

ECONOMIC, INFRASTRUCTURAL AND OPERATIONAL ANALYSIS OF THE ADVANTAGES AND DISADVANTAGES OF ELECTRIC VEHICLES

Y. Yoqubov

Senior Lecturer, Andijan State Technical Institute

O. Hakimov

Student, Andijan State Technical Institute

<https://doi.org/10.5281/zenodo.20546836>

Abstract: Electric vehicles are increasingly considered a strategic direction in the modernization of road transport, energy policy and sustainable urban mobility. While the technical and environmental benefits of electric vehicles are widely discussed, their practical implementation also depends on economic feasibility, charging infrastructure, service readiness, electricity supply, user behavior and operating conditions. This article analyzes the advantages and disadvantages of electric vehicles from economic, infrastructural and operational perspectives. The study examines the total cost of ownership of electric vehicles, including purchase price, energy cost, maintenance cost, battery life, depreciation, charging costs and potential savings compared with internal combustion engine vehicles. It also discusses the role of public and private charging infrastructure, home charging, fast charging, grid capacity, smart charging, service networks and high-voltage safety requirements. The operational limitations of electric vehicles are analyzed through factors such as range anxiety, charging duration, cold-weather performance, battery degradation, long-distance travel, rural use, towing load, used vehicle market uncertainty and dependence on the electricity tariff system. The results indicate that electric vehicles can provide significant long-term economic benefits under appropriate conditions, especially in urban driving, fleet operation, daily commuting and regions with affordable electricity. However, these benefits are reduced when charging infrastructure is insufficient, electricity prices are high, battery replacement risks are unclear or the vehicle is used in harsh climatic and long-distance conditions. The article concludes that the economic success of electric vehicles depends not only on the vehicle itself, but also on the coordinated development of charging infrastructure, energy systems, service education, battery recycling and supportive transport policy.

Keywords: electric vehicle, economic efficiency, total cost of ownership, charging infrastructure, maintenance cost, battery degradation, service system, operating cost, electric mobility, sustainable transport.

1. Introduction

The development of electric vehicles is one of the most important transformations taking place in the global automotive industry. For many decades, the economic model of road transport was based on internal combustion engine vehicles using gasoline or diesel fuel. This model created a wide network of fuel stations, service workshops, spare parts suppliers, repair specialists and vehicle operating practices. Electric vehicles introduce a different transport model. Instead of fuel tanks, fuel pumps, engine oil systems, exhaust systems and complex combustion processes, they rely on batteries, electric motors, inverters, onboard chargers, high-voltage cables and charging infrastructure. This transformation affects not only vehicle design but also the economics of vehicle ownership, maintenance, service, energy supply and infrastructure planning.

The question of whether electric vehicles are economically advantageous cannot be answered only by comparing the purchase price of an electric car with the purchase price of a gasoline car. In many markets, electric vehicles may have a higher initial price because the traction battery is expensive. However, during operation, electric vehicles may offer lower energy costs, lower

routine maintenance costs, reduced brake wear due to regenerative braking and fewer mechanical failures in some systems. Therefore, the correct economic analysis must consider the total cost of ownership. Total cost of ownership includes purchase cost, fuel or electricity cost, maintenance, repair, insurance, taxes, depreciation, battery replacement risk, charging equipment and resale value.

The economic attractiveness of electric vehicles depends strongly on local conditions. In a country where electricity is relatively affordable and fuel is expensive, electric vehicles may become economically beneficial faster. In a region where public charging infrastructure is weak, electricity tariffs are high or long-distance travel is common, the advantages may be more limited. For this reason, electric vehicle analysis should be connected with real operating conditions, infrastructure readiness and energy policy.

In addition to economic issues, infrastructure is a decisive factor. A conventional vehicle can be refueled within a few minutes at a fuel station. An electric vehicle requires charging, and charging can take from several minutes to many hours depending on charger type, battery capacity, state of charge and charging power. Home charging is convenient for users who have private parking or garages. However, people living in apartment buildings or dense urban areas may not have access to private chargers. Public charging stations, workplace charging, shopping center chargers, highway fast chargers and fleet depot chargers are therefore necessary for wider electric vehicle adoption.

