Chargers of
Electric Vehicles
in Learning

EV charger curriculum

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Author: Tímea Baranyi, C-Evil partnership

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1 - Introduction

The objective of C-Evil project is to develop new learning and training materials on EV chargers in order to fill the gap in electricity education due to the sufficient and efficient multiplying activities. The growing number of electric vehicles needs more and more EV chargers which require adequate electricity professionals who can install, operate and maintain the equipment properly. Expert partners will provide a special knowledge that can be taught to electricians or future professionals (VET students). Together with the VET partners, they will elaborate materials that can be used anywhere in the EU.

The materials will cover the main areas connected to EV chargers such as charger types, electrical connections, licencing and permitting, installation, electricity standards, management, maintenance and error maintenance. We will put special focus on not only the hardware part of the EV chargers, but also on its software features, i.e. smart management applications. We would like to also highlight in the materials that, even though, there are general information that is valid everywhere, there are also rules and specifications that are different in every country. Country-specified information will be available which will make the materials more thorough.

In order to help understanding the terminology in the different languages, and to facilitate the employment in the EU, a glossary will be set up with the most important terminology in the project partners' languages.

Four intellectual outputs of the C-Evil project will be built upon each other. O1 will provide a solid base for the further activities of the project by defining the learning objectives (O1-T1), methodology and approach (O1-T2), and also developing the EV charger curriculum (O1-T3).

Based on the O1, the partnership will elaborate the content of the training materials (O2-T1). In further tasks of the O2, methodology of trainers' assessment (O2-T2) will be described, and trainers' feedback on the training materials will be collected (O2-T3).

O3 will include the elaboration of the learning materials (O3-T1) which will be the adaptation of the training materials in a student- and user-friendly way. Students will evaluate the learning materials (O3-T4) which requires a description of evaluation methodology (O3-T2). This IO will involve the development of the online learning space (O3-T3) where learning materials will be available for e-learning purposes.

For enhancing the spread and the adaptation of the project results, in O4, project partners will prepare guidelines and handbooks for the most important stakeholders: VET institutions (O4-T1), VET trainers (O4-T2), e-learners (O4-T3) and policy makers (O4-T4).

The partners are committed to disseminate the project results during and even after the project closure, through their daily activity. The outputs will be available on the project's platform, thus, it can be used for future projects and for further educational purposes.

Duration: 24 months

CAM is a micro-sized enterprise in Hungary, acting as lead partner of C-Evil. CAM as an expert organisation has great experiences in the field of electric mobility and in international co-operation covering professional and financial management.

The Turkish EGE University offers courses, inter alia, in the field of electrical-electronics engineering, their experts have expertise and experience related to electric mobility, especially chargers.

The Hungarian VET school, Kecskeméti Szakképzési Centrum Kandó Kálmán Szakgimnáziuma és Szakközépiskolája offers, among others, trainings for electricians. They have professional project experience in an electric car battery project.

The Romanian Colegiul Stefan Odobleja offers a wide range of qualifications in the field of, among others, mechanics and electronics, focusing on providing practical trainings to students. Automotive industry has a priority in their trainings.

Servicios Extremeños Enseña is a Spanish training center providing high-quality educational service. The institution also has experience in training material development and widespread partners to reach out to, including Spanish VET schools.

Learning Hub Friesland is a Dutch NGO enabling, driving and maximizing innovation in education in Friesland. They have experiences in training programme and training material development, organizing workshop and seminars and they have a broad network in the field of education, social sector, industry and governmental.

The Italian-Slovak Chamber of Commerce is an NGO with wide range of partner network. In C-Evil, they will ensure the representation of the labour market, and they can contribute significantly to the dissemination purposes.

Avaca Technologies is a Greek IT expert who has the required expertise for developing the project platform and also has many experiences in international projects on education.

At this stage of the Chargers of Electric Vehicles in Learning (C-Evil) project, the partnership has already defined our learning objectives, and the learning methodology and approach we would like to apply in the project. Based on the first two tasks, the development of the curriculum intends to organize all the important information, knowledge and instruction regarding EV charger knowledge.

