Electric Vehicle and charging

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Definition of EV charging

- Charge battery of Electric Vehicle
- Connectivity of information
  - Between charging points and users
- Compensation for time consuming
  - Can NOT be as short as lubrication
  - Cheaper and make feel short by doing something else

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Location shift in EV charging world

- Gas station
  - Route charging
  - Easy to fine without additional information
  - highway rest area, main street, signage

- Charging station
  - Route charging + Destination charging
  - highway rest area, back street, in-building etc

Behavior shift – passenger EV

- Charging time consuming per charging point speed

CHARGING TIME	3 kW	11 kW	50 kW
18 kWh	6 h	1 h 38 min	22 min
40 kWh	13 h 20 min	3 h 38 min	48 min
100 kWh	33 h 20 min	5 h 5 min	2 h

*Estimated time on guaranteed formula from 0% to 80% recharge

- Self change management
  - Charging as often as possible like smartphone
  - Seeking non-time sensitive pattern

3~8 hours Parking
@ home, office, shopping mall

Within 30-min @ highway station

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Behavior shift – Fleet EV

- Taxi
  - 318kms/day in avg.
  - Gov't subsidy amount $15,000 for motivation
  - Fast charging in depot is necessary
- Bus
  - Express bus: 442kms/day in avg.
  - Cross-country bus: 401kms/day in avg.
  - Metro-city bus: 268kms/day in avg. → EV target sector
  - Gov't subsidy amount $80,000 for motivation
  - Fast charging in depot is necessary

	Y2019	Y2020	Remark
Diesel	17,878	17,754	Express, Cross-country
CNG	30,502	30,108	Metro-city
EV	395	1,095	Metro-city
FCEV	5	14	Metro-city

※ All numbers above are Korea market statistics released by Ministry of Environment

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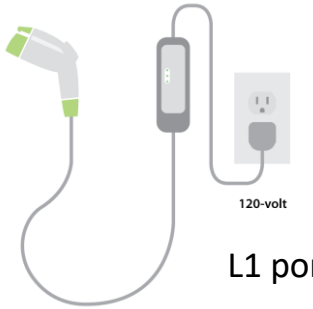
Type of chargers

	N. America	Japan	EU And the rest of markets	China	All Markets Except EU
AC	J1772 (Type 1)	J1772 (Type 1)	Mennekes (Type 2)	GB/T	Tesla
DC	CCS1	CHAdeMO	CCS2	GB/T	

[Charging connector type distribution]



L1 portable charger

Statistics of charging infrastructure in Korea

- Snapshot of charging points in Korea market

	ChargEV	Ministry of Environment	KEPCO	Other service providers	Local Gov't	Total	Ratio
No. of charging points(Y2020)	10,331	4,069	8,455	42,580	652	66,087	
No. of public service	10,331	4,069	1,718	34,418	494	51,030	77.2%

- MoE(Ministry of Environment): L3 charging stations to play a role of priming water
- KEPCO: Monopoly power distribution government company and roaming clearing house in the industry
- ChargEV: Service provider since 2012 and contract based relationship with most of OEMs(BMW, Benz, Hyundai, Volvo, Jaguar, etc.)
- Other service providers: +20 service providers and take subsidy for AC and DC charger installation
- Subsidy policy in Korea

