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Analysis of the advantages and disadvantages of electric vehicles

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Analysis of the advantages and disadvantages of electric vehicles

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Abstract. This paper examines the advantages and disadvantages of electric vehicles (EVs) as a sustainable alternative to traditional internal combustion engine vehicles. The analysis examines key advantages, including reduced greenhouse gas emissions, lower operating costs, and the potential for integration with renewable energy sources. At the same time, the study addresses issues such as limited range, the impact of battery production, and the need for extensive charging infrastructure. By providing a comprehensive overview, this study aims to inform stakeholders about the potential of electric vehicles to contribute to a greener future, while highlighting areas that require further development and innovation.

INTRODUCTION

Today, the number of electric vehicles in Uzbekistan is growing. According to the decree of the head of state dated December 19, 2022, "On measures to expand the infrastructure for the use of electric vehicles", a number of incentives have been provided [2, 8].

The use of electric vehicles has several environmental benefits. In particular, one electric vehicle used for a year prevents the pollution of atmospheric air by an average of 1,500 kg (CO₂) of carbon dioxide.

The introduction of electric vehicles can significantly contribute to reducing harmful emissions and improving air quality in cities. Electric vehicles do not produce exhaust gases, which directly reduces the level of pollutants in the air, such as carbon dioxide (CO₂), nitrogen oxides (NO_x), and particulate matter (PM) [6, 16].

By comparison, each gasoline-powered car emits up to 3 tons of carbon dioxide, 93 kg of hydrocarbons, 0.5 tons of carbon monoxide, and about 30 kg of nitrogen oxides into the atmosphere when traveling 15,000 km. These figures are slightly higher for diesel-powered cars.

Electric vehicles are charged using solar, wind, or other renewable energy sources, which significantly reduces the damage compared to gas or gasoline-powered cars, meaning that the total amount of carbon emissions is significantly reduced [1, 5, 9].

The introduction of environmentally friendly zones where only electric vehicles are permitted will reduce pollution levels in city centers. Improved air quality can lead to a decrease in disease incidence.

In addition, the transition to electric vehicles supports the concept of sustainable development, contributing to the creation of a clean and safe city [3, 12, 13].

Overall, the introduction of electric vehicles is an important step towards improving urban air quality and reducing harmful emissions. This will not only improve the environmental situation, but also enhance the quality of life in cities. (<https://gov.uz/ru/minenergy/news/view/23875>)

METHODS

Gasoline and gas-powered cars are certainly more popular, but electric cars are gradually gaining ground. They have undeniable advantages, although there are also some drawbacks.

Electric cars are considered an important step towards reducing oil dependence, protecting the environment, preventing ecological disasters, and increasing transport sustainability [4, 15, 20, 23].

ADVANTAGES OF ELECTRIC CARS

Electric vehicles (EVs) are a beacon of innovation and sustainability in the ever-evolving world of automotive technology. The debate surrounding the pros and cons of electric vehicles has taken center stage as the world grapples with pressing environmental issues and strives to transition to greener transportation alternatives. Examining the advantages of electric vehicles reveals a picture of environmental sustainability, economic efficiency, and technological advances that are transforming the automotive industry [11, 17, 22, 30].

1. Complete environmental friendliness. One of the main arguments in favor of electric vehicles is their environmental friendliness. The absence of exhaust gases reduces air pollution in cities. Electric vehicles do not emit carbon dioxide and other harmful substances while driving, making them the choice for those who care about the environment.

However, it is important to understand that the environmental friendliness of electric cars depends on the source of electricity. If it is produced using renewable sources (wind or solar energy), the advantages of electric cars in this regard are obvious. But in regions where the power grid relies on coal or gas, the downside of electric vehicles is that emissions are simply transferred from the car to the power plant.

Electric vehicles do not produce tailpipe emissions, reducing air pollution and combating climate change. Electric vehicles can use renewable energy sources such as solar and wind power, reducing greenhouse gas emissions.

Electric vehicles produce zero tailpipe emissions, contributing to clean air and reduced greenhouse gas (GHG) emissions. Studies show a 41% reduction in greenhouse gas emissions over the life cycle compared to gas-powered cars. (Source: International Council on Clean Transportation).

