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Araştırma Makalesi / Research Article

Emission Calculations of Vehicles Used in Konya and Stages of Electric Vehicle Use

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Abstract

Electric vehicles have been in our lives for a long time, but in the last two years, there has been an increase in electric vehicle sales and production. In addition to the spread of the environmental perspective day by day and the demand by wider masses, factors that will significantly affect human life, such as global warming and the decrease in fossil fuels, have become the biggest supporters of electric vehicles in the search for new technology. Emission gases created by internal combustion engines significantly affect the living space we live in. If we talk about these effects, many other components that are harmful to human and environmental health such as carbon dioxide, nitrogen oxides, sulphurous components, particles; dispersed into the air with the exhaust gas during emission. In this study, considering the damage caused by emission gases to the environment and people, we will gradually transition the internal combustion engine vehicles in Konya city center to electric vehicles in stages. In this way, we will see the significant decrease in emission gases in this study.

Keywords: Electric vehicles, emissions, road transport

1. Introduction

With the increase in the population in the world, the use of transportation has also increased. The transportation sector has an important share among all sectors in the consumption of non-renewable energy resources (Özbay et al., 2020), (Önçağ et al., 2021). Today, fossil fuels that we use in every field pose a threat to humanity. First of all, there are limited reserves (Durmaz 2016), (Zallinger et al., 2011). As the consumption continues, the decrease in fuels and the increase in costs proceed at the right rate. Another most important reason is that the greenhouse gases and other emissions released as a result of the combustion of fuels harm our World (Trofimenko et al., 2020), (Cheng et al., 2018), (Li-sheng, 2013), (Lu et al., 2018). All kinds of gas, liquid and solid waste emitted from a source and having harmful effects for the environment are called emissions. Emissions from motor vehicles consist of CO, NOx, HC, CO_2 and other gases (Hiroyasu et al., 2004), (Jenn et al., 2016). The reason why these emissions resulting from combustion are important from other polluting sources is that besides their pollutant qualities, they also have immediate and direct-acting toxin qualities (Mocerino, et al., 2021). A vehicle without emission control can destroy a person's daily need of $15m^3$ of fresh air within 10 minutes (Zaporozhets and Synylo, 2017). As a developing country, the known hydrocarbon resources are clearly insufficient to meet the increasing energy demand of Turkey (Ekmekçioğlu, 2019). While Turkey intensifies the exploration activities for domestic resources, on the other hand, it strives to activate other possible potentials such as putting renewable energy sources into use, increasing energy efficiency and benefiting from the geographical location of the country. Laws on the markets have been enacted, and the relevant secondary legislation has been completed to a large extent. Thus, an important part of the steps that can be taken for a competitive and transparent energy market have been taken (Varol, et al., 2018), (Zamboni et al., 2013), (Ediger and Çamdalı, 2007). Emissions from automobiles include carbon monoxide CO, unburned hydrocarbons HC and oxides of nitrogen NOx, which are currently controlled by emissions regulations. Solid particles from diesel engines are in this range, but are limited by regulations (Friedrich and Bickel, 2001), (Rexeis and Hausberger, 2009), (Hausberger, et al., 2003). Over time, high air pollution, global warming and the depletion of resources have created negativities for people and our world (Jie et al., 2013), (Du et al., 2017). Thanks to the technology that is advancing day by day, our transition to electric vehicles has become easier thanks to the electric motor working at high torque and the batteries with high-power storage area (Lv et al. 2019), (Liu et al., 2015). Today, the transition to electric vehicles is increasing. One of the main reasons for this is the development of battery technology. Due to the noticeable increases in range, their differences have decreased compared to internal combustion engines (Sun et al., 2016), (Wang et al., 2015), (Zhang et al., 2017). In this study, it is to reduce the emission values created by the vehicles in the center of Konya and to calculate the emissions that will occur while producing the energy we need. In this study, primarily, a ranking was made according to the engine power of the cars, minibuses and buses located in the center of Konya. Public transportation was also included in these vehicles, and they were separated again and added to our work as municipal buses, taxis and minibuses. Then, the number of these vehicles was determined and their emission values were calculated. While calculating the emission values, EURO IV, EURO V and EURO VI values were used. Daily average range and engine power calculations of each vehicle were made. As a result of these calculations, the amount of emissions produced by the vehicles was calculated. In the later stages, the transition of vehicles to electricity and the emission calculation that will arise from the production of the needed electricity have been calculated.

