Cost Benefit Analysis of the E-Mobility Concept in Montenegro-Case Studies

Study prepared by Energy Institute Hrvoje Požar | Zagreb | February 2019

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LIST OF ABBREVIATIONS

AC	Alternating current
EEAP	Energy Efficiency Action Plan
MNE	Montenegro
CO_2	Carbon dioxide
DC	Direct current
DFC	Discounted Cash Flow
EE	Energy Efficiency
EIB	European Investment Bank
EC	European Commission
ENPV	Economic Net Present Value
ERR	Economic Rate of Return
EU	European Union
FDR	Financial Discount Rate
FNPV(C)	Financial Net Present Value of the Investment
FRR(C)	Financial Internal Rate of return on Investment
IRR	Internal Rate of Return
NPV	Net Present Value
PBP	Payback Period
PI	Profitability Index

SUMMARY

The purchase of an electric vehicle under current market conditions requires a considerably greater investment of financial resources compared to the purchase of a conventional car of the same class. On the other hand, the regular maintenance of electric vehicles is less expensive and the cost of motor fuel is also lower.

The study conducted an analysis of the cost-effectiveness of purchasing electric vehicles along with their respective charging devices, during an observed period of 15 years, for the civil sector and for individuals in the public and private sectors. All analyzes took into account the specific characteristics of Montenegro in terms of the use of personal vehicles and the market conditions.

The analyzes concluded that there is a need to establish incentive mechanisms to encourage the purchase of electric vehicles for them to be generally used at a state level. Also, incentives need to be provided to integrate electric vehicles into the electric power system.

For both the civil and public sectors, the analyzes showed that direct **incentives for buying electric vehicles would play a crucial role in the profitability of such investments.** In the case of no incentives being offered, the financial indicators only appeared to show favorable results when a vehicle exceeded 20,000 km per year. However, even at that level, they were still not attractive in investment terms. It was therefore concluded that certain incentive mechanisms should be established to encourage the purchase of electric vehicles in both the civil and public sectors in order to initiate the development of e-mobility in Montenegro. It is not possible to draw conclusions regarding the needs and levels of incentives required to purchase electric vehicles in the private business sector due to the diversity of its activities and means of transport. The case example that was analyzed in this study displayed positive financial indicators; it was a high-class electric vehicle that was purchased without any financial incentives. However, it is likely that individual analyzes carried out by a number of private entities would still show that incentives play a crucial role regarding the assessment of cost-effectiveness and on the decision making process regarding the purchase of electric vehicles. Other effects, most particularly promotional financial incentives, should also be taken into account if a number of businesses decide to purchase electric vehicles.

If a successive increase of electric vehicles within the total percentage of registered passenger vehicles were to be achieved in Montenegro during the next thirty years, this would have a significant and positive effect on society. The positive externality, in terms of avoided CO_2 emissions, is an impact that would have no impact on the investor, but can still be monetized in the context of its positive effect on society. In the period up to 2050, the total **monetized social benefit of avoided CO_2 emissions**, due to the introduction of electric vehicles, could amount to approximately EUR 530,000,000. Additionally, the increase in the number of electric vehicles brings with it related developments such as changing the infrastructure and developing new associated services. These changes would result in significant benefits at a state level, but these have not been quantified in the analyzes within this study; these would result from the overall development of e-mobility. Such benefits would most probably include: an increase in tourism revenue due to an increase in the number of foreign tourists using electric vehicles; the growth of e-mobility would increase the attractiveness of Montenegro as a tourist destination and the country would be perceived as being an environmentally conscious state. A developed infrastructure for charging electric vehicles would enable the development of new services and business models as well as creating added value, creating new jobs and strengthening the state economy.

The development of e-mobility would **integrate more renewable energy sources into the power system, reduce greenhouse gas emissions, reduce local pollutant emissions and lower**

dependence on imported fossil fuels. If we look at the year 2050, electric vehicles would represent an additional load for the existing power system with an additional 300 MW peak load. In the context of the flexibility of the power system, in 2050, electric vehicles with a potential distribution tank capacity of approximately 16 GWh could actively participate in balancing the system. The available capacity at any given moment would depend on several factors such as the percentage of vehicles connected to the power system at a given time via slow chargers, battery charge status, and vehicle owners' default settings.

INTRODUCTION

Document Purpose and Goal

The Cost Benefit Analysis (CBA) aims to determine the justification for the investment in electric vehicles. It takes into account the direct financial benefits for the investor, as well as the consequential benefits and costs that such investment may have on society as a whole.

Since the purchase of an electric vehicle under current market conditions is financially considerably more demanding than the purchase of a conventional car of the same class, despite the fact that the costs of regular maintenance of electric vehicles and the costs of motor fuel are lower, it is necessary to conduct a cost-effectiveness analysis (CEA) for the purchase of electric vehicles, along with their related charging devices, for the civil sector and for individual cases in both the public and private sectors.

It has been determined that this analysis should be carried out over a period of 15 years, and should include key features specific to Montenegro such as the average mileage of personal vehicles, the expected range (autonomy) of vehicles of individual users, the fiscal policy of the country (customs duties, excise duties, taxes) and the energy market situation.

The aim is to make conclusions regarding the establishment of incentive mechanisms for the purchase of electric vehicles, their general use at a state level and finally, the consequences of integrating electric vehicles into the electric power system.

Document Structure

The document is structured in two general sections: (i) a description of the general principles of carrying out a cost and benefit analysis for this study; and (ii) case studies of the introduction of electric vehicles into driving fleets in particular sectors.

The first part describes the basic determinants of the financial and economic analyzes along with the defined baseline assumptions used in further calculations.

The second section presents three case studies for the introduction of electric vehicles into various driving fleets: the civil sector, the public sector and the private sector.

The document ends with the conclusions that arise from all analyzes carried out in this study. They also take into account the findings from previous studies developed within this project (Situational Analysis of the Montenegrin Legislative, Institutional and Financial Framework for E-Mobility, Analysis of E-Mobility Market in Montenegro).

PRINCIPLES FOR THE COST BENEFIT ANALYSIS

The Cost and Benefit Analysis was conducted in accordance with the guidelines of the European Commission and the European Investment Bank (EIB)[1].

The CBA analysis was carried out in such a way as to determine the differences in benefits and costs between the baseline and alternative scenarios. The baseline scenario was the absence of investment in electric vehicles, i.e. it assumed the continuation of the current behavior pattern within the context of vehicle purchases for both private and business purposes (the so-called Business As Usual (BAU) scenario). Due to a lack of investment in electric vehicles, significant costs linked to CO_2 emissions are expected in the baseline scenario.

The alternative scenario assumes investment in electric vehicles, resulting in lower maintenance costs and significantly lower CO_2 emissions.

BASIC SPECIFICATIONS OF THE COST BENEFIT ANALYSIS

The Cost and Benefit Analysis was based on a variety of different perspectives. The financial viability of the project was considered separately from a citizens' perspective and the socio-economic analysis was carried out from a state perspective. Additionally, analyzes were carried out within the context of the public sector, from the perspective of introducing electric vehicles into the Podgorica Communal Police Department and within the private sector, where electric vehicles were introduced into a fleet of cars belonging to a private travel agency providing road passenger transfer services.

Financial Analysis

The objective of the financial analysis is to:

- Assess the project's consolidated profitability,
- Confirm the financial sustainability of the project and specify the key feasibility conditions, and
- Describe the cash flows that support the calculation of socio-economic costs and benefits.

The financial analysis was prepared based on the following requirements:

- The financial analysis was carried out using a discounted cash flow (DFC).
- Only cash inflows and outflows were taken into account. Depreciation, provisions and other accounting items that did not correspond to cash flows were neglected.
- The financial analysis was carried out from the perspective of the vehicle owner.
- In order to calculate the present value of future cash flows, an appropriate financial discount rate (FDR) was applied.

[1] *European Investment Bank, The Economic Appraisal ofInvestment Projects at the EIB, March 2013*

- The financial analysis was carried out at constant (real) prices, i.e. at fixed prices determined in the baseline year. Consequently, the FDR is expressed as an actual amount.
- VAT is included in the analysis in case the user has no VAT refunds

Once the investment, labor, maintenance costs and funding sources were determined, it was possible to determine the project's profitability. Project profitability was measured through the following indicators:

- Financial net present value of investment (FNPV(C))
- Financial internal rate of return on investment (FRR(C)).

The net financial investment net present value (FNPV (C)) and the financial internal return rate (FRR (C)) aimed to compare the costs of investing with the net income (benefits or savings) of the project in order to ascertain whether, and to what extent, the investment would be paid for exclusively on the basis of net income (in this case savings), without taking into account the sources of funding.

