

# A comparative gap analysis for electromobility and alternative fuels

Foteini Orfanou<sup>1</sup>[0000-0002-3503-592X], Panagiotis Papantoniou<sup>1</sup>[0000-0003-2503-009X], Eleni Vlahogianni<sup>1</sup>[0000-0002-2423-5475] and George Yannis<sup>1</sup>[0000-0002-2196-2335]

<sup>1</sup> National Technical University of Athens, 5 Iroon Polytechniou, 15773, Athens, Greece  
forfanou;ppapant;elenivl;geyannis@central.ntua.gr

**Abstract.** Electromobility and alternative fuels are considered as key solutions towards the reduction of emissions and energy savings in order to achieve more sustainable and environmentally friendly transportation systems. European countries are trying to achieve significant progress in promoting these new technologies in order to ensure better life and air quality for their residents. However, the number of electric vehicles is still low and not all European cities have made worth mentioning progress towards this direction. The objective of this research is to identify the gaps hindering the promotion of electromobility and alternative fuels in 9 European regions from 8 European countries: Italy, Slovenia, Greece, Finland, Norway, Latvia, Belgium and Romania. The analysis is focusing on three thematic areas: Business, Governance and Research and Innovation Strategies for Smart Specialization (RIS3) and each area is divided in various aspects such as charging Infrastructure, e-Vehicle fleet, incentives, technology, campaigns, legislation, enforcement, education, research and Innovation. The analysis is based on estimating the progress achieved in each aspect using a scale from 1 to 10 (10 indicates the highest level of performance and level 1 the lowest). Results indicate that there are regions with significant progress in the field of electromobility and others that still should elaborate a lot to increase their performance in most of the analyzed aspects. The findings assessment will help policy makers to prioritize their effort on the areas that have the highest gap until the desired level in electromobility is achieved and identify other regions with similar electromobility issues.

**Keywords:** Gap analysis, electromobility, alternative fuels, European regions.

## 1 Introduction

Electric vehicles and other alternative fuel vehicles are promising alternatives to reduce CO<sub>2</sub> emissions providing better air quality for the city residents and the road users as well as increasing energy efficiency. Additionally, electric vehicles are more quiet than conventional cars and even silent in low speeds improving life quality and reducing noise levels. This advantage of electric vehicles has also psychological benefits for the drivers, passengers and other road users as the noise reduction or absence brings about less anxiety, less frustration and better and potentially less aggressive driving behavior. Production, sale and use of electric cars has already started in the European Region and

their penetration rate is being slowly increased during the last years [1]. More specifically, the biggest increase since 2008 occurred in 2017, when the sales of the battery electric vehicles (BEV) increased by almost 50% compared to 2016 while for plug in hybrid electric vehicles the corresponding increase was 35% for the same time period (Europe Environment Agency, 2018). Concerning registrations of these two types of electric vehicles in the European region, they consist 0.7% of the total number cars. Despite their advantages, the number of electric vehicles in Europe is still limited and various measures are taken by the EU members for increasing the fleet of the eco-friendly cars [2]. 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 [3,4].

The increase of the number of electric vehicles is a major target of the European Union within the framework of more environmentally friendly, cleaner and greener transportation systems. Forecasts made by the International Energy Agency support that the share of EVs in the European region can be up to 23% in 2030 concerning all road transport vehicles except of two and three wheelers. Additionally, the White Paper on Transport sets the aim of reducing CO<sub>2</sub> emissions in transportation by 60% by 2050 [5]. Achieving this target means formulation of a concrete methodology in local, regional or national level for effectively developing actions favoring the promotion of the new technologies. This methodology includes the analysis of the current situation in terms of electromobility and alternative fuels diffusion, a GAP and SWOT analysis as well as formulation of recommendations for promoting the sustainable technologies.

The objective of this research is presenting the results of the GAP analysis conducted in 9 European Regions concerning electromobility and alternative fuels. Gaps will be detected in order to identify the progress achieved as well as reveal and clarify the fields need to be further enforced. Three thematic areas have been selected and consist the basis for the GAP analysis: business, governance and Research and Innovation Strategies for Smart Specialization (RIS3). For each thematic area individual specific indicators are defined and evaluated for each region using a scale from 1 to 10. Finally, the results of the analysis for each region will be compared in order to reveal similarities along with differences among them. The paper is organized as follows: section 2 includes the description of the thematic areas and their indicators, section 3 the results of the GAP analysis while in section 4 conclusions are summarized and presented.

