Future of Standard Essential Patents in Electric Vehicle Charging

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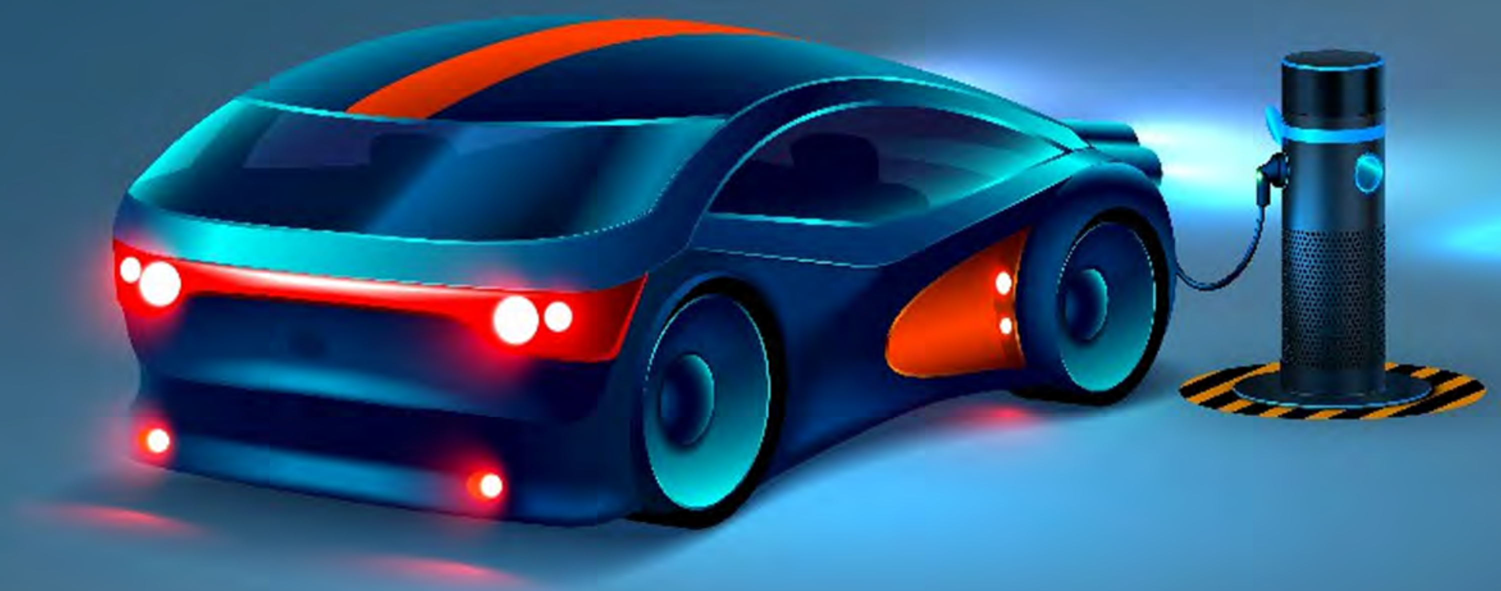
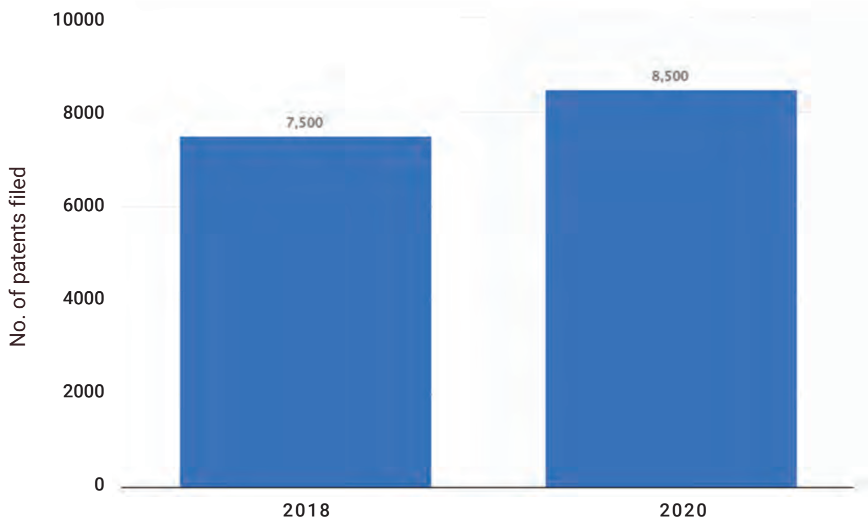


Contents

Introduction

Reliable and accessible charging infrastructure will be fundamental to changeover to electric vehicles from internal combustion engine vehicles. This is necessary to reduce the carbon footprint.



Projected number of electric vehicle-related patents filed worldwide between 2018 and 2020

The largest obstacle to switching over to EVs is the lack of charging infrastructure throughout the world. As of now, there are three levels of charging vehicles based on varying speed and power. The system of tiers starts with the lowest charging at Level 1 and gets faster from there. Level 1 offers 120 V chargers, level 2 offers 240 V chargers and level 3 offers DC rapid/fast/Superchargers.

Although a lot of different types of charging stations are being developed globally, large-scale adoption of Electric Vehicles (EVs) largely depends on the wide deployment of interoperable standards-based EV charging infrastructure.
Some of these standards are explained in section 2.

Standards on EV Charging

1. CCS or Combined Charging System

BACKGROUND

This standard for charging EVs makes use of two connectors: the Combo 1 and Combo 2 to provide power up to 350 kilowatts. Both these connectors are extensions of the IEC 62196 Type 1 and Type 2 connectors, with two additional direct currents (DC) contacts to allow high-power DC fast charging.

As per the standards listed by the CCS, electric vehicles or electric vehicle supply equipment are CCS-capable if they support either AC or DC charging.

DESCRIPTION

Currently, three versions of CCS exist:

Version 1.0
It covers the currently common features of AC and DC charging

Version 2.0
It addresses the near to midterm future. The automotive manufacturers supporting CCS decided to adopt CCS 2.0 in 2018. Hence, charging station manufacturers were also expected to support CCS 2.0 from 2018 onwards.

Version 3.0
The specifications of CCS 3.0 are not precisely defined. Although, all features of previous versions shall be preserved so that backward compatibility can be ensured. Potential additional features include: Reverse power transfer, Inductive charging, Wireless charging communication, Bus charging with a "pantograph" current collector.

Automobile manufacturers that support CCS include:

- The Combined Charging System is primarily driven by European and North American car manufacturers.
- Type 1 and Combo 1 chargers are primarily found in North and Central America, Korea, and Taiwan, whereas,
- Type 2 and Combo 2 can be found in North and South America, Europe, South Africa, Arabia, India, Oceania, and Australia.
- BMW, Daimler, FCA, Ford, Jaguar, General Motors, Groupe PSA, Honda, Hyundai, Kia, Mazda, MG, Polestar, Renault, Tesla, Tata Motors, and Volkswagen Group are the automobile manufacturers that support CCS.

2. Bharat EV Charging Standards AIS-138 (Part 1 and Part 2)

BACKGROUND

It is the public EV charging standard in India. For low voltage EVs(<120V), IS:17017 recognizes DHI(Department of Heavy Industry) approved Bharat charger specifications called:

For AC Charging: Bharat EV charger AC001
AC001 can deliver a maximum 15 amp charging current at 3.3Kw power to three vehicles simultaneously. Takes a 3 phase input. The type of each output is 230V single-phase AC.

Power Input	No. of Outputs	Power Output	Connector	EV-EVSE	EVSE-CMS Communication Protocol
3-Phase 415V AC	3	3*3.3kW	IEC 60309	None	OCPP 1.5 or higher

For DC Charging: Bharat EV charger DC001
DC-001 can deliver a maximum 200 amp charging current at 15Kw power, directly to the vehicle's battery. The type of output is DC 48V/60V/72V depending on the vehicle battery configuration.

Power Input	No. of Outputs	Power Output	Connector	EV-EVSE	EVSE-CMS Communication Protocol
3-Phase 415V AC	1	15 kW (max)	GB/T-20234.3	Based on custom GBT i.e. DC-001 Specs	OCPP 1.5 or higher

DESCRIPTION

Part 1

Here AIS refers to Automotive Industry Standards. It can be described in two parts.

• This standard is applied to charging electric road vehicles at standard AC supply voltages (as per IS 12360/IEC 60038) up to 1000 V.

• It also provides electrical power for any additional services on the vehicle if required when it is connected to the supply network.

• Electric road vehicles (EV) denote all road vehicles (2/3/4 Wheelers), including plug-in hybrid road vehicles (PHEV), that derive all or some of their energy from onboard batteries.