The financial net present value of an investment is defined as the sum obtained when the expected investment and operating costs of the project (discounted) are deducted from the discounted value of expected revenue.

$$\text{FNPV (C)} = \sum_{t=0}^{n} a_t\, S_t = \frac{S_0}{(1+I)^0} + \frac{S_1}{(1+I)^1} + \cdots + \frac{S_n}{(1+I)^n}$$

Where:

S_t is the balance of cash flow in time t,

a_t is a financial discounted factor selected for discounting at time t, and

i is a financial discount rate.

The financial rate of return on investment is defined as the discounted rate resulting from the zero FNPV, i.e. the FRR is given as the result of the following equation:

$$0 = \sum \frac{St}{(1+FRR)^t}$$

The FNPV is expressed as an absolute amount (EUR) and must be proportional to the size of the project. FRR is a percentage. FRR(C) is used to estimate the future outcome of an investment in comparison with other projects or to compare the return rate with a reference value.

This calculation makes it possible to determine whether the project requires additional funding or support (subsidy): if (FRR (C)) is lower than the discount rate used (or if FNPV (C) is negative) then the revenue is not sufficient to cover the investment costs and the project needs additional financial support. The justification of financial support is confirmed by the implementation of an economic analysis.

Economic Analysis

The purpose of the economic analysis is to determine whether the net benefit, in the form of lower costs for the society as a whole, is sufficient to justify the cost of investing in electric vehicles. After quantifying and evaluating all of the costs and benefits of a project, it is possible to measure the economic performance of a project by calculating the following indicators:

- Economic Net Present Value (ENPV) - the difference between discounted total social benefits and costs
- Economic Rate of Return (ERR) - the rate at which ENPV is zero

In principle, any project with an ERR lower than a social discount rate, or with a negative ENPV, should be rejected, as it does not generate enough added value for the society as a whole. Namely, a project with a negative economic rate of return uses too many socially valuable resources and achieves too few benefits for citizens.

Compared to the results obtained from the financial analysis, the benefit of the project was identified as a reduction in CO_2 emissions resulting from the reduction of fossil fuel combustion.

Sensitivity Analysis

Since the financial and economic analysis were carried out for the expected value of the input parameters, it was necessary to analyze the sensitivity of the final results in terms of changes seen in the input parameters. Specifically, the impact of changes made to investment costs was analyzed by introducing different rates of co-financing from the Eco Fund. In addition, the impact of changes in the average annual mileage generated by a specific vehicle was analyzed, which ultimately directly influenced the amount spent on operating costs.

DEFINITION OF INITIAL ASSUMPTIONS

The analyzes included an economic evaluation of the purchase of electric vehicles in various segments related to the civil (state) sector, and to the public and private sectors. Regardless of the different perspectives, the underlying assumptions were unified; they are used, as described, below.

Calculation and Discount Unit for the Cost Benefit Analysis

In any financial analysis, the discount rate has to reflect the opportunity cost of capital. As a reference value, a real discount rate of 4% was taken, which is the value recommended by the European Commission for the period 2014-2020.

The discount rate used in the economic analysis should reflect the opportunity cost of capital from the perspective of a society. As the reference value, a discount rate of 5% was taken, which is the value recommended by the European Commission for the period 2014-2020 for the Cohesion countries.

Project Life

Financial calculations from the perspective of citizens and from the public and private sectors were implemented for a period of 15 years. The remainder of the project value after 15 years is zero. Namely, it is presumed that the electric vehicles currently offered on the EU market, despite a gradual reduction of battery capacity, would have been able to fully satisfy all the needs of the citizens involved, throughout the lifetime of their 15-year exploitation, and that they would have been able to serve the regular activities of the private and public sectors. On the other hand, due to the poor development of the second-hand car market, any assumptions made about the residual value of an electric vehicle after a few years would be very unreliable.

The economic analysis for the state was carried out for a period of 30 years. In terms of 'going electric' from a state point of view, it was necessary to observe a longer period. The target year in this respect is 2050, for which there are defined basic guidelines and objectives that are being considered and which have already been partly defined by the European Union, all of which aim to reduce greenhouse gas emissions from road traffic.

Source of Financing

Financing with own capital (self-financing) was assumed, thus reducing dependence on the financial market and also reducing the problem of solvency maintenance, i.e. the ability to pay because there is no loan, and with it no repayment of annuity. The starting point in the considered scenarios includes the fact that a new vehicle was needed. Consequently, analyzes are focused on cost-effectiveness within the context of procurement: an electric vehicle vs. a conventionally-fueled vehicle.

In the sensitivity analysis, the co-financing of the initial investment amounted to EUR 2,500.00, EUR 5,000.00, EUR 7,500.00 and EUR 10.000,00 from the Eco Fund.

Investment in Fixed Assets

Investments were related to the purchase of an electric vehicle, i.e. electric vehicles (if the entity purchases more vehicles). In addition, if an entity purchased its own charger, investment also included purchasing/ installing the charger and a fee for connecting to the electric power distribution system. Investment was fully realized during the first year of the project.

Determining Benefits

Benefits, or savings, arise from savings made on the basis of differences in operating costs between electric vehicle traffic and conventional vehicle operation. Savings are manifested in the variety of supplies that are required to maintain and supply fuel (the price difference between gasoline, diesel fuel and electricity).

Determining Expenditures

Expenditure refers to the cost of additional investment in the replacement battery for an electric vehicle, if it becomes necessary within the projected lifetime of the project for technical reasons.

CASE STUDIES – COST BENEFIT ANALYSIS

Cost and benefit analyses were carried out for three case studies regarding the introduction of electric vehicles into driving fleets: for the civil sector, the public sector and the private sector. For each case study, the input assumptions and the scenario created for the purpose of the analysis have been described, and an analysis of the financial viability of the introduction of electric vehicles has been carried out. On the basis of this information, conclusions were ultimately drawn up.

CIVIL SECTOR

In the civil sector, two aspects were analyzed. One referred to the financial viability of purchasing an electric vehicle by an individual, and the other referred to the country-wide economic benefits, manifested in the long term due to the transition of citizens, resulting from electric vehicles and the development of all elements of e-mobility in general.

Financial Analysis from a Citizens' Perspective

In Montenegro there is great potential for citizens to use electric vehicles, especially as the inherent restrictions are negligible; globally, however, these restrictions represent the most common barriers to the development of e-mobility. Among others, one key factor is the range (autonomy) of electric vehicles currently available on the market, and this often represents a barrier in the decision-making process for the purchase of an electric vehicle. By analyzing both the situation and the market through a public survey, it was established that the vast majority of currently available electric vehicles could fully meet the needs of almost all citizens with regard to travelling particular routes in Montenegro.

On the other hand, the relatively high price of electric vehicles, when compared with equivalent conventional ones, was a key factor that prevented or discouraged citizens from purchasing them. Thus, the cost-effectiveness analysis regarding the purchase of electric vehicles by citizens in a variety of different scenarios concluded that certain incentive mechanisms should be introduced.

Scenario and Input Assumptions

For the purpose of the financial analysis, a scenario was developed to compare the purchase, by a citizen, of a new electric vehicle with a conventional diesel car. A period of 15 years was observed and the calculation did not take into account any extraordinary costs such as car failure or possible battery replacement.

The input data for calculating the initial investment, the maintenance costs, and energy consumption were approximately equivalent to those of a large number of electric and conventional cars, and were largely based on data corresponding to the VW e-Golf electric car and the VW Golf diesel car.

Financial performance indicators for different combinations of annual mileage and vehicle fuel incentives were calculated according to the following table.

Table 1 Combinations of annual mileage and sum of incentives for the purchase of vehicles

	Incentive amount to buy EV				
Annual Mileage	***EUR0***	***EUR2,500***	***EUR5,000***	***EUR7,500***	***EUR10,000***
10,000 km	*NPV, IRR, PBP, PI*	*NPV, IRR, PBP, PI*	*NPV, IRR, PBP, PI*	*NPV, IRR, PBP, PI*	*NPV, IRR, PBP, PI*

13,000 km	*NPV, IRR, PBP, PI*	*NPV, IRR, PBP, PI*	*NPV, IRR, PBP, PI*	*NPV, IRR, PBP, PI*	*NPV, IRR, PBP, PI*
16,000 km	*NPV, IRR, PBP, PI*	*NPV, IRR, PBP, PI*	*NPV, IRR, PBP, PI*	*NPV, IRR, PBP, PI*	*NPV, IRR, PBP, PI*
20,000 km	*NPV, IRR, PBP, PI*	*NPV, IRR, PBP, PI*	*NPV, IRR, PBP, PI*	*NPV, IRR, PBP, PI*	*NPV, IRR, PBP, PI*

Other assumptions used in the analysis are described in the following table.

