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TOWARDS A SUSTAINABLE TRANSPORT ENERGY POLICY IN PAKISTAN

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ABSTRACT

This paper scrutinizes Pakistan's transport sector's climate financing potential and environmental sustainability to achieve sustainability. The study targets specific objectives from the environmental compendium and uses the data from the Pakistan Economic Survey. It computes the Economic costs and Benefits of replacing engine fuel across Pakistan's small, medium, and large vehicles. Additionally, it assesses the influence of Policy Intervention on environmental degradation within the transport sector and gauges the economic value of CO2 emissions offsetting. The study advocates clean transport funding by employing calculations based on per-unit emissions and cost per kilometer. It dissects and aggregates environmental quality and economic feedback from policy interventions using component and compound-based methods. Notably, transitioning to cleaner fuel incurs significant engine shifting costs, yet the study concludes that, despite short-term cost increases in the sector and services, Pakistan can reap long-term economic benefits from this shift to achieve the sustainable transportation targets.

1.0 Introduction

The Transport sector is one of the most important elements, responsible for every economy's growth and development. Air transport and water transport play important roles in the trade economy, which is supported through road transport to deliver the products to the right places (Glaeser and Kohlhase 2004) & Hesse et al (2004) increase in population has led to the transport density being swamped over time. The number of cars, vegans, Jeeps, Scoters, rickshaws,

tractors, and buses has increased from 4784123 in FY 2001 to 35,506,571 in FY 2024 (Economic Survey 2024-25). The National Highway Authority (NHA) plays a significant part in the management of increasing vehicles for the development of Pakistan's economy. NHA has contributed to the enhancement of national consolidation across most of the urban settlements and some of the rural settlements. Presently, according to the National Highway Authority, the NHA network includes 48 national highways, motorways, expressways, and strategic roads with a total road elasticity of 14,480 km.

Besides the fact that increasing population needs more cars, the upcoming consequences of these carelessly developed facilities could not be ignored, as well; specially when it is keeping the sustainability of future generations at stake. The transportation system is causing a significant level of mutilation to Air quality and the environment in multiple ways (Anenberg, j, & R, 2017). Emissions caused by transport not only affect the concentration level of Particles Per Million in the Air but also spring food for climatic incidents. First, heat is trapped due to increasing CO_2 in the atmosphere and causing the greenhouse effect, and secondly, the health of our kids and elders becomes susceptible to Global warming. These issues are no doubt reported across the world on every climate forum, but the facts are not overwhelmingly connected to take action.

Although transport emissions can be curbed effectively by employing incentives and taxes. This research suggests an additional approach to reduce CO_2 emissions without hindering future transport demands in Pakistan. As a developing nation, Pakistan aims to eliminate our 0.08% carbon footprint while sustaining productivity for its growing population. (Khan I. M., 2019).

While all the large engines are consuming Diesel because Diesel engines were conventionally ideal due to their low running cost and restorable twisting features (Khan I. M., 2019) . But, during the last ten to fifteen years, strict emissions standards have required the use of numerous unconventional ignition and after-treatment machinery, which in turn have made diesel engine power expensive and complex. Initially, it was the sole recourse for transporters, yet modern Research and Development (R&D) has empowered many developing nations to harness electricity, gas, and alternative energy sources for transportation. Hybrid buses, proven and dependable, are widely used and available in various sizes and fuel combinations (e.g., diesel-hybrid or gas-hybrid). In urban settings, they exhibit approximately 20% fuel savings on average, with an incremental 20% investment cost recouped over the vehicle's lifespan through energy efficiencies (Deorah & Phadke, 2018). Hybrids serve as an interim towards full electrification, especially for large buses on lengthy, high-demand routes.

The current Pakistani scenario poses hurdles to investing in eco-friendly technologies, necessitating substantial funding and support to reshape the transport sector for environmental gains Ahmad, W., & Siddique, M., 2019). Therefore, incentives are vital, demanding significant resources to usher in novel technologies. Notably, organizations worldwide, like the Green Climate Fund (GCF), are making dedicated efforts to promote green, transformative change. GCF, distinct in its focus on impactful climate transformation, finances scalable mitigation and adaptation ventures aligned with the Paris Agreement, thus, propelling systemic shifts.

Pakistan's transport sector, transitioning from polluting energy to clean alternatives, beckons empowerment Iqbal et al (2021). With avenues like GCF's support, the nation can seize the opportunity for cleaner, sustainable development. GCF's approach goes beyond project funding, extending to enhancing countries' climate capabilities and readiness, and facilitating direct resource access, thereby guided by country ownership principles, assisting developing countries in achieving their low-emission, climate-resilient objectives in alignment with NDC goals.

The Fund is unique in its ability to engage directly with both the public and private sectors on transformational climate-sensitive investments. GCF can deploy a range of instruments, including grants, loans, equity, and guarantees. The Fund has the capacity to bear significant climate investment risk, allowing it to unlock another financing (Lattanzio, R. K. 2012). The important thing for receiving this fund is to make accounts for emissions reduced or stopped from emitting, which can be verified as well in times of need. The Carbon unit saved or reduced in Pakistan, as mentioned above, the emissions of the transport sector can be calculated and controlled with proper accounting, and it can also be verified. There is a specific price per ton of carbon unit saved. The prices range from two dollars to a hundred dollars, depending upon the country's status. According to GCF, the price range per ton of carbon is from 20$ to 30$ dollars (Asian Development Bank, 2018). This sector has the potential to generate some clean development funds. This study takes 30 $ as Carbon per unit (ton) for the estimation of the climate financing potential of Pakistan from transport (Khan I. M., 2019).