## **2 Methodology**

### **2.1 Gap Analysis**

Gap Analysis is conducted in order to reveal the current situation and the deficiencies prevailing in a specific sector or field. It gives an overview about the progress that has been achieved and whether the goals defined have been fulfilled. Through the gap analysis the deviation between the current and the target status is defined and clarified enabling the formulation and set of the next steps and actions that should be planned and

implemented in towards the goal satisfaction. In the present study, nine European Regions are analyzed and for each one a gap analysis was conducted where the three thematic areas (business, governance and RIS3) were evaluated. The nine European Regions are: Province of Brescia (Italy), Calabria region (Italy), Regional Development Agency of Gorenjska (Slovenia), Region of Attica (Greece), Flemish Government Department Environment (Belgium), Regional Council of Kainuu (Finland), Rogaland County Council (Norway), Bucharest-Ilfov Regional Development Agency (Romania) and Zemgale Planning Region (Latvia). Each of the three thematic fields was subdivided in various aspects and each one was evaluated on a scale from level 1 to 10. Level 10 indicates the highest level of performance or implementation and level 1 the lowest. For the evaluation of these indicators a group of stakeholders was formulated in each project partner region. The stakeholders are experts with deep knowledge in the field of electromobility and alternative fuels working in the industry, in the infrastructure and (public) service, regional public authorities, in business association and in the academia/research. This particular synthesis of the stakeholder group allows the more objective evaluation of the individual indicators.

## 2.2 Thematic Areas

The three thematic areas are defined below (Tables 1-3):

- Business: Market take-up of sustainable mobility from alternative fuels
- Governance: Needs, requirements and policies to enhance sustainable mobility from e-mobility and alternative fuels
- Research and Innovation Strategies for Smart Specialization (RIS3): e-mobility in relation to RIS3 Smart Specialization Strategy documents

### Thematic Area 1: Business

Electric vehicles can offer significant economic and environmental advantages as they are expected to have reduced maintenance and operational costs as well as zero CO2 emissions and reduced to zero level of noise in very low speeds. Business is one of the main areas that will play important role in the diffusion of electromobility and alternative fuels.

**Table 1.** Aspects of the thematic area Business.

Business Aspect	Description
Charging Infrastructure	Available charging stations already installed in the Region
e-Vehicle fleet	Number of electric vehicles in the Region
AF vehicles fleet	Number of vehicles using Alternative fuels in the Region
Technology	Existence of the available technology to support the use of electric and Alternative fuels vehicles.
Incentives	Given to the industry/companies in order to motivate and encourage them to be involved in these aspects.
Campaigns	Campaigns organized by the industry and the private sector for raising public awareness about electromobility and Alternative fuels

Incentives should be given to industry and enterprises in order to be involved in this field and contribute in promoting electric vehicle, enhance their characteristics and performance and increase user acceptance and willingness to use them. Market take up means how many people will shift from diesel and conventional vehicles to electric and alternative fuel ones and therefore the target is to achieve a continuous higher percentage. Additionally, business could also significant contribute in the necessary infrastructure, required for the easier and more comfortable use of electric vehicles. Joint investment programs should be proposed in order to establish an efficient and publicly accessible charging network.

### **Thematic Area 2: Governance**

It is significant that the people ruling a municipality, a region or a country are interested in transforming the prevailing transportation system into a more sustainable and environmental friendly one aiming at improving air and life quality of the residents as well as creating healthier conditions during the fulfilment of their transportation needs. Policies to expand the use of electric mobility and formulation and adoption of the appropriate legislation framework favoring and encouraging the use and purchase of electric vehicles is the first step for increasing users' willingness to use vehicles being equipped with this new technology. Public authorities and the state should take care of the establishment of a privately and publicly accessible charging infrastructure which is considered as a significant measure for adopting the use of EVs [6]. The charging network enables electric vehicle users to move within and outside of the city easily and more comfortable without anxiety and frustration about where to charge their cars if necessary.

**Table 2.** Aspects of the thematic area Governance.

Governance Aspect	Description
Legislation	The existing legal framework and policies established favoring the use and purchase of electric vehicles
Enforcement	Enforcement of regulatory changes, laws, directives and standards for the promotion of electromobility and increase of the share of electric
Education	Inform students about the advantage of electromobility and alternative fuels. Incorporation of electromobility sessions and courses in the rele-
Incentives	Incentives given to the private and public sector by the state and the public authorities
Campaigns	Campaigns organized by public authorities, regions and municipalities for raising public awareness about electromobility and alternative fuels.