The project partners together determine the main topics that the materials should include covering special knowledge and real-life examples as well as good practices. The main goal of this task is to define the topics and subtopics of the basic areas of the EV charger determined in the project proposal: introduction and types, installation, management and maintenance. These basic areas will constitute the main units of the training materials developed in the second intellectual output and the learning materials prepared in the third intellectual output.

By collecting the topics and types of knowledge in this task we intend to transfer to the students and distance learners, the partnership would like to facilitate the common work and workflow in the next tasks. Moreover, additional teaching materials, and types of assignments and evaluation materials, which seem useful and efficient at the current stage of the project, are collected. Project partners also list relevant sources in English or in their national languages connected to the defined topics. Any cultural or country-related specifications that should be involved in the materials are indicated in the current document.

In conclusion, the EV charger curriculum will serve as a basis and a source for good ideas for each project partner during the elaboration of the materials.

2 - Structure of the materials

This chapter contains the main the structure of the EV charger materials complemented by the planned subtopics and examples to be included. Additional information related to educational methodology or visualisation also indicated.

1. Introduction

The first unit will contain information on electric vehicles, batteries, chargers and specifications related to the electric network. It will give a general background for every student and e-learner about the sector and its characteristics. It will also create a common basis for the further units. The students will realize the importance and relevance of this course by understanding the sector's trends and future expectations, *Figures, flowcharts to be added for clear understanding. A video on how electric vehicles are the future and the relevance of the course for the student with the aim to spark their interest.*

1.1. History of Electric Vehicles

This section will give a background about electric vehicles before starting explaning the process of charging itself.

- evolution of electric vehicles: "milestones"; battery size; range; price trends; drive trains; newcomers and manufacturers entering the market; benefits of EVs
- hybrid EVs, full electric EVs, and their architectures
- EVs in your country (country specific section with some data on the status of EVs and chargers across the country)
- Electric vehicles in the future (trends and foresight): future scenarios, critical aspects and explanation how a move into EV could help the automotive sector to come out of the crisis and to help the reduction of pollution, especially particle pollution in the air
- Business opportunities of the sector for professionals

1.2. Battery Technologies for EVs

This section will introduce the main characteristics, restrictions and requirements of the charging. *Figures, flowcharts to be added for clear understanding. A short video clip of battery electric cars would raise the studens' motivation.*

- battery evolution (battery types, chemistry, pros and cons)
- how to interpret and understand the technical parameters of a car battery
- current technological trends
- price trends, safety regulations and measures
- battery degradation
- capacity preservation (e.g. best practices)
- effects of battery charging and depleting (C rate, SoC, cycles, heat)
- battery management systems, its functions and properties
- battery lifetime

- safe disposal of batteries, dangers connected with improper or careless handling of waste batteries (environmental protection)
- battery hazards
- energy storage possibilities (originally planned to 2.2.)

1.3. Charger Types

This section will help to understand the diffence among the several type of EV chargers such as fast chargers, DC or AC chargers etc. and the charging methodologies themselves.
Figures, flowcharts to be added for clear understanding.

1.3.1. Charging modes

- Mode 1: household AC socket and extension cord, no specific connector for EV, max. 16A per phase (3.7 kw- 11kW).
- Mode 2: household AC socket with special cable incorporating a protection device and a dedicated connector EV compatible with IEC 62196-2 , max. 32 A per phase (3.7 kw- 22kW).
- Mode 3: Fixed, AC charger with dedicated connector for EV which is compatible with IEC 62196, single or three-phase grid, max. power depends on the connector used, communication of charger with EV car.
- Mode 4: Fast DC charger with dedicated car socket, max. power depends on the connector used, communication of charger with EV car.

