



## Embracing Electromobility in Greece: Review of good practices in the Region of Attica

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### Abstract

Energy consumption and emissions production are exponentially increasing worldwide and reports from the European union indicate that the transportation sector has one of the highest shares in environment pollution. More specifically, the road transportation sector is responsible for most CO<sub>2</sub> emissions making urgent the implementations of actions towards sustainable mobility. Electromobility and alternative fuels are key solutions for a more environmentally friendly transportation sector. Scope of this paper is the identification of good practices concerning electromobility and alternative fuels, already implemented or planned in the Region of Attica. The good practices identified are classified and further evaluated for their effectiveness and their contribution in energy and emissions saving. The evaluation of each good practice as well as the identification of problems encountered during its implementation will become a useful guide for policy makers and stakeholders in regional and national level.

**Keywords:** *sustainability, electromobility, good practices, CO<sub>2</sub> emissions reduction, energy saving, alternative fuels.*

### 1. Introduction

The energy consumption and emissions production are exponentially increasing worldwide. Based on data from the European Union (europa.eu), the transportation sector has the highest share in energy consumption (33,1% in 2015) and constitutes the second contributing factor in CO<sub>2</sub> emissions (28,5% in 2015). Specifically, the road transportation field is responsible for most CO<sub>2</sub> emissions (72,9% in 2015). These high shares reveal the need for the design and implementation of interventions and actions towards a more sustainable mobility. Based on the above, electromobility and alternative fuels are considered to be key - solutions towards a more environmentally friendly transportation system, having a direct effect on energy saving and emissions reduction.

Electric vehicles are considered as the vehicles that consume less energy, have zero emissions and are less noisy than the conventional diesel ones. Despite their advantages, the number of electric vehicles in Europe is still limited but is slowly increased during the last year according to the data from the Europe Environment Agency. Different factors cause this low penetration rate such as applied policies, lack of financial and non- financial incentives, high price of



electric vehicles compared to the conventional ones, lack of charging infrastructure, low public awareness (Coffman et al., 2017, Sierzchula et al. 2014). Similar is the situation in Greece where the percentage of electric vehicles on the total fleet is among the lowest compared to the other European countries, indicating that much has to be achieved towards a Greek environmental friendly transportation system. According to an analysis conducted by the Hellenic Institute of Electric Vehicles, the Centre for Renewable Energy Sources and Saving and the Ministry of Environment and Energy, the number of electric vehicles in 2020, 2025 and 2030 is predicted to be up to 3.500, 8.000 and 15.000 respectively (National Policy Framework on alternative fuels, 2017). Nanaki and Coroneos (2013) conducted an analysis on the penetration rate of plug in , hybrid and electric vehicles in Greece based on 3 different scenarios: realistic, conservative and optimistic. According to the first scenario the market share for new, electrically chargeable vehicles is in the range of 5% - 26% from 2012 – 2025, for the second scenario the share is estimated from 2% to 12% while for the optimistic scenario the new electric vehicles will consist the 10% - 42% of the market.

In order to achieve any of these targets, significant steps should be made for promoting electromobility in Greece in various fields (awareness, infrastructure, etc.). Till now, little progress has been made by adopting measures named as Good Practices towards this direction. According to the Glossary of the Interreg, a Good Practice is defined as *“an initiative (e.g. methodologies, projects, processes, techniques, technologies, etc.) undertaken in one of the program’s thematic priorities which has already proved successful and which has the potential to be transferred to a different geographic area. Proved successful is where the Good Practice has already provided tangible and measurable results in achieving a specific objective.”* (“Glossary | Interreg Europe,” n.d.).

