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ENERGY SAVING AND ENVIRONMENTAL IMPLICATION OF NET ZERO TARGET IN LAND TRANSPORT OF BAGMATI PROVINCE

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Abstract

Global warming is seen to be raising concern on the global level so the Paris Agreement has been made by most of the nations setting the target of gaining net zero to reduce the global temperature rise and all nations have been developing their policies to achieve the common goal. The GON has also set different NetZero targets, which can impact the national energy demand. In the case of Nepal being a developing country, the transportation sector is seen to be mainly based on petroleum products. So, the impact of the target on the fuel mix of the Nation needs to be studied. Taking Bagmati province as the study area, the passenger and freight transport demand of Nepal is calculated from the years 2022-2050. Using the Leap model, the different scenarios including GON targets are developed and the fuel mix and emission comparison is performed in this study. On the Long-term analysis of the year 2050, it is observed that the WAM scenario has a Fuel saving of 26% and an emission reduction of 44.7%. The study shows that emissions can be reduced by the targets but cannot fully remain NetZero in the case of the transportation sector. The fuel switching to cleaner electric vehicles shows the trade-off that the nation has to increase its Power plant capacity to fulfill the demand in order to reduce emissions. This helps reduce the fuel import ratio and improve the energy security of a nation like Nepal with surplus energy.

Keywords: *NetZero targets, Fuel-mix, LEAP, Emission reduction, Fuel saving*

1. Introduction

It is observed that out of the major six energy-intensive economic sectors transportation sector is also one of them. As of the year 2022, the total installed capacity of hydropower in Nepal is 2023 MW with 53.4 MW thermal power plants and 49.74 MW grid-connected solar power plants. With a total installed capacity of 2205 MW. [1] It is observed that the peak energy demand in Nepal is 1864 MW and the national demand is 1564 MW. It is observed that Nepal is exporting electricity to neighboring nations at the time of the wet season. So, the electricity can be used to easily fuel vehicles as there is more under construction hydropower in Nepal as Nepal is seen to have a potential of about 42,000 MW of economically feasible hydroelectricity. [2]

In Nepal, the transportation sector is mainly dominated by the means of road transportation which comprises about 90% of all trips made throughout the nation[3]. Even though Nepal is in the motorization's earliest stages compared with other nations the growth of vehicle registration in Nepal growth rate has exceeded the rate of 16% per annum in the past decade. The petroleum vehicle in the world is the leading source of emission of GHG and the main area of consumption of petroleum products that leads to the depletion in the amount of fossil fuels throughout the world. Electric vehicles are taken as the means that can solve the problem of GHG emissions and depletion of fossil fuel resources. The

EV runs using the energy from the battery cells that are used as the driving source to drive the motor which in turn drives the vehicle. As electricity in Nepal is reported to be mostly from clean hydropower, it can be said that most of the electric source is hydropower in Nepal. The carbon emission in Nepal has increased drastically by about 32 times in one and half decades from 2000- to 2015 making Kathmandu one of the most polluted cities in the world[4]. The subsequent increase in the vehicle's number in the valley is regarded as the main reason for the increase in pollution, especially in private vehicles[5]. Thus, the search for a clean alternative vehicle in the case of Nepal is a necessity at the present date. In Nepal, more than 99% of the vehicle that is running are petroleum-powered which induce pollution by increasing carbon emission [6].

Nepal government had also set emission control goals via NDC to the UNFCCC secretariat. It is seen in the first NDC that Nepal had made the commitment to increase the EV shares by 20% by the year 2020 and the nation is planning to decrease the fossil fuel dependency in the transportation sector by 50% by 2050. As per the second NDC submitted. As Nepal was unable to attain the target of 2020 it is focusing on increasing the EV sale share by 25% in the case of private vehicles along with two-wheelers and 20% for four-wheeler public vehicles by 2025 [7]. As we can see GON has set ambiguous goals on EV adoption and emission control. There has not been any evaluation on the status of completion of the target as a feedback loop hence the EV penetration in the transportation sector is seen to be very small with a large deviation of status from the goals. This study is carried out to explore the environmental benefits of the application of net zero targets set by the GON. CES/UNDP at the present time frame in the case of the transportation sector in Bagmati province. The study has included the determination of the transport demand for the year 2022 which year-on-year growth is then forecasted to the year 2050 considering the independent variable of population and GDP to determine the passenger and freight transport in the time frame of 2022-2050. The demand baseline is generated and the total energy demand and emission after following different net zero targets are then analyzed in order to get insight into the environmental benefits of the government policies in the transportation sector.

2. Literature Review

Nepal is considered to be one of the most vulnerable countries to the impacts of climate change due to the nation's fragile topography. So, Nepal is seen to be more committed to getting along with the Paris Agreement even though the nation has negligible emissions compared to other emitter nations. Even as per the GON second NDC and Long-term strategy for net-zero emissions, Nepal is planning to develop a 200-kilometer electric rail network along with 20-25% penetration in different public and private EVs in the transportation sectors in the case of Nepal by 2030. [8]. The transport sector fuel mix is highly dependent on the plans and national-level policies and EV production.