• This standard is, however, not applicable to trolleybuses, rail vehicles, and off-road industrial vehicles.
There are 2 EV charging modes in part 1: AC Slow Charging Mode and AC Fast Charging Mode

Part 2

• This standard gives the requirements for DC electric vehicle (EV) charging stations, which can also be called "DC charger", for conductive connection to the vehicle, with an AC or DC input voltage up to 1000 V AC and up to 1500 V DC (as per IS 12360/IEC 60038) respectively.

• This standard includes information on EV for conductive connection, but it is limited only to the required content to describe the power and interface for signalling.

3. CHAdeMO

BACKGROUND

• CHAdeMO is the trade name of a fast-charging method for battery electric vehicles.

• The CHAdeMO Association was formed by the Tokyo Electric Power Company (TEPCO), Nissan, Mitsubishi, and Fuji Heavy Industries (now referred to as Subaru Corporation). Toyota later joined as its fifth executive member, followed by Hitachi, Honda, and Panasonic.

• CHAdeMO Research and Development started in the year 2005 to develop a public infrastructure of fast chargers which enables people to drive Electric Vehicles without worrying about the range of their batteries.

• It was proposed in 2010 as a global industry standard by an association of the same name formed by five major Japanese automakers and included in the IEC61851-23, -24 (charging system and communication) and the IEC 62196 standard as configuration AA.

• It is the most widely used DC fast charging protocol in the world. It gained another formal recognition when it was published as IEEE Standard 2030.1.1TM-2015.

• It is a fast-charging method for battery electric vehicles delivering up to 62.5 kW by 500 V, 125 A direct current via a special electrical connector.

ONGOING WORK

• A revised CHAdeMO 2.0 specification allows for up to 400 kW by 1000 V, 400 A direct current. It can charge low-range (120 km, or 75 mi) electric cars in less than half an hour.

• CHAdeMO allows up to 400 kW of charging (400A x 1kV) and aims for 900 kW. For that, it is co-developing with China Electricity Council (CEC) which is the next-generation ultra-high-power charging standard with the working name of "ChaoJi" also called CHAdeMO 3.0. This will unite the CHAdeMO standard with the CEC GB/T 20234.3 standard.

ABANDONMENT OF CHADEMO IN THE US AND EUROPE

• In July 2020, Nissan unveiled the new 2021 Nissan Ariya to the US market, which will have only a CCS charge port instead of the CHAdeMO port which was present on the Nissan Leaf for the last ten years.

• Auto analysts noted that it is the "death knell" for CHAdeMO in the US and Europe, due to this decision to abandon CHAdeMO charging, as only the Mitsubishi Outlander plug-in hybrid will be left as the one new car in the US using CHAdeMO.

• Hence, it was concluded that CCS won over CHAdeMO.

FEATURES

• CHAdeMO published its protocol for vehicle-to-grid integration (VGI) in 2014.

• Aside from vehicle to grid [V2G or V2B], applications also include vehicle to load [V2L] or home-off grid [V2H] and is collectively called V2X

• As of August 2019, CHAdeMO is the only standardized charging protocol that defines V2X and has mass-produced cars and chargers readily capable of it.

• V2X technology enables EV owners to use the car as energy storage. It saves costs by optimizing energy usage and providing services to the Grid.

• Since 2012, multiple V2X demo projects using V2X capacities of the CHAdeMO protocol have been demonstrated worldwide. **Some of the recent projects include UCSD INVENT in the United States, as well as Sciurus and e4Future in the United Kingdom that is supported by Innovate UK.**

4. GB EV Charging standards: GB 27930- 2015

BACKGROUND

• The GB standard also called Guobiao, or “national standard” in Chinese, was published by the China Electricity Council (CEC). A separate specification for inductive or wireless charging was published by the CEC as GB/T 38775.

• It is the Chinese standard for electric vehicle battery charging. This is the charging standard for cable and conductive charging and it is suitable for both electric vehicles (EV) and hybrid electric vehicles (HEV).

• It is based on the SAE J1939 network protocol and uses the CAN bus with a point-to-point connection between the charger and the battery management system (BMS).

FEATURES

• It uses the CAN bus

• It supports only two participants at a time: a charger and a BMS in the vehicle with fixed addresses: 86 (56h) for the charger and 244 (F4h) for the BMS

• It offers a primary CAN baud rate of 250 kbps with a possible reduction down to 50 kbps

• It has no direct connections to other CAN systems in the vehicle, such as the power train CAN.

• It is a J1939-based protocol

• It has diagnostic options like six diagnostic messages DM1 through DM6 are defined which are not compatible with SAE J1939.

PROBLEMS

Technical Faults:
Overheating, Line faults, Larger deviations in the target current and voltage values.

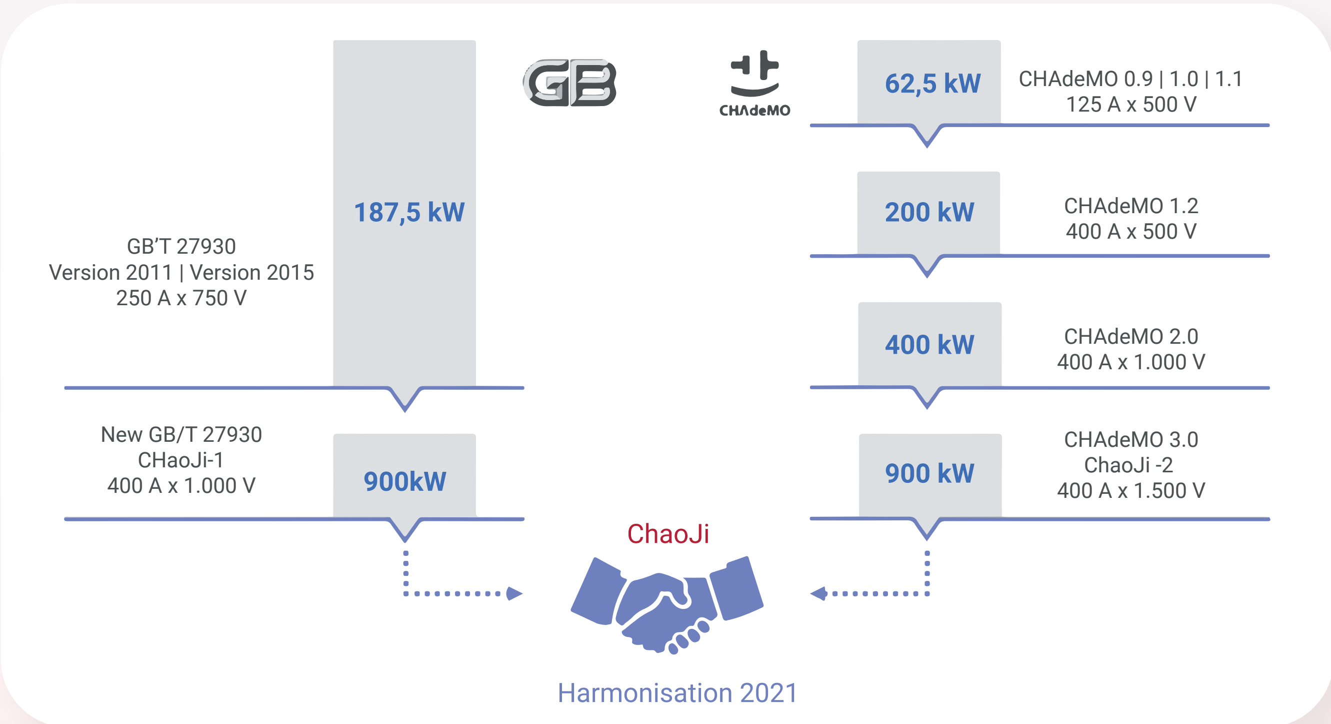
Communication Errors:
Status transition doesn't occur within the designated period, Message to be sent in a cycle takes longer time than allowed.

FURTHER DEVELOPMENT

• In 2018, cooperation on the development of a new charging standard called ChaoJi was announced by the publishers of the two national standards: CHAdeMO by the CHAdeMO Association in Japan, and GB/T 27930 by the China Electricity Council (CEC) in China.

• The goal of the new standard is to develop a secure, versatile, and rapid charging technology (up to 900 kW) using a standardized charging protocol and standardized physical infrastructure.

• In the first step, a new connecting plug is being developed. Using adapters, it must also be possible to charge vehicles that only support the CHAdeMO or GB/T standard at ChaoJi chargers.



5. SAE J1772

BACKGROUND

The main stimulus for the development of SAE J1772 came from the California Air Resources Board (CARB). The SAE J1772-2009 was adopted by the car manufacturers of post-2000 electric vehicles like the third generation of the Chevrolet Volt and Nissan Leaf as the early models. The connector became standard equipment in the U.S. market due to the availability of charging stations with that plug type in the nation's electric vehicle network.