Scope of the present research is the identification and analysis of good practices with respect to electromobility or alternative fuels, that have been already implemented or planned to be implemented in the region of Attica, the metropolitan region of Greece. To achieve this objective, a thorough review on good practices on electromobility and alternative fuels will take place and the identified practices will be classified. In the next step, different characteristics have been selected in order to evaluate each practice based on qualitative and quantitative information. More specifically, each practice’s performance is estimated in terms of ease of use, the vehicle performance, the public awareness, the environmental benefits as well as the energy system operation and management enhancement. Concerning the quantitative evaluation of each practice, the increase in the number of electric vehicles and charging stations as well as the emissions saved are recorded aiming to quantify the result of each practice. Through this research, the share and exchange of good practices will result in knowledge transferability, policy making process improvement and policy effectiveness increase while the evaluation of each practice as well as the identification of problems encountered during its implementation will become a useful guide for policy makers and stakeholders.



## ***2. Good Practices in the Region of Attica***

Totally, 11 Good Practices were collected for the region of Attica aiming at promoting the concept of electromobility and the use of electric vehicles and alternative fuels increasing their share in the total market fleet. The selected Good Practices are distinguished in different categories according to the project's predefined thematic areas:

- Category 1: Charging and tolling policies favoring e- vehicles
- Category 2: Development of charging infrastructure
- Category 3: Integration of charging infrastructure and charging hubs in spatial planning
- Category 4: Support to the deployment, purchase of alternative fuel vehicles in public transport by financial incentives and setting up regional financial support schemes (bus and ferry fleet)
- Category 5: Promotion of electromobility in niche market fleets (taxi, urban logistics, etc)
- Category 6: Promotion of new measures favoring public- private partnership (PPP) in e-mobility sector
- Category 7 – 8: Other themes related to e – mobility policy

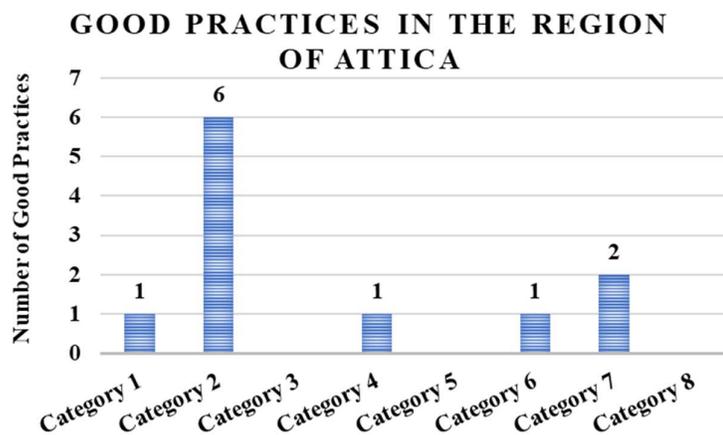
The Good Practices described as “Other” were further categorized as “Promotion and awareness” (Category 7) and “Research, training and education” (Category 8). As presented in Figure 1, the majority of the practices are related to charging infrastructure facilities (charging stations installation, development of network of charging stations, online platform informing users of electric vehicles about the nearest available station, etc).

The Good Practices selected for this work are listed below and described in the next section:

- Good Practice 1: Promotion of the use of electric scooters in urban areas through the development of sustainable market model – Exhibition of electric scooters in the port of Rafina, Greece and creation of a GIS web platform
- Good Practice 2: Composition of a Committee responsible for the investigation of the ways that the introduction and penetration of electric vehicles in the Greek market.
- Good Practice 3: Installation of 7 charging stations on pavements in Athens and use of corresponding number of electric vehicles within a demo pilot project in Athens (Green eMotion Project)
- Good Practice 4: Development, construction and operation of the first standalone Solar Electric-Vehicle (EV) Charging Station in the country, “CARPORT”
- Good Practice 5: Action Plan for the development of electric vehicles charging stations
- Good Practice 6: Development of the first network of electric vehicles charging stations
- Good Practice 7: Hi-Tech Eco Mobility Rally



