

JEL Classification: L62, O33, F01

DOI: https://doi.org/10.31521/modecon.V51(2025)-09

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World Experience of State Stimulation of Demand for Electric Vehicles

Abstract. Introduction. The electrification of transportation has become one of the main global trends in automotive industry development. The growing attention to electric transportation technologies is primarily due to stricter environmental regulations. Electric motors can reduce air pollution, making them a potential alternative to internal combustion engines (ICE). Despite the impressive growth of the electric vehicle fleet, various countries are taking additional measures to stimulate demand for electric vehicles.

Purpose. The purpose of the article is to analyze the world experience of government stimulation of demand for electric vehicles. The article analyzes the key areas of incentive measures for consumers, allowing to achieve optimal results based on the generalization of the best practices of the world experience of popularization of electric vehicles.

Results. Government incentives, such as subsidies, purchase benefits, and operational preferences, as well as restrictive measures for cars with internal combustion engines (ICE), significantly support the growth of demand for electric vehicles worldwide. An analysis of the demand for electric vehicles in various countries confirmed that most people who doubt the advisability of switching to electric transportation change their minds when direct and indirect financial measures are introduced by the state, primarily direct subsidies for purchasing electric vehicles. This measure effectively stimulates demand for electric vehicles in all national markets. Additionally, direct financing is easier to control since the distribution of funds is more transparent than indirect stimulation. Subsequently, direct financing can be reduced while maintaining indirect measures, such as exemption from transportation taxes and free travel on toll roads.

Conclusions. Thus, the growth of the electric vehicle market does not ensure increased demand for this mode of transportation among the population. Financial and non-financial incentive measures are important since the technology is still developing and there are many misconceptions about its effectiveness. Although the development of the electric vehicle market has been motivated by the "green" agenda, especially in EU countries, the environmental factor does not yet play a significant role for buyers in other countries and regions, including those planning to buy an electric vehicle and those doubting its feasibility.

Keywords: automotive industry; electric vehicle market; demand for electric vehicles; switching to electric transport; environmental requirements.

УДК 339.9

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Світовий досвід державного стимулювання попиту на електромобілі

Анотація. Електрифікація транспорту стала однією з основних світових тенденцій розвитку автомобільної промисловості. Зростаюча увага до технологій, що використовуються в електротранспорті, зумовлена, перш за все, жорсткішими екологічними вимогами. Використання електродвигунів може зменшити забруднення повітря, тому їх почали розглядати як альтернативу двигунам внутрішнього згоряння (ДВЗ). Водночас, незважаючи на вражаючу динаміку розширення парку електромобілів, різні країни вживають низку додаткових заходів для стимулювання попиту на електромобілі. Метою статті є аналіз світового досвіду державного стимулювання попиту на електромобілі. У статті аналізуються ключові напрямки стимулюючих заходів для споживачів, що дозволяють досягти оптимальних результатів на основі узагальнення передового досвіду світового досвіду популяризації електромобілів. Визначено, що зростання попиту на електромобілі у світі значною мірою підтримується державними стимулами, такими як субсидії, пільги на купівлю, преференції в експлуатації, а також обмежувальні заходи для автомобілів з ДВЗ. Проведений аналіз стимулювання попиту на електромобілі в різних країнах світу підтвердив, що більшість тих, хто сумнівається в доцільності переходу на електротранспорт, змінюють свою думку у разі запровадження державою прямих та непрямих фінансових заходів, переважно прямих субсидій на придбання електромобілів. Цей захід є корисним для стимулювання попиту на електромобілі на всіх національних ринках. Обґрунтовано, що розвиток ринку електромобілів не гарантує збільшення попиту на цей вид транспорту серед населення. Важливими стають як фінансові, так і обмежувальні (нефінансові) заходи стимулювання, оскільки технології лише розвиваються і існує багато упереджень щодо їх ефективності. Важливо зазначити, що, хоча розвиток ринку електромобілів був мотивований «зеленим» порядком денним, особливо в країнах ЄС, для покупців з

¹Стаття надійшла до редакції: 19.06.2025

Received: 19 June 2025

інших країн та регіонів екологічний фактор поки що не відіграє значної ролі, як серед тих, хто планує придбати електромобіль, так і серед тих, хто сумнівається в його доцільності.