1.3.2. Charging types

- on-board charging
- off-board charging
- How to interpret and understand the technical parameters of a car battery charger

1.3.3. Pros and cons of AC and DC charging (technical and economic aspects)
1.3.4. Regulations
1.3.5. Charging “speed”
1.3.6. Destination charging
1.3.7. Home charging
1.3.8. Charging at work
1.3.9. High Speed Charging (special requirements)
1.3.10. DC fast charging

1.4. Electrical connections

This section will explain the electrical connection towards both vehicles and electricity network.
Figures, flowcharts to be added for clear understanding.

1.4.1. Connector types (CHAdeMO, ISO/IEC 11518, IEC62196-2, SAE J1772, SAEJ1773)
1.4.2. Regulations and trends
1.4.3. Manufacturers and proprietary standards
1.4.4. The effect of EV chargers on utility grid infrastructure, how to prevent negative effects, smart grids and Evs

1.4.5. Advantages and inconveniences of electric motors in vehicles
1.4.6. Electric safety of the connectors

2. Installation

The second unit will explain the steps of installation of the EV chargers. Students and e-learners will learn how to install an EV charger considering all electricity and safety standards. The content will cover not only the technical part of the process but also provide insight to the legal framework of the installation. The safety standards and legal framework should be country specific and provided only in local language.

2.1. Licensing and permitting

It will include rules and regulations at European Union and also national level. The topic should be learner-centered, focusing on what an electrician is responsible for. Country-specific content only to be provided in local language.

2.1.1. Licensing and permitting deal flow (local/domestic/regional requirements)

- National licencing information for each countries regarding installation of EV charging station.

2.1.2. EU and local regulations

- Regulations from all participant countries for installation of EV charge station is required.

2.2. Installation

This section will contain information about what aspects the professionals should consider while planning the installation. Besides information for making preparations, the section will also introduce the main steps of installation. This chapter will be elaborated taking into account the responsibilities of an electrician. While it is important to understand the whole installation process, it is also noted that an electrician is not responsible for planning the EV charging station pr planning the use of renewable energy. They can install home EV chargers or check the adequacy of the electrical network for EV chargers. They can also do the physical installation work of public EV chargers.

- Choosing the right charging station for customer
- EV charging station architecture
- Utility connection requirements
- Renewable energy integration (HVDC photovoltaic & wind etc.) possibilities
- Energy storage possibilities (it’s also in 1.2)
- AC charging unit details (for home & work and small parking lots)
- DC charging unit details (for large parking lots, fast charging stations, highway charge stations etc.)
- Electrician installation works
- Installation schemes for recharging of vehicles
- How to budget the installation and configure charging stations

2.3. Safety considerations

Regulations and guidelines will be introduced in this section in order to be able to execute all related works while taking into account and applying all necessary safety rules.

- Electrical safety from charging socket to the EV
- Charging safety guidelines for EVs
- Selection the electrical equipment – isolation, standards etc.
- RCD, Residual current device
- Personnel protection systems
- Risk assessment, pre & post installation checklists

2.4. Electricity standards

This section will provide information about protection against fire, moisture and electric shock.

3. Management

The third unit will focus on the management of the EV chargers – from a regular and also from a smart management point of view. Students and e-learners will understand the main functions which are required for the proper operation of the charging stations. The unit will include the introduction of smart tools and functions.

3.1. Management of EV chargers

Figures, flowcharts to be added for clear understanding.

- Operation aspect
- SLA
- Transaction records
- Payment
- Billing
- Regulations
- Trends
- Management systems
- Connection to systems
- OCPP protocol

3.2. Smart management

Figures, flowcharts to be added for clear understanding.

- smart solutions
- energy management
- smart city aspects
- DSO connection
- smart function (automated functions, AI functions)

4. Maintenance

The fourth unit will contain information about how to maintain the chargers to keep them in shape and what to do when an error occurs.

4.1. Error management

Students and e-learners will get information about what type of errors can occur and what process they should follow while solving the problem.

Figures, flowcharts to be added for clear understanding.

