European Union
European Regional
Development Fund

EMOBICITY
Interreg Europe

Publishable Report on the Promotion of E-mobility in Low Integration Fields of selected countries. Challenges and possible solutions.

Author:
Azorean Government – Regional Directorate for Energy (AZORES)

Contribution:
Centre for Renewable Energy Sources and Saving (CRES) – lead partner
Portuguese Energy Agency (ADENE)
Energy Institute Hrvoje Pozar (EIHP)
Regional Management Northern Hesse GmbH (RMNH)
Northwest Regional Development Agency (NWRDA)

Date:
July 2021

Table of contents

Executive Summary 1
1. E-mobility in Low Integration Field of selected countries/regions. A state of art. 2
1.1. Greece 3
1.1.1. Characterization of the low integration field 3
1.1.2. Challenges to overcome 4
1.1.3. Possible solutions/current projects/regulatory initiatives 4
1.2. Portugal (Mainland) 5
1.2.1. Characterization of the low integration field 5
1.2.2. Challenges to overcome 5
1.2.3. Possible solutions/current projects/regulatory initiatives 6
1.3. Portugal (Azores) 7
1.3.1. Characterization of the low integration field 7
1.3.2. Challenges to overcome 9
1.3.3. Possible solutions/current projects/regulatory initiatives 9
1.4. Germany 11
1.4.1. Characterization of the low integration field 11
1.4.2. Challenges to overcome 11
1.4.3. Possible solutions/current projects/regulatory initiatives 12
1.5. Romania 12
1.5.1. Characterization of the low integration field 12
1.5.2. Challenges to overcome 13
1.5.3. Possible solutions/current projects/regulatory initiatives 13
1.6. Croatia 14
1.6.1. Characterization of the low integration field 14
1.6.2. Challenges to overcome 15
1.6.3. Possible solutions/current projects/regulatory initiatives 16
2. A Comparative Analysis of the E-mobility in Low Integration Field of selected countries/regions 17
3. List of Figures 19
4. References 20

Executive Summary

Electricity as an energy vector for vehicle propulsion offers the possibility to substitute oil with a wide diversity of primary energy sources. This could ensure security of energy supply and a broad use of renewable and carbon-free energy sources in the transport sector, which could help the European Union targets on the reduction of CO_2 emissions.

Electrification of transport (electromobility – e-mobility) is a priority for the European Union. It is an instrument to fulfil the Sustainable Development Goals by improving air quality through the reduction of air pollution, noise and contributing to the progressive decarbonization of economic activity while tackling climate change.

The evolution of the automotive industry, especially with regard to electric batteries, has been an asset in the consecration of the mobility strategy, as seen in other countries and regions that are world leaders in electric mobility.

It is essential to define policies and assess situations in *lato sensu* – EU level – but also in *stricto sensu* (narrower/micro level) – from the point of view of Member States, regions, and cities.

The promotion of electric mobility in low integration fields is essential for the introduction of policies, as well as for community engagement, whose objective is that local communities identify themselves with e-mobility and benefit from it. That means, for instance, the reduction of social costs due to the impact of emissions to health and to the eco-system, or the reduction of emissions from the greenhouse effect. In short, energy saving and greater efficiency.

This report considers the characterization of low integration fields in six distinct geographic areas – Greece, Portugal (mainland), Portugal (Azores), Germany, Romania and Croatia, in terms of electric mobility. Furthermore, challenges to be overcome and possible solutions will be identified whether through projects (under study or implemented) and/or regulatory initiatives.

1. E-mobility in Low Integration Field of selected countries/regions. A state of art.

European countries are promoting and investing on the electrification of transport. However, differences between urban, intermediate and rural regions are still obvious. According to Sandra Wappelhorst (2021), in 2019, over 560.000 new electric passenger cars were registered in Europe, a share of 3,6% of all new passenger car registrations.[1] This included battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs).

Considering the division between urban, intermediate and rural areas, regional differences in electric vehicle uptake are still dependent on population share. Taking into account a selected number of countries[2], more than 322.000 BEVs and PHEVs were registered in urban regions; almost 175.000 BEVs and PHEVs were registered in intermediate regions; and about 50.000 new electric passenger cars were registered in rural regions. On a per capita basis, electric passenger car registrations were the highest in urban regions when compared with intermediate and rural regions: **urban** – 15 registrations per 10.000 inhabitants; **intermediate** – 11 electric passenger cars registrations per 10.000 inhabitants; **rural** – 7 registrations per 10.000 inhabitants. In addition to that, when considering electric passenger car registrations within all new passenger car registrations in 2019, the market share was the following: 4,0% corresponded to urban regions; 3,5% to intermediate regions; and only 2,9% to rural regions (Wappelhorst, 2021, 1).

When analysing the living context of the population in the selected countries of this study, 48% of the population lived in urban regions in 2019, where 54% of all new passenger cars were registered and 59% of all new electric vehicles were registered. In the intermediate regions, where 36% of the population lived, the numbers are lower: 34% of all new passenger cars and 32% of new electric vehicles were registered. Finally, with 16% of the population living in rural regions, 12% of all new passenger cars were registered and 9% of all new electric passenger cars were registered. (Wappelhorst, 2021, 2).

As shown below (Fig. 1), European markets present wide variations. In the selected countries, the average electric passenger car registration share of new registrations was the lowest in rural regions relative to urban and intermediate regions. In Denmark, Italy and Portugal, the average BEV and PHEV registrations shares were the highest in intermediate regions, while for the remaining 14 countries the averages were the highest in urban regions. The relative difference between urban and rural average electric passenger car registrations shares was the lowest in Denmark and Portugal, where it was twice as high in urban regions relative to rural regions.

[1] This includes the 27 Member States of the European Union, the United Kingdom, and the countries of the European Free Trade Association (i.e. Iceland, Liechtenstein, Norway and Switzerland).

[2] (Wappelhorst, 2021). According to this paper, 17 European countries were selected – 13 EU Member States, the United Kingdom, Liechtenstein, Norway and Switzerland based on data availability.