Ключові слова: автомобільна промисловість; ринок електромобілів; попит на електромобілі; перехід на електротранспорт; екологічні вимоги.

JEL Classification: L62, O33, F01

Formulation of the problem. The electrification of transportation has become one of the main global trends in automotive industry development. The growing attention to electric transport technologies is primarily due to stricter environmental regulations. Electric motors can reduce air pollution, making them a potential alternative to internal combustion engines (ICE). However, electric cars will only be environmentally friendly if they are produced using renewable energy sources. Consequently, countries such as Germany, Great Britain, and the USA are developing electric transportation in parallel with transitioning to new energy sources.

As of the end of 2023, electric vehicles accounted for 9% of the global car fleet, with the majority in China, Western Europe (Germany, Norway, Great Britain, France, and the Netherlands), and the USA. The growth rate of the electric vehicle market is also impressive. In 2023, the global electric vehicle fleet reached 16 million, which was 60% higher than the previous year. Because Europe is pushing the environmental agenda the hardest, the highest growth rates in electric vehicle purchases are being seen there.

Compared to the previous year, the European electric vehicle fleet increased by 3.4 times in 2022, while the Chinese fleet increased by 0.9%, and the American fleet by 0.1%. Absolute sales figures show that 1.4 million electric vehicles were sold in Europe, 1.2 million in China, and 329 thousand in the USA in 2022.

Despite the impressive growth of the electric vehicle fleet, various countries are implementing additional measures to stimulate EV demand.

Analysis of recent research and publications. The analysis of government instruments that stimulate demand is widely presented in the literature, primarily foreign. This is due to the multifaceted nature of the approaches used in different countries. Recent economic studies have reached a consensus that government support is necessary to encourage the adoption of electric vehicles.

The effects of specific measures are usually analyzed in the context of regional and geographic factors since types of incentives vary by country and even by city.

Representative surveys show that the most significant obstacle to the adoption of electric vehicles is their high price and operating costs [3-4; 13-15; 20]. Therefore, reducing the total cost of owning an electric vehicle or providing partial compensation is important to potential buyers. Additionally, factors such as range per battery charge and charging infrastructure availability play an important role in purchase decisions [1-2; 16; 21].

Studies confirm that the growth in demand for electric vehicles was due to direct government subsidies

in combination with the development of charging infrastructure. Furthermore, these measures are most effective when a major automaker and sufficient charging stations are present in the country [21]. Early studies produced contradictory results when assessing subsidies and tax incentives. At that time, the effect of financial incentives may have been underestimated since potential buyers had limited information about electric vehicle capabilities [21-22].

Studies examining the Chinese electric vehicle subsidy program focused on subsidy size [9; 16]. The maximum effect was achieved when the subsidy made an electric vehicle comparable in cost to a vehicle with an internal combustion engine. However, even significant direct subsidies for electric vehicle purchases do not guarantee a high market share [16; 24]. Generally, direct subsidies can play an important role in the initial stages of market development.

As Norway's experience has shown, tax incentives can be effective. There, the state introduced a system of tax incentives, including the abolition of taxes on the purchase of electric vehicles and import duties on electric vehicle imports, as well as a reduction in the annual transport tax [19]. This contributed to an increase in demand [2]. Studies of the effects of non-financial measures to stimulate demand, such as allowing access to public transportation lanes and city centers, also indicate their positive impact. These measures are more commonly used in large cities and are most effective when combined with financial incentives.

Formulation of research goals. The purpose of this article is to analyze the global experience with state-stimulated demand for electric vehicles. It examines key incentive measures for consumers and provides recommendations based on the most effective practices for popularizing electric vehicles worldwide.

Presentation of the main research material. Government incentives, such as subsidies, purchase incentives, operating preferences, and restrictive measures for internal combustion engine vehicles, are significantly supporting the growth in demand for electric vehicles worldwide. In 2020, \$14 billion was spent globally on subsidies for electric vehicle purchases and tax deductions, which was 25% more than the previous year. Significant funds are invested in creating charging infrastructure, including subsidies for individuals and benefits for companies that install charging devices.

Germany, Norway, Great Britain, and France have the most developed charging infrastructure because the most significant investments have been made in its development.

Government incentives for purchasing electric vehicles can be divided into two categories:

– financial, which in turn can be direct (subsidies and benefits for the purchase of an electric vehicle) and indirect (reduced tariffs, exemption from paying for travel and parking, etc.);
 – non-financial, which are preferences for the operation of electric vehicles (including in the form of

bans and restrictive measures for cars with internal combustion engines).

