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Disclaimer

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¹ <https://ev4eu.eu/>

Executive Summary

The *Regulatory opportunities and barriers for V2X deployment in Europe* deliverable is the main report produced out of the work conducted in Task 1.3 of EV4EU named *Regulatory Challenges and Design (GAP identification)*. It presents a study of the regulatory and legislative framework around Electric Vehicles (EVs), their integration to the power system and transportation network and the accompanying charging infrastructure. The study analyses the regulatory ecosystem on a pan-European Union level first and then on a national level, focusing on the four countries hosting an EV4EU demonstration. It is important to highlight that not only strictly EV related topics were covered but all regulation and legislation that applies to the general problem of EV integration such as union-wide or nationwide energy policy, local markets and flexible demand in general, renewable energy, data management and cyber-security.

EV4EU is focused on EVs and their integration under mass deployment conditions with a special interest in V2X technology and policy. The project includes four demonstration sites: *a)* the Mesogia region in Greece, *b)* the Azores in Portugal, *c)* Krško in Slovenia and *d)* the island of Bornholm in Denmark. The demonstrators will test EV charging and V2X functionalities under different conditions and scenarios.

The first main product of this report is the analysis of the relevant European Union (EU) regulations and directives. The research that was conducted focused on 4 categories. First, EU Energy Policy which set the broad EU goals on energy and climate and directly affects EV related goals. Second, EVs and Charging infrastructure was studied, where a number of Directives and Regulations set rules on vehicle safety, charging points goals and CO₂ emissions, among others. Third, a series of legislation pieces were discussed on distributed energy resources, demand flexibility, electricity markets and power systems in general. Two of the most important pieces are Regulation 2019/943 and Directive 2019/944 on electricity markets. Fourth, on the topic of data, Regulation 2016/679 (GDPR) stands out as one of the most important.

On a national level, the four different countries show a variety of relevant legislative initiatives. In Greece, since 2019, a significant body of new legislation has passed which aims to help the country catch up with the rest of the union in terms of EV penetration. The flagship pieces of legislation are called “KINOUME ELEKTRIKA” I and II and include a variety of rules, incentives, and provisions. Portugal on the other hand, has established a national plan for electromobility already since 2009, i.e., Resolution No.20/2009 but the country continues to expand on EV legislation with the most recent law, on Zero Emission Vehicle, established in 2022. Similarly, Slovenia has adopted a number of incentives for EV uptake that adopt EU regulations and directives whereas, as recently as the Act on Efficient Use of Energy (ZURE) mandates the construction of charging points in new or renovated buildings. In Denmark, in recent years, topics such as monetary incentives, charging stations and smart meters are prominent.

Finally, one of the main products of this deliverable is the identification of gaps, barriers and opportunities after all frameworks are analyzed and, when applicable, in relation to EV4EU activities. In Greece, the main opportunity is the expansion of demand flexibility related legislation to local markets giving the system operator more tools to manage network conditions with EVs and Vehicle-to-Everything (V2X) being one of the most critical resources. Similarly, in Portugal V2X is not legislatively covered. In Slovenia, one of the main barriers is the lack of an encouraging environment for installing chargers in multi-apartment buildings, whereas in Denmark it is the fragmented public charging network.

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Acronyms

BEV	Battery Electric Vehicle
BSO	Basic Services Operator
CHP	Combined Heat and Power
COP21	Paris Climate Conference
CPH	Charging Point Holder
CPO	Charging Point Operator
CRES	Center for Renewable and Energy Saving
DER	Distribution Energy Resource
DR	Demand Response
DSO	Distribution System Operator
EC	European Commission
EDPS	European Data Protection Supervisor
EDRS	Electricity Demand Reduction Services
EE	Energy Efficiency and Electrification
EMSP	Electric Mobility Suppliers
ENISA	European Union Agency for Network and Information Security
ENTSO-E	European Network of Transmission System Operators
EU	European Union
EV	Electric Vehicle
EVCP	Electric Vehicle Charging Plan
FCO	Final Connection Offer
GDPR	General Data Protection Regulation
GHG	Greenhouse Gas
HETS	Hellenic Electricity Transmission System
ICT	Information and Computer Technology
ID	Identification
LGO	Local Government Organization
Li-on	Lithium-ion
LS	Long-term Strategy
M2M	Machine to Machine Communication
MEE	Ministry of Environmental and Energy
Mobi.E Network	National Electric Mobility Network (Portuguese entity)
MERP	Municipal Emissions Reduction Plan
NC	New Energy Carrier
NCL	National Climate Law
NECP	National Energy and Climate Plan
NGV	Natural Gas Vehicle
NRA	National Regulatory Authority
OCA	Open Charge Alliance
OCPP	Open Charge Point Protocol
OGG	Official Government Gazette

PHEV	Plug-in Hybrid Electric Vehicle
RAE	(Greek) Regulatory Authority for Energy
RES	Renewable Energy Source
RIEMO	Register of Infrastructures and E-mobility Market
SGU	Significant Grid User
TOU	Time Of Use
TSO	Transmission System Operator
VICC	Vehicle Inspection Control Center

1 Introduction

1.1 Scope and Objectives

This deliverable (D1.3) is associated with Task 1.3 of EV4EU named *Regulatory Challenges and Design (GAP identification)* which aims to research the regulatory and legislative framework around EVs. There are two main objectives in Task 1.3: a) to analyse the legislative and regulatory environment around EVs, including topics related to EV integration and charging infrastructure and b) to identify potential gaps or barriers (for the project or EVs in general) and, if applicable, suggest recommendations. The scope of the analysis performed in this deliverable is a) the European level regulatory ecosystem, which mostly consists of relevant EU Regulations and Directives, and b) the national legislative framework of the 4 countries in which demonstrations are planned within the activities of EV4EU.

1.2 Structure

This document is structured as follows. Chapter 1 introduces the document and Chapter 2 performs a high-level description of the 4 demonstrations. In Chapter 3, a thorough analysis of the European regulatory framework is performed and in Chapter 4 the analysis focuses on each demonstration country. Chapter 5 discusses Barriers and Suggestions. Finally, Chapter 6 concludes the document.

1.3 Relationship with other deliverables

This document is linked to deliverables D1.4 *V2X Related Business Models* [1] and D1.5 *Use Case Specifications*. This is because these deliverables, in practice, define the scope of the project in many practical ways and therefore affect any conclusion on which regulatory barriers exist for EV4EU. However, the analysis performed is focused both on the specific project activities but also on the topic of EVs and their integration in general. Therefore, the reader can have a broad understanding on the topic even without knowledge of D1.4 and D1.5.

2 Pilot description

This Chapter introduces basic information on each demo site. This introduction helps in the identification in Chapter 5 (Barriers and Suggestions) of gaps on the regulatory framework and in the justification of suggest solutions.

2.1 Greece

The Greek pilot will mostly take place in the Mesogia area (Figure 2.1), located in the Attica region of central Greece, which places it at the outskirts of the Athenian metropolis. Mesogia area includes the municipalities of Koropi, Lavrio, N. Makri and the interconnected islands of Kea, Andros and Tinos. It has been the pilot site for several Horizon 2020 and Europe projects, including Coordinet², Platone³ and now, EV4EU⁴. It is a semi-rural area that includes approximately 225,000 customers in its Low-Voltage (LV) and Medium-Voltage (MV) networks, varied from households to small, medium, and large industries. The area benefits from installations of various forms of renewables, wind farms, and PV, including net metering and rooftop PVs as well. One of the sections, the distribution network of Markopoulo, consists of several voltage feeders (20 kV) connected to three HV/MV transformers with a 50 MVA capacity, as is illustrated in Figure 2.1. Concerning RES penetration, there are 27.043 MW of PV plants connected to the Distribution Network. In addition, there are 20.7 MW of PV plants under approval for connection on the Distribution Network. There are no Wind farms connected to the Distribution Network.

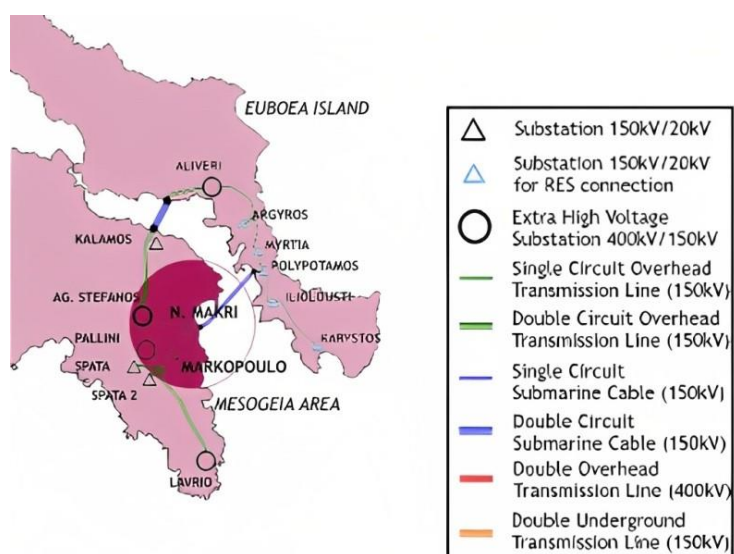


Figure 2.1 – The Mesogia region where the Greek pilot takes place.

² <https://coordinet-project.eu/>

³ <https://www.platone-h2020.eu/>

⁴ <https://ev4eu.eu/>

The main aspects of the Greek demo are the deployment and testing of the Open V2X management platform for public chargers, developed by PPC⁵; the integration and testing of the flexibility algorithms for local and system-wide grid services developed by DTU⁶ and INESC-ID⁷; and the investigation of exploitation and marketability strategies for the proposed solutions with the contribution of CITROËN. The Greek demo will develop in 4 distinct phases that are planned for the Greek pilot:

Phase 1: Open V2X Management Platform: (Testing the platform as a software tool) In this phase, the O-V2X Management Platform, developed in WP5 under the leadership of PPC, will be completed and tested. These tests will include new EV integration methodologies which require platform involvement, interoperability, and communication issues with end-devices, such as chargers, and user interface. PPC has an R&D campus near the Mesogia Area (Kantza, Athens), the Innovation Hub, where proof-of-concept scenarios of the V2X platform will be conducted.

Phase 2: New Demand Response and Flexible Capacity Contracts: (Smart EV methodologies and impact on the grid and public charging operation) In this phase, the Greek demo will validate the EV integration methodologies that are part of the Greek demo, such as demand response (DR), flexible capacity contracts, market services, green charging. Topics of interest are the impact on the distribution network, on the Public Charging operation of PPC and feasibility issues related to implementation of this method in cooperation with the O-V2X platform.

Phase 3: V2X management by CPO: (Platform and integration with users and other end devices) In the third phase, the platform will be tested in cooperation with all users and other end-devices from the field, such as public chargers. The scope in these tests is to identify efficient mechanisms for electric vehicle charging and discharging, that is also connected with the actual final scope of the demo. These mechanisms are closely connected with standardization activities of the Open Charge Alliance (OCA), such as the Open Charge Point Protocol (OCPP). Finally, the V2X platform integrated functionalities will be also tested in the field in this phase. KPIs collected from these tests include interoperability and communication metrics, activation success and user responsiveness, among others.

Phase 4: Activation of V2X services by DSOs: (Platform and DSO – Full integration – Interoperability) This is the final phase of the demo where the full functionality envisioned will be tested. The final piece missing from phase 3 is the integration of the platform with the DSO systems and operation in the actual demo scale. In this phase, this is accomplished, and the methodologies of the Greek demo will be tested in the field and/or in realistic validation environment. The objective is to assess the proposed solution across its operational chain, i.e., interoperability issues (including with DSO systems), user response, effect on the distribution network safe operation, contribution to flexibility management required by the DSO.

2.2 Portugal

The rising popularity of EVs in the Azores has become increasingly important due to the high share of clean energy in the islands, particularly in S. Miguel Island, which enhances the benefits of EV ownership and operation. It is important to mention that the literacy and socioeconomic aspects of the region may differ from the ones in mainland Portugal. When it comes to the purchasing power of the autonomous region, S. Miguel Island has a slightly lower index of 93 (100 for mainland Portugal)

⁵ Public Power Corporation, <https://www.dei.gr/en/>

⁶ Technical University of Denmark, <https://www.dtu.dk/english>

⁷ Instituto de Engenharia de Sistemas e Computadores: Investigação e Desenvolvimento em Lisboa, <https://www.inesc-id.pt/>

[2]. Additionally, the adoption rate of EVs in the island (1 EV per 200 inhabitants) is behind the national average (1 EV per 115 inhabitants) which, apart from the lower purchasing power index, can be also substantiated by a lower EV literacy in the region.

Nevertheless, over the last few years, the regional government of the Azores has committed to decarbonising the mobility sector on the islands by 2050. An example was the Azores Electric Mobility Plan (2018-2024) performed by the Azorean Directorate for Energy with a long-term strategy for e-mobility in the archipelago. Currently, there are around 700 electric vehicles in São Miguel Island, slightly above 1% of the total fleet, but the projections calculated previously (1.1) [3] predict an 18% fleet share by 2030 and above 85% by 2040, which could represent around 320 MWh and 2.4 GWh of storage, respectively.

In regards the public charging network, São Miguel Island has 19 charging stations (including 7 fast charging stations above 50 kW). All of these stations are strategically placed to ensure that no station is no more than 30 km from another, and there is a local commitment to keep growing this network in the coming years.

Within this context, the demonstrator to be installed in the São Miguel Island has favourable conditions for testing V2X technologies:

- According to the most recent data, the majority of the archipelago population has a car usage for transportation slightly higher than the mainland (64% in the mainland, 74% in the archipelago and 70% in São Miguel). Also, the size of the island promotes the use of electric vehicles, so the range limitation does not rise as a major issue because most trips are under 160 km.
- In the Azores case, the total energy demand of São Miguel Island is around 430 GWh, being geothermal energy the main primary energy source with over 40% of the total production, as well as wind power with a significant contribution during the night. This intermittency causes some energy to be curtailed.
- The island is not electrically interconnected with another system, giving a more controlled assessment of V2X control strategies.

With this in mind, the Portuguese demonstrator will entail 2 service procurement and activation bonded to a volunteer contractual framework that would give the users the possibility to participate and withdraw from these services if necessary:

- **RES curtailment management:** S. Miguel Island has an abundant surplus of wind power during the night period. This energy surplus can be predicted in advance and the DSO can request higher consumption to multiple V2X management systems.
- **Voltage management:** Due to a lesser redundancy of the S. Miguel Island grid, it may have a greater tendency to grid congestion during peak hours in certain locations, therefore the TSO can activate voltage regulation to V2X units to adjust the consumption.

In the case of the Azores, the TSO and DSO match the same entity, which is EDA, the utility of the Azores. These services are going to be tested in:

- **V2X management in Houses:** 5-8 individual houses near EDA's premises are going to be selected, and at least one will have a micro-generation (photovoltaic system). This UC addresses the main control strategies for cost minimization and self-consumption maximization.
- **V2X management in Buildings:** The demonstrator will be implemented in LREC (Civil Engineering Regional Laboratory) building. Similarly, to houses, several control strategies will be addressed to minimize the energy cost of the building. The algorithms will feature optimization techniques to address the multiple EVs that could be plugged in at the same time.

V2X management in Companies: The main goal is to evaluate innovative control methodologies for better management of the company fleet and coordination with employees and visitors EV

charging. The demonstrator will be at EDA's premises and will use the company fleet (10 EVs used by maintenance teams).

2.3 Slovenia

In Slovenia, the demonstration will take place in two locations. The first location is the business building in Krško with demo equipment already integrated. The facility has been equipped with 6 controllable charging stations (each charger has 2 sockets capable of delivering up to 22 kW) that can be autonomously controlled to provide behind-the-meter services. These services include limiting consumption at the point of common coupling or maximizing the consumption of locally generated renewable energy from PV systems (100 kWp) located on the roof of the building. This facility is already part of the Virtual Power Plant (VPP) portfolio (GEN -I). ABB will install additional 5 charging stations, as this will allow to analyze the impact of V2X on the grid and capacity. The second site will target existing GEN -I customers within the pre-selected substation (in Elektro Celje area). A smart V2X station will be set up for participating households. If necessary, some EVs will be rented from GEN -I during the V2X evaluation period in order to have a meaningful demonstration. The main objective is to analyze the impact of domestic V2X management on the grid and the required capacity (as it will be done in Task 4.1 of the project) as well as on the VPP portfolio.

The specific aims are:

- To demonstrate and evaluate the performance of energy management algorithms to be used by a Virtual Power Plant (VPP);
- To demonstrate the participation of VPP, aggregating Vehicle-to-Everything (V2X), in national markets and ancillary services;
- To demonstrate the participation of VPP, aggregating V2X, in services organized by the Distribution Services Organization (DSO);
- To demonstrate the VPP aggregating V2X control process, using ADMS advanced modules for technical activation, control, and performance monitoring of VPP.

Use- Cases (UC) will be tested in the Slovenia Demonstrator:

- **V2X management by a Virtual Power Plant (VPP)**
Tests will consider the aggregation of V2X flexibilities with other resources (generation and storage) taking into account the participation in multiple services and markets.
- **Participation of V2X in electricity markets**
This UC will demonstrate and evaluate the participation of V2X, aggregated with other resources, in markets at the national level (energy market, ancillary services markets). This UC intends to understand the users' advantages of V2X participation in these markets and the impact that mass participation of V2X can have in these markets. The models will be integrated into real tools, but participation in real markets is dependent on the market pre-qualification process that can take a long time. If participation in real markets is not possible, the services will be validated using market emulation tools.
- **Participation of V2X in Grid Services**
This UC will demonstrate and evaluate the participation of V2X, aggregated with other resources, in markets and services at the local level. The demonstration will focus on the contribution of V2X to solve problems in distribution systems.
- **Activation of V2X services by Distribution System Operator (DSOs)**
This UC aims to evaluate the integration and communication between VPPs and Advanced Distribution management Services (ADMS), activation of VPP for ADMS system, and activation triggered by ADMS operators.

2.4 Denmark

Campus Bornholm Location

Campus Bornholm is a Danish Educational institute with more than 1.500 below age of 18 and 4000 adults each year. The institution therefore is used primarily in hours from 07-18 each day. Campus Bornholm is equipped with a 180kW PV system, and a large parking lot. On this parking lot we will in the EV4EU project install 6 chargers with two outlets each, meaning we can cover charging of 12 EVs simultaneously.

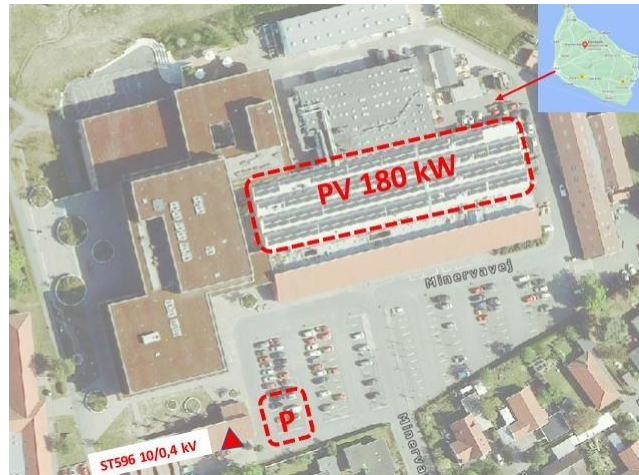


Figure 2.2 – Location of Bornholm demonstration site.

The parking lot with EV chargers is located next to the transformer station where a cable cabinet will be installed for safety purposes. The transformer is marked by a red triangle and is defined as ST596, 10kV to 0.4kV on charger side.



Figure 2.3 – Parking lot participating in the Bornholm demonstration.

The 12 chargers will be given 43kW to share between them, so the power sharing and charge schedule will be needed to charge the needs for all electric vehicles throughout the day. This number will also depend on the solar production from the PV system. At the parking lot it is possible to both test the priority charging schedule system to charge multiple EVs throughout a day, without able to charge on all outlets simultaneously. Also, charging can be dependent on local RES production.

Installation

At the location, the cable cabinet needs to include following:

Table 2.1: Material list for EV charging in Bornholm demonstration site.

3-phase electricity meter rated at >63A
RCD type B rated at >63A
63A 3phase + N circuit breaker
3-phase + N and PE 3 AWG (25 mm2) cable (alternative scankab solution)

Above list is a complete list of material needed for EV charging directly from a 0.4kV transformer station. This is not a mature list and is only for reference, however, the EV chargers have been made by the design so only one cable is needed from transformer to all EV chargers, and then a tap in system at each charger location is possible, since all safety measures are located inside the EV charger.

EV chargers

The EV chargers which will be installed will be a combination of fully extruded version and pole mounted versions. The two different versions are shown below, they can both handle 22kW on each outlet, and the total for each charger is dependent on the cable size used to supply the EV charger itself. Below is a spec list of the EV charger.

Table 2.2: Specifications list of the Bornholm demonstration site.

Max. charge power on 3-phase – per outlet	22 kW
Max. charge current on 1-phase – per outlet	32 A @ 230 VACrms
Max. charge current on 3-phase – per outlet	3 x 32 A @ 230 VACrms
Charging mode	Mode 3 [DS/EN IEC 61851-1:2019 chapter 6.2.3]
IP Rating	IP54
System Earthing	TN / TT
Personal protection – Per outlet inside EV charger	Type A RCD & 6mA DC [IEC 62955:2018] [DS/EN IEC 61851-1:2019 chapter 8.5]
Inlet cable size for total 32A	>6 mm2 / <9 AWG

3 EU regulation and legislation

This chapter analyses the existing regulatory and legislative landscape in EU level and its scope include all topics of relevance to EV4EU focusing mainly but not solely on EVs. Apart from *EVs and EV Charging* this chapter covers topics of *Energy Policy* on EU-level, general legislation of *Distributed Energy Resources, Markets and Power Systems* that might affect project activities, as well as *Data, Security, and Privacy* aspects.

The first section discusses the EU goals that originate from the need to tackle climate change and set concrete targets for energy generation and consumption. The next section examines the framework that on the one hand governs EVs' type approval and placing on the market requirements and on the other hand the regulation that sets out the minimum requirements for the building-up of recharging points for electric vehicles. The third section concerns flexibility and demand response, batteries, RES, and the distribution system. Finally, the last section is about the rules that govern data possession and exchange in order to achieve secure connections and user privacy.