- ticketing
- technical personnel requirements and training
- deal flow
- smart management
- typical errors

4.2. Regular maintenance (average lifetime)

In this section, recommended maintenance aspects will be collected in order to ensure the proper operation of the chargers and to reach the most of their expected lifetime.

- local requirements (e.g. measurement device reading and checking)
- typical maintenance issues
- warranty

4.3. EV charger fault diagnoses

This section will provide insight to the process of the fault diagnoses.

- Localization of the fault (Flowcharts)
- Checking the safety equipments (i.e. RCD device, fuses etc.)
- Necessary electrical measurements
- Grounding issue, checking the grounding circuit.
- Electrical safety (see: 2.3)

3 – Evaluation

At this stage of the project, the partnership has already thought about the different evaluation test types that we can use in the project. Overviewing the planned detailed structure of the materials, a few partners also made further recommendations and aspects we should take into account.

EGE

The evaluation of the materials will focus on the understanding level of the whole content. Students will take an online exam for evaluating their knowledge on EV chargers. Each unit will contain 1 (one) online quiz which includes XX questions. The criterion of this quiz to be passed should be 70%.

LHF – for classroom teaching

At the beginning of the course, we should give students an assignment before they start learning on the subject. An assignment could be that they do research and present how they think the future of mobility will look like in the year 2120.

Related to 1.3. Charger types chapter, an assignment can be to make photos of 5 different charger types in the students' neighbourhood.

KANDÓ

An initial test, especially in case of classroom teaching, can be essential to assess the current knowledge of the students and their interest and motivation in the topic.

Summative validation should be used for the professional part of the knowledge. This test can include:

- Image recognition (e.g. charger types)
- True or false questions
- Matching images and definitions
- Multiple choice quiz questions (with one or more true correct answers)
- Fill-in sentences with one or multiple words
- Open-ended questions

Concerning the online platform, there are good examples that can be useful in our project, too.

1. www.redmenta.com

This platform requires registration from both teachers and students, but here are a few images for the question types and their design.

Multiple choice quiz question

Hogyan nevezzük azt az áramerősség értéket, amikor az ember izomgörcsöt kap, de még képes kijönni a villamos körből? 1/1 pont

mozgást gátló áramerősség	0 pont	
érzetküszöb	0 pont	
veszélyes áramerősség	0 pont	
elengedési áramerősség	**1 pont**	✔

Értékeld a feladatot 0/5 csillag *Légy te az első, aki értékeli ezt a feladatot!*

True or false question

Döntsd el, hogy igazak vagy hamis-e az alábbi állítás! Az emberi test ellenállása 1 kΩ. 1/1 pont

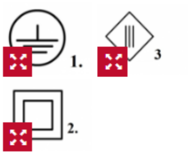
1 kΩ (Igaz)	**1 pont**	✔

Értékeld a feladatot 0/5 csillag *Légy te az első, aki értékeli ezt a feladatot!*

Matching images and definitions

Párosítsd az érintésvédelmi osztályokat és a hozzájuk tartozó jelöléseket! 9/9 pont

Jó válasz: 3 pont, Rossz válasz: 0 pont



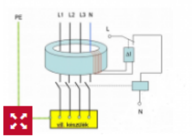
	A helyes megoldás	Általad megjelölt válasz	
I. érintésvédelmi osztály	1	1	✔
III. érintésvédelmi osztály	3	3	✔
II. érintésvédelmi osztály	2	2	✔

Értékeld a feladatot 0/5 csillag *Légy te az első, aki értékeli ezt a feladatot!*

Image recognition and short text explanation

Mit látsz az alábbi ábrán? Írd le saját gondolataiddal a működési elvét! 6/6 pont

Tartalom 6/6 pont Szerkesztés



Áram védő kapcsoló
müködési elve: figyeli a bemenő és kimenő áramok összegét és ha nem egyezeik akkor egy életvédelmi relé lekapcsol

Értékeld a feladatot 0/5 csillag *Légy te az első, aki értékeli ezt a feladatot!*