The EV was observed to be more efficient than the IC engine vehicle. The well-to-wheel efficiency of the EV is high on the EV generated from the energy source and lowest on the gas power plant-based energy with the WTW efficiency ranging from 11-72%[9]. The study on the grid shows that the electricity grid of Nepal is best for EV operation. As observed in the research [10] EV has helped in the reduction of CO2 emission and petroleum product dependence of any nation. Under different scenarios of the production of electricity, the societal impact of EV use was observed and the emission was largely reduced in smaller nations, and the countries using low-emission fuel are bound to gain millions of euros per year in the avoidance of external costs in case of countries in the EU. The increase in income level in the nation is positive with energy transition whereas the increase in population increases demand and negatively affects the energy transition in lower middle-income group nations [11]. As seen in the study of India [12] the comparative analysis of a nation highly dependent on thermal power the direct and indirect emissions in the case of ICEV and EV there seems to be a decrease in CO2 and CO emissions in case of EV but there is the indirect increase in the SO_2 and NO_x production. The article [13] stated that the impact of the energy use assessment helps in the designing of a nation's better policies even on the macro level hence the econometric model with different variable were analyzed in this report. The research [14] studied both indirect as well as direct benefits of emission reduction from the year 2005 to 2100 in countries with clean electricity like Nepal. The effect on supply mix, pollutant emission, cost of energy systems, and the energy security of the nation was analyzed using a model in the MARKAL framework. It shows an increment in employment opportunities and improvements in energy security in the case of Nepal if the low-carbon development is taken into consideration. The 3E benefits of net-zero emission strategy case study of Nepal showed that the in condition of WAM the nation's air pollution was seen to be reduced by 70% and 85% for organic and black carbon and the improvement in our nation's energy security parameters as well as the energy equity[15]. The long-term impact on the electric grid due to electric vehicle[16] showed that by the year 2040 EVs is bound to gain 11-28% of the global share of road transport which in turn increase electricity consumption by 11-20%. The demand side management has to be induced to address the peak EV charging demand.

After studying different past literature on transport and the penetration of electricity in the fuel mix, we observed that the research solely focused on the Kathmandu valley on the emission analysis was found only for road passenger transport showed that the annual rate of consumption of fossil fuel is increasing by 12% per annum and the passenger demand for the year 2050 is 45 billion passenger-km in case of Kathmandu valley alone with more than 400% increase in the demand compared to that of 2017. Different research on the transportation sector in Nepal [17] [18] analyzed the Kathmandu Valley emission and fuel consumption only without taking the Paris Agreement and government present policies into consideration. A detailed analysis on the province level was not available for the Bagmati province as the data on different transportation factors were not available in the aspect of how the following NDC affect the fuel mix and, emission of Bagmati province including the idea of EV penetration in both freight and passenger transportation. Hence, the research gap of the comprehensive case study of the impact of government policies on the transport sector is addressed by this research.

3. Methodology and Data

The modelling software used for the analysis of the policies and their scenario to make the comparison of emissions is LEAP. By developing a bottom-up model for the road transportation system[19]. The research framework listed below shows the key concept of carrying out the research project. The transportation sector is disaggregated into passenger and freight.

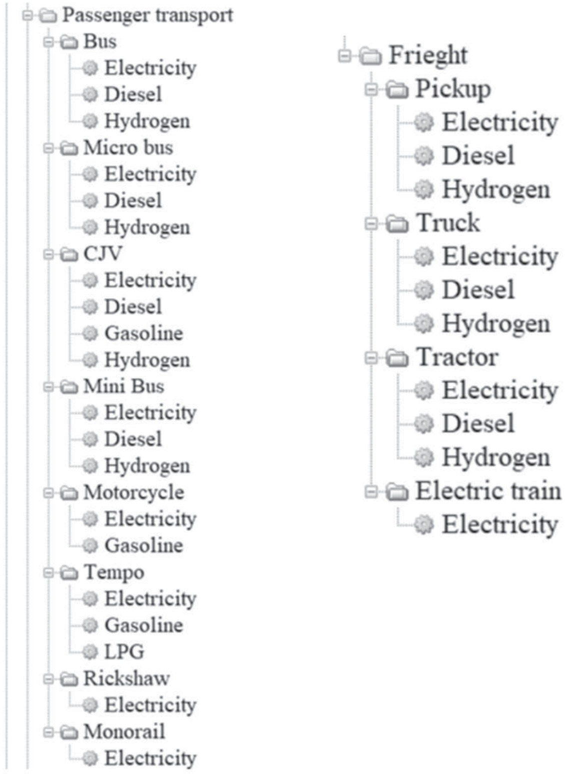

Figure 1 Disaggregation of the transport sector in Bagmati province in the LEAP model

3.1 Data Collection

The secondary source data for the research is obtained from the Department of Transport with the number of vehicles registered. WECS report provided per year petroleum product consumption data and its share in the total transport energy mix on the data as the input for the research. The emission scenario of Nepal at present is carried out from different national and international journals [15][20]. The data on the population and GDP is taken from CBS and NHPC whereas the energy mix and the data on annual vehicle km as well as the mileage in the transportation sector is taken from the report published by WECS[21]. The vehicle and their efficiency[22] on the basis of fuel type are taken from [23] and the data on fuel intensity are taken from [24].

3.2 Research Framework

The framework of calculation for emissions and energy demand is listed below;

3.2.2 Calculation of passenger vehicle and freight vehicle demand

For different categories of vehicles, each of their analysis is carried out in different units. Tonne km for freight and passenger km for passenger vehicles. The driving factors considered in the demand estimation are energy intensity, transportation intensity as well and the GDP/ Capita of the Bagmati province.