Operational factors are also important. Electric vehicles are convenient for daily commuting and city driving, where routes are predictable and overnight charging is possible. They are also useful for taxi fleets, delivery vehicles and municipal transport if charging is properly organized. However, long-distance travel, cold weather, high-speed highway driving, heavy loads and towing can reduce driving range and increase energy consumption. This means that electric vehicles should be selected according to usage profile rather than promoted as a universal solution for every condition without analysis.

The purpose of this article is to analyze the advantages and disadvantages of electric vehicles from economic, infrastructural and operational perspectives. The article aims to explain when electric vehicles are economically beneficial, what infrastructure is required for their effective use, what operational limitations remain and what measures can increase their practical value. The study is relevant for automotive engineering students because electric mobility requires knowledge not only of vehicle construction but also of energy systems, service organization, charging technology and economic analysis.

2. Literature Review

Research on electric vehicle economics often uses the total cost of ownership approach. This method considers all major expenses during the vehicle's life rather than only the purchase price. In the case of internal combustion engine vehicles, the main operating costs are fuel, engine oil, filters, spark plugs, belts, exhaust system maintenance and mechanical repairs. In the case of electric vehicles, the main costs are electricity, tire wear, brake maintenance, cooling system maintenance, battery degradation, charging equipment and high-voltage system diagnostics. Studies show that electric vehicles may have lower operating costs, but the final result depends on annual mileage, electricity price, fuel price, vehicle price, maintenance cost and depreciation.

Another group of studies focuses on charging infrastructure. The availability of charging stations affects user confidence and market adoption. Charging infrastructure can be divided into home charging, workplace charging, public slow charging and public fast charging. Home charging is usually the cheapest and most convenient option because the vehicle can be charged overnight. Workplace charging is useful for users who drive during the day and park for several hours. Public slow charging is suitable for parking areas, hotels, universities and shopping centers.

Fast charging is essential for long-distance travel and for users who cannot charge at home. However, fast charging stations are expensive, require high electrical capacity and must be located strategically.

Battery research is also highly important for economic evaluation. The battery is the most expensive component of an electric vehicle and its condition strongly affects resale value. Battery degradation is influenced by temperature, charging habits, fast charging frequency, depth of discharge and battery management quality. A battery may still function after many years, but its capacity gradually decreases. This means that an electric vehicle's range may become shorter over time. Buyers of used electric vehicles often pay attention to battery state of health, warranty conditions and replacement cost.

Research on electric vehicle maintenance shows that electric vehicles have fewer moving parts than internal combustion engine vehicles. They do not need engine oil changes, fuel filters, exhaust repairs or many traditional engine services. However, they require other types of maintenance, such as high-voltage safety checks, battery cooling system inspection, software diagnostics, insulation resistance testing, charging port inspection and thermal management service. Thus, electric vehicle maintenance is not simply "less maintenance"; rather, it is a different type of maintenance. Automotive service education must adapt to this change.

Policy studies emphasize that electric vehicle adoption depends on incentives, standards and regulations. Purchase subsidies, tax exemptions, import duty reductions, parking benefits, charging infrastructure support and low-emission zone policies can accelerate adoption. However, incentives alone are not enough. If charging infrastructure is inconvenient, service networks are weak or consumers lack information, adoption remains limited. Therefore, electric mobility policy should combine vehicle incentives with infrastructure planning, grid development, technical education and battery recycling.

The literature generally agrees that electric vehicles can provide economic and operational advantages, especially in urban use and high-mileage fleets. However, the benefits vary widely by country, climate, energy prices and infrastructure level. A balanced analysis must therefore include both advantages and disadvantages.

3. Research Methodology

This article uses analytical, comparative and system-based research methods. The object of analysis is the battery electric vehicle as a transport technology. The comparison is made with internal combustion engine vehicles, mainly gasoline and diesel passenger cars. The analysis focuses on economic, infrastructural and operational criteria.