Currently, over 85% of global vehicle sales are regulated by these measures. From the perspective of developing electric transportation, incentive measures in countries that produce electric vehicles are of particular interest (Table 1).

Table 1 Measures to stimulate the purchase of electric vehicles, by country - producer of electric transport

Country	Financial measures	Non-financial measures
USA	Subsidy of up to \$7,500 when purchasing an electric vehicle (valid only for the first 200,000 electric vehicles of each manufacturer). Exemption from transport tax. Tax incentives in the amount of 50% of the price of the “charger” (up to \$2,000)	Varies by state. California: ban on the sale of new passenger cars and light trucks with internal combustion engines from 2030. Ban on driving vehicles with internal combustion engines in specially designated lanes
France	A subsidy for the purchase of an electric car of up to 6,000–7,000 euros for cars with emissions of 2 g/km. A subsidy for the purchase of a new hybrid of €2,000. Compensation of up to €10,000 when replacing a car over 13 years old with an electric vehicle and 6,500 euros for a hybrid. The “Cash in exchange for a clunker” incentive system of €3,000–5,000 for buyers who buy a new car and scrap an old one with an internal combustion engine (for the first 200,000 cars)	A ban on the sale of new cars with internal combustion engines from 2040
Germany	Purchase subsidy: €9,000 for an electric car / €6,750 for a hybrid (from 2020 and phased out by 2025). Discounted or free parking, access to bus lanes. Electric cars purchased before 2016 are exempt from vehicle tax for 10 years, from 2016 to 2020 – for 5 year	Ban on driving ICE cars on specially designated lanes. Ban on the sale of new ICE cars from 2023
UK	Maximum purchase subsidy of £3,000 (for cars emitting 2g/km and taking into account the range). (Scheme extended until 2024–25 from March 2020). Free travel on toll roads. Free parking in London. Tax incentives for low-emission cars, exemption from annual road tax	Restrictions on entry into city centres for ICE cars. Ban on sales of new ICE cars from 2035
China	Electric vehicle purchase subsidy: 16,200–22,500 yuan for EVs, ¥8,500 for hybrids (until 2025). Exemption from 10% tax on car purchases until the end of 2025 Free travel on toll roads. Free parking. Exemption from registration and vehicle taxes	Access to lanes during rush hour. A number of Chinese cities have introduced a guaranteed license for buyers of electric vehicles (to purchase a car with an internal combustion engine, you must obtain a license, the number of which is limited. However, in the case of purchasing an electric car, a license is issued automatically.)
Japan	Subsidy for the purchase of an electric vehicle \$3,700. The subsidy is planned to be increased to \$7,300 for certain categories of electric vehicles. Free travel on toll roads. Preferential tariff for electricity. A one-time purchase tax and annual vehicle tax have been cancelled	By 2035, the transition to sales of cars with zero carbon dioxide emissions

Source: [12].

As the data in Table 1 shows, countries primarily use financial measures, both direct and indirect. All of them offer subsidies for purchasing electric vehicles, and the amount and terms of these subsidies vary greatly. The UK and Germany have the greatest variety of indirect

measures. The USA's experience is interesting because the set of tools varies by state.

Non-financial measures primarily involve restrictions on or refusal to use cars with internal combustion engines. These measures emerged due to the 2015 Paris

Agreement to the UN Framework Convention on Climate Change.

19 countries have introduced targets for electrification and a gradual reduction in sales of cars with internal combustion engines: by 2025 - Norway, by 2030 - Denmark, Iceland, the Netherlands, Ireland, Israel, Scotland. Singapore, Slovenia, Sweden, by 2035 – Cape Verde, Great Britain, China, Japan, by 2040 – France, Canada, Portugal, by 2050 – Sri Lanka, Spain.

Eight countries, including the European Union as a whole, have announced targets to achieve net-zero CO₂ emissions by the following years: Sweden by 2045, the EU by 2050, and Canada, Chile, Fiji, the Republic of Korea, New Zealand, and Norway by 2050. The United Kingdom is another country that has announced a target date.

Among countries that are not world leaders in electric vehicle production, Norway's experience is interesting. Incentive programs have been developed to popularize electric vehicles among consumers.