  MoE(Ministry of Environment): Electric Vehicle subsidy, AC charger subsidy

  MoTIE(Ministry of Trade, Industry and Energy): DC charger subsidy

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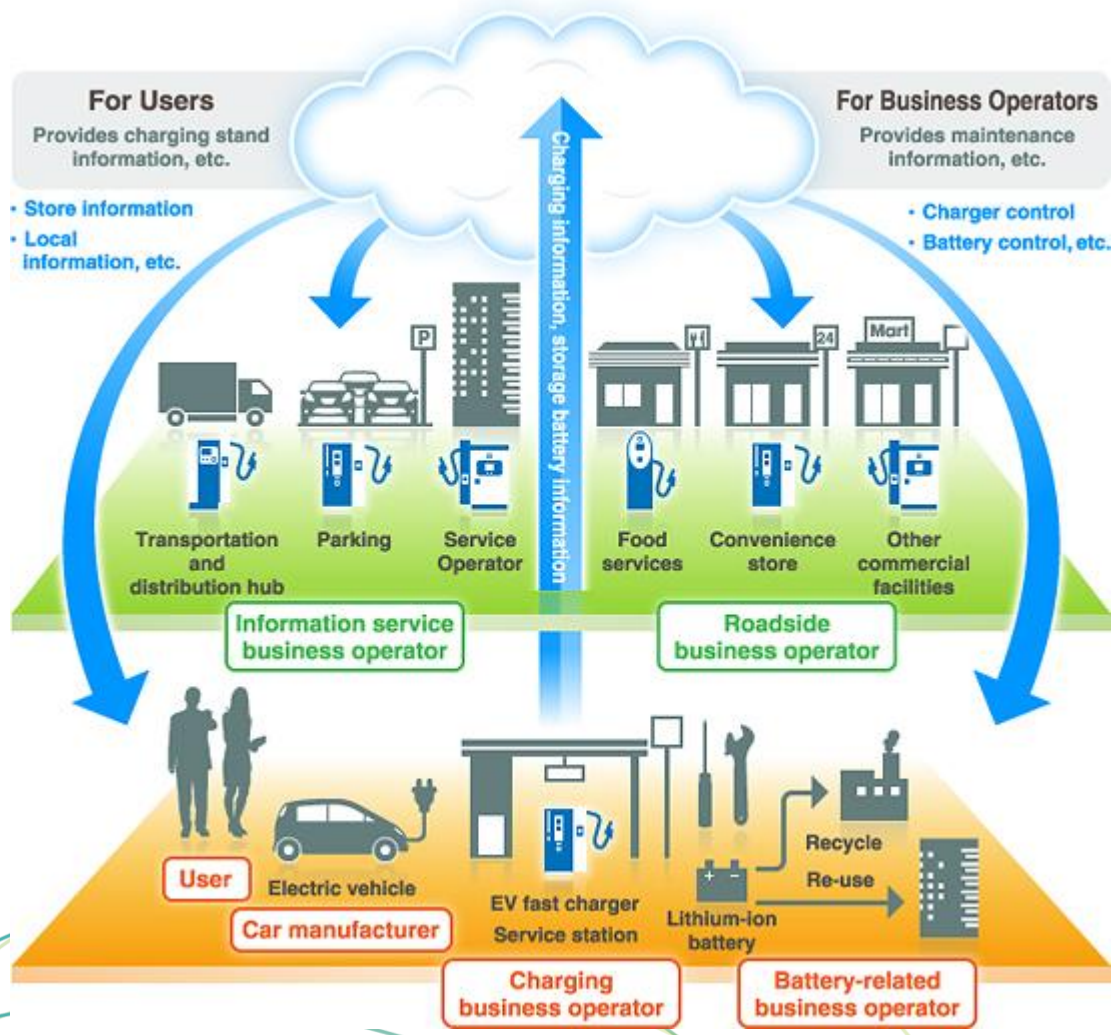
Charging architecture



[Source: NEC homepage]

- Locations
  - Dependent on charger speed
  - Dependent on business target
- Hardware component
  - Fast charger, AC charger
  - IoT modem
  - Canopy
- Software platform
  - App. to connect users and chargers
  - Authentication and billing
  - Backend system to enable various payment method
  - Value added services

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Things to consider in EV project

- Check government's policy direction
  - Subsidy policy plan, target vehicle type, emission-free plan
  - Which is higher priority – passenger car, taxi, bus, motorcycle etc.
  - [Korea case] Government prioritizes passenger car > bus > taxi >> motorcycle
- Understand local environment
  - Who owns the vehicle of the target project – government, personal, corporation, fleet etc.
  - To determine the most valuable place to locate charging points
  - [Korea case] 90% of highways are owned by government company and all government vehicle has to be replaced to EV or PCEV(Fuel Cell Electric Vehicle)
- Differentiate Must-Have and Nice-To-Have
  - Bigger battery size makes you feel comfortable but increases cost
  - Fast charger(DC) is nicer but much expensive than AC charger in terms of CAPEX and OPEX
- How to connect between EV and charging points
  - Utilize IT technology to provide location information, availability of chargers, enable the reservation feature, connect chargers and applications