The economic criteria include initial purchase price, electricity cost, fuel savings, maintenance cost, repair cost, battery warranty, battery replacement risk, depreciation and total cost of ownership. The infrastructural criteria include home charging, public charging, fast charging, grid capacity, charging station location, charger reliability, payment systems and maintenance of charging equipment. The operational criteria include driving range, charging time, daily commuting, long-distance travel, climate influence, battery degradation, user habits, fleet operation and service readiness.

The study is based on a qualitative comparison rather than a numerical calculation for one specific model. This approach is suitable for a diploma project because it allows the general advantages and disadvantages of electric vehicles to be explained in a systematic way. In addition, the article includes a model for evaluating the economic feasibility of electric vehicles under practical conditions. This model can be adapted for future calculations using real electricity tariffs, fuel prices, vehicle prices and annual mileage.

The research methodology includes the following stages. First, the main economic characteristics of electric vehicles are identified. Second, the infrastructure requirements for

charging and service are analyzed. Third, the operational advantages and limitations are examined. Fourth, the results are discussed in relation to sustainable transport development and the needs of developing electric mobility systems.

4. Economic Advantages of Electric Vehicles

One of the most important economic advantages of electric vehicles is the reduction of energy cost per kilometer. An internal combustion engine vehicle consumes gasoline or diesel fuel, while an electric vehicle consumes electricity. Because electric motors are more efficient than combustion engines, electric vehicles usually require less energy to travel the same distance. When electricity prices are favorable, the cost of driving one hundred kilometers can be significantly lower than the cost of driving the same distance with gasoline or diesel.

The economic advantage becomes stronger for drivers who travel many kilometers per year. For example, a private driver who uses a vehicle only occasionally may not recover the higher purchase price quickly. However, a taxi driver, delivery company, municipal fleet or corporate fleet may benefit more because energy savings accumulate every day. High annual mileage increases the importance of operating cost and reduces the relative importance of purchase price over time.

Another economic advantage is reduced routine maintenance. Electric vehicles do not require engine oil changes, spark plug replacement, timing belt replacement, fuel injector cleaning or exhaust system maintenance. These services are common in internal combustion engine vehicles and create regular expenses. Electric vehicles have fewer mechanical components in the drivetrain, and this can reduce maintenance frequency. Regenerative braking also reduces friction brake wear because part of the deceleration is performed by the electric motor. As a result, brake pads and discs may last longer, especially in city driving.

Electric vehicles can also reduce downtime for fleet operators. If a vehicle requires less routine maintenance, it spends more time in service and less time in repair shops. For commercial fleets, vehicle availability is directly related to income. A taxi that is not operating because of maintenance does not generate revenue. A delivery vehicle that is unavailable can delay logistics. Therefore, reduced maintenance has not only direct cost benefits but also productivity benefits.

Electric vehicles may also provide economic benefits through energy independence. Countries that import large amounts of petroleum products are exposed to international fuel price fluctuations. Electric vehicles can use electricity generated from domestic sources, including natural gas, hydropower, solar energy, wind energy or other local resources. This can reduce dependence on imported fuel and improve national energy security. If renewable energy is expanded, electric transport can become even more economically and environmentally attractive.

In some regions, governments provide incentives for electric vehicles. These may include tax reductions, import duty benefits, lower registration fees, parking privileges, access to restricted zones or subsidies for chargers. Such measures can reduce the cost difference between electric and conventional vehicles. However, incentives should be designed carefully so that they support real usage and infrastructure development rather than only vehicle import.

5. Economic Disadvantages and Cost Risks

Despite operating cost advantages, electric vehicles have several economic disadvantages. The first and most obvious is the higher initial purchase price. Although battery prices have declined over time, the battery remains one of the most expensive parts of an electric vehicle. Vehicles with larger batteries and longer driving ranges are usually more expensive. This creates a barrier for consumers who make decisions based mainly on purchase price.