Table 2 Assumptions for analysis - citizens

Assumption	Description
Vehicle maintenance	The total cost of vehicle maintenance is 50% lower for electric vehicles than for conventional ones. The maintenance cost includes all costs borne by the owner during the period of vehicle exploitation except for registration, insurance and fuel costs.
Fuel prices	For calculation purposes, it is assumed that diesel and petrol prices will remain at today's level over the next 15 years, including excise and VAT. The calculation used a price of 1.3 EUR/l of diesel.
Electricity prices	For calculation purposes it is assumed that electricity prices will remain at the present level for all customer categories, including VAT. The calculation used a price of 0.097 EUR/kWh of electricity.
Infrastructure for charging EV	The analysis includes the costs of setting up the appropriate infrastructure for charging an electric vehicle in its own parking space.
Electricity - connection	It is assumed that for charging purposes a vehicle would use its own charger; it would not, therefore, be necessary to build new electric power connections or to rent additional power capacities.

Determining Project Cost-Effectiveness

The combined results of the input assumptions and developed scenarios show that, with the investment of additional funds for the purchase of an electric car, the total investment required for this project would be EUR 18,800.

In order to determine the feasibility of the project, the following indicators were used:

- the net present value (NPV) of the project is determined at a discount rate of 4%,
- Internal Rate of Return (IRR),
- Profitability Index (PI)
- Discounted Payback Period (PBP)[2]

NPV, IRR, PBP and PI are determined on the basis of the financial flow, and the financial calculations are summarized in the table below.

NPV

In the case that a vehicle had an average annual mileage of 10,000 km, the net present value was calculated to be negative if there were no incentives at all, or if incentives for the purchase of an EV were provided at values of EUR 2,500 and EUR 5,000 respectively. However, with incentive figures of EUR 7,500 and above, the net present value of this project became positive.

In the case that a vehicle had an average annual mileage of 13,000 km, the net present value was calculated to be negative if there were no incentives at all, or of an incentive of EUR 2,500 was provided for the purchase of an EV. However, with incentive figures of EUR 5,000 and above, the net present value of this project became positive.

[2] *The minimum period (in years) in which discounted net cash flows will repay investment costs*

In the case that a vehicle had an average annual mileage of 16,000 km, the net present value was calculated to be negative only if no incentive at all was provided for the purchase of an EV. With incentive figures of EUR 2,500 and above, the net present value of this project became positive.

In the case that a vehicle had an average annual mileage of 20,000 km, the net present value of this project was positive without the provision of any incentive.

Table 3 Civil Sector - NPV

NPV

NPV (EUR)	Incentive amount for the purchase of EV				
Annual Mileage	***EUR0***	***EUR2,500***	***EUR5,000***	***EUR7,500***	***EUR10,000***
10,000 km	-6,265	-3,765	-1,265	1,235	3,735
13,000 km	-3,814	-1,314	1,186	3,686	6,186
16,000 km	-1,363	1,137	3,637	6,137	8,637
20,000 km	1,906	4,406	6,906	9,406	11,906

IRR

The internal rate of profitability is lower than the discount rate as follows: in cases with an average annual mileage of 10,000 km with an incentive of up to EUR 5,000; in cases with an average annual mileage of 13,000 km with an incentive of up to EUR 2,500; and in cases with an average annual mileage of 16,000 km with no incentives at all. In all other cases, the IRR is higher than the discount rate.

Table 4 Civil Sector – IRR

IRR

IRR	Incentive amount for the purchase of EV				
Annual Mileage	***EUR5,000***	***EUR7,500***	***EUR10,000***	***EUR7,500***	***EUR10,000***
10,000 km	-1.3%	0.5%	2.7%	5.5%	9.5%
13,000 km	0.9%	2.8%	5.2%	8.3%	12.7%
16,000 km	2.9%	5.0%	7.5%	10.9%	15.8%
20,000 km	5.4%	7.6%	10.4%	14.2%	19.6%

PBP

In the case that a vehicle had an annual average mileage of 10,000 km, the investment payback period was more than 15 years when no incentive was provided to purchase the EV, but with an incentive of EUR 2,500 it was ???, and with an incentive of EUR 5,000 it was 15 years.???? At the highest incentive level of EUR 10,000, the investment could be paid back over a period of 9 years.

In the case that a vehicle had an annual average mileage of 13,000 km, the investment payback period was more than 15 years when no incentive was provided to purchase the EV, but with an incentive of EUR 2,500 the investment could be repaid over a period of 15 years. At the highest incentive level of EUR 10,000, the investment could be paid back over a period of 7 years.

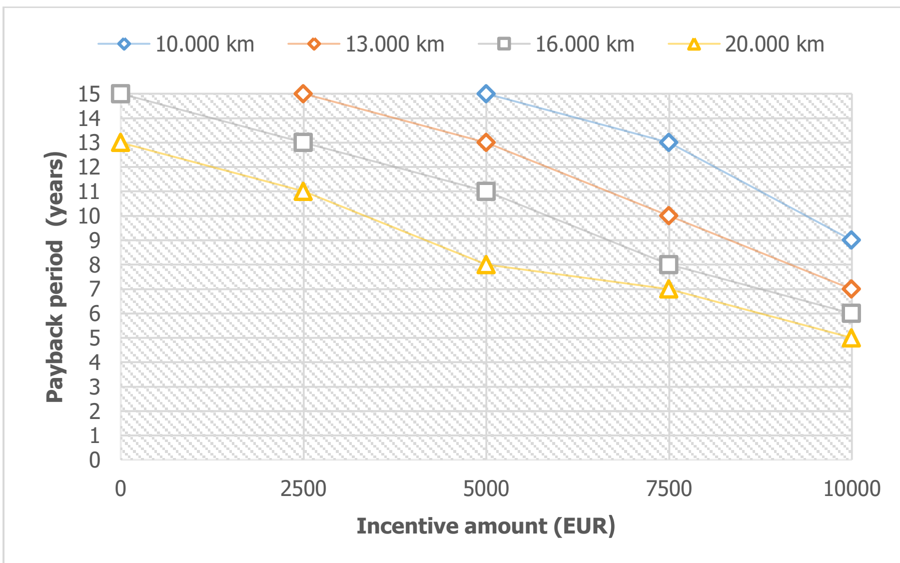
In the case that a vehicle had an average annual mileage of 16,000 km, the investment payback period was 15 years without any incentive being provided to purchase an EV. At the highest incentive level of EUR 10,000, the investment could be paid back over a period of 7 years.

In the case that a vehicle had an annual average mileage of 20,000 km, the investment payback period was 13 years without any incentive being provided to purchase an EV. At the highest incentive level of EUR 10,000, the investment could be paid back over a period of 5 years.

Table 5 Civil Sector - PBP

PBP					
PBP	**Incentive amount for the purchase of EV**				
Annual Mileage	***EUR5,000***	***EUR7,500***	***EUR10,000***	***EUR7,500***	***EUR10,000***
10,000 km	>15	>15	15	13	9
13,000 km	>15	15	13	10	7
16,000 km	15	13	11	8	6
20,000 km	13	11	8	7	5

The figure below clearly shows the investment payback period expressed in years, depending on the incentive amount provided for the purchase of an EV; results are shown for different average mileages covered by a specific vehicle on an annual basis.



Payback Period (years) – Incentive Amount (EUR)

Figure 1 Civil sector - PBP

PI

In the case that a vehicle had an annual mileage of 10,000 km, the profitability index was less than 1 when incentives provided to purchase an EV ranged from none at all to EUR 5,000. With the highest level of incentive provided to purchase an EV, EUR 10,000, the profitability index was 1.4.

In the case that a vehicle had an annual average mileage of 13,000 km, the profitability index was less than 1 when incentives provided to purchase an EV ranged from none at all to EUR 2,500. With the highest level of incentive provided to purchase an EV, EUR 10,000, the profitability index was 1.7.