The VKT (Annual vehicle KM), as well as the LF (Load factor) of the vehicles, is considered to be constant over the period of time.

For the calculation of the total demand of the passenger vehicle in passenger-km, we used the relation;

$$TPD(t) = \sum_{k=0}^{n}(VKT * OF * VN) \quad 1$$

Here,

VKT = Annual vehicle KM

OF = Occupancy factor of passenger transport.

VN = vehicle stock on that year.

For the calculation of the total demand for the freight transport in tonne-km, we used the relation;

$$TFD(t) = \sum_{k=0}^{n}(VKT * LF * VN) \quad 2$$

Here,

VKT = Annual vehicle KM

LF = Load factor of Freight transport in tonnes.

VN = vehicle stock on that year.

3.2.3 Emission and Energy Demand Estimation

The estimation of the annual energy demand of the passenger vehicle can be determined by the relation,

$$TPED(t) = \sum_{k=0}^{n}(VKT * VN * Mf) \quad 3$$

Similarly for freight vehicles,

$$TFED(t) = \sum_{k=0}^{n}(VKT * VN * Mf) \quad 4$$

For total transport energy demand;

$$TED(t) = TPED(t) + TFED(t) \quad 5$$

Here;

Mf = Mileage of fuel

TED(t) = Annual total transport energy demand

Similarly, the emission of each of the transportation sectors is given by;

$$E(t) = \sum_{k=0}^{n}(VKT * VN * Mf * EF) \quad 6$$

EF = Fuel emission factor

The emission factors are taken on the basis of national and international journal articles on the basis of the IPPC standards for the Indian subcontinent.

3.2.4 End-use energy calculation

While carrying out the analysis it is considered that the yearly demand for transportation on both the passenger as well as the freight is dependent on the population growth as well as the GDP growth. [25]

$$TPED_t = TPED_0 \times (POP_t/POP_0)^{\alpha 1i} \times (GDP_{r,t}/GDP_{r,0})^{\alpha 2i} \quad 7$$

$$TFED_t = TFED_0 \times (GDP_{r,t}/GDP_{r,0})\alpha i \quad 8$$

Here;

$TPED_t$ = Total Passenger energy demand type at year t;

$TPED_0$ = Total Passenger energy demand type at base year.

$TFED_t$ = Total Freight energy demand type at year t;

$TFED_0$ = Total Freight energy demand type at base year.

POP_t = Population of a given region in year t

$GDP_{r,t}$ = GDP of a given region in year t

$GDP_{r,0}$ = GDP of a given region in the base year

POP_0 = Population of base year

$\alpha 1i$ = Elasticity of population on Passenger transport demand

$\alpha 2i$ = Elasticity of GDP on Passenger transport demand

αi = Elasticity of GDP on Freight transport demand

3.2.5 Vehicle Stock Analysis

The Weibull equation is used to determine the stock of the vehicle stock remaining for that year. It is then multiplied with that year's registered vehicle data to determine the surviving stock of that year and the new year registration is added on each year to determine the VN on that year. The Weibull function is given as per [18] below;

$$Øi(K) = e^{-[\left(\frac{K+bi}{Ti}\right)\hat{}\,bi]} \quad 9$$

Here,

Øi(K) = Vehicle survivability probability,

K = Age of vehicle in the year

bi = Failure steepness of that vehicle

Ti = service life of the vehicle

From the Indian sub-context, the data is taken for the value of T and b for the vehicle [26]

3.2.6 Scenario Development in LEAP

The base year of 2022 is taken and the projection in LEAP is used to forecast the emission up to the year 2050. For the baseline scenario vehicle share is considered to be constant. The other scenarios for the analysis are the NDC, SDG scenario, and the net zero target set by the government. In which the WEM and WAM measures are taken on the basis of GON (2021) and CES/UNDP (2021) policies. [15]

Baseline scenario considerations:

- The population growth rate is taken as 0.97% (Source: CBS report) and the GDP growth rate of 6.74% (Source: Economic Survey report).
- The vehicle share and their fuel mix are considered to be the same throughout the period of analysis.
- The passenger transport demand is calculated taking GDP and population into consideration taking elasticity and freight transport demand is interpolated taking GDP and its elasticity into consideration.

SDG scenario considerations:

- In this scenario, the electric vehicle in the public transportation sector is considered to be 35% by 2025 and 50% by 2030.
- Other transport demands not mentioned in SDG goals are taken the same as the baseline scenario. Whereas another fuel mix on the transportation ratio is taken to be 65% of the baseline mix and 50% of the baseline mix in 2025 and 2030 respectively for the public transport.

NDC scenario Considerations:

- In this scenario, vehicle sales are considered to be 25% and 20% in case of the Private and public vehicles in the year 2025 also it will increase by 90% and 60% in the case of private and public vehicles by 2030.
- As per the DOTM report, the share of new vehicles in 2022 is 20%, 15%, 10%, 5%, and 5% in the case of motorcycles, cars/jeeps/vans, tempos, buses, and microbuses respectively. So, we used Weibull equations to determine the share for each vehicle type on the basis of its sale.

NZE with existing measures considerations (WEM):

It is based on the (GON, 2021) and (CES/UNDP, 2021) low carbon technology penetration targets[15].