Twelve years of experience in Norway shows the practical benefits of using tax incentives and other consumer preferences alongside a gradually increasing burden on owners of cars with internal combustion engines, including a moral burden due to their contribution to environmental degradation.

The first measures include significant government subsidies for purchase and operation, free parking and travel on dedicated public transportation lanes, and reduced tax payments. The second measure is the active formation of public opinion on banning the sale of cars with internal combustion engines by 2025.

It is worth emphasizing that, in the initial stage of the program, the total value of preferences for purchasing and operating an electric car was equal to its cost. The redundancy of government support measures became apparent with the appearance of the mass-produced, premium Tesla Model S car (priced at 112 thousand US dollars), since the buyer could save up to 135 thousand US dollars due to all the benefits and alternative advantages: a subsidy and tax benefits for the purchase, reduced transport tax calculations, fuel savings, free parking, use of dedicated public transport lanes (plus significant time savings during rush hour), a preferential interest rate on a car loan, and free ferry crossings [23].

The popularization of private electric transportation around the world began in the premium market segment. The offered models often had excessive characteristics that went far beyond using a different power plant (high power, autopilot features, etc.).

Despite the expansion of model ranges by most major brands to include electric cars at reasonable prices, manufacturers still position their products as vehicles of the future, with corresponding markups, rather than as more profitable alternatives to traditional cars..

However, these measures have generated a new class of eco-conscious consumers, which is showing steady growth despite a gradual decrease in total benefits. This

is due to the growth of service infrastructure and the gradual decrease in the cost of cars in general.

Norway's pioneering contribution to such programs allowed the government to officially announce a ban on internal combustion engines, including diesel ones, starting in 2025. By 2030, many other countries will have introduced similar legislation.

In 2020, the European Commission announced that it would prioritize the transition to a "green" economy for EU countries until 2027 and allocate additional budget funds. It is planned that they will be used to electrify road transport, including providing tax incentives to buyers of electric vehicles [11].

Honda, one of the largest Japanese automakers, has supplied only hybrid and electric vehicle models to the European Union since this year.

The UK has planned for the introduction of stationary charging stations ahead of demand, demonstrating classic market-oriented management and securing investments of 670 million US dollars.

It should be noted that the EU is pursuing a more stringent policy to stimulate demand for electric vehicles than the United States, where there is no official document yet prescribing the abandonment of vehicles with internal combustion engines. Generally, the largest vehicle producers, including the United States, China, and Germany, have not committed to completely phasing out internal combustion engines in the long term.

Another factor that determines policy on stimulating the transition to electric transportation is the availability of energy resources. Countries that export oil and gas are the most conservative about introducing non-financial restrictive measures. In particular, the USA stimulates the purchase of electric vehicles while simultaneously encouraging the use of petroleum fuels [12].

In general, American state incentive policies increase demand for electric vehicles by offering financial incentives. Twenty-seven states, in addition to the federal tax credit, have developed their own incentive policies. Nine states have introduced subsidies for producing zero-emission vehicles. Thus, by 2040, 58% of vehicles will be electric. Currently, about fifteen thousand electric charging stations have been introduced.

Conclusions. Thus, the growth of the electric vehicle market does not ensure increased demand for this mode of transportation among the population. Financial and non-financial incentive measures are becoming important since the technologies are still developing and there are many misconceptions about their effectiveness. At the same time, existing research shows the importance of direct subsidies in the early stages of the electric vehicle market's development.

An analysis of the demand for electric vehicles in various countries around the world confirmed that a majority of people who doubt the advisability of switching to electric transportation change their minds

when direct and indirect financial measures are introduced by the state, primarily direct subsidies for purchasing electric vehicles.

This measure stimulates demand for electric vehicles in all national markets. Additionally, direct financing is easier to control since the distribution of funds is more transparent than with indirect stimulation. Consequently, it can be reduced while maintaining indirect measures, such as tax exemptions and free toll road travel.

Although the development of the electric vehicle market was motivated by the "green" agenda, especially

in EU countries, the environmental factor does not yet play a significant role for buyers in other countries and regions, including those planning to buy an electric vehicle and those doubting its advisability. In this context, restrictive measures for vehicles with internal combustion engines are ineffective. Additionally, when considering non-financial measures, it is important to consider the issues associated with the entire production cycle of electric vehicles.

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