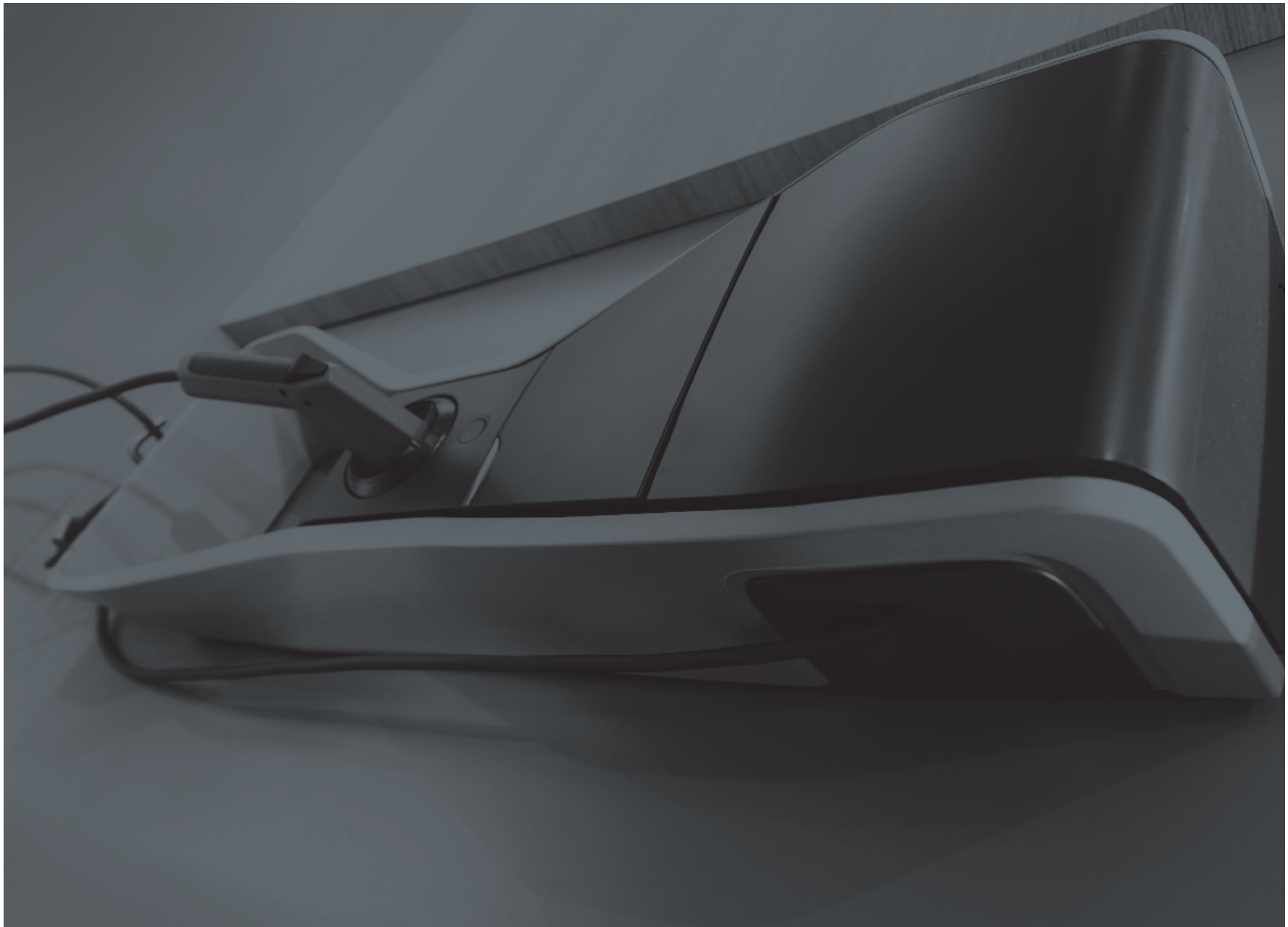
مكتب التنظيم و الرقابة
Regulation & Supervision Bureau

Installation of Electric Vehicle Supply Equipment (EVSE)