2. Emission Calculation of Konya City Vehicles

1- It has been determined that the municipal buses travel an average of 225 km per day. The total number of municipal buses is 510, and according to the fuel they use, 310 of them are natural gas (CNG) and 200 of them are Eurodiesel.

2- The total number of minibuses (14+1) in public transportation is 510. As for school and work busses, it has been determined that this number is 10,710 and they drive an average of 300 km per day (pandemic is taken into account in this number).

3- The total number of taxis is 700 and it has been determined from the taxi drivers' room that 260 of them are Eurodiesel and 440 of them are LPG. It has been determined that taxis make an average of 300 km per day.

4- The number of buses and shuttles other than the municipal buses is 3,446, and it is learned that they travel an average of 225 km per day.

5- The number of city cars was determined as 214,267 and their daily distance was calculated as 40 km on average.

6- EURO IV, EURO V and EURO VI standards have been taken into account for emissions. The number of vehicles was taken from the Konya Police Department and the relevant Chambers and included in the calculation in Konya city and districts.

2.1. Emission Calculations of Passenger Vehicles

While calculating the emission standards of passenger cars, Euro V and Euro VI standards are taken as basis. Vehicles are divided into three as gasoline, Eurodiesel and LPG according to the fuel they use. According to the fuel used by the vehicles in the city center of Konya, 52,101 vehicles with gasoline, 79,238 vehicles with LPG and 82,928 vehicles using Eurodiesel. In our emission calculation, we will consider our emissions per kilometer in grams. The calculated values are the emission value per kilometer. Multiplying this value by our average mileage and number of vehicles will result in our total emissions. For example, our CO value in EURO V and EURO VI values is 0.5 g/km. We multiply this by the average daily distance of our vehicle, which is 40 km, and the total number of vehicles. CO emissions are released from vehicles using 40×0.50×82928=1659 tons of Eurodiesel (Varol et al., 2018). Accordingly, all emission values calculated for taxis and cars are shown in Table 1 in EURO V and EURO VI tons.

Table 1. Total emission values of passenger cars

	Vehicles	CO	NOx	HC	PM	CO_2	**Total**
Euro V	Taxi	0,07	0,015	0,005	0,001	40,63	40,72
Euro V	Automobile	4,53	0,836	0,422	0,035	1615,60	1621,43

	Vehicles	CO	NOx	HC	PM	CO_2	**Total**
Euro VI	Taxi	0,066	0,01	0,007	0,001	39,99	40,083
Euro VI	Automobile	4,535	0,504	0,555	0,035	1403,99	1409,62

2.2. Emission Values for Minibuses

Public transportation vehicles are divided into two classes as minibuses. But they do not have a difference in terms of emission values. It is no different from passenger vehicle (automobile) accounts. The total emission value is reached by multiplying the emission standards, the daily distance traveled and the number of vehicles (Table 2).

Table 2. Total emission values of commercial vehicles

	Vehicles	CO	NOx	HC	PM	CO_2	**Total**
Euro V	Minibus	2,496	0,945	1,136	0,017	872,37	876,964

	Vehicles	CO	NOx	HC	PM	CO_2	**Total**
Euro VI	Minibus	2,496	0,422	0,705	0,017	830,22	833,86
	Vanbus	0,118	0,02	0,014	0,001	39,147	39,30

