10th INTERNATIONAL CONGRESS ON TRANSPORTATION RESEARCH

ICTR 2021

September 1-3
Rhodes, Greece

Techno-Economic Feasibility Analysis for Electromobility in the Region of Attica

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Introduction

- The transportation sector
  - Consumes nearly 2/3 of global oil consumption
  - Highly contributes to CO_2 emissions
- Smart and sustainable cities are gaining more and more attention
- Electromobility and alternative fuels are key solutions towards sustainability and urban life quality improvement
- The penetration rate of electric cars in the European Region is being slowly increased during the last years
- The increase of electric vehicles is a major target within the framework of more environmentally friendly, cleaner and greener transportation systems

Objective

The objective of the paper is the techno-economic feasibility analysis of the supply, optimal management and operation of:

- electric service vehicles,
- charging stations &
- management software

by the Region of Attica

Methodology

- Three alternative scenarios are analyzed that differ based on the distribution of electric vehicles to be supplied:
  - S1: passenger cars
  - S2: passenger cars & trucks
  - S3: passenger cars, trucks & construction machinery
  - S0: current situation

- For each scenario, the impacts on the following indicators are estimated, with a time horizon of 15 years (2021-2035):

Circulation Tax

Vehicle Maintenance

Energy Consumption

Emergency Project Machinery

Environment

	Vehicle Type	S0	S1	S2	S3
Conventional	Passenger Car–5seats	100	32	70	86
	Passenger Car–9seats	4	4	0	0
	Truck	22	22	2	2
	Street Sweeper	5	5	5	0
	Plow	6	6	6	0
Battery Electric	Passenger Car–5seats	0	68	30	14
	Passenger Car–9seats	0	0	4	4
	Truck	0	0	20	20
	Street Sweeper	0	0	0	5
	Plow	0	0	0	6
	Charging Stations	0	21	17	15
Conventional Fleet		**137**	**69**	**83**	**88**
Battery Electric Fleet		**0**	**68**	**54**	**49**

- The estimation of the investment cost in each scenario is based on the:
  - cost of purchasing battery electric vehicle fleet
  - installation cost of electric car charging station
  - cost for the use of software

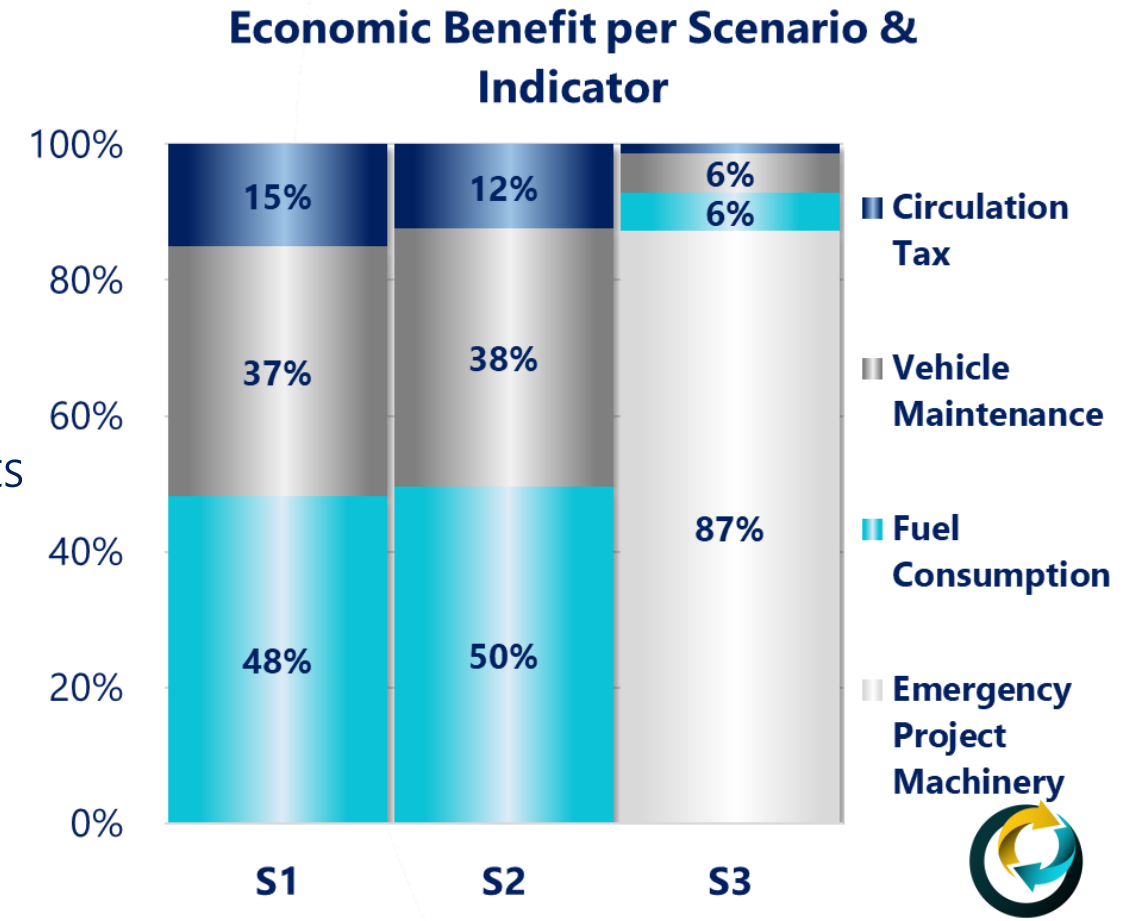
- The CBA for the supply of electric service vehicles is performed using the Internal Rate of Return