- Since the Bagmati province is in the urban areas where most of the population are on the urban area. So, Intracity transport is more prominent in Bagmati province hence the target of intracity transport is taken into model.
- The electrification of passenger transport will be 33% on microbuses, 20% on cars/jeeps/vans, 5% on motorcycles, and 25% on public minibus and bus by the year 2050. Also, 2% of the passenger demand will be reduced by monorail by 2050.
- The freight demand is 30% reduced by the electric train by 2050.

NZE with additional Scenario considerations (WAM):

To reduce the emissions further and meet the Net-zero emissions target additional scenario is created on the basis of all the technology present in the time period in the case of the transportation sectors. These are;

- The electrification is now bumped up in the case of buses to 48% and in the case of motorcycles to 10% whereas the ratio for the car/jeep/van is the same as 20% in WEM by 2050.
- 10% of the fuel mix of petroleum products will be replaced by electric fuel cells cars and buses by 2050.
- Similar to WEM the passenger demand of 2% is reduced by the introduction of monorail by 2050.
- In case of the freight transport, 40% of the freight demand will be reduced due to the introduction of electric trains by 2050.

- The remaining 30% will be fulfilled by electric and fuel-cell vehicles by the year 2050.

4. RESULT AND DISCUSSION:

4.1 VEHICLE SURVIVAL ANALYSIS

The Weibull equation is used for all the passenger and freight vehicles to determine the actual vehicle running on the road as the DOTM does not have any data regarding the vehicles currently running on the roads but has the data of the registered number of vehicles. On the basis of the Weibull equation, we obtained the survivability factor of each type of passenger vehicle under operation with the year that is shown in Figure 2 below;

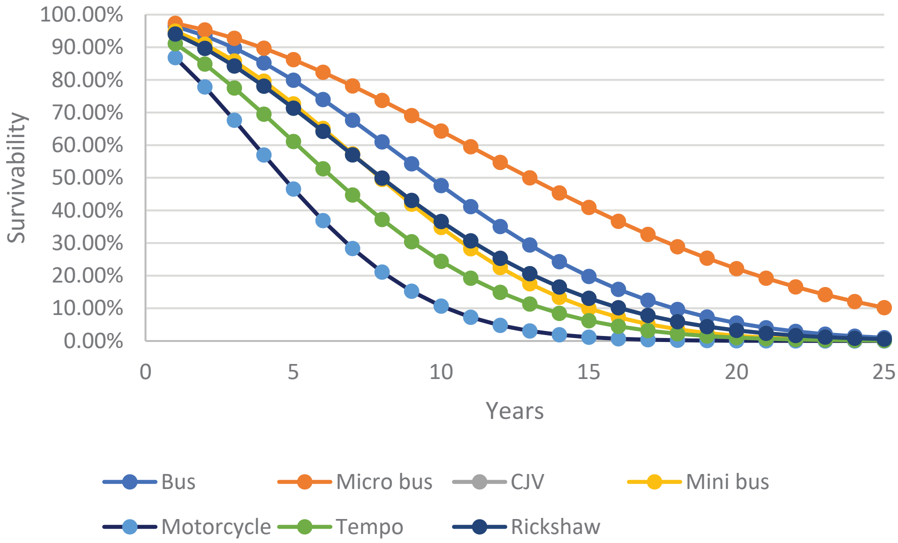

Figure 2 Passenger transport survivability factor

It is observed that the scrappage of the motorcycle is highest and that of microbus is lowest in the case of passenger vehicles. Based on the scrappage factor, the number of vehicles in operation at the base year is calculated.

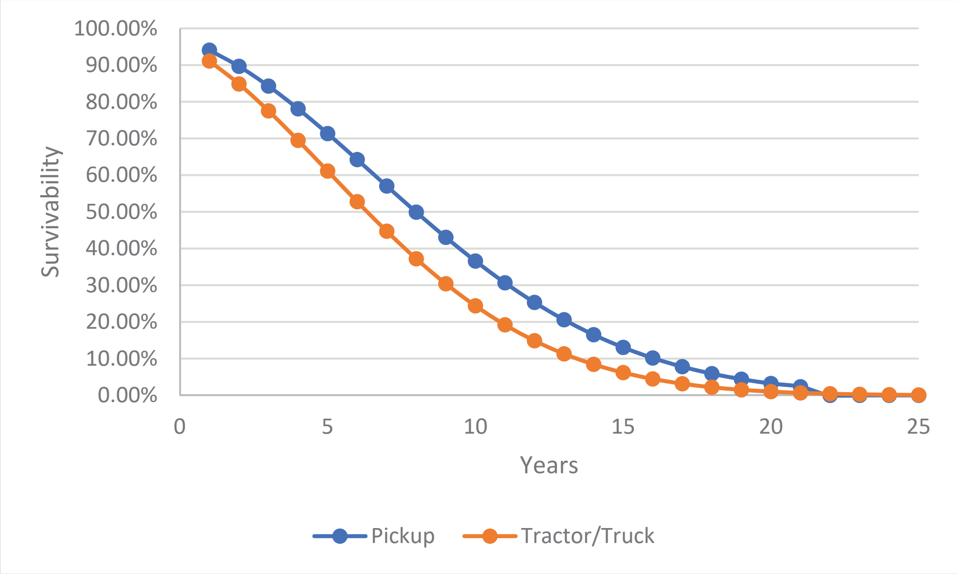

Figure 3 Freight transport survivability factor

On the basis of the survivability factor, it is observed that the tractor/truck scrappage factor is higher compared to that of pickup trucks.