DESCRIPTION

It is also known as JPlug. It is a North American standard for electrical connectors used in electric vehicles. It is maintained by SAE International and has the formal title "SAE Surface Vehicle Recommended Practice J1772, SAE Electric Vehicle Conductive Charge Coupler". It covers the general physical, electrical, communication protocol, and performance requirements for the electric vehicle conductive charge system and coupler. The main purpose of this standard is to define a common electric vehicle conductive charging system architecture including operational requirements and the functional and dimensional requirements for the vehicle inlet and mating connector. The J1772 5-pin standard supports a wide range of single-phase (AC) charging rates from 1.44 kW (12 amps @ 120 volts) up to 19.2 kW (80 amps @ 240 volts) via portable devices connected to a household NEMA 5-15 outlet from an EVSE (Electric Vehicle Supply Equipment, or a charging station). There is also a 7-pin Combo Coupler that has both a 5-pin J1772 connector and a CCS 2-pin connector that supports DC fast-charging up to 90 kW.

FEATURES

- Ultra-low standby UCC28740-based isolated AC/DC stage to achieve ENERGY STAR® certification for EV charging stations

- Tight output voltage regulation (< ±5%) of LDOs and the high slew rate of the TLV1805 device ensures SAE J1772 certification for the control pilot interface

- Ultra-low standby as well as cost-optimized converters and linear regulators to power up points-of-load

- DRV110 current controller to drive high-current relays and contactors for thermal protection and reducing power dissipation

- Isolated line voltage sensing using the ISO1212 digital-input receiver for welded relay and contactor detection

6. SAE J1773

• This SAE Recommended Practice establishes the minimum interface compatibility requirements for electric vehicle (EV) inductively coupled charging for North America.

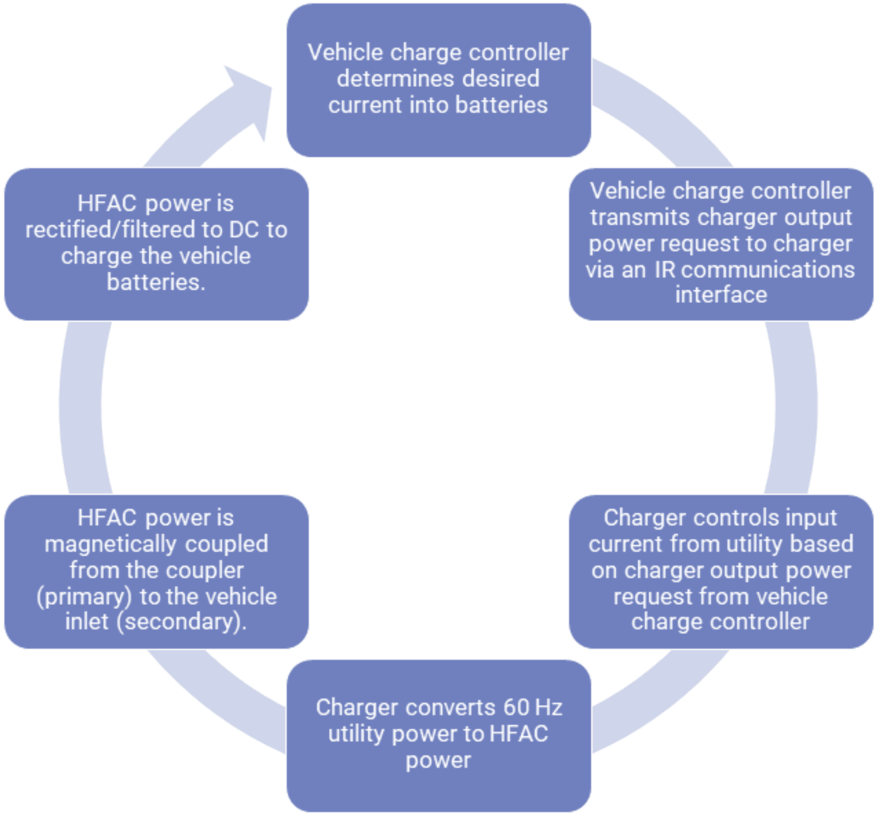
• This part of the specification is applicable to manually connected inductive charging for Levels 1 and 2 power transfer.

• This type of inductively coupled charging is generally intended for transferring power at frequencies significantly higher than power line frequencies.

• This part of the specification is not applicable to inductive coupling schemes that employ automatic connection methods or that are intended for transferring power at power line frequencies. in the charge coupler.

• The charge controller signals the charger to stop charging when it determines that the batteries are completely charged or a fault is detected during the charging process.

The steps of the process are explained in the form of closed loop charging system below:



This Process repeats until the vehicle charge controller determines the batteries are fully charged

7. SAEJ2954

BACKGROUND

SAE International has published the SAE J2954 standard for wireless charging of electric vehicles up to 11 kW. There is also an update to the SAE J2847/6 standard, which describes minimum requirements for communication between an electric vehicle and an inductive charging system.

DESCRIPTION

The canonical J2954 system consists of two parts:

1) a charger station and its associated induction pad is known as the Ground Assembly (GA), and
2) the vehicle-mounted section known as the Vehicle Assembly (VA).

• The GA connects to the grid, changing the grid power from alternating current (AC) to direct current (DC) using a conventional rectifier.

• The DC output of the rectifier then drives a power inverter that outputs AC at the desired 85 kHz frequency. This AC power is then fed into the induction coil.

• The GA also contains a Bluetooth-based communications system that it uses to communicate with the charger on the car to determine the maximum rate of charge, charge state, and other information.

FEATURES

• SAE J2954 addresses unidirectional charging, from the grid to vehicle, bidirectional energy transfer may be evaluated for a future standard.

• This standard is intended to be used in stationary applications (charging while the vehicle is not in motion), dynamic applications may be considered in the future.

• In this version, only above-ground or surface mounted installations are covered, flush-mounted installations are not ready for inclusion as of now.

FEATURES

- SAE J2954 contains requirements for safety, performance, and interoperability. It also contains recommended methods for evaluating electromagnetic emissions, but the requirements and test procedures are controlled by regulatory bodies.

- Development of the interoperability requirements in this standard employed a performance-based evaluation of candidate designs using a standardized test station and procedures, resulting in defining reference devices that are used to determine the acceptable performance of products.

8. SAEJ2954

BACKGROUND

The first edition, IEC 62196-1:2003, was published in 2003. This edition applied to plugs, socket-outlets, connectors, inlets, and cable assemblies for AC and DC charging of electric vehicles with rated voltages and rated currents as follows:

AC: up to 690 V, up to 250 A

DC: up to 600 V, up to 400 A.

DESCRIPTION

It is developed for use in conductive charging systems which incorporate control means, with a rated operating voltage not exceeding: - 690 V a.c. 50 Hz to 60 Hz, at a rated current, not more than 250 A; - 1500 V d.c. at a rated current not exceeding 400 A.

9. ISO-15118

BACKGROUND

• It specifies the communication between Electric Vehicles (EV), including Battery Electric Vehicles and Plug-In Hybrid Electric Vehicles, and the Electric Vehicle Supply Equipment (EVSE).

• As the communication parts of this generic equipment are the Electric Vehicle Communication Controller (EVCC) and the Supply Equipment Communication Controller (SECC), ISO 15118 describes the communication between these components.

• Although ISO 15118 is oriented to the charging of electric road vehicles, it is open for other vehicles as well.

• It specifies terms and definitions, general requirements and use cases as the basis for the other parts of ISO 15118.

• It provides a general overview and a common understanding of aspects influencing the charge process, payment and load levelling.

DESCRIPTION

Plug and charge

• The user-convenient and secure Plug & Charge feature that comes with ISO 15118 enables an electric vehicle to automatically identify and authorize itself to a compatible charging station on behalf of the driver, to receive energy for recharging its battery.

• The only action required by the driver is to plug the charging cable into the EV and/or charging station.

• The car and the charger identify themselves to each other by exchanging certificates with a certificate pool to allow payment.

• An open test system started in November 2021. The standard can be used for both wired (AC and DC charging) and wireless charging for electric vehicles.

• Cars that support the Plug & Charge standard include the 2018 Opel Ampera-e, the model year 2021 Porsche Taycan, Lucid Air, Ford Mustang Mach-E, and the Rivian R1T.