Open-ended question with list

Írd le röviden, hogy mi az érintésvédelem feladata! 1/1 pont

Felülpontozás: 1/1 pont Szerkesztés

Ha egy berendezés meghibásodik ne szenvedjünk áram ütést

A helyes megoldás:
baleset elhárítása - 1 pont
baleset megakadályozása - 1 pont
balesetmegelőzés - 1 pont
villamos baleset megakadályozása - 1 pont

Értékeld a feladatot 0/5 csillag *Légy te az első, aki értékeli ezt a feladatot!*

2. Google Classroom

During the COVID-19, Kandó school used Google Classroom for the digital education. One of its advantages was that everything could be handled in one place, e.g. uploading digital materials, sharing evaluation tests. Consequently, it can be used for both classroom and distance teaching.

Similarly to Redmenta, Google Classroom is also able to schedule the access of the students (seperately or as a whole class) to the tests which are based on Google Forms.

Matching defintions

Párosíts a transzformátornál az üzemállapotokat a kialakult áramokhoz! *

	mágnesezési áram	fogyasztó kielégítése	névleges áram 30 szoro...
Üresjárás	○	○	○
Terhelés	○	○	○
Zárlat	○	○	○

Multiple choice question with question

Milyen villamos gépet látsz az alábbi ábrán? *

- ○ Aszinkron
- ○ Szinkron
- ○ Egyenáramú

Multiple choice quiz question

Mit jelentenek a betűk a következő kifejezésben Dy5? *

- ☐ D= primer tekercs deltában van kötve
- ☐ D=szekunder tekercs deltában van kötve
- ☐ y=primer tekercs csillagba van kötve
- ☐ y=szekunder tekercs csillagba van kötve

4 – Country-specific information

The present table summarizes in which section we expect to provide national, local information such as data, legislation or statistics.

UNITS AND SECTIONS	TYPE OF COUNTRY-SPECIFIC INFORMATION
1. Introduction	
1.1. History of Electric Vehicles	- Current status of EVs and chargers in each participating county (some basic data: number, coverage etc.) - Future trends or predictions on national level
1.2. Battery Technologies	
1.3. Charger Types	
1.4. Electrical Connections	
2. Installation	
2.1. Licensing and Permitting	- National licencing information for each country regarding installation of EV charging station. *e.g. In Turkey, no licencing is required. It is enough to make a contract with local electricity Distribution Company.* - Regulations from all participant countries for installation of EV charge station is required. *e.g. In Turkey, general safety regulations held by local distribution company must be followed. Additionally, parking lots (of shopping malls, car parks etc.) should have at least one EV charging slot for every 50 vehicle. Moreover, gas stations can be transformed to EV charge station without licencing.*
2.2. Installation	
2.3. Safety Considerations	
2.4. Electricity Standards	
3. Management	
3.1. Management of EV Chargers	- Local legal background for the role of Charge Point Operator and e-Mobility Service Provider
3.2. Smart Management	

4. Maintenance	
4.1. Error Management	
4.2. Regular Maintenance	- Local requirements (e.g. measurement device reading and checking)
4.3. EV Charger Fault Diagnoses	

5 – List of relevant sources

This chapter includes the list of collected sources (books, online sources, videos, websites etc.) which can be used during the elaboration of the training materials and/or can be added to a reading list for providing further information to students and e-learners.

1. Introduction

1.1. History of Electric Vehicles

Title	Author	Hyperlink or Publisher & Publishing Date	Language
Electric vehicles charge forward	C. C. Chan and Y. S. Wong	IEEE Power and Energy Magazine, vol. 2, no. 6, pp. 24-33, Nov.-Dec. 2004, doi: 10.1109/MPAE.2004.1359010, Link	English
Charge! EVs power up for the long haul	C. B. Toepfer	IEEE Spectrum, vol. 35, no. 11, pp. 41-47, Nov. 1998, doi: 10.1109/6.730519, Link	English
A Brief History and Evolution of Electric Cars	Christopher McFadden	Link	English
Az elektromos autózás rövid története	Unkown	Link	Hungarian

