Integration of EVCS to SEC LV and MV Distribution Network

Guidelines for Consumers to Connect EV Charging System to SEC Distribution Networks

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1 SCOPE

This Guideline provides information meant for KSA Consumers and System EVCS Installers on the essential aspects which have to be taken into consideration in order to connect the EV charging system/station (which hereinafter shall be referred to as "EVCS") to the Low Voltage or Medium Voltage Distribution Network of SEC.

This Guideline applies to the planning, execution, modification, operation, and maintenance of the EVCS infrastructure and its associated services.

The basic principles of this kind of infrastructure and its specific requirements, along with the illustration of the connection process are provided for SEC-specific conditions. Thus, this guide shall serve as a basis for SEC and the Consumer or its appointed agent in the planning and decision-making process.

The detailed technical aspects of the EV station are not treated here but separately covered in the Technical Standards for the Connection of EVCS to the LV and MV Distribution Networks of SEC (in this document referred to as "Technical Standards"), which represents the main reference document for the definition of the requirements that have to be complied, by the manufacturers, to be connected to the SEC Distribution Network.

This document provides brief information on the EVCS technology and equipment, and on the process of getting the EVCS connected to the distribution network. The Annexes provide Consumers and EVCS Installers EVCS Installers a template and information needed to complete the installation process.

1.1 Notice to users

This document is for use by employees of SEC, Consumers, and EVCS Installers. Users of this guideline should consult all applicable laws, regulations, and applicable SASO standards. Users are responsible for observing or referring to the applicable regulatory requirements. SEC does not, by the publication of its standards, intend to urge action that is not in compliance with applicable laws, and these documents may not be construed as doing so.

Users should be aware that this document may be superseded at any time by the issuance of new editions or may be amended from time to time through the issuance of amendments, corrigenda, or errata. These Connection Guidelines at any point in time consist of the current edition of the document together with any amendments, corrigenda, or errata then in effect. All users should ensure that they have the latest edition of this document, uploaded on the SEC website.

Finally, the user shall refer to Saudi Building Code –Chapter 722, as well as to applicable SASO Standards, in particular, SASO IEC 61851-1 or International Standards mentioned in these SEC documents unless differently indicated in other SEC documents related to EVCS Regulations.

2 REFERENCES

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[9] Connection Process Bidirectional EVCS checklist, checklist defined according to the connection process developed by SEC for connecting bidirectional EVCS

[10] Connection Process Unidirectional EVCS checklist, checklist defined according to the connection process developed by SEC for connecting unidirectional EVCS

[11] IEC 62368-1: Audio/video, information and communication technology equipment

[12] IEC 60529: Corrigendum 1 - Amendment 2 - Degrees of protection provided by enclosures (IP Code)

[13] IEC 61439-7: Low-voltage switchgear and control gear assemblies - Part 7: Assemblies for specific applications such as marinas, camping sites, market squares, electric vehicle charging stations

[14] IEC 62262: Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)

[15] IEC 60364: Low-voltage electrical installations –Part 1: Fundamental principles, assessment of general characteristics, definitions

[16] IEC 62196-2: Plugs, socket-outlets, vehicle connectors and vehicle inlets - Conductive charging of electric vehicles - Part 2: Dimensional compatibility and interchangeability requirements for AC. pin and contact-tube accessories

[17] ISO 17409: Electrically propelled road vehicles — Connection to an external electric power supply — Safety requirements

[18] UL 2251: Standard for Plugs, Receptacles, and Couplers for Electric Vehicles

[19] UL 2202: Standard for Electric Vehicle (EV) Charging System Equipment

[20] IEC 61851-1:2017 Electric vehicle conductive charging system - Part 1: General requirements

3 TERMS AND DEFINITIONS

EVCS Installers – A company that is entitled to conduct electrical installations in KSA by the responsible entity. This company could belong to the manufacturers or EVCS-trained installers.

Consumer– A person who has a point of connection that meets the requirements of these Regulations and the Connection Conditions between the Distribution System and the Consumer's Premises as defined in the Distribution Code.

Converter – electric energy converter that changes alternating electric current (AC) to direct current (DC).

Distribution System / Network – The system consists of electric lines, an electric plant, transformers, and switchgear and which is used for conveying electricity to final Consumers. It can be either a Medium or Low Voltage system, and for the scope of the present document and in accordance with international standards:

- A Low Voltage (LV) Distribution System is a network with a nominal voltage lower than 1kV AC or 1.5 kV DC. The LV Distribution System nominal voltages in KSA are 400/230V, 380/220V, and 220/127V.
- A Medium Voltage (MV) Distribution System is a network with nominal voltage included in the range from 1kV AC up to 69 kV. The MV Distribution System nominal voltages in KSA are 13.8, 33, and 69kV.

Connection point – The physical point at which Consumer's Plant or apparatus is joined to the SEC Distribution System.

Inspection – examination of an electrical installation using all the senses to ascertain correct election and proper erection of electrical equipment.

Inverter – electric energy converter that changes direct electric current to single-phase or polyphase alternating current.

System EVCS Installers – An entity that is registered and approved by SEC to distribute and carry out design and Electric installation work specific to Electric Vehicles Charging Systems.

Switch – Mechanical device capable of making, carrying, and breaking currents in normal circuit conditions and, when specified, in given operating overload conditions. In addition, it can carry, for a specified time, currents under specified abnormal circuit conditions, such as short-circuit conditions.

Verification – All measures by means of which compliance of the electrical installation to the relevant standards are checked.

Internal Combustion (IC) engine - an engine that generates motive power by the burning of petrol, oil, or other fuel with air inside the engine, the hot gases produced being used to drive a piston or do other work as they expand.

Hybrid Electric Vehicle (HEV) - is a type of hybrid vehicle that combines a conventional internal combustion engine (ICE) system with an electric propulsion system.

Plug-in Hybrid Electric Vehicle (PHEV) - is a hybrid electric vehicle whose battery pack can be recharged by plugging a charging cable into an external electric power source, in addition to internally by its onboard internal combustion engine-powered generator.

Battery Electric Vehicle (BEV) – is a type of electric vehicle (EV) that exclusively uses chemical energy stored in rechargeable battery packs, with no secondary source of propulsion (e.g. hydrogen fuel cell, internal combustion engine, etc.)

Electric Vehicle On-Board Charging Systems - On-board charging systems (OBCs) is the system responsible for converting AC power injected from an external charging source into a DC voltage that is used to charge the battery pack inside the vehicle. OBCs also perform other functions including charge rate monitoring and protection.

Off-Board Charging Systems - An off-board charging system is responsible for taking incoming AC power and converting it to the DC power needed to charge the battery system. The term “off-board” refers to charging systems not native to the vehicle itself (e.g., public vehicle charging station) and the conversion process takes place outside the electrical vehicle.