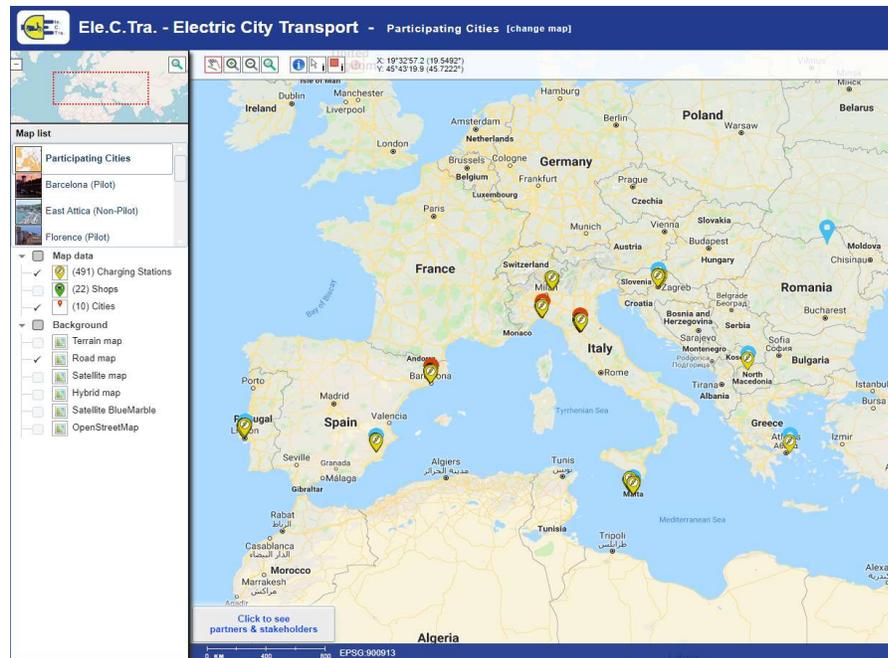
- Good Practice 8: Plan for infrastructure design for EV charging station installation
- Good Practice 9: Installation of 4 Vehicle-2-Grid electric vehicle charging stations in Meltemi in Greece
- Good Practice 10: The Ecocar



*Figure 1: Number of Good Practices in the Region of Attica per project theme*

### 2.1 Good Practice 1

The first Good Practice entitles “Promotion of the use of electric scooters in urban areas through the development of sustainable market model – Exhibition of electric scooters in the port of Rafina, Greece and creation of a GIS web platform.”. This Good Practice was implemented within the framework of the Ele.C.Tra (Electric City Transport) project (<http://www.electraproject.eu/>) whose objective is the promotion of a new urban mobility model with common characteristics among the partner cities so that it can be easily implemented in other cities and regions. The project includes 3 pilot actions with 90 electric scooters and full model set up (signs, parking system, users services, etc). Additionally, one of the main outputs of the project was the creation of a GIS web platform (<http://maps.electraproject.eu/#>) which provides data for all pilot and non - pilot cities of the project (including Athens). Through this platform the use and monitoring of electric scooters was achieved (Deliverable D.6.5) while the end-users will have access to the facility map and its services (pickup and delivery points of e scooters, parkings, and recharge stations). The development of the Electra model in Greece faced some significant constraints especially related to the financial restrictions, the lack of charging points and parking spaces for scooters, the difficulty in promoting a sharing system when car sharing in Greece is in a very preliminary step and of course safety concerns, as people do not consider scooters as a safe mode of transportation. The web platform of the project is presented in Figure 2.



***Figure 2: Web platform for electric scooter sharing and charging stations developed for the Ele.C.Tra project (<http://maps.electraproject.eu/#>)***

Within the project an e-vehicle exhibition took place in the municipality of Rafina in order to introduce to the citizens and public/private bodies and institutions the electric vehicles, scooters and bicycles and promote the idea of electromobility in Greece. The participants could also drive these type of vehicles in order to have a real experience and get familiar with the new technology which will influence the urban and touristic transportation in the future. More than 1.200 visitors from different municipalities of East Attica attended the exhibition, a fact that shows that people's willingness to learn more about the new technology. During the exhibition people had the chance to participate in test drives assisting them in getting more easily familiar with the electric vehicles. General outcome of the Good practice was the fact that the cooperation and idea exchange between different stakeholders (public and private bodies, institutions, etc) is necessary for the promotion of new technologies like electromobility.