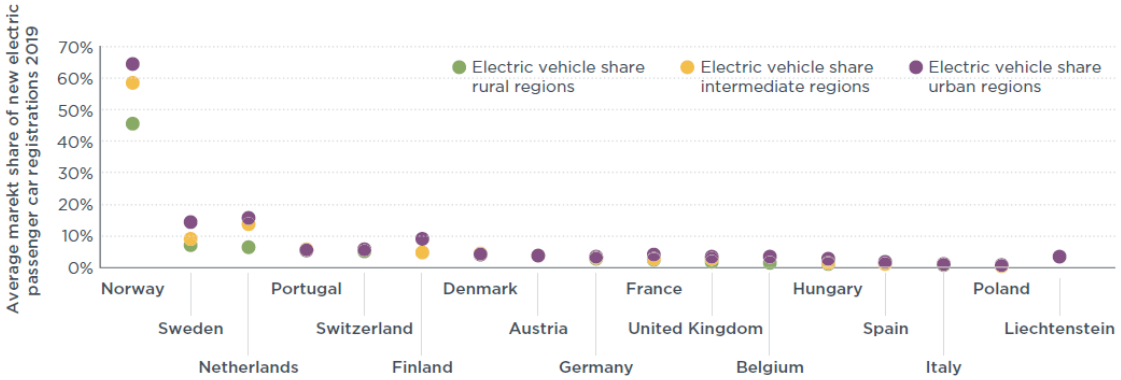


Figure 1: Average market share of electric passenger car registration shares by country and territorial typology (urban, intermediate, rural) in 2019. (Wappelhorst, 2021, 3)

In general, new electric passenger car registrations by total numbers, shares and on a per capita basis were the highest in urban and intermediate regions in 2019. Nevertheless, rural regions offer great potential to electrify the non-avoidable motorized car fleet. According to Wappelhorst (2021), the dependence level on private automobile and the motorization rate is much higher in rural areas, especially where there is still a lack of an alternative, such as public transport. Moreover, considering the high proportion of one- and two-family houses with garage or off-street parking, charging an electric vehicle on private premises becomes more practical in these regions.

There are three main conclusions to draw from the identified study: 1) the electric vehicle market is slowly evolving in rural regions; 2) providing equal access to electric vehicles in rural areas is crucial in the early stages of e-mobility; and 3) the extension of charging facilities is key to growing electric car adoption in rural regions. (Wappelhorst, 2021, 22-24).

Notwithstanding the provisions of the paragraphs above, EMOBICITY's partners have identified their 'low integration fields' in order to assess e-mobility's current status in these regions by characterizing them and identifying challenges and possible solutions to improve e-mobility.

1.1. Greece

1.1.1. Characterization of the low integration field

In Greece, the areas that are considered to be "low e-mobility integration fields" are mainly the rural mountainous areas and the small islands.

As a general description, about 20% of the total population of the country lives in rural areas, which are in many cases characterized by a mountainous terrain (80% of the total land is characterized as mountainous and semi-mountainous land).

Due to its geomorphological terrain, Greece has long distances between regions and thus requires an extensive charging network to support electric mobility for intercity transportation. The high level of urbanization creates the need for a more centralized approach in the development of the national EV charging network, for this to fit in with the urban transportation needs of Greek drivers.

Greece is also characterized by its insularity as there are about 117 inhabited islands. Of these, 79 have a population of over 100, while 53 of them have a population of over 1,000 people. Another important characteristic regarding Greek islands is that the Non-Interconnected Islands

market consists of 29 autonomous systems. Some of them consist of several islands (island clusters). As “Non-Interconnected Islands” (NIIs) we define the Greek islands where the Electricity Distribution Network is not connected to the Transmission System or the Distribution Network of the mainland. In almost all such Non-Interconnected Islands, the required energy on the island is produced from local oil-fired power stations, which is both expensive and a significant source of emissions and air pollutants. The lack of power interconnection with the mainland and of suitable energy storage means (e.g., battery storage or reverse hydro) does not allow for further penetration of renewable energy production on the islands, which could in turn be used for “clean” e-mobility.

As a result, the large majority of the public charging points and almost all high-power charging points are situated either in the big city centers or at the rest areas of the Greek motorways. The same applies in general for new vehicle registrations (either electric or conventional ones).

1.1.2. Challenges to overcome

The main challenges that low e-mobility integration fields are facing in Greece are:

- Inadequate charging infrastructure. Currently there are only a few public charging stations in these low integration areas. In addition to that, there are only a handful of fast charging stations on the islands (mainly on the largest Greek island – Crete) while on the rural mainland the only fast charging points available are at the rest areas of the closest motorway or big city.
- Initial cost of EV purchasing, which is still high relative to conventional vehicles even with the current subsidy scheme running in Greece (GO ELECTRIC) and other incentives.

1.1.3. Possible solutions/current projects/regulatory initiatives

Although there is a lack of public charging infrastructure in low e-mobility integration fields, there is greater flexibility in these areas regarding private charging (at home) since there are more detached houses than blocks of flats. Therefore, citizens in these areas should be encouraged to take advantage of this situation.

To overcome the obstacle of high cost of purchasing an EV, there is currently in Greece a subsidy scheme running (GO ELECTRIC), to promote the e-mobility uptake at a national level. Specifically for the islands, as low-integration fields and to further promote e-mobility, the scheme provides additional incentives i.e., the possibility for a legal entity to purchase up to 6 vehicles (instead of 3 vehicles for the rest of the country) and increased tax benefits (greater reduction of taxable income for legal entities that are participating in the scheme and are based on islands).

Regarding regulatory issues, it should be noted that it is expected within 2021 to have a detailed regulatory framework in Greece for energy storage systems. This framework will enable further penetration of renewable energy production and storage locally on the islands, providing clean energy for sustainable e-mobility uptake. Clean energy production and e-mobility usually operate in a complementary way as there is a need for clean energy to maximize the emission benefits of e-mobility while the e-mobility network may promote the functionality and stability of the electric network, through V2G interaction.

Another major program run by the national power transmission operator (IPTO) is the power interconnection of all islands with the mainland. This will again in return create more “space”

for the deployment of renewable energy sources production on the islands and rural areas and will further secure energy supply.

Furthermore, the national electricity distribution network operator (HEDNO) is running a major program on the upgrade of the electricity network to increase its capacity and allow for smarter monitoring. This program will enable the deployment of smart charging infrastructure on the non-interconnected islands and other low e-mobility integration areas.

Moreover, following the guidelines of the EU Green Deal, Greece has already developed its national Just Transition Plan to compensate for the transition from oil and coal fired power stations in specific rural areas and all non-interconnected islands to clean energy production. This plan foresees major investments in these areas that will promote, among others, the e-mobility uptake. Indicatively, in the current coal mining area of the Western Macedonia region, there is going to be a development of an industrial e-mobility park. This park foresees a plant for battery production and e-mobility chargers. Apart from the obvious advantage of promoting e-mobility at a national level, such initiatives are expected to make local citizens more familiar with e-mobility. Furthermore, through the relevant initiative GrecoIslands, many islands will be supported to deploy e-mobility, in accordance with their Just Transition pathways.

Notably, in Greece there are also several initiatives and projects running regarding the further uptake of e-mobility in low integration fields, i.e., small islands. One example is the project for the island of Astypalea, a collaboration between several stakeholders including the Greek Government and the Volkswagen Group, where the aim is to replace all conventional vehicles on the island with battery electric vehicles (BEVs). The required energy for charging the EVs will be produced exclusively from local RES, coupled with a Storage System. The program will be supported through a dedicated and generous subsidy scheme to achieve the aforementioned goals.