Guidance Document

January 2017

Publication No. EP/P04/100



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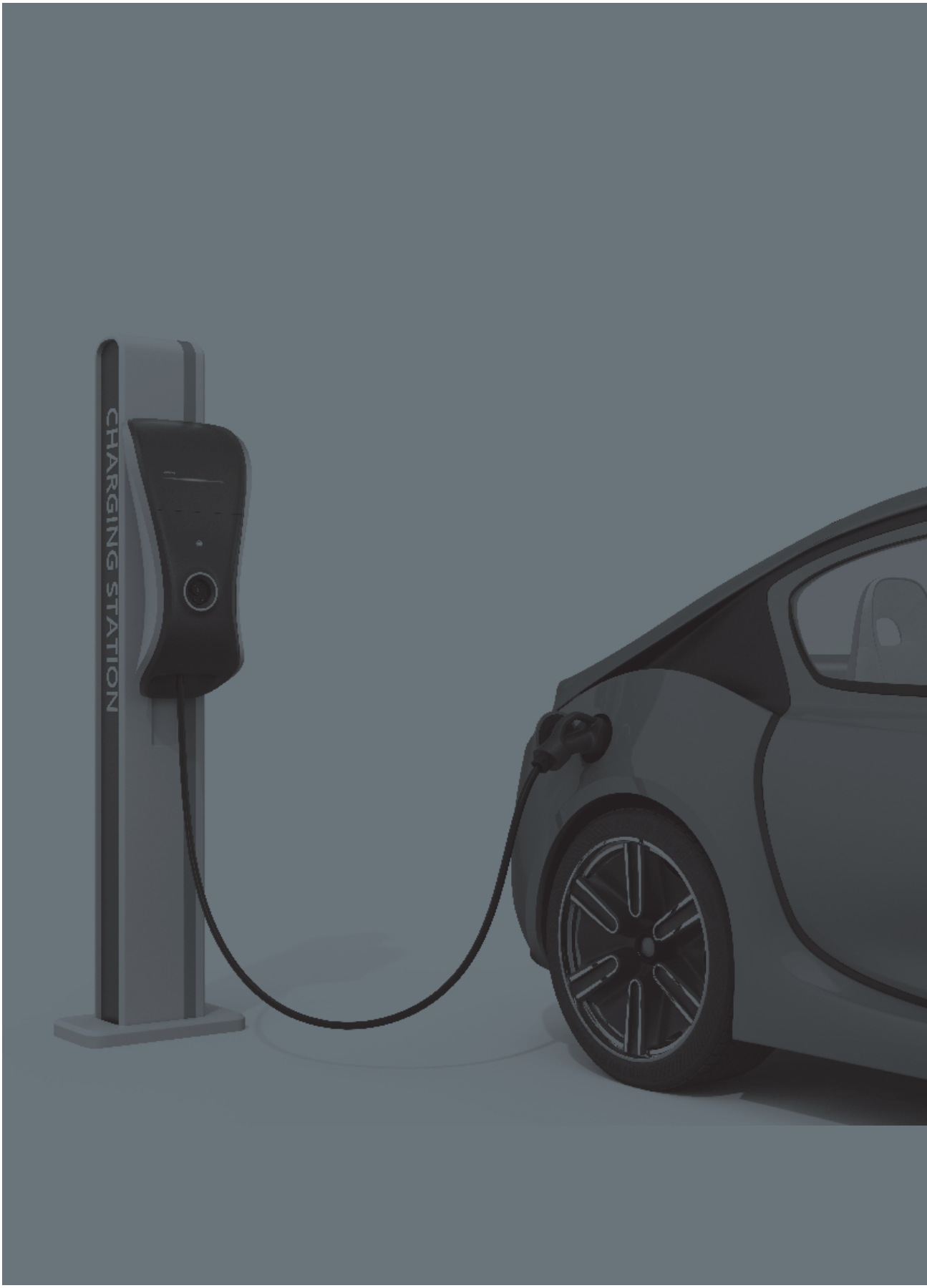
CHARGING STATION

Foreword

The Regulation and Supervision Bureau (the Bureau) is established under Abu Dhabi Law No (2) of 1998 to regulate the electricity, water and wastewater sectors and to oversee the technical and economic activities of the Persons that are licensed to undertake Regulated Activities in the Emirate of Abu Dhabi.

This document provides further guidance on the technical requirements of the installation of Electrical Vehicle Supply Equipment (EVSE). It also provides an informative reference to the general public in the Emirate of Abu Dhabi. This guidance document aims to complement the requirements established under the Electricity Wiring Regulation (Third Edition) – Addendum No. 1 concerning the technical requirements for EVSE installation.

These Guidance and Regulations come in support to the Government of Abu Dhabi drive for promoting low emission vehicles as well as clean and sustainable energy.

This guidance document is also available for download from the Bureau's website at www.rsb.gov.ae.

Saif Saeed Al Qubaisi
Director General

Acknowledgements

The Bureau gratefully acknowledges the contributions and comments provided by the following organisations:

a) Abu Dhabi Water and Electricity Authority
b) Department of Municipal Affairs & Transport
c) Abu Dhabi Urban Planning Council
d) Abu Dhabi Distribution Company
e) Al Ain Distribution Company
f) Abu Dhabi Quality and Conformity Council
g) Abu Dhabi Future Energy Company (Masdar)
h) Abu Dhabi Department of Economic Development

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1. Definitions

Words which are defined under this section are used in the document beginning with capital letters. For example, "any EV charging infrastructure...".

Terms in common use are not defined here and normal dictionary definitions apply (e.g. charging, plug, and cable).

1.1 **Charging Modes:** An operating mode in which energy transfer from a power source to the Electrical Vehicle's (EV) battery; below are related definitions:

1.1.1 **Mode-1 Charging:** Connection of the EV to the a.c. supply network utilising standardised socket-outlets not exceeding 16A and not exceeding a nominal supply Voltage of 230V a.c. single-phase or 400V a.c. three-phase, at the supply side, and utilizing the power and Circuit Earth Conductors (according to BE EN 61851-1). Mode 1 charging period is relatively long, typically 6 to 8 hours.

1.1.2 **Mode-2 Charging:** Connection of the EV to the a.c. supply network utilising standardised socket-outlets not exceeding 32 A and not exceeding a nominal Voltage of 230 V a.c. single-phase or 400 V a.c. three-phase, at the supply side, and utilizing the power and Circuit Earth Conductors together with a Control Pilot function and system of personnel protection against electric shock (RCD) between the EV and the plug or as part of the In-Cable Control Box.

1.1.3 **Mode-3 Charging:** Connection of the EV to the a.c. supply network utilising dedicated EVSE and a charging cable assembly. The control pilot cable of the charging cable assembly allows communication between the EVSE and the On-Board Charger of an EV platform functions including verification of connection with the EV, continuous checking of Circuit Earth Conductor integrity, energisation and de-energisation of the supply and selection of charging rate. The charging equipment are typically in the form of charging posts or wall mounted charging units, and come in a variety of current ratings e.g. 13A, 16A, 32A and 250A.

1.1.4 **Mode-4 Charging:** Connection of the EV to the a.c. supply network utilising an Off-Board Charger where the Control Pilot function extends to control equipment permanently connected to the a.c. supply. In this Mode, Direct Current Electrical Power is delivered to the vehicle. In Mode-4 either a single-phase or three phase a.c. is converted to d.c. within the EVSE. Such charging equipment units are considered not to be suitable for domestic Electrical Installations due to the higher Voltages and currents used (typically, 500V, 125A).

1.2 **Control Pilot:** The control conductor in the charging cable assembly connecting the In-Cable Control Box or the fixed part of the charging facilities, and the EV earth through the control circuitry on the vehicle. It may be used to perform several functions.