2.3. Emission Standards for Buses

Apart from the buses using Eurodiesel in the center of Konya, there are also CNG, that is, natural gas buses. There is a difference in the standards given when calculating on buses. Here it is used as g/kWh instead of g/km because our emission standard value is given in this unit in the table. Before starting the calculation here, the conversion of g/kWh to g/km has been calculated under the heading of emission calculation for bus below. 310 of the 510 municipal buses in Konya are CNG powered. Since most of the buses operating with Eurodiesel in Konya are produced in Euro IV standards, this standard will only be used for buses. The way to be followed while calculating is as follows; First of all, the average kW values of the vehicles should be found. Then, g/kWh value will be found according to the EURO IV value and multiplied by the operating time of the vehicle. The result will be divided by the distance traveled per day and the result will give the emission value per kilometer. While making emission calculations of buses, it is known that the buses are between 180 and 210 kW according to the brand. Since the vehicle does not always run at full power, the lowest value is accepted as 180 kW and it is considered that the buses are in motion for 12 hours in a day.

2.3.1. Finding Emissions Values for Eurodiesel Bus

The EURO IV value for CO emissions is 1.5 g/kWh for buses. The operating time of the vehicle with 180 kW power is 12 hours, and the daily emission value is found by multiplying it with the relevant emission value. The emission value per kilometer is found by dividing this value by the distance traveled per day. The same path will be followed for other emissions.
For instance;180 x 12 x 1.5 = 3240 g CO is formed. When this value is divided by the distance traveled daily;
Its emission value per km is determined as 3240/225=14.4 g/km CO. Other emission gases such as CO are calculated in the same way and the values are shown in Table 3.

Table 3. Bus emission values

	Vehicles	CO	NOx	HC	PM	CO_2	**Total**
Euro V	Municipal Buses	0,889	1,598	0,208	0,009	45,49	48,19
	Buses	11,16	26,05	3,42	0,15	624,15	664,95

3. Steps of Transition to Electric Vehicles

Today, electric vehicles have started to be mentioned a lot in our agenda. One of the main reasons for this is greenhouse gases that harm the environment and cause global warming. After this awareness, the number of vehicles in traffic in the last five years is as in Table 4. When Figure 1 is examined, the number of electric vehicles shows a steady growth, no matter how small. Here are some of the reasons why electric vehicles have been in high demand lately:

• Fuel economy is one of the most important advantages of electric vehicles. Natural resources are consumed for cars running on fossil fuels. Electricity is a cheap energy source compared to gasoline and diesel.

• Electric vehicles are designed with more technical equipment compared to fossil fuel vehicles.

• Electric vehicles are environmentally friendly and emit less carbon to the world.

Table 4. TUIK, distribution of vehicles in Turkey by fuel type of the last 5 years (TUIK, 2021)

	2017	2018	2019	2020	2021
Gasoline	3120407	308926	3020017	3201894	3319123
EuroDiesel	4256305	4568665	4769714	5014356	5085617
Lpg	4616842	4695717	4661707	4810018	4851798
Electric-Hybrid	1685	5367	15053	36487	56287

Today, even if there are problems such as battery and range, one of the most important steps to protect our environment is to electrify urban public transportation vehicles. In this way, we can get rid of emissions for vehicles in the city. Our aim in this study is to convert the vehicles that will not go in public transportation and long distances in the city to electric vehicles and to minimize harmful emissions to nature. While doing this study, we designed the transition of vehicles to electric vehicles gradually, because it is not possible to make almost all vehicles electric based on the infrastructure problems of electric vehicles such as charging units.

3.1. Stage 1: Suppose 25% of cars and taxis are electric vehicles

Our first application in this regard will be cars and taxis. Because the motor power is smaller compared to the others and can be charged for 8 hours in a 220 V household electricity. At this stage, 25% of the vehicles were first calculated according to Euro V and Euro VI values. At this stage, 53567 cars and 175 taxis are taken into account. Stage one emission results are seen in the Table 5.