4 GLOSSARY

The following acronyms and symbols are used throughout the document:

WERA	Water & Electricity Regulatory Authority
IP (or I.P.)	Interface Protection
LV	Low Voltage (namely 220/127 Vac or 380/220 Vac or 400/230 Vac)
MV	Medium Voltage (namely 13.8kV, 33kV and 69kV)
EV	Electric Vehicle
EVS	Electric Vehicle Charging System / Station
ECM	Electric Control Module
HEV	Hybrid Electric Vehicle
IC	Internal Combustion
SEC	Saudi Electricity Company
V	Voltage
Vnom	Nominal Voltage
CC	Constant-current
CV	Constant Voltage
DSP	Distribution Service Provider

5 EV SYSTEMS

5.1 Electric Vehicle System

The operation of an EV is like that of an internal combustion vehicle. The power/torque curves for electric motors are much broader than those for internal combustion (IC) engines so the acceleration of an EV can be much quicker. Most EVs have a built-in feature called regenerative braking, which comes into play when the accelerator pedal is released, or the brake pedal is applied. Regenerative braking replicates the deceleration effects of an IC engine.

The major components of the EV are:

- an electric motor,
- an ECM,
- a traction battery,
- a battery management system,
- a smart battery charger,
- a cabling system,
- a regenerative braking system,
- a vehicle body,
- a frame,
- EV fluids for cooling, braking, etc., and lubricants.

An EV is propelled by an electric motor. The traction motor is in turn controlled by the engine controller or an electronic control module (ECM). In an electric propulsion system, the electronic control module regulates the amount of current and voltage that the electric motor receives. Operating voltages can be as high as 360 V or higher. The controller takes a signal from the vehicle's accelerator pedal and controls the electric energy provided to the motor, causing the torque to turn the wheels.

In the Middle East, there are variations of EVs. These include EVs which run only batteries and Hybrid EVs (HEV), which use fuel & battery as alternate sources. Different types of EVs are shown below with their characteristics.

5.1.1 Category 1 – Hybrid EV

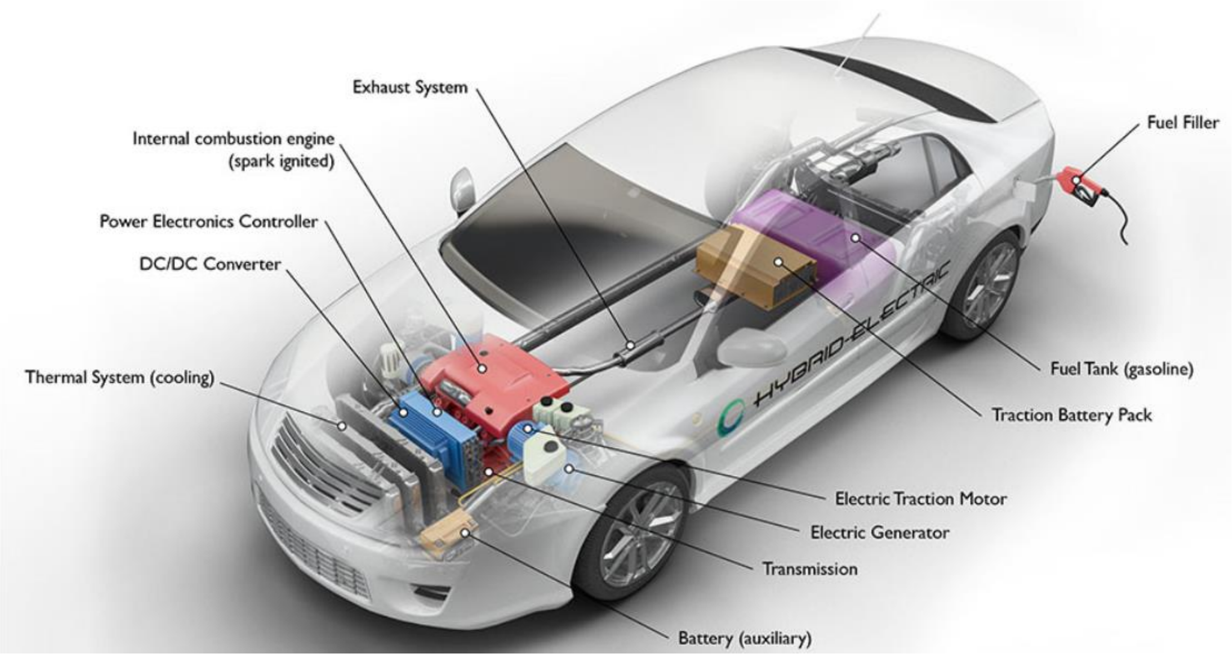


Figure 5-1 Basic schematic of a simple HEV system (U.S Department of Energy, 2020)

Hybrid electric vehicles are powered by an internal combustion engine and an electric motor, which uses energy stored in batteries. A hybrid electric vehicle cannot be plugged in to charge the battery. Instead, the battery is charged through regenerative braking and by the internal combustion engine. The extra power provided by the electric motor can potentially allow for a smaller engine. The battery can also power auxiliary loads and reduce engine idling when stopped. Together, these features result in better fuel economy without sacrificing performance.

5.1.2 Category 2 – Plug-In Hybrid EV or PHEV

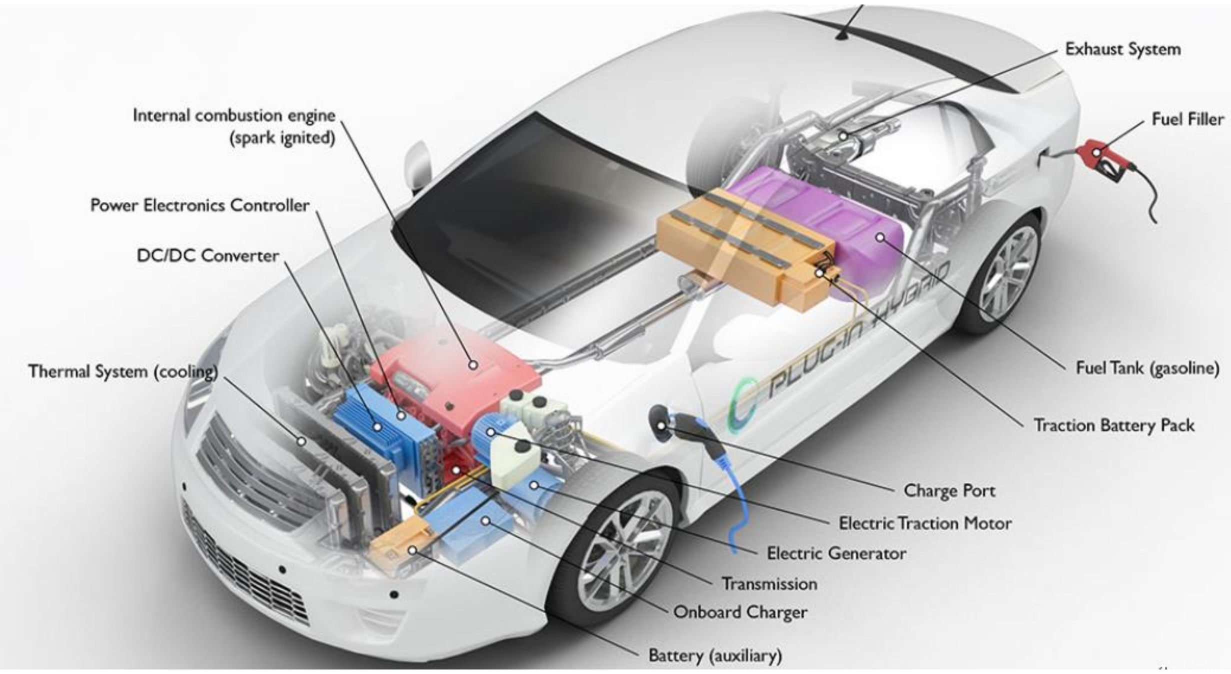


Figure 5-2 Basic schematic of a Plug-in HEV system [1]

Plug-in hybrid electric vehicles (PHEVs) typically use batteries to power an electric motor and use another fuel, such as gasoline, to power an internal combustion engine (ICE). PHEV batteries can be charged using a wall outlet or charging station, by the ICE, or through regenerative braking. The vehicle typically runs on electric power until the battery is depleted, and then the car automatically switches over to use the ICE.