The idea to control GHG emissions from the transport sector is to change the energy mix of vehicles running on roads. At least small passenger cars and personal use cars can be easily shifted to Gas, Solar, or electric cars by subsidizing their spare parts, energy products, and legal bodies. If incentives are given to small vehicle owners in terms of price cuts on cleaner energy, a significant quantity of Metric tons of CO_2 can be reduced. There is a high probability of reducing CO_2 emissions from the transport sector if only base driving is exercised across all the cities of Pakistan. This study focuses on quantifying and valuing GHG emissions reductions through transitions in engine-running energy sources. Employing a Well-To-Wheel approach, GHG emissions from Pakistan's transport sector are calculated. Due to the lack of emissions standards, South Asia's standards are adopted. Even if minimal emissions are reported, Pakistan's transport emissions exceed future climatic tolerance. Various scenarios are considered, measured by energy sources and yearly vehicle distances. Emissions are computed under the assumption of uniform engine types within vehicle categories.

1.1 Significance of the Study/Rationale

The gradual rise in temperatures is impacting communities while elevating living costs, particularly in developing nations. Temperature escalation correlates positively with heightened Greenhouse Gas (GHG) levels, attributed to anthropogenic and non-anthropogenic factors. Temperature spikes, primarily post-industrialization, exceeded tolerance thresholds due to excessive GHG emissions. Industrialization increased transportation demands for delivering goods globally, resulting in substantial CO2 emissions. In Pakistan's transport sector, curbing emissions necessitates strategic options, considering GHG reduction potential, sustainable gains, and cost efficiency. Passenger cars, taxis, buses, and vans form the transport network, with fuel alternatives including CNG, Diesel, Petrol, and Solar. Implementing these options can steer the sector toward carbon neutrality, fostering a sustainable transport policy. This transition supports the adoption of cleaner fuels, fostering a potential trajectory towards carbon neutrality.

1.2 Objectives

- To Identify the Climate Financing Potential of the Transport Sector of Pakistan
- To Calculate the Economic Cost and Benefits of Substituting Engine Fuel
- To Examine the Effect of Policy Intervention on CO_2 Emissions resulting from Transport

1.3 Scenario Description

The existing transport blend encompasses Diesel, Petrol, and CNG as engine fuels. This distribution consists of 30% diesel, 30% petrol, and 40% CNG for Motor-cars, jeeps, and station

wagons. Taxis are at 20% diesel, 30% petrol, and 40% CNG. Buses divide evenly between petrol and diesel. All large vehicles run on diesel, while 2-wheelers and 3-wheelers run on petrol. Uniform engine sizes are assumed within categories. Shifting these to CNG, especially small cars, presents a cost-effective option. To assess changes, we computed emissions and values for the current mix, then for diesel, petrol, CNG, and solar. Using a dummy variable for potential government intervention, our analysis gauges its impact on carbon units, environmental pressure (in million metric tons), and other key variables. Methodology provides detailed variable explanations.

1) Every registered Vehicle covers a distance of 1000 Kilometers
2) Every registered vehicle covers a distance of 50000 kilometers in a Year

1.4 Outcomes

Comparing costs per kilometer among current and alternative fuels for varied vehicles dictates outcomes. If the emissions reduction value surpasses shifting costs, feasibility is straightforward. If not, governmental subsidies are crucial for transitioning to cleaner energy sources.

2. Review of the literature

To meet the needs of people and other animals on the planet earth, transportation is crucial to the movement of products and services. Transport, defined as the movement of people and things from one location to another, has evolved into a basic human need and survival essential because it frequently enables the effective execution of social or economic activities in a world that is moving more quickly than humans. (Jahan, Khan , & Naqvi, 2022)

According to the study of (Andreae, Jones, & Cox , 2005) , global greenhouse gas (GHG) emissions increased significantly in 2010 (5.8%), and the concentrations of these gases more than doubled. Transport makes a significant contribution to Pakistan's emissions of greenhouse gases, as it is a growing nation with a population of over 220 million. The CO_2 emission trends in Pakistan point to a trend of steadily rising CO_2 emissions, which serve as a breeding ground for greenhouse gases, raise the temperature, and alter the climatic conditions of the nation. (Bashir, Dengfeng, Khan, Shahzad, & Khalil , 2023).

Pakistan's air quality is at its worst in many years because of substantial population expansion and urbanization. The usage of fossil fuels in industrial activities, transportation, and agricultural activities is a common cause of both air pollution and climate change (Hussain, Butt, Uzma, Ahmed, Islam, & Yousaf, 2019). The transport sector plays a vital role in a country's economy and acts as a driving force for progress and advancement (Mohmand, Mehmood , Mughal, & Aslam, 2021). This sector becomes more important in today's globalized world, where economic opportunities are, to an increasing extent, linked to the mobility of information, goods, and people (Kuznetsov, Kirichenko, & Slitsan , 2010). The world is currently most worried about climate change and how it affects society, the natural world, and the economies of states, especially those that are suffering economic troubles (Raza & Lin, 2020).

The majority of transportation emissions in Pakistan are produced by road transportation, primarily by diesel-powered vehicles. Diesel fuel is commonly used in generators, irrigation pumps, and heavy-duty vehicles like trucks and buses. Moreover, gasoline-powered vehicles, primarily cars and motorcycles, contribute to transportation-related emissions. 16.7% of the nation's total CO_2 emissions are related to the transport industry (Pakistan Economic Survey 2020-2021).