1.2. Portugal (Mainland)

1.2.1. Characterization of the low integration field

In Portugal (mainland) only 12% of the population inhabit areas considered as predominantly rural (National Statistics Institute, 2020). Rural areas can be defined as having a low population density and no cities of significant size within their boundaries, where agriculture plays an important role as a source of income. Nevertheless, rural tourism, small-scale industrial activities, residential economy (attracting retirees) and the production of renewable energy have recently gained a more relevant role in these areas.

In this sense, rural mobility has received far less attention from policymakers than urban mobility. There is a serious lack of public transportation systems, shared mobility options, integration of different modes of transport and even real-time information, which are common in urban areas. The reality for many rural areas is sparse buses, even fewer train stations and an almost total dependence on personal cars.

1.2.2. Challenges to overcome

According to Breuil (2016), the **barriers** for e-mobility introduction in rural contexts can be the same as those in urban ones, namely: vehicle costs (electric vehicles are more expensive than conventional ones, even with national subsidies), perceived autonomy, lack of specialized

vehicles (for professional use or adapted to rural areas), lack of information and lack of charging infrastructures.

The Portuguese reality in rural areas is not so different from this. In Portugal (mainland), there is evidence of a country divided between the coast and the inland (where rural areas are located). Inland areas do not have as many charging points available, relative to the coast. In certain areas, the lack of service stations is particularly critical, failing to provide confidence or tranquility to those who already have an EV or intend to acquire one. In this sense, the **expansion of the charging infrastructure** is particularly important to help overcome barriers such as range anxiety. Finally, challenges arising from vehicle costs and lack of information should not be particularly addressed focusing only on rural e-mobility, as they can be observed across the entire country.

1.2.3. Possible solutions/current projects/regulatory initiatives

There is a significant opportunity to electrify the passenger car fleet in rural regions, as dependency on personal cars is much higher due to a less comprehensive public transport system, compared to urban regions. In contexts of low population density such as rural areas, e-mobility stands out. Recognizing its vast potential, it seems pertinent to promote massification in commuting dynamics. The strategy can involve the **expansion of the fast-charging network in municipality centers**, as well as in the main inter-municipal axes. Furthermore, by reducing the operating costs of individual transport, e-mobility can contribute to the competitiveness of peripheral territories and to a strong increase in mobility.

Additionally, public transport cannot effectively cover all needs in rural areas. In fact, public transport operates with close to no regard to the actual demand in these areas and it is often directed exclusively towards students, leading to an inadequate service for a significant portion of the population. In these circumstances, any attempt to increase the coverage of the network is always associated with low demand rates, minimizing the profitability of the system. Therefore, the **creation of a public transport network "on demand"** through **e-buses** especially adapted to low-density territories could be a solution.

Furthermore, as stated by Breuil (2016), the main **drivers** to adopt e-mobility can also be set as: "lead by example" strategies (where local politicians or public bodies use EVs in their fleets), dissemination and information campaigns (in the form of test drives or public awareness campaigns that should be well adapted to the context) and the proposal of multimodality and intermodality new visions – interlinking personal transport (e-bikes and e-vehicles) with public transport (e-buses).

Regarding specific regulatory initiatives, in Portugal (mainland) there are several support programs set in place, specifically directed towards rural development, that could support e-mobility integration, namely the Regional Operational Programs and the Rural Development Program. The Economic and Social Stabilization Program is also promoting the expansion of the charging network through the deployment of ultra-fast chargers for e-vehicles. Furthermore, the Environmental Fund supports the purchase of e-vehicles and e-bikes through a subvention system, that is launched every year.

1.3. Portugal (Azores)

1.3.1. Characterization of the low integration field

According to the Plan for Electric Mobility in the Azores (PMEA), the Autonomous Region of the Azores gathers the perfect conditions for the implementation of electric mobility. This is mostly due to the small dimensions of the islands and the short daily commutes, together with the growing autonomy of electric vehicles.

In addition to that, the expansion of electric mobility comes as an advantage to the integration and optimisation of energy produced from renewable energy sources.

According to the data relating to 2020, the production of electricity in the Azores has not varied significantly between the years of 2012 and 2019 (Fig. 1). There is a slight decrease in the year of 2020, resulting from the pandemic situation. In addition to that, this production is mostly secured by fossil sources, through thermoelectric centrals that run on heavy oil (bigger dimensions) and diesel (smaller dimensions), representing around 60% of production.

After that, electricity is mostly produced through renewable energy sources, representing around 40% (ktep) of the total produced in 2020. This was made possible especially due to geothermal power plants and wind farms in the Azores, which combined produced 16.6ktep and 6.2ktep respectively, resulting in lower emissions of CO_2 – from 512gCO_2 eq/kWh in 2016 to 504gCO_2 eq/kWh in 2019 (EDA).

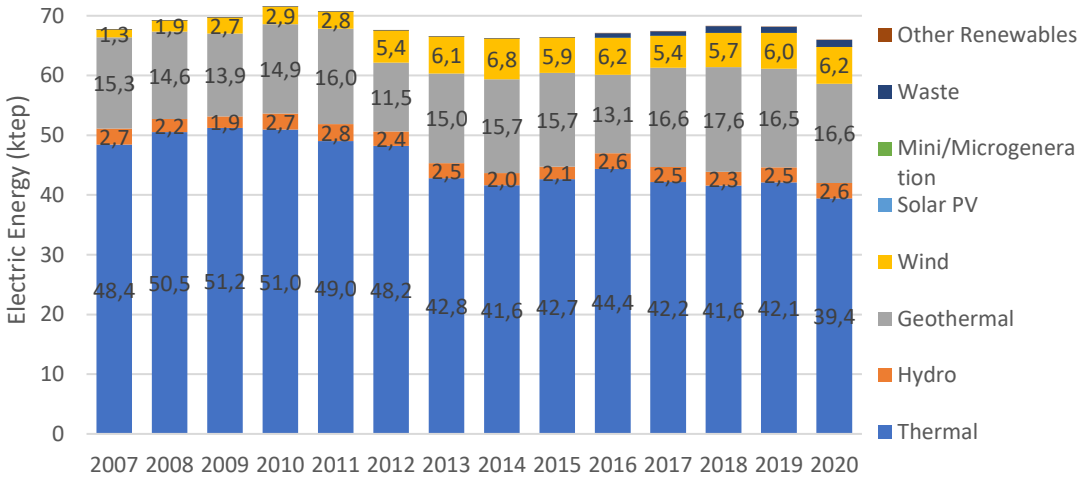


Figure 2: Production of electric energy in the Azores (ktep) (Source: EDA)

When it comes to final energy consumption (Fig. 2), land transport stands out as one of the main consumption sectors, with a more or less stable energy consumption throughout the last couple of years. As described in PMEA, this can be partly explained due to the fact that personal use cars continue to be the main land transport vehicle among citizens in the Autonomous Region of the Azores. According to the National Institute of Statistics (INE), 43% of the population travels by car as a driver, while 21% travels by car as a passenger. The same study also points out that around 18% of the population travels by walking while only 10% travels by bus.