5.1.3 Category 3 – EV or BEV Battery Electric Vehicles

All-electric vehicles (EVs) have an electric motor instead of an internal combustion engine. The vehicle uses a large traction battery pack to power the electric motor and must be plugged into a charging station or wall outlet to charge. Because it runs on electricity, the vehicle emits no exhaust from a tailpipe and does not contain the typical liquid fuel components, such as a fuel pump, fuel line, or fuel tank.

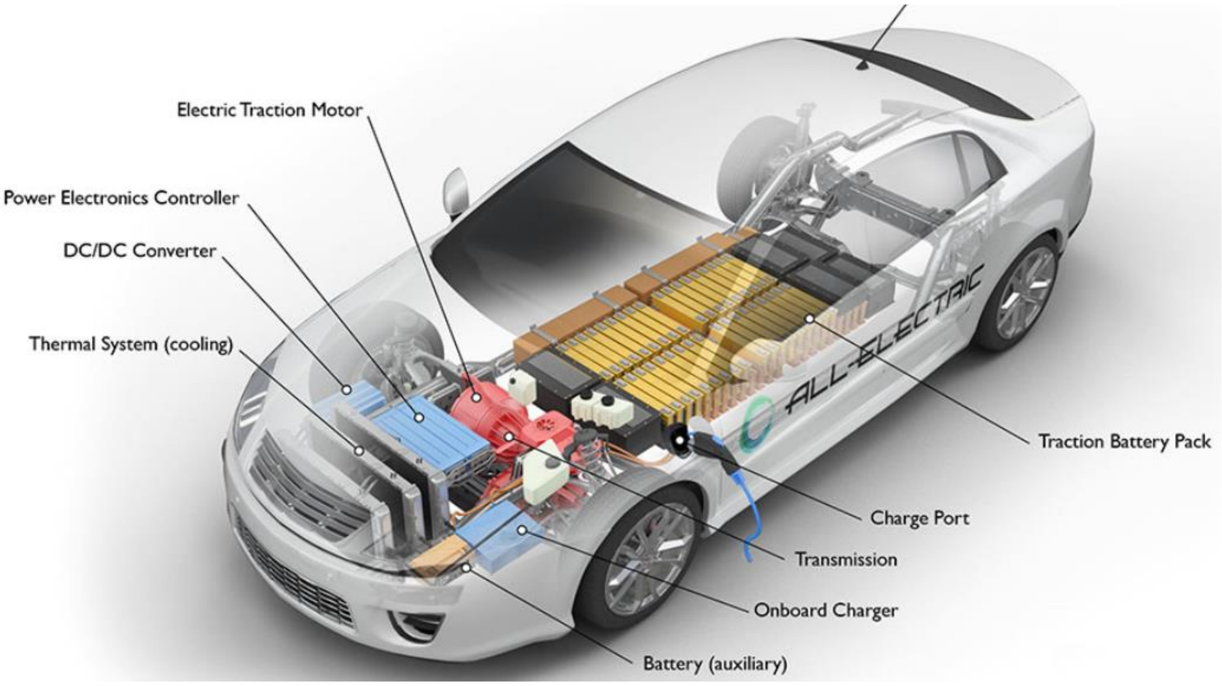


Figure 5-3 Basic schematic of an EV system [1]

From the above 3 categories of EVs, only the 2nd & 3rd category of EVs require charging infrastructure. Category 1 EVs take fuel only as input. Therefore, the document herein shall detail the requirements for category-2 and category-3 EVs.

5.2 Charging Infrastructure

An electric vehicle charging station also called an EV charging station is a location with single or multiple charging poles/docks sharing a common user identification interface each can have single or multiple charge points which can have one or several connectors (outlets/plugs) to create the physical connection to the EV but not more than one connector can be active at a time. A group of charging stations hence creates a charging pool.

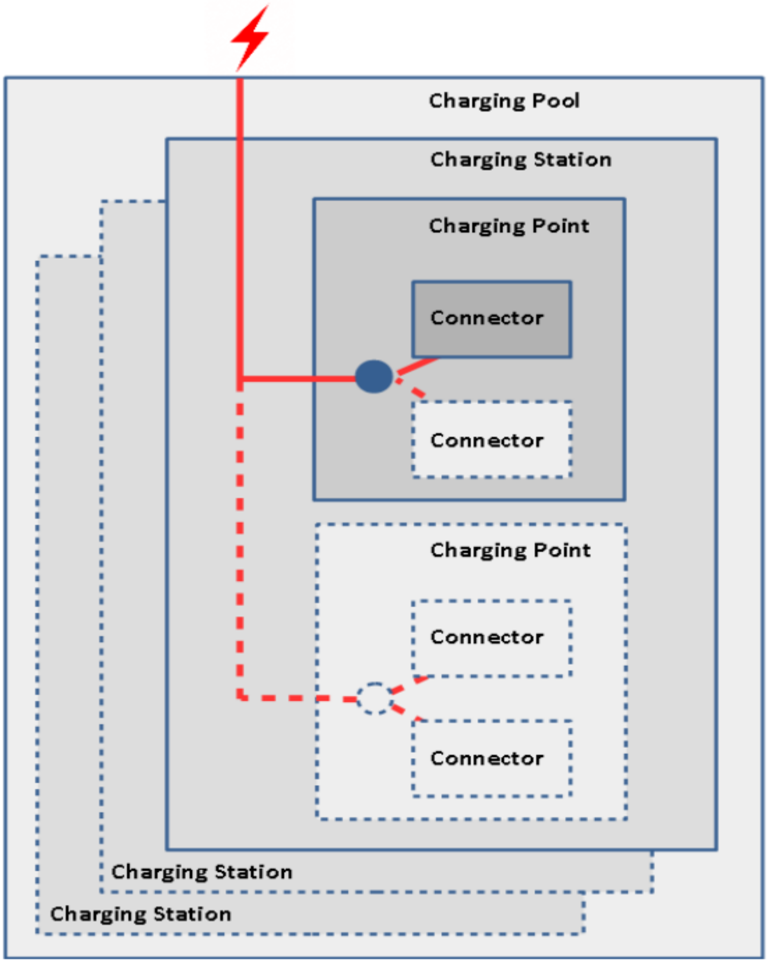


Figure 5-4 Charging Infrastructure outline (Rijksdienst voor Ondernemend Nederland, 2019)

The various charging plugs or connectors used are enumerated below:

- Type 1 (SAE J1772): These connectors are based on the Japanese standard SAE J1772 they are however widely adopted in North American countries and accepted by the EU
- Type 2 (IEC 62196-2): These connectors are adopted by the EU for charging below 22 kW
- Combined Charging System (CCS Combo): CCS is compatible with both AC and DC charging systems and is extensively adopted for fast charging solutions
- Type 4 CHAdeMO: DC fast charging connector extensively adopted for fast charging solutions and increasingly common in North American countries
- Tesla Supercharger: This connector is exclusively used by Tesla and has the same configuration as the type 2 connector.
- GB / T standard connector: At first glance, the connector seems to be the same as Type 2, but the cables inside are arranged in reverse order so they are not compatible. Is also compliant with IEC 62916-3

Charging infrastructure can be classified according to different charging modes defined in IEC 61851-1 (NPE, 2013a, b), which results in different charging rates. The charging modes vary primarily in charging power and security level., see

Table 1 and Figure 5-5:

Mode 1 (prohibited)

Charging in Mode 1 uses the standard power outlet in a building without any further safety equipment. Therefore, because the household electric installation must guarantee a safe charging process mode 1 is prohibited to be used. In accordance with the latest updated version of the SASO IEC 61851-1, this mode is completely prohibited in KSA.