1.3 **Electric Vehicle (EV):** Any vehicle propelled by an electric motor drawing current from a rechargeable storage battery or from other portable energy storage devices (rechargeable, using energy from a source off the vehicle such as a residential or public electricity services), which is manufactured primarily for use on public streets, roads or highways such as battery electric vehicles, hybrid vehicles, plug-in hybrid vehicles, and extended rang electrical vehicles.

1.4 **Electric Vehicle Supply Equipment (EVSE):** Conductors, including the phase, neutral and Circuit Earth Conductors, the EV couplers, attachment plugs, and all other accessories, devices, power outlets or apparatuses installed specifically for the purpose of delivering energy from the Premises wiring to the EV and allowing communication between them if required. Example: wall-box unit and charging pole.

1.5 **In-Cable Control Box:** A device incorporated in the charging cable assembly, which performs control functions and safety functions. Such functions include RCD, over-current, over-temperature, and protective Earth detection.

1.6 **Off-Board Charger:** Charger connected to the Premises wiring of the a.c. supply network (mains) and designed to operate entirely off the vehicle. In this case, direct current electrical power is delivered to the vehicle (e.g. Mode 4).

1.7 **On-Board Charger:** Charger mounted on the vehicle and designed to operate only on the vehicle.

1.8 **Vehicle Coupler:** Means of enabling the manual connection of a flexible cable to an EV for the purpose of charging.

1.9 **Vehicle Connector:** Part of a Vehicle Coupler integral with, or intended to be attached to, the flexible cable connected to the a.c. supply network (mains).

1.10 **Vehicle Inlet:** Part of a Vehicle Coupler incorporated in, or fixed to, the EV or intended to be fixed to it.

2. Introduction

2.1 Purpose and Statuary requirements

2.1.1 Purpose of this guidance document is to introduce the basic knowledge and the technical requirements for installing Electrical Vehicle Supply Equipment (EVSE) by Licensed Contractors. It also serves as an informative reference to the general public in the Emirate of Abu Dhabi.

2.1.2 This guidance document should be read with other regulations issued by the Bureau:

a) Electricity Wiring Regulations, Third Edition, 2014

b) Addendum No.1 (January, 2017) to the Electricity Wiring Regulations, Third Edition, 2014

2.1.3 This guidance document applies to all new charging facilities in the Emirate of Abu Dhabi.

2.2 Overview

2.2.1 The rapid developments and improvements in the technologies of EV batteries led to increased popularity in this type of vehicle, so the development of infrastructure of charging stations at home, commercial and public locations become very important. The basic components of any EV charging infrastructure are: (1) electrical power supply from the Distribution Company, (2) on-site wirings, and (3) charging stations.

2.2.2 EV owners or users need to have a solid understanding of EV charging equipment types and operation, so they can select the appropriate EVSE product and choose the right Licensed Contractor for proper installation.

2.2.3 For the economy and convenient of home charging, EV owner will assume the responsibility of installing a residential charging station in his/her garage with close coordination with the EV and EVSE manufacturers. However, to extend the driving range of EV and to enable practical driving patterns, further EVSE should be available at commercial and public locations.

2.3 Ownership and Tariff Rate

2.3.1 Ownership of EVSE is not a regulated activity pursuant to Article 71 of Law No. (2), as such EVSE owners do not need to seek a license from the Bureau, and the Bureau will not price regulate this activity. The service charge/rate will therefore be left to the market to decide.

2.3.2 The service charge or rate for the provision of EV charging services through EVSE to end users may be determined by the EVSE Owners. EVSE Owners and operators will need to comply with the Bureau's technical regulations and provision of information requests (and other regulations issued pursuant to Article (62) of Law No 2) as well as any other requirements by the Department of Economic Development or any other applicable legal or regulatory requirement in the Emirate of Abu Dhabi.

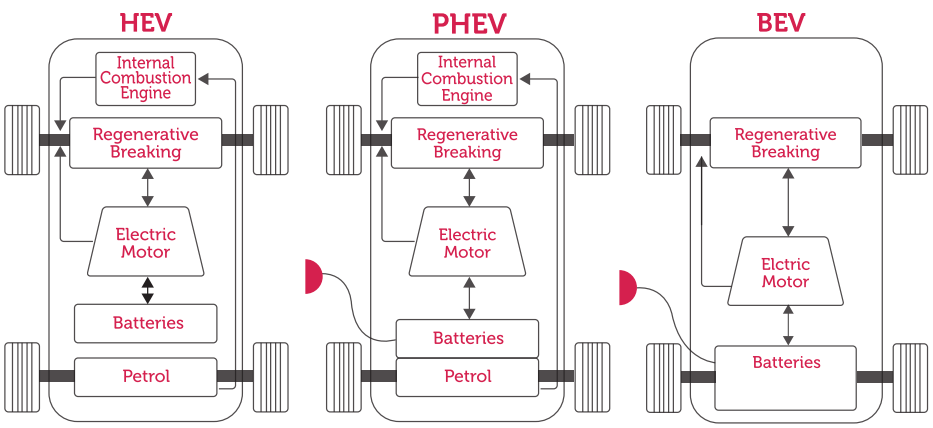
2.3.3 The electricity supply to the EVSE will be monitored and billed by the relevant Distribution Company through their billing meters. At this stage, the electricity tariffs charged will be in accordance with the premises type in which the EVSE will be connected to.

3. Electrical Vehicles Technology

3.1 Types of Electrical Vehicles

3.1.1 This section introduces the types of most common electrical vehicles that are available in the marketplace. The focus of this section is on street electrical vehicles that incorporate a battery energy storage device that can connect to the electrical distribution network for the supply of some or all of its fuel energy requirements.

3.1.2 The information provided in this section should increase the basic understanding of battery electrical vehicles and how they work with EVSE.