In each section, and according to the thematic area of the regulation, the important information regarding the framework is provided in a tabulated form, where the title of the regulation, the relevant Articles and/or Paragraphs, and a brief description of the respective item are provided. Before each table a Paragraph is given that serves as an introduction that defines the scope of the section and the category being analysed. After each table a Paragraph is included with comments on the table and the category in general. It also serves as a short summary for the topic that encloses the most important information.

For reference, we remind the reader of the types of EU legislation. The two most important for this deliverable are Regulations and Directives:

- *Regulations*: A binding legislative act which must be applied in its entirety across the EU.
- *Directives*: A legislative act that sets out a goal that all EU countries must achieve, however, it is up to the individual countries how to reach these goals.
- *Decisions*: A decision is binding on those to whom it is addressed (it can be an EU country or an individual company) and is directly applicable.
- *Recommendations*: A recommendation is not binding and allows the institutions to make their views known without any legal obligation.
- *Opinions*: Similarly, an opinion is an instrument that allows the institutions to make a statement in a non-binding fashion.

3.1 Energy Policy

Following a top-down approach on the relevant regulatory framework, the first step of the analysis concerns the long-term targets that have been established by the European Union to tackle climate change and achieve energy independence community. The primary goal of this strategy is to reduce greenhouse gas emissions, increase the presence of renewables and make the energy ecosystem smarter and more flexible. The contribution of electromobility in achieving these goals is identified as very significant. EVs are not only emission-free in their operation but can also act as energy storage mediums. Table 3.1 presents the respective EU regulation that is relevant to the long-term Energy Police goals of the union.

Table 3.1: Regulations and Directives - Energy Policy [4], [5]

Regulation title	Relevant Articles and/or Paragraphs	Brief description of this regulation (regarding the project and the pilot goals)
Directive 2012/27/EU Energy Efficiency	Article 3. Energy efficiency targets Article 9: Metering Article 15: Energy transformation, transmission and distribution Article 18: Energy services	Sets binding measures for using energy more efficiently at all stages of the energy chain, including energy generation, transmission, distribution, and end-use consumption
Regulation 2018/1999/EU on the Governance of the Energy Union and Climate Action	Article 4(d): National objectives, targets and contributions for the five EU dimensions (energy security, internal energy market, energy efficiency, decarbonization, research, innovation and competitiveness). Article 5: Member States' contribution setting process in the area of renewable energy. Article 6: Member States' contribution setting process in the area of energy efficiency. Article 8: Analytical basis of the integrated national energy and climate plans. Annex VI: Policies and measures information in the area of GHG emissions. Annex XI (from Directive 2012/27/EU): Energy efficiency criteria for energy network regulation and for electricity network tariffs. Annex XIV (from Directive 2012/27/EU): General framework for annual reports.	Strategies and measures to meet the objectives of the Energy Union and the Paris Agreement, stimulate cooperation between Member States, ensure the timeliness, transparency, accuracy, consistency, comparability, and completeness of reporting and contribute to greater regulatory certainty.
EU Emissions Trading System (EU ETS)	All Paragraphs	Market mechanisms for setting prices on CO2 emissions and incentivizing reduction of those emissions in the most economically efficient manner

The **Directive 2012/27/EU on Energy Efficiency** [4] is a European Union directive aimed at improving energy efficiency and reducing energy consumption in the EU. It amended Directives 2009/125/EC and 2010/30/EU and repealed Directives 2004/8/EC and 2006/32/EC. The directive sets several binding targets for member states to achieve by 2020, and also outlines a range of measures that can be taken to improve energy efficiency. Some key targets set by the directive are as follows:

1. A 20% improvement in energy efficiency by 2020, achieved through a combination of energy efficiency measures and the use of renewable energy sources.
2. Policy measures to achieve energy savings equivalent to annual reduction of 1.5% in national energy sales.
3. EU countries making energy efficient renovations to at least 3% per year of buildings owned and occupied by central governments.
4. Planned rollout of close to 200 million smart meters for electricity and 45 million for gas by 2022

Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action [5] amended Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repeals Regulation (EU) No 525/2013 of the European Parliament and of the Council. It lays down strategies and policies within the Energy and Climate sectors. The key provisions of the directive include:

1. National energy and climate plans: The directive require each EU member state to develop a national energy and climate plan, which sets out their national energy and climate objectives and policies. These plans must cover a ten-year period and must be updated every five years.
2. Reporting and monitoring: The directive establishes a system for monitoring and reporting on the implementation of the national energy and climate plans. Member states are required to report on progress towards their national objectives, and the European Commission will monitor progress and provide guidance and support.
3. Long-term strategy: The directive requires the EU and its member states to develop a long-term strategy for greenhouse gas emissions reduction, with a view to achieving a climate-neutral economy by 2050.
4. Transparency and public participation: The directive require member states to ensure transparency and public participation in the development and implementation of their national energy and climate plans.
5. Cooperation and coordination: The directive encourage member states to cooperate and coordinate on energy and climate issues, both within the EU and with third countries.

Some of the most important targets of the regulation are:

- 40% reduction in greenhouse gas emissions in 2030 with respect to 1990
- $\geq 32\%$ share of renewable energy by 2030
- $\geq 32,5\%$ of energy efficiency improvement by 2030
- $\geq 15\%$ electricity interconnections by 2030

The **EU Emissions Trading System (EU ETS)** [6] is a market-based instrument designed to reduce greenhouse gas emissions in the European Union (EU). It works by putting a cap on the total amount of greenhouse gases that can be emitted by certain sectors of the economy, such as power generation, industry, and aviation. Under the EU ETS, companies are allocated a certain amount of emission allowances, which they can trade with each other on the carbon market. This creates a financial incentive for companies to reduce their emissions, as they can sell any unused allowances to other companies that need them. The EU ETS is the largest emissions trading system in the world, covering over 11,000 installations in 31 countries. It has been in operation since 2005 and has been gradually expanded over the years. The EU plans to further strengthen the system in order to achieve its goal of reducing greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels. The EU ETS is the largest carbon market in the world, covering around 40% of the EU's greenhouse gas emissions. It has been in operation since 2005 and has undergone several changes and updates over the years to increase its effectiveness. The system has been credited with helping to drive emissions reductions across the EU and is seen as a key tool in the fight against climate change.

Additionally, to the listed regulations, the REPowerEU [7] initiative aims to make the EU's transport sector more energy efficient by accelerating the implementation of existing legislation and combining it with new regulatory measures. One important measure to boost energy efficiency is the deployment of alternative refuelling and recharging infrastructures to support the electrification of transport. The planned revision of the recovery and resilience plans will add additional financing for such measures, including the support to purchase zero-emission public transport vehicles. Furthermore, the Commission will consider a legislative initiative to increase the share of zero-emission vehicles in public and corporate car fleets above a certain size. These actions will help to reduce the demand for fossil fuels and promote the uptake of electric vehicles, contributing to a more sustainable and efficient transport sector in the EU.

3.2 EVs and Charging

This category lies in the core of EV4EU activities as it contains EU regulations and directives related to EVs and the Charging infrastructure as well as definitions on EV requirements and the use of alternative fuels. Nowadays, EV penetration rate has increased. The EU aims to stimulate the market for clean and energy-efficient vehicles, and especially to influence the market for produced vehicles as passenger cars, buses, coaches, and trucks. This is achieved by ensuring a level of demand for clean energy-efficient road transport vehicles which, in turn, is important to encourage manufacturers and the industry to invest and develop low energy consumptions and pollutant emissions vehicles. Table 3.2 gathers the most important EU regulations and directives related to this category with the most recent regulations published in 2018.

Table 3.2: Regulations and Directives - EVs and charging [8]–[11]

Regulation title	Relevant Articles and/or Paragraphs	Brief description of this regulation (regarding the project and the pilot goals)
Directive 2009/33/EC	Article 5: Purchase of clean and energy-efficient road transport vehicle Article 6: Methodology for the calculation of operational lifetime costs	Applies to procurement of certain road transport vehicles (cars, vans, trucks, and buses) and services, by public authorities and entities that are contracted by public authorities.
Directive 2014/94/EU	Article 3: National policy frameworks Article 4: Electricity supply for transport Article 7: User information Annex II: Technical Specifications	Sets minimum requirements and standard rules for the building-up of alternative fuels infrastructure, including recharging points for electric vehicles and alternative fuels and technical specifications for recharging points.
Regulation 2018/858/EU	Article 5: Technical requirements Article 12: Online data exchange Article 14: Obligations of manufacturers concerning their vehicles, systems, components, separate technical units, parts and	Lays down the administrative provisions and technical requirements for the type-approval and placing on the market of all new vehicles, systems, components, and separate technical units. Regulates the placing on the market and the entry into

	<p>equipment that are not in conformity or that present a serious risk</p> <p>Article 20: Cases in which obligations of manufacturers apply to importers and distributors</p> <p>Article 37: Certificate of conformity in electronic format</p> <p>Annex I(Part A): Criteria for vehicle categorisation</p>	<p>service of parts and equipment that may pose a serious risk to the correct functioning of the vehicle systems, requirements for the market surveillance of vehicles, components and separate technical units that are subject to approval.</p>
<p>Regulation (EU) 2019/631</p>	<p>Article 1: Subject matter and objectives</p> <p>Article 4: Specific emissions targets</p>	<p>Sets CO2 emission performance standards for new passenger cars and light commercial vehicles in the European Union.</p>

Directive 2009/33/EC on the promotion of clean and energy-efficient road transport vehicles [8] is a directive of the European Union that aims to promote the procurement of clean and energy-efficient vehicles by public bodies. The directive requires EU member states to ensure that public authorities and entities consider the environmental impact of their transport activities, and to encourage the procurement of clean and energy-efficient vehicles. The objective of the directive is to reduce greenhouse gas emissions and improve air quality in the EU, by promoting the purchase and use of vehicles with lower emissions. Directive 2009/33/EC, as amended by Directive (EU) 2019/1161, sets minimum public procurement targets for light-duty vehicles (cars and vans), trucks and buses for 2025 and 2030. In the case of buses, half of the targets must be met with zero-emission vehicles (battery electric or hydrogen buses). To achieve this objective, the directive establishes minimum procurement targets for clean and energy-efficient vehicles in three categories: passenger cars and light commercial vehicles, buses, and trucks. For passenger cars and light commercial vehicles, the directive requires that at least 50% of new vehicles procured by public authorities and entities have CO2 emissions of less than 130g/km. For buses and trucks, the directive requires that at least 50% of new vehicles procured by public authorities and entities meet the Euro V emission standard or higher. The directive also requires member states to provide information and guidance to public authorities and entities on the procurement of clean and energy-efficient vehicles, including best practices and available resources. Member states must also report on their implementation of the directive to the European Commission.

Directive 2014/94/EU on the deployment of alternative fuels infrastructure [9], based on directive 2009/28/EC, regulations 2013/1316/EU and 2013/1291/EU is a regulation of the European Parliament and of the Council that aims to promote the deployment of alternative fuels infrastructure across the European Union. The regulation sets out the minimum requirements for the development of such infrastructure, including electric vehicle charging points, hydrogen refuelling stations, and natural gas and liquefied petroleum gas refuelling stations. It requires EU member states to develop national policy frameworks and implementation plans to promote the deployment of alternative fuels infrastructure. These plans must cover the entire territory of the member state and include targets for the development of infrastructure for each alternative fuel. The regulation also requires the installation of minimum numbers of electric vehicle charging points and hydrogen refuelling stations in new or renovated non-residential buildings with more than ten parking spaces. It also sets out common technical specifications for alternative fuels infrastructure to ensure interoperability across the EU. In addition, the regulation includes provisions for the provision of information to consumers

about the availability and location of alternative fuels infrastructure, and for the harmonization of payment and access systems for such infrastructure. Overall, Directive (EU) 2014/94 aims to promote the development of alternative fuels infrastructure in the European Union, in order to reduce dependence on fossil fuels, improve air quality, and stimulate innovation and investment in the clean energy sector. The specific targets that Directive (EU) 2014/94 sets with numbers for the deployment of alternative fuels infrastructure in the European Union:

1. Electric charging points: Member States are required to ensure that an appropriate number of publicly accessible electric charging points are available for electric vehicles by 2020. The target is set at a minimum of one publicly accessible electric charging point per ten electric vehicles in each Member State.
2. Hydrogen refuelling stations: Member States are required to ensure that an appropriate number of publicly accessible hydrogen refuelling stations are available for fuel cell vehicles by 2025. The target is set at a minimum of one publicly accessible hydrogen refuelling station in each Member State.
3. Compressed natural gas (CNG) and liquefied natural gas (LNG) refuelling points: Member States are required to ensure that an appropriate number of publicly accessible CNG and LNG refuelling points are available for natural gas vehicles by 2025. The target is set at a minimum of one publicly accessible refuelling point for CNG and LNG per 150 km on the roads of the Trans-European Network for Transport (TEN-T).

These targets are designed to encourage the development of alternative fuels infrastructure and to promote the widespread adoption of low-emission vehicles in the European Union. By establishing these targets, the regulation aims to ensure that the necessary infrastructure is in place to support the transition to a more sustainable and environmentally friendly transport system.

Regulation (EU) 2018/858 on the approval and market surveillance of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles [10] is a regulation of the European Parliament and of the Council that establishes the requirements for the approval and market surveillance of motor vehicles and their trailers, as well as systems, components, and separate technical units intended for such vehicles. It amends regulations 2007/715/EC and 2009/595/EC and repeals directive 2007/46/EC, which had established a framework for the approval of motor vehicles and separate technical units intended for such vehicles. 2018/858 applies to all types of motor vehicles, including passenger cars, buses, trucks, and motorcycles, and is intended to ensure a high level of road safety, environmental protection, and consumer protection. The regulation introduces a new system of type-approval for motor vehicles and their components, which is based on a set of technical requirements and testing procedures that must be met before a vehicle can be placed on the market. It also establishes a framework for market surveillance, which aims to ensure that vehicles already on the market continue to meet the required standards throughout their lifetime. The regulation requires Member States to designate technical services responsible for carrying out type-approval testing and for monitoring compliance with the regulation. It also introduces several new provisions, including the requirement for manufacturers to provide access to repair and maintenance information, and the introduction of a new system for the certification of type-approval authorities. In addition, the regulation strengthens the existing legal framework for the protection of whistle-blowers, by requiring Member States to establish effective protection measures for individuals who report breaches of the regulation.

Regulation (EU) 2019/631 setting CO₂ emission performance standards for new passenger cars and for new light commercial vehicles [11] sets CO₂ emission performance standards for new passenger cars and for new light commercial vehicles and repealing Regulations (EC) No 443/2009 and (EU) No 510/2011. The regulations were amended multiple times in 2020 and 2021. It sets several targets:

- By 2024:

- 15% zero- and low-emission vehicles' benchmark for new passenger cars and light commercial vehicles by 2025
- 35% zero- and low-emission vehicles' benchmark for new passenger cars by 2030
- 30% zero- and low-emission vehicles' benchmark for light commercial vehicles by 2030
- reduction of 10 g CO₂/km of average emissions of new passenger cars and light commercial vehicles by 31 December 2024
- By 2030:
 - 15% reduction of the 2021 target for average emissions of new passenger cars and light commercial vehicles by 2025
 - 37.5% reduction of the 2021 target for average emissions of new passenger cars by 2030
 - 31% reduction of the 2021 target for light commercial vehicles by 2030

Smart charging (V1G), defined as a recharging operation in which the intensity of electricity delivered to the battery is adjusted in real-time, based on information received through electronic communication, is currently part of the European regulatory framework, proposing a mature technology. The Alternative Fuel Infrastructure Regulation (AFIR) proposal indicates that every publicly accessible charging station should support smart charging. The same applies for private charging infrastructures, under the Renewable Energy Directive III.

Vehicle-to-grid (V2G or bidirectional charging), defined as smart charging where the direction of electric charge may be reversed so that electric charge flows from the battery to the recharging point it is connected to, is not yet included in the European regulatory framework. Additionally, neither the technology is mature enough for mass deployment of V2G. The majority of EVs and charging infrastructure, currently in the European market, do not support bidirectional charging.

Implementing V2G technology requires more complex software and hardware infrastructure than V1G with communication and energy bi-directional flow to enable the advanced services. EU region and many member countries have conflict or/and lack of legislation about V2G. For that reason, many projects and pilots related to V2G run at last decade in EU region to ensure this technology and to create infrastructures and prototypes for mass deployment. Projects as “**Regulatory barriers for Smart Charging of EVs and second life use of EV batteries**” [12] by PWC (Germany, Sweden, France) about V2G regulatory frameworks, “**CITY-zen New urban energy**” [13] project about smart cities road mapping for Amsterdam and Grenoble, “**Multi Utilities Smart Energy GRIDS**” [14] project with V2G testing in Belgium and “**The Parker project**” [15] which provide frequency regulation with EVs in Denmark are approaching from different sector the V2G technology and promote that to EV users for a decarbonization future.

3.3 Distributed Energy Resources, Markets and Systems

Beyond legislation that applies directly to EVs there is a variety of topics that are of relevance to EV4EU indirectly and cover how distributed energy resources in general (demand response, storage, RES, etc.) are managed, the expansion of the existing market architecture (local flexibility markets) and, how the power system, and in particular, the distribution system is adjusting to the emergence of new technologies. This section aims to cover the regulatory and legislative status quo in the EU on this broad category, always in relation to EV4EU activities. The following Table 3.3 presents the relevant EU directives and regulations on the topic of Flexibility from DERs, Demand Response and Electricity Markets.

Table 3.3: Relevant Regulations and Directives – Flexibility from DERs, Demand Response and Electricity Markets.[16]–[19]

Regulation title	Relevant Articles and/or Paragraphs	Brief description of this regulation (regarding the project and the pilot goals)
Regulation (EU) 2017/2195	All Articles	Provides guidelines for electricity balancing, including common principles for procuring and settling reserves and a methodology for activating them.
Regulation (EU) 2017/1485	Article 40: Organisation, roles, responsibilities and quality of data exchange Article 48 Structural data exchange Article 49 Scheduled data exchange Article 50 Real-time data exchange Article 182 Reserve providing groups or units connected to the DSO grid	Lays down detailed guidelines on requirements and principles concerning operational security, the coordination and data exchange between system operators, training and certification of system operator employees, outage coordination scheduling between control areas, and the establishment of a Union framework for load-frequency control and reserves.
Regulation (EU) 2019/943	Article 21: General principles for capacity mechanisms Article 22: Design principles for capacity mechanisms Article 55: Tasks of the EU DSO entity	Sets rules for upgrading the electricity markets such as free price formation, more flexible generation and demand, consumers as market players, integrating renewables and energy efficiency, more cross-border flows, and more demonstration projects
Directive (EU) 2019/944	Article 8: Authorisation procedure for new capacity Article 13: Aggregation contract Article 15: Active customers Article 16: Citizen energy communities Article 17: Demand response through aggregation Article 20: Functionalities of smart metering systems Article 31: Tasks of distribution system operators Article 32: Incentives for the use of flexibility in distribution networks Article 33: Integration of electromobility into the electricity network Annex I: Minimum requirements for billing and Annex II: Smart metering systems	The rules cover the entire electricity supply chain and aim to create competitive, flexible, and transparent markets in the EU. They also include consumer protection measures and outline obligations, tasks, and incentives for DSOs related to network flexibility and integrating electromobility.

Regulation (EU) 2017/2195 establishing a guideline on electricity balancing [16] sets out network codes for electricity balancing in the European Union. The regulation aims to facilitate the integration of renewable energy sources into the electricity system by establishing rules for the operation of balancing markets. The regulation does not set specific targets for the integration of renewable energy sources, but it does establish common rules for the operation of balancing markets and the dispatch of balancing energy. It requires TSOs to establish and operate balancing markets, which allow them to balance supply and demand in real time. The regulation also requires TSOs to ensure that balancing markets are open to all market participants, including demand response resources. The regulation establishes rules for the dispatch of balancing energy, which is used to balance supply and demand in real time. The regulation requires TSOs to ensure that the dispatch of balancing energy is cost-effective, and to provide transparent information on the prices and volumes of balancing energy. The regulation also establishes rules for the activation and participation of balancing service providers, which can provide balancing energy or adjust their consumption in response to system needs. Overall, Commission Regulation (EU) 2017/2195 aims to facilitate the integration of renewable energy sources into the electricity system by establishing rules for the operation of balancing markets. By doing so, it aims to improve the efficiency of the electricity system and help to achieve the EU's climate and energy objectives, including reducing greenhouse gas emissions and promoting renewable energy.

Regulation 2017/1485 establishing a guideline on electricity transmission system operation [17] defines a set of minimum requirements for EU-wide transmission system operation, cross-border cooperation between TSOs, using the relevant characteristics of the connected distribution system operators (DSOs) and significant grid users (SGUs) which are important for safeguarding operational security, power supply frequency and the efficiency of the interconnected system and resources. Among others, it defines the rules on cross-border exchange of electrical energy among balancing areas while preserving the EU's internal market setup. In addition, the Regulation establishes the European Network of Transmission System Operators for electricity (ENTSOE) which, together with the Agency for the Cooperation of Energy Regulators, is responsible for the development of the European network codes and.

Regulation 2019/943 on the internal market for electricity [18] contains rules on the wholesale market and network operation whereas **Regulation 2019/944 on common rules for the internal market for electricity** [19] which was adopted at the same time contains rules on retail markets for electricity. Key aspects of 2019/943 include the free price formation in electricity markets according to the law of supply and demand and the encouragement of flexible demand, renewables, and energy efficiency. Furthermore, there are provisions investments in low-carbon production using appropriate capacity mechanisms. Cross-border cooperation and flow of energy and services in general is provisioned, partly with the encouragement of Regional Coordination Centres. At the same time, 2019/944 deals with topics closer to the consumer, such as customer rights, billing, aggregators, citizen energy communities, access to data and interoperability, DSOs, TSOs and NRAs. Among others, and closer to the topic of EV4EU, it includes provisions for electromobility which suggest that *EU countries must establish a regulatory framework to facilitate the connection of electric vehicle recharging points to the distribution network and that DSOs would only be allowed to own, develop, manage or operate recharging points if no other body has expressed interest in an open tendering procedure, subject to regulatory approval and in line with third-party access rules.*

The following table concerns batteries and battery storage in general. It defines requirements on sustainability, safety, labelling, and information of batteries, as well as provision for the collection, treatment, and recycling. In addition, common rules for the internal market for electricity energy

storage facilities (and EV batteries as a result) are proposed. Table 3.4 contains the latest EU Directives regarding the topic.