Mode 2

For Mode 2, the charging cable that connects the electric vehicle and the standard power outlet is equipped with an in-cable control and protection device (IC-CPD). This device contains a residual current protective device (RCD) and a communication module. The user is protected from electric shock even if the household electric installation has no RCD and the communication module sets the charging power of the car by a PWM signal. Furthermore, the earth conductor is monitored. In accordance with the latest updated version of the SASO IEC 61851-1, this mode will be restricted, and its use will be limited only to the single phase 230V - 16A in KSA. The 3-phase use of Mode 2 is prohibited at the time of releasing these guidelines.

Mode 3

For Mode 3, charging a permanently installed wall box (Electrical Vehicle Supply Equipment, or EVSE) is needed. The wall box communicates with the car by PWM according to IEC 61851-1 or by power line communication (PLC) according to IEC 15118. With that, the charging power can be set with respect to the electric installation. The wall-mounted box shall consist of a communication module, an RCD, a circuit breaker, and a dedicated charging socket.

Mode 4

Mode 4 is DC charging with an external charging device. The charging operation is controlled by the vehicle. The external charger communicates with the car to set the right charging voltage and current. For charging Mode 4 the connection cable between the vehicle and stationary charger is fixed permanently to the charging point. The connector pins have to be rated for currents above 100 A, and the connection to the car has to be locked during the charging operation.

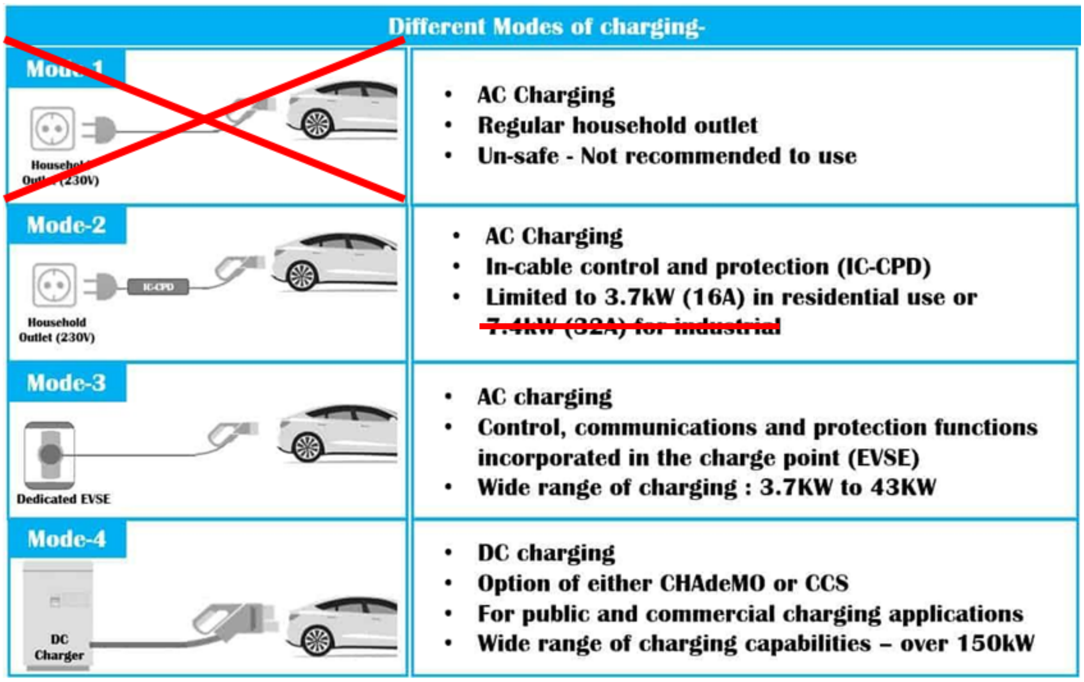
Table 1: Charging Modes as per SASO IEC 61851-1

Charging mode	Maximum current	Voltage	Max. charging power	Charging time for recharging ca. 20kWh[a]
Mode 1	Prohibited			
Mode 2	16 A ac, 1-phase	230 V AC	3.7 kVA (3.3 kW)	5 h
Mode 3	63 A ac, 3-phase	400 V AC	44 kVA (40 kW)	0.5 h
Mode 4	350 A DC	300–1000 V DC	Approx. 40-350kW	6 min

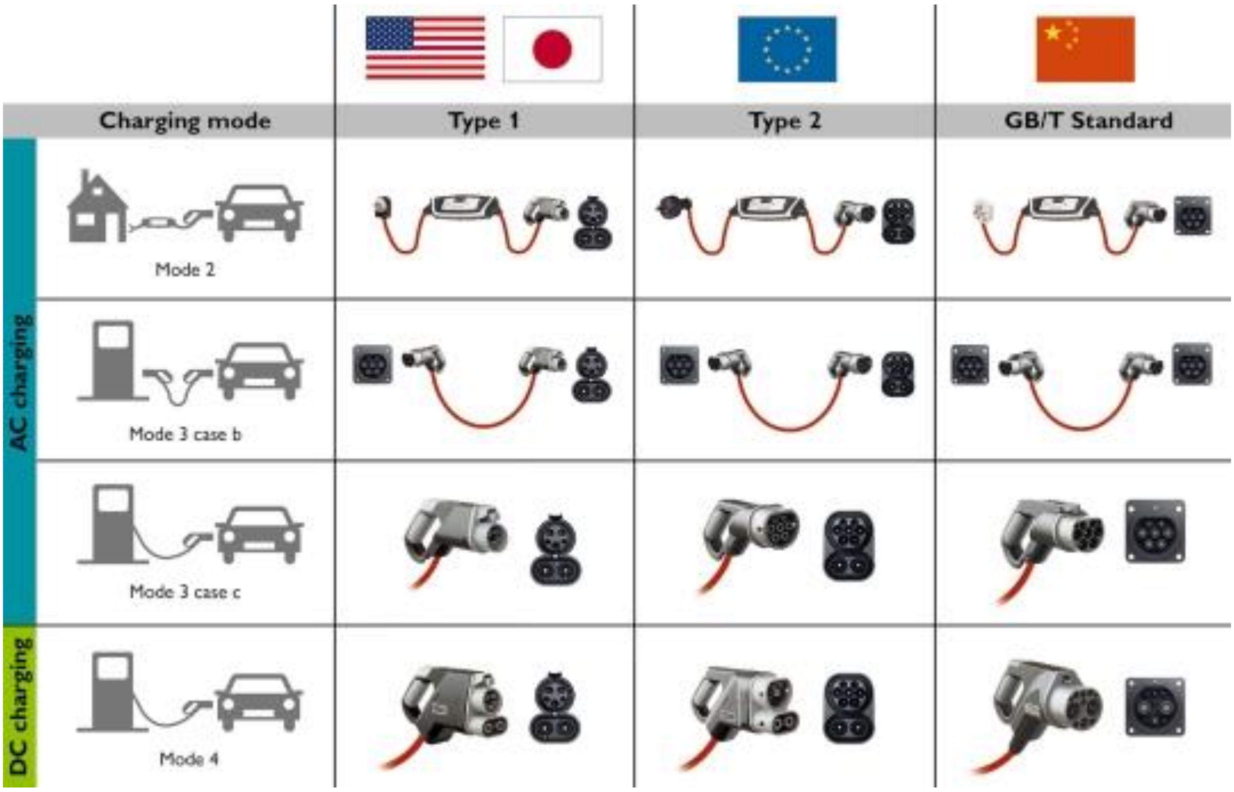
[a] Sufficient for ca. 100-150 km electric driving.