Table 5. Stage 1 emission results

	Tons	CO	NOx	HC	PM	CO_2	**Total**
Euro V	Total Emission	19,15	29,63	5,22	0,211	3198,26	3252,46
	25% Vehicle Emission	1,15	0,21	0,10	0,0092	264,95	266,44
	Percentage Change	6,01%	0,72%	2,05%	4,38%	8,28%	8,19%

	Tons	CO	NOx	HC	PM	CO_2	**Total**
Euro VI	Total Emission	19,15	28,59	4,90	0,21	2943,86	2996,71
	25% Vehicle Emission	1,15	0,128	0,141	0,009	264,95	266,37
	Percentage Change	6,01%	0,45%	2,87%	4,29%	9,00%	8,89%

The total EURO V and total EURO VI emission headings seen in Table 5 are the emission values of cars, taxis, minibuses and buses currently in traffic. 25% vehicle emissions are the emissions of automobiles and taxis that are taken into account. The percentage change is the percentage change between the emission values of all vehicles and the emission values of the cars and taxis taken into account. Internal combustion engines, which are 25% of the total emissions, were withdrawn and replaced by electric motors in traffic. The highest emission reduction rate is 8.28% CO_2 in percent.

3.2. Stage 2: 50% automobile and taxi, 25% minibus

In the second stage, cars and taxis were increased from 25% to 50%, while minibuses and minibuses were switched to electric vehicles at a rate of 25%. The number of cars is 107,134, the number of taxis is 350, minibuses and minibuses are taken into account, and the total number of vehicles is calculated as 2811. Today, minibuses are available with a range of 210 km and a capacity of 25 people. Second stage emission values are shown in the Table 6.

Table 6. Emission values in the 2nd stage

	Tons	CO	NOx	HC	PM	CO_2	**Total**
Euro V	Total Emission	19,151	17,815	4,317	0,211	1718,42	1759,91
	Vehicle Emission	2,925	0,662	0,272	0,0225	656,35	660,23
	Percentage Change	15,28%	3,71%	6,31%	10,66%	38,18%	37,51%

	Tons	CO	NOx	HC	PM	CO_2	**Total**
Euro VI	Total Emission	19,11	4,19	1,90	0,131	1718,42	1743,79
	Vehicle Emission	2,92	0,362	0,359	0,02	657,35	661,016
	Percentage Change	15,27%	8,65%	18,93%	16,98%	38,25%	37,91%

In terms of total emissions, 50% of cars and taxis with internal combustion engines and 25% of minibuses with internal combustion engines were withdrawn from traffic. The maximum emission reduction rate is CO_2.

3.3. Stage 3: 75% cars and taxis, 50% minibuses, 25% buses and municipal buses

In the 3rd stage, 25% of the buses and city buses with internal combustion engines and CNG were withdrawn from the traffic. 128 municipal buses, 5620 minibuses, 525 taxis, 160701 cars and 862 buses were included in the 3rd Stage. With the inclusion of buses, total emissions increased from 22% to 57%. Third stage emission values are seen in the Table 7.

Table 7. 3rd stage emission values

	Tons	CO	NOx	HC	PM	CO_2	Total
Euro V	Total Emission	19,15	29,63	5,22	0,211	3198,26	3252,47
	Vehicle Emission	7,711	7,769	1,80	0,074	1848,78	1866,14
	Percentage Change	40,26%	26,22%	34,57%	35,28%	57,81%	57,38%

	Tons	CO	NOx	HC	PM	CO_2	Total
Euro VI	Total Emission	19,15	28,58	4, 90	0,21	2943,86	2996,71
	Vehicle Emission	7,71	7,55	1,69	0,074	1668,52	1685,54
	Percentage Change	40,26%	26,43%	34,43%	35,28%	56,68%	56,25%

Since the production years of the buses in Konya are old, the calculations are made on the basis of the Euro IV emission standard. A serious percentage increase is observed in emission values. The main reason for this is buses. Because buses have a larger volume compared to other vehicles that are taken into account as engine volume.

3.4. Stage 4; 100% automobile and taxi, 75% minibus, 50% bus and municipal bus

In the 4th phase, 255 municipal buses, 8431 minibuses, 700 taxis, 214267 cars and 1723 buses were included. Fourth stage emissions are shown in the Table 8.