Table 3.4: Relevant Regulations and Directives - Energy Storage [19], [20]

Regulation title	Relevant Articles and/or Paragraphs	Brief description of this regulation (regarding the project and the pilot goals)
Directive 2006/66/EC	Article 14: Disposal Article 6: Placing on the market Article 12: Treatment & recycling Annex III: Detailed treatment & recycling requirements	Describe Battery management system for industrial and electric vehicle batteries and access on the lifetime and health data. Rules exist for placing batteries on the market and recycling waste batteries.
Directive (EU) 2019/944	Article 15: Active customers Article 36: Ownership of energy storage facilities by distribution system operators Article 40: Tasks of transmission system operators Article 42: Decision-making powers regarding the connection of new generating installations and energy storage facilities to the transmission system	Active customers. Ownership of energy storage facilities by distribution system operator. Tasks of TSOs. Decision-making powers regarding the connection of new generating installations and energy storage facilities to the transmission system.

Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators [20] aims on batteries and accumulators, repealing Directive 91/157/EEC. In addition, the Consolidated **Directive (EU) 2019/944 on common rules for the internal market for electricity [19]** sets the common rules for the internal market for electricity amending Directive 2012/27/EU. EV batteries shall contain a battery management system that stores the information and data needed to determine the state of health of batteries. In addition, access to the data on the parameters in the battery management system shall be provided to the legal or natural person who has purchased the battery at any time for evaluating the residual value of the battery, facilitating the reuse, repurposing, or remanufacturing of the battery and for making the battery available to aggregators operating virtual power plants in electricity grids. Furthermore, rules are set regarding the placing on the market of batteries and accumulators, also for the collection, treatment, recycling and disposal of waste batteries and accumulators. An important sector in industry, residential buildings and road vehicles are the batteries their charging, maintenance, and storage, also the recycling and avoidance containing hazardous elements. For those reasons European Commission lay down frameworks, which contains instructions for the manufacture and disposal of batteries for industrial and electric vehicles, Batteries Management Systems and their data accessibility, energy storage facilities and decision-making powers to the transmission system.

Next are the regulations and directives about RES and their integration into the energy market framework, as well as establishing the framework of measures to promote energy efficiency. The European Union targets that the overall share of energy from renewable sources in 2030 will be 32%. For that cause, financial support for electricity from renewable sources, on self-consumption of such electricity, heating, and cooling sector as well as transport sector. Table 3.5 presents the latest directives.

Table 3.5: Regulations and Directives – RES [4], [21], [22]

Regulation title	Relevant Articles and/or Paragraphs	Brief description of this regulation (regarding the project and the pilot goals)
Directive 2009/125/EC	Article 13: Small and medium-sized enterprises Article 15: Implementing measures	Regulating the energy consumption and environmental impact of energy relevant products
Directive 2012/27/EU	Article 7: Energy savings obligation Article 2 Paragraph 26 'small and medium-sized enterprises 2010/31/EUs	Implementing and regulating efficiency measures for Energy (service) providers, obligatory implementation of energy management systems for industrial enterprises with more than 250 employees
Directive (EU) 2018/2001	Article 3(2): Binding overall Union target for 2030	Defines promotion of renewable energy by fundings, the regulation of electricity market, the penetration of renewable energy. Describes the taxation of fossil and renewable traffic fuels and regulates the share of renewable traffic fuels in conventional traffic fuels as well as gas market and grid-access for biogas.

Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources [22] describes the promotion of the use of energy from renewable sources. Also, Consolidated **Directive 2012/27/EU on energy efficiency** [4], amending **Directives 2009/125/EC establishing a framework for the setting of eco-design requirements for energy-related products** [21] and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC aims on energy efficiency. In addition, consolidated Directive 2009/125/EC sets a framework for the setting of requirements for energy-related products. It also aims to achieve sustainability and greenhouse gas emissions saving criteria for biofuels, bioliquids and biomass fuels. Moreover, regarding energy efficiency, rules and targets have been introduced in order to implement and regulate efficiency measures. In addition, the regulation of energy consumption and environmental impact of energy relevant products is mentioned. Many issues have been covered regarding the RES and its framework in particular, including their rising penetration in the energy mix, the taxation of fossils and traffic fuels, the regulation of electricity and biogas market, the monitoring of fossil fuels. In addition, the regulation of greenhouse gas emissions in the building sector is introduced as well as the energy consumption and environmental impact of energy relevant products.

The connectivity of transmission networks between Member States and electricity emergency situations, such as blackouts, are analyzed in the following part. Electromobility and its flexibility scheme help distribution and transmission system to be more sustainable and balancing the energy consumptions with fewer emergency and blackout states for each Member State. The two most important EU regulations in this category are presented in Table 3.6, with the most recent one to be voted in 2022.

Table 3.6: Regulations and Directives - Electricity Network [23], [24]

Regulation title	Relevant Articles and/or Paragraphs	Brief description of this regulation (regarding the project and the pilot goals)
REGULATION 2017/2196/EU	Article 15(6): Automatic under-frequency control scheme Article 15(7): Automatic under-frequency control scheme Annex: Automatic low frequency demand disconnection scheme characteristics (Table)	Establishes a network code that manages emergency, blackout, and restoration states, coordinates system operations, conducts simulations and tests for reliable restoration, and provides necessary tools and facilities.
REGULATION 2022/869/EU	Annex I(2): Priority electricity corridors Annex I(6, 7): Priority offshore grid corridors Annex I(10): Priority corridors for Hydrogen and electrolyzers Annex I(12): Priority thematic areas	Identifies projects of common interest, helps streamline permit processes, encourages public participation, allocates costs, and incentivizes risk-taking for cross-border projects.

Regulation 2022/869/EU on guidelines for trans-European energy infrastructure [23] amends regulations 2009/715/EC, 2019/942/EU, 2019/943/EU and directives 2009/73/EC and 2019/944/EU and repeals regulation 2013/347/EU. It sets guidelines for development and interoperability of the priority corridors and areas of trans-European energy infrastructure. **Regulation 2017/2196/EU establishing a network code on electricity emergency and restoration** [24] is relying on regulations 2009/714/EC and 2017/1485/EU. This regulation sets a network code for safeguarding operational security and the restoration of the electricity system from emergency states, which aims at the prevention of the propagation of incidents. The scope of those regulations is to lay down the requirements for the management and coordination of an emergency or blackout and its restoration. In addition, it defines requirements for tools and facilities which are needed to guarantee a reliable, efficient, and quick restoration of the interconnected transmission systems.

3.4 Data, Security and Privacy

We have defined the data security and privacy category because it is particularly important for EV users' infrastructure to know and be protected from any electronic interception of personal data and cyberattack, to trust and keep use those infrastructures. Relevant regulation is presented in Table 3.7, that include specific articles and a summary description.

Table 3.7: Regulations and Directives - Security and Privacy [25]

Regulation title	Relevant Articles and/or Paragraphs	Brief description of this regulation (regarding the project and the pilot goals)
Regulation 2014/910/EU	Article 6: Mutual recognition Article 42: Requirements for qualified electronic time stamps Article 44: Requirements for qualified electronic registered delivery services	Sets rules for trust services, about electronic transactions and legal framework for electronic time stamps, electronic registered delivery services and certificate services for website authentication.

Regulation 2014/910/EU on electronic identification and trust services for electronic transactions in the internal market [25] complies fully with Directive 2006/123/EC, about services supplied by providers and repeals Directive 1999/93/EC, about electronic signatures framework. This regulation determines the conditions for the electronic identification means of natural and legal persons and rules of trusted services, mainly for electronic transactions. In addition, it creates a framework for electronic signatures, seals, time stamps, documents, registered delivery services and certificate services for website authentication. This regulation applies to electronic identification systems notified by a Member State and to trusted service providers established in the Union.

Regarding cybersecurity, electric cars, electric chargers as well as their management system must follow certain safety protocols and have the necessary certifications to ensure the smooth operation of the system. Thus, the management system will avoid cyber-attacks. The relevant regulation on these issues is analyzed in Table 3.8, highlighting the important points.

Table 3.8: Regulations and Directives – Cybersecurity [26]

Regulation title	Relevant Articles and/or Paragraphs	Brief description of this regulation (regarding the project and the pilot goals)
Regulation 2019/881/EU	Article 8: Market, cybersecurity certification, and standardization Article 56: Cybersecurity certification Annex: Requirements to be met by conformity assessment bodies	Sets objectives, tasks and organizational matters relating to ENISA (the European Union Agency for Cybersecurity) and framework for the establishment of European cybersecurity certification schemes to ensure an adequate level of cybersecurity for ICT products, ICT services and ICT processes in the Union.

Regulation 2019/881/EU on ENISA (the European Union Agency for Cybersecurity) and on information and communications technology cybersecurity certification [26] repeals regulation 2013/526/EU, which is about the European Union Agency for Network and Information Security (ENISA). This regulation determines objectives, tasks and organizational matters related to ENISA. In addition, it lays down a framework to establish a European cybersecurity certification scheme for ICT products, services, and processes to avoid the fragmentation of the internal market regarding cybersecurity certification schemes. Other frameworks, which contribute to the cybersecurity levels are Regulation 2016/676/EU and Directives 2002/58/EC, 2016/1148/EU and 2018/1972/EU. The cybersecurity is a sector factored in both EV charge stations and charge station management system. The mechanism attests that ICT products, services and processes that have evaluated in accordance

with such schemes comply with specified security requirements for the purpose of protecting the availability, authenticity, integrity, or confidentiality of stored or transmitted or processed data.

The following table lists the regulations and directives related to the provision of data for analyzing and prediction of loads and EVs users' behavior. This category is important to applications such as the optimization of the electromotive system, as well as the network and its safe operation. Therefore, the EVs charging data is essential to used anonymized for power demand forecast and the systems flexibility. The most significant regulations and directives are summarized in Table 3.9, with the most recent regulation to have been published by 2018.

Table 3.9: Regulations and Directives - Data Provision [4], [27], [28]

Regulation title	Relevant Articles and/or Paragraphs	Brief description of this regulation (regarding the project and the pilot goals)
Directive 2012/27/EU	Paragraph 32 Article 9: Metering	Sets security of smart meters and data communication and capabilities of smart metering systems.
Regulation 2016/679/EU	Article 5: Principles relating to processing of personal data	Protection the processing of personal data and rules relating to the free movement of personal data (natural person).
Regulation 2018/1725/EU	Article 13: Safeguards relating to processing for archiving purposes in the public interest, scientific or historical research purposes or statistical purposes	Protection the processing of personal data by the Union institutions and bodies and rules relating to the free movement of personal data between them or to other recipients established in the Union.

Directive 2012/27/EU on energy efficiency [4] has been discussed previously in this chapter. Of relevance to the topic of data is Article 9 on Metering which describes metering and billing information systems and the right to access this data. **Regulation 2016/679/EU on the protection of natural persons with regard to the processing of personal data and on the free movement of such data** [27] repeals directive 95/46/EC known as General Data Protection Regulation (GDPR). This regulation sets out rules for the protection of natural persons about the processing of personal data and the free movement of that. The general data protection regulation (GDPR) protects individuals when their data is being processed by the private sector and most of the public sector. The GDPR includes general provisions, principles, rights of the data subject, duties of data controllers or processors, transfers of personal data to third countries, supervisory authorities, cooperation among member states, remedies, liability or penalties for breach of rights, and miscellaneous final provisions. Regulation 2018/1725/EU is guaranteeing the free flow of personal data within the Union. In addition, it sets provisions on the European Data Protection Supervisor (EDPS). The EDPS is entitled to monitor the application of the provisions of this Regulation to all processing operations carried out by a Union institution or body. In addition, it protects the main rights and freedoms of personal data. However, the free movement of these data internal the Union shall not be restricted or prohibited for some purposes, which sets out this regulation. **Regulation 2018/1725/EU on the protection of natural persons with regard to the processing of personal data by the Union institutions, bodies, offices and agencies and on the free movement of such data** [28] is based on directive 2016/680/EU and repealed regulation 2001/45/EC and decision 2002/1247/EC. This regulation defines rules for the processing of personal data by the Union institutions, bodies, and the free movement of those data.

4 National regulatory frameworks

This chapter lists and analyses the legislative and regulatory ecosystem in the countries of the four demonstrators. It includes an extensive list of the related legislation with a short description, followed by an analysis of the most important aspects and elements. Although certain themes are repeated, the structure in each section is not rigid in terms of the topics discussed. This is due to the differences in focus, prioritization and maturity in each country that demands a freer format. Regardless, the reader will obtain a full picture of the ecosystem around EV legislation in each country and is advised to use this chapter as a reference for future research.

4.1 Greece

This section analyzes the regulatory framework that is relevant to EV4EU for Greece and the Greek demo. In order to better facilitate comprehension some of the abbreviations and codenames used in the Greek legislative environment are summarized here.

- (GR) **ΕΣΜΗΕ**: Ελληνικό Σύστημα Μεταφοράς Ηλεκτρικής Ενέργειας ⇒ (EN) **HETS**: Hellenic Electricity Transmission System
- (GR) **ΔηΣΜΕ**: Δημοτικά Σχέδια Μείωσης Εκπομπών ⇒ (EN) **MERP**: Municipal Emissions Reduction Plan
- (GR) **ΚΑΠΕ**: Κέντρο Ανανεώσιμων Πηγών και Εξοικονόμησης Ενέργειας ⇒ (EN) **CRES**: Center for Renewable an Energy Saving
- (GR) **ΚΤΕΟ**: Κέντρο Τεχνικού Ελέγχου Οχημάτων ⇒ (EN) **VICC**: Vehicle Inspection Control Center
- (GR) **ΜΥΦΑΗ**: Μητρώο Υποδομών και Φορέων Αγοράς Ηλεκτροκίνησης ⇒ (EN) **RIEMO**: Registry of Infrastructures and E-mobility Market Operator
- (GR) **ΟΠΣ**: Οριστική Προσφορά Σύνδεσης ⇒ (EN) **FCO**: Final Connection Offer
- (GR) **ΟΤΑ**: Οργανισμός Τοπικής Αυτοδιοίκησης ⇒ (EN) **LGO**: Local Government Organization
- (GR) **ΥΜΖΗΕ**: Υπηρεσίας Μείωσης Ζήτησης Ηλεκτρικής Ενέργειας ⇒ (EN) **EDRS**: Electricity Demand Reduction Services
- (GR) **ΥΠΕΝ**: Υπουργείο Περιβάλλοντος και Ενέργειας ⇒ (EN) **MEE**: Ministry of Environment and Energy
- (GR) **ΦΕΒΥ**: Φορείς Εκμετάλλευσης Βασικών Υπηρεσιών ⇒ (EN) **BSO**: Basic Services Operator

Energy Policy

At the COP21 climate conference, held in Paris in 2015, the European Union pledged to limit greenhouse gas (GHG) emissions to low levels, as needed to keep the rise in average global temperatures below 2°C above pre-industrial levels. In this section, the Greek Energy Strategies and Policies, set in place to reach COP21 goals, are analyzed. To achieve these goals, the Greek State issued the National Energy and Climate Plan for 2030 (NECP2030) [29], the Long-Term Strategy for 2050 (LS2050) [30] and the National Climate Law (NCL) [31]. Table 4.1 presents in summary the two National Strategies and the Law about Climate in Greece.

Table 4.1: Regulations and Directives, National – Energy Policy GR [29]–[31]

Regulation title	Relevant Articles and/or Paragraphs	Brief description of this regulation (regarding the project and the pilot goals)
Ministerial Decision 4/2019 (OGG B' 4893/31.12.2019): Ratification of the National Energy and Climate Plan (NECP2030)	Chapter 1.1.2: General Strategy about five sectors of Energy Union Chapter 1.1.3: Development and prioritization framework policy Chapter 2.1.1: Revised NECP: Ambitious and Realistic Goals Chapter 2.2: Climate change, greenhouse gas emissions and absorptions Policy Priorities 1.3: Actions to reduce emissions in transport	Aims to decrease at least 42% greenhouse gases since 1990 emissions, shutdown all lignite units until 2028, to increase participation of RES at least 35% at energy consumptions and for an improvement of at least 38% of energy efficiency.
Long Term Strategy for 2050/Ministry of Environment and Energy	Chapter 4.1.1: Greenhouse gases emissions Chapter 4.1.3: Indicators for RES Chapter 4.3.3: Energy consumptions at transportations Chapter 4.3.7: Electricity system	Alternative solutions and transition routes towards an economy that will approach climate neutrality. Aiming to drastically reduce greenhouse gases by 2050 and strategies stopping climate change at 2°C and 1.5°C.
Law 4936/2022 (OGG A' 105/27.05.2022) : “National Climate Law”	Article 11: Prohibition of electricity production from solid fossil fuels Article 12: Measures to promote zero emission vehicles Article 14: Installation of parking and recharging points for Electric Vehicles Article 16: Municipal Emission Reduction Plans Article 21: Transformation of the development model of the islands and their transition to climate neutrality	Establish measures and policies to adapt the country to climate change and ensure the decarbonization path by the year 2050 with lowest possible cost, indicators for monitoring progress towards the relevant objectives, measures to mitigate emissions from power generation, the building sector, transport, and business.

Ratification of the National Energy and Climate Plan (NECP2030) Nr. 4 (OGG B' 4893/31.12.2019) [29] describes the strategy for 2030 about the electricity connections between mainland-islands and other countries, the starting of a new electricity market model and developing of new financial tools, the digitalization of the power network, the promotion of e-mobility and new technologies, and support initiatives in research and innovation. The **NECP 2030** main goals by 2030 are the reduction of greenhouse gases emissions, raise of RES participation at energy consumptions and improvement of energy efficiency. These targets present numerical as follow:

1. Reduction at least 42% of greenhouse gasses emissions since 1990 and at least 56% since 2005
2. Withdrawal of lignite units until 2028
3. Increase RES participation at total energy consumptions at least 35%
4. Increase RES participation at total electricity consumptions at least 60%
5. Increase RES participation at Heating and Cooling at least 40%

6. Increase RES participation at Heating and Cooling at least 19%
7. Improvement of energy efficiency at least 38%
8. The total power consumption for 2030 will be up to 16,5 Mtoe and energy savings from 2021 to 2030 will be up to 7,3 Mtoe.

The **Long-term Strategy for 2050 from Ministry of Environment and Energy (LS50)** [30] analyzes scenarios for the evolution of the energy system and the consumption pattern in the final sectors, with the goal of transitioning to a climate-neutral economy by the year 2050 without presenting specific specialized measures. The LS50 goals for reaching greenhouse gases targets until 2050 are the following:

- Energy Efficiency and Electrification for 2°C (EE2)
- New energy carriers for 2°C (NC2)
- Energy Efficiency and Electrification for 1.5°C (EE1.5)
- New energy carriers for 1.5°C (NC1.5)

The EE scenarios consider the promotion of a higher degree of electrification of energy use in all sectors and the improvement of energy efficiency, including transformations towards the direction of circular economy in industry and milder means in transport. For climate neutrality it is obvious that electricity generation must be zero carbon footprint and therefore will be based on large-scale development of RES.

The NC scenarios assume the adoption of policies at the European level that ensure the gradual maturity of technologies and the introduction of hydrogen, biogas and synthetic methane with climate-neutral preconditions to achieve a drastic reduction in the carbon footprint. The targets for improving energy efficiency and electrification are slightly lower in the NC scenarios than in the EE scenarios. In the EE scenarios emissions are avoided mainly due to the very ambitious improvement of energy efficiency, electrification, and the increased use of biomass.

Table 4.2: Results of LS2050 strategies [30]

LS2050	EE2	NC2	EE1.5	NC1.5
Reducing of total greenhouse gases	~85%	85%	~95%	95%
Total indicator of RES	81.9%	98.7%	98.7%	113.8%
Total net electricity consumptions	87.9 TWh	138.1 TWh	99.2 TWh	173.2 TWh
Rising of electricity storage	16.8 TWh	30.6 TWh	21.6 TWh	42.4 TWh
Total energy consumptions at transportation sector	7.489 Mtoe	7.855 Mtoe	6.834 Mtoe	7.395 Mtoe

The purpose of the **Law 4936/2022 (OGG 105/A/27.05.2022): National Climate Law - Transition to climate neutrality and adaptation to climate change, emergency provisions to address the energy crisis and protect the environment** [31] is to create a framework to improve the country's adaptive capacity and climate resilience and ensure the country's gradual transition to climate neutrality by the year 2050. The adopted policies and measures to mitigate climate change aim to reduce emissions and increase absorptions, strengthen legal certainty for investors and citizens, and smooth transition of the economy and society to climate neutrality. To achieve the long-term objective of climate neutrality,

the reduction of greenhouse gas emissions, considering the projections of the National Energy and Climate Plan (NECP). Furthermore, it sets the following deadlines and goals:

1. The production of electricity from solid fossil fuels is prohibited from 31 December 2028.
2. From 01.01.2026, the new TAXI and one in three new vehicles will be zero emissions vehicles.
3. From 01.01.2024, at least 25% of the new company's cars (passenger vehicles) will be BEV or PHEV ($\leq 50\text{g CO}_2/\text{km}$).
4. From 01.01.2030, all new vehicles will be zero emissions vehicles.
5. The deadline for preparation of Electric Vehicle Charging Plans (EVCP) has been extended.
6. Until 31.03.2023, every Local Government Organization (LGO) prepares a Municipal Emissions Reduction Plan (MERP). MERP calculates the carbon footprint investigates, identifies, and prioritizes the necessary measures and actions to reduce the relevant company's emissions and is compatible with the NECP objectives.
7. Development Strategic Framework for the Greek islands "GR-eco islands".

EVs and Charging

This category is of strong relevance to EV4EU project as it contains Greek Laws, Ministry Decisions and other regulation related to EVs and their charging infrastructure as well as definitions on EV requirements and incentives to consolidate EV purchasing.