## ***2.2 Good Practice 2***

The second Good practice refers to the composition of a Committee responsible for the investigation of the ways that the introduction and penetration of electric vehicles in the Greek market can be achieved by the Ministry of Environment and Climate Change ([www.ypeka.gr](http://www.ypeka.gr)). The composition of this Committee was triggered by the fact that the promotion of electromobility in Greece is in a very preliminary stage, there is low citizens and stakeholders awareness of electromobility and its benefits, no legislative framework for electromobility has been formulated and there is lack of Strategic Plan for the electromobility in Greece.



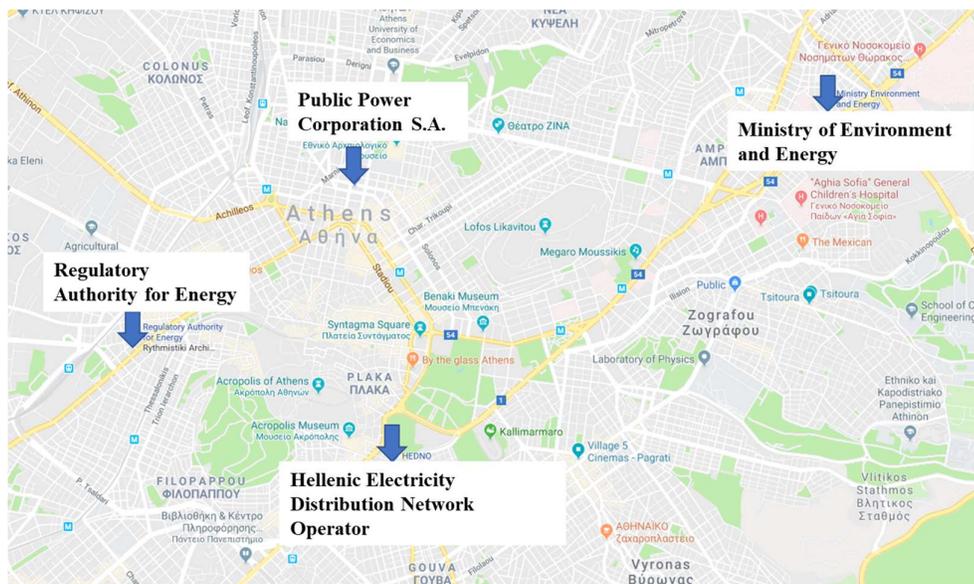
The focus areas of the Committee are:

- The analysis and investigation of the most appropriate methods for supporting the first steps of the electric vehicle penetration in the Greek market
- The development of an incentive plan for the promotion of electric vehicles
- Stronger incentives should be given for the promotion of electric vehicles purchase
- Submission of a technical report entitled: “Investigation of the methods for the development and penetration of electric vehicles in Greece”. This report will be the basis for decision making and for policy establishment for the electromobility in Greece.

### 2.3 Good Practice 3

Within the framework of the Green eMotion Project (<http://www.greenemotion-project.eu/>) the installation of 7 charging stations on pavements in Athens and use of corresponding number of electric vehicles within a demo pilot project in Athens was planned. The Green eMotion project is part of the European Green Cars Initiative (EGCI) launched within the context of the European Recovery Plan. Its main achievements were the definition of European standards for an interoperable electromobility system and the IT architecture for a European marketplace and the development of a commonly accepted and user-friendly framework. Within the project the practical usability of the defined European standards and the feasibility of the interoperable system were demonstrated and tested in 12 selected demo regions.