Khan et al (2020) Road transportation in Pakistan, notably the use of diesel-powered vehicles, is the primary source of transportation emissions. Trucks, buses, generators, irrigation pumps, and other heavy-duty vehicles frequently use diesel fuel. Transport emissions are also produced

mainly by cars and motorcycles that run on gasoline (Danish & Baloch, 2018) and (Ahmed, et al., 2012). The study by Khan et al., (2022) stated that carbon emission rises due to the development of cities and the rapid growth rate of urbanization, and it is not only the transport sector but also the household energy choices also contribute to it.

At 157-million-ton CO_2 emissions in 2007-08, or more than 51% of the nation's overall emissions (0.45% of the global total), the energy sector (including transportation) is Pakistan's largest source of GHG emissions. According to a report by the Asian Development Bank, Pakistan's transport emissions might increase by up to 300% by 2050 if current policies are implemented (ADB). This increase in emissions will have a severe impact on the nation's air quality, environmental deterioration, and public health.

According to a report by the International Energy Agency (IEA) compressed natural gas (CNG) was introduced as an alternative fuel and public transportation infrastructure was expanded as only two of the numerous initiatives Pakistan has put in place to lessen the impact of transportation emissions on climate change. Several initiatives have also been launched by the government to encourage the use of electric vehicles (EVs), and it has set a target of having 30% of all vehicles on the road be EVs by 2030.

It will be highly challenging to cut transportation-related emissions over the long term, according to the International Energy Agency (IEA), as Pakistan is projected to have triple its existing number of vehicles by 2050. The goals of ongoing government, corporate sector, and civil society actions to address this issue must be the long-term reduction of emissions and the promotion of sustainable transportation systems. Sustainable transportation systems should play a significant role in overcoming the negative externality (Fatima , Khan, & Naqvi, 2022). To cut greenhouse gas emissions to 50% of the baseline estimated levels by 2030, the Government of Pakistan (GoP) has ambitious plans. By 2040, these plans call for USD 151 billion in investments in projects aimed solely at reducing the energy sector's impact. According to the GOP, and 50% decrease in emissions below the baseline predicted emissions should be supported by 15% local sources and 35% foreign sources. Most of the time, international funding should be provided at a discount. Pakistan has relatively high emissions and a low GDP per person, yet it must nevertheless meet strict requirements in order to be eligible for concessional international climate finance (CF) (Mako, Nabi, Mahmood, & Khan, 2022).

3. DATA AND METHODOLOGY

2.1 Data description

Data from the Pakistan Economic Survey 2018-19 is used, providing registered vehicle counts annually. CO_2 emissions calculation involves employing emissions standards and cost-per-kilometer data for various energy fuels sourced from diverse studies and reports. Carbon offset's economic value is established using a $30 per ton price for emission reduction, cessation, or storage.

2.2 Methods for emissions calculations

According to **(**Darlington, T. 2005) **Well-To-Tank (WTT),** Life Cycle Analysis of a petroleum-based fuel pathway includes all steps from crude oil recovery to final finished fuel. **Tank-to-wheel (TTW)** analysis by (Mendes-Lopes, J. M. 2006) includes the actual combustion of fuel in a motor vehicle for motive power. WTT and TTW analysis are combined to provide a total **Well-To-Wheel (WTW)** analysis by De la Iglesia, F. G. (2009). This study has used the emissions factors that came through these methods.

Diesel: 1 liter of diesel weighs 835 grams. Diesel consists of 86,2% of carbon or 720 grams of carbon per liter diesel. To combust this carbon into CO_2, 1920 grams of oxygen is needed. The

sum is then 720 + 1920 = 2640 grams of CO_2/liter diesel. An average consumption of 5 liters/100 km then corresponds to 5 l x 2640 g/l / 100 (per km) = 132 g CO_2/km.

Petrol:

1 liter of petrol weighs 750 grams. Petrol consists of 87% of carbon or 652 grams of carbon per liter of petrol. To combust this carbon into CO_2, 1740 grams of oxygen is needed. The sum is then 652 + 1740 = 2392 grams of CO_2/liter of petrol. An average consumption of 5 liters/100 km then corresponds to 5 l x 2392 g/l / 100 (per km) = 120 g CO_2/km.

CNG AND LPG:

1 liter of LPG weighs 550 grams. LPG consists for 82,5% of carbon, or 454 grams of carbon per liter of LPG. To combust this carbon to CO_2, 1211 grams of oxygen is needed. The sum is then 454 + 1211 = 1665 grams of CO_2/liter of LPG. An average consumption of 5 liters / 100 km then corresponds to 5 l x 1665 g/l / 100 (per km) = 83 g of CO_2/km. CNG is a gaseous fuel (natural gas), stored under high pressure. Consequently, the consumption can be expressed in Nm3/100km, but also in kg/100km. Consumption of natural gas vehicles is, however, most often expressed in kg/100km.