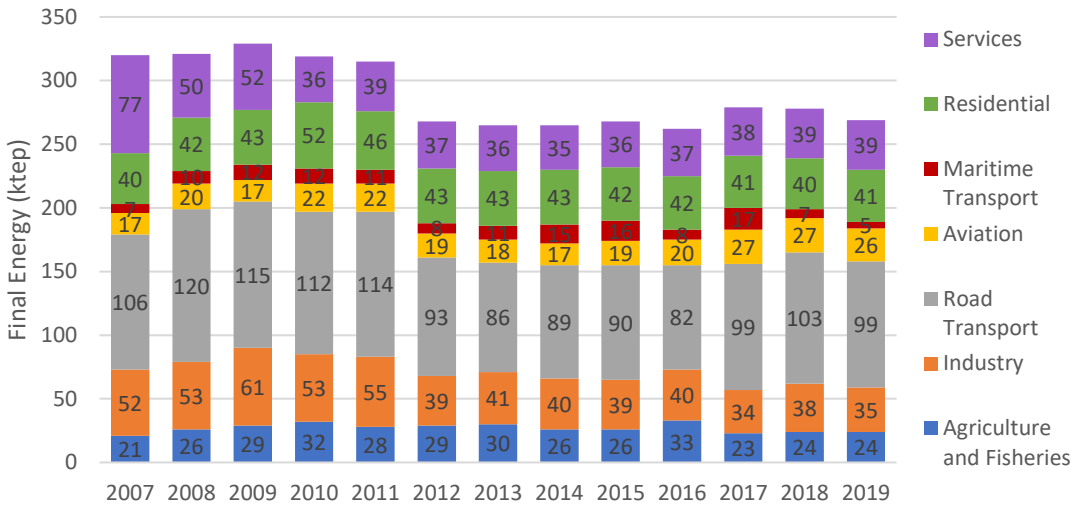


Figure 3: Consumption of energy (ktep) per sector in the Azores (Source: DGEG)

It should be noted that there has been a consistent increase in the number of vehicles in circulation in the Azores between 2015 and 2019 (Fig. 3). In 2019, there was a total of 161 767 vehicles, with the majority of them allocated to São Miguel Island, followed by Terceira and Faial.

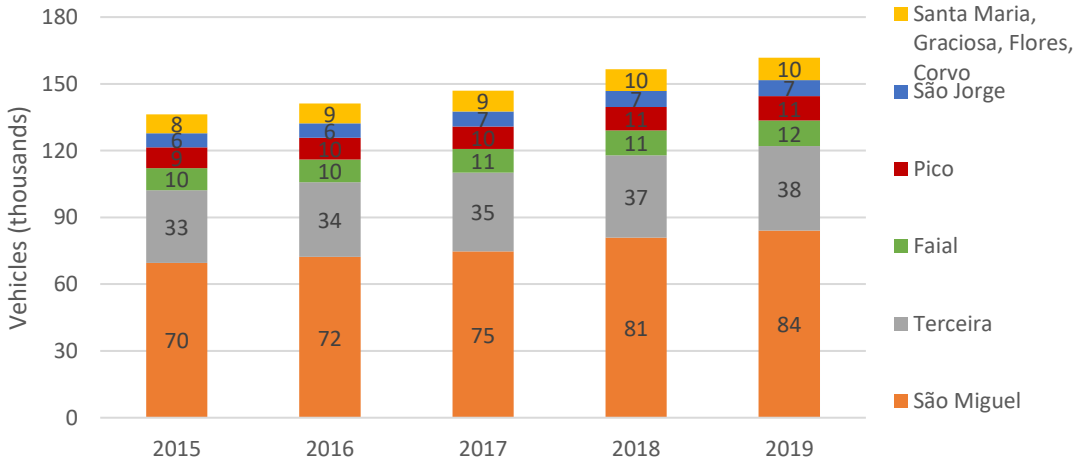


Figure 4: Number of Vehicles (thousands) by Azorean island (Source: ASF)

When we consider the type of vehicles purchased in the archipelago (Fig. 4), on average, internal combustion vehicles represented around 96% of vehicles purchased between 2015 and 2020. However, there has been a gradual increase on the purchase of electric vehicles. In 2020, new electric vehicles represented 4% of vehicles bought in the Azores, relative to the 1% purchased in 2015, as mentioned in a study carried by the Regional Service of Statistics of the Azores (SREA).

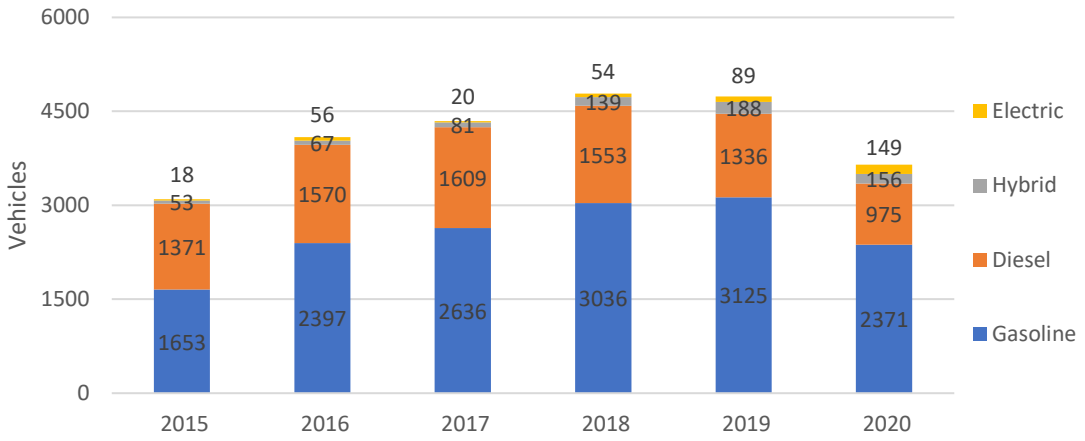


Figure 5: New vehicles purchased in the Azores per type of engine (Source: SREA)

This increase in the purchase of new electric vehicles is due not only to the increasing variety of electric vehicles available for purchase, but also due to the implementation of the system of incentives for the purchase of electric vehicles available since 2020. It can also be a result of the expanding public network of charging stations in the Azores.

1.3.2. Challenges to overcome

The transition from internal combustion engine vehicles to electric vehicles is of great importance. Not only do these zero emission vehicles contribute towards reducing the emission of greenhouse gases, but also stimulate the use of renewable energy sources and their integration into the electroproduction system.

Even so, there are several barriers to overcome. The costly initial investment in electric vehicles continues to be a challenge when implementing e-mobility, not only for individuals/families, but also for companies, despite the incentive systems already in place. In addition to that, economic and social/cultural obstacles need to be tackled. These problems come in the form of low-income households/individuals, as well as the lack of information regarding EV autonomy. Apart from that, the charging infrastructure is of great importance in the Azores, especially in residential areas, as it is estimated that only about 40% of residencies have an allocated parking space. Lastly, there is still a lack of information regarding the current situation of e-mobility in the Azores (e.g.: the exact number of electric vehicles in circulation). This presents a considerable setback as the only data available is regarding the number of new EV.