The cities of Kozani and Athens, in Greece, were chosen as the replication regions where a real Greenfield installation of an electromobility system was implemented by replicating the tested and approved solutions from the demo regions. The implemented system consisted of 8 charging stations in Kozani, 7 in Athens and 15 leased electric vehicles. During the design of this action obstacles, technical and practical issues and other problems were detected, identified and solutions were investigated and suggested. First of all, there was lack of knowledge and no legislative framework formulated regarding the electromobility concept and the organization/implementation of a demo pilot project. Additionally, since such actions requires the cooperation and involvement of different stakeholders it was difficult to set and distribute the responsibilities among them. Finally, there was lack of technical rules and guidelines on how such an action could be implemented and realized. Finally, the Green eMotion project was a very important step towards development of the appropriate infrastructure for EVs as there was no similar electromobility project, action in Greece referring to public charging stations on pavements and cooperation with electric vehicles and therefore it (Lioliou, 2015). Figure 3 shows the location of the charging stations in the city of Athens.



*Figure 3: Locations for the installation of the first 4 charging stations in the city of Athens*

#### 2.4 Good Practice 4

The fourth Good Practices involves the development, construction and operation of the first standalone Solar Electric-Vehicle (EV) Charging Station in the country, "CARPORT". The Laboratory of Soft Energy Applications and Environmental Protection (SEALAB) of the Piraeus University of Applied Sciences (former TEI of Piraeus) was responsible for planning, design and installing the station (Kaldellis et al., 2015). The target of this practice is monitoring all energy data, supporting the efforts towards the infrastructure development, accelerating the implementation of a European national electrification action plan through the construction of EV charging stations based on PV generators. The station is considered to be very environmental friendly, able to support the decarbonisation of the European transport sector.

The issues triggered the introduction of this Good Practice is the fact that transportation sector is the second mayor energy consumer and therefore improving energy efficiency in this field could result in reducing emissions and negative environmental impacts. The advent and use of electric vehicles could significantly contribute towards this direction and this practice tries to support Greece's effort towards the infrastructure development and strengthening in the field of electro-mobility. Finally, the comparison between Solar-based (powered) Electric Vehicles Charging Station and Stations connected with the electrical grid will reveal the most environmental solution.

For defining the dimensions of a charging station of electric vehicles, it is necessary to consider the following aspects: corresponding energy and power demand, environmental behavior and some preliminary cost-benefit estimations. The solar-based EVCSs have remarkable first installation costs. Severe problem of charging station batteries replacement throughout the



operational life of the installation and their final disposal. The charging station is showed in Figure 4.



***Figure 4:** Charging station developed and installed by the SEALAB of the Piraeus University of Applied Sciences (Kaldellis et al., 2015)*

### **2.5 Good Practice 5**

A very important step towards promotion of electromobility in the Region of Attica was the Action Plan for the development of electric vehicles charging stations. Unfortunately, this action was not finalized and thus it cannot be considered as a Good Practice but it is worth mentioning. The Action Plan aims at promoting electromobility through the investigation and analysis of different pilot scenarios in order to identify the most appropriate and user friendly charging station infrastructure and settlement. The first steps of this practice is the cooperation of the related stakeholders and the implementation of the Action Plan. The last step consists of the installation of 120 electric charging stations in predefined specific locations within the Region of Attica as well as their effective operation and maintenance.

The issues that have to be taken into consideration for such a Good Practice are the following:

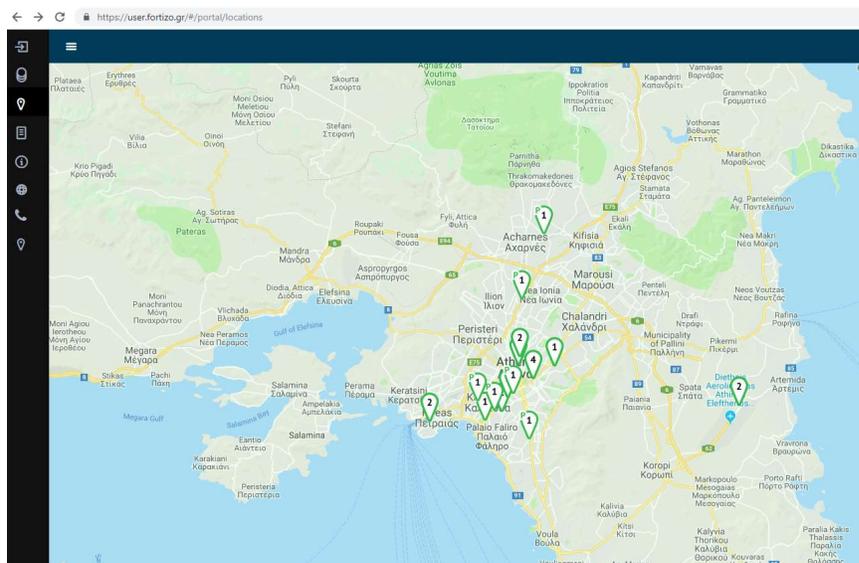
1. The cost of designing and constructing the appropriate infrastructure as well as obtaining the new technologies is extremely high
2. Efficient infrastructure operability for safe and effective user service
3. Synergy and cooperation of different stakeholders
4. Public awareness and familiarization with the new technologies and their perspectives
5. Technical, environmental and financial restrictions and criteria should be considered



6. Interactions between infrastructure and electric energy should be taken into account so that large investments could be avoided
7. The chosen pilot scenario should not create extremely high expectations to the users
8. The selection of the appropriate locations for the station installation
9. Clarification of the characteristics of the charging stations
10. Cover the needs of the potential users (Origin – destination matrixes)

### **2.6 Good Practice 6**

Development of the first network of electric vehicles charging stations by FORTISIS (fortisis.eu). The first network of electric vehicles charging stations consists of 23 charging stations located in different cities in Greece. The majority of them (12 out of 23) are located in different spots within the Region of Attica. All charging stations are for public use and the users should register in the platform in order to search for the closest station. Additionally, through the platform it is possible to see the status of each station (available, occupied, faulty, no communication, out of working time), its characteristics and the connectors available. Through the platform the users can check remotely the charging duration and interrupt the EV charge. Users can find the closest EV charging station, the available chargers and the type of access in the web platform FORTISIS company has developed (<https://user.fortizo.gr/#/portal/locations>). According to the Vice President D. Micharicopoulos, the problems the company has to overcome is the lack of incentives, bureaucracy obstacles, negative attitude towards electromobility create hold back the development of charging infrastructure. Additionally, very long term profit from the installation, management and operation of the charging stations is very low due to the low use of electric vehicles. Finally, strategic choice of the locations of the charging stations in order to fulfil users' and public sector's need for public accessible stations where they can charge their vehicles is necessary to be carefully investigated (Micharicopoulos, 2015). The online platform of the FORTIZO network is displayed in Figure 5.