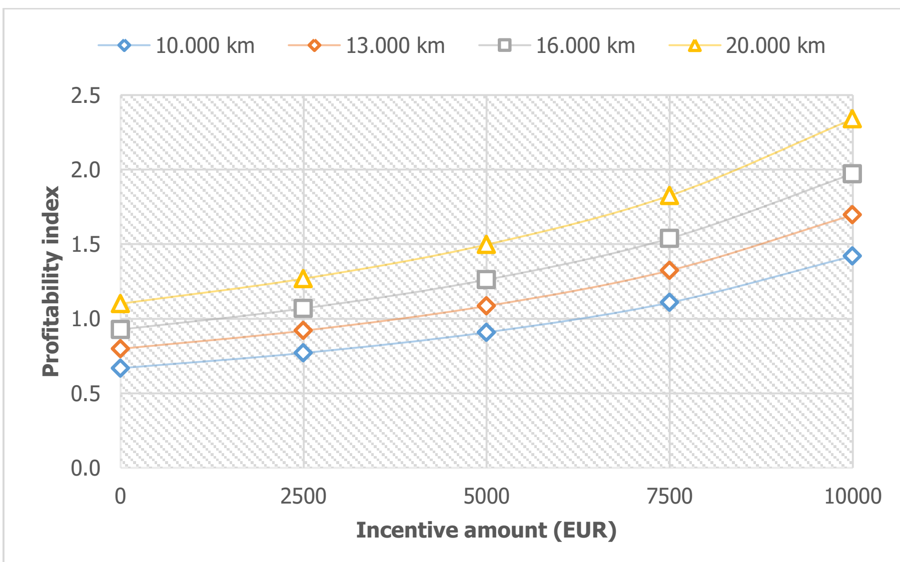
In the case that a vehicle had an average annual mileage of 16,000 km, the profitability index was only less than 1 when no incentive at all was provided to purchase an EV. With the highest level of incentive provided to purchase an EV, EUR 10,000, the profitability index was 2.0.

In the case that a vehicle had an average mileage of 20,000 km a year, the profitability index was more than 1 even when no incentive was provided to purchase an EV. With the highest level of incentive provided to purchase an EV, EUR 10,000, the profitability index was 2.3.

Table 6 Civil sector - PI

PI					
PI	**Incentive amount for the purchase of EV**				
Annual Mileage	***EUR5,000***	***EUR7,500***	***EUR10,000***	***EUR7,500***	***EUR10,000***
10,000 km	0,7	0,8	0,9	1,1	1,4
13,000 km	0,8	0,9	1,1	1,3	1,7
16,000 km	0,9	1,1	1,3	1,5	2,0
20,000 km	1,1	1,3	1,5	1,8	2,3

The figure below clearly shows the profitability index depending on the incentive amount provided for the purchase of an EV; results are shown for different average mileages covered by a specific vehicle on an annual basis.



Profitability Index – Incentive Amount (EUR)

Figure 2 Civil sector - PI

Conclusion

According to the analysis of the current market situation, half of all vehicles owned by citizens cover up to 10,000 km annually (see Figure below).

ANNUAL MILEAGE

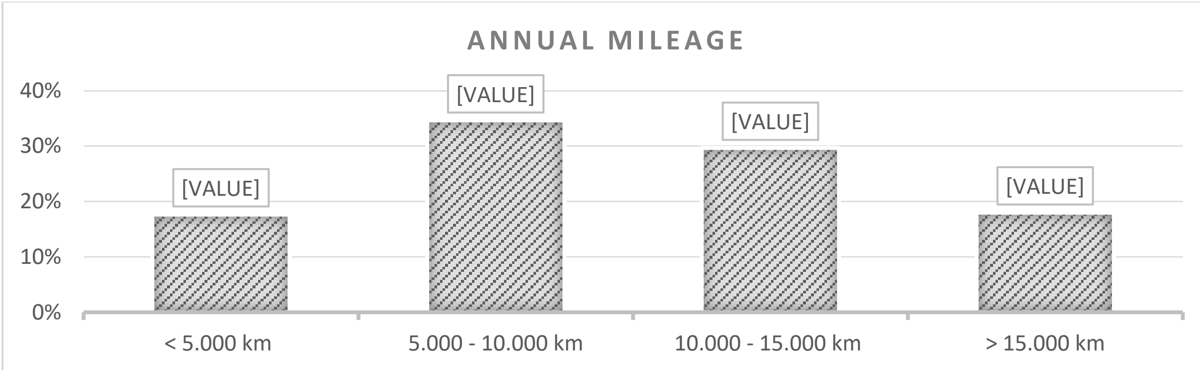


Figure 3 Vehicle usage - public survey

Taking into account the results of the survey and of the financial analysis, it is clear that it is **necessary to establish certain incentive mechanisms to encourage citizens to purchase electric vehicles in order to initiate the development of e-mobility in Montenegro.** Namely, the financial analysis clearly showed that the purchase of electric vehicles for citizens who travel more than 10,000 km per year was viable only with an incentive of EUR 7,500. However, in this case, regardless of the financial viability of the vehicle during its life, the purchase of an EV only became attractive with an incentive of EUR 10,000, and with an investment payback period of less than 10 years.

In addition, the survey found that about 18% of citizens annually travelled more than 15,000 km per year. The results of the financial analysis showed that this group of citizens could achieve very attractive profitability indices with an incentive figure of EUR 7,500; it is anticipated that this segment of society could pioneer the introduction of EV into the fleet of registered vehicles in Montenegro.

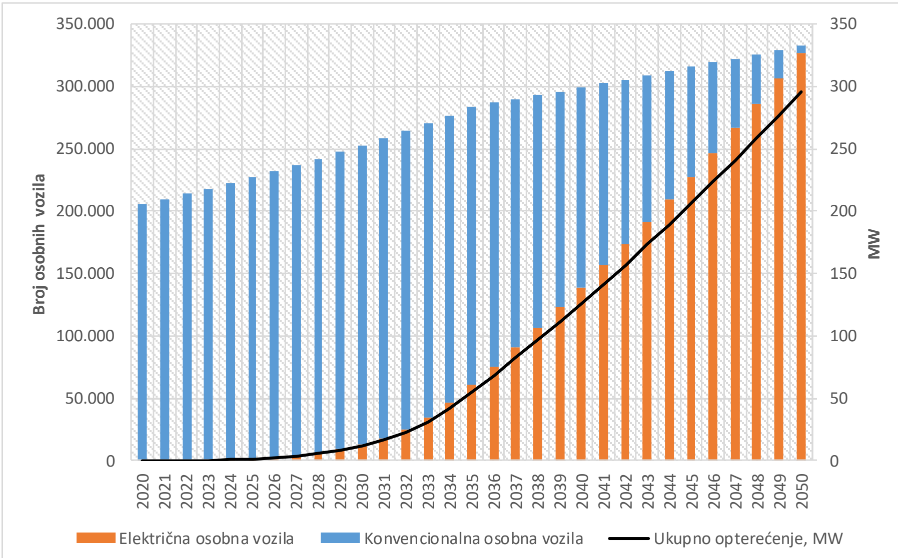
It has been unambiguously and clearly affirmed by both the financial analysis and the market survey that, for a more significant initial proliferation of EV in Montenegro, at this stage of market development, it is necessary to establish an incentive mechanism to encourage people to invest in EV. Any investment must be financially viable; with the support of appropriate incentives, investment in EV has to be brought as close as possible to the wider public.

Economic Analysis from a State Perspective

Within the context of the dynamics of the electrification of road traffic, modeling has to take into account factors such as the level of technological development and its related infrastructure, the preparation of business models for private investors and the affordability of electricity as an alternative option for end users. All of these factors combined result in realistic constraints in terms of market development in the period up to 2035 (the basic modeling principles described in the *Situation Analysis of the Montenegrin Legislative, Institutional and Financial Framework for E-Mobility*). In accordance with the related specifications, the schedule of electrification by 2050 was also defined (shown in the picture below). **The so-defined scenario implies that the percentage of electric vehicles in 2050 will exceed 95%**, and that the total number of passenger vehicles will be approximately 333,200.

Assuming that in 2050, 90% of charging will take place on slow low-power (home) chargers and that the remainder of vehicles will use a combination of fast chargers (power> 22kW), the potential impact of the vehicles in question on the electric power system, in the context of increasing peak load, was determined by modeling. **The potential peak load that would be initiated by electric vehicles in 2050 was calculated as approximately 300 MW.**

Within the context of the flexibility of the power system, **the total potential electric vehicle battery capacity required to provide flexibility, as detailed in the scenario, would be about 16 GWh in 2050.**



Number of personal vehicles / Electric Personal Vehicles – Conventional Personal Vehicles – Total Load, MW

Figure 4Dynamics of road transport electrification by personal vehicles and the resulting load for the electric power system

The **social benefit** of avoided CO_2 emissions was calculated according to the principles applied by the European Investment Bank and the European Commission, using the following formula:

$$\textit{Benefit of avoided } CO_2 \textit{ emissions} = \textit{amount of avoided } CO_2 \textit{ emissions} * \textit{unit cost of } CO_2$$

The prices of emission units by 2050, prepared by the European Commission for the elaboration of national energy-climate plans[3], were used as a starting point in the analysis of the avoided cost of CO_2 emissions. Current market prices also show higher values than those recommended by EC. Based on such trends, alternative price trends were estimated until 2030, reduced to the euro in 2015. Target values (shown in the table below) were used in the analysis of avoided cost. It is important to note that these are not market prices, but are prices that reflect the actual cost of CO_2 emissions for society.