3.1.2.1 Hybrid Electric Vehicles (HEV)

HEVs have two motors: an internal combustion engine (ICE) and an electric motor. Their storage batteries are generally low-capacity, which greatly limits their range and top speed in electric mode. HEV batteries are charged by the ICE or other propulsion source and during regenerative braking, so they cannot be recharged from the distribution network therefore not covered by this Guide. Example: Toyota Prius and Honda CR-Z.

3.1.2.2 Plug-in Hybrid Electric Vehicles (PHEV)

PHEVs are hybrids that can be plugged into the distribution network for battery charging. In general, they have a medium-capacity battery that allows the vehicle, in all-electric mode, to achieve a range of several dozen kilometres, and rates of acceleration and top speeds comparable to those of gasoline-powered vehicles. Example: Chevrolet Volt, Ford C-Max, Cadillac E L R and Toyota Prius PHEV.

3.1.2.3 Battery Electric Vehicles (BEV)

BEVs operate solely on the electricity stored in a high-capacity battery, which can be recharged from the distribution network. Depending on battery capacity, they have a range of 100 to 400km; charging time varies by battery capacity and whether, it is also affected by the ambient temperature and the remaining battery charge at the start of charging. Typically, a fast-charge station is used for this type of electrical vehicle. Examples: Nissan LEAF, Tesla Model S.

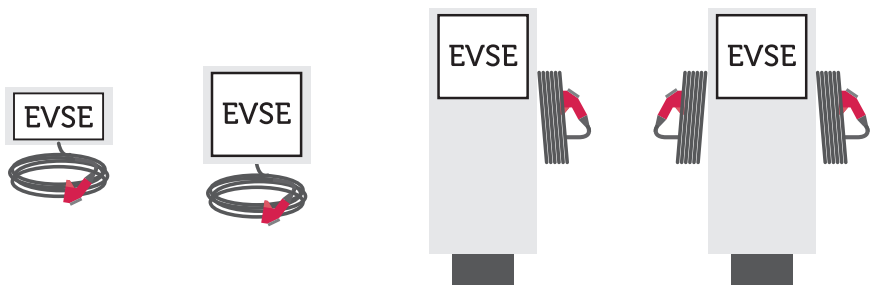
3.1.2.4 Extended Range Electric Vehicles (EREV)

EREVs are battery electric vehicles equipped with an internal combustion generator that produces enough power for the vehicle to reach a charging station when its battery is depleted. Example: BMWi3

4. Overview of charging stations

4.1 General overview

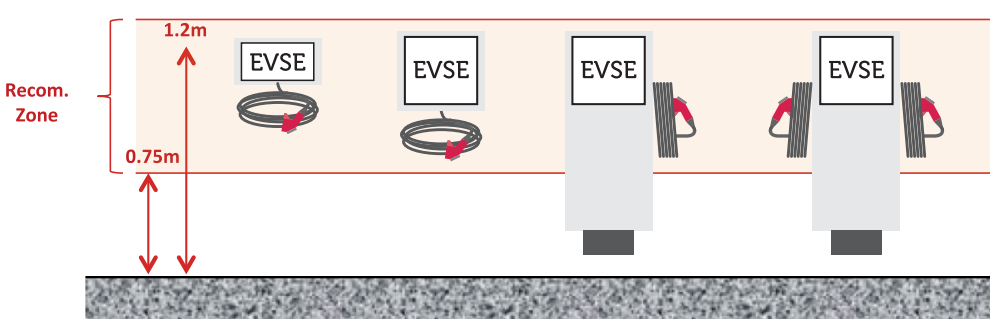
4.1.1 A charging station or an EVSE is typically a stand fixture, which is fed directly from a distribution panel or from a dedicated electrical socket-outlet. An EVSE can have one or more charging cable, a display screen or a set of colourful lights that indicate the charging status. An EVSE may also have Start/Stop push-buttons for charging operations. It can also include electronic payment system, energy meter and internet/wireless communication.



4.2 Height of EVSE controls and socket-outlet

4.2.1 EVSE shall be installed such that the main operating controls and any socket-outlet are between 0.75m and 1.2m above ground.

4.2.2 Mounting height may be varied for special circumstances such as access for disabled persons or physical conditions at the site.

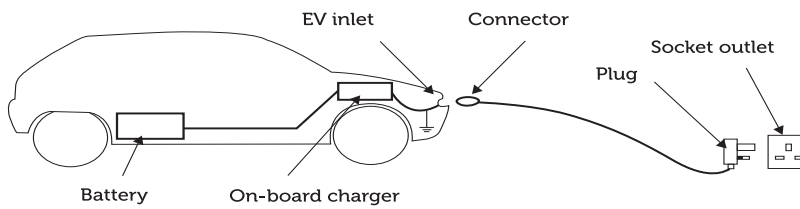


4.3 Charging Modes

There are four (4) different modes of conductive charging for Electrical Vehicles as specified by IEC 61851 (Electrical Vehicle conductive charging system):

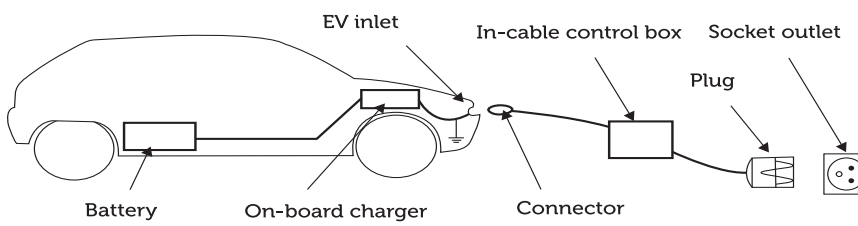
4.3.1 Mode 1 Charging

For Mode 1 charging, an AC charging current is delivered via a standard socket outlet e.g. BS1363 13A and a charging cable without communication function to the On-Board Charger of the EV. The presence of a residual current device (RCD) for shocking protection is a must on the supply side of the fixed electrical installation. This mode of charging is suitable for longer period of charging at home or office. Mode-1 is not permitted due to the lack of safety measures associated with this mode of charging.