1.2. Battery Technologies

Title	Author	Hyperlink or Publisher & Publishing Date	Language
Electric Vehicle Batteries Eye Solid-State Technology: Prototypes Promise Lower Cost, Faster Charging, and Greater Safety	A. Bindra	IEEE Power Electronics Magazine, vol. 7, no. 1, pp. 16-19, March 2020, doi: 10.1109/MPEL.2019.2961203 Link	English
The prospects of panel style nano-battery technology for EV/HEV	A. Rahman, M. Rashid, A. K. M. Mohiuddin and H. Moktar	2015 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM), Singapore, 2015, pp. 1531-1535, doi: 10.1109/IEEM.2015.7385903, Link	English

Electric vehicle battery technologies: From present state to future systems	Sergio Manzetti – Florin Mariasiu	Link	English
Performance and cost of materials for lithium-based rechargeable automotive batteries	Richard Schmuch et al.	Link	English
Current Li-Ion Battery Technologies in Electric Vehicles and Opportunities for Advancements	Yu Miao et al.	Link	English
Advances in battery technologies for electric vehicles	Bruno Scrosati et al.	Link	English
Five emerging battery technologies for electric vehicles	Jack Karsten and Darrell M. West	Link	English
Impacts of Electric Vehicles - Deliverable 2. Assessment of electric vehicle and battery technology	Gopalakrishnan Duleep et al.	Link	English
Technology Development of Electric Vehicles: A Review	Xiaoli Sun et al.	Link	English
Electric vehicles and battery technologies	VTT	YouTube link	English
Innovation in Battery Technologies for Electric Vehicles	n.a.	Link	Romanian
Akkumulátor technológia: a jövő akkumulátorai	Peter Magyar	Link	Hungarian

1.3. Charger Types

Title	Author	Hyperlink or Publisher & Publishing Date	Language
Different fast charging methods and topologies for EV charging	N. Trivedi, N. S. Gujar, S. Sarkar and S. P. S. Pundir	2018 IEEMA Engineer Infinite Conference (eTechNxT), New Delhi, 2018, pp. 1-5, doi:10.1109/ETECHNXT.2018.8385313, Link	English
Fast charging system of electric vehicle (EV) based on hybrid energy storage system	F. Liu, J. Liu, B. Zhang and H. Zhang	2012 Twenty-Seventh Annual IEEE Applied Power Electronics Conference and Exposition (APEC), Orlando, FL, 2012, pp. 2115-2120, doi: 10.1109/APEC.2012.6166113, Link	English
A Bidirectional Wireless Power Transfer EV Charger Using Self-Resonant PWM	J. Lee and B. Han	IEEE Transactions on Power Electronics, vol. 30, no. 4, pp. 1784-1787, April 2015, doi: 10.1109/TPEL.2014.2346255	English
Elektromos autó töltő típusok	e-cars.hu	Link	Hungarian

1.4. Electrical Connections

Title	Author	Hyperlink or Publisher & Publishing Date	Language
Grid integration of DC fast-charging stations for EVs by using modular li-ion batteries	M. Gjelaj, S. Hashemi, C. Traeholt and P. B. Andersen	IET Generation, Transmission & Distribution, vol. 12, no. 20, pp. 4368-4376, 13 11 2018, doi: 10.1049/iet-gtd.2017.1917 Link	English
Power quality and stability impacts of Vehicle to grid (V2G) connection	E. Alghsoon, A. Harb and M. Hamdan	2017 8th International Renewable Energy Congress (IREC), Amman, 2017, pp. 1-6, doi: 10.1109/IREC.2017.7925995 Link	English
Electrical Vehicle Charging	niceic.com	Link	Hungarian

