Electric Vehicle Charging Stations Business Models for India

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Electric Vehicles – Introduction

- Evolution of Electric Vehicles:
  - Full Electric Vehicles with Lead Acid Batteries – decades before
  - Hybrid Electric Vehicles – Toyota Prius (since 1997) and Honda Insight
  - Plug-in Hybrid Electric Vehicles – since early 2000s
  - Full Electric Vehicles with Lithium Ion Batteries (LiB) – gained traction since 2010
- All EVs have electric motor as the prime-mover which is powered by electricity stored in the rechargeable batteries
- Batteries require DC power which is supplied through:
  - AC power from the grid which is converted to DC by an AC-DC convertor on board the EV
  - DC charger connected to the grid supplies DC to the EV battery
- Charging speed of an EV battery depends on:
  - Battery chemistry – all types of batteries can not be fast charged
  - DC power output of the on-board AC-DC converter in case of AC charging
  - DC power output of the DC Charger in case of direct DC charging
  - Ambient temperature

Electric Vehicles – Impact on the Grid

- EVs are usually plugged on to low voltage distribution grid for charging
- EVs can have huge impact on the distribution grids
- Battery sizes vary from 11kWh (for entry level electric cars) to 20 kWh (for mid-size cars), 30-40 kWh for Nissan Leaf, Chevy Bolt; and 65-90 kWh for Tesla. Compare this with 2kW load of a typical room air conditioner
- Since EV buying behaviour is generally influenced by friends and neighbours, EV offtake tend to create pockets of EV concentration; and when all EV owners in a locality connect their cars to the grid to charge, the grid equipment gets overloaded
- Typically in developing countries the distribution grid is overloaded – particularly during peak hours
- Installation of EV charging stations require proper planning with data on loading of the distribution grid during the day and load flow studies. In most cases, higher capacity distribution transformers and bigger size cables may be required for installing DC fast chargers and high capacity chargers for buses

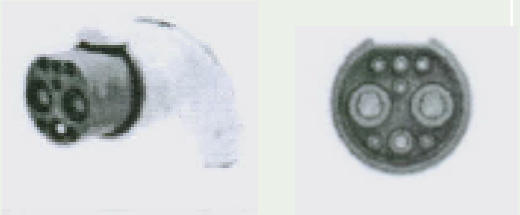
Electric Vehicles – New Jargons

- EV : Electric Vehicles
- EVSE : Electric Vehicle Supply Equipment (charging station)
- EVSP : Electric Vehicle Service Provider
- BMS : Battery Management System (both Hardware and Software)
- C – rate : Charging rate or speed. If a battery can be fully charged in ONE hour, it is 1C rate; if it can be charged in 2 hours, it is 0.5 C; if the battery can be fully charged in 30 mins, it is 2C
- G2V : Grid to Vehicle
- V2G : Vehicle to Grid
- V2B : Vehicle to Building
- VGI : Vehicle Grid Integration
- EVCC : EV Communication Controller
- SECC : Supply Equipment (EVSE) Communication Controller

Types of EVSE – AC Chargers

Chargers Types & Sockets	Picture	Origin and Popular EV Models	Maximum Power Output & Communication Protocols
Type-1 with Yazaki Socket		Japan, USA (uses separate standard – JSAE 1772 due to 110 Voltage)	Up to 7.4 kW (32 Amps, Single Phase)
Type-2 with Mennekes Socket		Europe (Germany) – many European cars	Up to 44 kW (63 Amps, 3 Phase)
Type-3 with Le Grand Socket		France and Italy – some European cars	Up to 22 kW (32 Amps, 3 Phase)

Types of EVSE – DC Chargers

Chargers Types & Sockets	Picture	Origin and Popular EV Models	Maximum Power Output & Communication Protocols
CHAdeMO		Origin from Japan; Most popular DC charger in the world; used in Japan, Korea and parts of USA and Europe; Nissan Leaf, Mitsubishi, Kia etc	Up to 400 kW DC charging (1000 Volts, 400 Amps); Control Area Network (CAN) for communication between EV and EVSE)
GB/T		Used in China; as well as Bharat Chargers in India; Chinese Vehicles and Mahindra Electric in India	Up to 237.5 kW DC charging (950 Volts x 250 Amps); CAN for communication between EV and EVSE
Tesla Super Charger		Tesla has its own supercharger. Tesla also sells adapter for connecting to a CHAdeMO charger	Up to 135 kW DC charging (410 Volt x 330 Amp); CAN for communication between EV and EVSE