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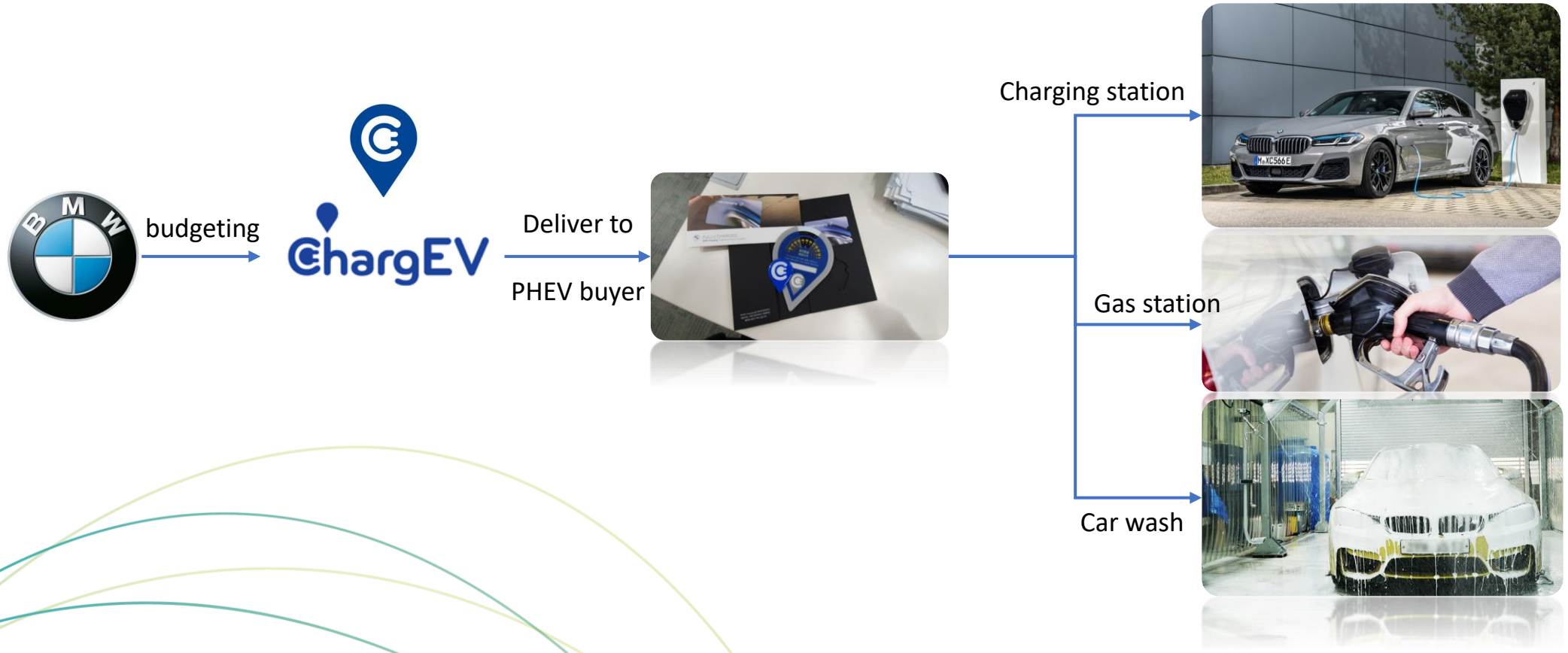
Case study: Prepaid charging card for Plug-in Hybrid EV

- ChargEV has started EV prepaid card business targets to OEMs since 2014
- Various business models with BMW, Daimler, Jaguar, Volvo, Hyundai, Nissan etc.



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- Further questions to philip.joo@chargev.co.kr

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