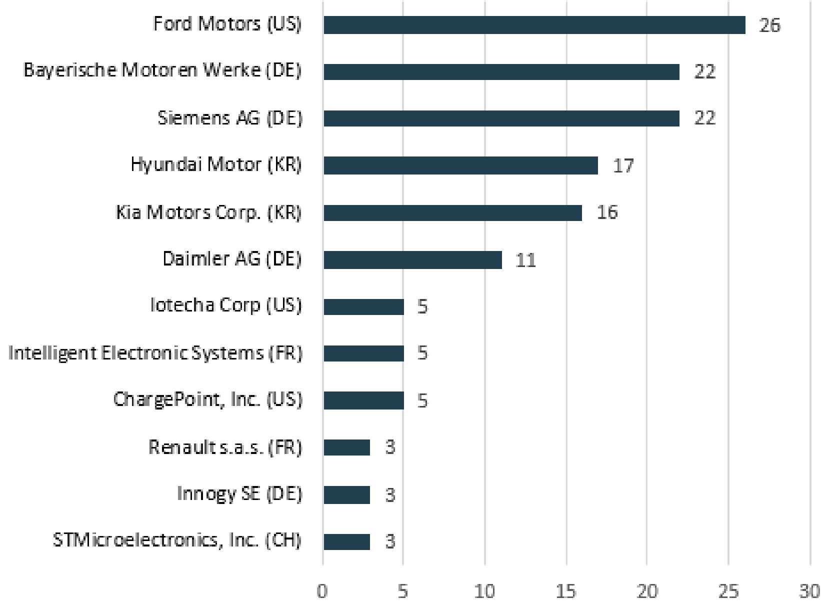
Use of ISO15118 in heavy duty vehicles:

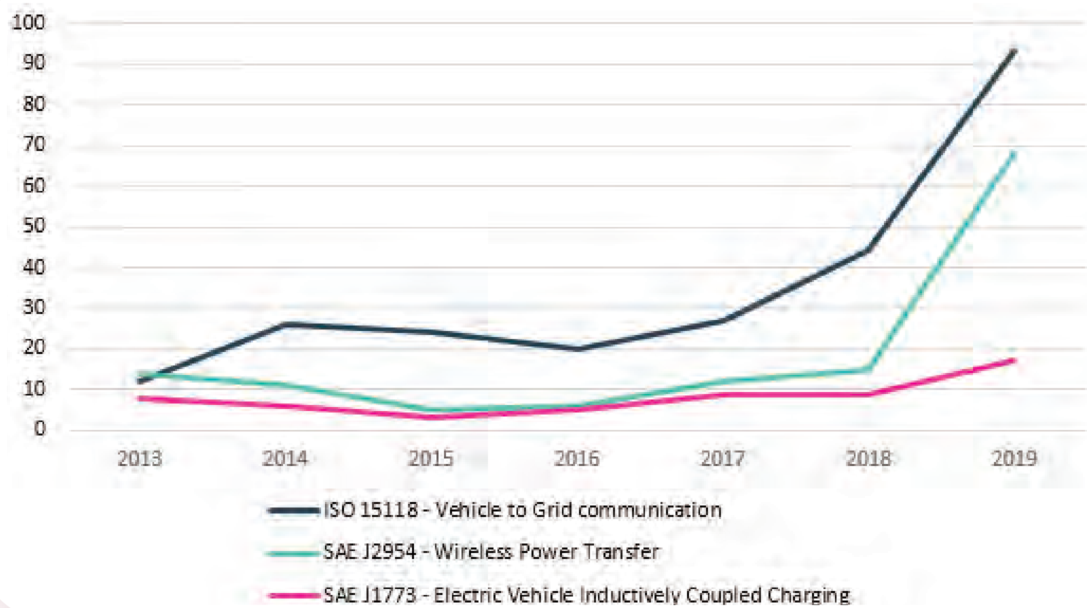
The ISO 15118 is also used as communication protocol for charging of heavy- duty vehicles as:

- Harbor Automated Guided Vehicles
- Public transportation

The graph below shows the patent ownership of patent families filed that reference the wireless charging standard ISO 15118.

- The list of companies is dominated by car manufactures with top patent owner, such as Ford, BMW and Hyundai.
- Beyond the auto industry, the platform identified companies from the industrial manufacturing sector, energy sector and semiconductor sector, including Siemens, Innogy and STMicroelectronics.





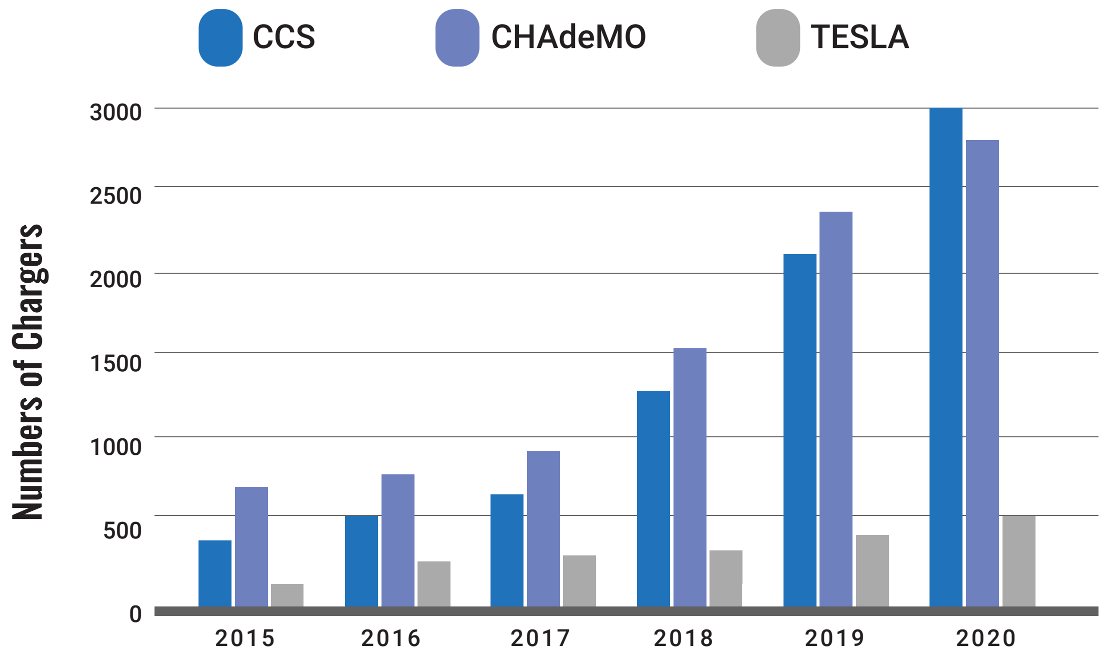
- The graph below displays patents that reference the three most relevant wireless electric vehicle charging standards ISO 15118 vehicle-to-grid communication, SAE J2954 wireless power transfer and SAE J1773 electric vehicle inductively coupled charging, among the above described standards.
- The graph shows the number of patents filed that reference ISO 15118, SAE J2954 or SAE J1773 over time.
- While patent filings for all three standards has been increasing the magnitude of the number of total patents is still small compared to the wireless phone charging patent filings.

EV Charging standards region wise:

1. UK

Next-generation rapid charging deployment networks within the UK are favouring CCS, reversing the growing deployment of CHAdeMO (shown in graph below). Even Tesla, with its proprietary connector and comms protocol, has now switched to CCS on its Model 3 and Model Y EVs.

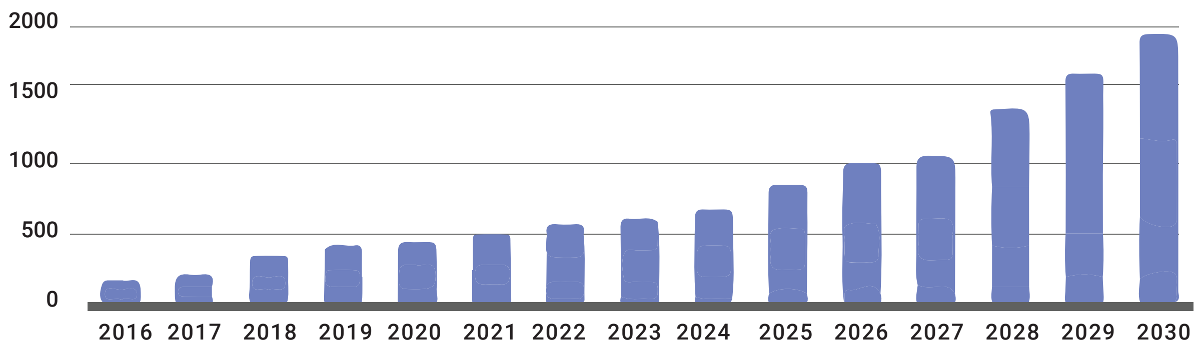
The graph shows almost equal deployment of CHAdeMO and CCS charge points.