The second disadvantage is uncertainty about battery replacement cost. Modern electric vehicle batteries are designed to last many years and are usually covered by warranty, but battery degradation still occurs. If a battery loses significant capacity after warranty expiration,

replacement may be expensive. Even if full replacement is not needed, battery condition affects the resale value of the vehicle. Used car buyers may hesitate if they cannot easily verify battery state of health.

Depreciation is another important economic factor. The resale value of electric vehicles depends on battery condition, brand reputation, charging standard compatibility, software support and market demand. If new battery technology develops quickly, older electric vehicles may lose value faster because their range and charging speed become less attractive. On the other hand, if fuel prices rise and charging infrastructure improves, used electric vehicles may become more desirable. Therefore, depreciation is uncertain and market-dependent.

Charging equipment can also add cost. A user who has a private house may install a home charger, but installation requires electrical wiring, safety devices and sometimes grid connection upgrades. In apartment buildings, charger installation can be more complicated due to shared parking, ownership issues, electrical capacity and permission procedures. For commercial fleets, depot charging infrastructure may require significant investment in transformers, cables, chargers, control systems and parking layout changes.

Electricity tariffs can affect the economic benefit. If electricity prices increase significantly, the fuel savings of electric vehicles may decrease. Time-of-use tariffs can be beneficial if users charge at night when electricity is cheaper. However, if tariffs are not designed properly or if users charge during peak hours, operating costs may rise. Therefore, electricity pricing policy is important for electric vehicle economics.

Insurance and repair costs may also be higher in some markets. Electric vehicles contain expensive batteries, sensors, power electronics and software-controlled components. If a vehicle is damaged in an accident, repair may require specialized equipment and trained technicians. In regions where service centers are limited, repair costs and waiting times may increase. Thus, economic analysis should include not only routine maintenance but also repair risk.

6. Charging Infrastructure as a Key Condition

Charging infrastructure is one of the most important factors determining the success of electric vehicles. Even the most advanced electric vehicle becomes inconvenient if charging is difficult. Charging infrastructure should be planned according to user needs, parking habits, urban structure, electrical grid capacity and transport routes.

Home charging is the foundation of convenient electric vehicle use. Many users prefer to charge at home overnight. This is similar to charging a mobile phone: the vehicle is connected in the evening and ready in the morning. Home charging reduces dependence on public stations and usually has lower cost. However, it is available mainly to users who have private parking, garages or dedicated spaces. In apartment buildings, many users do not have personal charging points. This creates inequality in access to electric mobility.

Workplace charging is another useful solution. Many vehicles remain parked for several hours during the working day. If workplaces install chargers, employees can recharge while they work. Workplace charging can reduce pressure on public chargers and support users who cannot charge at home. Universities, factories, government offices and business centers can become important charging locations.

Public charging is necessary for drivers who travel longer distances or lack private charging. Public chargers should be reliable, easy to access, visible, safe and compatible with different vehicle models. Payment systems should be simple. If chargers are broken, occupied or too few, users lose confidence. Therefore, charger maintenance is as important as charger installation.

Fast charging is essential for highway travel and commercial use. A fast charger can add significant range in a short time, but it requires high power. Installing fast chargers may require grid upgrades, transformer capacity, cooling systems, safety equipment and digital communication

systems. Fast charging stations should be located along main roads, near service areas, shopping centers and transport corridors.

The charging infrastructure must also be integrated with the electrical grid. If many vehicles charge at the same time during peak demand, the grid may experience additional stress. Smart charging can help solve this problem by shifting charging to periods when electricity demand is low or renewable energy supply is high. In the future, vehicle-to-grid technologies may allow electric vehicles to return power to the grid, but this requires technical standards, battery warranty solutions and market mechanisms.

7. Operational Advantages in Daily Use

Electric vehicles have strong advantages in daily urban use. Most daily trips are relatively short, and many drivers travel predictable routes between home, work, school, shops and service areas. For this usage pattern, an electric vehicle is very convenient. The driver can charge at home or at work and does not need to visit a fuel station frequently.