Electric vehicles reduce local air pollutants such as nitrogen oxides and particulate matter, improving public health. A study by the American Lung Association found that switching to electric vehicles could prevent 54,000 premature deaths annually in the United States. (Source: American Lung Association)

Reduced greenhouse gas emissions. Electric vehicles produce fewer greenhouse gas emissions over their lifetime than internal combustion engine vehicles, even when accounting for the electricity used to charge them. As the power grid becomes greener with the increase in renewable energy sources, the overall carbon footprint of electric vehicles will continue to decline.

Reducing air pollution. Electric vehicles do not emit pollutants from their tailpipes, which significantly reduces air pollution in urban areas. This can lead to much better public health outcomes, as air pollution is linked to various health problems, including respiratory and cardiovascular diseases.

Energy efficiency. Electric vehicles are generally more energy efficient than traditional gasoline-powered vehicles. They convert a significant portion of the electrical energy from the grid into power at the wheels, resulting in less energy loss and higher efficiency [21, 36].

Integration of renewable energy sources. Electric vehicles can be integrated with renewable energy sources such as solar and wind power. This reduces dependence on fossil fuels and enables more flexible energy consumption models, such as charging when large amounts of renewable energy are being produced.

Life cycle emissions. While it is true that the production of electric vehicles, especially batteries, can have a greater environmental impact than the production of conventional vehicles, the overall life cycle emissions of electric vehicles are generally still lower. This includes the manufacturing, operation, and disposal stages.

Recycling and reuse of secondary raw materials. Advances in recycling and reusing batteries for secondary uses, such as energy storage, can further mitigate the environmental impact of electric vehicles. Efforts are currently underway to improve battery recycling processes to recover valuable materials and reduce the need for new raw materials.

2. Economic benefits. Although purchasing an electric vehicle typically requires a significant initial investment, this cost is offset by low operating expenses.

Lower Charging Costs. Charging a car is significantly cheaper than filling up with gasoline or diesel. EV owners can charge their vehicles at home. It can be charged from a standard 220 V outlet. In some cases, you can even find

free charging stations, which is not the case with fuel. For example, charging an electric car at home, especially at night when rates are lower, can result in significant savings.

Minimal maintenance costs. The advantages of electric cars also include minimal maintenance costs. Electric cars have fewer moving parts than internal combustion engines, which reduces the likelihood of breakdowns and the need for complex and expensive repairs. Electric vehicles have fewer moving parts than internal combustion engine vehicles, which over time leads to lower maintenance requirements and costs. Electric vehicles have fewer moving parts, which means less frequent and less expensive maintenance than gasoline-powered vehicles.

Government Incentives. Many governments offer tax breaks and other incentives to reduce the cost of electric vehicles. These include tax credits, purchase rebates, reduced registration fees, and exemptions from road tolls. Such measures decrease the upfront cost of EVs and encourage their adoption.

Energy Efficiency Savings. Data shows that the savings are primarily due to the fact that modern electric vehicles are 2.5 to 5.0 times more efficient per mile than gasoline-powered internal combustion engines.

Corporate and Fleet Savings. Businesses that adopt EVs for their fleets benefit from reduced fuel and maintenance costs, improving profitability. In addition, corporate EVs may qualify for additional tax deductions or sustainability credits.

In conclusion, some of customers or owners of EVs may seem costlier, but their vehicles have lower operational expenses, government incentives, and energy efficiency make them as a financially investment. These benefits are particularly appealing in regions where electricity is sourced from renewables, further reducing long-term costs [27].

3. Operational efficiency. Internal combustion engines are inherently less efficient than electric motors, resulting in lower energy consumption and higher energy efficiency [19, 33].

Regenerative Braking. Electric vehicles can capture and convert kinetic energy during braking, increasing range and overall efficiency. The range of an electric car is between 100 and 1,600 km.

Higher Energy Conversion Efficiency. Electric vehicles convert more than 85% of electrical energy into motion, compared to 20-30% for gasoline engines. This means lower energy consumption and less dependence on fossil fuels. (Source: U.S. Department of Energy)

Safer energy. Electric vehicles do not require gasoline, making them safer to use.

Cost-Effectiveness of Energy. Gasoline is often more expensive than electricity, and because electric vehicles have fewer moving parts, they require less maintenance. In the long run, this can lead to significant savings. A Consumer Reports study found that electric vehicle owners save an average of \$1,800 per year on fuel compared to gasoline-powered cars. (Source: Consumer Reports)

Environmental and Safety Advantages. The higher energy efficiency of EVs contributes to reduce greenhouse gas emissions, especially when powered by renewable energy sources. Additionally, EVs eliminate the risks associated with handling flammable fuels, enhancing safety.