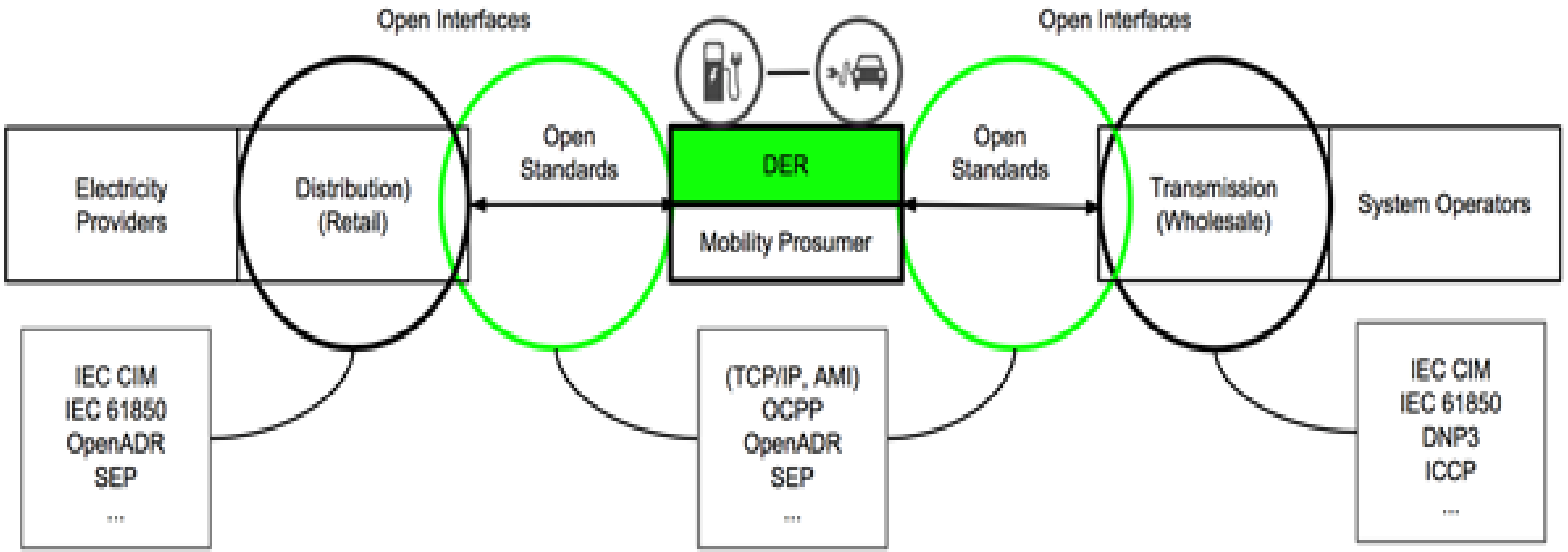
Types of EVSE – Combined (AC and DC) Chargers

Chargers Types & Sockets	Picture	Origin and Popular EV Models	Maximum Power Output & Communication Protocols
SAE Combined Charging System (CCS)	   	CCS-1 and CCS-2 versions available; same plug used for both AC and DC charging; Most European Cars - Audi, BMW, Daimler, Ford, GM, Porsche, VW etc	Up to 43 kW AC and up to 400 kW DC (1000 Volt x 400 Amp) Power Line Communication (PLC) for communication between EV and EVSE.