[b] Without charging in constant voltage phase up to approx. 50% SOC

In Figure 5-5 the mode of charging and type of plugs are shown.



a) Modes



b) Plugs

Figure 5-5. Charging Modes and plugs

In line with the charging modes listed in

Table 1, single-phase is limited to 3.7 kVA, 16A and for 3-phase charging the power is limited to 44 kVA with a maximum current rating of 63A at 400V with the corresponding reference circuit shown in Figure 5-6.

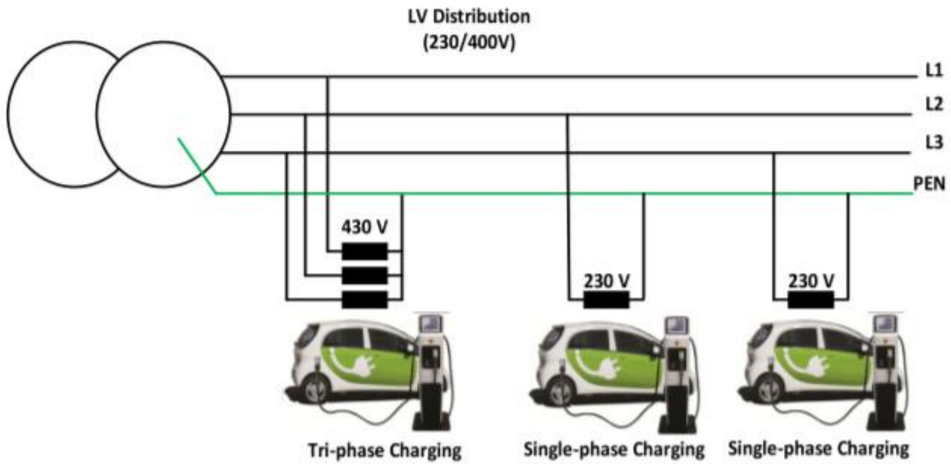


Figure 5-6 Reference circuit of EV connection schemes (Bohn, Agsten, Dubey, & Santoso, 2015)

Details of charging infrastructure are provided in "Technical Requirements for the Connection of EV Systems to the LV and MV Distribution Networks of SEC".

5.3 Example of Environmental Impact

Electric vehicles offer more sustainable mobility, especially with the current stringent car emission legislations worldwide along with a reduction in the dependence on fossil fuels following the Saudi 2030 vision. While EVs are carbon emissions-free at the tailpipe, the energy that is required to charge the batteries powering the EVs may not be so. The actual impact of net emissions depends on the underlying generation mix in the power sector in the kingdom. Ideally, it is desirable to charge EVs from a low ono-carbon energy source (Renewables) so that the emissions avoided by switching from internal combustion engine vehicles (ICEVs) outweigh the incremental emissions from the power used to charge the EVs.

Taking the results of an EV study in Saudi Arabia done by The King Abdullah Petroleum Studies and Research Centre (KAPSARC) using the marginal generation emissions method which showed that deployment of EVs in the Kingdom would, on average, result in a net decrease in carbon emissions. The study takes into consideration 18 different scenarios as shown in Table 2.

Table 2: Summary of scenarios simulated.[1]

Factor to be varied	Number of scenarios	Overview of scenario	Total number of scenarios
EV deployment level	3	Low: 25,000 Medium: 50,000 High: 100,000	18
Load profile, i.e., when charging occurs	3	Peak Off-peak Random	
Incremental load to be satisfied based on EV and ICEV efficiencies	2	Low: EV at 0.09 kWh/km and ICEV at 0.15 L/km High: EV at 0.20 kWh/km and ICEV at 0.06 L/km	

The net emission results are summarized using best and worst-case scenarios as shown in Table 3 and Figure 5-7. Observing how the best-case scenarios result in an overall emissions reduction. These cases correspond to situations where the entire ICEV fleet to be retired comprises SUVs, replaced by the most efficient EVs. On the other hand, the worst-case scenarios result in an overall increase in emissions. The latter corresponds to a situation where only small ICEVs were taken off the road and replaced by the least efficient EVs. With this analysis, the upper and lower limits of net carbon emissions gave a realistic target and showed the potential of EVs to reduce carbon emissions has been quantified.

Table 3: Net emissions in tons calculated as the difference between incremental CO2 emitted due to additional power generation caused by EV deployment and avoided emissions resulting from ICEVs taken off the road.[2]

Deployment scenario	Incremental load scenario (based on ICEV and EV efficiency scenarios)(1)	Incremental CO_2 emitted from power sector(2)	Avoided CO_2 emissions from retiring ICEVs and deploying EVs(3)	Net emissions
Low (25,000 EVs)	Low (best-case scenario)	28,524	-146,530	–118,006
	Median	93,577	-160,269	–66,692
	High (worst-case scenario)	158,630	-91,583	67,692
Med (50,000 EVs)	Low (best-case scenario)	57,104	-293,060	–235,956
	Median	187,239	-320,538	–133,299
	High (worst-case scenario)	317,374	-183,165	134,209
High (100,000 EVs)	Low (best-case scenario)	114,243	-586,120	–471,877
	Median	374,701	-641,075	–266,374
	High (worst-case scenario)	635,159	-366,330	268,829

[1] https://www.kapsarc.org/file-download.php?i=33488

[2] 'Low' represents the best-case scenario; 'High' represents the worst-case scenario; 'Median' represents a realistic midpoint. Parameters used for 'Low': 14,653 km for kilometers driven and 0.4 kg·CO2/km for ICEV emission factor. Parameters used for 'High': 36,633 km for kilometers driven and 0.1 kg·CO2/km for ICEV emission factor. Parameters used for 'Median': 25,643 km for kilometers driven and 0.25 kg·CO2/km for ICEV emission facto.