Moreover, the creation of a fast charging station network within the country will also encourage tourists to visit the country with their electric vehicles and should also be a priority for the state. These actions along with the efficient improvements and upgrades of the infrastructure requires the strong cooperation between governance and business and support of the entrepreneurial decision of integrated e-mobility productions. Funding is also an important issue concerning actions about promoting electromobility and alternative fuels like research and innovation activities as it will be further described in

the next section (Thematic Area 3: RIS3). Finally, communication strategies including information and education campaigns organized by public authorities, regions and municipalities brings about raise in public awareness about electromobility and alternative fuels as potential users may have an incomplete or distorted view about these technologies [3,7,8]

### **Thematic Area 3: Research and Innovation Strategies for Smart Specialization (RIS3)**

Research and Innovation Strategies for Smart Specialization – RIS3 are integrated, place – based economic transformation agendas, taking into consideration the special and individual characteristics of each region. The mission of the formulation of these strategies is summarizing in the following 5 axes [9]:

- They focus policy support and investments on key national/regional priorities, challenges and needs for knowledge-based development.
- They build on each country/region’s strengths, competitive advantages and potential for excellence.
- They support technological as well as practice-based innovation and aim to stimulate private sector investment.
- They get stakeholders fully involved and encourage innovation
- They are evidence-based and include sound monitoring and evaluation systems

**Table 3.** Aspects of the thematic area RIS3.

RIS3 Aspect	Description
Research	Intensiveness of research activities on technologies related to electromobility and alternative fuels concepts.
Innovation	Level of innovation and experimentation in projects related to electromobility and alternative fuels
Synergies	Level of involvement of various stakeholders in projects related to electromobility and alternative fuels
Strategic Plan	Formulation of a regional strategic plan concerning the diffusion of electromobility and alternative fuels.
Monitoring	Existence of a sound monitoring and evaluation system in projects related to electromobility and alternative fuels.

Research and Innovation Strategies involves research activities on various technologies concerning every sector (transportation, agriculture, economy, etc.) and the participation of research departments and institutions. The RIS3 concept indicates flexible and dynamic innovation strategies aiming to regional firms and productive system and tries to avoid fragmentation efforts in the field of innovation support. It refers to all three priorities of Europe2020 – sustainable, smart and inclusive growth – and guides priority-setting in national and regional innovation strategies, as well as cross-border cooperation where appropriate. The strategies are formulated based on each country's/re-

gion's strengths, competitive advantages and potential for excellence and the main focus areas include policy support and stimulation of private sector investments and technological support.

### 3 Results

#### 3.1 Business

Charging infrastructure is an aspect where 4 out of 9 regions have achieved significant progress (Table 4). The well-developed and sufficient charging infrastructure in Flanders, Bucharest – Iliov, Rogaland and Gorenjska is a very important step towards the increase of the number of electric and alternative vehicles. On the other hand, the regions of Calabria, Kainuu, Brescia and Zemgale need to elaborate more on the installation of charging stations and the creation of an appropriate network. Especially, for Gorenjska, it is controversial that despite the available charging infrastructure and facilities in the region, the number of electric vehicles is extremely low. Region of Attica evaluated the charging infrastructure with only 2 out of 10 indicating that charging facilities and have to be increased and installed in various locations within the region to enable the use of an EV.

**Table 4.** Comparative Gap Analysis for the thematic area Business

European Region	CI*	EV** Fleet	AFV*** Fleet	Technology	Incentives	Campaigns
Brescia	5	4	2	8	5	2
Calabria	4	3	1	5	4	4
Gorenjska	9	1	1	4	6	2
Attica	2	2	3	4	2	3
Flanders	8	5	5	5	7	4
Kainuu	4	3	1	5	3	2
Rogaland	8	8	8	7	9	6
Bucharest-Ilfov	8	5	5	4	8	4
Zemgale	5	2	2	4	2	3

\* CI: Charging Infrastructure, \*\* EV: Electric Vehicles, \*\*\* AFV: Alternative Fuels Vehicles