Table 8. 4th stage emission values

Euro V	Tons	CO	NOx	HC	PM	CO_2	**Total**
	Total Emission	19,15	29,63	5,217	0,21	3198,26	3252,46
	Vehicle Emission	12,5	15,48	3,106	0,18	2645,34	2676,55
	Percentage Change	65,27%	52,23%	59,54%	60,55%	82,71%	82,29%

Euro VI	Tons	CO	NOx	HC	PM	CO_2	Total
	Total Emission	19,15	28,58	4,90	0,21	2943,86	2996,71
	Vehicle Emission	12,5	14,65	2,91	0,13	2401,48	2431,67
	Percentage Change	65%	31%	59,33%	60,55%	81,58%	81,14%

Emission values are reduced by 83%. When the majority of vehicles are converted to electric vehicles, the damage to nature is minimized. In the next stage, electric vehicles are replaced by vehicles that are withdrawn from traffic, and the amount of emissions generated while generating the electricity needed by vehicles is taken into account and recalculated.

4. Electricity Requirements of Electric Vehicles and Emissions From Electricity Generation

In addition to the amount of emissions we reduced when we switched to electric public transportation vehicles instead of public transportation vehicles with internal combustion engines, the emissions from the electricity required by electric vehicles on the road were also calculated.

4.1. Phase 1: 25% cars and taxis

In Table 9; %25 of the electricity needs for cars are seen below.

Table 9. In the first phase, 25% of the electricity needed for cars

Vehicle	Number	kWh/km	KM	Energy Required for a Vehicle (kW)	Total Required Energy (kWh)
Automobile	53567	0,18	40	7,2	385682,4
Taxi	175	0,18	300	54	9450
				TOTAL	395132,4

The energy consumed per km by vehicles with smaller engines such as automobiles is 0.18 kW. Here, the calculation made to find the required energy is multiplied by the energy consumed per kilometer and kilometer by the vehicle, and the amount of energy required for the vehicle is found. Then, when the required energy is multiplied by the number of vehicles, the total energy needed for the vehicles that are electrified in the first step is found. The energy required by the conversion of the vehicles in the 1st stage to electric vehicles is 395.13 MW. Let's examine the emissions caused by this electricity need. Emission produced for energy needs are shown Table 10.

Table 10. Emission produced for the energy needed

kW		CO	NOx	CO_2
	Automobile	0,759	1,697	162,37
	Taxi	0,018	0,041	3,98

The emission values here were found by multiplying the total required energy with the above-given power plant emission value. These values are calculated in tons. Table 11 includes the emission changes in stage one.

Table 11. Emissions change in stage 1 (Euro V)

	Tons	CO	NOx	HC	PM	CO_2
Euro V	Total Emission	19,15	29,63	5,22	0,211	3198,26
	Vehicle Emission	1,150	0,21	0,11	0,009	264,95
	Percentage Change	0,060	0,007	0,02	0,044	0,08
	Power Plant Emission	0,78	1,74			166,35
	Net Emission Decrease	0,37	-1,53			98,59
	Net Total Emission	18,78	31,15			3099,67
	Total Reduction Rate	0,020	-0,05			0,0318

When the emissions of the electricity needed are added in addition to these emissions, the total change is seen in Table 3.4.
• Total Euro V Emission (Ton): Emission of total vehicles in Konya
• Vehicle Emission (Ton): Emissions of the vehicles we handled in the 1st stage
• Percentage Change: Ratio of vehicles withdrawn from traffic in Phase 1 compared to overall emissions
• Power Plant Emission:1. Emissions from the electrical needs of vehicles in phase
• Net Emissions Reduction: The difference in power plant emissions from converted vehicles
• Net Total Emission: The difference of the net emission reduction from the total emissions
• Total Reduction Rate: The ratio of net emissions to net total emissions is given as a percentage.
The same process works in Euro 6. Values are shown in Table 12.