Driving comfort is another advantage. Electric motors provide smooth acceleration and instant torque. In city traffic, this makes driving easier and more responsive. There is no gear shifting shock in many electric vehicles, and noise is lower than in internal combustion engine vehicles. This improves comfort for drivers and passengers.

Electric vehicles are also suitable for stop-and-go traffic. In congested urban conditions, internal combustion engines often operate inefficiently because they idle, accelerate and brake repeatedly. Electric vehicles are more efficient in such conditions because they do not consume energy in the same way when stopped, and regenerative braking recovers part of the energy during deceleration. This makes electric vehicles especially attractive for taxis, buses, delivery vehicles and municipal fleets.

Another advantage is the possibility of preconditioning. Many electric vehicles allow the cabin to be cooled or heated while the vehicle is still connected to the charger. This means that the driver starts the trip with a comfortable cabin without using battery energy during the first minutes of driving. Preconditioning can also improve battery temperature and efficiency.

For fleet operators, electric vehicles provide predictable energy management. Vehicles can be charged according to schedule at depots. Delivery companies can calculate daily route distance, charging needs and operating costs. If properly planned, electric fleets can be economically efficient and environmentally beneficial.

8. Operational Disadvantages and Limitations

The main operational disadvantage of electric vehicles is range limitation. Although modern electric vehicles can travel much farther than early models, their range is still influenced by many factors. High speed, cold weather, heavy load, aggressive driving, use of heating or air conditioning and mountainous roads can reduce range. Drivers must understand that official range values are laboratory-based and real-world range may be different.

Charging time is another limitation. Even with fast charging, electric vehicle charging usually takes longer than filling a fuel tank. This may not be a problem for daily commuting if the vehicle charges overnight, but it becomes important during long trips. Drivers may need to plan stops, check charger availability and wait if chargers are occupied.

Cold weather can reduce electric vehicle performance. Low temperature affects battery chemistry and increases energy demand for cabin heating. In winter conditions, the driving range can decrease noticeably. Battery thermal management and heat pump systems can reduce this problem, but they do not eliminate it completely. Hot weather can also affect energy consumption because air conditioning and battery cooling require electricity.

Long-distance travel requires a reliable charging network. If charging stations are far apart or unreliable, drivers may experience range anxiety. Range anxiety is not only a technical problem

but also a psychological barrier. Even if the vehicle has enough range, users may feel uncertain if they do not trust the infrastructure.

Towing and heavy load operation can significantly increase energy consumption. Electric vehicles can tow trailers, but range may decrease sharply under towing conditions because aerodynamic resistance and rolling resistance increase. This is especially important for pickup trucks, commercial vehicles and users who frequently carry heavy loads.

Rural use may also be more challenging. In rural areas, distances may be longer and charging stations fewer. Users may depend heavily on home charging. If electrical capacity is weak or power supply is unreliable, electric vehicle operation becomes more difficult. Therefore, rural electrification and grid reliability are part of electric mobility development.

9. Service and Maintenance Transformation

The transition to electric vehicles changes the structure of automotive service. Traditional mechanics are trained to work with engines, transmissions, fuel systems, exhaust systems and mechanical diagnostics. Electric vehicles require additional knowledge of high-voltage safety, battery systems, inverters, electric motors, onboard chargers, charging communication and software diagnostics.

High-voltage safety is essential. Electric vehicle battery packs operate at high voltage, and incorrect handling can be dangerous. Service workers need special training, insulated tools, personal protective equipment and safety procedures. Before repairing high-voltage components, the system must be safely disconnected and verified. Emergency responders also need training for electric vehicle accidents, battery fires and damaged high-voltage systems.

Routine maintenance of electric vehicles is different but not absent. Tires, suspension, steering, cabin filters, brake fluid, coolant, wipers and lighting systems still require inspection. Battery cooling systems may require maintenance depending on design. Software updates and diagnostic scanning are also important. Charging ports and cables must be checked for damage, overheating or corrosion.