Nevertheless, progress in order to promote electric mobility in the Azores is being done. The Azorean archipelago has been working on several initiatives that include financial support for the purchase of electric vehicles, awareness campaigns and expanding the public network of charging stations, in coordination with municipalities, public entities, companies and organisations.

1.3.3. Possible solutions/current projects/regulatory initiatives

PMEA presents a number of measures to promote electric mobility that take into account both financial and non-financial incentives. Financial incentives include a system of incentives implemented by the Government of the Azores, through the Regional Decree-Law 4/2021/A.

These incentives are available for both natural and artificial persons, so as to ease the financial challenge that comes when first purchasing an electric vehicle.

As for non-financial incentives, these include the gradual expansion of the public network of charging stations in strategic locations, so as to disseminate this technology and encourage potential new electric vehicle users. As of right now, all islands and municipalities in the Azores are covered by at least one charging station.

In addition to that, the Government of the Azores has also been holding awareness campaigns that stress the environmental and financial advantages that come with the use of electric vehicles. These campaigns bring together mainstream and social media, as well as companies, schools, the hospitality sector and industry in general.

As for the projects currently underway in the archipelago, as established in PMEA, Graciosa has been chosen as the Model Island for the promotion of innovative solutions regarding electric mobility. The Graciólica project has allowed for over 60% of renewable energy integration. This private project consists in a hybrid production unit, relying on wind and solar power, together with an innovative energy storage system, that can supply the island with over 24-hour consecutive periods of electric energy.

In order to take maximum advantage of the clean energy coming from this project, the Government of the Azores has been working towards promoting Graciosa as a Model Island through a number of measures and initiatives, namely:

- The system of incentives for the purchase of electric vehicles has come to include rent-a-cars and taxi companies in the island of Graciosa.
- Together with the Municipality of Santa Cruz, the Government of the Azores has acquired an electric minibus that will allow citizens to opt for public transportation while contributing towards the decarbonisation of the island.
- At the moment, an electric bike sharing system is in the final stages of development. It will allow both locals and tourists to ride electric bikes through the streets of Graciosa.
- Lastly, the Government of the Azores has been optimising its fleet through prioritising electric vehicles over internal combustion ones and through the management of an organised sharing system.

Graciosa is leading the way in the decarbonisation of the Azores, tackling land transport, citizen self-consumption and optimisation of the electric grid. A model to be implemented on the other islands of the archipelago.

The Island of São Miguel is also the focus of an innovative pilot project named Vehicle-to-Grid (V2G) that aims to develop the technology related to intelligent grids, through a bidirectional interaction between electric vehicle batteries and the public electricity grid. This will allow electric vehicles to contribute towards the electricity grid, no longer relying on it exclusively for self-consumption. This project will showcase how V2G technology can support the electricity system, promoting its efficiency and supporting both electric vehicle users as well as the electricity grid operator, contributing towards the implementation of national decrees that will define the future of the V2G business model.

1.4. Germany

1.4.1. Characterization of the low integration field

Around 90% of Germany's land area is rural. More than half of Germany's inhabitants live in villages, communities and small towns in rural areas. Rural areas can be defined in terms of a low population density. In Germany, rural areas can also be characterized by larger residential plots, a distinctive landscape and recreational space, small and medium-sized economic structures, predominant agricultural and forestry land use, and long distances to major centers.

Where local transportation is limited to commuting to work and school, the population highly depends on personal cars. This poses particular problems for young people, those with limited mobility and those on low incomes. New trends have been creating more participation and offering new perspectives.

For most people in rural areas, mobility means driving a car. Almost two-thirds of all trips in rural areas are carried out by cars. If only commutes are taken into account, the figure rises to almost three-quarters. Only a good third of the rural population can reach the nearest major center within 30 minutes by bus or train – provided they run at the appropriate times. This is problematic for all those who are not yet allowed to drive their own vehicle or who can no longer do so, such as children, young people and the elderly. They usually have to rely on other people to drive them, resulting in dependency and additional stress for family members. The "parent cab" is in constant use in rural regions (Bundesministerium für Ernährung und Landwirtschaft [BMEL], 2021 p. 22).

In Germany, e-vehicles are driven in rural areas mainly by high-income households. The stock of electric cars in Germany is still small, but it is developing dynamically. The research department of Kreditanstalt für Wiederaufbau (KfW) announced on May 18, 2021, that in 2020, according to the Federal Motor Transport Authority, electric vehicles accounted for just under 14% of all new registrations – and the outlook continues to rise. According to a survey by KfW Research, 1.3% of households in Germany currently own a battery-electric car or a plug-in hybrid. Another 1.1% of households plan to use them within a year. At present, these numbers represent mainly high-income households in single or two-family homes. Electric cars also have a significantly above-average presence in rural regions (KfW, 2021).

1.4.2. Challenges to overcome

In rural regions, schools, workplaces, shopping facilities and doctors' offices are usually not within easy reach. At the same time, the cost of maintaining roads and the bus or rail network increases when communities and rural districts are sparsely populated or must contend with shrinking populations. In addition to that, the proportion of elderly people in rural areas is already higher and will continue to rise. Although they are much more mobile today than they were ten years ago, private motorized transport is not the only solution for everyone. This is also particularly true against the backdrop of climate protection (BMEL, 2021).

In North Hesse/Germany, the **barriers** for e-mobility introduction in a rural context are the same as in many other regions, namely:

- Vehicle costs – electric vehicles are still more expensive than conventional ones, even with national subventions.
- Perceived autonomy – range anxiety.

- Lack of specialised vehicles – vehicles for professional use or adapted to country trips.
- Lack of information – this can be changed with the promotion of e-vehicles test drives.
- Lack of charging infrastructures.

1.4.3. Possible solutions/current projects/regulatory initiatives

Many good ideas can improve mobility in rural areas. On-call buses and shared cabs can fill in where regular bus and rail services are not available. Neighbourhood assistance, citizen buses, local ridesharing centres or (e-)car sharing rely on local community spirit and volunteerism. In addition to that, fundamental considerations play an important role: how mobile do people need to be? Conversely, can goods, services and work become more mobile? Therefore, delivery services and the Internet are playing an increasingly important role. Working from home, online shopping, e-government, e-health and e-learning continue to grow. This means that some trips can be avoided, but not all of them can be made digitally (BMEL, 2020). In many cases, the introduction of sustainable electric vehicles could overcome the current challenges.

Various projects and subsidy-programs to adopt e-mobility are promising:

- A high subsidy for private e-vehicles (6000€ per car).
- Free parking for e-vehicles.
- Public authorities leading by example. For instance, local authorities, local politicians and public bodies using EVs in their fleets.
- Expansion of the EV public network of charging stations. Charging stations network for EV expansion.
- Dissemination and information campaigns to promote e-mobility – test drives or public awareness campaigns.