Table 2.1 CO2 Emissions Standards for different types of transport vehicles with different energy sources

CO2 EMISSIONS Gram/KM 2015 small cars					
Vehicle fuel type	Diesel	Petrol	Hybrid	Electric car	Mix car
Tank-To-Wheel (TtW)	109	132	106	1	1
Well-To-Tank (WtT)	22	27	22	117	149
Total Emissions	131	159	128	118	150
CO2 EMISSIONS Gram/KM 2015 BUS AND TRUCKS					
FUEL ENERGY TYPE	DIESEL	CNG	SOLAR	SOURCE	
Bus	1288	644	322	[1]LEAD	
Truck	876	435.5	217.7	LEAD	
CO2 EMISSIONS GRAM/KM TWO AND THREE-WHEELERS					
Two-wheeler	40	20	10	LEAD	
Three-wheeler	71	35.5	17.25	LEAD	

Source: Danish Petroleum Association 2009 Kanal, F., & Denmark, C. K. (2009)

2.3 Climate financing potential to become a net-zero sector

The climate financing potential means, what amount of funds can be generated against the reduced amount of Carbon units through shifting decisions in the transport sector. The price per unit carbon stored or stopped from emitting is 30 dollars per MT ton CO2. Now the idea is, how

[1]Source: These calculations are extracted from the lead chapter 13 transport sector's which were taken from the calculations of International Vehicle Emissions Model (University of California at Riverside College of Engineering Center for Environmental Research and Technology, based on databases compiled by University of California Riverside research team in 2004).

many tons can have reduced in the transport sector by changing the fuel mix? The funds will be paid to those, whose proposed reduction of environmental pressure can be calculated and verified, the units reduced are converted to economic value by multiplying units by the price per unit saved or reduced. In the transport sector we can calculate it from registered vehicles by using the data of registered vehicles every year, per km emissions from each type of vehicle with different fuel sources for engine, and using the simple mathematics we have calculated, the changes in Carbon units and cost of fuel by replacing the different type of engine fuel.

3: RESULTS AND DISCUSSION

3.1 Descriptive statistics

The results show that there is a consistently increasing trend in vehicle registration over time. The population of vehicles registered in Pakistan has more than doubled in every category of vehicles. However, we still have only 18 cars per 1000 people in Pakistan. A drastic increase in the registration of trucks shows an increase in demand for delivery services in the economy. Other categories of cars include medium-sized vehicles, demand for which has increased in the last 17 years, accordingly to a growth rate of 4.56 % annually.

Table No 3.1 Registration of Vehicles by Type (2001-2019)

Year	Motorcars, jeeps and station vegans	Taxis	Trucks	Busses	Others
2001	1198918	90062	155793	161507	786907
2005	1318488	91893	182516	168713	861851
2010	1726347	122882	216119	198790	1081916
2015	2640188	168166	260720	229228	1483920
2019	2710411	169403	264462	230612	1508471

The author's estimations (the economic survey of Pakistan)

3.1 Average Vehicle Registration by Type in Pakistan 2001-2019

The data of the Pakistan Economic Survey shows that taxi registration remained only one percent on average, against total vehicle registration in Pakistan over the last seventeen years, which is the lowest registration ratio to total in all the existing registration categories in Pakistan. On average estimates, the number of Trucks and buses registered is only 4 percent in the last 17 years in Pakistan, where delivery trucks are just 2 percent, and 2 percent are buses for passengers. Only 3 percent of the three-wheeler motorcycles are registered on average over the last one and a half decade in Pakistan, but 62 percent two-wheeler motor cycles are registered in the same time span, which is the highest among all the vehicles registered since 2001 in Pakistan, followed by the registration of motor cars, jeeps and station vegan, which is 19 percent on average. However, other vehicles are registered at only 11 percent from 2001 to 2017. Other vehicles include tractors, rollers, and other construction machinery.

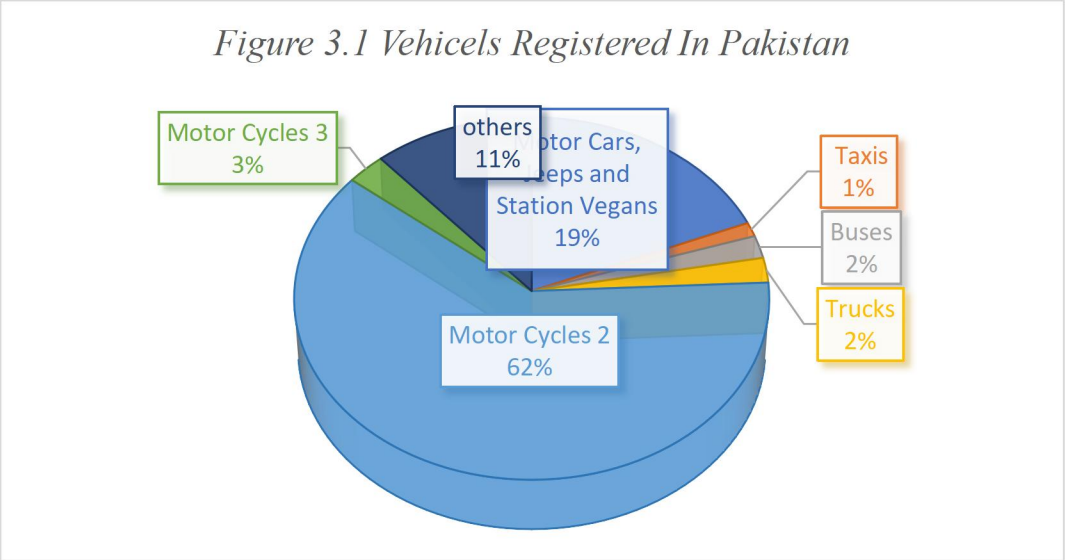

Figure 3.1 Vehicles Registration in Pakistan 2001-2019: Economic Survey of Pakistan

3.2 Local transport trend in Pakistan

Local transport buses and taxi cars registration no matter persisted very low out of total vehicles registered in the past 18 years, but the trend remains positive from day one till the last day of 2019. However, the number of buses registered is always higher than the number of taxis registered in Pakistan.