Table 7 Price of emission units

Price of emission units	2025	2030	2035	2040	2050
EUR'15/tCO$_2$	29.9	34.3	43	51.1	92.1

CO_2 emissions are defined in terms of total energy consumption from tank to wheel. Emission factor values recommended by the Intergovernmental Authority for Climate Change (table below) were used.

Table 8 Conventional fuel emission factors[4]

Emission factor	tCO$_2$/TJ
Petrol	69.3

[3] *EU Reference Scenario 2016*

[4] *IPCC Guidelines for National Greenhouse Gas Inventories 2006*

Diesel	74.1

In the period up to 2050, the total monetized social benefit of avoided CO_2 emissions, due to the introduction of electric vehicles, according to the scenario assumptions, will amount to approximately EUR 530,000,000.

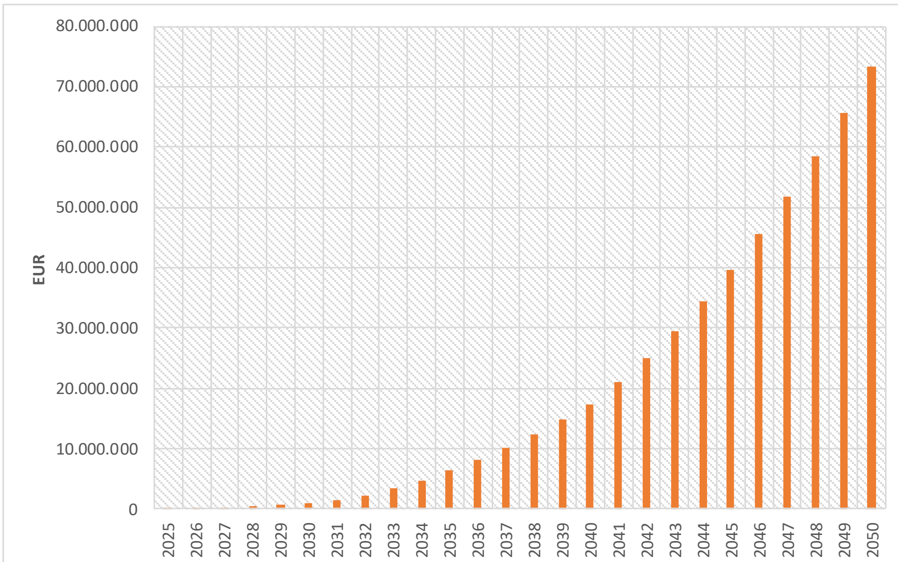


Figure 5 Benefit of avoided CO_2 emissions (TTW)

In the event that the state decides to encourage the purchase of electric vehicles through co-financing measures in the private or public sectors, it is necessary to specify each cost savings item (avoided CO_2 emissions) that will result in the implementation of such measures. The tables below show the incurred cost (expressed in EUR) per unit of CO_2 avoided in the vehicle life span, for different levels of potential incentives for the purchase of electric vehicles and for different levels of average annual mileage traveled or to be traveled by the vehicles in question. The cost of saving is, for example, reduced to half where incentives amount to € 7,500 for the purchase of a vehicle that annually travels 20,000 km, rather than an incentive of € 10,000 for a vehicle that annually travels 13,000 km.

Table 9 Cost of savings per unit of CO_2 emissions

Cost of Savings (EUR/tCo2)					
EUR/tCO$_2$	**Incentive Amount for the Purchase of EV**				
Annual Mileage	***EUR5,000***	***EUR7,500***	***EUR10,000***	***EUR7,500***	***EUR10,000***
10,000 km	0	89	178	267	356
13,000 km	0	68	137	205	274
16,000 km	0	56	111	167	223
20,000 km	0	45	89	134	178

PUBLIC SECTOR

A number of state and local organizational units were considered for the case study of cost and benefit analysis in the public sector segment. The Podgorica **Communal Police** Department was selected for analysis, after assessing the condition of the vehicle fleet, the characteristics of the vehicles used and the availability of relevant data.

The Law on Communal Police regulates the tasks and powers of communal police, organizations and other matters of importance for the work of the communal police. Communal police activities include municipal oversight and provision of communal services in accordance with the law regulating the area of communal activities and other areas in which the municipality carries out its own affairs or tasks under the authority of the state administration that have been transferred to it by law or entrusted to it under the law.

Scenario and Input Assumptions

In the performance of their duties, the communal police have a fleet of nine of their own vehicles. Two vehicles have diesel engines, and seven vehicles use petrol as fuel. The average age of the fleet is 10 years and the average annual mileage is 14,100 km.

Table 10 Vehicle Fleet of Communal Police (2019)

No.	Fuel Type	Engine Power (kW)	Year of Manufacture	Vehicle Type	Euro standard	Average Consumption [l/100 km]	Annual Mileage
1	Diesel	81	2016	Škoda Octavia	6	6.5	13,900
2	Petrol	55	2008	Dacia Logan	4	9.5	10,200
3	Petrol	43	2000	Renault Clio	2	8.5	12,600
4	Petrol	66	2014	Dacia Stepway	5	7.5	11,100
5	Diesel	55	2015	Dacia Sandero	5	6.6	15,600
6	Petrol	55	2005	Dacia Logan	3	10	16,200
7	Petrol	55	2005	Dacia Logan	3	10	16,130
8	Petrol	55	2007	Dacia Logan	4	10	15,800
9	Petrol	55	2007	Dacia Logan	4	10	15,650

Each vehicle has its own parking space, thus fulfilling an important prerequisite for setting up the appropriate infrastructure for charging electric vehicles. The parking places are 20 meters away from the Communal Police administrative building, and each parking place is connected and marked. The distance between the parking spaces and the electrical installation of the building is 20 meters.