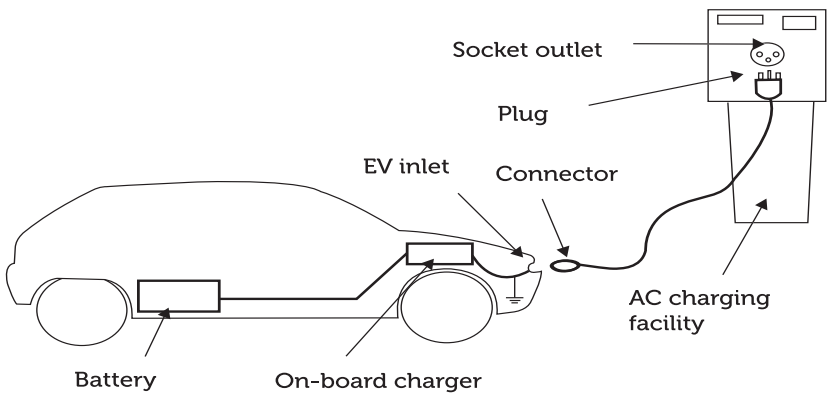
4.3.2 Mode 2 Charging

For Mode 2 charging, an In-Cable Control Box is incorporated into the charging cable assembly. The provision of fixed electrical installation for charging facility is similar to that for Mode 1 except that the final circuit, protective device and socket outlet shall be of a suitable rating to cater for the higher level of charging current not exceeding 32A.



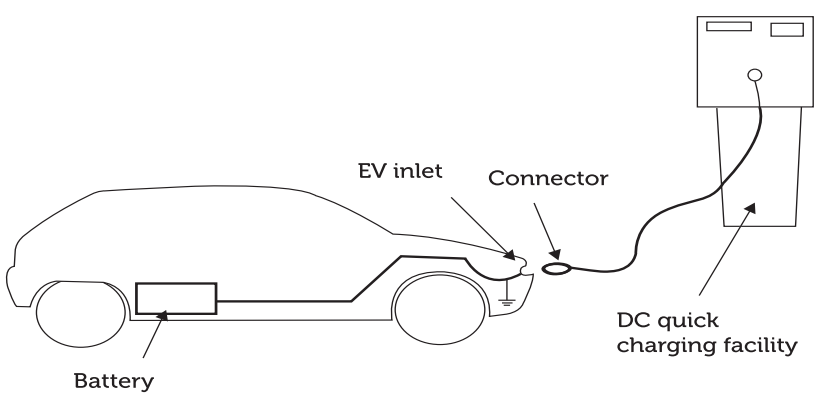
4.3.3 Mode 3 Charging

For mode 3 charging, dedicated EV supply equipment (EVSE) and a charging cable assembly shall be employed. The control pilot cable of the charging cable assembly allows communication between the EVSE and the On-Board Charger of an EV to perform functions including verification of connection with the EV, continuous checking of protective earth conductor integrity, energization and de-energization of the supply, and selection of charging rate.



4.3.4 Mode 4 Charging

Mode 4 charging employs the principle of using an Off-Board Charger to deliver a DC current directly to the battery bypassing the On-Board Charger. DC quick charging can charge up an EV in a relatively short time as a substantially higher electrical power ranging from 20kW to 120kW is used.



5. Planning

5.1 General requirements

5.1.1 Various locations can be suitable for EVSE such as business and government sites as well as petrol stations and parking lots/structure. The selected EVSE location should be convenient and highly visible and available to a large number of EV drivers.

5.1.2 The location and capabilities of the EVSE (charging mode) should match the needs of the EV drivers visiting the charging station. For example visitors to a shopping mall may park their EV for several hours while shopping, thus mode 3 or 4 are most appropriate for this location. Mode 2 may be more suitable for longer period of parking such as office parking, home garage or airport parking. Mode-1 charging is not permitted due to the lack of safety measures associated with this mode of charging i.e. mode-1 lacks the existence of personnel protection against electric shock (RCD) between the Electric Vehicle (EV) and the plug as part of the In-cable Control Box which is the case for Mode-2 charging.

5.1.3 The installation of EVSE should adhere to UPC's Estidama requirements, Urban Streets Design Manual (USDM) and Public Realm Design Manual (PRDM) and other as applicable.

5.1.4 Electric Vehicle Supply Equipment (EVSE) shall be integrated within the "Right of Ways" (ROWs) as per the UPC's Manual and the relevant agencies requirements to avoid any impacts that might be resulting on the ROWs and its user.

5.1.5 The installation of EVSE should adhere to the distribution company's approval and requirement to ensure the availability of required load and feeding source allocation.

5.2 Physical installation requirements

5.2.1 Consider the following criteria in selecting the physical location for an EVSE:

a) Configuration of the charging station such as the charging mode and number of charging cables (single/dual);

b) Location of underground tanks or utility services when planning for excavation work;

c) The expected number of EV drivers and the potential traffic around the charging station;

d) Number of parking spaces currently available;

e) The expected number of charging stations;

f) Expectation of future expansion including the facility's electrical capacity;

g) The expected effect on the power load density (w/m2);

h) The expected time each EV driver will spend at this location;

i) The cars traffic around the EVSE location. EV drivers stopping for charging their car should not cause a roadblock or obstruct traffic movement;

j) The selected location shouldn't be in high pedestrian traffic to avoid any associated risks such as tripping hazards or vandalism;

k) Protection against collision from moving vehicles;

l) Close proximity to existing power source;

m) Access to a cellular network and or fibre optic for internet access, if required by the EVSE control; and

n) Getting the relevant authorities approvals.

5.3 Electrical installation requirements

5.3.1 The installation of an EVSE and any other associated equipment shall be in accordance with:

a) Electricity Wiring Regulations, Third Edition;

b) Addendum No. 1 to the Electricity Wiring Regulations, Third Edition;

c) BS EN 61851 (Electric Vehicle conductive charging system);

d) Instructions and guidance from the manufacturer.