In Greece, many large cities have problems with atmospheric pollution and air quality. The two important factors which contribute to atmosphere pollution are the old fleet of passenger vehicles with an average age of 16,6 years and the 50% of those vehicles which have outdated anti-pollution technology. 90% of cars have gasoline motors and only 1% of fleet are low emissions vehicles (BEV, PHEV, NGV).

Table 4.3 gathers the most important Greek Law and Decisions related to EVs and Charging Stations.

Table 4.3: Regulations and Directives, National – EV chargers GR [32]–[43]

Regulation title	Relevant Articles and/or Paragraphs	Brief description of this regulation (regarding the project and the pilot goals)
Law 4233/2014 (OGG A' 22/29.01.2014)	Article 15: Replacement of Paragraph 7 of Article 114 of Law 4070/2012	About EV chargers installation at existing or under licensing "Fuel and Energy Supply Stations", indoor or outdoor car stations, maintenance and repair workshops for cars, motorcycles and e-bicycles, public or private Vehicle Technical Control Center.
Law 4389/2016 (OGG A' 94/27.05.2016)	Article 59: Amendments to the provisions of Articles 120, 121, 123, 126 and 141 of Law 2960/2001 "National Customs Code" and Article 17 of Law 3833/2010	Defines the classification fees for PHEV and BEV, replacement of Paragraph 5 at Article 121 of Law 2960/2001.
Law 4410/2016 (OGG A' 141/03.08.2016)	Article 46: Amending Article 20 (L2948/2001)	Defines yearly traffic fees for passenger cars (PHEV, motorcycles, tricycles, BEV, Hydrogen vehicles, TAXI and Public used vehicles) from 01.11.2010 until present.

<p>Joint Ministerial Decision 42863/438/2019 (OGG B'2040/04.06.2019)</p>	<p>Article 4: Technical requirements for Electric vehicles charges Article 5: Definition of minimum safe distances and position of Electric vehicles chargers Article 6: Licensing-approval process for EV chargers' installation</p>	<p>Defines accepted EV charging methods, requirements of EV chargers for public and private stations and requirement open information for public Chargers. Specifies the minimum safety requirements for Public Chargers and necessary documents of Public Chargers installation process.</p>
<p>Law 4710/2020 (OGG A' 142/23.07.2020)</p>	<p>Part A/Chapter B: Incentives for the development of electromobility (Articles: 3, 5) Part A/Chapter C: Tax incentives for the development of electromobility (Articles: 3,7) Part B/Chapter A: Electromobility market organization (Articles: 12, 13, 14, 16) Part B/Chapter B: Spatial planning for the development (Articles: 17, 20) Part B/Chapter C: Urban planning regulations and other requirements for the installation of charging infrastructure (in accordance with Directive 2018/844/EU (Articles: 21, 22, 23, 24, 25, 26, 27) Part B/Chapter D: Topics related to car parks, garages, EV mechanics and VICC (Vehicle Inspection Control Centers) (Articles: 29, 32) Part F/Chapter A: Authorizing provisions (Article: 62) Part F/Chapter C: Repealed provisions (Article: 64)</p>	<p>Sets free EV parking, prohibits the import of old vehicles, discounts of rent for Zero Emissions company vehicles and for public Chargers, defines the Charging Point Operators for Public Chargers and their liabilities. Sets safety measures, signaling, accessibility and design of Public Chargers, space for EVs in garages.</p>
<p>Ministerial Decision 77472/520 (OGG B' 3323/07.08.2020): "KINOUME ILEKTRIKA"</p>	<p>Article 3: Objective of the Action Article 4: Beneficiaries/Final Recipients of the Action Article 6: Commencement and Duration of the Action Article 7: Aid Amount and Start of Expenditure Eligibility</p>	<p>Defines the terms, conditions, and procedures for enhancing the purchase of a BEV or PHEV, renewal of the vehicles fleet, development of House chargers and reduce the pollutant emissions; gives at individuals people, TAXI and Legal Entities financial subsidy to purchase or lease BEV/PHEV.</p>

	Article 12: Application procedures/implementation of the action	
Ministerial Decision 106871/930 (OGG B' 4904/07.11.2020)	Article 2: Amendment of Paragraph (c) of Article 4 Article 3: Replacement of Paragraphs 4 and 5 of Article 5 Article 4: The case in Paragraph 7.1 of Article 7 "CATEGORY C (legal entities)" is replaced by the case "CATEGORY C (businesses)"	Amendment of Decision of the Ministry of Environment and Energy 77472/520 (OGG B' 3323/07.08.2020) change the Legal Entities at Companies.
Joint Ministerial Decision 355033/2021 (OGG B' 5776/10.12.2021)	Article 4: Format of electronic unique identification (ID) codes Article 5: Data collection Article 10: Annex	Relates issues to the management and sending of data related to the Operation of E-mobility Market Operators, to publicly accessible Charging Points for electric vehicles are regulated. Specifies the type, body and quality of Charging Point data and collection of those data. Defines the ID codes, to ensure interoperability.
Joint Ministerial Decision 355076/2021 (OGG B' 5777/10.12.2021)	Article 3: Registration at Register of Infrastructures and E-mobility Market Operators (RIEMO) Article 4: Necessary documents for the change of data in RIEMO Article 5: Defining deposit Article 6: Compliance with the principles of the General Regulation for the protection of personal data	Sets the requirements fees and documents for registration the Charge stations at RIEMO, changes at Chargers infrastructures and data protection based on GDPR.
Ministerial Decision 70517/238 (OGG B' 3981/27.07.2022): "KINOUME ILEKTRIKA-2 nd round"	Article 3: Objective of the Action Article 4: Beneficiaries/Final Recipients of the Action Article 5: Action Budget (Public Expenditure) Article 6: Commencement and Duration of the Action Article 7: Aid Amount and Start of Expenditure Eligibility Article 8: 8.1 Eligible Vehicles for Purchase Article 12: Application procedures/implementation of the action	Defines the terms, conditions, and procedure for enhancing the purchase of a BEV, renewal of the vehicles fleet, development of smart chargers and reduce the pollutant emissions; gives at individuals people and Companies financial subsidy to purchase or lease BEV.

Ministerial Decision 137582/646 (OGG B' 6789/28.12.2022): “GREEN TAXI”	Article 3: Objective of the Action Article 4: Beneficiaries/Final Recipients of the Action Article 6: Commencement and Duration of the Action Article 7: Aid Amount and Start of Expenditure Eligibility Article 12: Application procedures/implementation of the action	Defines the terms, conditions, and procedure for enhancing the purchase of a TAXI (BEV), renewal of the vehicles fleet, development of smart chargers and reduce the pollutant emissions; gives TAXI owners financial subsidy to purchase or lease BEV.
Ministerial Decision 210/3 (OGG B' 17/09.01.2023)	All Articles	Amendment of Article 6 of the decision of the Ministry of Environment and Energy 77472/520 (FEK B' 3323/07.08.2020) on the final payment of support by 30.06.2023

The older Law of the table is **Law 4233/2014 (OGG A' 22/29.01.2014): National Flight Coordination Authority and other provisions** [32], which replaces Paragraph 7 of Article 114 of Law 4070/2012, about the installation of Charging Stations at existing or under licensing Fuel and Energy Supply Stations, Indoor and Outdoor parking, garages and public or private Vehicle Inspection Control Centers (VICC). **Law 4389/2016 (OGG A' 94/27.05.2016): Emergency provisions for the implementation of the agreement on fiscal objectives and structural reforms and other provisions** [33] amended Article 120, 121, 123, 126 and 141 of Law 2960/2001 “National Customs Code” replacement Paragraph 5 of Article 121. It releases Hybrid Vehicles from a 50% classification fee and BEV exempt from classification fee.

Next is **Law 4410/2016 (OGG A' 141/03.08.2016): Amendments to the National Customs Code to strengthen the fight against illegal tobacco and manufactured tobacco trade and Establishment of a Coordinating Center to Combat Smuggling, harmonization** [34], which is amending Article 20 of Law 2948/2001. It sets traffic fees for passenger cars, from 01.11.2010 until present, with 0-90 CO₂ gr/Km at 0 €. In addition, Hybrid cars, motorcycles, and tricycles up to 1549 c.c., exempt from traffic fees and those with 1549 c.c. at least, the traffic fees are 60% of conventional cars. BEV or Hydrogen vehicles, motorcycles and tricycles, are exempt from traffic fees. Also, Public used Hybrid motorcycles and tricycles up to 1929 c.c., are exempt from traffic fees and those upper than 1929 c.c. traffic fees are 50% of conventional vehicles.

Joint Ministerial Decision 42863/438/2019 (OGG B' 2040/04.06.2019): Defining the terms, conditions and technical specifications for the installation of electric vehicle battery chargers (recharging points), at vehicle service facilities, at publicly accessible recharging points [35]. Specifically, sets that the accepted EV charging modes are mode 3 (Mode 3 AC Charging) and mode 4 (Mode 4 DC Charging), as these are determined by the EN/IEC 618511 standard “Electric Vehicle Conductive Charging System”. Also, defines installation components as power outlet, plugs and terminals from standard EN/IEC 621962 “Plugs Socket outlets, Vehicle Couplers and Vehicle Inlets Conductive Charging of Electric Vehicles”. For example, Type 2 plugs for mode 3 charging and Type 3 (DC Combo 2) for mode 4 charging. It is also possible to provide a terminal in parallel for charging with mode 4, as specified in the CHAdeMO protocol. All the charging equipment must have CE certification, the sockets are equipped with safety shutters and EV Chargers which are installed on the ground are protected with appropriate type of pillars or shock absorbers. Also, all public chargers provide the possibility of ad hoc charging for users of electric vehicles, without the obligation to conclude a contract with the relevant electricity

supplier or administrator. In addition, the administrator of Public Charging Station must provide as minimum information the coordinates of station, availability, type, and number of plugs, charging Mode and installed power, operation hours, method of payments and billing and their contact information. The Public EV chargers are installed in researched locations in the public road network, in points with public access and in Motorist Service Stations along highways. The Charger installation and operation must have the Manufacturer's EU Declaration of Conformity, Responsible Declaration of Licensed Electrician Installer, Electrical Installation Delivery Report and Electrical Installation Suitability Control Protocol according to ELOT HD 384 and Proof of notification to HEDNO SA of the photocopy of the supporting document.

Law 4710/2020 (OGG A' 142/23.07.2020): Promotion of e-mobility and other provisions [36] has as purpose the expansion of the use of low and zero emission vehicles, the development of charging infrastructures, especially publicly accessible ones, and the formation of a regulatory framework for the electric mobility market. Particularly, it demands free parking in paid public parking for EVs with a special sign from responsible authorities. Moreover, it increases the environmental fees for imports of Euro-4, Euro-5a cars and is prohibiting Euro-1, Euro-2, Euro-3 importations. All the revenue from environmental fees is allocated to the implementation of actions to promote e-mobility and electric vehicles through financial incentives for the purchase or lease of any type of BEV or PHEV. Additionally, it reduces the taxes for the purchase or lease of a zero-emission company passenger car, on installing public chargers and on electricity from RES used for charging. Also, for public chargers the Charging Point Operators (CPO) must have a connection contract with the DSO, a supply contract with one or more electricity suppliers and provide ad hoc recharging services to non-contracted EV users with direct billing. This Law also defines the type of Charging Stations Data as Static (ID code, coordinates, charging method, station owner etc.), Dynamic (availability, current state, charging price) and Accounting/Operational (amount of EVs, total number of charging sessions, average charging time etc.). Additionally, it defines safety measures for indoor chargers, design of Public Chargers and requirements for EV workshops.

In 2020, another action to promote e-mobility is **Ministerial Decision 77472/520 (OGG B' 3323/07.08.2020): Announcement of the action "KINOUME ILEKTRIKA"**[37]. The main purpose of this action is the renewal of the vehicles fleet, development of home chargers and reduction of emissions. The beneficiaries are divided in three Categories. Category A includes regular consumers, who do not engage in business activity. Category B, include owners of TAXIs and Category C, all legal entities, of any form. The public expenses for Category A are up to 13.800.000€, for Category B up to 15.000.000€ and Category C up to 17.000.000€. The financial support of this action for:

Category A was:

- a) 20% and up to 6.000€ for BEV with price before tax up to 30.000€
- b) 15% and up to 6.000€ for BEV with price before tax from 30.001€ to 50.000€
- c) 500€ for installation of a house smart charger
- d) 20% and up to 800€ of e-motorcycle/tricycle price
- e) 40% and up to 800€ of e-bike
- f) Optional replacement of old vehicle 1.000€/ old motorcycle 400€
- g) Disabled/Multiple children: extra 1.000€ (for BEV)/500€ (for motorcycle/e-bike)

Category B was:

- a) 25% and up to 8.000€ for BEV at the price before tax
- b) 15% and up to 5.500€ for PHEV (≤ 50 g CO₂/km) at the price before tax
- c) Mandatory replacement and declassification of old TAXI vehicle 2.500€
- d) Disabled/Multiple children: extra 1.000€

Category C up to 3 vehicles (on islands up to 6) was:

- a) 15% and up to 5.500€ for BEV or 4.000€ for PHEV at the price before tax for vehicles to transport of goods with maximum mass of up to 3.5 tons

- b) 20% and up to 800€ for e-motorcycle, tricycle (except e-bikes) at the price before tax
- c) 15% and up to 5.500€ for BEV at the price before tax
- d) Optional replacement of old vehicle 1.000€/ old motorcycle 400€

Also, set up requirements of house smart chargers. After that, a new **Ministerial Decision 106871/930 (OGG B' 4904/07.11.2020): Amendment of the Joint Decision 77472/520 of the Ministers of Finance, Environment and Energy and Infrastructure and Transport "Proclamation of the Action KINOUME ILEKTRIKA " (OGG B' 3323/07.08.2020)**. [38] was published by Ministry of Environment and Energy and amendment the Joint Decision 77472/520 replaced the Paragraph C of Article 4 where replace Legal Entities with Companies, which has headquarters or branch store inside the Greek territory. Replace of Paragraphs 4 and 5 of Article 5, which "The distribution of Public Expenditure per category of Beneficiary/Final Recipient and also per Category of Vehicles, where there is a relevant quota provision, may be adjusted depending on the absorption of available resources". A second amendment of **Ministerial Decision 77472/520 (FEK B' 3323/07.08.2020)** was published in 2023, which is the **Ministerial Decision 210/3 (OGG B' 17/09.01.2023): 2nd Amendment of the Joint Ministerial Decision 77472/520/2020 "Proclamation of the Action KINOUME ILEKTRIKA " (B' 3323)** [43] and expand the payment dates of financial support to 30.07.2023.

After action "KINOUME ILEKTRIKA" The Ministry of Environment and Energy published **Ministerial Decision 70517/238 (OGG B' 3981/27.07.2022): Announcement of the Action " KINOUME ILEKTRIKA - 2nd round"** [41]. This action has the same purpose of "KINOUME ILEKTRIKA". The difference in motives and categories are presented below. There are two categories A (Natural People) and B (All businesses and legal entities). The public expenses for Category A are up to 15.000.000€ and for Category B up to 35.000.000€. The beneficiaries from category A have financial support:

- a) 30% and up to 8.000€ for BEV at the price before tax
- b) Electric motorcycle/tricycle:
 - a. 30% at the price before tax and up to 1.300€, for categories L1e to L4e
 - b. 40% at the price before tax and up to 3.000€, for categories L5e to L7e
- c) 40% at the price before tax and up to 800€, for e-bikes
- d) Withdrawal of old vehicle 1.000€/ old motorcycle 400€
- e) 500€ for installation of a house smart charger, if the purchase cost is lower than 500€ then the subsidy is equal of that cost
- f) Disabled: extra 1.000€ for EV category M and 500€ for category L or e-bike
- g) Families with at least 3 dependent children: extra 1.000€ for each dependent child (EV category M) / 500€ for each dependent child (EV category L or e-bike). The maximum subsidy cannot exceed €4,000 category M.
- h) For people younger than 29 years old: extra 1.000€ for category M or categories L6e, L7e

The financial support for category B is:

- a) Electric passenger and business cars:
 - a. 30% at the price before tax and up to 8.000€/vehicle for application from 1 to 20 BEV
 - b. 20% at the price before tax and up to 6.000€/vehicle for application over 20 BEV
- b) Electric motorcycle/tricycle:
 - a. 30% at the price before tax, for categories L1e to L4e, and up to 1.300€
 - b. 40% at the price before tax, for categories L5e to L7e, and up to 3.000€
- c) E-bikes 40% at the price before tax, and up to 800€
- d) Purchase smart charging point at the private parking of the company's 400€/BEV maximum weight 3.5 tons.
- e) Withdrawal of old vehicle or/and motorcycle/tricycle (except bikes) 1.000€/400€ for each vehicle
- f) Purchase extra battery for vehicles type L1e to L7e, 300€ for each vehicle.

Additionally, the decision defines the vehicle categories L1e to L7e, M1, N1 and specifications of smart charging points.

On the same year, **Ministerial Decision 137582/646 (OGG B' 6789/28.12.2022): Announcement of the Action entitled "GREEN TAXI", which will be implemented with the support of the Recovery and Resilience Fund** [42] was published. It supports financially the beneficiaries to purchase or lease TAXI vehicles, with possibility for replacement of the old one. The National goal of those actions is to achieve 1 in 3 vehicles to be electric by 2030, to reduce emissions and improve air quality. The action “**GREEN TAXI**” gives financial incentives to buy or lease TAXI vehicle of categories Euro-5 and later. The financial support is:

- a) 40% and up to 17.500€ at the price before tax
- b) Mandatory replacement and declassification of old TAXI vehicle 5.000€
- c) 500€ (for each TAXI license) for installation of a house smart charger
- d) Disabled/Owners younger than 29 years old/families with at least 3 dependent children: extra 1.000€

In addition, it sets technical specifications of eligible Charging Points, based on Mode 3 and 4 type of Charging, which are defined from IEC 61851-1. Include four requirement sectors for Charging stations:

- a) Common requirements (CE certification, IP 44 at least, etc.)
- b) AC Chargers (Power limits for house and businesses Chargers, compatible with ELOT EN 61851-1 standard)
- c) DC Chargers (Power limits for house and businesses Chargers, compatible with ELOT EN 61851-1 standard)
- d) Ability to manage power (exchange data with OCCP 1.6 or newer protocol, Power adjustment, energy consumption, 2 years guarantee of good operation, etc.)

In 2021, two Joint Ministerial Decisions were published about management and sending of data related to the operation of the electric mobility market and the Register of Infrastructure and E-mobility Market Operators (RIEMO) (**Joint Ministerial Decision 355033/2021 (OGG B' 5776/10.12.2021): Management and sending of data related to the operation of the electric mobility market operators, electric vehicle recharging points and access rights to the Register of Infrastructure and E-mobility Market Operators (RIEMO) of the interested parties** [39]) and definition the kind and price of fees and technical details for RIEMO (**Joint Ministerial Decision 355076/2021 (OGG B' 5777/10.12.2021): Determination of the type and amount of the price of the tariff, its adjustment, the method and process of its payment, collection and performance, the interconnection with other Registries and applications of the public sector and the technical details of the operation of the Registry of Infrastructure and E-mobility Market Operators (RIEMO)** [40]). The **Decision 355033/2021** [39] sets the Identification code for Operators Market E-mobility to exchange data with safety. The first part of ID code published from RIEMO, after the registration and register fee paid. The second part is published by e-mobility market operators when activating any new service or infrastructure. Additionally, the data exchange is performed through secure communication channels using the corresponding digital token. Incompatible data are rejected by the RIEMO, with simultaneous notification of the electric mobility market operator via M2M, to ensure interoperability, Data Exchange. **Decision 355076/2021** [40] defines that at the initial registration of market operators at RIEMO, you must pay a one-time registration fee (150.00€, which may be modified) and an annual maintenance fee. Also, to change data for infrastructures already declared in the RIEMO, one must submit the necessary documents to the Ministry of Infrastructure and Transport. The annual maintenance fee is defined as the amount 1% of one-time registration fee for each charging point. The last important thing is that the processing of any personal data is applied to the principles of personal data protection provided in the GDPR. According to **Law 4710**, it is mandatory for owners (public or private) of electric vehicle (EV) chargers to declare them to the DSO. This declaration serves to ensure that the DSO is aware of the location of all EV chargers to better manage the distribution of electricity to meet the demand of EVs. The procedure for declaring an EV charger to the DSO involves submitting to the application platform with the relevant details of the charger, such as the model, its location,

capacity, and ownership information as well as relevant certifications of the model. Also, regarding public chargers, it should be stated whether they implement smart charging feature.

In Greece, the concept of **V2X and mainly V2G** is gaining more attention as the country strives towards a more sustainable future. The National Energy and Climate Plan (NECP) [29] acknowledges the importance of consumers' role in providing energy to the grid through small-scale Renewable Energy Source (RES) plants and flexibility services [44]. With the aid of digital applications, innovative information systems, and decentralized network development technologies such as blockchain, transactions between consumers and small-scale producers can take place directly without the need for intermediaries. Additionally, it is proposed that net-metering stations could install storage systems, further facilitating the integration of V2G technology. As a result, V2G is expected to become a crucial component of the future energy landscape in Greece, however, no explicit piece of legislation or regulation has been produced yet on the topic.

Distributed Energy Resources, Markets and Systems

In this section, is presented the legislative framework of Greece for Energy Networks, RES, and Energy Markets. In the following Table 4.4, is mentioned Laws and Decisions which are relevant on this chapter from year 2011 to 2022. The important points of these legislation could be the base of integration EVs with Distribution Network, Renewable energy sources and their management, with the aim of their optimal contribution to the energy system.