Germany wants to be a pioneer in the field of electric mobility, both as a lead provider and as a lead market. The Region of North Hesse is involved in several projects, such as OmniE, which aims to develop an ICT tool for fleet analysis for electric omnibuses.

The range of products offered by manufacturers, the promotion of electric mobility in Germany and perhaps also the discussion surrounding the emissions scandal (Dieselgate) have had a positive effect on the demand for e-cars. Nevertheless, the high acquisition costs, the lack of a charging station infrastructure that can be expanded and the short range of electric vehicles are certainly still a hurdle for some. The latter two points in particular are still seen as an exclusion criteria by some company fleets if the vehicle is to be used by field staff or service technicians for long distances. The automotive industry and policymakers must do more to increase the appeal of e-cars.

1.5. Romania

1.5.1. Characterization of the low integration field

In Romania the promotion of e-mobility is still in the early stages. There is a historical tradition for providing electric public transport in urban areas with trolley buses and trams. However, aside from these electric vehicles used by transport operators, the widespread deployment of EVs throughout the country has been limited.

Up until 2017, there were only 4 hybrid and electrical buses/minibuses registered in the country (National Statistics Institute, 2021). This number has been rapidly increasing, with 15 such

vehicles in 2018, 71 in 2019 and 335 in 2020, due to additional funding sources. Nevertheless, these 335 vehicles represent only 0.6% of the total, country wide, bus/minibus fleet.

Similarly, for personal cars, the number of EVs has increased significantly, due to incentives from recent years. In 2014, there were 2.737 EVs registered, while in 2019, the amount reached 29.244 (National Statistics Institute, 2021). However, these electric cars represent an insignificant percentage out of the total registered fleet of only 0.42%.

The charging infrastructure is important in supporting the use of electric vehicles and this was quite limited in Romania. In January 2017, there were only 113 charging stations in the country and the majority were installed in urban areas (EV Romania, 2017), making long distance travel challenging for EV owners. The total number of charging points rose to 242 by January 2019 (EV Romania, 2019), with some improvements to the territorial coverage.

In 2021, we can see part of the impact of having national policies to support the take-up of electric vehicles, even if the transition towards EVs is moving slowly. Therefore, within the scope of the project, the whole country is being considered as a low integration zone due to the overall limited use of electric or hybrid vehicles.

1.5.2. Challenges to overcome

The main challenges in increasing the share of e-mobility in Romania are related to:

- Electric vehicle costs – the acquisition cost for an electric vehicle is higher than the cost for their fossil fuel counterpart, even after taking advantage of all the available subsidies.
- EV charging network coverage – the extension of an available public network of charging station is important in Romania. Firstly, in order to support longer distance travel, and secondly due to the housing characteristics of the urban areas. A large part of the urban population lives in dens neighbourhoods, in high rises, and therefore would need to rely on a public network of charging stations.
- Limited local and regional policies to promote the adoption of EVs. The existing policies are developed at the country level and each local authority can choose how to take advantage of such policies and how to use the available funds, particularly for expanding the charging network or making changes to the public transport fleet.
- Limited capacity for the public sector in developing and implementing mature electro mobility projects at local level. This also extends to operations and management of implemented projects. Multiple charging stations are not yet in function because the power grid is not ready. While most local administrations have not yet come up with business plans to provide this service, charging is still free.

1.5.3. Possible solutions/current projects/regulatory initiatives

There have been several initiatives implemented in recent years which have already started to generate effects, such as:

- The Environment Fund, which provides the Rabla Plus subsidies for electric vehicles acquisition and dedicated subsidies for installing charging stations. The effects of the fund can be seen in the EV increase in recent years. An important outcome is the high increase in charging stations and the improvement of the territorial coverage. In the last

year, the number of charging stations has skyrocketed with a 44% increase, from 542 locations in August 2020, to 782 locations in April 2021 (Lektri.co, 2021). The current coverage includes more urban areas, but also rural areas (especially with touristic potential and along national roads).

- The Regional Operational Program 2014–2020, which provided funds for local authorities and public transport operators for upgrading their fleet to electric vehicles and the installation of charging stations for public transport. Furthermore, local authorities are eligible to install charging stations in their cities for the general public.

Additionally, some local authorities are starting to introduce restrictions and incentives to further support the adoption of EVs. The effects of these actions are not yet apparent:

- The Bucharest municipality supports the installation of charging stations in commercial and office buildings, which have more than 100 parking spaces. A General Council Decree has been in force since 2017, introducing fines for the aforementioned buildings that do not have charging stations installed.
- The Cluj-Napoca municipality amended the approach for street refurbishment projects, ensuring that charging stations will be installed during the refurbishment work. In addition to that, they have started to encourage taxi operators to upgrade their fleets to EVs, by limiting all new taxi authorisation to the use of EVs.
- Similarly, the Zalău municipality is working to incentivise the uptake of EVs for taxi operators, by offering better evaluation conditions for EVs compared to fossil fuel vehicles, when applying for a licence. Meanwhile, Cluj-Napoca is giving new taxi permits only to electric or hybrid vehicles.
- Several cities (e.g., Constanța) do not charge parking for EV users.
- Low emission zones might also help to hasten the uptake of electric vehicles. However, no such measures have been implemented so far in Romania. Although Bucharest started working on this approach, after a popular vote on social media the administration stopped the implementation.

1.6. Croatia

1.6.1. Characterization of the low integration field

As there is no single register of charging stations for electric vehicles in the Republic of Croatia, the analysis of the number of charging stations is based on estimates, mainly based on data and maps published by stakeholders or on online platforms.

It can be assessed that, as of two years ago, the public available EV charging infrastructure was lacking considering the number of electric vehicles. However, the strong expansion of charging stations in that period, especially encouraged by the use of EU funding for investments in such projects, lead to a relatively good ratio of EV charging stations (about 12 vehicles per charging station). Even so, despite good accessibility in some urban areas and sections of the highways, there is still some territory with poor coverage of charging stations, which proves to be a big barrier for EV users, especially for those with a shorter range with a single battery charge.

As one of the Mediterranean countries in which tourism is one of the most important economic branches, the development of e-mobility in Croatia should also be viewed in this, considering its popularity as a car destination for visitors of many EU and foreign countries.

When analysing the existing infrastructure, it can be concluded that the Croatian coast is very well covered by public available infrastructure for charging electric vehicles.