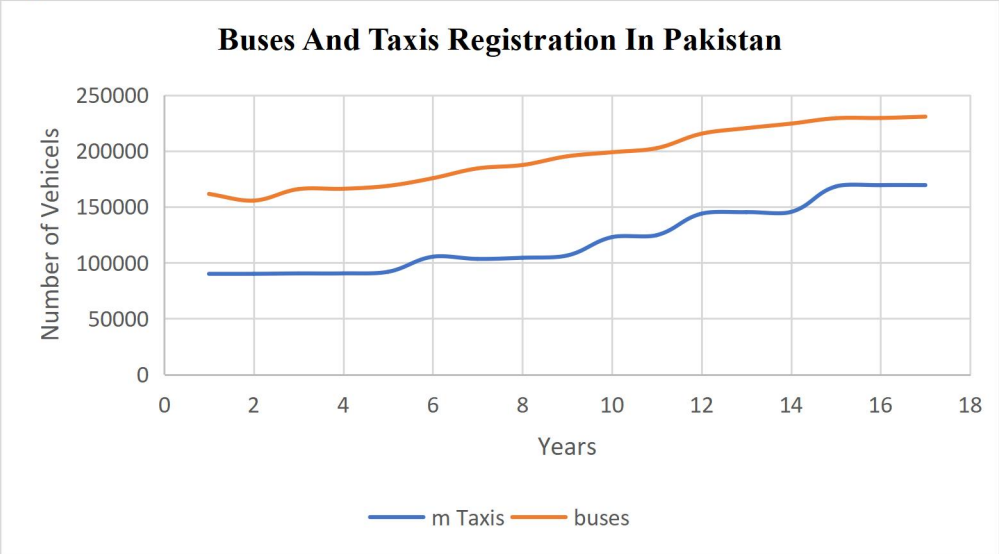

Figure 3.2: Local transport trend in Pakistan 2001-2017

3.3 Registration trend of Motorcycles 2 and 3 wheelers in Pakistan 2001-2017

Annual data of the last few years shows that the number of two-wheelers has increased in Pakistan, which has sped up after FY 2009, and the gap between two and three wheelers is increasing over time. An increase in the demand for 2 wheelers is the consequence of policies adopted by the companies of motor cycles companies, where a major factor is the credit sale of 2 wheelers on monthly installments. These types of policies are still at their peak in electronics product markets and vehicle markets. Most of the time, it is observed that banks are also offering these installment policies throughout the country.

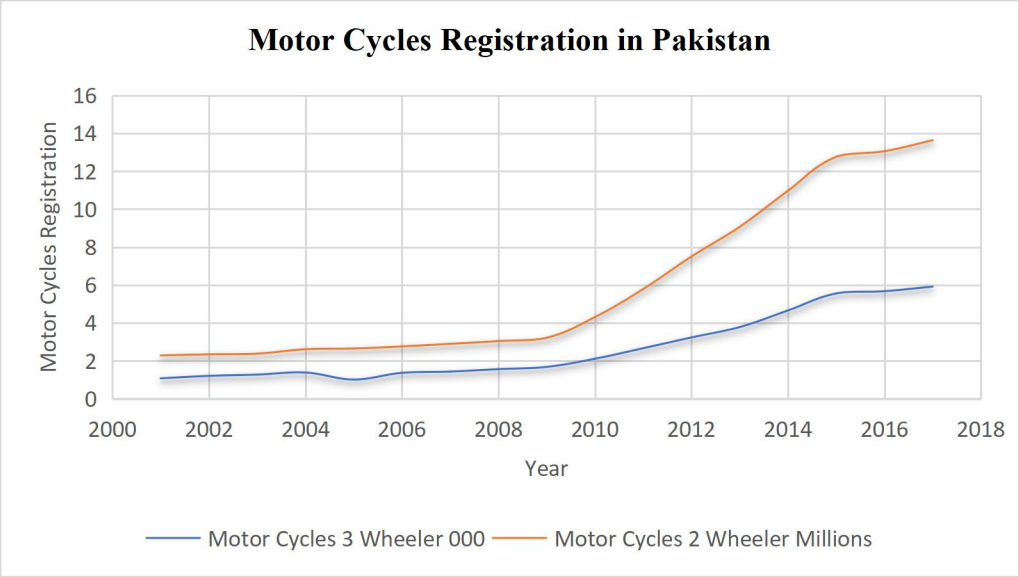

Figure 3.3: Registration trend of Motorcycles 2 and 3 wheelers in Pakistan 2001-2017

3.4 Economic and Environmental Cost of One Vehicle by fuel source and Engine size for 1000 Kilometers

Estimations in table 3.2 show, that there is an observable and significant difference in GHG Emission and fuel consumption across different engine size and different source of energy. Diesel Oil fuel is expensive relatively, but it serves the most powerful engines on steep and long distances, which is the limitation of other sources like CNG, LPG. However, in Pakistan, for small engines CNG is highly preferred over others because of Prices but these days it has crossed the limits of its own historical prices and CNG has gone beyond the prices of petrol for the first time in history of Pakistan, increasing CNG based Cars and transport might be the reason of increasing CNG prices. Per Kilometer cost of Oil based small engine cars is less than CNG based small engine cars in Pakistan but due to variation in engine design and fuel intensity, the medium size engines and large size engines are expensive on per Kilometer bases. While Solar based Cars owners are facing less expenses comparatively in Pakistan. The emission factor of Diesel engines is greater than CNG and Solar in Pakistan, where emissions of Diesel Engine Car is three time greater than a solar engine car and two time higher than CNG engine cars. If a diesel engine car covers the distance of 1000 kilometers, it will consume 4 to 28 thousand PKR fuel and it will emit 1.31 to 12.8 Tons of CO_2, depending upon the size of engine and slop of roads. The estimations indicate that, development and movement towards cleaner energy sources as an engine fuel in transport sector is apparently expensive at initial stage but the economic consequences of cleaner energy is rational in long term and on long routes. So, it seems very conclusive to adopt new technology in transport sector for sustainable development of economy in Pakistan.