**Figure 5:** The FORTIZO network (<https://user.fortizo.gr/#/portal/locations>)

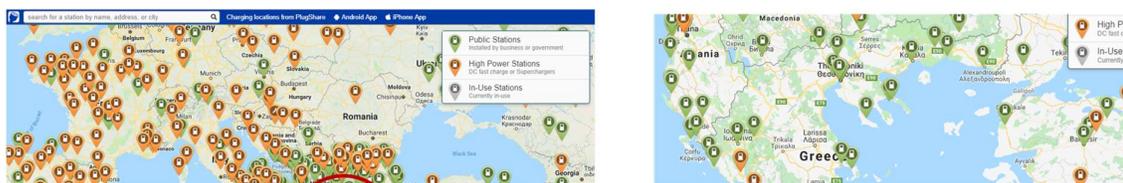
## 2.7 Good Practice 7

Since 2009, the Hellenic Institute of Electric Vehicles organizes every year the Hi-Tech Eco Mobility Rally where electric, hybrid and vehicles using alternative fuels can participate. The scope of this action is the promotion of new technology vehicles, saving energy and reducing gas and CO<sub>2</sub> emissions. This contests contribute in improving driving habits so that drivers could set as their priority the environment protection and sustainable mobility through the use of alternative fuels and electric energy. Through this experience, public awareness is raised, people get familiar with these new type of vehicles and they can be ensured that such vehicles can be environmental friendly but also fast and safe at the same time. The incentive for this action was the fact that people in Greece are not familiar with electric, hybrid and vehicles using alternative fuels and as a result they are concerned about their own safety and the how the vehicle can perform in real driving conditions.

For participating in the Rally, all vehicles must be in conformity with the Technical Regulations of the FIA E-Rally Regularity Cup while the supervision of compliance to the rules of the contest is very strict. The successful organization of the event showed that the Hi-Tech EKO Mobility Rally should continue to be held during the next years (and every year) since the new technologies of electric vehicles are radically spread and it is necessary to inform the potential users about their characteristics and their advantages. Apart from the users getting familiar with the electromobility idea and electric vehicles, The Hi-Tech EKO Mobility Rally 2019 in Athens showed that the use of electric vehicles can significantly reduce energy consumption. The energy spare is estimated to be from 2/3 to 4/5 of the energy that the modern diesel cars use ([www.heliev.gr](http://www.heliev.gr)).



Moreover, the HELIEV has developed a platform where the users of EV can search for a charging station all over the world and check their characteristics such as location, number of ports, type of ports, cost, etc. The platform is illustrated in Figure 6.



*Figure 6: The web platform for charging station location and characteristics developed by Hellenic Institute of Electric Vehicles ([www.heliev.gr](http://www.heliev.gr))*

## 2.8 Good Practice 8

The Hellenic Electricity Distribution Network Operator (HEDNO) has developed a plan referring to the infrastructure design for EV charging station Installation. The Plan consist of 2 phases:

- Phase A: Pilot Installation of 100-150 Charging stations on the Greek Islands and the mainland. These stations belong to the Charging level category Mode 3 (AC, 22kW) – 2018/2019
- Phase B: Installation of 1000 – 1500 charging station in the Mainland. These stations will belong to the Charging Level category Mode 3 and Mode 4 (DC, 50kW και 120kW) – 2019/2020

Figure 7 illustrates the location of the charging stations on the Greek islands and mainland classified in MODE 3 and Mode 4 as it was presented by the General Manager of Network Development and Operation of HEDNO in the ECO mobility Conference in 2018 (Menegatos, 2018).



*Figure 7: Location of the charging station planned by the Hellenic Electricity Distribution Network Operator (presentation of Mr. Menegatos in the ECO mobility Conference 2018)*

## **2.9 Good Practice 9**

The installation of 4 Vehicle-2-Grid electric vehicle charging stations in Meltemi in Greece is also an important step in promoting electromobility and use charging stations for energy storage. This Good Practice is developed within the framework of the SHAR-Q project (<http://www.sharqproject.eu/home>) and aims to establish an interoperability network that connects the capacities of the neighborhood and wide regional RES+EES ecosystems into a framework. One of the stakeholders' activities was the installation of adaptive charging of e-vehicles and V2G services. Therefore within the project 4 Vehicle-2-Grid electric vehicles charging stations in Meltemi in Greece aiming at exploitation of the synergies of electric vehicles and Renewable energy Sources (RES). According to the project report, the battery of an electric vehicle can be used as distributed storage device during the time that the vehicle is parked, which consists the 90% of the day. Therefore, Meltemi pilot aims at achieving efficient integration of EVs into distribution grids with high RES share increasing their deployment levels in distribution networks.