2. Installation

2.1. Licensing and Permitting

Title	Author	Hyperlink or Publisher & Publishing Date	Language
Efficient Allocation of Electric Vehicles Charging Stations: Optimization Model and Application to a Dense Urban Network	F. Baouche, R. Billot, R. Trigui and N. El Faouzi	IEEE Intelligent Transportation Systems Magazine, vol. 6, no. 3, pp. 33-43, Fall 2014, doi: 10.1109/MITS.2014.2324023 Link	English
243/2019. (X. 22.) Korm. Rendelet az elektromobilitás szolgáltatás egyes kérdéseiről	Hungarian Government	Link	Hungarian
Határozat: elektromos gépjármű töltésére vonatkozó engedély	A Magyar Energetikai és Közmű-szabályozási Hivatal	Link	Hungarian
Töltőtelepítés szabályai Magyarországon – 100 milliós bírság a tét!	n.a.	Link	Hungarian

2.2. Installation

Title	Author	Hyperlink or Publisher & Publishing Date	Language
How Electric Vehicles and the Grid Work Together: Lessons Learned from One of the Largest Electric Vehicle Trials in the World	J. Quiros-Tortos, L. Ochoa and T. Butler	IEEE Power and Energy Magazine, vol. 16, no. 6, pp. 64-76, Nov.-Dec. 2018, doi: 10.1109/MPE.2018.2863060 Link	English
VEHICLE-TO-GRID NETWORKS	D. H. K. Tsang, Y. Zhang, Y. Wu and A. Leon-Garcia	IEEE Network, vol. 31, no. 2, pp. 6-7, March/April 2017, doi: 10.1109/MNET.2017.7884942 Link	English

How-To Guide: electrical vehicle charger installation	City of Boston brochure	Link	English

2.3. Safety Considerations

Title	Author	Hyperlink or Publisher & Publishing Date	Language
Electrical safety of electric vehicle.	F. Freschi, M. Mitolo and R. Tommasini	2017 IEEE/IAS 53rd Industrial and Commercial Power Systems Technical Conference (I&CPS), Niagara Falls, ON, 2017, pp. 1-5, doi: 10.1109/ICPS.2017.7945109 Link	English
Electrical Safety Considerations in Large-Scale Electric Vehicle Charging Stations	B. Wang, P. Dehghanian, S. Wang and M. Mitolo	IEEE Transactions on Industry Applications, vol. 55, no. 6, pp. 6603-6612, Nov.-Dec. 2019, doi: 10.1109/TIA.2019.2936474, Link	English
Safety considerations for electric vehicles and regulatory activities	Costandinos Visvikis	Link	English

2.4. Electricity Standards

Title	Author	Hyperlink or Publisher & Publishing Date	Language
Performance Evaluation of a Multi-Standard Fast Charging Station for Electric Vehicles	I. Zenginis, J. Vardakas, N. Zorba and C. Verikoukis	IEEE Transactions on Smart Grid, vol. 9, no. 5, pp. 4480-4489, Sept. 2018, doi: 10.1109/TSG.2017.2660584, Link	English
IEEE 1609 WAVE and IEC 61850 Standard Communication Based Integrated EV Charging Management in Smart Grid	S. M. S. Hussain, T. S. Ustun, P. Nsonga and I. Ali	IEEE Transactions on Vehicular Technology, vol. 67, no. 8, pp. 7690-7697, Aug. 2018, doi: 10.1109/TVT.2018.2838018, Link	English
Electric Vehicle Charging Technology Analysis And Standards	Doug Kettles	Link	English