Table 3.2: Economic and Environmental Cost of a single Vehicle by fuel source and Engine size for 1000 Kilometers

Fuel Type	OIL			CNG			SOLAR		
	SENG	MENG	LENG	SENG	MENG	LENG	SENG	MENG	LENG

[2]Cost Per-kilometer Fuel	5.2	14.2	35.36	5.34	7.99	29.16	5	7	10
Total Fuel Cost PKR	4160	11360	28288	4272	6392	23328	4000	5600	8000
GHG Grams Per Kilometer Emission	131	353	1288	118	176.5	644	95	118	322
Total emissions tons	1.31	3.53	12.8	1.18	1.76	6.44	9.5	1.18	3.22

SENG = Small Engine, MENG = Medium Size Engine, LENG= Large Engine.

3.5 Per Unit Cost and Distance Covered by Vehicles with different Fuel consumption

The results in Table 3.3 show that, Diesel based small engine vehicle covers 20 kilometers per liter, medium size engine cars can cover 7.47 Kilometers per liter and large size engines can cover only 2.04 to 3.01 kilometers per liter diesel consumption. Small size engine on petrol has less mileage than diesel cars, and the same applies for the medium and large size engines. However, Large engine vehicles designed for CNG are more economical compared to other energy source-based engines, because large engines for diesel are more energy intensive and large engines designed for CNG are not that much powerful and energy intensive, which allows the vehicle to move for longer distances.

Table 3.3 Per kilometer Cost and per Unit Distance Covered by Vehicle with different Fuel Type

Fuel Type	Truck Per Litter/KM	Bus Per Liter/KM	Jeep Van Etc Medium Size Per Liter/KM	Small Car Per Liter/KM
Diesel	3.01	3.00	7.478	20.152
Petrol	2.73	3.00	6.776	18.259
CNG	5.17	3.49	12.759	19.084
Fuel Type	TRUCK Per Km Cost	BUS Per Km Cost	Jeep Van Etc Medium Size Per Km Cost	Small Car Per Km Cost
Diesel	35.36	35.52	14.24	5.28
Petrol	33.69	30.66	13.57	5.03
CNG	19.72	29.16	7.99	5.34
Solar	9.86	14.58	3.99	2.67

3.6 Economic and environmental cost of registered vehicles covering the distance of 1000 km

The results of the study show that by travelling 1000 kilometers the registered Jeeps and vans in transport sector of Pakistan are emitting 0.51240259 million metric tons CO_2. This indicates that current fuel mix of transport sector is causing significant environmental damages to clean air and contributes to global warming through CO2 emissions. The emissions will increase to

[2] To neutralize the affect for long routs and fuel efficiency, we have subtracted 20 % of the total cost of the fuel from each type of engine

0.640503238 million metric tons for each year if Jeeps and vans are shifted to diesel energy as engine fuel. The results indicate that shifting same number of Jeeps to CNG as engine fuel will reduce the carbon emissions to 0.320251619 million tons each 1000 kilometers distance, furthermore, it can be reduced to 0.214105898 million tons by shifting to solar energy as the cleanest source of engine energy source.

Pakistan can reduce 50 % of its carbon emissions from transport sector by shifting large vehicles to cleaner energy sources. However, with current energy sources for large vehicles, the transport sector contributes 0.18748363 million tons emissions on every 1000 kilometers, which can be reduced to 0.04659268 million tons emissions, if the cleaner energy sources are utilized. Shown in table 4.5, every type of vehicle emits large amount of carbon, which is possible to control by environmental friendly technologies and energy fuel use.

Shifting the cars from one source of fuel energy to other source of fuel energy has certain economic cost to be faced. The study results show that fuel cost increases by shifting towards diesel and petrol and it reduces to significant level by shifting to cleaner energy sources like CNG and Solar as engine energy fuel. The substitution of energy fuel for transport sector in Pakistan is both economically and environmental feasible if the funds are provided for this noble cause from the Global Climate Funds. In other words, if the proposed amount of emissions is reduced, Pakistan can contribute to reduce the swiftness of global warming through clean transport policy.

Table 3.4 Current Economic and environmental cost of 1000 Kilometers distance covered by vehicle type.

Mode of transport	Two-Wheeler	Three-Wheeler	Taxi	Motor jeeps and station vegans	Trucks	Buses	Others
Millions of tons CO2 from current fuel mix	0.238	0.019	0.016	0.512	0.187	0.163	0.392
Millions of tons Co2 Diesel	0.238	0.019	0.015	0.640	0.187	0.171	0.616
Millions of tons Co2 petrol	0.238	0.019	0.019	0.640	0.187	0.155	0.601
Millions of tons Co2 CNG	0.178	0.013	0.014	0.320	0.093	0.125	0.377
Millions of tons Co2 Solar	0.119	0.006	0.011	0.214	0.046	0.062	0.206
Economic cost of 1000 Kilometers Travel by fuel and vehicle type							
Current fuel mix cost in million PKR	17865.3	1072.04	635.62	20947.9	7568.2	6445.5	15841.5
Diesel in	11910.2	804.03	641.2	25856.0	7567.8	6918.5	23433.5