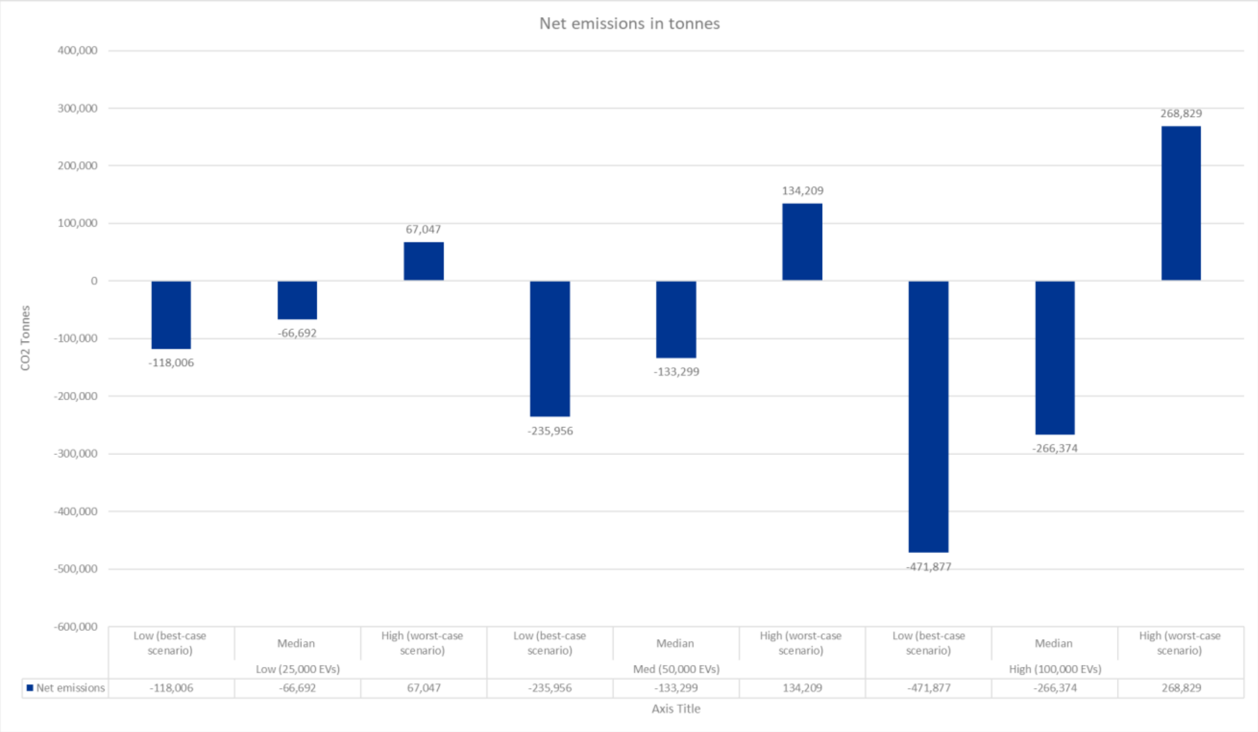


Figure 5-7:Net emissions in tones

5.4 Grid Impact

The establishment of charging poles and/or stations imposes an additional load on the utility and/or a new different type of behavior; this depend also on the charging mode.

While mode 1 is prohibited, mode 2 will consider only an AC plugin with limited power absorption, (up to 3.7 kW single phase), mode 3 and mode 4 will increase the power from 50 to some 350 kW per charger. This may generate e fast voltage dip when the Electric Vehicle begins to be charged. Also, other Consumers connected to the same feeder may suffer the same. Finally, the AC/DC converter Battery/Charger, on or off-board, ultimately determines harmonic injections into the system. Therefore, high charging loads of fast EV charging stations will have an impact on the operating parameters of the distribution network. Degradation of voltage profile, voltage fluctuation, increase in peak load, and harmonic distortions are some of the consequences of the uncoordinated charging of EVs. It is also crucial to note that placing fast charger stations at weak buses of a power network can greatly affect the smooth operation of the power distribution network, this can be aggravated with additional economic losses.

Therefore, a detailed analysis of the load pattern along with the following minimum studies is required to be performed before integrating EV charging stations into the network.

- Power flow studies at various network loads and a different statue of chargers
- Dynamic stability studies during initial charging for multiple chargers
- Power quality studies to determine network harmonics, flicker and voltage unbalance with different combinations of chargers in the ON state.
- Network Reliability study

For details, a reference to “Technical Requirements for the Connection of EV Systems to the LV and MV Distribution Networks of SEC” should be made.

Depending on the application, a charging station can have one or more EV chargers of the type described in IEC-61851. Based on the current international experience, see Table 4.

Table 4 Largest EV System currently in operation

Stalls	Country	Location	Amenities	Commissioned	Notes
50	China	Shanghai-Lilacs		2017-10-23	
50	China	Beijing - Hairun		2018-01-04	
50	China	Beijing - Baolong		2017-09-18	
44	Norway	Eidsvoll Verk / Nebbenes		2016-08-31	One of the first European S/Cs with CCS Combo 2 plugs
42	Norway	Rygge			
40	United States	Kettleman City, CA	24-hour Tesla Consumer Lounge	2017-11-14	Solar canopy

Stalls	Country	Location	Amenities	Commissioned	Notes
40	United States	Baker, CA		2017-11-15	Solar canopy
32	Netherlands	Badhoevedorp	Free Wifi	2018-11-21	
28	Netherlands	Breukelen	Free Wifi	5/15/2018	
26	Denmark	Køge		2015-02-04	Solar canopy
24	Netherlands	Eindhoven		11/20/2015	
24	Norway	Lillesand			
24	Switzerland	Dietikon	24-hour Tesla Consumer Lounge	2019-05-09	
20	France	Mâcon	Free WiFi	2018-06-20	
20	Sweden	Mellbystrand	Free WiFi	2019-06-30	

Table 5: Largest operational Supercharger stations by number of V3 Supercharger stalls; 250kW dedicated

Stalls	Country	Location	Amenities	Commissioned	Notes
24	US	Flamingo & Caesars Palace Las Vegas monorail station	solar canopy	2019-07	13 Destination Chargers are also available
8	UK	Station in Park Royal, London		019-12	8 V2 chargers are also available
8	Canada	Regina		2019-12	

The total installed power can achieve more than 7 MW.

According to some studies, the global EV fleet in 2020 consumed over 80 TWh of electricity; electricity demand from EVs accounts for only about 1% of current electricity total final consumption worldwide. Global Electricity demand for EVs is projected to reach 525 TWh in the Stated Policies Scenario and 860 TWh in the Sustainable Development Scenario in 2030. By 2030, electricity demand for EVs will account for at least 2% of global electricity total final consumption in both scenarios.

In these cases, an appropriate ‘worst-case scenario’ shall be identified by DSP and a Grid Impact pre-feasibility Study shall be performed by SEC based on the information provided by the Client.

As seen above, in general, the impact of EV charging depends also upon the charge regulation of the battery. The battery is considered a vital device in EVs. Batteries can store electrical energy in the form of chemical energy through charging and release the stored energy through internal chemical reactions through the discharge process. The charging and discharging process of a battery bank could be influenced by many factors, such as reactant concentration, temperature, and range of reaction.

For EV batteries, three basic schemes are usually used for charging control, see for example Figure 5-8; these schemes are:

- constant current
- constant voltage
- taper-current charging

With reference to Figure 5-8, the Constant-current (CC) charging merely means that the charger supplies current with a relatively uniform rate, regardless of the battery temperature or state of charge. This charging algorithm assists in the elimination of imbalances between cells and series-connected batteries. However, defining the battery charging current rate can be challenging. Generally, a charging current that is too low cannot satisfy the charging time speed requirement, and a high rate charging current could readily stimulate damage during the charging process.