Service networks must adapt. If electric vehicles become common but qualified service centers are few, repair delays and costs may increase. Universities and technical institutes should therefore update curricula to include electric vehicle technology. Students should learn battery structure, electric motor operation, power electronics, charging systems, insulation testing, safety rules and diagnostic methods.

Spare parts supply is another issue. Electric vehicles use different components from conventional vehicles. Batteries, inverters, onboard chargers, DC-DC converters, electric compressors and high-voltage cables may not be available in ordinary parts shops. A reliable supply chain is necessary for maintaining electric vehicles over many years.

10. Infrastructure and Policy Considerations for Developing Markets

For countries where electric mobility is still developing, the introduction of electric vehicles requires careful planning. It is not enough to allow import of electric vehicles. A complete system must be created. This system includes charging stations, technical standards, service training, safety regulations, electricity tariff policy, parking policy, battery recycling and public awareness.

Charging infrastructure should be developed gradually but strategically. First, chargers should be installed in major cities, universities, government institutions, shopping centers and service stations. Then intercity highway corridors should be covered with fast chargers. Finally, residential charging solutions should be expanded, especially for apartment buildings. Without residential charging, many urban users will not be able to own electric vehicles conveniently.

Electricity grid capacity must be considered. If many electric vehicles are charged in one neighborhood at night, local transformers may need upgrading. If fast charging stations are

installed along highways, high-power electrical connections are required. Grid planning should therefore include expected electric vehicle growth.

Tariff policy is important. Time-of-use tariffs can encourage users to charge at night when demand is lower. Smart charging can reduce peak loads and make better use of renewable energy. If tariffs are too high or unpredictable, electric vehicle operating cost advantages may decrease.

Battery recycling policy should be prepared before large numbers of batteries reach end of life. Used electric vehicle batteries can sometimes be used for stationary energy storage before recycling. Recycling can recover valuable materials and reduce environmental harm. Regulations should define collection, transportation, safety, responsibility and recycling standards.

Public awareness is also necessary. Many consumers have questions about battery life, charging time, range, safety and maintenance. Accurate information can reduce fear and unrealistic expectations. Dealers, universities, service centers and media can help educate users.

11. Comparative Economic Discussion

The economic comparison between electric vehicles and internal combustion engine vehicles depends on the balance between higher initial price and lower operating cost. If the electric vehicle is used intensively, operating savings can compensate for the purchase price difference. If the vehicle is rarely used, the economic advantage may take longer to appear.

For example, a driver who travels 30,000 kilometers per year saves much more energy cost than a driver who travels 5,000 kilometers per year. A taxi or delivery vehicle may therefore be an ideal candidate for electrification. In contrast, a private vehicle used only occasionally may not generate enough savings to justify a higher purchase price unless incentives or other benefits are available.

Fuel and electricity prices are decisive. If fuel prices rise, electric vehicles become more attractive. If electricity prices rise or public fast charging is expensive, the advantage decreases. Home charging is usually more economical than public fast charging. Therefore, users with access to home charging often benefit more.

Maintenance savings are real but should not be exaggerated. Electric vehicles avoid many engine-related services, but tires, suspension, brakes, cooling systems and electronic components still require attention. In some cases, electric vehicles may have higher tire wear because batteries increase vehicle weight and electric motors provide strong torque. Therefore, maintenance analysis should be realistic.

Battery replacement risk is often a concern. However, many batteries last longer than early users expected if properly managed. Battery warranties provide some protection, but used vehicle buyers still need diagnostic information. Battery state-of-health reporting may become important for used electric vehicle markets.

12. Results

The analysis shows that electric vehicles have several clear economic and operational advantages. They can reduce energy cost per kilometer, lower routine maintenance requirements, improve urban driving comfort, reduce downtime for high-mileage fleets and support energy diversification. Their advantages are strongest in daily commuting, city driving, taxi services, delivery fleets and municipal transport.