The operational efficiency of EVs makes them sustainable and cost-effective transportation. EV's energy conversion, innovative features like regenerative braking, and reduced maintenance needs contribute to lower overall costs and greater reliability. These days charging infrastructure and battery technologies are continued to improve, EVs will likely set new benchmarks for operational performance and efficiency.

4. Quiet and smooth ride. One of the obvious advantages of electric vehicles is their quietness. The absence of a noisy internal combustion engine makes trips more comfortable for the driver, passengers, and those around them and while reducing pollution levels in urban areas too [18, 26].

Noise Reduction. Electric vehicles operate almost silently, which has a positive effect on the overall noise level in the city. Electric cars do not make any noise, unlike gasoline-powered cars.

Instant Torque for Smooth Acceleration. In addition, electric motors provide instant torque, which improves acceleration dynamics and makes driving smoother. Unlike internal combustion engines, which require acceleration, electric cars instantly develop high speeds, which is especially noticeable when starting from a standstill. Electric motors provide instant torque, ensuring rapid acceleration and a smoother ride. Electric cars run quietly, creating a more peaceful driving environment than cars with internal combustion engines. Many electric vehicles offer impressive acceleration thanks to high-torque electric motors, providing a more responsive and enjoyable driving experience. Electric vehicles generate significantly less noise than gasoline engines, providing a quieter ride for passengers and the environment. There is virtually no extraneous noise when driving.

Enhanced urban and environmental benefits. By minimizing noise pollution, electric vehicles contribute to quieter urban spaces. This can lead to reduced stress levels for drivers, passengers, and pedestrians, making cities more comfortable places to live.

Responsive and enjoyable driving. Many electric vehicles offer exceptional acceleration and handling thanks to high-torque electric motors. This makes driving not only efficient but also enjoyable, as electric vehicles provide a more responsive and dynamic driving experience compared to ICE vehicles.

The quiet and smooth ride of electric vehicles is a defining characteristic that sets them apart from traditional vehicles. From reducing noise pollution in cities to providing a quiet and comfortable driving experience, electric vehicles offer benefits that enhance both individual satisfaction and community well-being. As EV technology advances, these features are likely to become even more refined, further enhancing their appeal [25, 31].

5. Stability and handling. Thanks to the low position of the batteries, which take up a significant amount of space in the design, electric vehicles have a low center of gravity. This improves the vehicle's stability on the road and makes its handling more predictable, especially when cornering.

Advanced all-wheel drive systems. In addition, electric cars are often equipped with advanced all-wheel drive systems, which improve traction and increase road safety.

Many electric vehicles are equipped with sophisticated all-wheel drive (AWD) systems that efficiently distribute power to all wheels. This improves traction, especially in challenging weather conditions such as rain or snow, and enhances safety during acceleration and cornering.

Compact design. Almost all models are compact in size, making them very convenient for getting around town (in traffic jams).

Electric vehicles often have a compact design, making them ideal for urban environments. Their smaller size and tight turning radius make it easier to navigate busy city streets and heavy traffic.

Improved weight distribution. Even distribution of battery weight throughout the vehicle contributes to balanced handling and stable performance. This feature makes electric vehicles more predictable and stable when driving at high speeds or during sudden changes in direction.

Enhanced safety features. Many electric vehicles incorporate advanced safety technologies, such as electronic stability control and adaptive suspension systems, to further enhance driving confidence and control.

The design and technology of electric vehicles provide exceptional stability and maneuverability, making them a practical choice for both urban and highway driving. The combination of a low center of gravity, advanced drive systems, and compact size enhances driver safety and confidence while contributing to a comfortable and enjoyable driving experience [28, 34].

6. Easy start in cold weather. In winter, cars with internal combustion engines often face the problem of starting the engine in cold weather, especially in severe frosts. Electric cars are more reliable in this respect — the electric motor does not require warming up, and starting is instantaneous. The car interior heats up faster thanks to electric heating systems, which is a significant advantage of electric cars in cold weather.

Instant engine start. Unlike cars with ICE, electric motors do not require engine warm-up, as electric motors operate independently of outside temperature. This ensures an immediate and smooth start, even in sub-zero conditions.