Table 4.4: Regulations and Directives, GR – DER, Markets and Systems [45]–[59]

Regulation title	Relevant Articles and/or Paragraphs	Brief description of this regulation (regarding the project and the pilot goals)
Law 4001/2011 (OGG A' 179/22.08.2011)	Article 22: Monitoring and supervision of the energy market Article 23: Taking regulatory measures for the orderly operation of energy markets. Article 27: Data collection Article 59: Implementation of intelligent measurement systems	RAE monitors and supervises the energy market, prepares reports, recommends necessary measures, and issues regulatory acts to comply with rules, obligations, and protect consumers, the environment, and supply security.
Law 4203/2013 (OGG A' 235/01.11.2013)	Article 2: Large Hydroelectric Plants (LHP) Article 3: Transfer of installation location Article 4: Terms and conditions for small installation wind turbines	Sets the framework about installation of RES power plants

<p>Law 4342/2015 (OGG A' 143/09.11.2015)</p>	<p>Article 11: Measurement (Article 9 of Directive 2012/27/EU) Article 12: Pricing (Articles 10 and 11 of Directive 2012/27/EU) Article 26: Center for Renewable Sources and Energy Saving</p>	<p>Energy retailers provide smart energy meters and data to users, while the Center for Renewable Sources and Energy Saving (CRSES) coordinates activities related to renewable energy and energy efficiency.</p>
<p>Law 4414/2016 (OGG A' 149/09.08.2016)</p>	<p>Article 3: New support regime for power plants from RES and CHP</p>	<p>Participation of RES and CHP power plants in energy markets and for new power plants at support regime with Operation Reinforcement based on Differential Compensation Price, about electricity which production and absorption from Connected System and Network.</p>
<p>Law 4425/2016 (OGG A' 185/30.09.2016)</p>	<p>Article 8: Electricity Energy Markets</p>	<p>Reorganization of the Greek electricity market, in implementation of the legislation for the integration of the single European electricity market including Forward Market, Day Ahead Market, Intra-Day Market, Balancing Market.</p>
<p>Law 4513/2018 (OGG A' 9/23.01.2018)</p>	<p>Article 2: Members of Energy Community Article 3: Cooperative Energy Community Shares Article 4: Purpose - Object of Energy Community activity Article 6: Disposal of usage surpluses</p>	<p>Determines the entities which can entry and create Energy Communities, the number of members, objectives of Energy Communities, electricity sharing percentages between members and the electricity disposal.</p>
<p>Law 4559/2018 (OGG A' 142/03.08.2018)</p>	<p>Article 41: Replacement of Article 143D of L. 4001/2011 (A' 179)</p>	<p>Flexibility Service is the ability of energy providers to quickly increase or decrease power to meet HETS demand within 3 hours of an Allocation Order, with a minimum rate of change of 8 MW/min for at least 3 consecutive hours.</p>
<p>Ministerial Decision MEE/74999/302 4 (OGG B' 3971/ 30.08.2021)</p>	<p>Article 4</p>	<p>Storage systems can be installed by the State, public or private entities with public interest or local objectives that own RES, CHP plants, and electricity systems in the Interconnected System or on Crete.</p>

<p>Law 4920/2022 (OGG A' 74/15.04.2022)</p>	<p>Article 225: Investment and operating support for electricity storage stations - Addition of Article 143F to Law 4001/2011</p>	<p>Addition to Law 4001/2011 (A' 179) the Article 143F about financial support for electricity storage stations in the Hellenic Electricity Transmission System.</p>
<p>Law 4951/2022 (OGC A' 129/04.07.2022)</p>	<p>Article 5: Final Connection Offer Article 42: Radical renewal</p>	<p>The goal is to modernize renewable energy systems and develop pilot marine photovoltaic stations, while regulating energy and environmental protection issues.</p>
<p>Ministerial Decision MEE/81329/3660 (OGG B' 4247/ 10.08.2022)</p>	<p>Article 4: Load Agent charge adjustment and invoicing process Article 5: Unit charge calculation methodology Article 7: Net Electricity Process</p>	<p>Determines the calculation methodology of charge Load unit, the creation and amount of the security reserve of the Calculation, the procedure for imposing and readjusting the charge, the procedure for invoicing and clearing the Load Representatives for the compensation of new RES and CHP Projects which are put into operation from 1.1.2021.</p>
<p>Ministerial Decision 84014/7123 (OGG B' 4333/ 12.08.2022)</p>	<p>Article 2: Specific Priority Framework - Priority Teams Article 9: Specific Priority Framework for Network Operator - Priority Teams Article 10: Specific Priority Framework for Network Operator - Special Situations Article 11: Priority framework about saturated Networks Article 12: Storage stations which are checked by Network Operator</p>	<p>Sets a Priority Framework for Network and System Operators to provide FCO for RES, CHP, and storage stations. Criteria considered include feasibility, security, economics, and technology and others.</p>
<p>Law 4986/2022 (OGG A' 204/28.10.2022)</p>	<p>Article 13: Monitoring and supervision of the energy market Article 21: Contract for the provision of demand response services Article 28: Monitoring, installation, evaluation and application of intelligent metering systems Article 29: Functional capabilities of smart metering for electricity Article 30: Data management, interoperability requirements and procedures for access to data related to electricity energy activities</p>	<p>Modernises national legislation on electricity markets aiming at the smooth transition to a low-carbon energy system, to ensure affordable and transparent energy prices, to strengthen the security of supply and the position of electricity consumers, to expand the authorities of the electricity market, and strengthen spatial planning, urban planning and forest protection.</p>

	<p>Article 32: Technical requirements for demand response participation through cumulative representation and data access issues</p> <p>Article 68: Installation programs for solar thermal systems, photovoltaic systems and storage systems - Authorizing provision</p>	
<p>Law 4994/2022 (OGG A' 215/18.11.2022)</p>	<p>Article 41: Electricity Demand Reduction Service - Addition of Article 143G to Law 4001/2011</p>	<p>Recommends an Electricity Reduction Service for consumers to limit peak-hour power consumption and receive financial compensation and outlines conditions for the service, peak hours, reduction methods, payment, non-compliance charges, and selected participants.</p>
<p>Joint Ministerial Decision MEE/135277/47 06/2022 (OGG B' 6649/ 23.12.2022)</p>	<p>Article 2: Electricity Demand Reduction Services</p> <p>Article 6: Electricity Demand Reduction Auctions</p> <p>Article 8: Financial compensation for the Electricity Demand Reduction Service</p>	<p>Defines the most special characteristics of the Electricity Demand Reduction Service, of the peak hours and the conditions for its provision EDRS, of consumers who can participate, the obligations of load operators and consumers and the financial compensation for participation at EDRS.</p>

Law 4001/2011: On the Operation of Electricity and Gas Energy Markets, for Exploration, Production and Transmission Networks of Hydrocarbons and other provisions [45] describes the Regulatory Authority for Energy (RAE) regarding the operation of Electricity and Natural Gas Energy Markets, for Exploration, Production and Hydrocarbon transmission networks and other arrangements. Specifically, RAE:

- monitors and supervises the operation of energy market,
- prepares, publishes, and submits reports,
- makes recommendations,
- decides or recommends to the competent bodies the taking of necessary measures, including the issuance of regulatory and individual acts, to comply with competition rules and the regulatory obligations set by this law,
- protects the consumer,
- fulfills public utility service obligations,
- is responsible for environmental protection,
- oversees the security of supply and the development of the internal energy market of the European Union.

Additionally, RAE sets measures and conditions for Companies with Energy activities, for creation conditions of healthy competition and orderly functioning of the market. It collects any data about technical, financial, market and relevant sectors to complete its responsibilities. Finally, RAE aims to enable consumers to actively participate in the energy market but also more generally to more efficient and economical operation.

Law 4203/2013: Regulations on Renewable Energy Sources and other provisions [46] sets out the framework about installation of RES power plants. **Law 4342/2015: Pension arrangements, integration into Greek Framework of Directive 2012/27/EU** [47] approaches topics regarding energy distributors and energy retailers responsible for installing, operating and maintaining electricity meters are required to provide at a competitive price to end consumers individual meters that reflect their actual energy consumption and provide real-time information, in the following cases: (a) when replacing an existing meter or after a radical renovation of a building or building unit (b) when a new connection to a new building takes place. Intelligent metering systems should enable accurate pricing based on actual consumption. Energy distributors and energy retailers must provide end consumers with easy access to additional information that enables them to check their consumption history in detail.

The Center for Renewable and Energy Savings (CRES), which has been designated as the National Coordinating Center for Renewable Energy Activities (REA), Energy Saving and Rational Use of Energy, is also designated as the National Center to support the implementation of the national policy to improve energy efficiency and promote RES, in accordance with the provisions of this Regulation. In brief CRES:

- provides technical expert services to public bodies to promote the energy upgrading of their buildings.
- provide technical support services to public bodies on the design and implementation of their actions to increase energy efficiency in buildings or other functions of their competence.
- carries out information, awareness-raising and technical training activities.
- support technically and scientifically the relevant departments of the Ministry of the Environment and Energy, in the preparation of studies and in the drafting of action plans and reports.

Law 4414/2016: New support regime for power plants from Renewable Energy Sources and High-Efficiency Cogeneration of Electricity and Heat - Provisions for the legal and operational separation of supply and distribution branches in the natural gas market [48] focuses on the development of a new support scheme for power plants from Renewable Energy Sources (RES) and High Efficiency Cogeneration (CHP) compatible with the Guidelines on State aid to the environment and energy (2014-2020) Since 1.1.2016 the participation of RES and CHP power plants in the electricity market and for new plants from the same date are included in a support scheme in the form of Operating Aid on the basis of a Differential Compensation Price for the electricity they generate, which is absorbed by the Interconnected System and the Interconnected Network. The Differential Add-on is expressed in monetary value per unit of measurement of the electricity output injected into the Interconnected System and the Interconnected Network, whereas the clearing, invoicing and the transactions governing it are settled on a monthly basis.

Law 4425/2016 (OGG A' 185/30.09.2016): Urgent arrangements of the Ministries of Finance, Environment and Energy, Infrastructure, Transport and Networks and Labour, Social Security and Social Solidarity for the implementation of the agreement on fiscal targets and structural reforms and other provisions. [49] reorganizes the Greek electricity market, in application of the legislation completing the single European electricity market and in particular the provisions of Regulation (EC) 714/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity. The electricity transactions in the Interconnected Electricity System are conducted in the following Markets:

- Forward Market: Participants conclude contracts for the purchase and sale of electricity.

- Day-Ahead Market: Submission of electricity trading orders with physical delivery obligation on the next day. The quantities of energy committed through trading in Electricity Futures, either through the wholesale market of Electricity Futures or outside it, shall be declared.
- Intraday Purchase: Participants shall submit Transaction Orders for physical delivery on the Physical Delivery Day, after the deadline for submitting Transaction Orders to the Next Day Market, considering the amount of energy committed.
- Balancing Market: includes the Balancing Power Market, the Balancing Energy Market, as well as the imbalance settlement process. The Participants have an obligation to submit bids with a physical delivery obligation for all their available power, both in the Balancing Energy Market and in the Balancing Power Market.

For the operation of the Markets, appropriate certified information systems are used, which should ensure the functional interface between them and the smooth transfer of data from one Market to another. (No 8)

Law 4513/2018: Energy Communities and other provisions [50] determines the entities which can entry and create Energy Communities, the number of members, objectives of Energy Communities, electricity sharing percentages between members and the electricity disposal.

Law 4559/2018 (OGG A' 142/03.08.2018): University of Ioannina, Ionian University and other provisions [51] a transitional Flexibility Compensation Scheme is hereby established and implemented. The transitional Flexibility Compensation Mechanism is defined as the availability of the Flexibility Services to the Hellenic Electricity Transmission System (HETS). The Administrator of the HETS pays compensation to the Providers of the above Service. Flexibility Service is defined as the rapid increase or decrease of the selected Provider's power to meet the demand of the HETS, following the Distribution Orders of the HETS Manager. Providers must have the responsiveness within three (3) hours of the issue of a Distribution Order of the Manager, with a measured rate of change of production/injection or consumption/absorption power of at least eight (8) MW/min and a responsiveness for at least three (3) consecutive hours. Also, providers are defined as the Distributed Production Units that have the capability to provide the Flexibility Service. The Distributed CHP Units that have the capability to provide the Flexibility Service are defined as Providers only for the part of their power that is not remunerated by an RES/ CHP support mechanism. There is an auction for the availability of power to provide the Flexibility Service to which Providers may submit distinct offers up to ten power steps, with a minimum discrete power of 1 MW. The maximum bid price is set at \$39/kW/year. For the Flexibility Service, a fee is set which is paid to the Providers and is calculated based on the offer price of the Providers in the Competitive Procedure (pay-as-bid).

Ministerial Decision MEE/15084/382/2019: Installation of energy plants by self-generation consumers with applying energy offset or virtual energy offset in accordance with Article 14A of Law 3468/2006, as applicable, and by Energy Communities with the application of virtual energy netting in accordance with Article 11 of Law 4513/2018 [60] sets the operation of Storage System. This Ministerial Decision ensures that storage systems will not exchange energy with the distribution network, i.e., the energy stored in the storage system comes exclusively from the generating station and the stored energy is available exclusively for the supply of self-generation consumers.

Ministerial Decision MEE/74999/3024 (OGG B' 3971/30.08.2021): Amendment of the MEE/DAPEEK/15084/382/19.02.2019 ministerial decision "Installation of generating stations by self-producers with the application of energy offset or virtual energy offset in accordance with Article 14A of Law 3468/2006, as applicable, and by Energy Communities with the application of virtual energy netting in accordance with Article 11 of Law 4513/2018" (B' 759).[52] concludes that RES, CPH plants and

electricity storage systems of the legal entity of the State or legal persons governed by public or private law pursuing public interest, general or local objectives, which are established in the Interconnected System or on the island of Crete, are permitted to install a storage system.

Ministerial Decision MEE/81329/3660 (OGG B' 4247/10.08.2022): Determination of calculation process, apportionment and invoicing of the charge of Load Representatives for the compensation of new RES and CHP targets of NECP, the Calculation of new RES and CHP projects of NECP targets of the Special RES, CHP and Interconnected System and Network Storage Account and relevant implementation provisions lays out the process for Load Agent charge adjustment and invoicing, as well as the calculation methodology for unit charges and the creation and amount of the security reserve for the calculation. The decision also outlines the procedure for imposing and readjusting the charge, as well as the invoicing and clearing process for Load Representatives. One of the key aspects of this decision is the compensation of new RES and CHP Projects that are put into operation from 1.1.2021. The decision sets the guidelines for determining the charges associated with these projects and how they will be paid out to Load Representatives. By establishing a clear methodology for unit charge calculations and security reserve creation, this decision provides a framework for ensuring that Load Representatives are fairly compensated for the new RES and CHP Projects, while also ensuring the stability and reliability of the Net Electricity Process. Overall, this decision is an important step towards creating a more efficient and sustainable energy system, one that balances the needs of all stakeholders and promotes the growth of renewable energy sources.

Ministerial Decision MEE/84014/7123 (OGG B' 4333/12.08.2022): Determination of a priority framework in the granting of definitive Connection Offers for RES and CHP stations and storage stations by Network Operator and the System Operator, including areas characterized as saturated networks in derogation of any other general or special provision [53] defines the priority framework for the granting of Final Connection Offers for Renewable Energy Sources (RES), High Efficiency Heat and Power Cogeneration and storage plants by the Network Operator and the System Operator, including areas identified as saturated networks, taking into account the energy supply, the technical feasibility of connecting plants to the network or the System Operator's system, the size of the plants under development, the reduction of energy costs for consumers and businesses and economic and technical criteria. Terms, conditions, and restrictions shall be laid down for specific categories of power plants to be given priority. The plants' owners included in this subcategory are obliged, within two (2) months of the publication of the present decision, to provide the appropriate technical documentation in relation to the power absorption capacity of the storage technology, otherwise a limitation of 50% maximum absorption capacity shall apply. The owners shall accept, within twenty (20) days of the notification of the System Operator the following:

- The bilateral contract bond shall be valid for at least two (2) years, which must be renewed before expiry for at least two (2) years at a time, until the plant has been tested and the testing certificate has been issued.
- Requests for the granting of a definitive Offer of Connection for electricity storage stations which, due to the injection and/or absorption restrictions applied, do not limit the capacity of the electricity networks to accommodate RES and CHP generation capacity.

Law 4951/2022 (OGC A' 129/04.07.2022): Modernization of the licensing process for Renewable Energy Sources - Phase B, Licensing of electricity production and storage, framework for the development of Pilot Marine Floating Photovoltaic Stations and more specific provisions for energy and environmental protection.[54] purposes modernization of the licensing framework for Renewable Energy Sources, as well as the production and storage of electricity. In addition, it seeks to develop

pilot marine floating photovoltaic plants, as well as to regulate more specific energy and environmental protection issues. Regarding the interconnected system of the country, power plants that are less than 8MW, HEDNO (DSO) is responsible, otherwise if power capacity exceeds 8MW IPTO (TSO) is responsible. Stations with power capacity between 1-8MW, the Operator to which to submit the application for RES or CHP and/or energy storage can be chosen. For Non-Interconnected Islands” (NIIs) the applications are all submitted to the DSO.

Law 4986/2022 (OGG A' 204/28.10.2022): Integration of Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal electricity market and the amendment of Directive 2012/27/EU and other urgent provisions. [59] emphasizes on:

- the modernization of the national legislation on the electricity market and its harmonization with the corresponding legislation of the European Union
- the smooth transition to a low-carbon energy system
- ensuring affordable and transparent energy prices,
- strengthening the security of supply, as well as the position of electricity consumers,
- the expansion of the authorities of the electricity market, and
- the strengthening of spatial planning, urban planning and forest protection.

Joint Ministerial Decision MEE/135277/4706/2022 (OGG B' 6649/23.12.2022): Electricity Demand Reduction Service (E.D.R.S.) of Article 143G of Law 4001/2011 (A 179). [56] defines the Electricity Demand Reduction Service. It outlines the obligation of Consumers or Demand-Response Aggregators to limit the energy they consume during Peak Hours, at least up to an agreed quantity, resulting from the Electricity Demand Reduction Auctions, given financial compensation.

Law 4920/2022 (OGG A' 74/15.04.2022): Integration of a) Directive 2019/2164/EU, b) Directive 2019/1153/EU, c) Directive 2019/2034/EU, d) Article 1 of Directive 2019/2177/EU, e) Directive 2020/1504/EU, f) Directive 2019/1160/EU, g) Directive 2021/338/EU provides the addition to **Law 4001/2011 (A' 179)** [57] the new Article 143F about financial support for electricity storage stations in the Greek Electricity Transmission System. It allows investment aid and/or annual operating aid to electricity storage stations connected and operating in the Greek Electricity Transmission System, as well as to storage stations installed in countries within the European Economic Area. Regarding cases where aid is granted through competitive tendering procedures, the following are specified in particular:

- the way the competitive tendering procedures shall be conducted and the model of the tender.
- the number of competitive tendering procedures per year
- the timetable for the implementation of the competitive procedures
- the minimum and maximum duration from the invitation to tender until the start of each tendering procedure.
- the starting price for each competitive procedure
- the power limitations for participation and award, regarding the participants of the tender
- the capacity of the electricity storage power plants to be put out to tender through the competitive tendering procedures.
- the minimum acceptable technical characteristics, such as the minimum capacity of the electricity storage facilities, in order to participate in the competitive procedures,
- the degree of licensing maturity of the electricity storage facilities participating in the competitive procedures
- the time schedule for the commissioning of the electricity storage facilities selected through the competitive procedures regarding the amount of investment aid, the duration of the operating aid, the rules for establishing the methodology for calculating the net market revenue and operating aid for these plants, the incentives for efficient and beneficial operation of the

electricity system granted to the owner of each supported plant, as well as the permissible range of variation of the annual allowed revenue.

Finally, in **Law 4994/2022 (OGG A' 215/18.11.2022): Integration of Directive 2019/882/EU of the European Parliament and the Council of 17 April 2019 on accessibility requirements for products and services and other urgent provisions to enhance development.** [58] Electricity Reduction Service is established as an obligation for electricity consumers or independent aggregators to reduce the active power they consume or represent during peak hours, at least by an amount, in exchange for financial compensation. The decision shall also lay down the conditions for the provision of the service, the peak hours during which the service is provided, the method of determining the amount of reduction of the energy consumed, the method, time, and conditions of payment of the economic compensation of the selected participants for the provision of the service and the amount of the non-compliance charges.

The recent **Decision No 707A/2021** by the RAE “**Adoption of the Network Usage Charges Manual of the DSO’s Management Code, definition of transitional provisions and implementation details - Installation schedule telemetered hourly meters to selected categories of consumers.**” [61] regarding the framework for determining Network Usage Charges has led to a significant improvement in the cost-effectiveness and fairness of charges. This is due to the modern possibilities of measuring electricity consumption using smart meters, which provide signals to Network Users. By limiting peak loads and postponing or limiting investments in the network, the DSO can increase the capacity and ensure a degree of decoupling from energy consumption, resulting in more predictable and stable revenue streams. Moreover, the rapid installation of smart meters for EV’s as well as the signaling of the meter readings every 15 minutes to the DSO establishes the conditions for a dynamic pricing market for EV’s. This market can respond to changing demand patterns by providing incentives for EV owners to charge their vehicles during off-peak hours, resulting in a more efficient and cost-effective use of the grid. Overall, these developments have the potential to transform the energy market, creating a more dynamic and sustainable system that benefits both consumers and operators.

Data Security and Privacy

This part outlines the regulatory framework of Greece related to data management, data security and privacy. Table 4.5 contains legislation related to the topic.

Table 4.5: Regulations and Directives, GR – Data Security and Privacy [62]–[65]

Regulation title	Relevant Articles and/or Paragraphs	Brief description of this regulation (regarding the project and the pilot goals)
Law 4577/2018 (OGG A' 199/03.12.2018)	Article 2: (Article 2 of Directive 2016/1148/EE) Article 11: Security requirements and event notification (Article 16 of Directive 2016/1148/EU)	Incorporates into Greek legislation Directive 2016/1148/EU of the European Parliament and of the Council of July 6, 2016 (EE L 194), which establishes measures to achieve a high level of security for network and information systems.