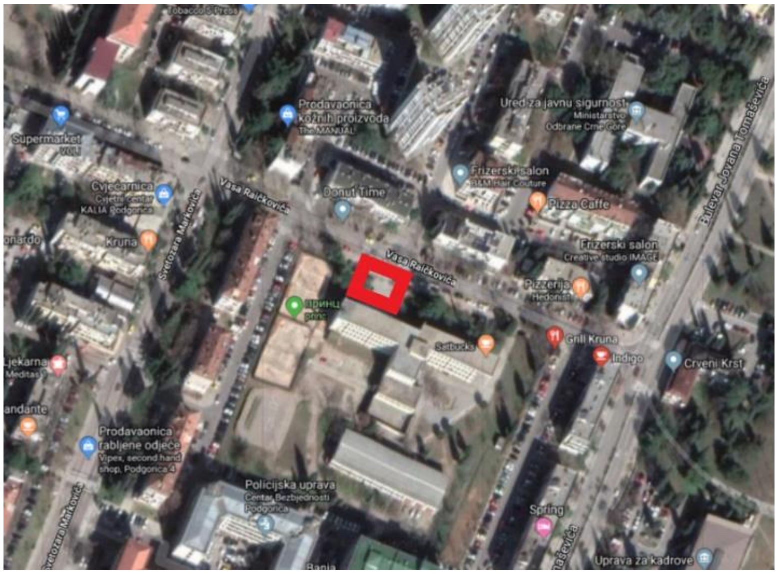


Figure 6 Parking lot belonging to the Communal Police

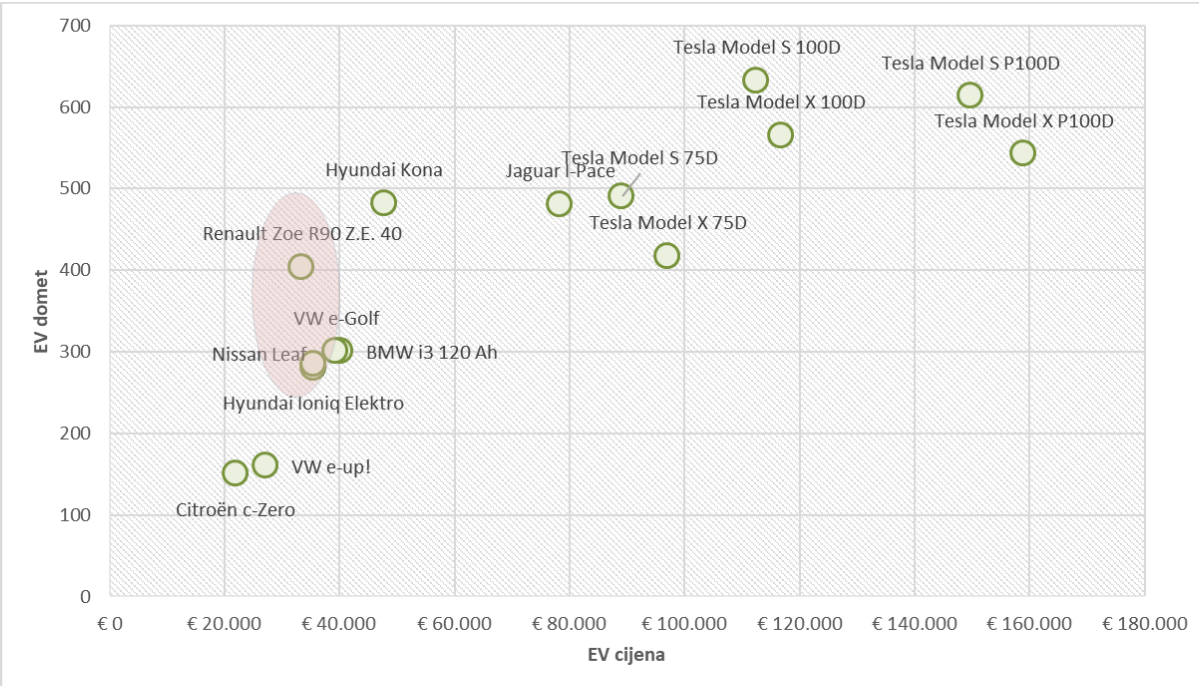
According to the information gathered, four vehicles from the current fleet are currently being replaced. For the purpose of analyzing the costs and benefits in this study, **a scenario was developed in which four vehicles (Table 11) were replaced by new vehicles with the same characteristics or by corresponding electric vehicles.** It was assumed that new vehicles would travel the same annual mileage as the vehicles they replaced.

Table 11 Vehicles in the vehicle fleet of the Communal Police that need to be replaced

Fuel Type	Engine Power (kW)	Year of Manufacture	Vehicle Type	Euro standard	Annual Mileage
Petrol	43	2000	Renault Clio	2	12,600
Petrol	55	2005	Dacia Logan	3	16,200
Petrol	55	2005	Dacia Logan	3	16,130
Petrol	55	2007	Dacia Logan	4	15,650
				Total	**60,580**

According to the information gathered, almost every vehicle belonging to the Communal Police is used on three shifts, and vehicles are used on weekends. Vehicles typically exceed 120 km per day but, except in specific situations, no vehicle exceeds 200 km in one day. It was therefore concluded that the majority of electric vehicles currently available on the EU market could meet all the needs of the Communal Police.

Since there are still relatively few electric vehicles available on the EU market, it is not possible to accurately determine the equivalent of an electric vehicle compared to a conventional one. Therefore, for this analysis, an overview of the range of electric vehicles available was prepared with regard to their range and approximate price; the average price of several vehicle models from the same segment was used for further calculations. A group of vehicles that responded to the needs and requirements of the Communal Police is shown in the chart below. These are all electric vehicles with an autonomy of about 250 to 500 km and a price of about EUR 25,000-40,000. Nissan Leaf and Renault Zoe are the current representatives in this segment.



EV range – EV price

Figure 7 EV Market Overview

Other assumptions used in the analysis are described in the table below.

Table 12 Assumptions for the analysis – public sector

Assumptions	Description
Vehicle Maintenance	The total cost of vehicle maintenance is 50% lower for electric vehicles than conventional ones. The maintenance cost includes all costs borne by the owner during the period of vehicle exploitation, other than the registration, insurance and fuel costs.
Fuel Prices	For calculation purposes, it is assumed that fuel prices will remain at the present level over the next 15 years, including excise duties. The price of 1.19 EUR/l for petrol (excluding VAT) was used for calculation purposes.
Electricity Prices	For calculation purposes it is assumed that the prices of electricity will remain at the present level, for all categories of buyers. The price of 0.077 EUR/kWh of electricity (excluding VAT) was used for calculation purposes.
EV Charging Infrastructure	The analysis includes the costs of setting up the infrastructure for charging electric vehicles. It is a control unit with a total of four sockets, 2x Type2 11kW and 2x schuko socket 3.7kW. The cost is estimated at EUR 2,900 (excluding VAT).
Electricity – connection	It is necessary to build a new electricity connection with a lease capacity of 30 kW. The cost of this item is estimated at EUR 3,000 (excluding VAT).
Annual Mileage Travelled	It is assumed that new vehicles will travel the same mileage as those that they are replacing. An average mileage of 15,100 km per year was used for calculation purposes.
Incentive Level	Financial indicators are calculated in the analyzes given the various amounts of direct subsidies for the purchase of electric vehicles. Subsidy

	levels of EUR 2,500, EUR 5,000, EUR 7,500 and EUR 10,000 were used for calculation purposes, as well as an option without any subsidies.

Determining Project Cost-Effectiveness

Based on the input assumptions and the developed scenario, the total investment for this project amounts to EUR 84,400. This includes additional funds for the purchase of 4 electric vehicles, the procurement of an appropriate charging infrastructure and the cost of connecting to the power grid.

In order to determine the feasibility of the project, the following indicators were used:

- net present value (NPV) of the project is determined at a discount rate of 4%
- Internal Rate of Return (IRR)
- Profitability Index (PI)
- Discounted payback period (PBP)

NPV, IRR, PBP and PI are determined on the basis of the financial flow. A summary of financial calculations is shown in *Table 13* below.

Table 13 Results of financial calculations – Communal Police

Financial Analysis Results

	Incentive Amount for the Purchase of EV				
	EUR 0	***EUR 2,500***	***EUR 5,000***	***EUR7,500***	***EUR 10,000***
FNPV (EUR)	-15,541	-5,541	4,459	14,459	24,459
IRR	1.2%	2.9%	5.0%	7.6%	11.1%
PBP	15	15	13	11	8
PI	0.8	0.9	1.1	1.3	1.6

NPV

The net present value is negative in the case of no incentive as it is also in the case of a EUR 2,500 incentive for the purchase of an EV. In the case of an incentive amounting to EUR 5,000 or more, the net present value of this project is positive.

IRR

The internal rate of profitability is higher than the discount rate in cases where incentives are equal to or greater than EUR 5,000.

PBP

The payback period of the investment is longer than 15 years in the case of no incentive being provided to buy an EV, but it is equal to 15 years with an incentive of EUR 2,500. With the largest incentive level of EUR 10,000 per EV, the investment payback period is 8 years.

PI

The profitability index is less than 1 when incentives range between none at all and EUR 2,500. If the highest incentive level is provided, EUR 10,000 per one EV, the profitability index is 1.6.

Conclusion

It can be concluded from the financial analysis that the introduction of electric vehicles into the Communal Police fleet becomes **financially viable only if incentives of EUR 5,000 or more are provided**. From the point of view of the Communal Police, a segment of the public sector, it can be expected that an investment with a positive FNPV would be deemed to be justifiable.

In addition to the results of the financial analysis, other factors should be taken into account when deciding on whether or not to introduce electric vehicles into the Communal Police fleet. Considering that communal order is one of the key factors that determines the quality of life for citizens, the Communal Police work to raise communal discipline in the capital city through three daily shifts, on work days, at weekends and on holidays. Thus, **by the introduction of electric vehicles into the Communal Police fleet, general public awareness would be raised and concern for the environment and the quality of the environment would be demonstrated by setting a positive example.**

PRIVATE SECTOR

Several companies providing courier services, taxi services and tourist services were considered for the analysis regarding the introduction of electric vehicles into the fleets of private companies. Following discussions with all of the stakeholders and after analyzing the specific characteristics of their activities along with the particular types of vehicle they used for carrying out their activities, it was concluded that the travel agency **TA Grand** would be the subject of the case study.

The Travel Agency Grand was established in May 2004 and is one of the leading travel agencies in Montenegro. As well as offering a wide range of services, including organizing package tours and cruises, booking air tickets, and providing car rentals, TA Grand also offers VIP transfer services to any point in Europe with a professional driver service. Most VIP transfers involve transport from/to Podgorica Airport to destinations such as Budva, Tivat or Dubrovnik. It is within this segment of TA Grand's activities that there is potential for the introduction of electric vehicles, to be used for providing transfer services.

Scenario and Input Assumptions

TA Grand has two vans and three high-class passenger cars with luxury accessories (*Figure 8*). For the purposes of this case study, a scenario was created in which TA Grand needed to purchase an additional vehicle for the provision of the aforementioned service; the option of purchasing an electric vehicle was considered.