Faster cabin heating. Electric vehicles use electric heating systems that heat the cabin faster than traditional vehicles that use engine heat. This is especially beneficial in winter, increasing comfort for drivers and passengers.

Reduced dependence on fuel. Since electric vehicles operate without fuel, they avoid common cold weather problems faced by ICE vehicles, such as frozen fuel lines or thickened engine oil.

Consistent performance. Electric vehicles maintain consistent performance in cold conditions thanks to their battery systems. Modern electric vehicles are equipped with thermal management systems to regulate battery temperature, ensuring reliable operation and optimal energy efficiency.

Reliable start-up and rapid heating make electric vehicles particularly suitable for cold climates. Their ability to operate smoothly without engine overheating or weather complications gives them a significant advantage over ICE vehicles, ensuring a more comfortable and convenient winter driving experience [10, 29].

7. Political support and technology. Various governments offer incentives such as tax breaks, discounts, and access to truck lanes to promote the adoption of electric vehicles and make them more financially attractive to consumers. Some regions offer regulatory incentives such as congestion charge exemptions and reduced parking fees for electric vehicle owners.

Incentives for purchasing electric vehicles. Governments around the world offer various incentives, including tax breaks, purchase discounts, and access to motorways, to promote the adoption of electric vehicles. In some regions, electric vehicle owners are eligible for regulatory benefits such as congestion charge exemptions and reduced parking fees, further enhancing their appeal.

Policy alignment with sustainability. Many governments are implementing policies to phase out internal combustion engine vehicles and support the development of infrastructure for electric vehicles. These policies are consistent with broader goals of reducing greenhouse gas emissions and meeting climate targets.

Improved Battery Range and Charging Time. Battery range and charging times are constantly improving. The average range of an electric vehicle in the US is now 259 miles, with some models exceeding 300 miles.

Expansion of Charging Infrastructure. The public charging station infrastructure is expanding rapidly: there are more than 180,000 public charging stations in the US alone. (Source: Alternative Fuels Center)

Advanced Driver Assistance Systems (ADAS). Many electric vehicles feature advanced driver assistance systems (ADAS), paving the way for autonomous driving technologies.

Overall, the comprehensive benefits of electric vehicles include environmental protection, cost savings, and cutting-edge innovation, making them a key force in shaping the future of transportation.

8. Consumer Awareness. The environmental benefits of electric vehicles depend on several factors, including the sources of electricity used for charging, advances in battery technology, and improvements in recycling processes.

Understanding charging energy sources. The true environmental impact of electric vehicles varies depending on the electricity mix used for charging. Charging electric vehicles with renewable energy sources, such as solar or wind power, significantly increases their sustainability. Conversely, regions that rely heavily on coal or natural gas for electricity generation may offset some of the environmental benefits.

Advances in battery technology. Today's consumers should be aware of advances in battery development, such as increased energy density and longer life. These improvements not only extend the range of electric vehicles, but also reduce their overall environmental impact during production and use.

Recycling and sustainability. Improving battery recycling processes is critical to reducing the environmental impact of electric vehicle production. Effective recycling systems extract valuable materials such as lithium, cobalt and nickel, minimizing the need for new raw materials and contributing to the circular economy.

Educating consumers about these factors enables them to make informed decisions about electric vehicle ownership. Awareness campaigns and transparent information about the life cycle impact of electric vehicles, charging options, and technological advances can help consumers align their choices with sustainability goals.

By understanding the broader context of electric vehicle adoption, consumers can actively contribute to reducing carbon emissions and support the transition to greener transport.

9. An excellent option for city driving.

Electric vehicles (EVs) are an excellent option for urban travel, offering practicality, efficiency, and reliability for city dwellers.

Adequate Range for Urban Needs. One battery charge is sufficient for approximately 180 km. On average, the mileage of such a car will depend on the power of the engine, but in any case, it is at least 200 km on a full charge.

Durable and Low-Maintenance Engines. The engine is much more durable than a conventional gasoline engine, provided it is operated correctly and charged in a timely manner.

Efficiency of stops and movements. Electric vehicles are particularly efficient in urban transport, where regenerative braking helps to save energy and extend the range. This makes them well suited to urban environments, where there are frequent stops.

With practical range, durable motors, and increased efficiency in urban conditions, electric vehicles are the optimal choice for city travel. Their suitability for short distances and ease of use make them a convenient and sustainable option for navigating city life.

