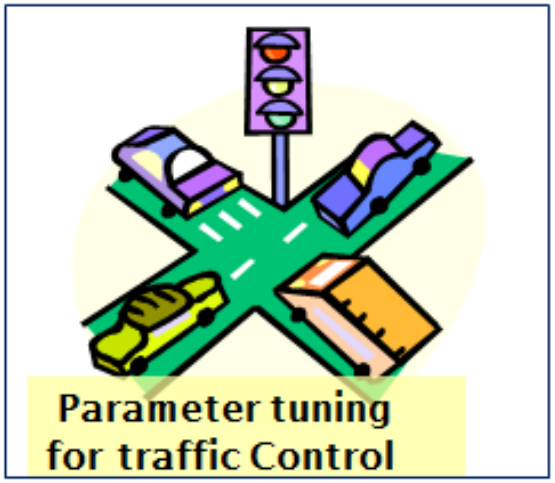




POC in Masdar, Spain

- Available Service

Probe data used at back office

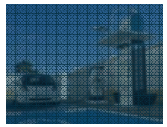


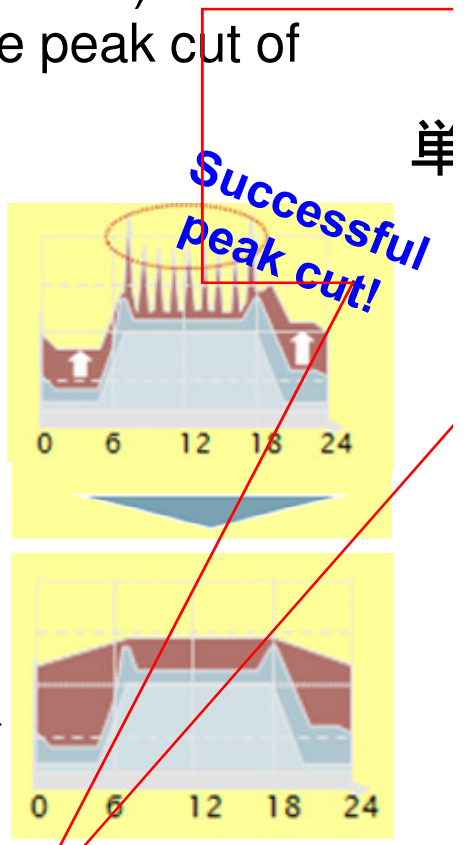
POC in Masdar, Spain

■ Cunclusion

1. Successfully managed a big group of vehicles (more than 200)
2. Dynamic price changing method is proved effective in the peak cut of power demand.

※Evaluation criteria
(○: More than 10% effect compare to the year before,
×: No effect)

		Registered participants	Individuals	Companies
Discourage		+ 4.0% X	− 16.2% O	+ 14.2% X
Courage		X	O	X



3. The total drive distance have reached 46 Billion meter (app. 1,150 times of the equator), which is equivalent to 14t of CO_2.

POC in Kobe, Japan

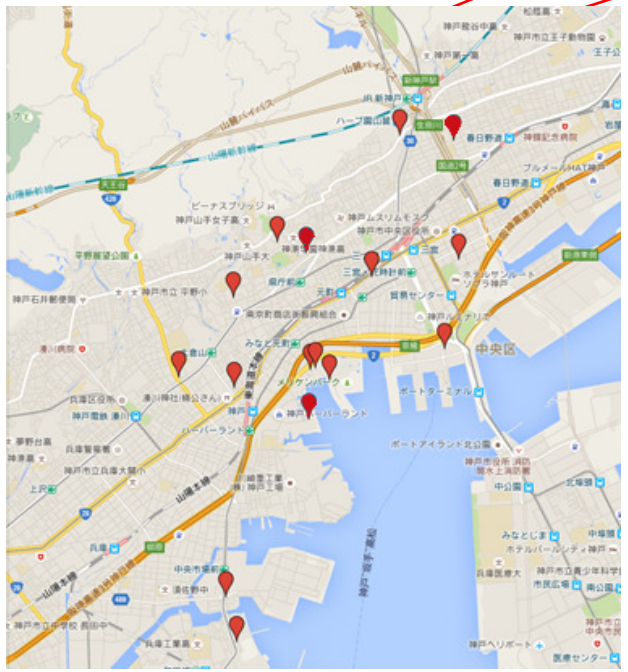
	Project Name	Country	Location	Period	POC of;	Feature	Vehicles	Power charging
4	SEA:MO	Japan	Kobe	2015/8 ~ 2016/3	One way type car sharing	・EV only ・One way car sharing ・Multiple vehicle models	3 models Total 20 units	Car station 16 points

- Evaluated of “One way type car sharing” can be the alternative to the existing public transportation.
- Evaluation conducted by three models of EVs (total 20 vehicles).