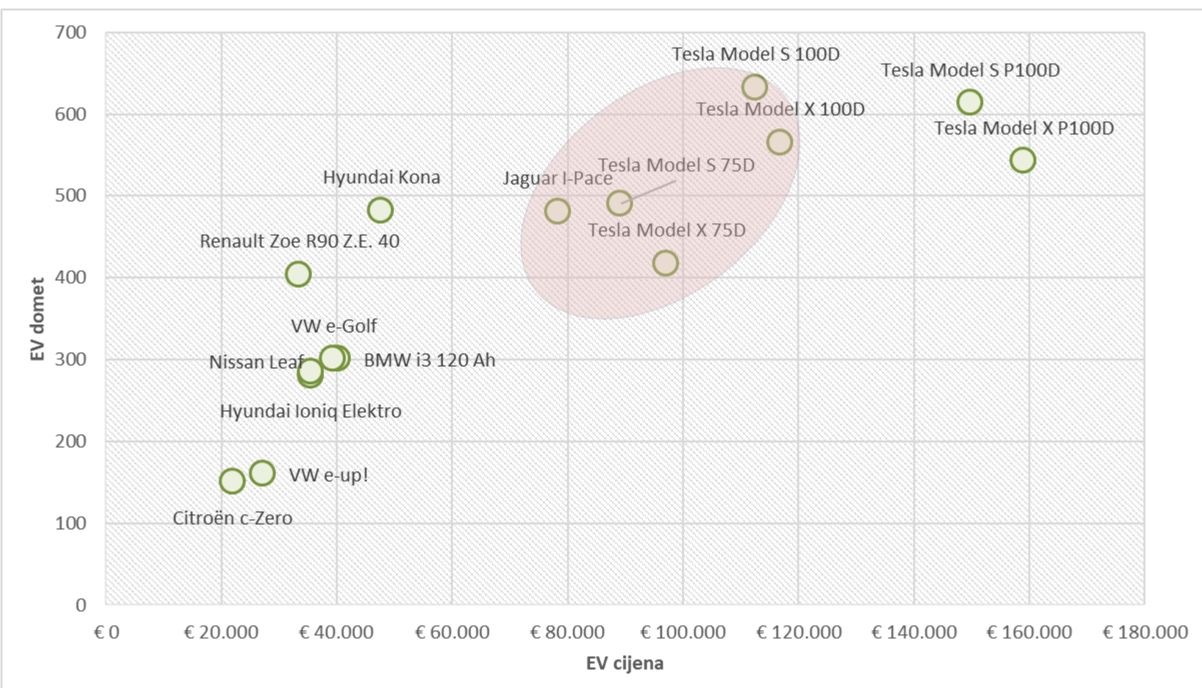
Mercedes E class 220 (Model 2012)

Mercedes S class 350 Bluetec Long (Model 2013)

Mercedes S class 350 Bluetec Long (Model 2015)

Figure 8 Vehicle Fleet TA Grand (personal vehicles)

For the selection of an electric vehicle that would fit in with the existing fleet and be in line with the level of service currently provided, the high-end market of EV was analyzed. The basic criteria for the EV was for it to have a range of more than 350 km and to be in the price-range of EUR 75,000-120,000 (including VAT). Several electric vehicles, mainly Tesla models (**EV range – EV price** *Figure 9*) met this criteria. For this reason, the calculation used data based on the electric vehicle Tesla Model S 75D (*Figure 10*), which cost approximately EUR 70,000 without VAT. The electric vehicle procurement project was analyzed in comparison to the purchase of a conventional vehicle for which the input data was based on the vehicle Mercedes E class AMG estimated at EUR 58,000 without VAT.



EV range – EV price

Figure 9 EV Market Overview

Figure 10 Tesla Model S (Source: Tesla)

The basic features of the car Tesla S are shown in the following table.

Table 14 Basic features of Tesla S model (Source: Tesla)

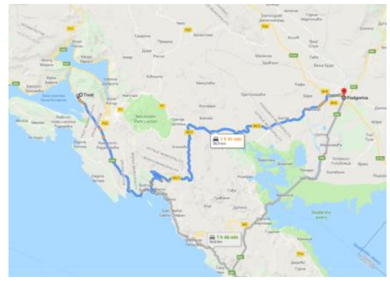
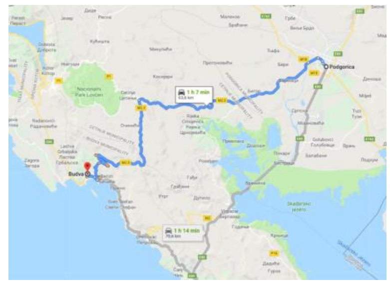
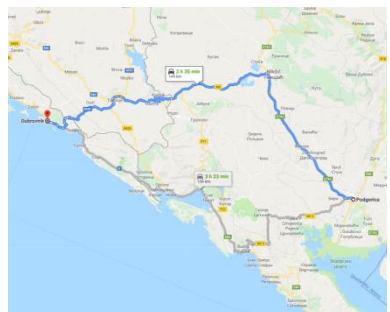
Model	**Tesla S 75D (standard range)**	**Tesla S Long Range**
Drive	All 4 wheels	All 4 wheels
Battery capacity	75 kWh	100 kWh
Approximate charging time on AC charger at a power of 16.5 kW	5h 15m	7h
Range	450 km (WLTP cycle)	610 km (WLTP cycle)
Maximum speed	250 km/h	250 km/h
Acceleration 0-100 km/h	4.2 s	3.8 s
Base price in Germany (without tax)	EUR 69,300	EUR 77,000

Besides purchasing a vehicle, it was also necessary to set up a suitable vehicle charging infrastructure. Since it was a private charging point for just one vehicle, the analysis was based on the installation of a home charger with a Type2 connector of 11 kW. With such a charger, the Tesla S 75D (standard range) can fill 80% of its capacity in about 6 hours.

The characteristics of transfer services provided by TA Grand are recognized as being highly advantageous for using an electric vehicle, in particular due to the predictability of the time, duration and distance of the transfer to be made. Since most transfers are pre-arranged, it is possible to plan the time it takes to charge the vehicle so that it is ready to perform certain tasks at the exact time.

Table 15 Typical transfers TA Grand

Transfer	**Distance (one way /both ways)**	**Route**

Podgorica – Tivat	90/180 km	
Podgorica – Budva	65/130 km	
Podgorica - Dubrovnik	150/300 km	

Other assumptions used in the analysis are described in the following table.

Table 16 Assumption for analysis– private sector

Assumption	Description
Vehicle Maintenance	The total cost of vehicle maintenance is 50% lower for electric vehicles than conventional ones. The maintenance cost includes all costs borne by the owner during the period of vehicle exploitation, other than the registration, insurance and fuel costs.
Fuel Prices	For calculation purposes, it is assumed that fuel prices will remain at the present level over the next 15 years, including excise duties. The price of 1.075 EUR/l for petrol (excluding VAT) was used for calculation purposes.
Electricity Prices	For calculation purposes it is assumed that the prices of electricity will

	remain at the present level, for all categories of buyers. The price of 0.077 EUR/kWh of electricity (excluding VAT) was used for calculation purposes.
EV Charging Infrastructure	The analysis includes the costs of setting up the infrastructure for charging electric vehicles. It is a home charger of 11kW. The installation cost is estimated at EUR1,600 (excluding VAT).
Electricity Connection	It is necessary to build a new electricity connection and lease capacity of 11 kW. The cost of this item is estimated at EUR 2,600 (excluding VAT).
Annual Mileage Travelled	Several scenarios of annual averaged mileage were assumed: 40,000 50,000 and 60,000 kilometers.
Incentive Level	It is anticipated that the battery would need to be replaced in the 7th year of the project, and the cost of this is estimated at EUR 5,800 (excluding VAT).
Incentive level	The analyzes were made on the assumption that direct subsidies for the purchase of electric vehicles would not apply to this vehicle segment.

Determining Project Cost-Effectiveness

Based on the input assumptions and the developed scenario, the total investment for this project amounted to EUR 15,150. This included additional funds for the purchase of an electric vehicle, the procurement of an appropriate charging infrastructure and the cost of connecting to the power grid.

In order to determine the feasibility of the project, the following indicators were used:

- Net present value (NPV) of the project is determined at a discount rate of 4%
- Internal Rate of Return (IRR)
- Profitability Index (PI)
- Discounted payback period (PBP)

NPV, IRR, PBP and PI are determined on the basis of the financial flow. Summarized financial calculations are shown in *Table 17*.