5.3.2 For EVSE installations that are part of a TT system, the charging equipment may be connected to this existing earthing arrangement whether the charging equipment is installed within a building or not. The installer must confirm that the earthing and bonding arrangements meet the current requirements of the Electricity Wiring Regulations, 3rd edition, for TT systems, and that any non-compliances are rectified.

[Note: refer to Annex C and D for typical EVSE installations at domestic and commercial/public locations].

5.3.3 The voltage drop at the power terminals of the EVSE should be within the appropriate limits as required by the Electricity Wiring Regulations, Third Edition and the manufacturer recommendations and guidance.

5.3.4 EVSE must be supplied from a separate branch circuit; this may require adding a circuit breaker to the existing distribution panel.

5.3.5 EVSE is considered as a continuous load so the existing distribution panel should have enough spare capacity to accommodate the additional load.

5.3.6 The following specifications should be considered in selecting an EVSE:

a) Must be marked with an internationally recognized independent testing organization such as UL, ANSI, IEC to ensure that EVSE meets the safety requirements and the standards of these organizations.

b) EVSE must be marked with intended use (electrical vehicle charging).

c) The cable used between the EVSE and vehicle can only be one of several types specifically designed for EV charging.

d) EVSE should have an interlock to confirm the power delivery only to an electric vehicle.

e) If the charging cable is disconnected either intentionally or unintentionally, the power supply should automatically disconnect.

f) EVSE should have a built-in overcurrent protection and earth leakage protection.

g) The connector of an EVSE should not be interchangeable with any other standard connector.

h) The connector of an EVSE should have a latch to prevent unintentional disconnection and it must have earthing connection that makes first and break last to discharge any build-up static electricity.

[Note: Refer to Annex B for photos of common EVSE connectors/inlets]

5.4 Labelling of EVSE installation

5.4.1 Labelling and identification of power circuit feeding an EVSE installation should be in accordance with section 3.6 of the Electricity Wiring Regulations. Any dedicated socket-outlet for EV charging should be identified with the following label:

Electrical Vehicle
Connecting Point

5.5 Signs for EVSE locations

5.5.1 EVSE charging areas are required to have an approved signage on street by the relevant authority.

5.5.2 A standard sign such as shown below should be used to identify EV charging stations in public and commercial parking areas.

6. EVSE Connection Process

6.1 Relevant Sector Entities – Roles & Responsibilities

Regulation & Supervision Bureau (Bureau)

6.1.1 The Regulation and Supervision Bureau (Bureau) is the independent regulatory body for the water, wastewater and electricity sector of the Emirate of Abu Dhabi.

6.1.2 In essence the Bureau enforces the relevant laws through the licensing of activities to various 'persons' who undertake a 'Regulated Activity' in the sector. Regulated Activities include; generation, transmission, distribution and supply of electricity and the desalination, transmission, distribution, and supply of water in addition to sewerage services.

6.1.3 With respect to EVSE installations, The Bureau is mainly responsible for the following:

a) Issuance of electricity supply license/exemption where required for EVSE public charging.

b) Issuance of technical Regulations, in particular Electrical Installation requirements for EVSE installations.

Abu Dhabi Water and Electricity Authority (ADWEA)

6.1.4 ADWEA was established in 1998 to oversee all business related to the formation, development and implementation of Government policies related to the water and electricity sector. ADWEA is also mandated to promote researches in order to support Abu Dhabi water and electricity sector.

Distribution Companies

6.1.5 Al Ain Distribution Company (AADC) is a wholly owned subsidiary of ADWEA. AADC is the sole distributor of water and electricity in the Eastern Region of the Emirate of Abu Dhabi (Al Ain city and its surrounding rural areas). This includes the ownership, operation and maintenance of the water and electricity distribution network assets, billing and customer services for the supply of water and electricity.

6.1.6 Abu Dhabi Distribution Company (ADDC) is a wholly owned subsidiary of ADWEA and responsible for distributing and supplying water and electricity to all customers in the Emirate of Abu Dhabi, excluding the Al Ain region. ADDC's core business is the planning, design, construction, and operation of electricity and water distribution networks.

6.1.7 The Distribution Companies, inter alia, are responsible for:

a) Reviewing and approving the connection applications for EVSE connections to existing distribution network.

b) Enforcing the requirements of the Electricity Wiring Regulations, which include:

- Licensing of Electrical Contractors.
- Approval of EVSE Electrical design and Installations.

6.2 Steps in connecting EVSE

Step 1: Selection of EVSE product

6.2.1 The owner of an EV should consult with the manufacturer of his/her EV for the recommended EVSE product for home installation.

6.2.2 There are several types of EVSE with different charging modes and socket/connectors and because public stations will serve a variety of EVs, a good option is to install a variety of EVSE products at such locations.

Step 2: Selection of charging location

6.2.3 In selecting the appropriate site for the EVSE installation, the following should be considered in assessing the potential location:

a) Close proximity to the power supply.

b) Existing underground services such as water, power, gas and sewage pipes.

c) Availability of lighting and security for the convenient and safety of EV drivers.

Step 3: Obtaining Design Approval from Distribution Companies

6.2.4 Owner of EVSE should prepare and submit to the Distribution Company all design documents related to EVSE.

6.2.5 The Distribution Company will review the design documents of EVSE and if satisfied the Distribution Company will approve the design for implementation.

Step 4: EVSE installation

6.2.6 The EVSE owner should consult with the EVSE manufacturer and Distribution Company for the registered Licensed Contractor to install the EVSE at the selected site.

Step 5: Distribution company inspection and energization

6.2.7 After completing the installation process, the Distribution Company shall inspect the EVSE installation before the energization.