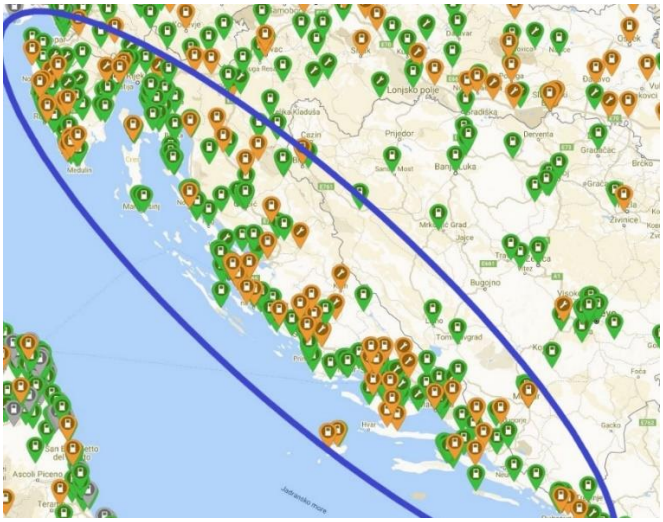
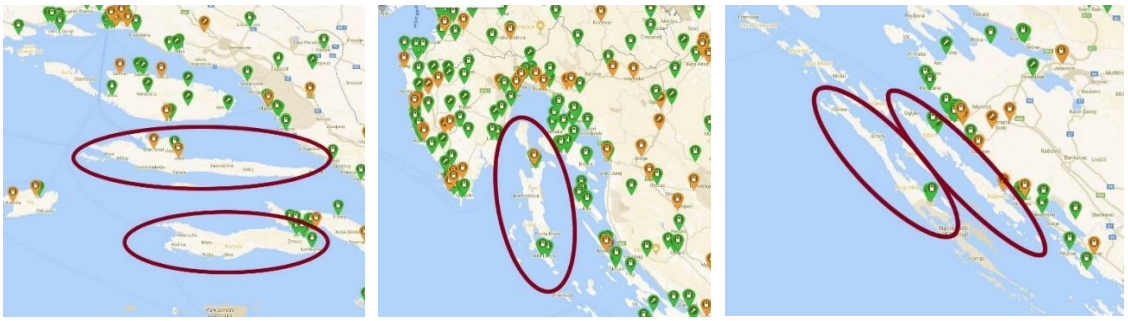


Figure 6: Croatian coast - EV charging infrastructure coverage (Source: plugshare.com)

In Croatia, the Dalmatian Coast is composed of more than a thousand islands, with 48 of them being inhabited. The islands are very popular destinations for tourists, and most can be reached by ferry lines that can also transport vehicles.

Despite the good availability on the coast, the EV charging infrastructure is poorly accessible on most islands. This is certainly not encouraging for visitors choosing to stay on these islands, as they are not able to make full use of their EV. Simultaneously, residents are discouraged from transitioning to electric vehicles.



Hvar and Korčula *Cres and Lošinj* *Dugi otok, Ugljan and Pašman*

Figure 7: Low integration fields - Croatian islands

Therefore, it can be concluded that the Croatian Islands can be considered as "low integration fields" in terms of the development of e-mobility, lagging behind the rest of the country.

1.6.2. Challenges to overcome

Improvement of incentive policy schemes

The existing system of e-mobility incentives has played an important role so far in initiating and creating the beginnings of the e-mobility market and a special contribution can be assessed in

the form of promoting e-mobility and placing this topic in the public space. However, the current situation and trends indicate that the current incentive system is not enough and needs to be improved. This includes reviewing what needs to be co-financed, analysing the need to expand the subject of the incentives, reviewing the amounts of the incentives, improving the operational implementation of the allocation of funds and finding a way to reach a wider range of beneficiaries.

Awareness of e-mobility

Lack of information and insufficient knowledge of all the elements that make up e-mobility on the part of the local and regional communities. This can slow down the development of e-mobility in certain areas.

1.6.3. Possible solutions/current projects/regulatory initiatives

Some of the main guidelines for improving the incentive system in Croatia are:

- Continuity and improvement of operational implementation of co-financing.
- Revision of the amount of incentives for the purchase of electric vehicles.
- Co-financing of the cost of connection to the distribution network.

However, in the context of e-mobility development in "low integration fields", **co-financing of infrastructure depending on the zones** should be implemented. Namely, from the analysis of the current situation, it can be concluded that, in future public calls for co-financing the installation of charging stations, it is desirable to define zones for how different amounts of co-financing will be applied, in order to encourage a balanced development of charging infrastructure in all parts of Croatia.

Furthermore, it is necessary to focus more and more on the development of destination charging infrastructure. In low integration fields, the problem is not the infrastructure that enables transit, but the need for as many chargers as possible, which will be widely available.

An additional activity for the development of e-mobility in low integration fields, and perhaps crucial, is to educate and inform all stakeholders about the benefits that the development and application of e-mobility can bring to their region and to the quality of their lives. It is necessary to conduct designed campaigns for each target group, such as restaurants, hoteliers, private accommodation renters, private companies and all potential users of electric vehicles.

These actions and measures, other than at the national level, can and should be introduced and implemented at the regional or local level. This can be done by incorporating such measures into local energy efficiency action plans.

2. A Comparative Analysis of the E-mobility in Low Integration Field of selected countries/regions

Electric mobility in low integration fields is still a challenging issue in the selected countries and regions. Although commitment and significant steps are being made towards the implementation of electric mobility, some challenges can still be identified.

One of the elements pointed out by all selected countries/regions is the disparity between urban and rural areas and islands. For instance, **Greece**, due to its geomorphological terrain, presents long distances between regions and thus requires an extensive range for their charging network to support e-mobility for intercity transportation. **Portugal (mainland)** states that only 12% of the population inhabit in rural areas, so rural mobility has received less attention from policymakers relative to urban mobility. The **Azorean archipelago** gathers the perfect conditions for the implementation of electric mobility due to the small dimensions of the islands and the short daily commutes. Nevertheless, internal combustion vehicles represented around 96% of vehicles purchased between 2015 and 2020. Even so, there has been a gradual increase on the purchase of new electric vehicles (i.e., in 2020, electric vehicles represented 4% of new vehicles bought in the Azores). For its part, Germany characterises 90% of the country as being rural land. In these areas, the population still highly relies on personal vehicles. Even so, in 2020, electric vehicles accounted for just under 14% of all cars purchased in the country, a number that they expect to surpass in the coming years. The promotion of e-mobility in **Romania** is still in its early stages. However, the number of electric vehicles has significantly increased in recent years due to incentives, supported by the impact of national policies. Finally, **Croatia** focuses on the importance of public EV charging stations network to the promotion of electric vehicles. Despite a good coverage of the coast, the EV charging infrastructure is poorly accessible on most islands.

There is a shared understanding regarding the challenges between the selected countries/regions, underlining the inadequate charging infrastructure and the high initial cost for the purchase of electric vehicles as the two main challenges. Regarding the latter one, EVs are still more expensive than conventional ones, albeit national/regional subventions. Lack of information was also identified as a major obstacle, bearing in mind that the population still points out the perceived autonomy of electric vehicles as matter inflicting range anxiety.