Table 17 Results of financial calculations – TA Grand

Financial Analysis Results

	Annual Mileage (km)		
	40,000	***50,000***	***60,000***
NPV (EUR)	11,333	17,983	24,632
IRR	13%	18%	23%
PBP	8	5	4
PI	2.0	2.4	2.9

NPV

The net present value is positive in all cases. With a minimum mileage of 40,000 km per year, the NPV is EUR 11,300, and with a maximum mileage of 60,000 km, the NPV is EUR 24,600 per year.

IRR

The internal rate of profitability is higher than the discount rate in all cases.

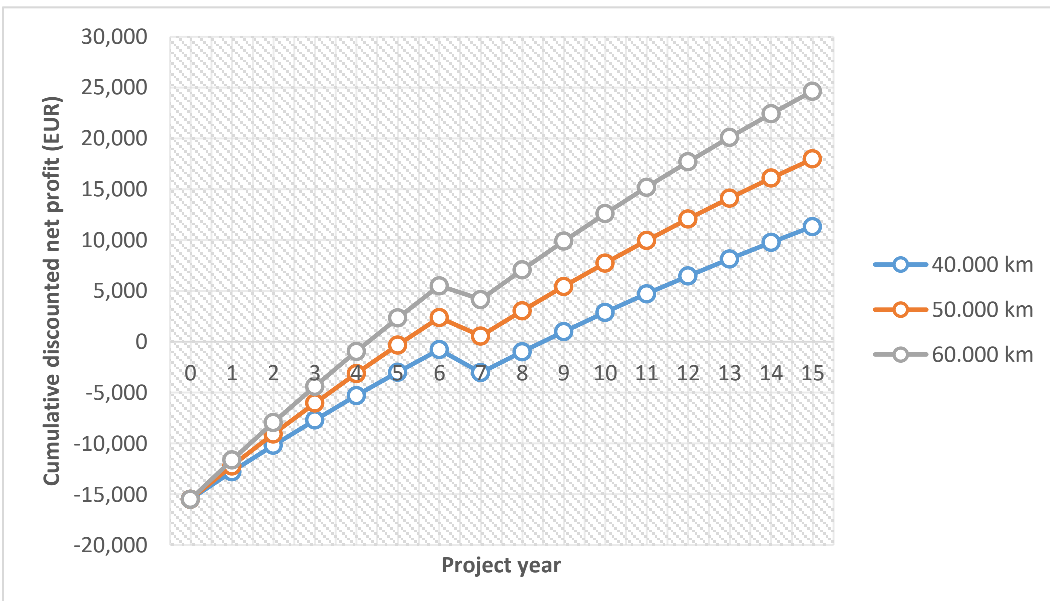
PBP

The investment payback period is 8 years for an annual mileage of 40,000 km, 5 years for an annual mileage of 50,000 km and 4 years for an annual mileage of 60,000 km.

PI

The profitability index is greater than 1 in all three cases. With an annual mileage of 60,000 km the profitability index is 2.9.

The cumulative discounted net profit, where a drop in the seventh year of the project is observed due to an investment in replacing the battery of the electric vehicle, is shown in Cumulative discounted **net profit - Project Year**
Figure 11.



Cumulative discounted net profit - Project Year

Figure 11 Cumulative discounted net profit

Conclusion

The financial analysis, based on established assumptions, showed that the project was profitable for all indicators. However, it should be noted that there are very few vehicle models available on the electric vehicle market and therefore it is difficult to determine the equivalent of a conventional vehicle. In particular, this refers to the segment of luxury vehicles that were considered in this case study; it should, therefore, be borne in mind that financial indicators could vary considerably with regard to the models of vehicles compared.

In addition to the positive financial performance indicators of the project, the introduction of an electric vehicle to the fleet, for the purpose of providing transfer services, was accompanied by an innovative approach to creating more tourist offers and to offering higher standards of business, all of which are characteristic of TA Grand.

CONCLUSIONS

The purchase of an electric vehicle within the current market requires a considerably greater level of investment compared with the purchase of a conventional vehicle of the same class. On the other hand, the regular maintenance of an electric vehicle is less costly and the costs of consumed energy are also lower. Part of this study included carrying out cost-effectiveness analyzes for the purchase of electric vehicles and corresponding charging devices for the observed period of 15 years; analyzes were carried out for the civil sector and for individual cases in both the public and private sectors.

All analyzes took into account the characteristics specific to Montenegro, such as the average mileage of personal vehicles, the expected range (autonomy) of vehicles owned by individual users, the fiscal policy of the state (customs, excises, taxes) and the market energy situation.

The analyzes concluded that there was a need to establish an incentive mechanism for the purchase of electric vehicles, to review the general benefits gained at a state level, and finally, to examine the integration of electric vehicles into the electric power system.

INCENTIVES FOR PURCHASING ELECTRIC VEHICLES

The financial analysis showed that direct incentives for the purchase of electric vehicles in the public and private sectors played a crucial role in the profitability of such investments. In the case of no incentive being provided, the net present value was only positive, the return period of the investment was only less than 15 years, and the profitability index was only greater than 1 **when a vehicle exceeded 20,000 km per year or more**. Previous market research found that only 18% of the population annually exceeded 15,000 km. Based on this, it was concluded that it is necessary to establish certain incentive mechanisms for citizens to purchase electric vehicles in order to initiate the development of e-mobility in Montenegro.

The same goes for the public sector. Here the financial indicators were even more unfavorable due to input parameters based on the purchase of electric vehicles in comparison with conventional low-priced vehicles.

Regarding the private sector, the diversity of business activities and the way transport is used makes it impossible to make a general conclusion about either the need or the amount of incentives required for the purchase of electric vehicles. In the particular case that was analyzed in this study, the financial indicators were shown as positive for investing in a high-class electric vehicle compared to a high-class conventional vehicle to provide transfer services without any the provision of any financial incentives. However, it seems that the analysis of many private entities would nevertheless show that incentives play a crucial role in assessing cost-effectiveness and in the decision-making process of whether or not to purchase electric vehicles. Other, primarily promotional effects should also be taken into account; by granting financial incentives, would a number of business entities perhaps decide to purchase electric vehicles?

POTENTIAL BENEFITS

A significant positive impact on society would result from achieving a successively greater percentage of electric vehicles within the total number of registered passenger vehicles in Montenegro; it is hoped that this will increase substantially over the next thirty years. Namely, the positive externality, in terms of avoided CO_2 emissions, is a result that has no impact on the investor, but it can be monetized in the context of having a positive effect on society. During the period up to 2050, the total monetized social benefit of avoided CO_2 emissions, due to the introduction of electric vehicles, could potentially amount to approximately EUR 530,000,000.

An increase in the number of electric vehicles carries with it the related responsibility of creating a charging infrastructure as well as the development of new associated services. Therefore, it is also important to point out that there are significant benefits at a state level that have not been quantified in the analyzes within this study but that will result from the overall development of e-mobility. This primarily relate to an increase in tourism revenue due to a higher number of foreign tourists using electric vehicles. Developing e-mobility increases the attractiveness of Montenegro as a tourist destination and at the same time presents it as an environmentally conscious country. Furthermore, a developed infrastructure for charging electric vehicles would enable the development of new services and business models along with the creation of added value. All of this contributes to the creation of new jobs and the strengthening of the national economy.

IMPACT ON ELECTRICAL GRID

The development of e-mobility would encourage the integration of renewable energy sources into the power system, it would reduce greenhouse gas emissions and the emission of pollutants at a local level and would also decrease dependence on imported fossil fuels.

Looking at the year 2050, electric passenger vehicles would generate an additional load for the existing power system with an additional peak load of 300 MW.

Within the context of the flexibility of the power system, in 2050, electric vehicles with a potential distribution tank capacity of approximately 16 GWh could actively participate in balancing the system. The available capacity at any given moment would depend on several factors such as the percentage of vehicles connected to the power system at any given time on slow chargers, on battery charge status, and on vehicle owners' default settings.

Regarding the functionality of a system in which electric vehicles represented distributed energy storage for intermittent energy sources, along with the potential for providing flexibility within the service, certain preconditions would need to be met. Such preconditions can be divided into technical, legal and regulatory, and economic requirements. In technical terms, the basic precondition for providing flexibility is the existence of infrastructure, vehicles and other parts of the system that support bi-directional electricity flow and data exchange, and where all elements are integrated into one smart grid concept. From a legal and regulatory viewpoint, it is necessary to recognize the elements of the e-mobility concept in terms of providing new services, including the ability to provide flexibility to the power system, and its definition within the legal framework. Finally, the need to manage the entire process of providing flexibility within services creates an opportunity for the creation of new business models in which various stakeholders would find interests. To achieve this, a sufficient number of electric vehicles is required along with an adequate infrastructure to economically justify such processes.

LIST OF FIGURES

LIST OF TABLES