CCS vs. CHAdeMO vs Tesla UK charge point connector deployment

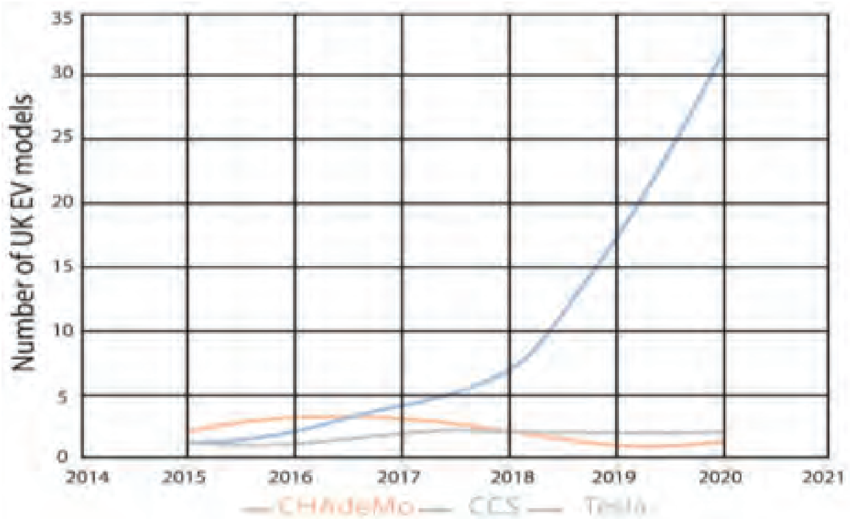
• In the United Kingdom, the govt. is actively granting incentives to develop infrastructure so that it can be beneficial to EV users, including the availability of grants to customers purchasing an EV, albeit reduced from the initial GBP 5000 to 2500 per EV under a capped threshold of GBP 35,000.

• The rate of investment into the United Kingdom EV rapid charging network supported by actual and forecast data from SMMT 2020 is displayed within the graph below.

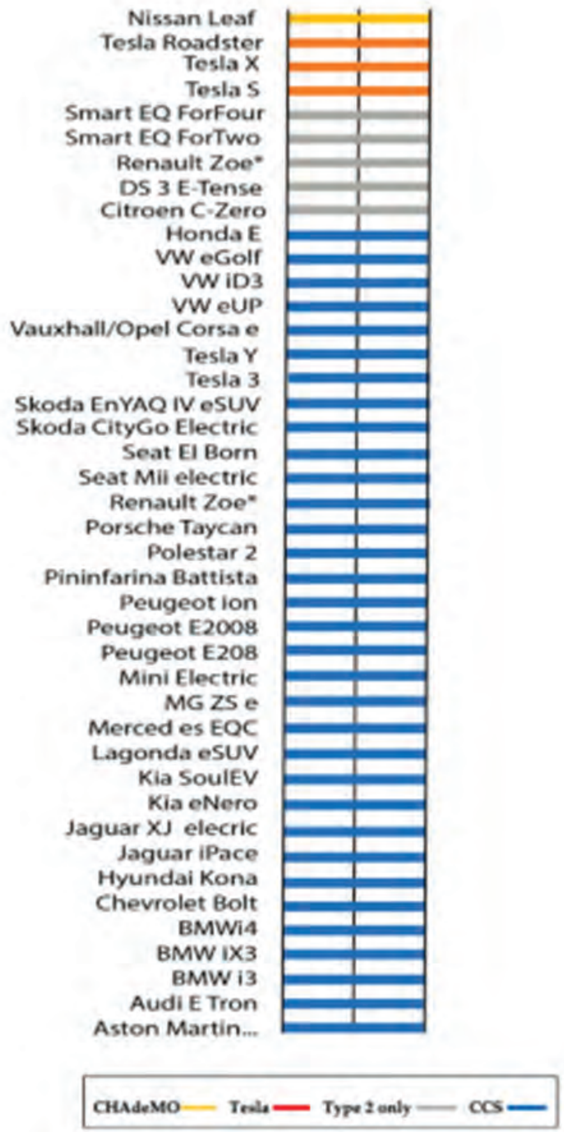


Annual UK investment in charging infrastructure (£millions)

The graphs below shows that CCS EVs amount to 78% of all new car production, with only two pure EV manufacturers using CHAdeMO, namely Nissan and Lexus. However, Nissan disclosed that its next model will adopt CCS as its charging standard. The remaining models will continue using either Type 2 connectors only or Tesla proprietary connectors.



CCS adoption in UK, versus CHAdeMO and Tesla



Charger connector types on UK EVs (sourced from each manufacturer—November 2020

2. India

• Bureau of Indian Standards (BIS) has setup ETD 51 which is a sectional committee for electrotechnology in mobility for making the new Indian standards for EV charging in 2021.

• EV charging standards currently in work by ETD 51 is shown below:

EV CHARGING

STANDARD	STATUS	ABOUT THE STANDARD
IS 17017-1	Published	Ev Charging general, Safety, Analog communications for EV Charging
IS 17017-21,22	Published	EMI/EMC
IS/IEC/ISO 15118	Published	Digital Communication for EV Charging (PLC)
IS 17017-24	Draft	Digital Communication for EV DC Charging (CAN)
IS 17017-25	Draft	DC Light EV
IS 17017-23	Draft	DC charging Station
IS 17017-23-1	Draft	DC Automated Pantograph

CCS vs. CHAdeMO vs Tesla UK charge point connector deployment

• Light EV AC charging standard is predicted to achieve a proper approval from BIS soon. This standard elaborates the definitions for low-cost chargers with 3.3 kW power output which maybe a subset of AC-001 which needs 3 power outlets per charger.

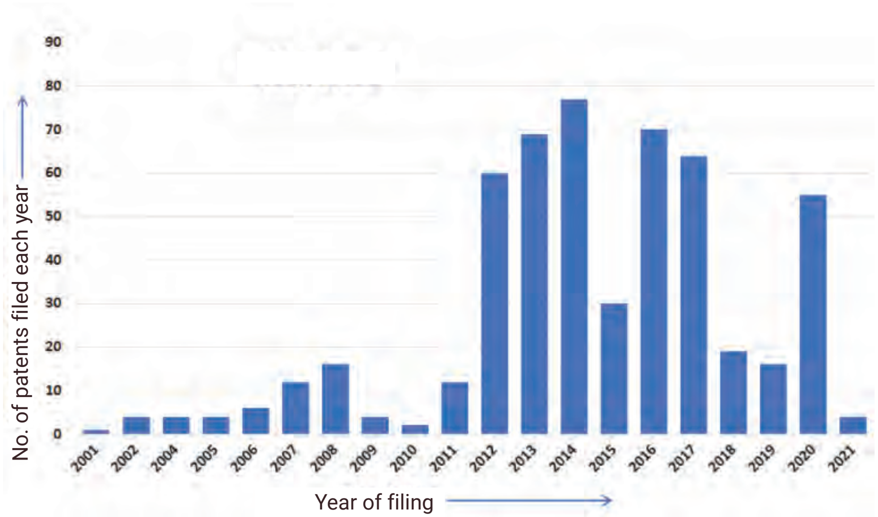
• The graph below shows that ever since the primary application in EV powertrain in 2001, patent filing peaked much later at over 75 patents in 2014, showcasing a sharp fall within the next year. Afterwards the filing activity fluctuated for a pairof years before falling sharply again in 2019.

• Interestingly, during the initiation of pandemic in 2020, approximately 55 patents were filed in this year.

• The majority of patents filed during this year were for 2-wheeler EVs.

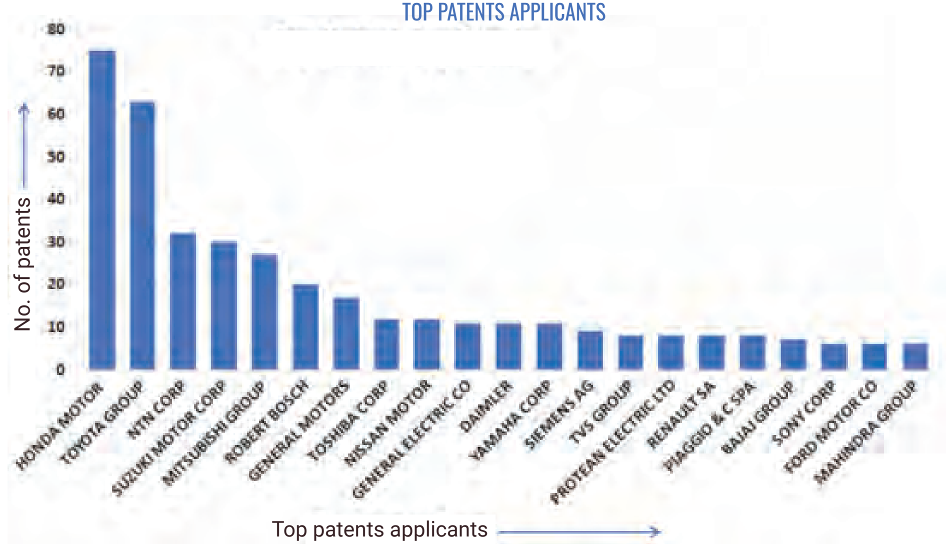
• Among the newest patents filed in 2021 is, IN202141012385A owned by TVS focuses on the positioning on 2 electric motors within the powertrain of 2 or 3 wheeled vehicles.