10. Power plant characteristics. Higher efficiency compared to conventional motor vehicles.

The objective advantages of electric vehicles include the characteristics of the motor.

High Efficiency and Transmission-Free Design. They provide an efficiency of over 90% (when using the recuperation mode), do not require a transmission, and have high torque. Among other things, electric cars are also convenient to operate.

Simplified Mechanical Systems and Easy of Maintenance. These vehicles have simpler mechanical parts than cars with internal combustion engines, fewer moving parts, and no need for motor oil, filters, or other fluids. As a result, maintenance of this equipment is less expensive.

11. Electromagnetic brake. There is an electromagnetic brake for emergency braking, which increases reliability and safety.

Some types of electric cars can have higher speeds and acceleration than gasoline cars.

Emergency braking. Electromagnetic braking provides effective emergency braking, delivering faster and more reliable stopping power. This system enhances the overall safety of electric vehicles, especially in critical situations that require immediate response.

Regenerative function. Many electric vehicles include regenerative braking systems that capture kinetic energy during braking and convert it into electricity that is stored in the battery. This not only improves energy efficiency but also reduces wear on traditional brake components.

High speed and acceleration. Some electric vehicles outperform gasoline-powered vehicles in terms of speed and acceleration due to the high torque provided by electric motors. This combination of rapid acceleration and reliable braking makes electric vehicles dynamic and safe to drive.

DISADVANTAGES OF ELECTRIC CARS

The use of electric cars is not without its drawbacks. There is no way around this, but gasoline-powered cars also have their disadvantages. If we talk in detail about the negative aspects, the disadvantages of electric vehicles include such problems as limited range, gaps in the charging infrastructure, and initial price barriers, which hinder widespread adoption and require strategic solutions [14].

1. High purchase price. One of the main disadvantages of electric cars is their high cost. Although the operating costs of electric cars are lower, the initial purchase price is higher than that of similar internal combustion engine cars. This is because the technology used in electric cars is still expensive, especially batteries.

Electric vehicle prices are falling over time, but for many buyers this remains a significant barrier.

2. Limited range. One of the most discussed disadvantages of electric vehicles is their limited range. On average, electric vehicles can travel about 300–400 km on a single charge, and in more affordable models, this figure may be even lower. While this is sufficient for city driving, it can pose challenges for longer journeys.

In addition, range depends on factors such as ambient temperature, vehicle weight, and driving style. For example, batteries lose some of their capacity in cold weather, which can be a problem for those living in northern regions.

Electric vehicles typically have a shorter range than traditional vehicles, which can cause range anxiety, especially during long trips. Despite improvements, electric vehicles typically have shorter ranges than gas-powered vehicles. The average range of an electric vehicle of 259 miles may only be suitable for some, especially those who frequently take long trips [24].

3. Charging time. Charging an electric vehicle is another significant disadvantage of electric vehicles. Unlike traditional cars, which can be refueled in a matter of minutes, charging an electric vehicle can take anywhere from 30 minutes to several hours, depending on the type of charging station. However, there are ways to speed up this process, with fast charging taking 20–30 minutes, but there is a belief that this has a negative impact on the battery's service life. Fast charging is not available everywhere, and charging at home from a domestic power supply can take all night. The lack of a developed charging station infrastructure, especially in less urbanized regions, remains a problem for those who plan to use an electric vehicle not only for short trips.

4. Battery wear. Over time, batteries lose their capacity, which leads to a reduction in range and a deterioration in vehicle performance. Although modern batteries are more durable, this issue is particularly relevant for budget models with outdated lithium-ion batteries, such as the Nissan Leaf. Replacing a battery is an expensive process that can reduce the economic benefits of owning an electric vehicle.

5. Infrastructure limitations. In countries where charging station infrastructure is not yet developed, electric vehicles may not be a practical solution. When charging stations are rare even in large cities and may be non-existent outside of cities, long-distance travel becomes problematic.

It may be necessary to improve the availability of charging stations, especially in rural areas or regions with limited investment in charging networks. Charging an electric vehicle can take longer than refueling a traditional car, especially when using standard charging methods, which may be inconvenient for some users. Electric charging stations are gradually beginning to develop. If charging a battery used to be a real problem, now it is practically no longer an issue. Of course, there are virtually no electric charging stations in small towns, but in a few years' time, the situation is expected to be completely rectified and stabilised. Public charging infrastructure still needs to be widely available, such as gas stations, especially in rural areas. Charging time can also be significantly longer than filling up a gas tank. Home charging requires installation and access to electricity, which is feasible for some [32].

