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Mini Review

The Benefit-Cost Analysis of Electric Vehicles in the USA and Michigan based on the 2022 Registration Data

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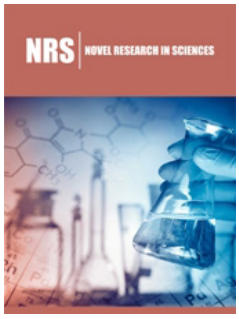

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Mini-Review

In 2020, the U.S., transportation emissions contributed 27 percent of greenhouse-gas emissions. In the same year, global carbon-dioxide emission of the transportation sector was recorded 7.2 billion tons [1]. Electric Vehicles (EV) have been considered a practical and expedient means of reducing carbon and other greenhouse-gas emissions in the transportation sector. Electric vehicles produce zero emission but pose a challenge to the infrastructure funding. The purpose of this note is to explore benefit-cost of EV population considering 2022 EV registration data. According to AFDC Energy.Govt/data [2] a maximum number EVs were registered in California (563,070) in 2022 and the least number were recorded in Wyoming (510). The state of Michigan noted 14,460 EV registrations and the USA overall had 1,454,480. However, these number represents only all-Electric Vehicles (EV's) and Plug-in Hybrid Electric Vehicles (PHEVs) are not included. American Petroleum Institute (API) cited that in 2020 average fuel tax in the USA was 57.09 cents per gallon of gasoline [3]. It is little bit higher for the diesel. The breakdown of tax is shown in (Table 1). The national average is volume weighted and takes into account fuel consumption in each state.

Major contribution of carbon emission in the USA

In the USA the electricity, transportation and manufacturing sectors contribute 80 percent of the CO_2 emission (20-30 percent each sector) followed by agriculture at about 10 percent. According to the Environmental Protection Agency (EPA) the amount of Carbon dioxide (CO_2) emitted while burning one gallon of fuel is displayed in (Table 2) [4].

Table 1: Breakdown of fuel tax year 2022.

US National Average	Gasoline (cents/gallon)	Diesel (cents/gallon)
State Excise tax	26.16	26.72
Other State Taxes/Fees	12.53	13.52
Total State Taxes/Fees	38.69	40.24
Total State and Federal taxes	57.09	64.64

Table 2: Carbon dioxide created by burning one gallon of fuel.

CO Emissions from a gallon of gasoline	8,887 grams CO_2/ gallon
CO Emissions from a gallon of diesel	10,180 grams CO_2/ gallon

Carbon dioxide emission from gasoline from driving one mile

Most vehicles on the American road system are gasoline driven vehicles and their average is about 22.0 miles per gallon.. Therefore, based on the above chart

Carbon dioxide emission per mile=8887/22=404grams

Average annual carbon dioxide emissions of a typical passenger vehicle

The average gasoline driven vehicle has a fuel economy of 22 miles per gallon and drives about 11, 500 miles per year. Thus, the amount of yearly carbon dioxide emission from a typical passenger car in the USA:

Annual CO emissions =CO_2 per gallon 8,887/22MPG x11,500=4.6 metric tons

This means an effective carbon mitigation program that can reduce 460 tons of CO_2 per year has the equivalent impact of removing 100 gasoline driven vehicles from the road.

What is the social cost of Carbon? [5]

Carbon pricing is an instrument that captures the external costs of Greenhouse Gas (GHG) emissions which include the costs of emissions that the public pays for, such as damage to crops, health care costs from heat waves and droughts, and loss of property from flooding and sea level rise-and ties them to their sources through a price, This is usually done in the form of a price on the carbon dioxide (CO_2) emitted. According to Environmental Defense Fund, the social benefit of zero carbon emission is the benefit of preventing the damages resulted from one extra tone of carbon dioxide emission. Furthermore, while computing the benefit of zero emission emphasis is placed on how a reduction in carbon emissions would affect economic outcomes which include changes in agricultural productivity and damages caused by sea level rise as well as decline in human health and labor productivity.

According to Goulder & Burke, two academic researchers from Stanford the cost carbon emission is calculated by using "Integrated assessment Models". These models

a) First quantify the changes in the atmospheric concentration such as average global surface temperature and precipitation. due to an extra tons of carbon emission.

b) Then compute the damages to economy and human welfare due to the changes in the atmospheric concentration.

The social cost of carbon has been used to develop various related polices and regulations. This is also used as a means to examine the effectiveness of specific policies. The Obama administration developed the first estimated social cost of carbon at $43 per ton. While explaining this estimate they stated that preventing production of one ton of carbon dioxide, would save $43 worth of damage to the climate. Also, their estimate was based on the damage due to carbon emission originating in the US that would impose on the whole world. The estimated carbon cost of the trump administration was $3-$5 per ton. While estimating the cost of carbon, they calculated damage from the climate change within the US only. The Biden administration followed the Obama's assumptions (global impact) and come up with an estimate of $51 per ton.

Benefit-cost computation of EVs based on the 2022 registration

Considering information such as the number of registered EVs in the US as well in Michigan, gas tax per gallon of gas, EV registration fees and benefit of zero emission, the net benefit of from each electric vehicle, total US/Michigan EV population in 2022 are computed and presented in (Table 3). The net benefit of each electric vehicle is $36 during 2022 [6].

Table 3: Benefit-cost analysis result.

Benefit-Cost of Electric Vehicles (EVs) in 2022				
		Related Information for Each EV	EVs Registered in 2022	
			USA	Michigan
			1,454,480	17,460
1	CO_2 emission by a mid-size passenger car			
	Assumption Miles of travel per year	11,500		
	Travel Miles per Gallon (MPG)	22		
	CO_2 Emission per gallon (EPA)in gm	8,887		
	Annual CO_2 Emission (gm/car)	4,445,477		
	Annual CO_2 Emission (ton/car)	4.6		
	Cost of Emission per ton (Biden Adm.) $$	51		
	Average Gas tax in USA per gallon ($$)	0.57		
2	EV Emission saving (ton) per year	4.6	6,690,608	80,316
3	EV Zero emission saving in $$	235	341,221,008	4,096,116
4	Revenue loss (gas tax) due to EV in 2022 ($$)	299	433,901,135	5,208,675
5	Registration fees (extra) for EV in 2022($$)	100		
6	Registration fees extra income form EVs ($$)	100	145,448,000	1,746,000
7	Net benefit of EV in 2022 ($$)	36	52,767,873	633,441

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Finding of this study

a) By removing 1,454,480 gasoline driven car from the US road system during 2022, a reduction of close to seven million tons of carbon dioxide from the atmosphere.

b) For the State of Michigan reduction of carbon is more than 80,000 ton in 2022.

c) In 2022, emission reduction due to EVs resulted in the saving of $341 million for the US.

d) However, it is to be noted that EV owners receive $7,500 federal tax credit per car in the USA.

e) If the growth of EV population continues, the United States should be able to keep climate commitment to the world.

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