The operation factor of the different vehicle mix determining the operating vehicle ratio to the number of registered vehicles in the year 2022 is listed below;

Table 1 Vehicle operating factor in Bagmati province

Type of Vehicle	Operating factor
Minibus	52.18%
Car, Jeep and Van	38.12%
Bus	46.31%
Microbus	70.90%
Motorcycle	30.95%
Tempo	68.20%
e-rickshaw	71.23%
Pickup	53.24%
Truck	32.73%
Tractor	62.99%

4.2 TOTAL ROAD TRANSPORT DEMAND

On the basis of the population growth rate and GDP growth rate the population of the Bagmati province is calculated for the future and the passenger travel demand and freight transport demand that is forecasted for the Bagmati province is listed in the Table 3 below;

Table 2 Passenger and freight transport demand

Year	2022	2025	2030	2035	2040	2045	2050
Freight demand in billion Tonne-km	4.26	4.79	5.83	7.09	8.62	10.5	12.8
Passenger demand in billion passenger-km	20.6	23.3	28.6	35	42.9	52.5	64.4

The future freight demand has been calculated by taking an elasticity of 0.6 on the basis of GDP. The year-on-year growth on the freight demand tonne-km demand is observed to be 3.99% whereas that of the passenger-km demand is 4.15% as the GDP, as well as population elasticity, is taken in calculating the passenger demand.

4.3 TOTAL ROAD TRANSPORTATION ENERGY MIX

4.3.1 TYPES OF TRANSPORT AND THEIR SHARE

The energy of the transportation sector on the basis of the vehicle types on the baseline scenario is presented in Figure 4.14 below;

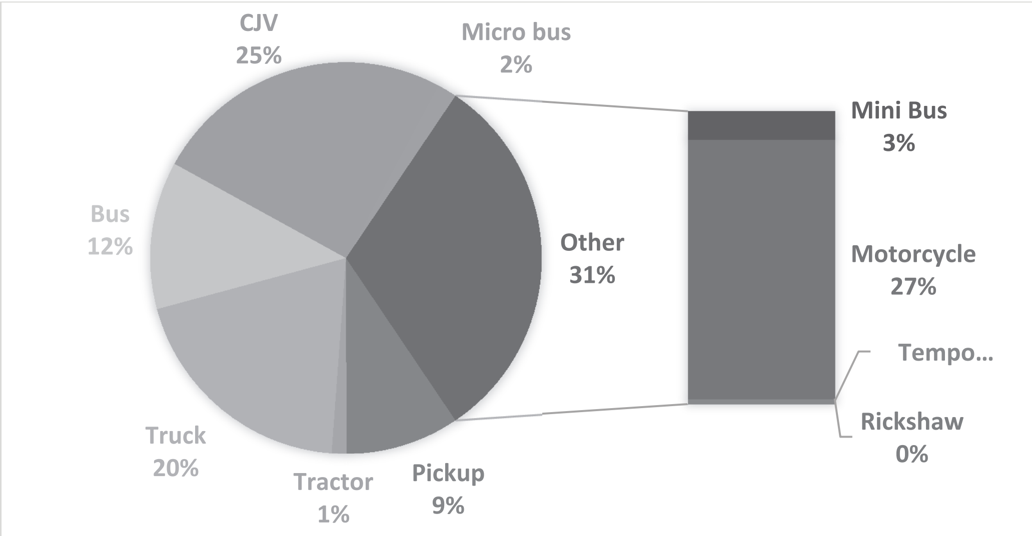

Figure 4 Share of each vehicle type in the baseline scenario.

The share of fuel consumption is observed to be highest in the case of motorcycles that is 27% of total fuel consumption and that of cars, jeeps, and vans 25% is highest in the case of 4-wheeler passenger transport and the highest share of the fuel consumption is by truck i.e. 20% in case of freight transport. These shares of energy consumption are similar from the base year to the end year of 2050.