COMS (TOYOTA)

NMC (Nisan)

i-MiEV (Mitsubishi)



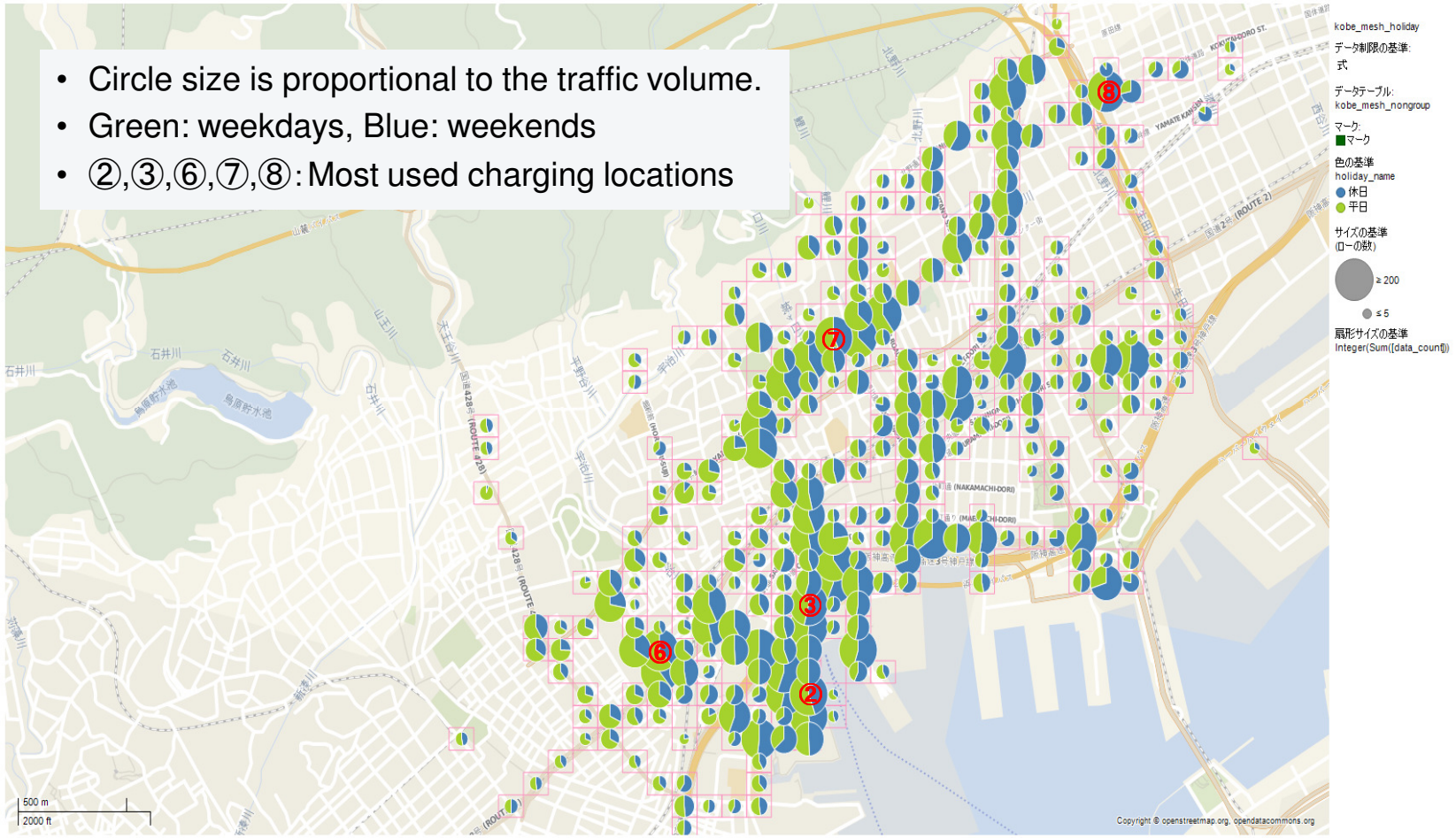
Charging locations, Kobe

POC in Kobe, Japan

Example of the study

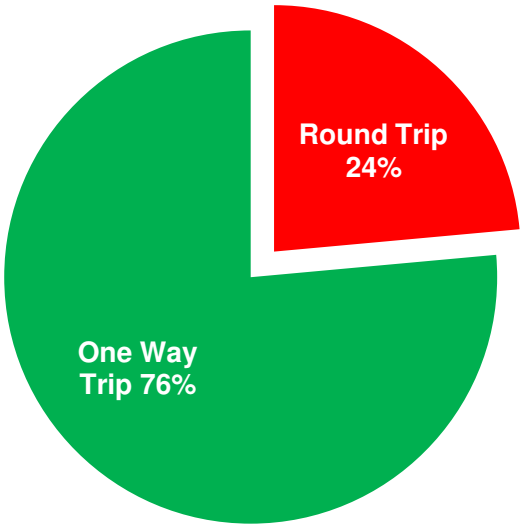
Drive data shows which charging station is popular and needs to be well equipped.