***Figure 8: The Meltemi Campus - Meltemi site future EV infra facility (Deliverable 2.4 of the SHAR-Q project)***

### ***2.10 Good Practice 10***

The last good practice refers to the cheapest electric vehicle of the Greek market, the Ecocar, of the Greek company Ecosun (<https://ecosun.gr/>). The car is 224.5cm long, 130cm wide, 157cm height while its weight is around 670kg including the batteries. Even if it small, it is ideal for two people, its range is from 100 – 120 km (with one fully charge) and the maximum speed it can drive is 80km/h. Except of the low price, the Ecocar has the lowest operational costs as the energy it consumes for covering a 100km distance corresponds to only 1 euro. Due to its small size, it is ideal for covering urban transportation needs, it can be parked easily everywhere, it totally environmentally friendly and silent (<https://ecocar.city/>). Ecocars are already in use in the Region of Attica, offering comfortable, easy and fast transportation.



*Figure 9: The Ecocar (<https://ecocar.city/>)*

### 3. Evaluation of Good Practices

After their classification according to the project themes, the selected good practices were then evaluated from a group of experts in the field of electromobility based on the criteria presented in Table 1. Each criteria was evaluated using a scale from 0 to 5, where 0 is no significant impact and 5 very high positive impact of the good practice on each criteria. In Table 2, the evaluation results for the above described Good Practices are presented.

*Table 1: Evaluation Criteria*

Evaluation Criteria	Description
Relative Advantage	Does the GP give alternative fuel vehicles a distinct advantage over internal combustion engine vehicles?
Ease of Use	Does the GP make alternative fuel vehicles more convenient and enjoyable to use?
Vehicle Performance	Does the GP enhance the design, construction and performance of electric vehicles?
Awareness	Does the GP help people to better understand alternative fuel vehicles?
Environmental	Does the GP provide direct environmental benefits?
Energy System	Does the GP enhance the management and operation of energy systems?



*Table 2: Evaluation of the Good Practices*

Good Practices	Relative Advantage	Ease of Use	Vehicle Performance	Awareness	Environmental	Energy System
Good Practice 1	3.5	3.5	4*	4	0	0
Good Practice 2	4	1	0	3	0	0
Good Practice 3	1	3	0	3.5	3	1
Good Practice 4	1	3	0	3.5	4	4
Good Practice 5*	3.5	4	0	4	3	3
Good Practice 6	2	4	0	1	0	0
Good Practice 7	3	4	3.5	4	0	0
Good Practice 8*	3.5	4	0	4	3	3
Good Practice 9	1	3	0	3.5	4	4
Good Practice 10	3.5	4	4	4	3.5	2

Results from Table 2 show that most of the practices have a high positive impact on increasing public awareness on electric vehicles. The installation of electric vehicles, the exhibitions, the electric vehicles rally, setting incentives for electric vehicle purchase and use make people wondering about this new technology and its advantages and benefits and as a result they try to be more informed either by searching for more information or by participating in related events. Additionally, it is important to highlight that Good Practices 5 and 8 were evaluated concerning the impact on the different criteria in case of their implementation and the increase in the number of the electric vehicles, while Good Practice 1 was evaluated in case participants were giving their feedback after driving the electric scooters or vehicles regarding vehicle design, comfort, performance etc. Finally, a significant outcome is that there is lack of Good Practices aiming at enhancing design, construction and performance of the electric vehicle.

#### **4. Conclusions**

Electromobility begins a new era towards a transportation sector more sustainable, more environmentally friendly with less energy consumption, less pollution and less noise offering better quality of life for the citizens. This paper has shown that despite the fact that in Greece the number of electric vehicles is very low, there are actions that have been planned or implemented favouring the promotion of electromobility and the use of electric vehicles as well as increasing public acceptance and familiarization with this new technology. These Good Practices can be the start for introducing and stabilize electromobility and can be a useful guide not only for the Region of Attica, but also for other Greek regions as well as other cities.



### *Acknowledgements*

The analysis is conducted within the framework of eMOPOLI project (Electro MObility as driver to support POLicy Instruments for sustainable mobility) funded by the European Union within the framework of the Interreg Mediterranean (MED) Program.

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