Table 12. Emissions change in phase 1 (Euro VI)

	Tons	CO	NOx	HC	PM	CO_2
Euro VI	Total Emission	19,15	28,59	4,90	0,211	2943,86
	Vehicle Emission	1,150	0,13	0,140	0,009	264,95
	Percentage Change	6,01%	0,45%	2,87%	4,29%	9,00%
	Power Plant Emission	0,78	1,74			166,35
	Net Emission Decrease	0,37	-1,61			98,60
	Net Total Emission	18,78	30,20			2845,26
	Total Reduction Rate	1,99%	-5,33%			3,47%

4.2. Phase 2: %50 cars and taxis, %25 minibuses

Table 13 shows the energy needs for producing emission.

Table 13. Emission produced for the energy needed

		CO	NOx	CO_2
Tons	Automobile	1,519	3,394	324,744
	Taxi	0,037	0,083	7,956
	Minibus	0,664	1,484	142,057

2. the total electricity required to be generated for all electric vehicles is 1127.69 MW.

The required energy and power plant emissions are as shown in Table 14;
The values of EURO V and EURO VI are as follows;

Table 14. Emissions change in stage 2

	Tons	CO	NOx	HC	PM	CO_2	**Total**
Euro V	Total Emission	19,15	29,63	5,22	0,211	3198,26	3252,46
	Vehicle Emission	1,15	0,21	0,11	0,009	264,95	266,43
	Percentage Change	6,01%	0,72%	2,05%	4,38%	8,28%	8,19%
	Power Plant Emission	0,78	1,74			166,35	168,87
	Net Emission Decrease	0,37	-1,53			98,59	97,56
	Net Total Emission	18,77	31,15			3099,67	3154,91
	Total Reduction Rate	1,99%	-4,90%			3,18%	3,09%
	Tons	CO	NOx	HC	PM	CO_2	**Total**
Euro VI	Total Emission	19,15	28,59	4,90	0,211	2943,81	2996,71
	Vehicle Emission	1,150	0,128	0,141	0,009	264,95	266,38
	Percentage Change	6,01%	0,45%	2,87%	4,29%	9,00%	8,89%
	Power Plant Emission	0,78	1,74			166,351	168,87
	Net Emission Decrease	0,37	-1,61			98,598	97,51
	Net Total Emission	18,78	30,20			2845,263	2894,24
	Total Reduction Rate	1,99%	-5,33%			3,47%	3,37%

As can be seen at this stage, higher numbers were reached than the percentage values in the 1st stage. But the percentile of NOx still remains negative. The reason for this is due to the intensity of the use of power plants such as coal, and high value increases are observed in terms of emissions. In order to prevent this situation, it is necessary to switch to clean energy sources and reduce the fossil fuel energy production at our disposal.

4.3. Phase 3: %75 cars and taxis %50 minibuses, %25 municipal buses and buses

The amount of energy needed for the system package is shown in the Table 15.

Table 15. System package for needed energy

		CO	NO_x	CO_2
Tons	Automobile	2,279	5,091	487,116
	Taxi	0,055	0,124	11,935
	Minibus	1,46	3,255	312,168
	Buses	0,389	0,87	83,286
	Municipal Buses	0,057	0,129	12,367

The electrical energy we need to produce in the 3rd stage is 2120,72 MW. In the Table 16, we can see the emission changes in third stage.

Table 16. Emission change in the 3rd stage (Euro V and Euro VI)

	Tons	CO	NO_x	HC	PM	CO_2	Total
Euro V	Total Emission	19,15	29,63	5,22	0,211	3198,26	3252,47
	Vehicle Emission	7,71	7,77	1,80	0,074	1848,78	1866,14
	Percentage Change	40,26%	26,22%	34,57%	35,28%	57,81%	57,38%
	Net Emission Decrease	3,53	-1,562			955,95	959,80
	Net Total Emission	15,62	31,19			2242,30	2292,66
	Total Reduction Rate	22,62%	-5,00%			42,63%	41,86%