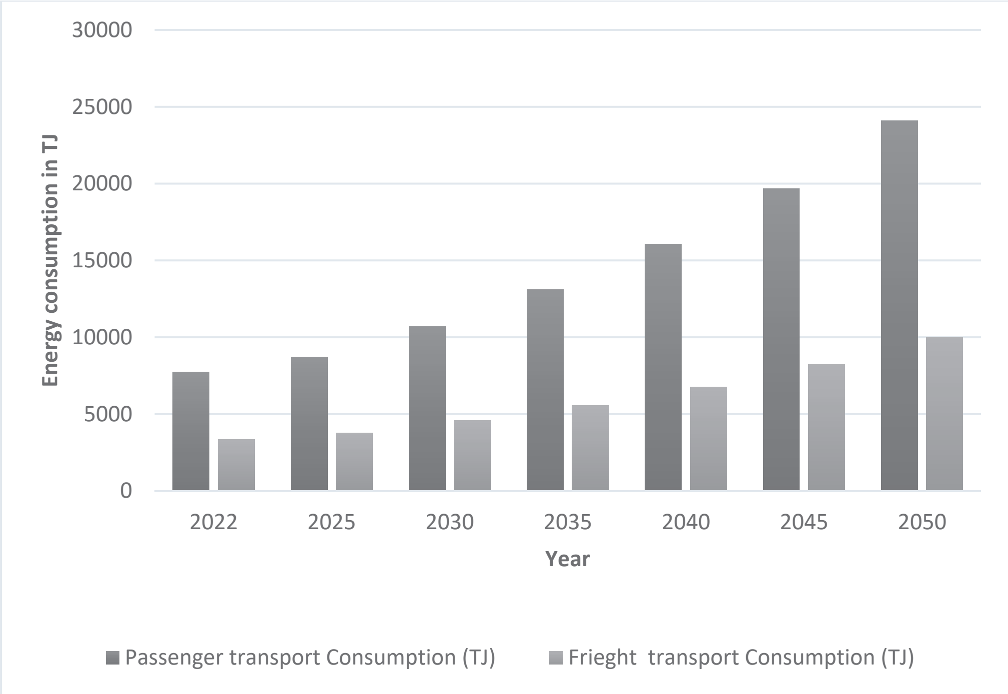

Figure 5 Energy consumption by the transport sector in the baseline scenario

The final energy consumption of the road-type passenger transport on the base year is 7,721.5 TJ and that of the freight transport is 3,348.2 TJ respectively. The total energy demand for transport is expected to rise by 4.1% per year on the baseline scenario causing the final transportation demand in the year 2050 to increase to 24,096.8 TJ for the passenger transport sector and 10,016.2 TJ for the freight transport sector which is equivalent to total transport sector fuel consumption of 34,113 TJ.

The share of petroleum-based fuel is prominent as they comprise 99.78% of the total fuel mix. Where the share of electricity is a measly 0.074% of the fuel mix and LPG with only 0.139% of the fuel mix. The highest share is of diesel i.e. 55.824% in the year 2022 and it changes to 55.257% in the year 2050 as the gasoline share changes from 43.964% to 44.529% from the year 2022 to the year 2050 under the baseline scenario.

Table 3 Fuel demand on TJ in the Baseline scenario

Year	2022	2025	2030	2035	2040	2045	2050
Electricity	8.16	9.21	11.29	13.83	16.95	20.77	25.45
Natural Gas	15.33	17.32	21.22	26.01	31.87	39.05	47.84
Gasoline	4,866.64	5,498.97	6,738.09	8,256.43	10,116.92	12,396.64	15,190.06
Diesel	6,179.57	6,963.07	8,497.46	10,370.11	12,655.64	15,445.10	18,849.66
Hydrogen	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	11,069.69	12,488.57	15,268.06	18,666.38	22,821.37	27,901.55	34,113.02

4.4 Scenario Comparison

4.4.1 Energy Comparison

The fuel consumption of the different scenarios is carried out in this section as the SDG and NDC has only adjustment written till 2030 in government policy. So, the comparison of all the scenarios from S1-S5 is carried out within the short-term range 2022-2030, and another long-term comparison is made between S1, S4, and S5.

Short-term energy comparison 2022-2030

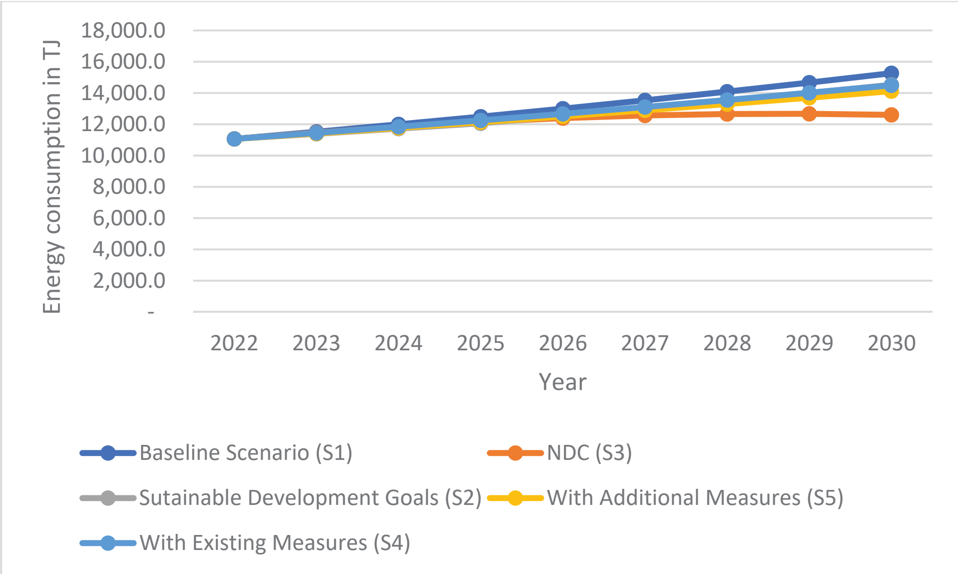

Figure 6 Scenarios impact on fuel consumption by the transport sector

As shown in Figure 5 above, out of all the scenarios developed for the study, the minimum fuel consumption is observed on the NDC. So, out of all the policies that are studied, NDC can help in substantial fuel consumption demand reduction in the transportation sector compared to that of other scenarios. The SDG scenario is observed to be less effective after the baseline scenario as it has less reduction in fuel consumption. The final energy demand in the year 2030 is seen to be 15,268.1 TJ under the baseline scenario which is very least reduced by SDG (S2) Scenario to 14,54.5 TJ followed by WEM (S4) with 14,119.8 TJ. The lowest value of consumption can be attained by following NDC targets which is 12,606.2 TJ.