At the same time, electric vehicles have important disadvantages and risks. Higher purchase price, charging time, infrastructure dependence, battery degradation, uncertain resale value, service network limitations and climate-related range reduction must be considered. These disadvantages do not make electric vehicles ineffective, but they show that adoption must be planned according to real conditions.

The results also show that infrastructure is as important as vehicle technology. A reliable electric vehicle without reliable charging infrastructure cannot provide full user confidence.

Similarly, charging stations without grid capacity and maintenance support cannot guarantee long-term success. Therefore, electric mobility is a system rather than a single product.

13. Recommendations

Based on the analysis, several recommendations can be made. First, electric vehicles should be promoted where they are most effective: urban commuting, taxi services, delivery fleets, public institutions and predictable daily routes. Second, charging infrastructure should be developed together with vehicle adoption. Home, workplace and public charging should complement each other.

Third, fast charging corridors should be created on major intercity roads to reduce range anxiety and support long-distance travel. Fourth, technical education should be modernized. Automotive students should study electric vehicle diagnostics, battery management, high-voltage safety, charging systems and power electronics.

Fifth, economic analysis should be introduced into electric vehicle planning. Consumers and institutions should calculate total cost of ownership before purchasing vehicles. This calculation should include vehicle price, annual mileage, electricity cost, fuel savings, maintenance, battery warranty, charger cost and resale value.

Sixth, battery recycling and second-life systems should be prepared early. Waiting until large numbers of batteries reach end of life may create environmental and logistical problems. Recycling policy should be part of electric mobility strategy from the beginning.

14. Conclusion

Electric vehicles have significant economic, infrastructural and operational advantages, but they also have limitations that require careful analysis. Their main economic advantages include lower energy cost, reduced routine maintenance, less brake wear, potential fuel savings and improved suitability for high-mileage urban operation. Their operational advantages include smooth acceleration, quiet driving, convenience in daily commuting and the possibility of home or workplace charging.

However, electric vehicles also have disadvantages. They often have higher initial purchase prices, depend on charging infrastructure, require longer charging time than refueling, may lose range in cold weather, face battery degradation and need specialized service systems. The economic benefit of an electric vehicle depends on annual mileage, electricity price, fuel price, charging access, battery warranty and vehicle use pattern.

The main conclusion is that electric vehicles should not be evaluated only by purchase price or only by environmental image. They must be assessed through a comprehensive total cost of ownership and infrastructure approach. If charging infrastructure, service systems, electricity supply and user education are properly developed, electric vehicles can become economically efficient and operationally practical. If these systems are weak, the advantages of electric vehicles may be reduced.

For countries developing electric mobility, the priority should be coordinated planning. Vehicle import, charging station construction, grid modernization, service training, safety regulation and battery recycling must be developed together. In this case, electric vehicles can contribute not only to environmental improvement but also to economic modernization, technological education and sustainable transport development.

For automotive engineering students, the analysis of electric vehicle advantages and disadvantages is highly relevant because it connects vehicle design, energy systems, economics, infrastructure and environmental responsibility. The future specialist must understand not only how an electric vehicle works, but also when it is economically justified, how it should be charged, how it should be serviced and what infrastructure is required for its reliable operation.

Journal: <https://ifsmrc.org/index.php/aijrm>

References

1. International Energy Agency. Global EV Outlook 2025. Paris: IEA, 2025.
2. International Energy Agency. Global EV Outlook 2026. Paris: IEA, 2026.
- 3 U.S. Department of Energy, Alternative Fuels Data Center. Electric Vehicle Benefits and Considerations.
4. U.S. Department of Energy, Alternative Fuels Data Center. Maintenance and Safety of Electric Vehicles.
5. U.S. Environmental Protection Agency. Electric Vehicle Myths.
6. Argonne National Laboratory. GREET Life-Cycle Assessment Model.
7. International Council on Clean Transportation. Life-Cycle Greenhouse Gas Emissions from Passenger Cars.