Results

Cost Benefit Analysis

- The highest investment cost for the supply and operation of electric fleet of service vehicles, is observed in S3 due to the high cost of electric construction machinery
- Scenario S3 presents the highest IRR index (IRR=15.5%)
- The S1 has a positive IRR with the most significant benefit (48%) coming from fuel consumption
- The S2 presents a similar distribution of economic benefits in relation to S1
- The most important economic benefit in S3 is due to the supply of new construction machinery, leading to the avoidance of the annual cost of renting construction machinery

	S1	S2	S3
Investment Cost	**-1,994,000 €**	**-2,388,000 €**	**-4,680,000 €**
Benefits (2021-2035)	**2,249,102 €**	**1,919,174 €**	**12,387,734 €**
IRR	**1.5%**	**-2.5%**	**15.5%**



Results

Sensitivity Analysis

- The value of IRR index increases as the percentage of annual change in the price of gasoline increases while it decreases as the rate of annual change in the price of electricity increases

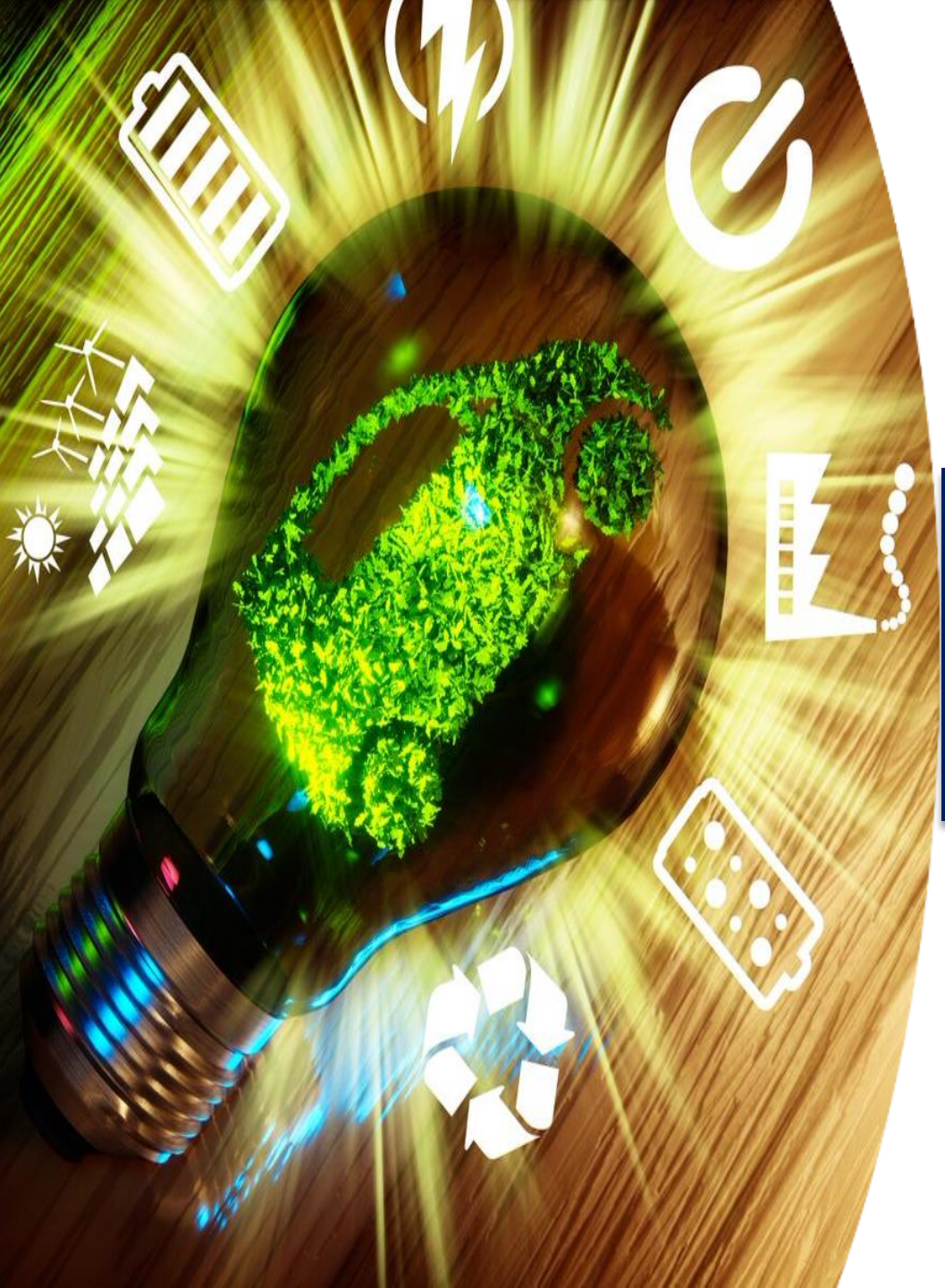
- The IRR index increases as the purchase price of battery electric vehicles decreases

Annual change in electricity price \ Annual change in the price of gasoline	-0.1%	-0.05%	0.05%	0.1%	0.15%	0.2%
-0.1%	15.0%	15.0%	15.7%	15.7%	15.7%	15.7%
-0.05%	15.0%	15.0%	15.7%	15.7%	15.7%	15.7%