マップチャート



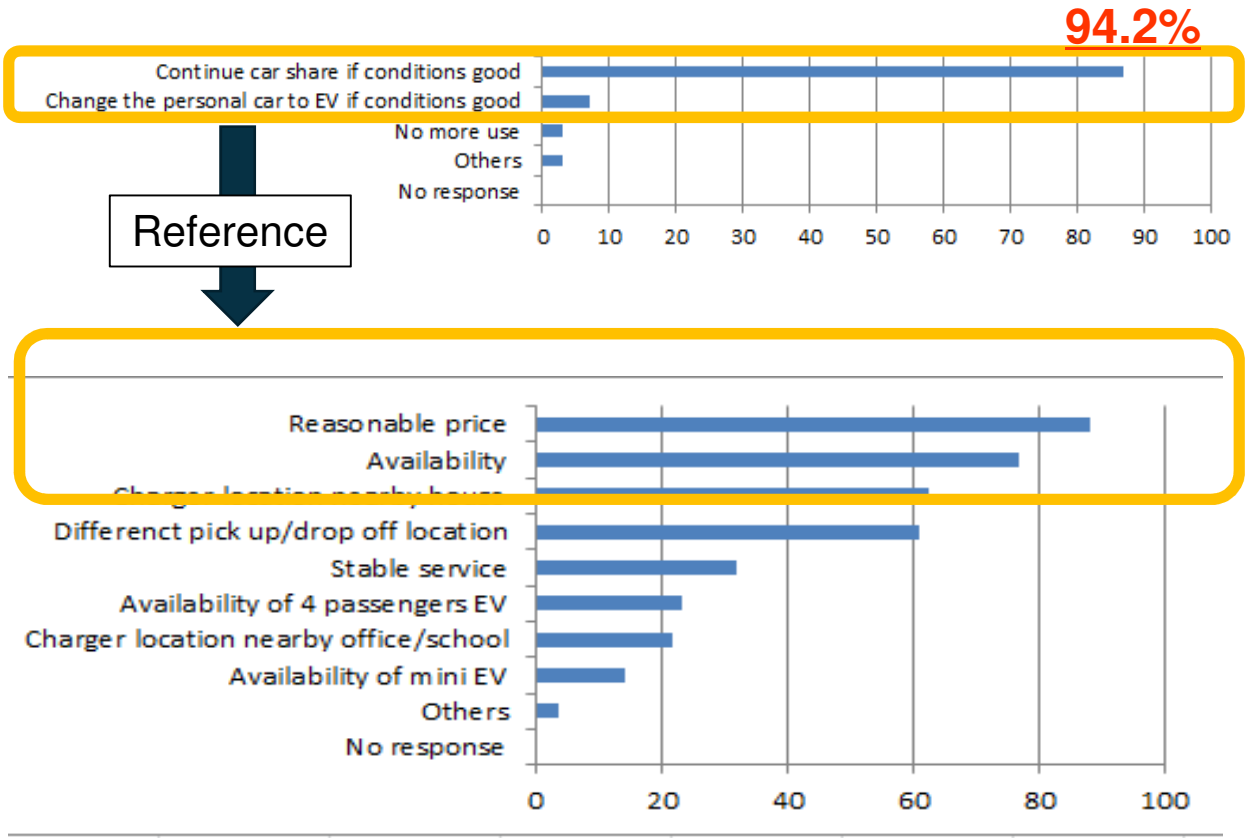
POC in Kobe, Japan

■ Conclusion



One Way / Round Trio Ratio

More than 90% users satisfied with EV car sharing service ☺☺



This POC indicated that the user's preference on "One way type car sharing" is strong and the service can coexistent with the other transportation services, such as Bus or Rail.