However, for owners of private homes or parking spaces, there is an effective solution: installing your own charging station. This will allow you to charge your electric vehicle at home, which completely covers. However, there is an effective solution for owners of private homes or parking spaces—installing their own charging station. This will allow them to charge their electric vehicle at home, which completely solves the issue of charging and makes operating an electric vehicle as convenient as possible. Having your own charging station not only saves time, but also allows you to choose more favorable electricity rates, which adds another plus to the list of advantages of electric vehicles.

6. Initial price barriers. The high price of a new car, which may be unaffordable for most consumers. Prices are worth mentioning separately. The average price of the cheapest electric car is around \$20,000, which is quite a lot. However, if we consider the savings during operation, the cost is fully recouped in just a few years, as conventional fuel is much more expensive than electricity. There is also no need for complex and professional maintenance; electric cars, when operated correctly, require virtually no maintenance. Electric cars often have a higher initial purchase price due to the cost of battery technology, although this is gradually decreasing with technological advances and economies of scale.

Electric vehicles typically have higher initial purchase prices compared to similar gas-powered vehicles. However, government incentives and long-term cost savings can offset this difference.

- According to Cox Automotive, the parent company of Kelley Blue Book, the average transaction price for electric vehicles in July 2023 was \$53,469, compared to \$48,334 for gasoline-powered vehicles. (Source: Kelley Blue Book)

7. Battery issues. Lithium-ion batteries, commonly used in electric vehicles, wear out over time, reducing the battery's range and overall performance, and must be replaced or recharged regularly. The production and disposal of lithium-ion batteries have environmental implications, including resource extraction, energy consumption, and potential waste disposal issues.

Electric vehicle batteries wear out over time, reducing range. Replacing batteries can be expensive. The average electric vehicle battery loses about 2.3% of its range per year.

8. Infrastructure and equality issues. Some communities may face inequality in access to charging infrastructure, particularly in underserved or rural areas, exacerbating existing mobility equity gaps. The widespread adoption of electric vehicles poses challenges for the capacity and stability of electricity grids, requiring investment in grid infrastructure and smart charging solutions to effectively manage increased electricity demand [38].

9. Frequent charging required. It is generally not recommended to frequently charge electric vehicles to 100%, as this will shorten the battery life. Most manufacturers recommend maintaining a charge level between 20% and 80% to optimize battery health and extend battery life.

This charging practice may be inconvenient for some users, especially those who rely on their cars for long journeys or have limited access to charging infrastructure. Balancing the need for frequent charging with preserving battery life remains a challenge for electric vehicle owners [35].

10. Difficulties in operation in severe frost. Difficulties in operation in severe frost, as the battery discharges quickly.

Operating electric vehicles (EVs) in extremely low temperatures presents unique challenges, as batteries tend to discharge more quickly in such conditions. This decrease in performance is due to the chemical nature of lithium-ion batteries, which slows down at low temperatures, affecting both range and charging efficiency.

Cold weather can also increase charging time, as the battery management system must warm the battery to an optimal temperature before it can begin charging. In addition, the use of vehicle heating systems in winter further drains the battery, exacerbating the reduction in range.

For drivers in colder climates, these issues can make electric vehicles less reliable, especially for long journeys or outdoor parking. To mitigate these issues, manufacturers are integrating thermal management systems and preconditioning to maintain battery performance in extreme temperatures. However, these solutions may not fully eliminate the impact of harsh winters on the usability of electric vehicles, leaving room for improvement in future models.

TABLE 1. Factors affecting the advantages and disadvantages of electric vehicles include a number of technological, environmental, economic, and infrastructure considerations

Technological achievements - Battery technology - Charging infrastructure	Economic factors - Advance expenses - Operating expenses	Policy and regulation - Incentives and subsidies - Emissions standards
Infrastructure development - Charging availability - Network capacity and stability	Environmental considerations - Energy source- Производство и переработка аккумуляторов	Consumer preferences and behavior - Range requirements - Perception and awareness

THE FUTURE OF ELECTRIC VEHICLES

However, despite ongoing developments in this area, it is too early to say that all cars will soon be replaced by electric vehicles. This is due to the reluctance of most car owners to replace their conventional cars with electric

vehicles. We are used to internal combustion engines, despite the stench of exhaust fumes, dirt, and the high cost of maintaining modern cars.