0.05%	14.8%	14.8%	15.4%	15.5%	**15.5%**	15.5%
0.1%	14.8%	14.8%	15.4%	15.5%	15.5%	15.5%
0.15%	14.8%	14.8%	15.4%	15.5%	15.5%	15.5%
0.2%	14.8%	14.8%	15.4%	15.4%	15.5%	15.5%

Battery Electric Passenger Car Price (€) \ Electric Snowplows Price (€)	200,000	250,000	320,000	370,000	420,000
10,000	20.5%	18.6%	16.5%	15.1%	13.9%
15,000	20.0%	18.3%	16.1%	14.8%	13.6%
25,000	19.2%	17.5%	**15.5%**	14.2%	13.1%
35,000	18.4%	16.8%	14.9%	13.7%	12.6%
45,000	17.6%	16.1%	14.3%	13.1%	12.1%

Conclusion

- Scenario S3 in which all the electric vehicle types under consideration are supplied, is the most economically feasible scenario for the Region of Attica, since it shows the highest IRR= 15.5% and therefore the highest efficiency
- Regarding scenarios S1 and S2, the most significant economic benefit comes from the fuel consumption followed by the vehicle maintenance
- The most important economic benefit in S3, is due to the supply of new construction machinery and mainly electric snowplows
- Even in extreme price changes over a 15-years period, the IRR index remains positive, ensuring the feasibility of the investment
- This research paper highlights the opportunities and benefits that the gradual transition to e-mobility can create and offer in the Region of Attica



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