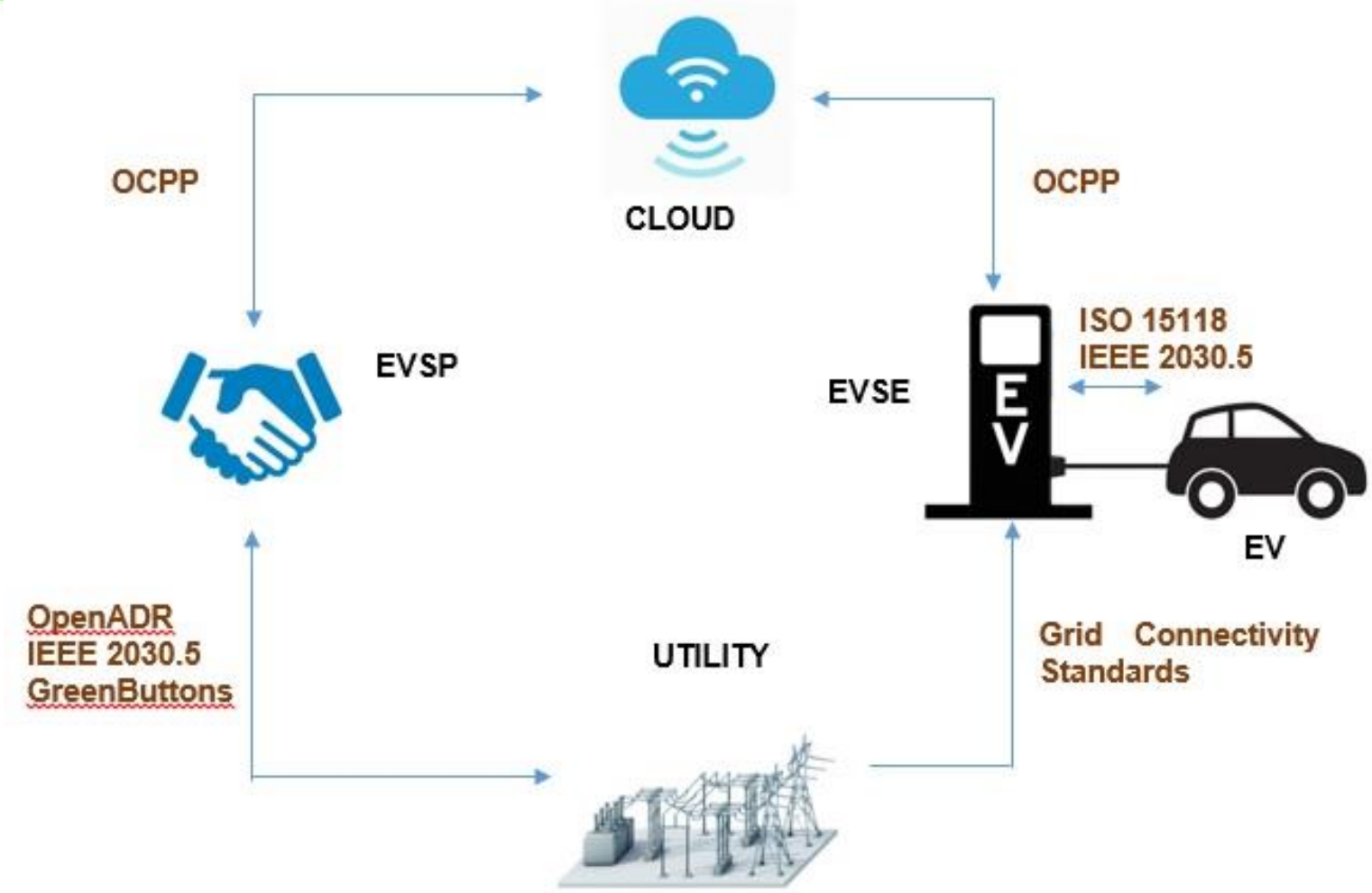
EVSE Standards in India

Indian Standards	Description	Status
IS:17017 series of Standards	Primarily based on IEC 61851; IEC 62196 and ISO 15115 series of Standards	
IS:17017-1	General Requirements and Definitions of EVSE (Adapted from IEC 61851-1)	Published by BIS in August 2018
IS:17017-21	EV requirements for connection to AC/DC Supply (Adapted from IEC 91851-21)	Work in progress; expected to be published in October 2018
IS:17017-22	AC EVSE (Adapted from IEC 61851-22)	Work in progress; expected to be published in October 2018
IS:17017-23	DC EVSE (Adapted from IEC 61851-23)	Work in progress; expected to be published in October 2018
IS:17017-24	Control Communication between DC EVSE and EV (Adapted from IEC 61851-24)	Work in progress; expected to be published in October 2018
IS: 17017 – Part 2	IEC 62196 Part-1, Part-2, Part-3 Standards for the plugs, socket outlet, vehicle couplers and vehicle inlets. These are being adapted as IS:17017 Part 2 – A, B and C	Work in progress; expected to be published in October 2018
IS/ISO:15118	ISO 15118 series for communication between the EV and the EVSE. There are seven documents in this series. These are adopted as it is.	Work in progress; expected to be published in October 2018