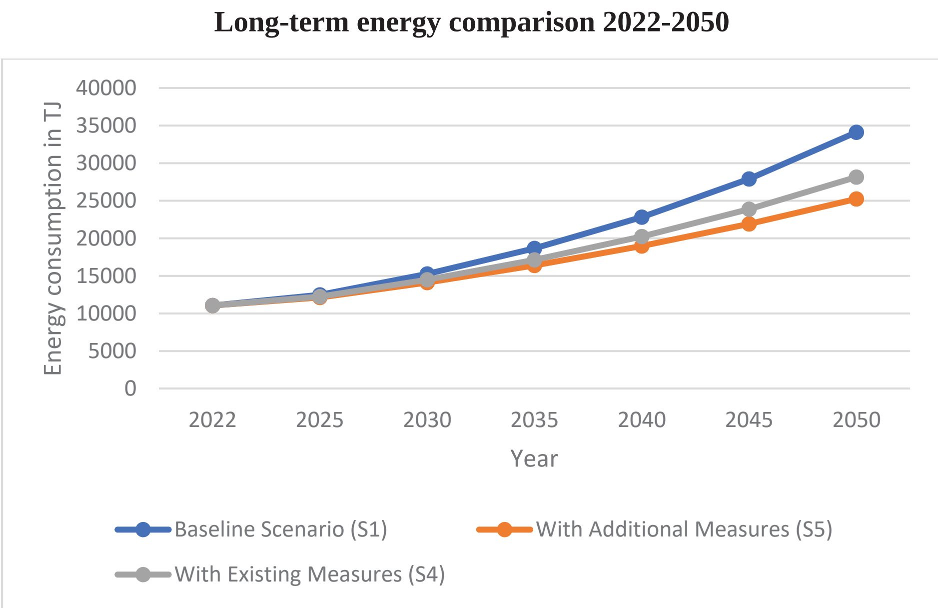

Figure 7 Scenarios comparison from 2022-2050 in case of fuel consumption

From the above Figure 7, it is observed that the WAM (S5) scenario is able to fulfill the transportation demand of the Bagmati province with only 73.99% of the energy requirement on the baseline scenario whereas the WEM (S4) scenario takes 83.52% energy requirement of the baseline scenario in the year 2050.

4.4.2 Emission comparison

The implications of the different scenarios have their own environmental benefits, which can be analyzed on the basis of the 100-yr GWP emission of the GHG gases in different scenarios. Similar to the Fuel consumption analysis the comparison is carried out on short-term and long-term basis as stated below;

Short-term emission comparison 2022-2030

As shown in Figure 8 below, out of all the scenarios developed for the study the minimum emission is observed on the NDC. So, out of all the policies that are studied NDC can help in emission reduction and in attaining Net zero targets on the transportation sector compared to that of other scenarios. The WEM scenario is observed to be less effective as it has only a 6.53% emission reduction. The final emission in the year 2030 is seen to be 1,093.6 thousand Metric tonnes of CO2 equivalent under the baseline scenario which is then least reduced by SDG (S2) Scenario by 8.91% followed by WAM (S5) with a 14.45% reduction. The lowest value of emission can be attained by following NDC targets which is able to reduce the baseline emission by 28.32%.