<p>Law 4624/2019 (OGG A 137/29.08.2019)</p>	<p>Article 5: Legal basis for processing personal data by public bodies Article 30: Processing of personal data for the purposes of scientific or historical research or the collection and maintenance of statistical data</p>	<p>Replaces the legislative framework that establishes and operates the Personal Data Protection Authority, taking measures for the protection of natural persons against the processing of personal data and for the unrestricted circulation of such data.</p>
<p>Ministerial Decision 1027/2019 (OGG B' 3739/08.10.2019)</p>	<p>Article 4: Basic Security Requirements Article 16: Methodology for Identifying Operators of Basic Services</p>	<p>Sets basic security requirements about information and technology systems, processes to provide information and share security issues to responsible authorities. Methodologies to define the Basic Service Operators (B.S.O.) and how assess and control them.</p>
<p>National Cybersecurity Strategy 2020-2025/National Cyber Authority</p>	<p>All Paragraphs</p>	<p>Establishes an effective cybersecurity governance framework, to secure critical infrastructures, protect new technologies, streamline incident management processes and combat cybercrime. Also, ensures privacy protection and modernizes the cybersecurity investment landscape.</p>

Law 4577/2018 (OGG A' 199/03.12.2018): Integration of Directive 2016/1148/EU into Greek legislation [62], incorporates into the Greek regulatory framework Directive 2016/1148/EU on measures for high level of security at information and technology system. In 2019, **Ministerial Decision 1027/2019 (OGG B' 3739/08.10.2019): Implementation issues and procedures of Law 4577/2018 (A' 199)** [64] defines the basic requirements on data security such as identification and protection on encounter issues to secure information, based on Directive 2019/1148/EU and Law 4577/2018. **Law 4624/2019 (OGG A 137/29.08.2019): Personal Data Protection Authority, implementing measures of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons against data processing** [63] sets the framework which allows public bodies to process personal data when the processing is necessary for the fulfilment of a task performed for the public interest or in the exercise of public authority. Law 4624/2019 is fully harmonized with Regulation 2016/679 (GDPR) of European Union. **National Cybersecurity Strategy 2020-2025 by National Cyber Authority** [65] complements Law 4577/2018 and the ministerial decision 1027/2019 and presents the next goals on information technology systems, such as to increase cybersecurity and privacy protection levels and to develop new technologies. Additional goals are the shielding of critical Infrastructures, fighting against cybercrimes, privacy protection, and raising of awareness.

4.2 Portugal

In this section, a summary is introduced concerning the evolution of legislation related with electric mobility in Portugal, the main incentives to promote the EVs adoption and the rules for electric mobility infrastructures.

Electric Mobility legislation evolution in Portugal

The national plan for electric mobility in Portugal was established over a decade ago by **Resolution No.20/2009** of February 20th [66], which highlights Portugal as a pioneer in boosting new sustainable mobility models. This program aimed to create tax incentives for acquiring electric vehicles and to define targets regarding public access to charging infrastructure. The rules for the execution of electric mobility plan were defined in **Decree-law no. 39/2010** of April 26th [67] and, four years later amended, by **Decree-law No. 90/2014** of June 11th [68] decrees regulate the organisation, access and exercise of the electric mobility network and establishes rules for creating an electric mobility pilot network. Also, it includes rules for integrating charging points in private spaces into the electric mobility network (Mobi.E). One year later, **The Electric Mobility Regulation No. 879/2015** of December 22nd [69] was published, providing some changes in **Decree-Law No. 90/2014** of June 11th [68] regarding a set of operational aspects related to the management of the electric mobility network. According to this regulation, until November 2018, charging EVs in electric mobility network was free of cost for users.

Moreover, the **Resolution of Ministers No.49/2016** of September 1st [70] was published, approving the final of the first phase of the Mobi.E pilot network and proceeding to open the second phase of the pilot network in order to cover the municipalities not served in the first phase. Afterwards, based on the **European Alternative Fuels Infrastructure Directive (AFID)** [71], **Decree-law No. 60/2017** of June 9th [72] approved a framework for implementing a national infrastructure for alternative fuels aiming to reduce the use of oil-based energy sources and mitigate the impact of the transport sector on the environment.

Later in 2019, integrated charging points into the electric mobility network, as well as the charging fee for users in private places with public access, became optional. Subsequently, the present **Regulation No. 103/2021** of 1st February [73] revokes **No. 879/2015** [69], highlighting changes regarding the densification of the contractual model between agents, clarification of the role of the charging point holder, provision for electricity network access tariffs, and simplification of the regulatory framework including the tariff structure. Furthermore, the government provides annually, with most recent the **regulation No. 3419-B/2022** of 22nd March [74], a set of financial and tax incentives related to the acquisition of electric vehicles and charging stations. Following this, the Azores (Portugal), **Report No. 4/2022** [75] set a strategy for implementing electric mobility across financial and tax incentives by **Decree-law No. 4/2021/A** of 26th April [76] and charging infrastructure (car parks, buildings, ventures, public and private access, etc. **Table 4.6** reviews the main steps for Portuguese policies on electric mobility.

Table 4.6: Summary of Portuguese’s policies for electric mobility.

Regulation title	Relevant Articles and/or Paragraphs	Brief description of this regulation (regarding the project and the pilot goals)
Resolution No. 20/2009	All Articles	National Plan for electric mobility in Portugal
Decree law No. 39/2010	All Articles	First rules for the implementation of the electric mobility and Pilot Network
Decree law No. 90/2014	All Articles	Electric Mobility Pilot Network

Resolution of Ministers No.49/2016	All Articles	2 nd phase of the Electric Mobility Pilot Network
Decree law No. 60/2017	All Articles	National infrastructure for alternative fuels
Regulation No. 103/2021	All Articles	Electric Mobility Regulation
Decree law No. 4/2021/A	All Articles	Incentive for the Introduction of Zero Emission Vehicles in Azores
Regulation No. 3419-B/2022	All Articles	Incentive for the Introduction of Zero Emission Vehicles in 2022

Incentive for the Introduction of Zero Emission Vehicles in Portugal

Since 2017, the Portuguese State has been providing financial incentives to increase the penetration of electric mobility, e.g., financial incentives for the purchase of electric vehicles and charging stations by the Azores government in [77]. The most recent **regulation No. 3419-B/2022** of 22nd March [74] approved incentives for introducing zero-emission vehicles, as described in Table 4.7 It changes the 2021 regulation by including tricycles, quadricycles, and other soft electric mobility. Another significant difference is the introduction of the possibility to have charging stations in multifamily condominiums connected to the Mobi-E Network.

In this framework, as described in Table 4.7 a financial incentive of 4000 € is provided for the purchase of a fully electric passenger light vehicle by end users whose cost does not exceed 62500 €. In addition, according to the Motor Vehicle Tax Code [78] an exemption from the payment of road tax (IUC) for Battery Electric Vehicles (BEV) is applied, as well as a reduction of 75% in vehicle tax (ISV) for Plug-in Hybrid Electric Vehicles (PHEV) with a minimum autonomy of 50 kilometres in electric mode and emissions lower than 50g CO₂/Km. Also, Hybrid Electric Vehicles (HEV) with the same autonomy and emission characteristics support ISV tax reduction by 40%.

Regarding companies, there are also tax benefits related to electric mobility for BEV, PHEV and HEV presented in Table 4.7 based on **Motor Vehicle Tax Code** [78], **Value Added Tax Code**[79] and **Corporate Tax Code (IRC)** [79]. The last both were altered by **law No. 82-D/2014** [80].

Moreover, the government offers financial incentives through a charging cost discount of 0.1902 € for each charge in the national electric mobility network. It also supports the tariffs of the Electric Mobility Network Managing Entity by charging Point holders (CPH) through the environment fund for two years [74]. Additionally, there are municipal incentives where the parking of electric vehicles is free of charge, and a tax-free identification tag is provided on the car [81]. However, these incentives can be different in each municipality.

Table 4.7: Portugal's ZEV incentives for 2022 (Based on [78]–[80], [82], [83]).

Support Area	Typology	Rule	Tax support	Financial support
Passenger Cars	T1- Light passenger vehicles (100% electric)	Number of incentives: 1300/year EV maximum cost: 62 500 € Maximum 1 incentive by candidate (End-user)	Exemption from the payment of ISV and IUC	4 000€
Passenger Cars	HEV PHEV	Reduction of vehicle tax with a minimum electric autonomy of 50 kilometres and emissions below 50g CO ₂ /Km	Reduction of 40% in the ISV for HEV Reduction of 75% in the ISV for PHEV	N/A
Charging Infrastructure	T7-Chargers for electric vehicles in multifamily buildings with a connection to the Mobi.E Network	Number of incentives: 270/year Maximum 1 incentive by condominium (End-user) Maximum 10 incentives by condominium for condominium administrations of parking spaces or residents' groups.	Charging cost discount of 0.1902 € for each charge Support tariffs of the Electric Mobility Network Managing Entity for CPH for 2 years	80% of the charger value (maximum of 8 000€ per station) 80% of the electrical installation cost (Maximum of 1000€ per parking place)
Companies	BEV	Total VAT deduction related to the expenses of acquisition, manufacturing, importation, to leasing and transformation in light passenger BEV, when considered as tourism vehicles, whose acquisition cost does not exceed 62 500 € Number of incentives: 150/year	Exemption from Autonomous Taxation Exemption from the payment of ISV Exemption from the payment of IUC Total VAT deduction related to the expenses of electricity used for BEV	6 000 €

		Maximum 2 incentives by candidate (Companies)	Total VAT deduction related to the expenses for BEV	
Companies	HEV	<p>Reduction of vehicle tax with a minimum electric autonomy of 50 kilometres and emissions below 50g CO₂/Km</p> <p>Total VAT deduction related to the expenses of acquisition, manufacturing, importation, to leasing and transformation in HEV, when considered as tourism vehicles, whose acquisition cost does not exceed 50 000 €</p>	<p>Reduction of 40% in the ISV</p> <p>Total VAT deduction related to the expenses for HEV</p>	N/A
Companies	PHEV	<p>Reduction of autonomous taxation fees and vehicle tax with a minimum electric autonomy of 50 kilometres and emissions below 50g CO₂/Km</p> <p>Total VAT deduction related to the expenses of acquisition, manufacturing, importation, to leasing and transformation in light passenger PHEV, when considered as tourism vehicles, whose acquisition cost does not exceed 50 000 €</p>	<p>Reduction of 75% in the ISV</p> <p>Deduction of total VAT related to the expenses when considered as tourism vehicles</p> <p>Autonomous taxation fee of 5 % for vehicles with an acquisition cost below 27 500 €</p> <p>Autonomous taxation fee of 10 % for vehicles with an acquisition cost equal to or above 27 500 € and below 35 000 €</p> <p>Autonomous taxation fee of 17.5 % for vehicles with an acquisition cost equal to or above 35 000 €</p>	N/A

In the case of the Azores and following the government's strong commitment to decarbonize their activities, the regional legislative **decree no. 21/2019/A** (August 8th), defines the strategy for the implementation of electric mobility in the autonomous region. According to this legislation, the implementation of electric mobility in the Azores is achieved through certain measures, namely the provision of incentives for the adoption of electric mobility and the installation of charging infrastructures. Thus, the financial incentives for the acquisition of electric vehicles and charging points are established in Regional Regulatory **Decree No. 15/2020/A**.

More recently, to achieve the goals set for the massification of electric mobility in the Azores, the eligibility of these incentives was extended to new light electric vehicles, leasing contracts and people with a certain level of disability established in Regional Regulatory **Decree no. 4/2021/A**. By default, the incentives can be slightly lower in the Azores than in mainland Portugal but may be higher if the user chooses a flexible electricity tariff, is in a biosphere protected area, delivers an ICE for scrapping or have some sort of disability [73]. Charging Infrastructure Rules in Portugal

As mentioned in Section "Electric Mobility legislation evolution in Portugal",⁰ in Portugal, the legal regime of electric mobility has been established by **resolution 39/2010** [67], **90/2014** [68] and **Electric Mobility Regulation No. 103/2021** [73]. In these documents, some roles are defined namely:

- Charging Point Operator (CPO) refers to a company responsible for installing and managing the charging infrastructure for the e-mobility.
- Charging Point Holder (CPH) is the owner of a charging point located in a private space, which, by option, can be integrated in the electric mobility network for own use or a limited number of users.
- Electric Mobility Supplier (EMSP) is an entity that sells electric energy to EV users.
- Mobi.E Network (National Electric Mobility Network) is a network of universal access electric vehicle charging stations that allows EV charging independent of CPO, CPH when the EV user have an active contract with an EMSP.

An important topic to mention, the autonomous region of the Azores has mandatory regulated prices [84] that are provided by the TSO, DSO, and retailers in the region. In the Azores, the TSO and DSO are represented by a single entity, EDA, whom the EMSPs should establish contracts with.

The regulatory regime that governs the price-fixing for regulated services is contained in different regulatory documents:

- Commercial relations regulations for electricity and gas.
- Regulation for the services of intelligent electricity distribution networks.
- Regulation of electricity self-consumption.

For the distribution grid, the end-user tariffs for the Azores region are divided into three different power contracts: $\leq 2,3$ kVA, $2,3 - 20,7$ kVA and $20,7 - 41,4$ kVA. For clients with power contracts above 20,7 kVA there is only the option for tri-hourly tariffs. Further information on the tariff structure can be found in [[84], [85].

The present topic is divided into two sections. The first section (0) addresses regulatory aspects related to public charging stations and the second section (0) presents legal issues for charging electric vehicles in houses and buildings.

Public Charging stations

In this regard, the operation of charging points, the legal regime is applicable depending on the entity (CPO or CPH) and depending on the type of access to the charging station (public or private) [86] . Figure 8.1 and Figure 8.2 in the appendix provide a summary of the legislation applicable in these cases. Besides, according to **Decree Law 39/2010** [67] the operation of CPO of public or private access allows

trading practices but prohibits the same for CPH of private access in art.8º/2 of RME [73]. In addition, about **DL 39/2010** [67], integrating the CPO of public or private access in the electric mobility network is mandatory and optional for the CPH. The commercialisation of electricity to the CPO must be done by the electric mobility suppliers (EMSP) and also for CPH if the station is integrated, as well as via the commercialiser of the electricity sector if the station is not integrated in the electric mobility network.

Regarding the type of access, according to **DL 39/2010** [67] the entity that may operate is exclusive to CPO in public access places. However, in private access places, it may be operated by the CPO or CPH. In addition, integration in the electric mobility network is mandatory for the CPO and optional for the CPH. EMSP must commercialise electricity in the case of the CPO and also for CPH if the station is integrated or by a supplier from the electricity sector if the station is not integrated.

Further, the **Plan for Electric Mobility in the Azores** [87] provides the implementation of a charging infrastructure covering all islands and municipalities of the Azores, integrated into the national electric mobility system through Mobi.E in terms of the amendments of the **DL 90/2014** [68].

The electric mobility network allows EV users to charge at any charging station (Mainland, Azores, Madeira Island) independent of CPO and CPH if integrated in the Mobi.E network and have an active contract with ESMP [88]. Furthermore, information is exchanged between the stakeholders, including consumption, tariff, payments and network availability, as illustrated in Figure 4.1 below.

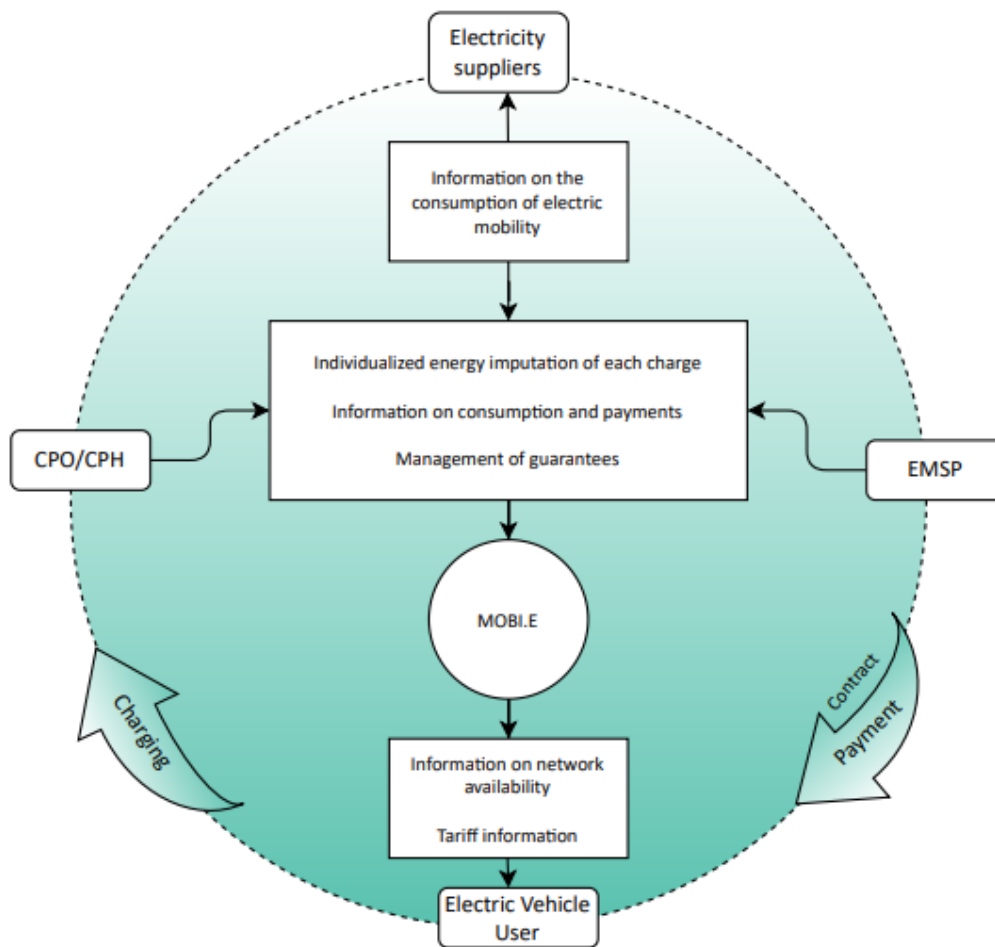


Figure 4.1 – Illustration of the National Network for Electric Mobility. (Based on: [88])

Charging stations in buildings and houses

According to **resolution No. 90/2014** [68], it is necessary to inform the condominium to install charging stations in buildings. The condominium administration or owner can claim the installation of a charging point within 90 days from the notice. In buildings constructed before 2010, it is possible to use the electrical energy from the condominium, or a wall-mounted charging station could be installed since the consumer must pay the electricity expenses. It is also possible through a CPH activated with a card by ESMP that does not require CPO intervention. It thus makes the charger cost more affordable and does not influence the common consumption of the condominium. Further, installation is mandatory for buildings constructed after 2010 to allow connection in the electrical box between each apartment and its respective garage. Also, in buildings after 2010 in which the charging point will be used for more than one EV user, the condominium administration should do the installation if approved by at least 2/3 of the General Assembly of the Condominium, which covers the associated costs. In general, installation can only be refused under special conditions if it is related to the safety of the building.

Also, in accordance with Article 29th of the aforementioned law, any condominium member can install charging points on their own initiative, assuming the costs as well as following the security rules and notifying the condominium at least 30 days before the installation.

In this sense, another important aspect concerns charging an electric vehicle in houses instead of buildings. Most EVs come with a cable for charging the battery in a Schuko model socket. However, by the technical guide to electrical installations for the supply of electric vehicles [89] and minimum requirements for project design regarding electric mobility [90], the residence must have an earth wire installed.

4.3 Slovenia

In this section, it is introduced a brief summary concerning the evolution of legislation related with electric mobility in Slovenia, the main incentives to promote the EVs adoption, the rules for electric mobility infrastructures, and the description of the main barriers for the mass development of EVs in Slovenia.

Electric Mobility legislation evolution in Slovenia

E-mobility is an environmentally friendly mean of transport, that reduces greenhouse gas emissions. Electric vehicles are equipped with electric motors and batteries for storing electricity, which are mainly charged by connecting to external energy supply points. The development of e-mobility is closely related to the promotion of the purchase and use of electric vehicles, as well as to building an efficient network of charging infrastructures.

According to the **State Administration Act (ZDU-1)** and especially Article 38, the Ministry of Infrastructure performs tasks in the field of railway, air, maritime transport, navigation on inland waterways and road transport, with the exception of road traffic safety control, tasks in the field of transport infrastructure and cableway devices, tasks in the field of energy, mining and tasks in the field of efficient use and renewable energy sources. On the basis of Article 3 of **Directive 2014/94/EU**, Slovenia (until 18 November 2016) was forced to adopt its 'national policy framework for the development of the market in relation to alternative fuels in the transport sector and for the establishment of appropriate infrastructure. This part of the directive was transposed into Slovenian law with the Strategy in the field of market development for the establishment of appropriate infrastructure related to alternative fuels in the transport sector in the Republic of Slovenia (Strategy for Alternative Fuels). The goals are set in accordance with the guidelines of **Directive 2014/94/EU** and represent only the minimum framework that the Republic of Slovenia (RS) must achieve in order to

reach the environmental goals in the transport sector – measures to promote e-mobility relate to promoting the development of technologies and the economy; charging infrastructure; financial incentives for vehicles, promotional activities; recommendations to local communities, etc.

The Directorate for Sustainable Mobility and Transport Policy performs professional, administrative, and regulatory tasks related to sustainable mobility, transport policy, public passenger transport and international affairs and protocol. This includes the preparation of strategic documents, expert bases, regulations, and measures in the field of transport policy (strategy and resolution on the state transport development program), sustainable mobility and public passenger transport, as well as international matters in the field of transport. The Directorate is responsible for monitoring the European transport policy, the implementation of the transport policy of the Republic of Slovenia, its inclusion in the pan-European transport network and the transport networks of third countries, as well as the funding frameworks for transport policy measures and sustainable mobility from EU sources. It prepares and monitors tenders in the field of sustainable mobility, including the promotion of sustainable forms of mobility and combined transport and proposing measures for the development and regulation of traffic. It also participates in the coordination of measures in the field of environment and climate change related to the field of transport and monitors European affairs and international relations from the work areas of the ministry.

The Ministry of Infrastructure (MzI or the Ministry) has undertaken to prepare an annual review of the implementation and results achieved in this area and, if necessary, supplement or proposed amendments to the Strategy for Alternative Fuels to the Government of the Republic of Slovenia.

Table 4.8: Slovenia’s Electric Mobility legislation.