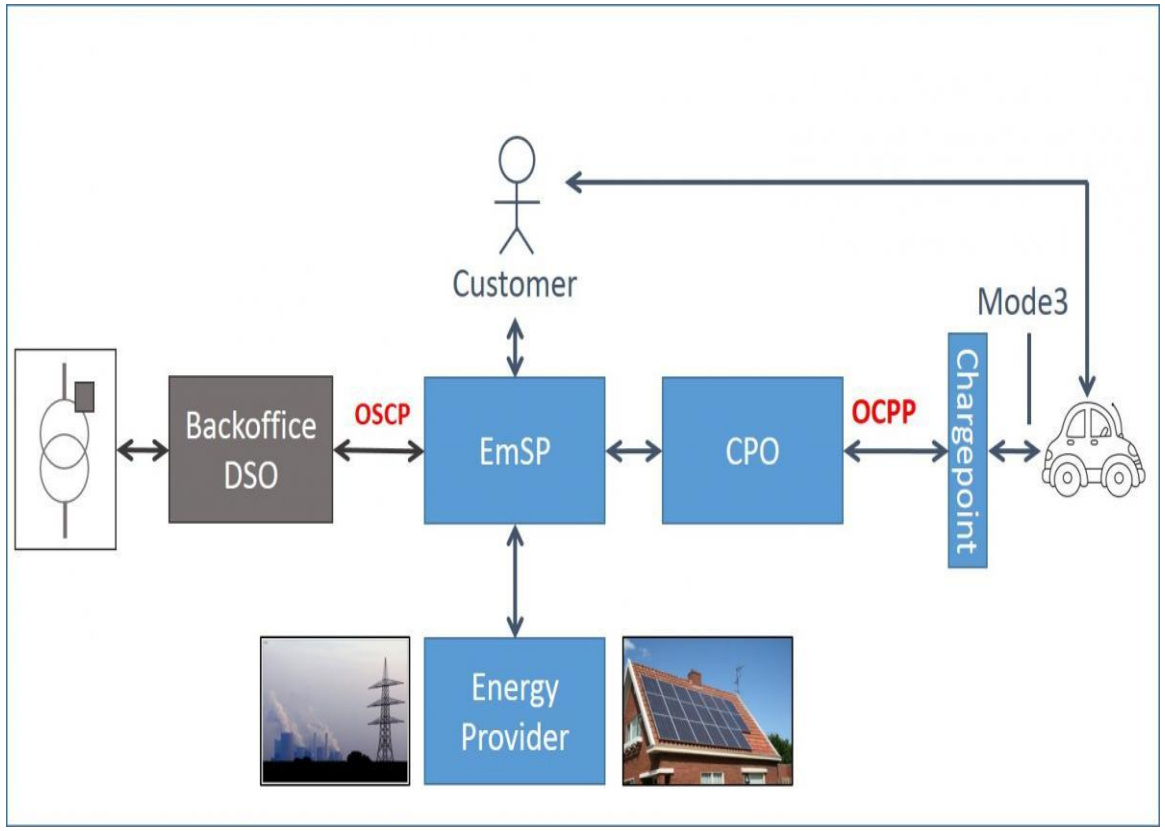
EV Interoperability with Power Systems and Electricity Markets