But soon everything will change. Electric cars can already be seen on Russian roads. People are buying electric bicycles and electric scooters to get to work. Talk to them. We assure you that they are happy they took this step. There are already free charging stations throughout Europe. People buy electric cars and travel completely free of charge from charge to charge through Prague, Paris, Berlin, Amsterdam, Moscow, etc.

Electric transport is coming into our lives whether we like it or not. In the not-too-distant future, all gas stations will disappear from your city. The air will become cleaner and the city quieter. One day, when you leave your house, you will find yourself in a completely different world.

It will be the world of electric transport. The beginning of a new era of industry and engineering [7].

RESEARCH RESULTS

1. Environmental Impact. Electric vehicles (EVs) significantly reduce urban air pollution and greenhouse gas emissions, particularly when powered by renewable energy sources. They offer an effective solution to combat climate change and improve public health.

2. Economic Challenges and Opportunities. Although the upfront cost of EVs remains higher than traditional vehicles, operational savings from lower fuel and maintenance costs, combined with government incentives, gradually make them economically viable.

3. Technological Advancements. Improvements in battery technology have enhanced energy density, range, and efficiency, making EVs increasingly competitive. Features like regenerative braking and advanced driver-assistance systems (ADAS) showcase the potential for further innovation.

4. Infrastructure Limitations.

Inadequate public charging infrastructure and disparities in access, especially in rural areas, hinder the widespread adoption of EVs. Investments in charging networks and grid capacity are essential for overcoming these challenges.

5. Battery Lifecycle Issues. The environmental and economic impact of battery degradation, production, and recycling is a critical area for improvement. While modern batteries are more durable, sustainable solutions for battery end-of-life remain a priority.

6. Usability in Extreme Climates. Cold weather reduces battery performance, affecting range and charging efficiency. However, emerging thermal management systems aim to mitigate these limitations.

7. Future Vision. EVs are gradually shaping a cleaner and quieter urban environment. With ongoing advancements in technology and infrastructure, they promise a transformative impact on transportation systems, industry, and sustainability efforts worldwide.

CONCLUSIONS

So, the answer to the question: are electric vehicles better for the environment? The lie is obvious. Electrification of the transport sector is a cornerstone of the global strategy to achieve carbon neutrality. While electric vehicles offer a viable solution for reducing emissions and combating climate change, addressing the challenges associated with battery production and disposal is imperative. Through thoughtful policy and innovative technology, we can ensure that electric vehicles play a key role in our sustainable future [2, 8, 37].

Electric vehicles are an important step towards a more sustainable world. By adopting electric mobility, we can reduce our environmental impact, improve air quality, and move closer to achieving our climate goals. So, whenever you wonder, are electric vehicles better for the environment? The answer is yes. The road ahead is challenging and full of obstacles, but through continuous innovation and global cooperation, electric vehicles can lead us to a greener and cleaner future.

At present, the disadvantages of electric vehicles outweigh the advantages.

The development of electric vehicle transport is currently viewed by many countries around the world as a way to solve existing environmental problems and an opportunity to create new markets for innovative products, and is therefore actively supported by the state in various ways. However, the main barriers to the development of "green" transport are cost (the high price of electric vehicles) and infrastructure (the lack of the necessary charging, replacement, and disposal facilities for batteries). Experts consider the main drivers of growth in the global electric vehicle market to be government measures to support demand for environmentally friendly modes of transport,

adopted in many countries in Europe, the US, and China, as well as technological advances in battery production, which reduce the cost of the most expensive component of an electric vehicle—the battery [6, 36].

Electric vehicles are a technology of the future with many advantages. They are environmentally friendly, economical to operate, and offer a high level of comfort thanks to their quiet operation and excellent handling. However, the disadvantages of electric vehicles, such as high cost, limited range, and lack of a developed charging station infrastructure, make them not always an affordable or convenient choice for a wide range of consumers.

Everyone should weigh the pros and cons of electric vehicles based on their personal needs and operating conditions. In urban environments with home charging options and short trips, electric vehicles can be the ideal solution. For those who frequently travel long distances or live in regions with cold climates and underdeveloped infrastructure, internal combustion engine vehicles remain the more practical option.

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