Despite the fact that some of the regions provide the necessary infrastructure the number of electric vehicles is still low in all of them except of the Rogaland where the EV fleet was evaluated with 8. It is interesting to investigate why the number of EVs is not higher in the regions where enough charging stations have been installed favoring the use of EVs. Exactly the same picture for the number of alternative fuels vehicle fleet, with the Rogaland Council achieving the highest score. Province of Brescia has achieved significant progress in developing the required technology to support the use of electric vehicles along with the Rogaland while for all the others regions this aspect

got an average score. Concerning incentives, it is worth mentioning that in Flanders, Bucharest – Iliov and Rogaland, lot of incentives are given to the industry and the public sector in order to motivate and encourage their people to get involved in the electromobility concept and improve the technology they use. Attica, Kainuu and Zemgale are the regions with the lowest score (2 and 3) in this aspect.

Finally, the highest deficiency for all regions is identified in the aspect of the informative campaigns. Campaigns for promoting the new technologies for a more sustainable and environmental friendly transportation system are not a strong asset for any of the analyzed regions, a fact that indicates that industry should be more active in this field as it consists a valuable tool for getting potential users familiar with electromobility and alternative fuels. The lack of campaigns can explain the low penetration rates of electric and alternative fuels vehicles in some regions as people do not support or are not aware of the technology and they didn't have the opportunity of getting familiar with these new technologies by using or driving test vehicles.

### 3.2 Governance

In the Governance sector, the Rogaland has significantly high scores in almost all aspects while Flanders and Gorenjska have achieved significant progress in terms of education – incentives- campaigns and legislation – enforcement – incentives respectively (Table 5). The appropriate legislation framework is a very important tool for encouraging the purchase and the shift towards more sustainable authorities. Additionally, enforcement of regulatory changes, laws, directives and standards for the promotion of electromobility and increase of the share of electric vehicles and alternative fuels in the fleet can also contribute towards more sustainable transportation system.

Similarly to the business sector, incentives given to the public sector and campaigns organized by regional or local authorities are not a priority for most of the regions. It is important to understand the importance of informing public about the existence of alternative technologies as well as their advantages and therefore raise public awareness. Low evaluation scores are also observed in the aspect of education for most of the regions with Brescia and Attica having the lowest ones.

**Table 5.** Comparative Gap Analysis for the thematic area Governance

European Region	Legislation	Enforcement	Education	Incentives	Campaigns
Brescia	6	7	2	3	3
Calabria	5	5	5	4	5
Gorenjska	8	8	5	8	5
Attica	3	2	2	2	3
Flanders	5	4	8	8	8
Kainuu	7	5	7	4	2
Rogaland	8	8	6	10	7
Bucharest-Ilfov	6	6	5	6	4

Zemgale	2	3	6	2	5
---------	---	---	---	---	---

### 3.3 RIS3

The third thematic area is mainly focusing in research and technology advances as well as the strong cooperation of the various involved stakeholders (synergies). Table 6 shows that most of the regions achieve significant progress in almost all aspects apart from Attica as the overall score is around 2 out of ten. More specifically, the province of Brescia has made remarkable steps in the aspect of research activities and the intense participation of research institutions and universities in the development of technologies for making the use of electric vehicles and alternative fuels more convenient and beneficial for the users. Additionally, innovation and experimentation is also encouraged and highly progressing as it was assessed with 8 out of 10. Almost the same scores are observed for Flanders, Kainuu and Gorenjska in the aspects of research and innovation. It is interesting to mention that the scores for the region of Kainuu were very low in the previous thematic areas. The level of involvement of various stakeholders is very low in the Province of Brescia (Synergies were evaluated with 4/10) and its increase should be a priority for the region as one of the main goals of RIS3 is the involvement and strong cooperation among different sectors and is one of the key factors for the efficient promotion and development of electric vehicles. The same results concerning synergies between various stakeholders are also presented in Table 6 for the regions of Calabria, Attica and Zemgale. For Calabria and Attica, the aspect of research and innovation are also not a strong asset and a lot of effort should be put for improving this indicator. Finally, Bucharest – Iliov region has an average evaluation score for all aspects of RIS 3 as the scores are fluctuating around 5. One of the basic and easy steps for further progress is the promotion of synergies among different sector and a broad network of experts and their strong cooperation is considered a necessity not only for promoting sustainable technologies but also in other various fields.