EVSE – Communication Standards

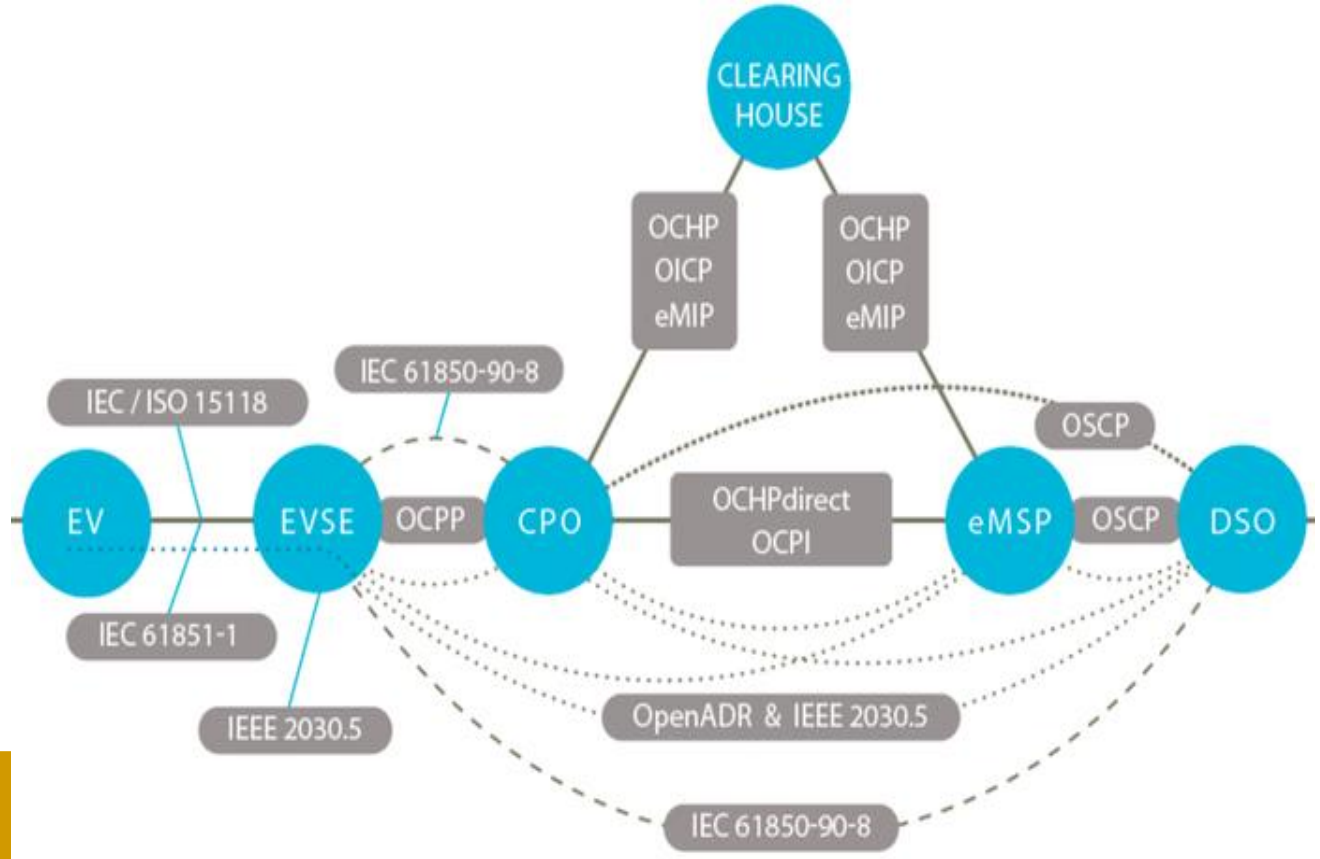


Open Charge Point Protocol (OCPP)