Millions PKR							
Petrol in millions PKR	14887.8	804.03	611.01	24640.3	7210.4	5972.6	22824.1
CNG in Millions PKR	14887.8	1340.05	648.13	14505.1	4221.6	5680.8	17120.3
Solar in Millions PKR	11910.2	804.03	324.06	7252.5	2110.9	2840.3	8560.7

3.7 Fuel Replacing Average Cost and subsequent change in GHG emissions

The results show that replacement of engine fuel has significant implication for cost and emissions reduction. For understanding purpose, the calculations are confined to 1000 kilometers, which can be extrapolated for more distance covered. The estimations show that, Pakistan has to face the incremental transport fuel cost of 6755.23 million PKR by shifting to diesel fuel energy, which indicates that the use of diesel for transport across the country will increase the overall transport cost of Pakistan by significant amount. Calculating this amount for the year indicates that Pakistan has to face the extra cost of 337761.64 million PKR each year for shifting to diesel. As compare to diesel energy current energy mix is less expensive.

The cost of petrol as energy fuel on aggregate level for transport sector is lower as compare to diesel as energy fuel in Pakistan. By replacing current fuel mix of transport engine with CNG as fuel for transport will reduce the economic burden of -6442.72 million from Jeeps, and -3346.21 million PKR from trucks and -764.676 million from buses for only 1000 kilometers of distance, while the distance covered in one year is almost 50000 for each type of vehicle, if we calculate it for one years, this can be significance cost reduction through changing fuel mix. The estimations show that Pakistan can reduce the transport fuel cost by more than 50 billion each year, with using clean energy fuel for transport.

The results in table 4.6 shows that shifting from current fuel mix to diesel is not economically feasible and not even environmental friendly for Pakistan. Pakistan should never opt diesel as transport fuel across all types of transportation vehicles. Shifting to petrol as a fuel energy for transport sector in Pakistan is neither economically feasible, nor it is environmental friendly in terms of CO_2 emissions. The analysis shows that change in fuel mix from current fuel mix to CNG is feasible both economically and environmentally. The shift towards CNG is less costly as fuel and less pollutant for environment. Highest benefits are reflected in fuel shifting of large vehicles to cleaner energy sources. However, the cost for some types of vehicles can go higher as it also requires the shifting cost, which is the limitation of this investigation. The study found that being a developing nation the reduction in cost with shifting from one source to other source of fuel energy across all types of vehicles will help the economy, economically and environmentally in long run.

Table 3.5 Fuel Replacing Average Cost and subsequent GHG emissions in transport sector of Pakistan (2000-2019) 1000 km

Change in Fuel Cost Millions PKR							
Mode of transport	***Two-Wheeler***	***Three-Wheeler***	***Taxi***	***Motor jeeps and station vegans***	***Trucks***	***Buses***	***Others***

Shifting from current fuel mix to Diesel	-11910.26	-536.022	5.660	4908.11	-0.385	472.940	7592.05
Shifting from current fuel mix to petrol	-2977.56	-268.011	-24.617	3692.42	-357.80	-472.940	6982.60
Shifting from current fuel mix to CNG	-2977.57	268.011	12.506	-6442.72	-3346.21	-764.676	1278.84
Shifting from current fuel mix to solar	-5955.13	-268.011	-311.561	-13695.31	-5456.92	-3605.192	-7280.74
Shifting from Diesel to CNG	2977.56	536.022	6.845	-11350.82	-3346.21	-1237.617	-6313.21
Shifting from Diesel to Solar	-11910.26	-1339.253	-156.195	-15676.90	-5855.65	-8567.469	-34511.34
Shifting from CNG to Solar	-2977.56	-536.022	-324.067	-7252.58	-2110.71	-2840.516	-8559.58
Change in GHG Emissions Millions of Tons							
Shifting from current fuel mix to diesel	**0**	**0**	-0.0002	0.128	**0**	0.008	0.223
Shifting from current fuel mix to petrol	**0**	**0**	0.0031	0.128	**0**	-0.008	0.208
Shifting from current fuel	-0.059	-0.005	-0.0018	-0.192	-0.094	-0.037	-0.015

mix to CNG							
Shifting from Current fuel mix to Solar	-0.119	-0.012	-0.0045	-0.298	-0.140	-0.100	-0.185
Shifting from Diesel to Petrol	0	0	0.0033	0	0	-0.016	-0.015
Shifting from Diesel to CNG	-0.059	-0.005	-0.0015	-0.320	-0.094	-0.045	-0.238
Shifting from Diesel to Solar	-0.119	-0.012	-0.0043	-0.426	-0.140	-0.108	-0.409
Shifting from petrol to CNG	-0.059	-0.005	-0.0049	-0.320	-0.094	-0.029	-0.223
Shifting from petrol to Solar	-0.119	-0.012	-0.0077	-0.426	-0.140	-0.092	-0.394
Shifting from CNG to Solar	-0.059	-0.006	-0.002	-0.106	-0.046	-0.062	-0.170

3.8 Reduction in Cost as a Percentage of total cost by Shifting from Current Fuel Mix to Solar Energy in Transport Sector

The study revealed that Pakistan has an opportunity to reduce significant transport fuel cost on aggregate level by changing the existing fuel mix of transport. The opportunity can be cashed, focusing the policy on small engine cars. Change the fuel mix to solar energy will lead to decrease 20 percent cost of energy fuel for transport sector in Pakistan.