Finding solutions is key to promote e-mobility. While there is still a long way to go, there is a strong commitment for e-mobility implementation across Europe. **Greece** points out several initiatives, such as an incentive scheme (GO ELECTRIC), the progress in regulatory framework as well as national plans and program. **Portugal (mainland)** focuses on the importance of public authorities leading by example, for instance, through the electrification of their fleet. Besides that, the need for a reliable charging stations network and an interesting view about multimodality and intermodality are also included. Lastly, there are several Portuguese support programs that promote e-mobility. **Portugal (Azores)** focuses on financial and non-financial incentives: the system of incentives available for both natural and artificial persons is just as important as the gradual expansion of the public network of charging stations in strategic locations. In addition to that, the Azores has been holding awareness campaigns that stress the environmental and financial advantages that come with the use of EVs among regional

stakeholders. Lastly, **Portugal (Azores)** identified its initiative 'Graciosa–Model Island' as a crucial for the promotion of innovative solutions regarding e-mobility, incorporating several projects. **Germany**, for its part, shares the views above (incentives schemes, charging stations for EV expansion and dissemination campaigns), adding that free parking for electric vehicles could increase e-mobility. **Germany** declares that in their pursue to be a pioneer in e-mobility field, both as lead provider and lead market, the automotive industry and policymakers are key to boost e-mobility across the country. **Romania** also focuses on the importance of financial incentives through national programs, and identifies local policies that are expected to have a significant impact on the promotion of e-mobility. For instance, by supporting the installation of charging stations in commercial and office buildings or by limiting all new taxi authorisation only to electric/hybrid vehicles. **Croatia** states that co-financing the cost of connection to the distribution network and revising the financial incentives currently in place would be a great step towards the integration of e-mobility. Within the context of e-mobility in low integration fields, education and information are key among stakeholders.

Lastly, the importance of the Vehicle-to-Grid (V2G) is rightly mentioned by **Greece** and **Portugal (Azores)**, as it aims to develop the technology related to intelligent grids, through a bidirectional interaction between electric vehicle batteries and the public electricity grid. This will allow electric vehicles to contribute towards a greater capacity and stability of the electricity grid, which will enable further penetration of e-mobility.

3. List of Figures

Figure 1: Average market share of electric passenger car registration shares by country and territorial typology (urban, intermediate, rural) in 2019. (Wappelhorst, 2021, 3) 3
Figure 2: Production of electric energy in the Azores (ktep) (Source: EDA) 7
Figure 3: Consumption of energy (ktep) per sector in the Azores (Source: DGEG) 8
Figure 4: Number of Vehicles (thousands) by Azorean island (Source: ASF) 8
Figure 5: New vehicles purchased in the Azores per type of engine (Source: SREA) 9
Figure 6: Croatian coast - EV charging infrastructure coverage (Source: plugshare.com) 15
Figure 7: Low integration fields - Croatian islands 15

4. References

Wappelhorst, S. (2021). Beyond major cities: analysis of electric passenger car uptake in European rural regions. The International Council on Clean Transportation. Working Paper 2021-10. Retrieved from: https://theicct.org/sites/default/files/publications/Ev-europe-rural-mar2021.pdf

Greece

Regulatory Authority for Energy (2021). Non-Interconnected Islands. Retrieved from: https://www.rae.gr/non-interconnected-islands/?lang=en

Germany

Bundesministerium für Ernährung und Landwirtschaft [BMEL] (2021). Ländliche Regionen verstehen - Fakten und Hintergründe zum Leben und Arbeiten in ländlichen Regionen. Retrieved from: https://www.bmel.de/SharedDocs/Downloads/DE/Broschueren/LaendlicheRegionen-verstehen.pdf?__blob=publicationFile&v=12

Kreditanstalt für Wiederaufbau [KfW] (2021). Elektroautos werden aktuell vor allem von einkommensstarken Haushalten und in ländlichen Regionen genutzt. Retrieved from: https://www.kfw.de/KfW-Konzern/Newsroom/Aktuelles/Pressemitteilungen-Details_651072.html

Portugal (Mainland)

Instituto Nacional de Estatística (2020). População residente (N.º) por Local de residência (NUTS - 2013), Sexo e Tipologia de áreas urbanas; Anual. Data update: July 19th, 2021. Retrieved from: https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_indicadores&indOcorrCod=0008856&contexto=bd&selTab=tab2&xlang=pt

Breuil, D., Khafallah, M. e Hassoune, A. (2016). Electromobility in Rural and Peri Urban Areas. International Conference on Traffic and Transport Engineering – Belgrade, November 24-25, 2016. P. 767.

TRENMO (2018). Plano de Ação de Mobilidade Urbana Sustentável (PAMUS) na Comunidade Intermunicipal da Região de Coimbra. Atualização do PAMUS de Fevereiro de 2016.

International Council on Clean Transportation (2021). Beyond major cities: Analysis of electric passenger car uptake in European rural regions. Working Paper 2021-10.

Portugal (Azores)

Autoridade de Supervisão de Seguros e Fundos de Pensões (2021). Parque automóvel seguro. Retrieved from: https://www.asf.com.pt/NR/exeres/7D383D46-9431-416E-98C7-395B0A9E7080.htm

Direção-Geral de Energia e Geologia (2021). Balanços Energéticos da Região Autónoma dos Açores. Retrieved from: https://www.dgeg.gov.pt/pt/estatistica/energia/balancos-energeticos/balancos-energeticos-da-regiao-autonoma-dos-acores/

Eletricidade dos Açores, SA (2021). Produção e Consumo. Retrieved from: https://www.eda.pt/Mediateca/Publicacoes/Producao/Paginas/default.aspx

Região Autónoma dos Açores (2018). Plano para a Mobilidade Elétrica nos Açores. Retrieved from: https://portaldaenergia.azores.gov.pt/portal/Portals/0/Documentos/ME/PMEA.pdf?ver=2019-10-04-134500-553

Serviço Regional de Estatística dos Açores (2021). Automóveis novos vendidos nos Açores, por tipo de combustível/elétricos e por mês. Retrieved from: https://srea.azores.gov.pt/ReportServer/Pages/ReportViewer.aspx?%2fRelatoriosVarios%2fComercio+-+Automoveis+por+combustivel

Romania

EV Romania (2017). Dinamica dezvoltarii infrastructurii statiilor de incarcare pentru vehiculele electrice in Romania in primele 6 luni ale 2017. Retrieved from: https://www.evromania.ro/2017/09/17/dinamica-dezvoltarii-infrastructurii-statiilor-de-incarcare-pentru-vehiculele-electrice-in-romania-in-primele-6-luni-ale-2017/

EV Romania (2019). % Crestere nr. statii de incarcare ptr VE in Romania in ultimele 6 luni 2018. Retrieved from: https://www.evromania.ro/2019/01/28/crestere-nr-statii-de-incarcare-ptr-ve-in-romania-in-ultimele-6-luni-2018/

Lektri.co (2021). Studiu PlugShare: Locațiile EV au crescut cu 44% în aprilie 2021. Retrieved from: https://lektri.co/ro/studiu-plugshare-locatiile-ev-au-crescut-cu-44-de-procente-in-aprilie-2021/