FILING TRENDS



No. of patent applications related to EV powertrain from 2001 to June 2021 in India

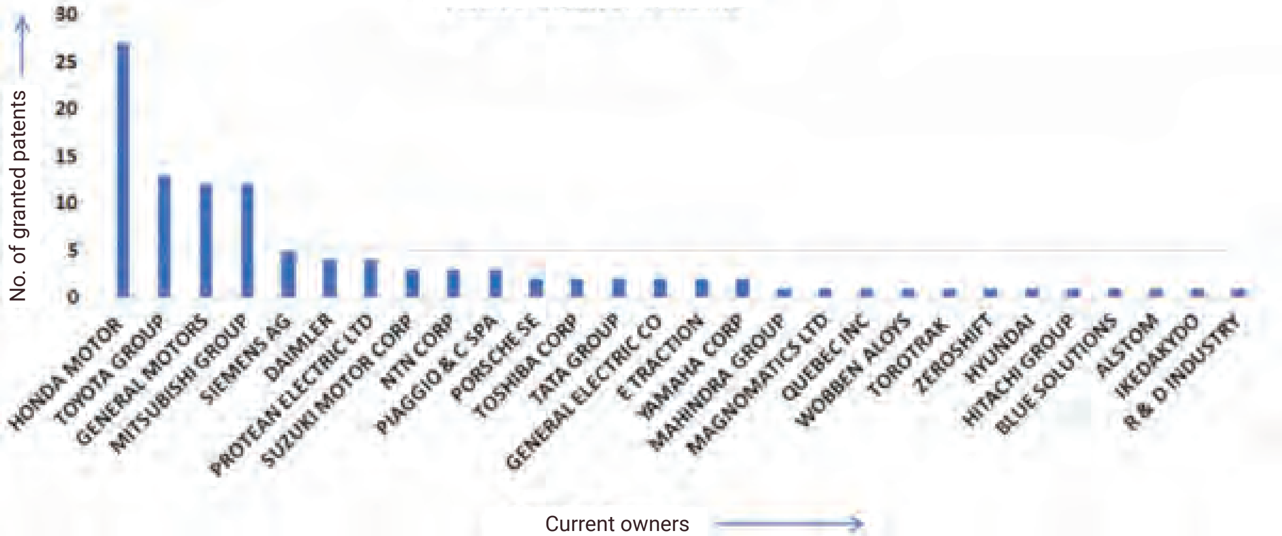
TOP PATENTS APPLICANTS



No. of patents filed by the top patent applicants in the EV powertrain segment to date

Companies with active granted patents in EV powertrain technologies

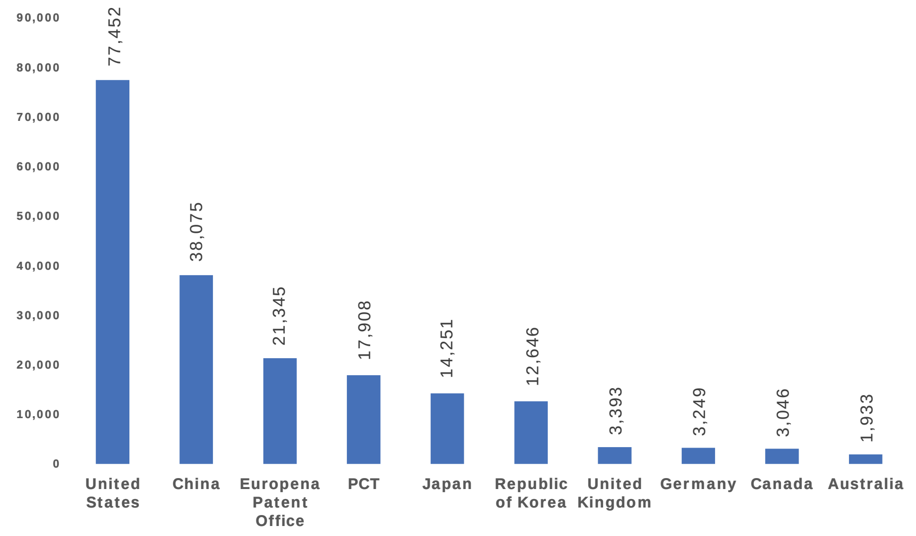
ACTIVE GRANTED PATENTS



3. Patent trends for EVs in general

• The highest demand, development, and manufacture of electrical vehicles is within the Asia-Pacific region, followed by Europe and thereafter, the USA.
• The USA and China are the highest regions within the world conducting most research within the field of EVs.
• Based on research and development, these regions filed largest number of patent applications in between the years 2010–2020.

• The last ten years have seen a dynamic change with respect to the patent trends within the wireless battery charging for electric vehicles.
• With less registration of mere 21 in the first year, the patent applications grew by approximately 100 per cent in the following year, summing to 43.
• The third year saw a decline where the recorded patents were only around 28, much lower than the previous year.
• The fourth year saw a slow rise, followed by the fifth, where the records showed 42 and 64 patent applications, respectively.
• The sixth year recorded 74 patents, while in the seventh year, the number of patents showed a rapid hike, and the count went to 116.
• The next year saw a drop in the number of patents where the number was approximately 92.
• The ninth and the tenth year recorded 110 and 92 patent records showing the dynamism in its nature.



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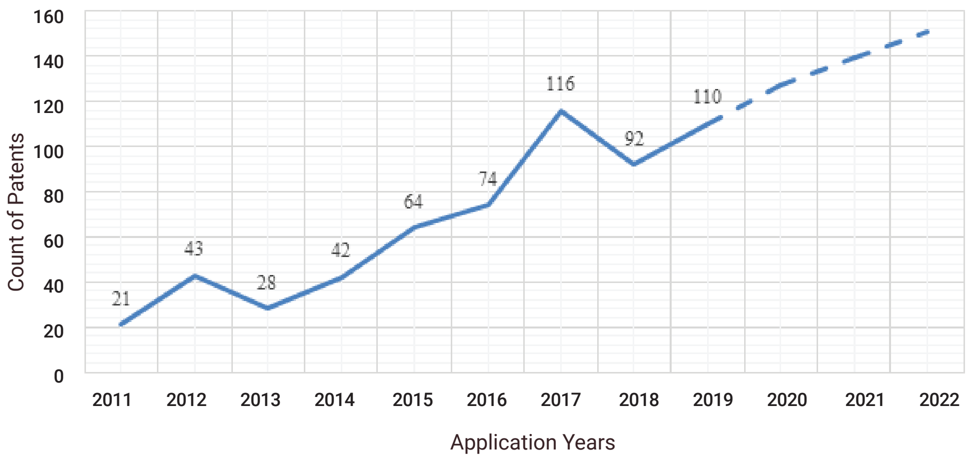


Patent trends for wireless battery charging for EV

4. Patent trends for EVs in general

Drivers for EV Charging Infrastructure:

• The growing adoption of electric cars across the globe may boost the market growth.

• Due to rising environmental problems, favourable initiatives, and government policies, there is an increase in the use of EVs across different regions. This is leading to a significant boost in the need for the EV charging station market.

• As the prices of petrol and diesel are rising rapidly, electric vehicles help in reducing the operating price of usage. Manufacturers are creating EVs with longer usage duration and better battery life that is boosting the market growth.

Problems and Challenges:

• The high costs included in initial investments for fast charging.

• The need for better batteries, and more charging time of EVs over fuel vehicles specifically in Level 1 and 2 charging.

• The non-uniform charging compatibility and therefore, the current trend of pricing and grid capacity of EVs are above fossil fuels.

Market Analysis:

UK

• The UK Government has earmarked £500M for investment in rapid charging infrastructure from 2020 to 2025, with the objective that drivers will never be more than 30 miles far from a rapid charging point.

• The objective of the Rapid Charging Fund is to make available at least 6, and up to 12, high-powered charge points at each motorway services area in England by 2023, and to reach 6,000 rapid charge points across England's motorways and major A roads by 2035.

Norway

• Norway is the world leader in EV adoption in terms of the percentage of zero-emission vehicles on the roads.

• Data from CleanTechnica shows that in August 2020 the plug-in passenger vehicle market share in Norway reached 70.2 percent.

Asia Pacific

The Asia Pacific market is projected to hold the largest share by 2027.

India

• The Government of India has aimed the electrification of 70% of all commercial vehicles, 30% of private cars, 40% of buses, and 80% of two-wheeler and three-wheeler sales by year 2030.

• This objective carries with it the need of simultaneous installations of charging stations across India.

• The Government of India has been supportive of the EV industry through schemes like: FAME1 and FAME2 with main focus on charging infrastructure.

• The Indian government has also disclosed plans that they are looking forward to equip 69,000 EV charging stations across India as part of its initial phase of EV infrastructure growth, which may have a requirement of 4 lakh charging stations by 2026.

• On the other hand, data from NextGreenCar proves that the combined EV market share in the UK in August 2020 was 9.8 percent.

China, Japan & Korea

• The Asia Pacific is expected to be the largest market.

• China's rapidly rising economy is driver for the expansion of advanced technologies for the improve electrification in the country.

• China has already spent an amount of approximately USD 2.4 billion until 2020 for the improvement of the charging facility infrastructure within the country.