The figure 3.4 shows that large engine vehicles can be more economically feasible if the fuel mix is changed to cleaner energy. Only trucks can bring the cost down by 15 percent and also the emissions by significant amount from the existing situation

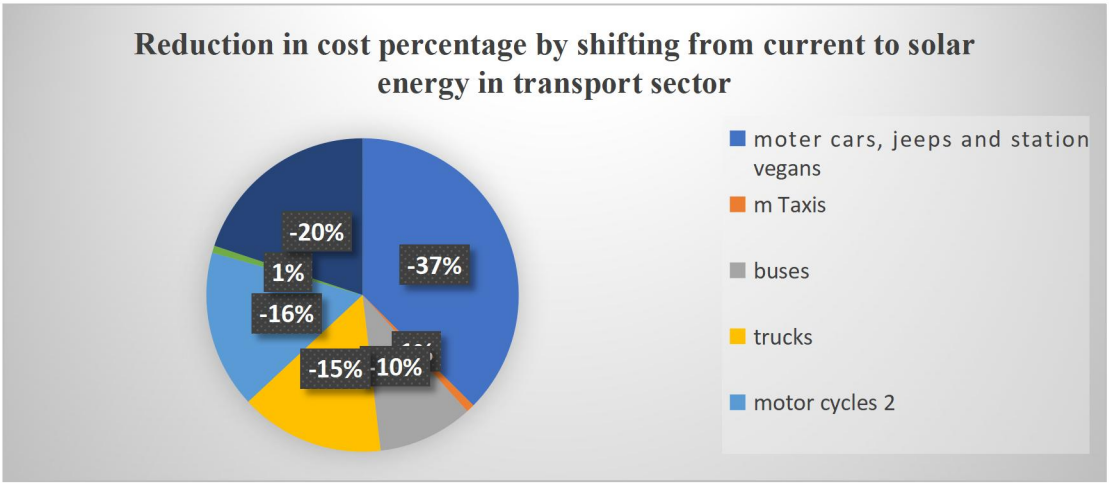

Figure 3.4; Reduction in Cost Percentage by Shifting from Current Fuel Mix to Solar Energy in Transport Sector of Pakistan.

3.9 Climate finance generated through Fuel Replacing in Transport Sector of Pakistan (5000 Km distance For One Year)

Replacing the existing fuel mix with diesel will neither generate climate finance nether it is economically feasible for the economy. Doing this will increase the liabilities of climate funds by more than 1000 million dollars each year on transport sector of Pakistan. The result shows that by shifting from current fuel mix to CNG in Pakistan has the capacity to generate the funds of 620.45 million dollars every year. The carbon offset takes the mentioned value by shifting to cleaner energy in transport. The funds of 1.29 billion dollars can be generated by shifting from current fuel mix to solar energy for transport in Pakistan. Changing fuel mix of large vehicles is important for environment as well as for direct economic benefits.

Table 3.6: Economic benefits of Fuel Replacing in Transport Sector of Pakistan (5000 Km distance For One Year)

Economic Value of GHG Emissions Million Dollars $							
Mode of transport/vehicle type	Two-Wheeler	Three-Wheeler	Taxi	Motor jeeps and station vegans	Trucks	Buses	Others
Shifting from current to diesel	0.00	0.00	-0.34	-699.7	0.00	-12.07	-355.09
Shifting from current to petrol	0.00	0.00	-4.74	-192.1	33.2	9.5	-301.30
Shifting from current to CNG	89.32	8.44	2.71	288.22	141.57	67.50	22.69
Shifting from current to solar	178.65	18.49	6.89	447.44	211.33	150.93	278.97

(-) The sign means, that Pakistan has to pay this much amount if the fuel mix is changed from the current to a specific fuel mix

4. CONCLUSION

The transport sector of Pakistan has a significant potential to generate Green Climate Fund by replacing the existing fuel mix with cleaner energy. This sector can generate more than one

billion dollars each year. The study identified that shifting to CNG and solar energy is the best option to generate funds or to pursue clean development in the transport sector without compromising the future needs of transport with the increasing population. A significant quantity of Carbon and GHG can be alleviated by the possible ways of fuel inputs changing and technological improvement in the transport sector of Pakistan. The study suggests focusing on the fuel replacement possibility in the transport sector. If green climate funds are provided the issue of carbon emissions can be resolved with sustainable development in the transport sector. It is quite plausible to think, that being an underdeveloped country, how Pakistan can pursue the goals of suitable and sustainable development without a pull of funds gravity. The writer appeals to GFC to consider the case of the Pakistan transport sector for Funds Announcement to make it a better service for future generations. Sustainability can be achieved if the existing pressure is reduced or the pas of emissions from the transport sector is slowed down to the regeneration capacity of forest, to sequester the carbon emitted from the transport sector in Pakistan.

5. Recommendation

- The findings of the study show that there is a significant level of potential in the transport sector to grow as the carbon-neutral sector, but it requires government attention in terms of incentive or penalty policy to transform the energy choices of drivers and develop a sustainable transport sector.
- The most effective tool for reducing the carbon footprint can be taxing carbon-emitting vehicles. I recommend that the government of Pakistan should impose or increase the carbon taxes in the transport sector, keeping in mind the value and Engine size of vehicles to implement the policy effectively.

6. Limitations of the study

- The study has used the data from the Pakistan economic survey, which doesn't cover non-registered cars, which is why this study has the limitation of calculating CO_2 emissions from only registered transport vehicles
- The study has used only road transport because of the nature of other transport, as we can shift our air plans to other fuels, and the data on water and rain transport will be used in the coming working papers.
- This study will have an extension that will cover the data after 2019, as due to COVID-19, the fuel price and dollar prices have significantly changed during 2020 and 2021, especially for Pakistan.

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