[Note: refer to Annex A for EVSE installation/connection process flowchart]

7. Inspection, testing, handover and documentation requirements

7.1 Inspection and Testing

7.1.1 Inspection and testing of the power supply circuits feeding the EVSE installation shall be carried out in compliance with the requirements of the Electricity Wiring Regulations, Third Edition and documented by a Licensed Contractor under the direction and supervision of the EVSE manufacturer.

7.1.2 The inspection and testing documentations consist of the following:

a) Electrical installation certificate;

b) Electrical inspection report; and

c) Electrical installation testing report.

7.2 Documentation requirements

7.2.1 Owner of EVSE should ensure that upon completion of the design, installation and commissioning of the EVSE, adequate and proper documentations and handover are provided by the EVSE manufacturer and Licensed Contractor.

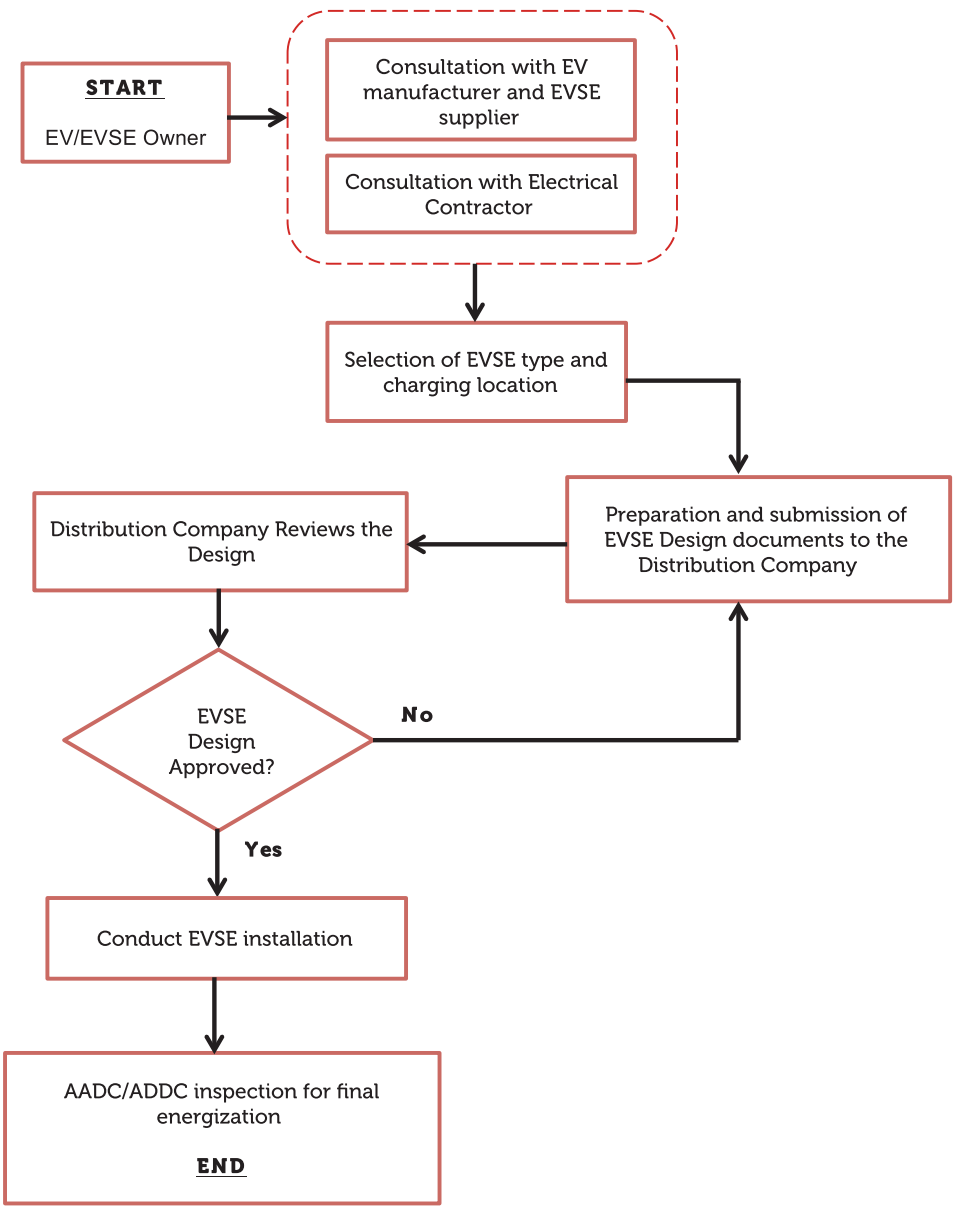
7.3 Routine inspection

7.3.1 The purpose of routine inspection is to ensure that the integrity of the installed EVSE remains intact throughout the intended life of the system.

7.3.2 EVSE installation typically requires little maintenance, and the majority of maintenance issues can be discovered by doing a proper visual inspection.

7.3.3 It is recommended that EVSE installation to be inspected and maintained on regular basis, refer to the manufacturer literature for the required inspection and maintenance period.