**Table 6.** Comparative Gap Analysis for the thematic area RIS3

European Region	Research	Strategic Plan	Synergies	Innovation
Brescia	8	6	4	8
Calabria	5	5	5	5
Gorenjska	7	9	6	8
Attica	3	2	2	2
Flanders	8	7	7	7
Kainuu	8	9	7	8
Rogaland*				
Bucharest-Ilfov	6	6	7	6
Zemgale	4	7	3	3

\* Rogaland does not have yet Research and Innovation Strategies for Smart Specializations

## 4 Discussion and Conclusions

Electromobility and alternative fuels are considered the key solutions for dealing with the continuously increasing energy consumption and emissions. The effective promotion of these sustainable technologies highly depends on identifying and detecting the aspects where a region lacks of knowledge and ideas so that targeted actions and measures are taken, designed and implemented. The Gap Analysis conducted in 9 European regions, within the framework of this study, revealed these deficiencies in terms of three thematic areas (business, governance and RIS3) and their indicators.

The results showed that most of the analyzed regions need to elaborate more in most and important indicators such as the formulation of appropriate and favorable legislation framework, the enforcement of laws and directives, as well as the development of sufficient infrastructure by installing charging stations in key locations. The increase of incentives, such as financial incentives are considered to increase the electric vehicle market take up [10]. Two of the aspects that all regions received low scores are the organization of campaigns and the strong synergies. For promoting the environmentally friendly technologies, it is necessary to inform public about their characteristics and advantages as well as ensure their safety. Furthermore, the cooperation between the involved stakeholders is an important step. From the 9 European regions analyzed in the present study, Rogaland is the most advanced one, achieving high scores in all aspects indicating the significant progress achieved and the good level of electromobility promotion. Flanders, Gorenjska and Bucharest are achieving high scores in the majority of the aspects while Brescia is trying to achieve a good effort. Attica, Zemgale, Kainuu and Calabria are the regions with the lowest scores in almost all aspects indicating that industry and government as well as researcher should increase their involvement in the electromobility field and take actions and measures towards this direction.

The results of the present research can be used as knowledge, ideas and policy exchange among the regions while cooperation between them can also be activated. Besides, they will be used as the basis for the development of recommendations favoring the promotion of electromobility in the regions in each thematic area and afterwards in the formulation of a regional action plan including concrete actions that will be adopted and implemented by the regions but it can also be an inspiration for any other local, regional or national authority supporting electromobility and alternative fuels.

### Acknowledgment

The research is based within the framework of e-MOPOLI project (Electro MOBility as driver to support POLicy Instruments for sustainable mobility) funded by the European Union within the framework of the Interreg Europe Programme.

### References

1. European Environment Agency Homepage, <https://www.eea.europa.eu/>
2. Cansino, J., Sánchez-Braza, A., Sanz, M.: Policy Instruments to Promote Electro-Mobility in the EU28: A Comprehensive Review. Sustainability, (2018).

3. Coffman, M., Bernstein, P., Wee, S.: Electric vehicles revisited: A review of factors that affect adoption. *Transp. Rev.* 2017, 37, 79–93 (2017).
4. Sierzchula, W., Bakker, S., Maat, K., Van Wee, B.: The influence of financial incentives and other socio-economic factors on electric vehicle adoption. *Energy Policy* 2014, 68, 183–194 (2014).
5. European Commission. Roadmap to a Single European Transport Area—Towards a Competitive and Resource Efficient Transport System; White Paper, (2011).
6. Mersky, A. C., Sprei, F., Samaras, C., & Qian, Z. S.: Effectiveness of incentives on electric vehicle adoption in Norway. *Transportation Research Part D: Transport and Environment*, 46, 56–68 (2016).
7. Zhang, Y., Yu, Y., & Zou, B.: Analyzing public awareness and acceptance of alternative fuel vehicles in China: The case of EV. *Energy Policy*, 39(11), 7015–7024, (2011).
8. Thiel C., Alemanno A., Scarcella G., Zubaryeva A., Pasaoglu G. Attitude of European car drivers towards electric vehicles: a survey. JRC report (2012).
9. European Union Homepage, <https://ec.europa.eu/>
10. Bühne, J.A., Gruschwitz, D., Hölscher, J., Klötzke, M., Kugler, U., Schimeczek, C.: How to promote electromobility for European car drivers? Obstacles to overcome for a broad market penetration, *Eur Transp Res Rev*, 7 (3), p. 30 (2015).