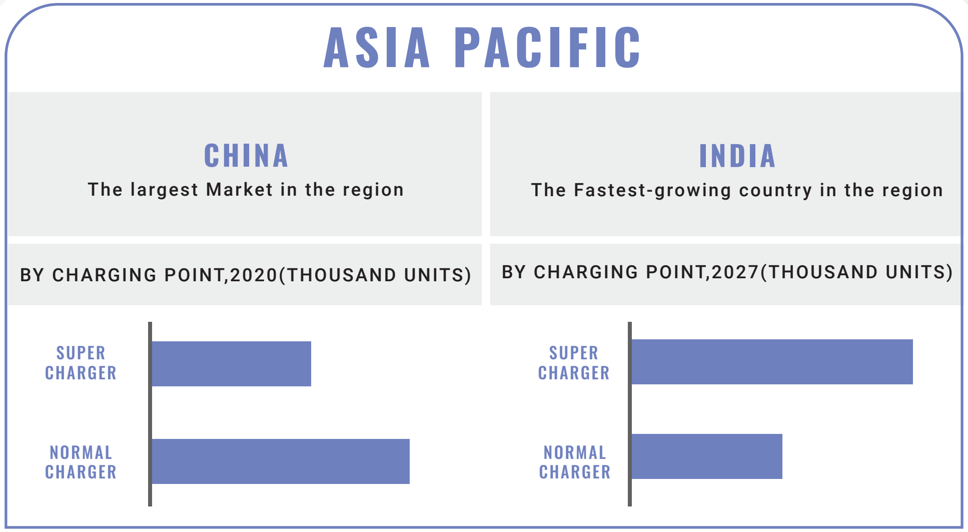
• The Japanese and Korean Governments have also taken measures for the improvement of the number of electric vehicle charging points across their countries in the following years.

• The Asia-Pacific region is the largest market worldwide for electric vehicle charging systems.

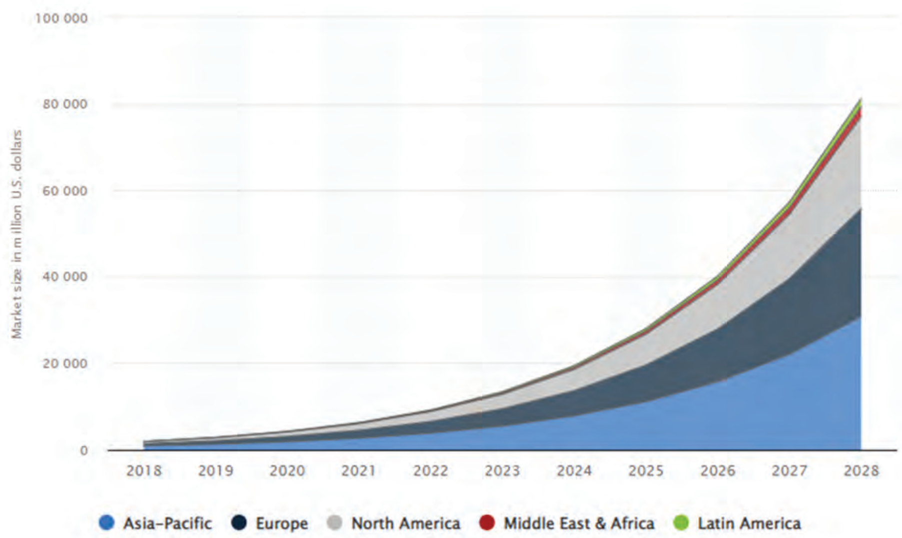
• By 2028, it is expected that the market within the APAC region may cross 30.8 billion U.S. dollars, rising at a CAGR of about 42% from 2.6 billion U.S. dollars in 2021.

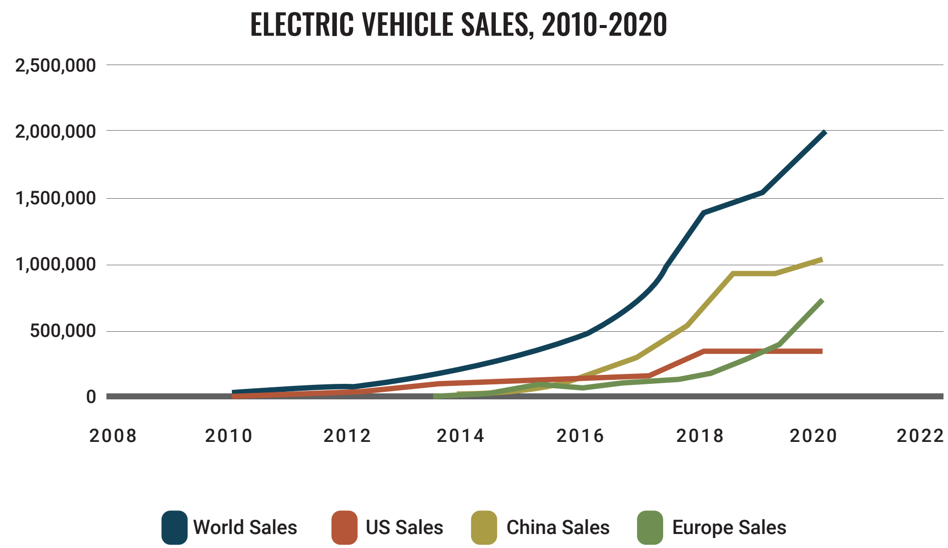
• The Asia-Pacific market represents about 38% of the global market for charging systems in 2028.

• It can be seen from the graph below.



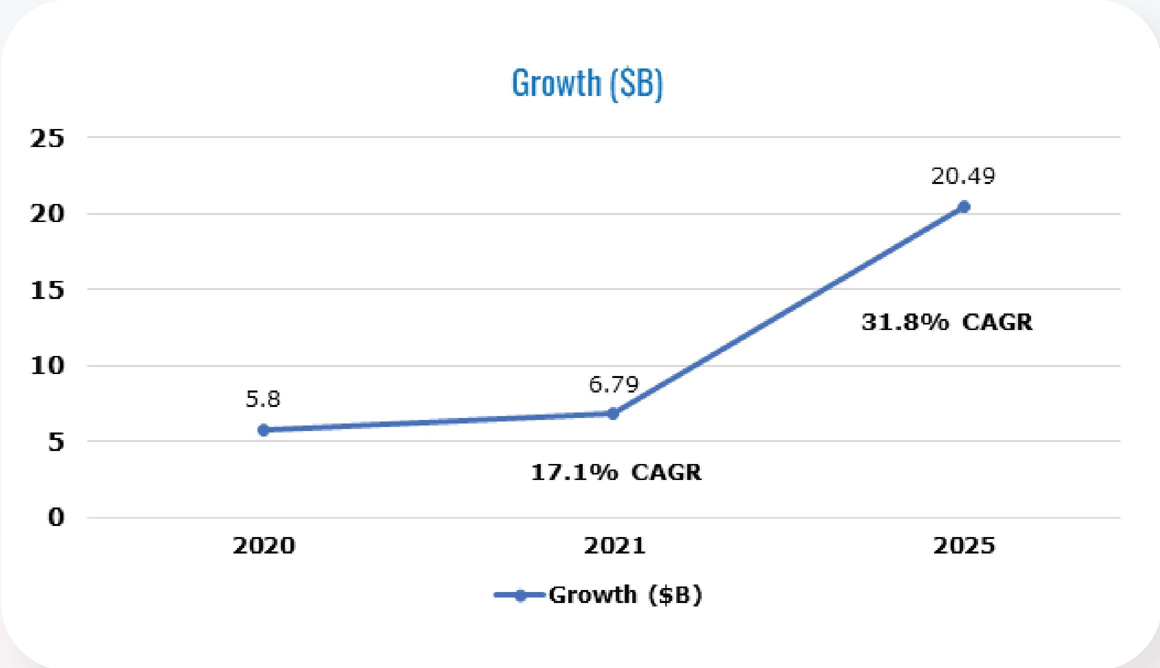
No. of patents filed by the top patent applicants in the EV powertrain segment to date





• The global electric vehicle charging stations market may rise from $5.8 billion in 2020 to $6.79 billion in 2021 at a CAGR of 17.1%.

• The market is expected to reach $20.49 billion in 2025 at a CAGR of 31.8%.



5. Licensors and Licensees

MPEG LA:

• It is a consortium that provides license to patents in various domains including wireless EV charging technology.

• It is the leading packager and provider of licenses for standards and many different technology platforms globally. They have built the pool market space.

• By providing assistance to the users for implementation of their technology choices, MPEG LA is also responsible for offering licensing solutions that gives access to fundamental intellectual property, freedom to operate, reduced litigation risk and predictability in the business planning process.

• In turn, this helps inventors, research institutions and other technology owners to monetize and fasten market adoption of their assets to a global market while substantially decreasing the licensing cost.

• Any organization that has patents which can prove to be essential to the EV Charging Standard, can be a part of this consortium.