Annex A- General process installation process for an EVSE in a public location



Annex B- Photos of EV charging Socket & Plug, EV connectors and inlets

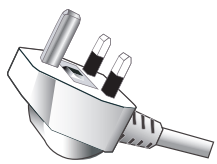


Figure 1: BS 1363 Rewirable Plug

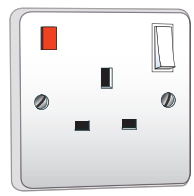


Figure 2: BS 1363 Socket

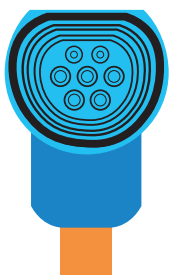


Figure 3: IEC 62196 Type2 Connector

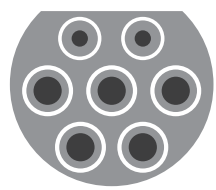


Figure 4: IEC 62196 Type2 Inlet

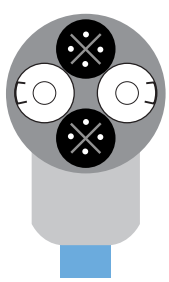


Figure 5: CHAdeMO Connector

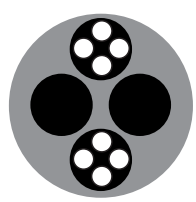


Figure 6: CHAdeMO Inlet

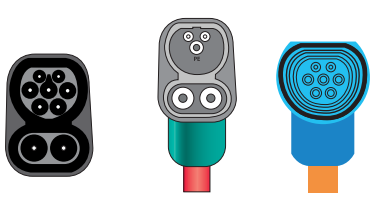
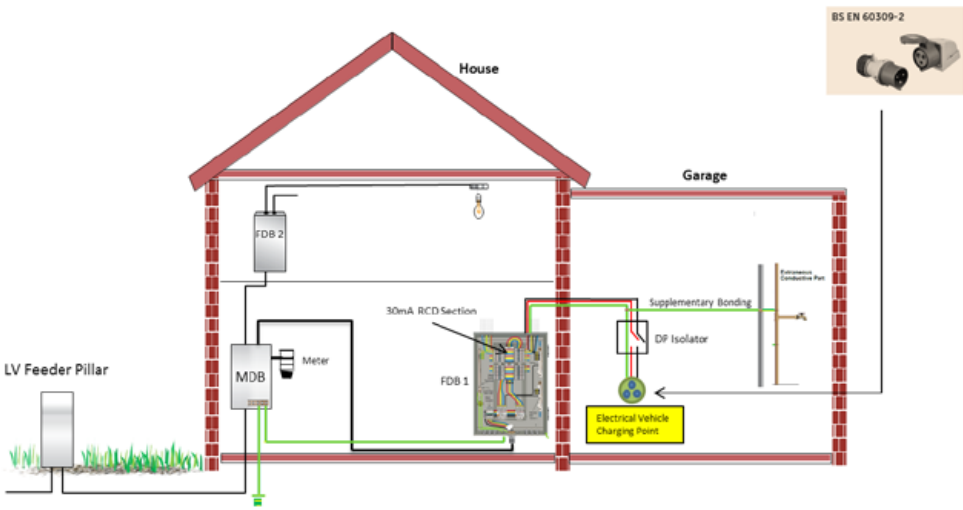


Figure 7: IEC DC Combo 2

Figure 8: BS EN 60309 Type2 connector/Inlet

Annex C- Typical Electrical Installation for a Single Phase EV Charging Point in a Garage



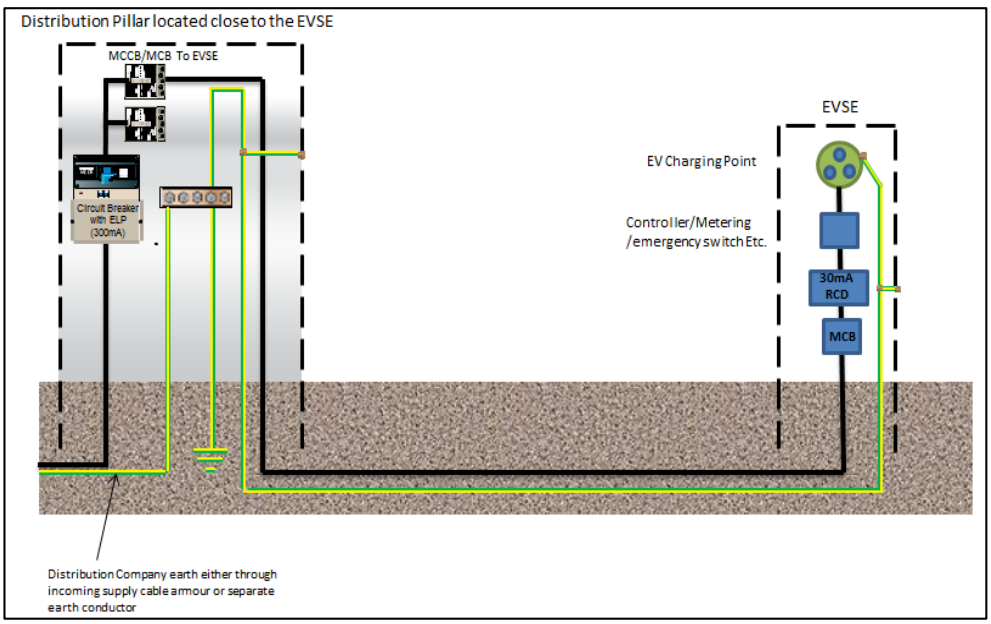
Note 1: Typical height of charging point socket-outlets should be between 0.75 and 1.2 m above ground, refer to the Electricity Wiring Regulations clause 1.4.1 of Addendum No. 1.

Note 2: For domestic Electrical Installations, typically Mode-2 is recommended. The charging point is typically a socket-outlet complying to BS EN 60309. Socket-outlets must be of the weather protected type and a minimum IP rating of IP 55 should be used for socket-outlet located outdoors and IP 44 for socket-outlets located indoors..

Note 3: Double pole isolator switch may not be required for standard socket-outlets (BS 1363) if a switch is incorporated with the socket.

Note 4: For mode-2 charging, the charging cable typically comes with in-cable control box incorporating RCD protection.

Annex D- Typical Electrical Installation for an EVSE Located on a Street or Parking lot



Note 1: Typical height of charging point socket-outlets should be between 0.75 and 1.2 m above ground, refer to the Electricity Wiring Regulations clause 1.4.1 of Addendum No. 1.

Note 2: The above is a typical installation for commercial and on street installation where mode 3 charging is typically utilized.

Note 3: Advise should be sought for the technical specification and metering equipment location from the relevant Distribution Company.

Note 4: The Distribution pillar should typically be as close as possible to the EVSE, if it is a distance greater than 30m a separate earth pit is required at the EVSE.

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Guidance Document