The constant voltage (CV)method charges the battery at a constant voltage. This method is suitable for all kinds of batteries and is probably the simplest charging scheme. The battery charging current varies along the charging process. The charging current can be large at the initial stage and gradually decreases to zero when the battery is fully charged. The drawback of this method is the requirement of very high power in the early stage of charging, which is not available for most residential and parking structures.

In a taper-current charging scheme, the charging current decreases proportionally to the terminal voltage rise of the EV battery.

Normally, CC and CV charging methods are integrated during the battery charging process. Generally, the charging schemes consist of CC charging until the EV battery voltage reaches the charge voltage level, then CV charging is applied, allowing the charge current to taper until it becomes a small value. It is recommended to follow the charging current during the charging process, which represents the ideal current at which the battery should be charged initially (to roughly 70% of state-of-charge) under the CC charging scheme before transitioning into the CV charging scheme.

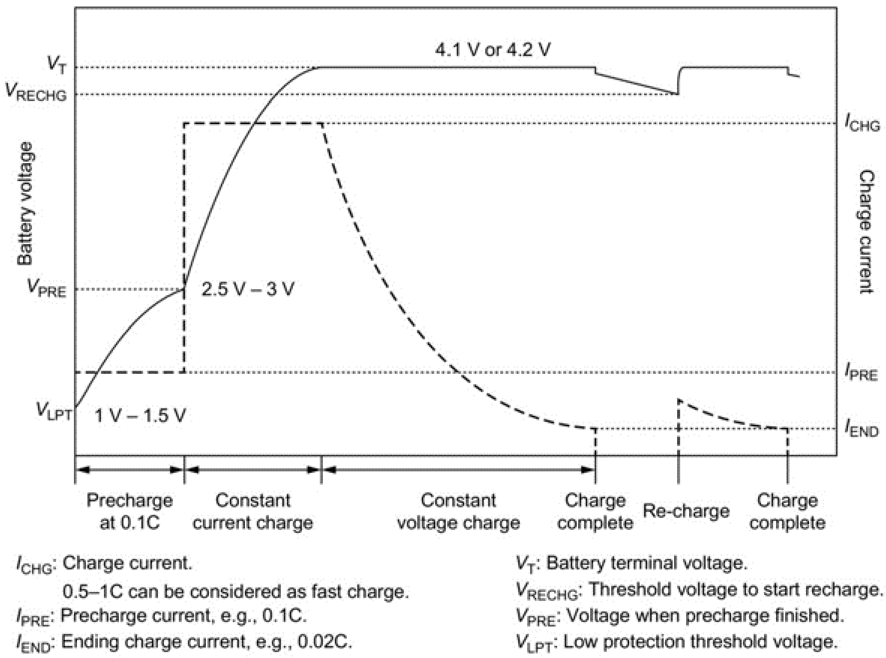


Figure 5-8 IU charging characteristic for a Li-ion cell (Muneer, Kolhe, & Doyle, 2017)

For details, a reference to “Technical Requirements for the Connection of EV Systems to the LV and MV Distribution Networks of SEC” should be made.

6 EV CONNECTION PROCESS

The connection process for EVs is designed in accordance with WERA regulations for the connection and installation of EV charging systems known in this document as EVCS. The process is divided into 3 steps and each of these steps has different phases in it. The 3 steps are illustrated and reported in the below figure.

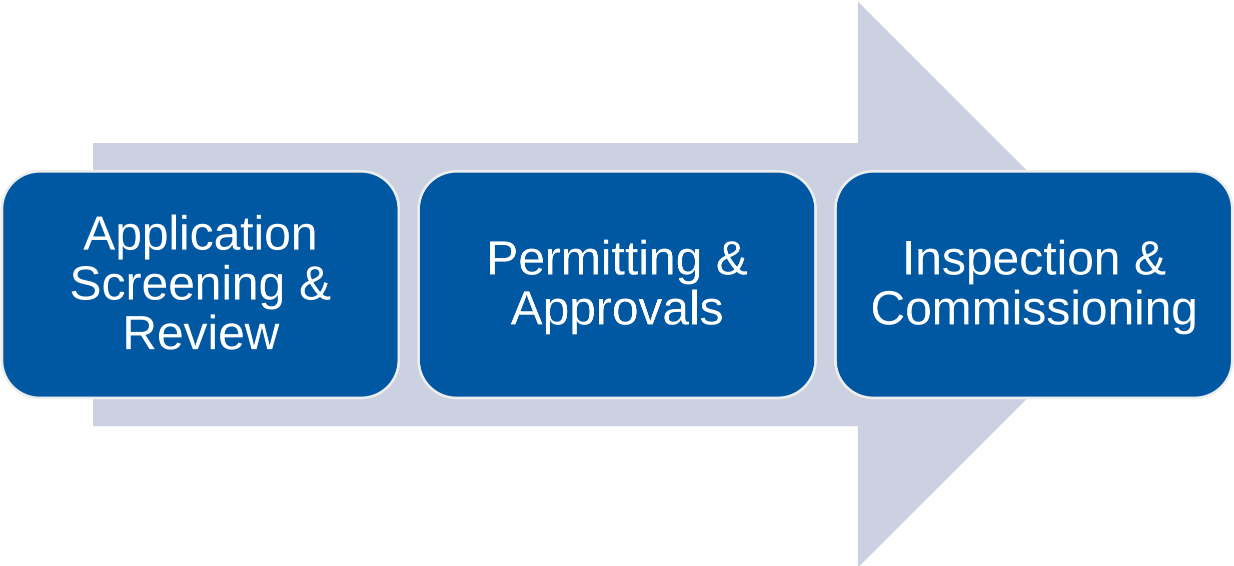


Figure 6-1 main stages in the EV connection process

The main philosophy behind the EV connection process is to provide the consumer with a tool that guides them in their new request for connecting EVCS and in selecting the model and the contractor. The documents to be submitted or uploaded will differ based on the category of the consumer. Usually, the residential consumer will be asked to upload less information and fewer permits in comparison to the permits and information asked from commercial consumers for instance.

The municipality known as MOMRA which has adopted BALADI initiative does have an important role in issuing and releasing the necessary permits needed for the installation of the EVCS. MOMRA will also assign an engineering consultant to develop the electrical diagrams and engineering documents needed in the application.

The below figure is illustrating in detail the phases that a new EVCS application has to go through before connecting to the network. A detailed description of each step or phase will follow in the upcoming paragraphs.