• Some of the existing companies (licensors) that are a part of the consortium for EV charging are:

- GE Hybrid Technologies, LLC: 58 patents
- Mitsubishi Heavy Industries, Ltd: 9 patents
- Robert Bosch GmbH: 18 patents
- Siemens AG: 19 patents
- Sun Patent Trust: 2 patents

EV Charging Attachment 1

GE Hybrid Technologies, LLC

AT 2,199,143
BE 2,199,143
BG 2,199,143
CH 2,199,143
CN 102761156
CN 102810858
CN 103023093
CN 104002691
CY 2,199,143
CZ 2,199,143
DE 60 2009 055 930.3
DE 60 2009 063 932.3
DK 2,199,143
EE 2,199,143
ES 2,199,143
FI 2,199,143
FR 2,199,143
FR 2,379,363
GB 2,199,143
GB 2,379,363
GR 2,199,143
HR 2,199,143
HU 2,199,143
IE 2,199,143
IS 2,199,143
IT 2,199,143
JP 5,624,556
KR 1,934,938
LI 2,199,143
LT 2,199,143
LU 2,199,143
LV 2,199,143
MC 2,199,143
MK 2,199,143
MT 2,199,143
NL 2,199,143
NO 2,199,143
PL 2,199,143
PT 2,199,143
RO 2,199,143
SE 2,199,143
SI 2,199,143
SK 2,199,143
SM 2,199,143
TR 2,199,143
US 8,232,763
US 8,315,930
US 8,384,347
US 8,390,252
US 8,466,656
US 8,500,013
US 8,706,312
US 8,823,330
US 9,030,153
US 9,054,535
US 9,475,393
US 9,475,399
US 9,475,400

Mitsubishi Heavy Industries, Ltd.

JP 5,851,730
JP 5,901,906
JP 6,047,284
JP 6,140,430
JP 6,464,531
JP 6,539,903
JP 6,738,380
US Re. 48,406
US 10,850,630

Robert Bosch GmbH

CN 103648828
CN 103930297
CN 103959590
CN 104203636
CN 105922883
KR 1,976,223
US 6,650,120
US 8,624,719
US 8,710,796
US 8,860,366
US 8,886,391
US 8,890,473
US 9,024,744
US 9,121,073
US 9,124,104
US 9,278,620
US 9,487,099
US 9,590,416

Siemens AG

AT 2,678,185
BE 2,678,185
CH 2,514,056
CH 2,678,185
CN 102574476 B
CZ 2,678,185
DE 50 2010 008 152.6
DE 50 2010 012 131.5
DE 50 2012 001 693.2
ES 2,514,056
ES 2,678,185
FR 2,454,117
FR 2,514,056
FR 2,678,185
GB 2,514,056
GB 2,678,185
IT 2,454,117
IT 2,514,056
IT 2,678,185
LI 2,514,056
LI 2,678,185
NL 2,514,056
NL 2,678,185
PL 2,678,185
PT 2,678,185
SE 2,454,117
SE 2,678,185
TR 2,514,056
TR 2,678,185
US 8,850,226
US 9,227,519
US 9,283,863
US 9,783,068
US 10,263,413

Sun Patent Trust

US 8,860,559
US 9,090,174

List of patents by different licensors in MPEG LA

EV Charging Patent Portfolio License Cross-Reference Chart:

- The following chart shows illustrative essential claims for each patent.
- Other claims may also be essential and/or other portions of the Standard may be covered.

Many more similar patent claims for different patents are present in the source.

Ctry	Patent	Description	Cl	Standards / Sections
AT	2,199,143	System and Method for Electric Vehicle Charging and Billing Using a Wireless Vehicle Communication Device	1	IEC 61851-1:2017, Sec. 1 ISO 15118-1:2013, Secs. 1, 3.1.27, 3.1.30, 3.1.31, 3.1.33, 3.1.34, 3.1.58, 3.1.68, 5.5.4, 5.6.2, 6, 7.6.1, 7.6.2, 7.9.2, 7.11.2, B.1.2.1, B.1.2.2; Figs. 1, 2, 3; Tables 12, 31, 39, B.2
AT	2,678,185	Method for Establishing an IP-based Communications Connection Between an Electric Vehicle and a Charge Control Unit	1	ISO 15118-1:2019, Secs. 1, 3.1.12, 3.1.30, 3.1.31, 3.1.33, 3.1.57, 3.1.68, 7.2.1, 7.4.1, Tables 3 and 8 ISO 15118-2:2014, Secs. 1, 3.1, 3.2, 3.11, 7.4, 7.6, 7.6.3.3, 7.7.1.1, 7.8.2, 7.10.1.1, 7.10.1.4, 7.10.1.5, 7.10.1.7, Figs. 1 and 16, Table 8
BE	2,199,143	System and Method for Electric Vehicle Charging and Billing Using a Wireless Vehicle Communication Device	1	IEC 61851-1:2017, Sec. 1 ISO 15118-1:2013, Secs. 1, 3.1.27, 3.1.30, 3.1.31, 3.1.33, 3.1.34, 3.1.58, 3.1.68, 5.5.4, 5.6.2, 6, 7.6.1, 7.6.2, 7.9.2, 7.11.2, B.1.2.1, B.1.2.2; Figs. 1, 2, 3; Tables 12, 31, 39, B.2
BE	2,678,185	Method for Establishing an IP-based Communications Connection Between an Electric Vehicle and a Charge Control Unit	1	ISO 15118-1:2019, Secs. 1, 3.1.12, 3.1.30, 3.1.31, 3.1.33, 3.1.57, 3.1.68, 7.2.1, 7.4.1, Tables 3 and 8 ISO 15118-2:2014, Secs. 1, 3.1, 3.2, 3.11, 7.4, 7.6, 7.6.3.3, 7.7.1.1, 7.8.2, 7.10.1.1, 7.10.1.4, 7.10.1.5, 7.10.1.7, Figs. 1 and 16, Table 8
BG	2,199,143	System and Method for Electric Vehicle Charging and Billing Using a Wireless Vehicle Communication Device	1	IEC 61851-1:2017, Sec. 1 ISO 15118-1:2013, Secs. 1, 3.1.27, 3.1.30, 3.1.31, 3.1.33, 3.1.34, 3.1.58, 3.1.68, 5.5.4, 5.6.2, 6, 7.6.1, 7.6.2, 7.9.2, 7.11.2, B.1.2.1, B.1.2.2; Figs. 1, 2, 3; Tables 12, 31, 39, B.2
CH	2,514,056	Method for Testing Electrical Components in Main Supply	1	ISO 15118-2:2014, Secs. 1, 3.21, 7.3.1, 7.3.4, 7.5, 7.7.3.1, 7.7.3.2, 7.7.3.3, 7.7.3.4
CN	102761156	Charging System and Method for Monitoring an Electric Vehicle	1	GB/T 18487.1:2015, Secs. 2, 3.4.1, 5.2.1.1, A.1.1 IEC 61851-23: 2014, Sec. 6.4.1, pg. 11-12, Secs. 6.4.3.102, 6.4.3.114, Table CC.5, Fig. CC.6 ISO 15118-1: 2013, Sec 5.5.2

WiTricity:

• WiTricity Corporation is the one and only licensee of MIT patents for Wireless Energy Transfer.

• Since the initial discovery, WiTricity has filed many patent applications on its own innovations, including improvements to the technology, product and application specific uses of the technology, and architectures and designs for safety, efficiency, and control.

• Recently, WiTricity purchased Qualcomm Halo, adding certain Wireless Electric Vehicle Charging (WEVC) patents owned by Qualcomm and the exclusive license from Auckland UniServices.

• WiTricity has the exclusive right to license to interested parties the MIT and WiTricity patents in any field of use, and the Auckland patents in the field of road vehicle charging.

Some of the innovative global organizations who are licensing WiTricity technologies to bring standards-based and non-standard wireless charging products to market are:

- STMicroelectronics
- Toyota
- Systech
- Green Power
- ATC

Vehicle Charger System and Method	AU2011312376	Australia	16-Jun-16	WiTricity
Reconfigurable control architectures and algorithms for electric vehicle wireless energy transfer systems	US10,424,976	United States	24-Sep-19	WiTricity
Secure wireless energy transfer for vehicle applications	US9,698,607	United States	04-Jul-17	WiTricity
Multi power sourced electric vehicle	US8749334	United States	10-Jun-14	Auckland
Roadway powered electric vehicle system	US10,325,717	United States	18-Jun-19	Auckland

Conclusion

The identification of SEPs plays an important role in evaluating the own portfolio and as well as identifying other consortiums who have a pool of SEP patents which could be valuable in a cross-licensing deal. It is also important to identify which of the patents are standard essential to determine the monetary value of a patent in the industry. A lot of big companies are joining the consortiums like MPEG La to cross license the patents for an expedited evolution of the technology in Electric Vehicles.

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