	Tons	CO	NOx	HC	PM	CO_2	Total
Euro VI	Total Emission	19,15	28,58	4,90	0,211	2943,86	2996,71
	Vehicle Emission	7,71	7,55	1,69	0,074	1668,52	1685,54
	Percentage Change	40,26%	26,43%	34,43%	35,28%	56,68%	56,25%
	Net Emission Decrease	3,53	-1,77			775,694	777,45
	Net Total Emission	15,62	30,36			2168,167	2214,14
	Total Reduction Rate	22,62%	-5,85%			35,78%	35,11%

In the 3rd phase, the buses with the highest emission rates according to the EURO values were converted to electric buses at a rate of 25%. While the rate of CO2 was 6% in the 2nd stage, it changed to 35% as a result of this stage. The main reason for this is considering the weight of the bus ranging from 6 to 15 tons and the engine power required to move it, the conversion of high-engine vehicles such as buses into electricity is of great importance for nature and for us. It is understood from the result that the transformation of buses and municipal buses into electric vehicles will make a great contribution to the environment. The increase in NOx emission in the 2nd phase does not continue in the 3rd phase. The reason is that although the number of buses handled in the 3rd phase is low, the amount of emissions they produce is very high, and the increase was prevented when electric buses were included instead.

4.4. Stage 4; 100% automobile and taxi, 75% minibus, 50% bus and municipal bus

The emission produced for the energy needed are shown in the Table 17.

Table 17. Emission produced for the energy needed

		CO	NOx	CO_2
Tons	Automobile	3,039	6,788	649,486
	Taxi	0,074	0,166	15,914
	Minibus	2,092	4,664	447,22
	Buses	0,778	1,739	166,475
	Municipal Buses	0,115	2,574	24,638

The electrical energy we need to produce is 3096.78 MW. Stage four emission change is seen in the Table 18.

Table 18. Emission change in stage 4

	Tons	CO	NO_x	HC	PM	CO_2	Total
Euro V	Total Emission	19,15	29,62	5,217	0,211	3198,26	3252,46
	Vehicle Emission	12,5	15,47	3,106	0,127	2645,34	2676,55
	Percentage Change	65,27%	52,23%	59,54%	60,55%	82,71%	83,68%
	Power Plant Emission	6,1	13,62			1303,74	1323,47
	Net Emission Decrease	6,4	1,851			1341,6	1349,85
	Net Total Emission	12,751	27,78			1856,66	1897,19
	Total Reduction Rate	50,19%	6,66%			72,26%	71,15%

	Tons	CO	NO_x	HC	PM	CO_2	Total
Euro VI	Total Emission	19,15	28,58	4,90	0,211	2943,86	2996,71
	Vehicle Emission	12,5	14,65	2,91	0,128	2401,48	2431,67
	Percentage Change	65%	31%	59,33%	60,55%	81,58%	81,14%
	Power Plant Emission	6,1	13,62			1303,74	1323,47
	Net Emission Decrease	6,4	1,03			1097,74	1105,17
	Net Total Emission	12,751	27,55			1846,12	1886,43
	Total Reduction Rate	50,19%	3,74%			58,19%	59,86%

Now at stage 4, NOx gas is turned to advantage. As can be seen, all the results are the results of a cleaner future that contributes immensely to the environment. Except for the NOx gas, the reduction rates of other emission gases are over 50%. There is a 3% change for NOx.

5. Conclusion

As seen in our study, we see how much difference the results make for us. In the 4th stage, we reduced the total emissions of 3252.46 tons to 1897.19 tons. Based on these results, directing the electricity we produce to cleaner sources is a very important principle for humans and nature. Emission changes of EURO V and EURO V1 Stages can be seen in the Figure 1 and 2.