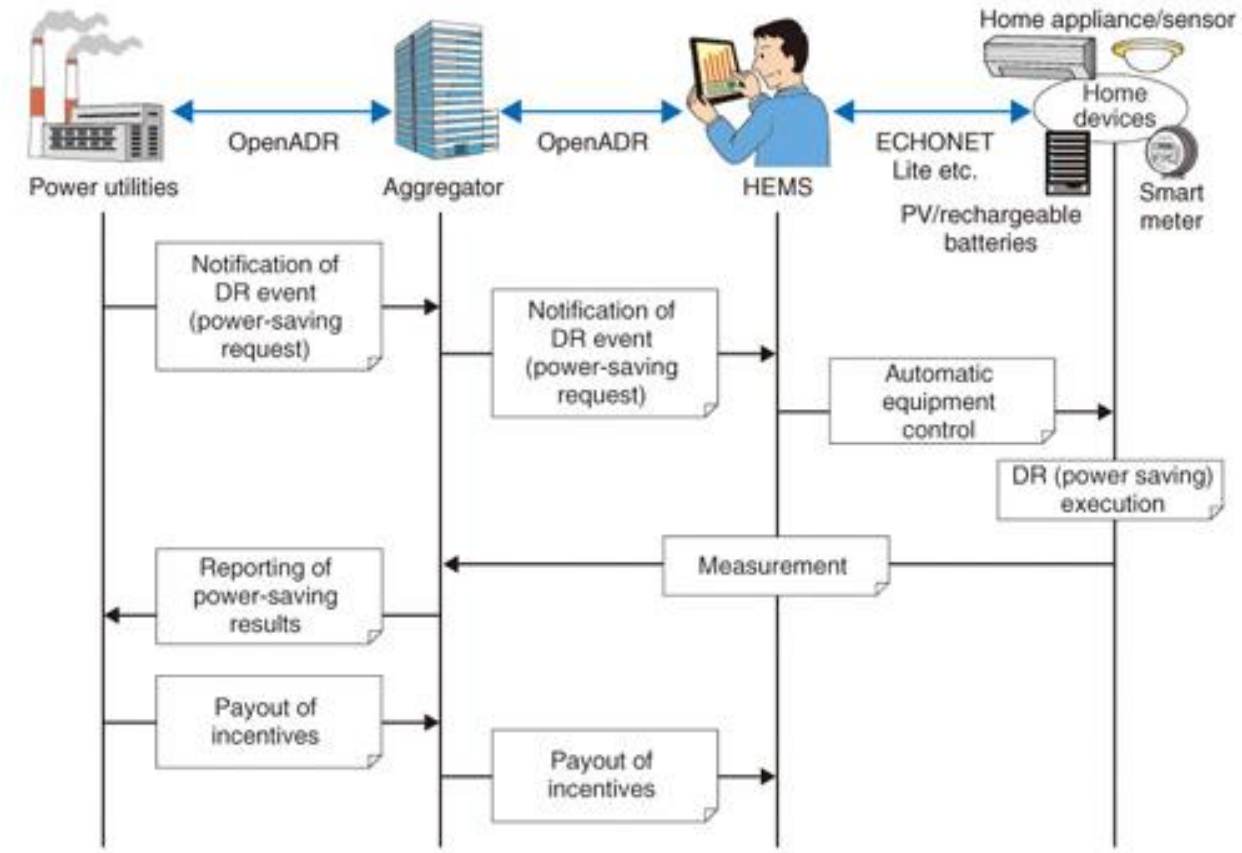
- Internationally established open protocol for communication between EV Charging Stations and Charging Station Networks.
- Tells the charging stations to communicate and send data to a particular service provider (EVSP)
- Major component of an EV Charging Network – Charging Station Management Software

ISO 15118



- Specifies communication between EV and EVSE
- Describes communication between EV Communication Controller (EVCC) and Supply Equipment Communication Controller (SECC)
- Does not specify the vehicle internal communication between battery and charging equipment and the communication of SECC to other equipment

OASIS Energy Interoperation (or OpenADR 2.0)



ECHONET: Energy Conservation and Homecare Network
HEMS: home energy management system
PV: photovoltaic

- Used in Peak Load Management Programs in Utilities
- Can communicate event messages, reports, registration services and availability schedules for price and energy usage-based programs

IEEE 2030.5 (or Smart Energy Profile)

- Standards for communication between the smart grid and electricity consumers
- Standard is built using Internet of Things (IoT) concepts
- Gives consumers a variety of means to manage their energy usage and generation
- Information exchanged includes pricing, demand response, energy usage, enabling integration of devices such as thermostats, meters, PHEV, smart inverters and appliances

ISGF Suggestions on EVSE Business Models in India

- Electric utilities maybe mandated to setup EVSE network in strategic locations in their service area under CAPEX for grid upgrades
- City governments/municipalities and Highway Authorities ay be mandated to allot space for EVSE networks on long lease at concessional rates
- Bundle EVSE as mandatory in new buildings through Building Codes for a categories of buildings exceeding certain built area
- EV manufacturers to contribute a certain percentage of the vehicle cost towards EVSE fund utilized to build EVSE network in respective cities/states
- EVSE infrastructure may be clubbed with Highway Construction cost – have negligible impact on per kilometre cost of highways

ISGF Suggestions on EVSE Business Models in India

- In commercial centres, tourist and religious places, the shop owners may be encouraged to invest in EVSE infrastructure and entry of diesel/petrol vehicles may be banned
- Allot land and licences to setup large EVSE stations at strategic locations which will have – Cafes/ATMs, Gyms, Air/Tyre Changing Stations
- Public Sector Undertakings and large private companies may be mandated to set up EVSE infrastructure in their area of operation
- Oil distribution companies may be mandated to create EVSE infrastructure nearer to their retail outlets on highways
- EV manufacturer consortiums may promote EVSE networks and collect monthly subscription from EV owners and pay to the EVSE owners and operators

ISGF Suggestions on EVSE Business Models in India

- Fleet operators and car rental companies may be allowed to setup EVSE networks
- Other incentives like Tax concessions, Free or Concessional land on long term lease and transparent allocation of EVSE locations preventing formation of monopolies could be included

Thank you for your kind attention

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