3. Management

3.1. Management of EV Chargers

Title	Author	Hyperlink or Publisher & Publishing Date	Language
Deploying Electric Vehicles Into Shared-Use Services: Amping up Public Charging Demand to Justify an Investment in Infrastructure	P. Kosak	IEEE Electrification Magazine, vol. 7, no. 1, pp. 32-38, March 2019, doi: 10.1109/MELE.2018.2889548 Link	English
Managing the Charging of Electrical Vehicles: Impacts on the Electrical Grid and on the Environment	R. Faria, P. Moura, J. Delgado and A. T. de Almeida	*IEEE Intelligent Transportation Systems Magazine*, vol. 6, no. 3, pp. 54-65, Fall 2014, doi: 10.1109/MITS.2014.2323437 Link	English
Electric Vehicles Charging: Management and Control Strategies	F. J. Soares, D. Rua, C. Gouveia, B. D. Tavares, A. M. Coelho and J. A. P. Lopes	IEEE Vehicular Technology Magazine, vol. 13, no. 1, pp. 130-139, March 2018, doi: 10.1109/MVT.2017.2781538 Link	English
Development and trends in Electric Vehicles and charging infrastructures	Joan Pallisé	Link	English
Charging ahead: Electric-vehicle infrastructure demand	Hauke Engel, Russell Hensley, Stefan Knupfer, and Shivika Sahdev	Link	English

3.2. Smart Management

Title	Author	Hyperlink or Publisher & Publishing Date	Language
Profitability analysis of grid supporting EV charging management	R. Uhlig, S. Harnisch, M. Stötzel, M. Zdrallek and T. Armoneit	CIRED - Open Access Proceedings Journal, vol. 2017, no. 1, pp. 1945-1948, 10 2017, doi: 10.1049/oap-cired.2017.0219 Link	English
Assessment of Technical and Economic Impacts of EV User Behavior on EV Aggregator Smart Charging	J. Clairand, J. Rodríguez-García and C. Álvarez-Bel	Journal of Modern Power Systems and Clean Energy, vol. 8, no. 2, pp. 356-366, March 2020, doi: 10.35833/MPCE.2018.000840 Link	English
ELECTRIC-VEHICLE SMART CHARGING INNOVATION LANDSCAPE BRIEF	IRENA	Link	English
What is OCPP? What is OCPP's relevance to Electric Vehicle Charging?	Evreporter	YouTube link	English

4. Maintenance

4.1. Error Management

Title	Author	Hyperlink or Publisher & Publishing Date	Language
State of charge, state of health, and state of function monitoring for EV BMS	Zong-You Hou, Pang-Yen Lou and C. Wang	2017 IEEE International Conference on Consumer Electronics (ICCE), Las Vegas, NV, 2017, pp. 310-311, doi: 10.1109/ICCE.2017.7889332, Link	English
Electric cars: technical characteristics and environmental impacts	Eckard Helmers & Patrick Marx	Link	English

4.2. Regular Maintenance

Title	Author	Hyperlink or Publisher & Publishing Date	Language
Research on coordinated charging and influence of EV based on distributed charge control	C. Xu, J. Shi, X. Han, J. Ma and D. Lv	2017 Chinese Automation Congress (CAC), Jinan, 2017, pp. 5766-5769, doi: 10.1109/CAC.2017.8243813, Link	English
Controlling EV charging and PV generation in a low voltage grid	J. Groenbaek, S. Bessler and C. Schneider	22nd International Conference and Exhibition on Electricity Distribution (CIRED 2013), Stockholm, 2013, pp. 1-4, doi: 10.1049/cp.2013.1150 Link	English
Impacts of Electric Vehicles - Deliverable 2 - Assessment of electric vehicle and battery technology	Gopalakrishnan Duleep (ICF) Huib van Essen (CE Delft) Bettina Kampman (CE Delft) Max Grünig (Ecologic)	CE-publications are available from www.cedelft.eu., Delft, April 2011	English
Electric cars vs Petrol cars	Learn Engineering	YouTube link	English

4.3. EV Charger Fault Diagnoses

Title	Author	Hyperlink or Publisher & Publishing Date	Language
A fuzzy logic approach for fault diagnosis and recovery in PHEV and EV chargers	W. Chen, L. Wang, A. Ulatowski and A. M. Bazzi	2014 IEEE Transportation Electrification Conference and Expo (ITEC), Dearborn, MI, 2014, pp. 1-5, doi: 10.1109/ITEC.2014.6861758, Link	English
Fault Diagnosis of Power Components in Electric Vehicles	Fei Lin, K. T. Chau, C. C. Chan, Chunhua Liu	Link	English