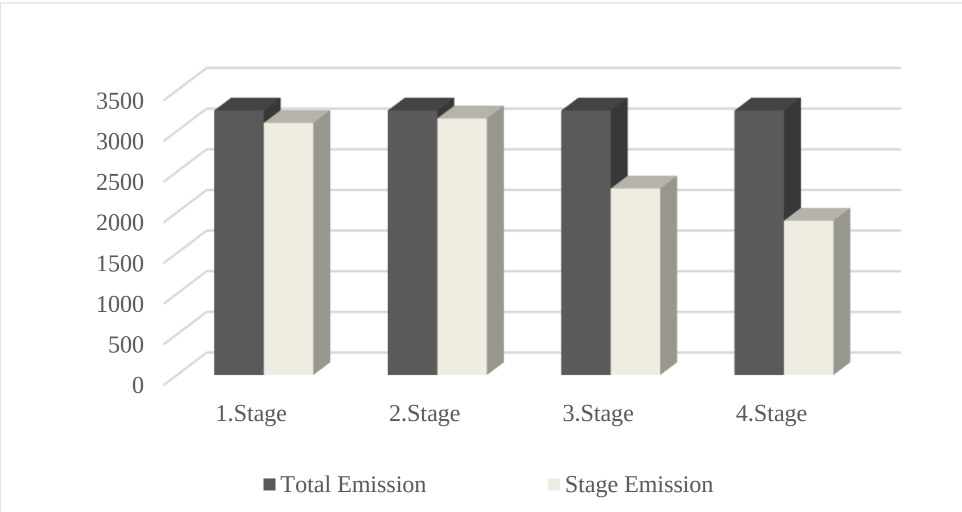

Figure 1. Emission change of EURO V Stages

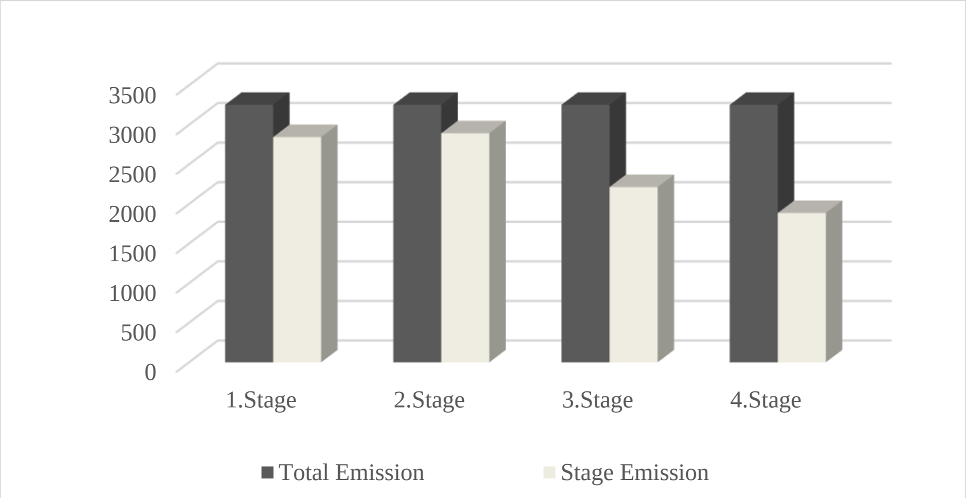

Figure 2. Emission change of EURO VI Stages

The biggest change that can be made in this regard is the encouragement of people to electric vehicles. In this regard, incentive methods such as tax deductions can be applied and people can be bought as private vehicles. Although the transition period of people to electric vehicles is a process that will take time, the most important and first return should be to apply in public transportation.With the transition of electric vehicles, our energy requirement is 3096.78 MW. Our country is in a very favorable position in terms of clean energy. We have natural resources from which we can produce a lot of energy, such as solar energy, thermal energy and wind energy. It is very possible that we will accelerate our progress in terms of clean energy in our country and carry this process to a closer date.

Declaration of Author Contributions

The authors declare that they have contributed equally to the article. All authors declare that they have seen/read and approved the final version of the article ready for publication.

Declaration of Conflicts of Interest

All authors declare that there is no conflict of interest related to this article.

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