Regulation title	Relevant Articles and/or Paragraphs	Brief description of this regulation (regarding the project and the pilot goals)
State Administration Act (ZDU-1)	Article 38	The Ministry of Infrastructure performs tasks in the field of railway, air, maritime transport, navigation on inland waterways and road transport
Strategy for alternative fuels	All Articles	Adoption of Directive 2014/94 EU
Transport Development Strategy of the Republic of Slovenia Until 2030 (SRP)	Ro.35: Stimulation of the use of eco-friendly vehicles and construction of a charging stations network M.11: Filling stations for alternative fuel – maritime	Adoption of Directive 2014/94 EU

Motor Vehicle Tax Act (ZDMV-1) (Official Gazette of the Republic of Slovenia, No 200/20)	All Articles	Motor vehicles (e.g. EVs) are exempt from paying motor vehicle tax (DMV)
Income Tax Act (ZDoh-2)	Article 43, Paragraph 2.a	Tax reduction measures for employees provided with electric vehicles
Income Tax Act for legal entities (Official Gazette of the Republic of Slovenia, no. 117/06, 56/08, 76/08, 5/09, 96/09, 110/09 – ZDavP-2B, 43/10, 59/11, 24/12, 30/12, 94/12, 81/13, 50/14, 23/15, 82/15, 68/16, 69/17, 79/18, 66/19 and 172/21)	All Articles	Tax base reduction for investing in hybrid and electric vehicles
Act on Duties for Motor Vehicles (ZDaiMV)	All Articles	Vehicles with exclusively electric powered motor exempted from the annual duty for the use of vehicles in road traffic
Toll Act - ZCestn-B (Official Gazette of the Republic of Slovenia, No. 158/20 of 2 November 2020)	All Articles	Reduced tolls for electric vehicles
Development plan of Distribution System Operator of Slovenia (SODO d.o.o.) for 2021 – 2030	All Articles	Determination of the number or the need charging infrastructure

Act on Energy Efficiency (Official Gazette of the Republic of Slovenia 158/20) (ZURE)	Article 29: Electric vehicles charging points	Conditions for the deployment of EV charging points at new and renovated buildings
System operating instructions for the electricity distribution system (SONDSEE) by the Distribution System Operator of the Republic of Slovenia (SODO d.o.o.)	Schemes PS.1, PS.2, PS.3	Determination of new ways for connecting system users, including the connection of electric charging stations (PEV)
Building Construction Act (ZGO-1)	All Articles	EV charging stations do not require static and construction technical verification

Incentive for the Introduction of Zero Emission Vehicles in Slovenia

The transport sector is one of the biggest emitters of greenhouse gas emissions, and at the same time it represents a significant share of the final use of energy. The European Green Deal and the legislative package "Ready for 55" require decisive actions by member states aiming to mitigate emissions of the transport sector, that include the transition to alternative energy sources, especially electricity.

In that direction, a comprehensive national legislation is needed, regulating the area of infrastructure for alternative fuels in transport and introducing mechanisms to encourage the transition to alternative fuels. The upcoming law will be cross-sectoral, including transport and energy. The law proposal aims to establish a legal framework for the establishment, development, expansion and safe use of an interoperable and user-friendly charging and supply infrastructure for alternative fuels in transport for road, air and maritime transport and three types of energy sources, i.e., electricity, hydrogen and natural gas.

The Ministry prepares:

- the **Alternative Fuels Act** (currently in interdepartmental coordination),
- by June 30, 2023, renew the Strategy for Alternative Fuels and submit it to the Government of the Republic of Slovenia (this date coincides with the date by which Slovenia must prepare a draft of the updated Comprehensive **National Energy and Climate Plan** of the Republic of Slovenia (NEPN), and submit it to the Commission. The existing measures and policies from the Strategy for Alternative Fuels are also summarized in the NEPN).

The aforementioned proposals:

- lay down the rules for planning the national policy framework for the development of infrastructure for alternative fuels in transport,
- set mandatory targets for the establishment of sufficient infrastructure for alternative fuels in transport,

- determine measures to encourage the transition to alternative fuels for road vehicles, stationary aircraft, and vessels, as well as the sources and methods of their financing,
- regulate the establishment and operation of the commercial public service for the establishment and management of charging parks with a total output power of 300 kW and more,
- regulate the obligations of managers of filling and supply points, technical requirements related to the establishment, operation, and maintenance of infrastructure for alternative fuels in transport and requirements related to information for users,
- determine the procedures for registration of infrastructure for alternative fuels in transport and record keeping.
- regulate the establishment and operation of the Center for promoting the transition to alternative fuels in transport.

Additionally, it should also be mentioned that the Government of the Republic of Slovenia also considered Directive 2014/94/EU, when preparing the **Strategy for the Development of Transport in the Republic of Slovenia** until 2030 (SRP) dated 7/29/2015. The SRP deals with alternative fuels, infrastructure for the use of alternative fuel in transport and measures (Ro.35), encouraging the use of ecological vehicles and building a network of filling stations, filling stations for alternative fuel - maritime (M.11) and filling stations for alternative fuel – aviation (A.11). For these measures, the Resolution on the **National Transport Development Program** for the period up to 2030 determined more detailed activities, carriers, deadlines, and necessary financial resources.

Motor vehicle tax (DMV) payments are due from 1 January 2021 with the revision of the **Motor Vehicle Tax Act (ZDMV-1, OGG of the RS, No. 200/20)** exempt motor vehicles without CO₂ emissions, i.e., cars exclusively electrically powered (battery electric vehicles, BEVs). As of January 1, 2020, the **Income Tax Act (ZDoh-2)** has been amended, which in Article 43 (Paragraph 2.a) determines if the employer provides the employee with an electric powered personal motor vehicle for private purposes, regardless of the actual use of the vehicle for private purposes and regardless of the method that the employer acquired the vehicle, 0.3% of the purchase value is included in the employee's tax base vehicle monthly for each calendar month of vehicle use, if the value upon acquisition of the vehicle, including value added tax, does not exceed 60,000 euros. Otherwise, it will be deducted from the excess work the purchase value of the credit rating as for other vehicles, i.e., 1.5% of the purchase price of the vehicle per month.

Persons liable for corporate income tax may, in accordance with the **Income Tax Act** of legal entities (OGG of the Republic of Slovenia, no. 117/06, 56/08, 76/08, 5/09, 96/09, 110/09 – ZdavP-2B, 43/10, 59/11, 24/12, 30/12, 94/12, 81/13, 50/14, 23/15, 82/15, 68/16, 69/17, 79/18, 66/19 and 172/21) enforce reduction of the tax base in the amount of 40 percent of the amount invested in passenger cars on hybrid or electric drive and buses with hybrid or electric drive, but no more than the amount of the tax base taking into account the total limitation in relation to the reduction of the tax base in the amount of 63% of the tax base.

The system of taxation of supplies of goods and services with VAT in the Republic of Slovenia is regulated by the Tax Act on added value (OGG of the Republic of Slovenia, No. 13/11 – UPB, 18/11, 78/11, 38/12, 83/12, 86/14, 90/15, 77/18, 59/19 and 72/19) (**ZDDV-1**), which is harmonized with EU legislation, namely with Council Directive 2006/112/EC on the common system of value added tax. Based on point c 66. of Article ZDDV-1, the taxpayer has the right to deduct the VAT that he is obliged to pay or that he has paid at procurement of vehicles used for carrying out activities of transporting passengers and goods, vehicles for placing in rental and lease and for resale of vehicles used in driving schools for the implementation of the program training in driving, combined vehicles for carrying out

activities of public regular and special line transport and personal special vehicles adapted exclusively for the transport of the deceased. In accordance with ZDDV-1 enables the possibility of VAT deduction when purchasing a vehicle, regardless of the type of drive of the vehicle. V in accordance with the fourth Paragraph of Article 106 of the Rules on the Implementation of the Value Added Tax Act (Official Gazette of the Republic of Slovenia, no. 141/06, 52/07, 120/07, 21/08, 122/08, 105/09, 27/10, 104/10, 110/10, 82/11, 106/11, 108/11, 102/12, 54/13, 85/14, 95/14, 39/16, 45/16, 86/16, 50/17, 84/18 and 77/19) has a tax a taxpayer who, based on point c of Article 66 of the ZDDV-1, has the right to deduct VAT for the purchase of a vehicle, also the right to deduct VAT from the purchase of fuels and lubricants as well as spare parts and services closely related to these.

In the context of the **Act on Duties for Motor Vehicles (zDajMV)**, exclusively electric vehicles are exempted from the annual duty for the use of vehicles in road traffic. As part of the changes and amendment to the **Toll Act-- zCestn-B** (Official Gazette of the Republic of Slovenia, No. 158/20 of 2 November 2020) considering the environmental or sustainability goals of the transport policy for electric vehicles, the largest of which permissible mass exceeds 3,500 kg, introduced a reduced toll in 2020, namely in such a way that these were vehicles placed in the same class as the cleanest vehicles of emission class EURO EEV and EURO VI.

Charging Infrastructure Rules in Slovenia

Pursuing the principles of sustainable mobility, an infrastructure for alternative fuels in Slovenia is established. This includes charging infrastructure for electric vehicles as well as charging infrastructure for gas vehicles. In addition to the charging infrastructure, subsidies for the purchase of electric vehicles are introduced.

In accordance with European legislation, Slovenia has adopted a **Market Development Strategy** for the establishment of appropriate infrastructure related to alternative fuels in the transport sector. Based on the strategy, the Action Program for the period 2018 to 2020 was prepared.

The action program includes measures in the field of vehicles, charging infrastructure and other measures that enable the realization of the adopted goals. The action program is focused on the following areas:

- promoting economic development, innovation, and research in the field of alternative fuels and their use
- information and media strategies
- financial incentives and tax measures
- elimination of administrative obstacles
- legislative changes
- vocational training and education
- demonstration projects
- recommendations to local communities.

Charging with direct current takes place via special sockets, which currently allow a maximum current of 400 A and a voltage of up to 900 V. The charging station and the electric vehicle are connected by a control line that enables the charging power to be managed. The rectifier is in the charging station, the charging powers are higher than charging with alternating current, so such charging stations are suitable for larger charging infrastructures. Suitable overcurrent protection for this type of charging stations are NV fuses with gG characteristic for the AC side of the power station, and to protect the DC side of the power station, ETI has developed NV fuses with a DC breaking capacity of 550, 700, 800 or 1,000 V. The advantage of DC NV fuses is a high degree of disconnection capacity as a necessary guarantee for safe operation when charging electric vehicles with high powers via DC voltage. The

adopted strategy for alternative fuels assumes that with the projected growth of vehicles, we will need 7,000 charging stations of normal power in 2025 and as many as 22,300 in 2030. Also at the beginning of 2021, the **Development Plan of the Electricity Distribution System** in the Republic of Slovenia 2021-2030, published by the Slovenian DSO (SODO d.o.o.), contains the active integration of electric mobility and, regarding the planned charging infrastructure, states the same number of charging stations for battery electric vehicles.

An action program for alternative fuels in transport was also adopted, according to which the establishment of public charging infrastructure in municipal centres and larger towns in Slovenia, as well as charging infrastructure for multi-apartment buildings and in private use, will be encouraged.

In its Article 29, the **Act on Efficient Use of Energy (ZURE)** adopted at the end of 2020 also specifies the conditions for charging points in the construction of new and major renovations of non-residential buildings that have more than ten parking spaces, conditions in the construction and major renovations of off-road rest areas public roads, conditions for non-residential buildings with more than twenty parking spaces and conditions for the construction of new and major renovations of residential buildings with more than ten parking spaces.

Distribution System Operator of Slovenia (SODO d.o.o.) published on 19/01/2021 the new System operating instructions for the electricity distribution system (SONDSEE), which determine new ways of connecting system users, including the connection of electric charging stations (PEV), schemes PS.1, PS.2, PS.3.

In further accelerating the development process of electric mobility, a key step is the establishment of standards, especially regarding the safety of vehicles and charging infrastructure – electric charging stations (PEV). Adequate standards significantly reduce all risks (technology, electrical power systems, renewable energy sources, investment, environmental, ...) for stakeholders, which are essential to provide resources for the transition to electric mobility.

The regulation on the establishment of infrastructure for alternative fuels in transport determines alternative fuels in transport and the method of providing infrastructure for them. With this regulation, Directive 2014/94/EC of the European Parliament and of the Council of 22 October 2014 on the establishment of infrastructure for alternative fuels is transposed into the legal system of the Republic of Slovenia (OJ L No. 307 of 28 October 2014, p 1).

Public Charging stations

Sales of public AC and DC charging stations for EVs reached 1.3 million at the end of 2020, up 300 thousand from 2020. In 2020, there were approximately 285,800 public electric vehicle charging stations in Europe (including Turkey) with an alternating current (AC) power of up to 22 kW, as well as fast direct current (DC) electric vehicles with a power of more than 22 kW. There were almost 40,000 public charging stations for electric vehicles in Germany in 2019, and the largest number of charging stations for electric vehicles was in Norway. Currently, around 3,000 electric vehicles and plug-in hybrids are on Slovenian roads, and approximately 1,000 electric vehicle charging stations have been installed. In 2020, the share of all-electric vehicles in Slovenia was 2.6%.

In Slovenia, there is no need of a building permit to set up a public charging station. It is desirable, but not mandatory, to obtain locational information during the design phase or to check the possibility of building an electric charging station at the intended location. In the event that the intended location of the charging station is a public area, we must acquire the building right or easement or ownership of the plot. The **Building Construction Act (ZGO-1)** classifies buildings according to the complexity of construction and maintenance into demanding, less demanding, undemanding, and simple. Charging stations are classified as simple objects that do not require special static and construction technical verification.

In order to set up a charging station as a simple facility, it is therefore not necessary to obtain a building and use permit. For direct connection to the distribution system, it is necessary to obtain approval for the connection by previously submitting a conceptual design or conceptual project to the manager of the economic public infrastructure.

Charging stations in buildings and houses

The recently adopted Act on the Efficient Use of Energy stipulates, among other things, the mandatory placement of charging stations for electric vehicles, namely at least one charging station per ten cars, considering the type of cars, charging technology and private charging stations that are available. In the case of new buildings and in the case of major renovations of commercial buildings, every tenth parking space in front of the building or in the garage must be equipped with an electric charging station, and every fifth parking space must be equipped with appropriate wiring that allows the installation of an electric charging station. In the case of multi-apartment buildings, wiring must be done in every tenth parking space. In the case of renovation, this applies to all buildings for which it is necessary to obtain a building permit. Dynamic load management and remote control will also have to be enabled, so that the connection of new charging points does not exceed the load of the supply network.

It is not necessary to obtain any approvals for the installation of a home charging station, as these stations are connected directly to the customer's existing home network. In the event that charging takes place via a normal socket, no additional equipment is required in the network. For special sockets, the installation of a charging box is required, and this is considered a home charging station. The **Building Construction Act (ZGO-1)** classifies buildings according to the complexity of construction and maintenance into demanding, less demanding, undemanding, and simple. Charging stations are classified as simple objects that do not require special static and construction technical verification.

In order to set up a charging station as a simple facility, it is therefore not necessary to obtain a building and use permit. For direct connection to the distribution system, it is necessary to obtain approval for the connection by previously submitting a conceptual design or conceptual project to the manager of the economic public infrastructure. Electric vehicles can also be charged at home. In this case, for the user safety, it is recommended to install a charging station or at least a special outlet dedicated to electric vehicles charging. Some electric vehicle manufacturers offer both, a charging station, or a dedicated outlet, together with the vehicle.

When choosing a charging station, the choice should take into consideration the charging time. For example, when charging time is not an obstacle, then for home use it is possible to choose single-phase charging up to 3.7 kW or up to 7.4 kW. For the more demanding, domestic charging stations with one socket are available, which enable three-phase charging up to 22 kW. In all cases, it is considered necessary to check the internal installations beforehand.

Rulebook on requirements for low-voltage electrical installations in buildings determine the requirements and methods used to ensure the safety of low-voltage electrical installations and permanently installed devices (hereinafter referred to as: electrical installations) in buildings throughout their lifetime, and the aim of which is to limit the risk to people, animals, and property. This regulation applies to the design and construction of new buildings as well as the reconstruction, maintenance, maintenance work for the public benefit and the change of purpose of existing buildings. For reconstruction, maintenance and change of purpose, it is used under the conditions of the fourth and fifth Paragraphs of Article 15 of the **Building Act** (OGG of the Republic of Slovenia, no. 61/17, 72/17 – app., 65/20 and 15/21 – ZDUOP). The requirements of this rulebook are also applied mutatis mutandis to construction engineering facilities and other construction interventions.

Other documents related to EV charging stations:

- Regulations on safety at work against the danger of electric current
- Key standards - infrastructure for PEV installation, SIST EN 61851-1, SIST EN ISO 15118-1:2019, SIST EN IEC 63119-1:2019
- Manual for designing charging stations for electric vehicles, IZS, December 2020.

Data Security and Privacy

The protection of personal data is otherwise a legal area that is gaining increased importance with the development of digital society. GDPR, the acronym for the General Data Protection Regulation, which has been directly applicable in all EU member states since May 25, 2018, also emphasizes that companies must process data fairly, transparently and on a lawful legal basis and protect it accordingly. In December last year, the National Assembly of the Republic of Slovenia adopted the long-awaited **Personal Data Protection Act**, the so-called **ZVOP-2**, which entered into force on January 26 of this year. ZVOP-2 places the aforementioned regulation in the Slovenian legislative space and prepares the basis for its implementation.

Table 4.9: Data Security and Privacy.

Regulation title	Relevant Articles and/or Paragraphs	Brief description of this regulation (regarding the project and the pilot goals)
Personal Data Protection Act (ZVOP-2)	All Articles	Law on the protection of personal data, addresses the General Regulation on the Protection of Personal Data by the direct validity of the majority of the provisions of the GDPR,

ZVOP-2 is the Slovenian law on the protection of personal data, which even more explicitly addresses the General Regulation on the Protection of Personal Data by the direct validity of most of the provisions of the GDPR, which largely replaces the provisions of the currently valid Slovenian **Act on the Protection of Personal Data ZVOP-1**. The new **Act ZVOP-2** also brings some changes, below we highlight some of the most significant and important ones.

4.4 Denmark

The Danish government has implemented several regulations and directives to promote the use of electric vehicles (EVs) and the development of EV charging infrastructure. Table 4.10 provides an overview of the key national regulations and orders that pertain to EV chargers in Denmark. It includes information about initiatives promoting EVs, technical requirements, and other relevant details that EV charger operators and developers should be aware of. Table 4.10 serves as a useful resource for anyone interested in understanding the regulatory landscape for EV charging in Denmark.

Energy Policy

Denmark's energy policy for the years 2030 and 2050 aims to achieve energy independence and reduce greenhouse gas emissions through a transition to renewable energy sources. The country aims to meet its energy demand by increasing the use of wind, solar, and biomass energy, and implementing energy-efficient technologies in buildings and industry. The target is to produce at least 50% of electricity from renewable sources by 2030, 100% renewable energy in electricity and heating by 2035, and to reach a carbon-neutral energy system by 2050. Additionally, Denmark is promoting the use of electric vehicles

and encouraging the development of smart grid systems to integrate renewable energy sources into the existing grid [[91].

EVs and Charging

Denmark's policy on EVs is bind under the “**Green Conversion of Road Transport Agreement**” [92] and aims to promote the adoption of EVs as a means of reducing greenhouse gas emissions and transitioning to a more sustainable transportation system. The country has implemented a range of incentives to encourage the uptake of EVs, including tax exemptions, grants, and access to bus lanes. Additionally, Denmark has committed to building a comprehensive network of charging infrastructure, with the aim of having at least one charging point per 10 km of public roads by 2030. The government is also supporting the development of smart charging systems to optimize the integration of EVs into the electricity grid. Overall, Denmark's EV policy is designed to make EVs an attractive and convenient alternative to traditional internal combustion engines and to support the country's goal of achieving a carbon-neutral energy system by 2050.

Table 4.10: Regulations and Directives, National – EV chargers DN [92]–[98]

Regulation title	Relevant Articles and/or Paragraphs	Brief description of this regulation (regarding the project and the pilot goals)
AGREEMENT: Green conversion of road transport 04/12/2020	All Articles	Ambition of 1 mil. Sustainable cars I 2030. A stop to the sale of new fossil cars by 2030 at the latest. Low electricity tax for registering and charging electric vehicles
BEK. 181 05/03/2020 (EV Charger Regulation)	Paragraph 3: Existing buildings Paragraph 4: Major renovations Paragraph 5: New constructions Paragraph 6: Technique	Defines minimum number of charging stations required for new and existing buildings as well as for major renovations. General technical requirements for charging stations.
BEK. 582 28/05/2018 BEK. 774 01/06/2022	Paragraph 7: Owner of electricity meter Chapter 3, Paragraph 8-14: Manufacturer's obligations	Requirements for making and using electricity meters as a basis for calculating the consumption of electricity in households, business environments or light industrial environments

<p>DS/HD 60364-7-722:2018+Ret.1+Ret.2:2022</p>	<p>All Articles</p>	<p>Applies to - circuits intended to supply energy to electric vehicles, - circuits intended for feeding back electricity from electric vehicles into the supply network.</p>
<p>LOV nr 412 af 04/04/2022</p>	<p>All Articles</p>	<p>Lays down requirements for the establishment and operation of recharging points</p>

The agreement “**Green Conversion of Road Transport**” aims to enhance the benefits of changing to green sustainable transportation and ensures at least 775.000 green cars on the roads by 2030 and with the ambition of 1 mil. cars. For electric cars, a special deduction from the up to a maximum of 45 kWh. The deduction is written down annually and amounts to DKK 900 in 2023 and DKK 500 in 2024, after which it will lapse from and including 2025.

On registration in 2022, zero-emission private cars are subject to a basic deduction of DKK 167,500 from the vehicle registration tax. Zero-emission vans are subject to a basic deduction of DKK 78,750 on registration in 2022, while the deduction for electric and fuel-cell powered motorbikes amounts to DKK 105,200 on registration in 2022 [98]. In addition, the parties to the agreement also agree to extend the special scheme with a low electricity tax on electricity for charging zero and low-emission cars up to and including 2030.

BEK. 181 05/03/2020 Order on preparation for and establishment of charging stations in connection with buildings (EV Charger Regulation) [95] is a set of regulations issued by the Danish government that pertain to the development and operation of EV charging stations in Denmark. The regulation lays out technical requirements for EV charging stations, including compliance with international standards. It also includes definitions on the minimum amount of EV charging station on parking lots, e.g., “Buildings with more than 10 parking spaces that are not residential buildings undergoing a major conversion must establish at least 1 charging station adjacent to the parking facility and prepare at least every fifth converted parking space for charging stations.”