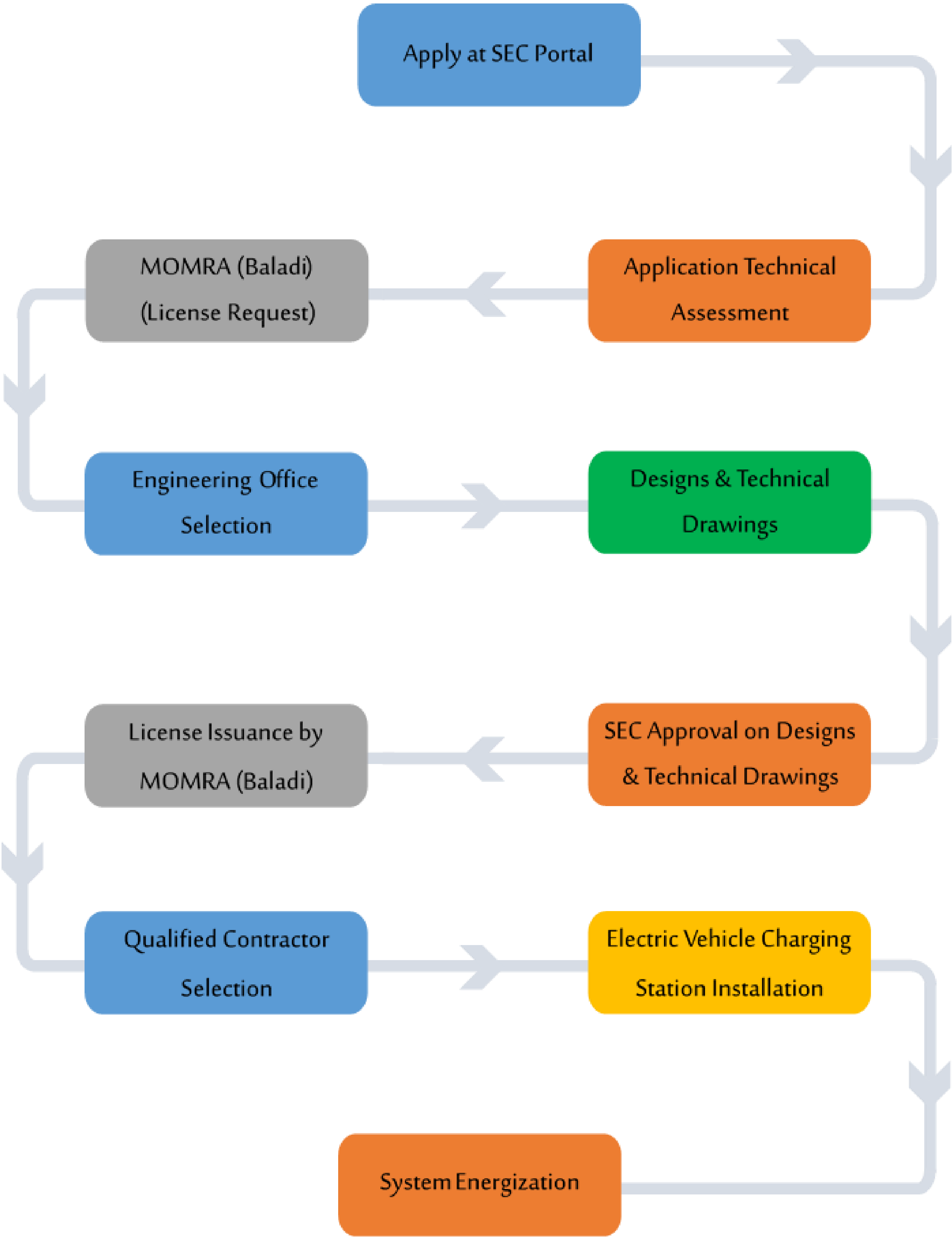


Figure 6-2 detailed phases of the EV connection process

6.1 Apply at SEC portal

Block type	Performer	Max time (days)	Flowchart
Activity WEB	Consumer	–	1

This is the first activity that an eligible consumer shall perform when asking for a new connection of an EVCS. The eligible consumer must have an existing account in SEC portal, and he/she must insert the details of the EVCS he/she is willing to install.

6.2 Application technical assessment

Block type	Performer	Max time (days)	Flowchart
Activity	SEC	–	1

SEC will receive the application from the consumer and will decide internally if this particular application requires an on-site visit or not. This will depend on the network information available, if SEC personnel doubts the information at their disposal, they can decide to conduct a site visit to check the substation capacity, the transformer information, and all information concerning the connection point.

Afterward, SEC can start conducting the CYME analysis in order to assess the feasibility of the new EVCS connection. Based on the CYME analysis, SEC can decide if the new EVCS will require a network or a substation reinforcement or if the application is approved and it doesn't impact the network. On the other hand, if the study shows that the EVCS impacts negatively the network, here below are listed some actions that SEC engineers might apply before totally rejecting the application:

1. Redefine the simulation scenarios by using realistic data instead of extreme scenarios in terms of utilization factor and load consumption
2. Check the possibility to operate the EVCS absorption with different power factors in case of voltage violation and see if this solves the problem
3. If the problem persists, then reduce the EVCS-connected capacity until the violation is eliminated
4. If the problem persists, then a network reinforcement is required, and it has to be implemented according to SEC planning criteria and requirements.

6.3 MOMRA Baladi License request

Block type	Performer	Max time (days)	Flowchart
Activity	consumer	–	1

At this stage, the consumer after receiving positive feedback from SEC, can proceed with the application and ask MOMRA for the necessary permits required for the EVCS application. As mentioned previously that the permits that will be issued by MOMRA will vary based on the category of the consumer.

6.4 Engineering office selection

Block type	Performer	Max time (days)	Flowchart
Activity	MOMRA	–	1

After receiving the request from the eligible consumer, MOMRA shall select an engineering office capable of releasing the engineering documents needed for the application e.g., single-line diagrams, wiring diagrams, layout, etc.

6.5 Design & Technical Drawings

Block type	Performer	Max time (days)	Flowchart
Activity WEB	Consultant	–	1

Once the consultant finalizes the development of all necessary engineering documents, he/she shall upload these documents to SEC web portal.

6.6 SEC Approval on Design & Technical Drawings

Block type	Performer	Max time (days)	Flowchart
Activity	SEC	–	1

SEC personnel will review all the uploaded documents and will focus mainly on the components impacting the network and the uploaded data sheets of the EVCS. SEC will approve the documentation submitted if they include all the technical requirements asked by SEC.

6.7 License issuance by MOMRA

Block type	Performer	Max time (days)	Flowchart
Activity	MOMRA	–	1

Once SEC approves the technical documentation a notification will be sent both to MOMRA and to the consumer informing them of the positive outcome of the revision. MOMRA shall then proceed with the release of the permits and licenses needed to forward them to the eligible consumer.

6.8 Qualified Contractor Selection

Block type	Performer	Max time (days)	Flowchart
Activity WEB	Consumer	–	1

Once received all permits and approvals, the eligible consumer can at this stage select a qualified contractor for the connection of the EVCS he/she has applied for.

6.9 Electrical Vehicle Charging Station Installation

Block type	Performer	Max time (days)	Flowchart
Activity	Contractor	–	1

The selected contractor must proceed with the installation of the EVCS according to the engineering design, single-line diagrams, and layouts. The qualified contractor must ensure the procurement of the selected components as per the design, if a change is made in the procurement which has led to a change in the purchased equipment, the contractor must justify this change and ensure that the new datasheet of the purchased equipment is similar of not identical to the previously approved equipment and datasheet.

6.10 System Energization

Block type	Performer	Max time (days)	Flowchart
Activity	SEC	–	1

After the compilation of the installation, the contractor has to conduct all the necessary checks and tests as per the manufacturer's recommendations, the contractor is obliged to upload the declaration of conformity to inform SEC of the compilation of the installation.

At this stage, SEC will inspect the EVCS following the internal checklist and focusing on the components that could impact the distribution network. If the onsite inspection results are positive, SEC will proceed with the system energization and approval.