POCs for EV - Conclusion

	What we learned
1	EVs' charging trend
2	Construction of EV charger management system
3	EVs functionality in rough environment
4	EVs as a tool to travel from city to city
5	EVs' effect to save the environment
6	Demand response and people's behavior
7	High demand for one way car share
8	Positive idea toward EVs (with some conditions)

Conclusion

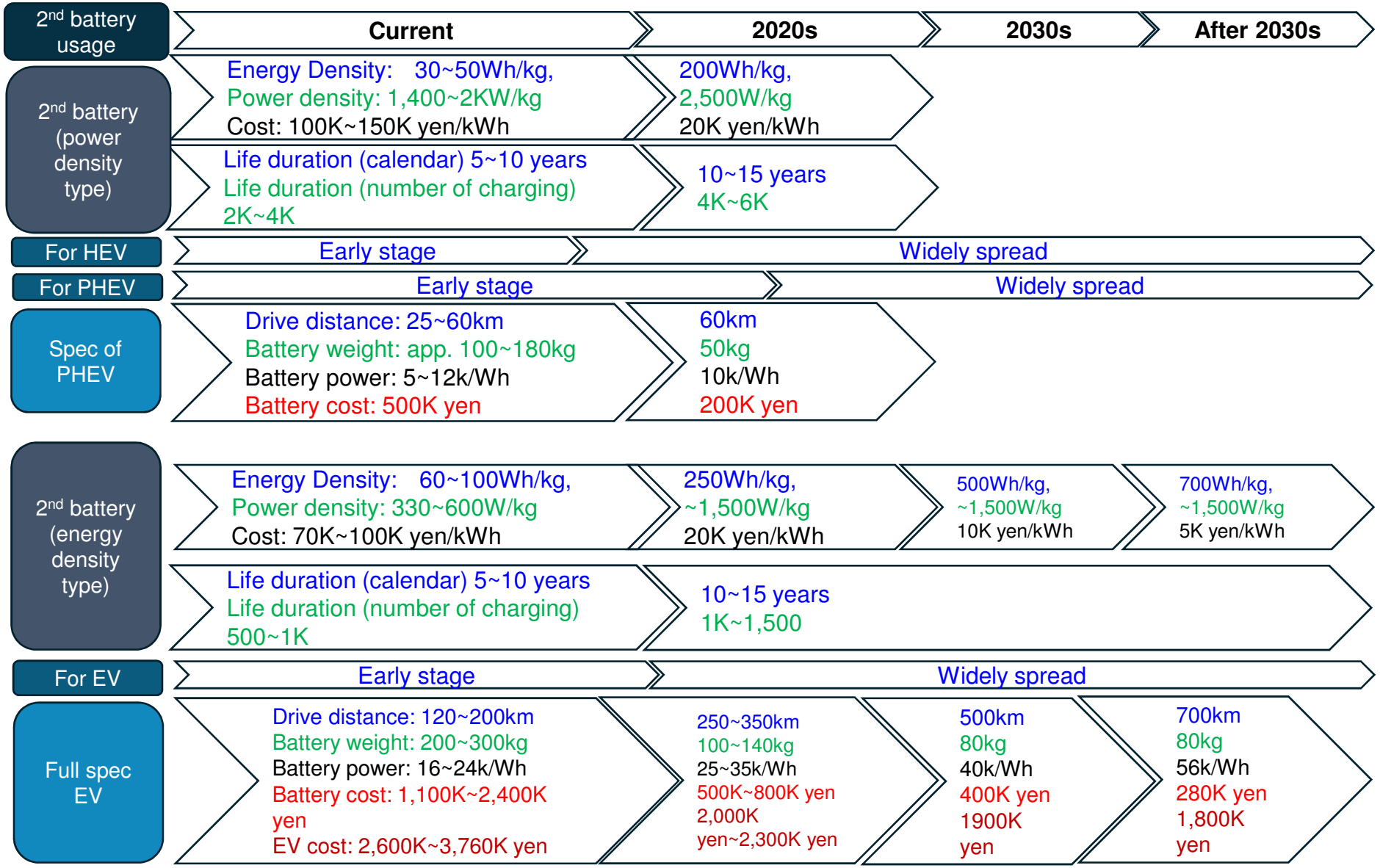
The cutting edge luxury EV now will travel 550km at one charge.
NEDO* predicts that the affordable EV will reach this level by 2030.
It is clear that we are heading to the EV society.

However, due to their big demand of the electric power, EV fleet without the power management could cause the power supply shortage or require the bigger supply infrastructure.
Therefore, sophisticated management system is required.

MHI has the experience and the know-how of the EV fleet management though these four POCs.
We can say that the technology for EV society is ready now.

*Japan research institute: New Energy and Industiral Technology Developmant Organization

Reference (Battery Roadmap)



Source: NEDO

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