The scopes of regulation **BEK. 582 28/05 2018 Order on the use of measuring instruments for measuring the consumption of water, gas, electricity, or heat** [96] and **BEK. 774 01/06/2022 Order on making measurement instruments available on the market** [94] are to inform about the requirements for making and using electricity meters as a basis for calculating the consumption of electricity in households, business environments or light industrial environments, as it would be used in the pilot projects.

DS/HD 60364-7-722:2018+Ret.1+Ret.2:2022 Requirements for special installations or areas – Supply of electric vehicles [97] applies to circuits intended to supply energy to electric vehicles and circuits intended for feeding back electricity from electric vehicles into the supply network including necessary installation precautions.

Denmark has a free market in electricity and charging stations. This means that there is no specific legislation that forces authorities or companies to deploy charging stations, so the deployment of charging infrastructure is market driven. Before **LOV nr 412 af 04/04/2022** [93] legislation came into place, none of the electric vehicle charging firms were required to pay for a permit or the parking spaces. With the new legislation, each municipality must now put the agreement to act as operator out to tender. In Danish, the legislation is called “AFI-lov” and is an implementation of Alternative Fuels Infrastructure Directive (AFI Directive) from EU.

Data Security and Privacy

EVs are equipped with a variety of sensors and systems that gather information about the vehicle and its surroundings. This can include data on the battery's charge level, the vehicle's location, driving behavior, and other information that is necessary to operate the car safely and efficiently. This data is typically transmitted wirelessly to the manufacturer or a third-party service provider for analysis and monitoring.

Given the sensitive nature of this data, it is important that it is protected from unauthorized access or use. Fortunately, the Danish government and regulatory bodies have taken several steps to address these concerns. One of the primary ways they have done so is through the General Data Protection Regulation (GDPR) [28]. This EU-wide regulation, which came into force in 2018, sets out strict guidelines for the handling of personal data, including data collected by EVs.

Under the GDPR, manufacturers and service providers are required to obtain drivers' consent before collecting or using their data. They must also ensure that the data is stored securely and that it is only accessible to authorized personnel. Additionally, the GDPR gives drivers the right to access and delete their data at any time. This gives EV drivers more control over their personal information and helps to protect them from potential data breaches or misuse.

Another way that the Danish government is working to protect EV drivers' data is through the development of industry standards. The Danish Standards Foundation [99] has been working to create a set of standards for secure communication and data exchange between EVs and charging infrastructure. These standards will help to ensure that data is transmitted securely, and that EV drivers' privacy is protected.

Distributed Energy Resources, Markets, and Systems

In Denmark, electric vehicles (EVs) are considered a form of distributed energy storage and are regulated under the country's energy market laws and regulations. The Danish government has implemented policies and incentives to encourage the use of EVs for energy storage and to facilitate their integration into the energy market. Energinet is responsible for ancillary services in Denmark and is therefore interested in being able to use the battery of electric cars for this. It takes place through an official bidding platform where the player/aggregator can bid.

One of the key policies that enables EVs to compete in the energy market as storage is net metering. Net metering allows owners of distributed energy resources, including EVs, to sell excess energy back to the grid, providing a source of revenue for owners and helping to balance the electricity grid.

Another important policy that enables the integration of EVs into the energy market is time-of-use (TOU) pricing. TOU pricing incentivizes EV owners to charge their vehicles during off-peak hours when electricity prices are lower, and to discharge their batteries during peak demand periods when electricity prices are higher. This helps to reduce the strain on the electricity grid during peak periods and provides an additional source of revenue for EV owners.

5 Barriers and suggestions

After Chapter 3 establishes the current regulatory situation in European level and Chapter 4 in each of the four demonstrators, this Chapter expands the discussion on regulatory barriers, gaps, and suggestions. These items are a product of the cross-reference of the analysis on the current framework and the innovations suggested by EV4EU. The outcome is the answer to questions such “what regulation is missing”, “which regulation is preventing us from applying our innovations”, and “what additions can we suggest in order to improve the legislation towards the direction we propose”.

5.1 Greece

The Greek regulatory and legislative framework has evolved significantly over the past four years. Since 2019, several initiatives have been undertaken, with the “*Kinoume Ilektrika*” legislation I and II being in the centre of these efforts. However, the focus of the legislation has been the incentives for new EV owners and some provisions for the charging infrastructure. With regards to the overall framework around flexible demand, which is essential to EV integration in conditions of mass deployment, and more specifically, V2X there are few, if any, activities.

Currently, the Greek DSO (HEDNO), who is responsible for the secure and efficient operation of the distribution network in Greece, has no means of coordinating demand in locations that are problematic in terms of congestions. This inflexibility is limiting RES integration, with many areas already at RES penetration limit, as calculated now, i.e., conservatively. It is a matter of time before the rapid increase of EVs that is observed start creating similar issues for the DSO and consumers. It is a question whether network upgrade investments can keep up with so rapid changes in the makeup of distribution network users, or even if network upgrades are the answer. The changes that will be observed include, not only a significant increase in consumed energy volume but more frequent and more sudden peaks due to participation of demand (and distributed RES) to system-wide services.

There is currently no mechanism for consumers or prosumers to actively participate in the flexibility market. However, with the complete implementation of the Target Model, it is expected that consumers will be incentivized to provide flexibility. One of the current indirect incentives for consumers to shift consumption to off-peak hours is the exemption from network tariffs during these periods. Despite this, the DSO is not allowed to procure flexibility services. Similarly, Energy Communities have the right to operate distribution grids, but they are not allowed to provide flexibility. The lack of a legal framework for flexibility provision represents a barrier to the development of a local flexibility market in Greece. As a result, residential use during low voltage night consumption is subject to lower charges, but this does not constitute a direct provision of flexibility. Overall, there is still significant work to be done to enable and incentivize flexibility provision by consumers and prosumers in Greece.

It is therefore important that the Greek legislative environment starts to adjust to the possibility of flexible demand playing a significant role in electric energy system operation and more efficient distribution network management. Provisions for flexible Distribution Use-of-System tariffs can be introduced to allow for some first level of demand coordination from the DSOs. A distinction between passive customers, which should be treated equally for their right to consume energy, and active customers, which use the distribution network to increase their monetary values, can be made. Beyond Use-of-System tariffs, local flexibility markets should be introduced which will allow for the DSO to buy flexibility services, such as flexible capacity contracts that limit customer power output.

With regards to V2X technology, there are no specific obstacles in place. There is no explicit provision for V2X, but this can be due in the near future without affecting other pieces of legislation. Distribution

level batteries are a similar case and a new law with provisioning for them was announced early in 2023. The main obstacle, at the moment, for future V2X adoption is the same that exists for all DERs (including batteries and PVs). This is reverse power flows which are a safety concern for DSOs (e.g., fault current reduction is the most common) under conditions of limited observability. Hence, even if V2X is provisioned by Greek law in the near future, it is likely to be restricted to areas with less distributed generation, which are becoming fewer every year, as was the case recently with batteries.

An additional obstacle to the mass integration of EVs into the Greek market, especially in the large cities' centres, is the lack of sufficient number of EV charging stations. This obstacle can be separated in two different issues. The first issue is identified in the lack of private parking spaces, where charging stations can be installed. This issue is specifically located at the city centres, mostly in the cities of Athens and Thessaloniki, that represent more than half of the Greek population. The second issue is related to the insufficient number of installed publicly accessible charging stations. This condition serves as a negative incentive for the wider deployment of EVs. Nevertheless, this issue is expected to be mitigated, due to the plans conducted by all Greek municipalities for the allocation and installation of publicly accessible charging stations (in the context of Law 4710/2020). The deployment of these plans should have been completed by 2025.

5.2 Portugal

There are still several challenges related to regulating electric mobility in Portugal, which are limited to the few existing legal frameworks. Concerning EV charging in buildings, the law is more stringent for buildings built after 2010, in which condominiums have the legal obligation to pre-install basic infrastructure to facilitate the use of chargers. However, most Portuguese buildings are older than this date and need adequate electrical infrastructure to support simultaneous charging, and users must cover the costs.

Within this context, the e-mobility ecosystem in Portugal has an e-roaming platform by Mobi.E, which enables anyone to charge an electric vehicle at any public charging station integrated in the electric mobility network. Furthermore, it is a goal aligned with Alternative Fuels Infrastructure Regulation (AFIR) [100] to enhance the charging network through, for instance, e-roaming at the European level from an interoperable and integrated system allowing ad-hoc payment [101].

Moreover, the commercial practice of charging EVs for CPH (e.g., houses, condominiums, hotels, and restaurants) is prohibited. However, based on the Electric Mobility Regulation [73], it is possible to apply V2XG technology in a pilot project related to scientific research with a maximum duration of three years to promote innovation in the electric mobility sector.

It is also possible to refer that there is a limited fiscal and financial incentive at the national level, given the size of the population and some rules mentioned previously that make it a barrier to applying for support. Further, there is no directly applicable regulation of mobility for renewable energy and energy communities.

Intelligent management of EVs charging is already allowed in the Portuguese regulation. In that case, tariffs should be applied for the supplied energy (€/kWh) but hourly payments are not allowed. This information should be visible for the users that will use charging station. However, charging electric vehicles in charging stations connected to National Electric Mobility Network in energy communities or collective self-consumption installations is not considered in the Portuguese regulation. The main problem occurs when the generation inside these systems are higher than the consumption and the EVs are charged by the community and not by the EMSP. Another aspect that is not considered in the Portuguese regulation is the possibility of V2X possibility. In a more futuristic vision, that will be

addressed in the present project, regulation should also consider services that can be activated by system operators helping in the grid management.

5.3 Slovenia

Although the wishes of individual apartment owners to install electric charging stations in multi-apartment buildings are increasingly appearing, there are few reasons to be optimistic. In multi-apartment buildings, investments are divided into two parts. The first includes mainly maintenance investment works, which are necessary for the normal operation and functionality of the building. In the framework of these works, especially in recent years, energy renovations of buildings (facades with thermal insulation, roof insulation, hydraulic balancing of heating systems, etc.) have also been included, which are partially co-financed by *Ekosklad* and are on the priority list, especially for older buildings. Improvements are also represented by the second set of investments, for which, however, it is most often stuck in obtaining the appropriate approvals, and often also in financing. In practice, condominium owners somehow manage to agree on the installation of an elevator, electric sliding doors and similar matters, which later serve all or at least the vast majority of condominium owners in one way or another. Thus, it often gets stuck already when obtaining consent for implementation, as some owners see such devices as an immediate danger, unnecessary or non-urgent interventions in common areas and parts of the building or fear of an increase in the regular operating costs of the building. The calculation of total electricity costs can be arranged by installing additional countdown meters, but even this is not feasible everywhere. The likely need to increase the connection power, as a rule, significantly increases the fixed costs of total electricity, the exception being buildings in which larger consumers of electricity are already installed (elevators, heating stations, etc.), in which they are already faced with lack of parking spaces. The Housing Act, which regulates mutual relations between apartment owners in multi-apartment buildings regarding improvements, such as the installation of an electric charging station, exceptionally allows the implementation of improvements within an individual part of the building even without the consent of the apartment owners, but on the condition that the intervention does not mean deterioration for any other individual part or common parts of a multi-dwelling building and does not change its external appearance of the multi-dwelling building. This statutory exception comes into play in very rare cases, but since managers and individual condominium owners understand it in different ways, the interested investor often gives up and abandons his intention in the end.

5.4 Denmark

The state's incentives for EV adoption, such as reduced registration fees, may not be sufficient to offset the higher purchase price of EVs compared to traditional gasoline vehicles. There have been calls for more comprehensive and targeted financial incentives to make EVs more affordable and accessible for consumers. It is important to note that the tax system has been a point of contention for EV adoption in Denmark, as EVs can still be subject to high registration taxes due to their higher initial purchase price compared to traditional gasoline vehicles. The government has implemented tax incentives and exemptions for EVs, but they may not be enough to offset the high initial cost for some consumers.

Another legal barrier is related to the regulatory environment for EV charging. In Denmark, there are different types of charging stations, and they are subject to different regulations and standards. This can create inconsistencies and complications for charging station providers and can result in a fragmented charging network. Some stakeholders have called for more standardized regulations and guidelines for the installation and operation of charging stations to ensure consistency and interoperability across the network.

5.5 Summary of most important outcomes

In this section, we summarise the most important gaps and suggestions related to the regulatory and legislative framework for each demonstrator country. Table 5.1 illustrates this summary. Table 5.1: Summary of the most important regulatory gaps or suggestions for each demonstrator country.

Table 5.1: Summary of the most important regulatory gaps or suggestions for each demonstrator country.

Country	Gaps and suggestions
Greece	<ul style="list-style-type: none"> • No framework for flexibility provision from DERs, including EVs and V2X, to the transmission and distribution networks. • Lack of network observability restricts DER capacity, including V2X. • V2X regulation defining the business case (beyond its flexibility aspect) is missing. • Incentives for more chargers.
Portugal	<ul style="list-style-type: none"> • Lack of infrastructure for chargers in old buildings. State should incentivise their installation. • Charging EVs for CPH is prohibited in commercial scale. • Strict regulation and limited financial incentives. No regulation for mobility in Energy Communities. • No regulation for charging in energy communities / self-consumption installations. • Regulation should consider services to operator for grid management.
Slovenia	<ul style="list-style-type: none"> • Not sufficient incentives for the purchase of EVs. • Lack of acceptance for installing chargers in multiapartment buildings. • Regulation allows the installation without consent from all owners, but some exceptions make the process long-lasting and therefore not feasible in many cases.
Denmark	<ul style="list-style-type: none"> • Lack of incentives for increasing the EV penetration rate. • Lack of unified regulations and standards of EV chargers.

6 Conclusions

This report presented the results of Task 1.3 of EV4EU on the regulatory and legislative surrounding the activities of the project. The focus of EV4EU is electromobility on mass scale with an emphasis on V2X. Therefore, it was of relevance to this analysis, not only thematic categories that apply strictly to EVs and the charging infrastructure, but also topic of broader energy policy, flexibility as a service which commonly includes EV-provided flexibility, power network management, RES coordination, data, and cybersecurity.

The analysis included both the EU-level regulations and directives, as well as the national frameworks. The European framework was analysed in a more rigid format and included 4 broad categories: a) Energy Policy, b) EVs and Charging, c) Distributed Energy Resources, Markets and Systems, and d) Data, Security and Privacy. For the national regulations, a freer format was preferred, and reporting included flagship legislations that are in place, important development in the local ecosystem and future developments. Both for the EU and national levels, relevant tables summarise the most important pieces of legislation, serving as a beginners guide to the ecosystem in each case.

The first main conclusion of the analysis is that the EU regulatory framework has covered a lot of ground in terms of defining and mandating changes that facilitate EV uptake and EV integration. The regulations and directives produced on the topic are not limited to setting quota-style goals for the member states but, instead, define technical rules, bodies and initiatives that have a practical impact on the increased penetration of EVs and the harmonisation among the states. The regulations that affect the EV market and integration are not strictly related to the EVs as devices but include several fields with the most prominent being the topic of smart grids (power systems, electricity markets, active users, etc.) where the union has made significant progress in the past year.

In addition, the conducted analysis undertook a detailed survey of the legislative and regulatory frameworks of the four EV4EU demonstration countries, namely, Greece, Portugal, Slovenia, and Denmark. Results showed that all countries have reached a significant level of maturity in terms of legislation, while their EV penetration levels are not equal. There are a lot of common elements among countries, which is expected due to all being obliged to follow EU regulation. On the topic of V2X, all reported issues on the legislation ranging from non-existing provisions in the law to barriers set by other pieces of legislation. Finally, another important issue reported by all countries is the insufficiency of the current charging infrastructure. Again, the reported problems cover a broad area, including obstacles for installing private chargers in residential buildings and lack of public chargers in highways and popular hubs.

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8 Appendix

Figure 8.1 and Figure 8.2 depict the legal regime applicable to the operation regarding the entity and type of access to the charging point.

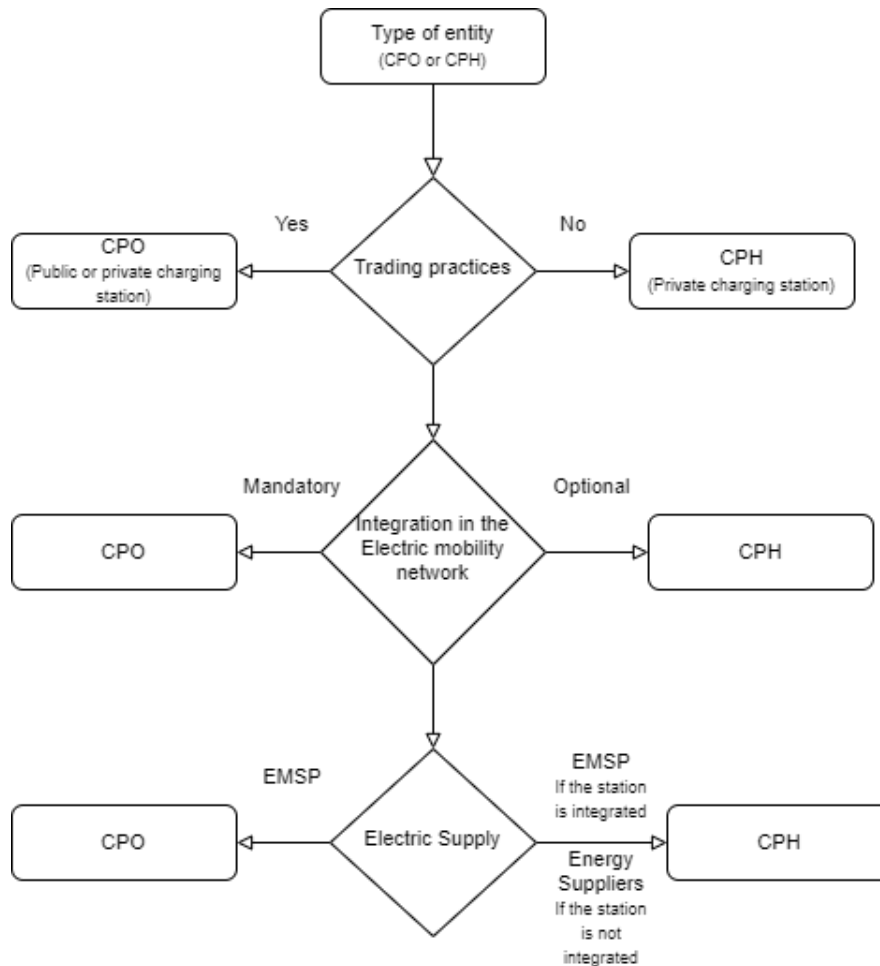


Figure 8.1 – Illustration related to electric mobility regulation depending on the entity Charging Point Operator(CPO) or Charging Point Holder(CPH). (Source: [67], [73], [86])

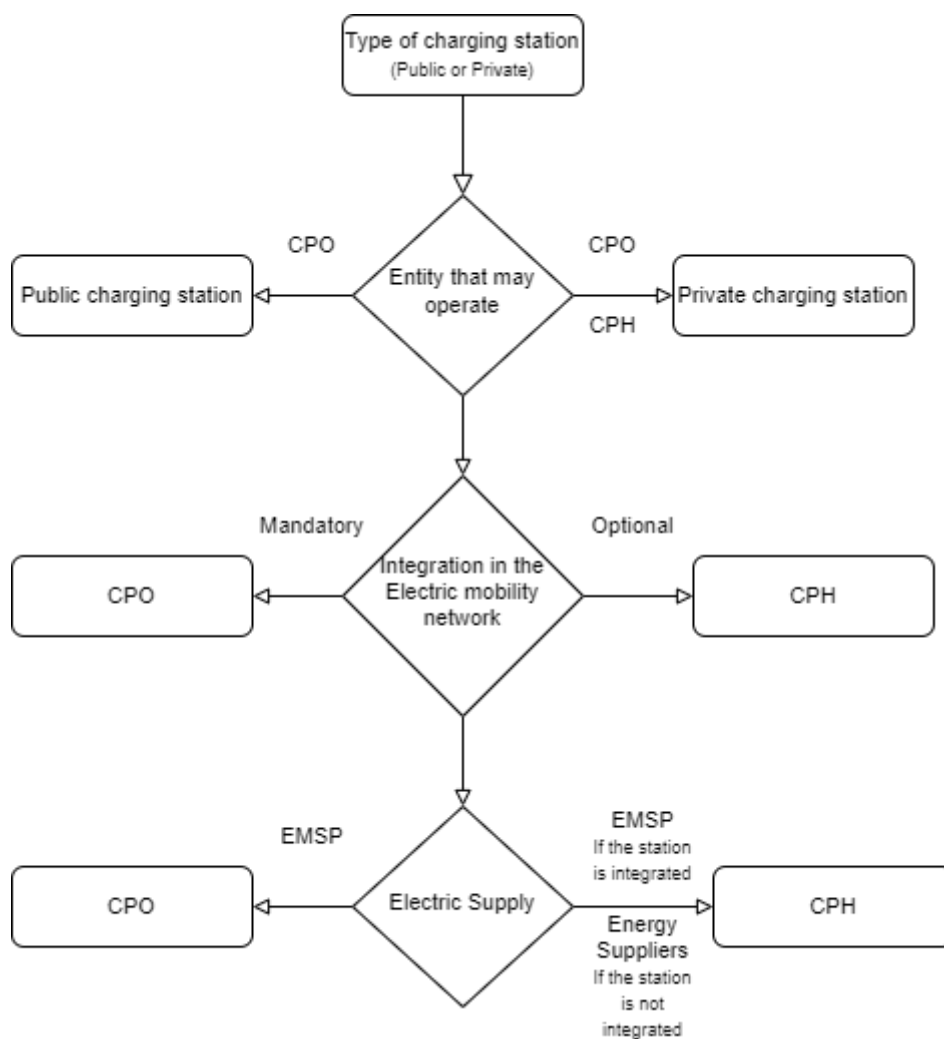


Figure 8.2 – Illustration related to electric mobility regulation depending on the type of access to the charging point (public or private). (Source: [67], [73], [86])