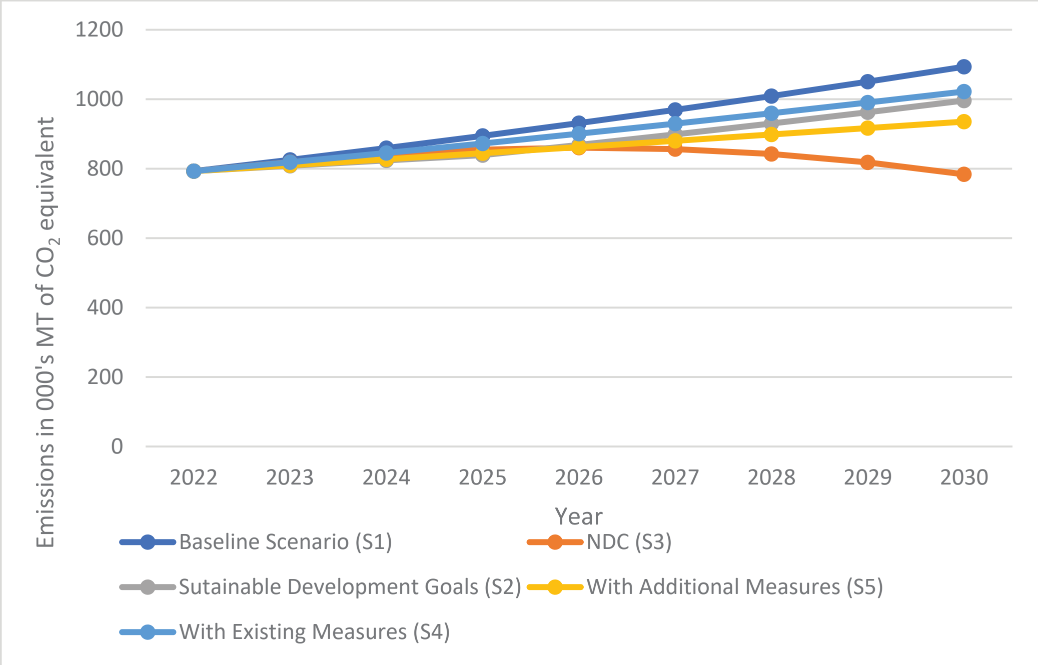

Figure 8 Scenarios impact on emission by the transport sector

Long-term emission comparison 2022-2050

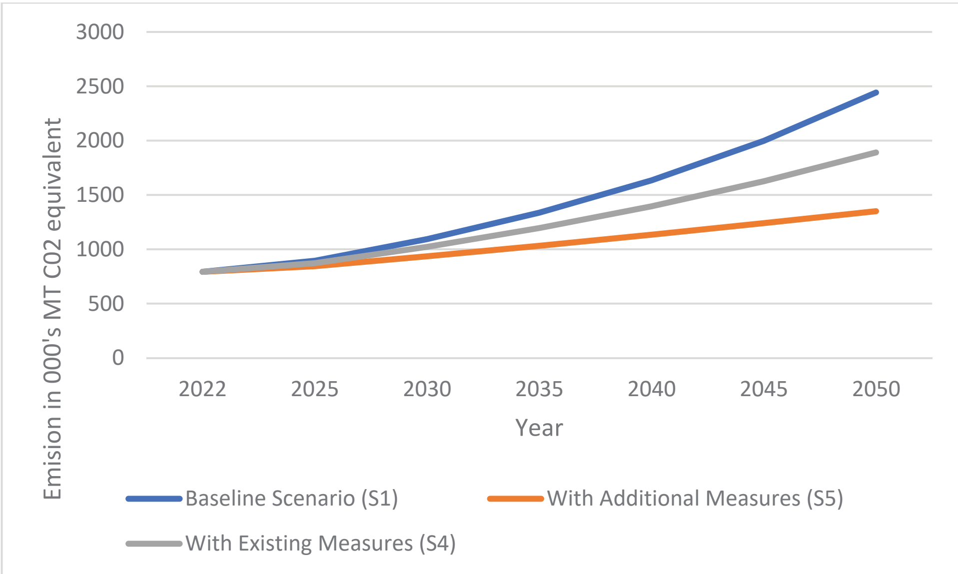

Figure 9 Scenarios comparison from 2022-2050 in case of emission

From above figure 9, it is observed that the WAM (S5) scenario is able to reduce the increase of the emission of the Bagmati province with only a 70.33% increase in 2022 emissions over the period of 28 years. The WEM scenario on the other hand has a 138% increase in year 2022 emission of 792.94 thousand Metric tonne CO2 equivalent over the period of 28 years.

4.5 Power plant capacity requirements:

The electric capacity to fulfill the need for the electrification of the transportation sector in the case of the Bagmati province under scenarios S1-S5 are listed below;

Table 4 Electricity generation requirement

The electricity generation demand on the base year is just 0.74 MW taking into consideration the share of electricity in the fuel mix. The rise in the baseline scenario in the year 2050 is 2.31 MW. Due to the electrical vehicle penetration following the net-zero strategy, the plant capacity is bound to increase to 363.94 MW in order to fulfill the demand need in the year 2050 under additional scenarios and that of the existing scenario will be 151.36 MW.

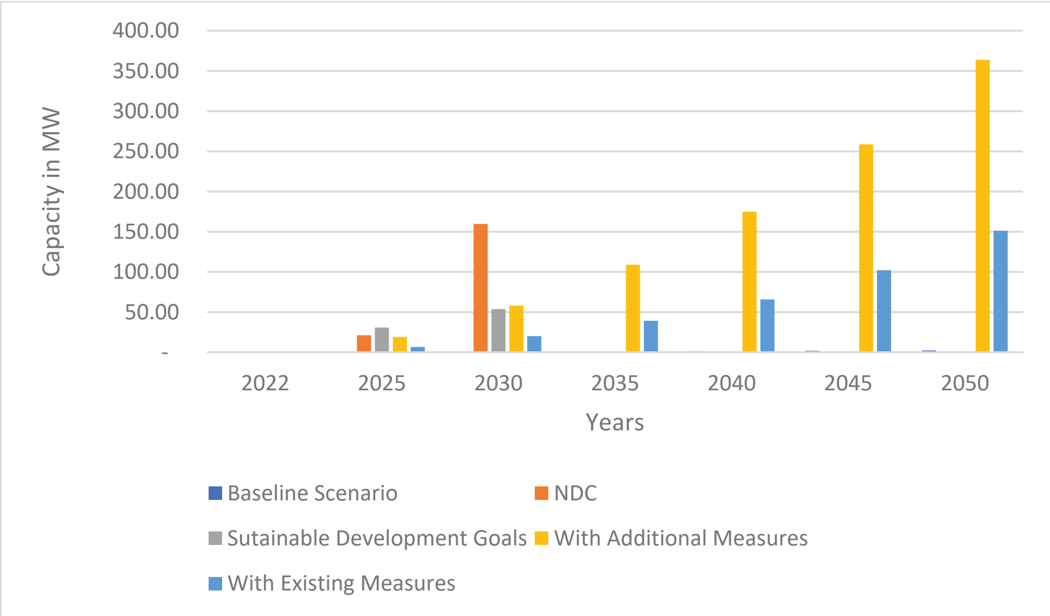

Figure 10 Plant capacity requirements

5. CONCLUSION:

Forecasting of the demand of the transport sector, the year-on-year growth in the freight demand is observed to be 3.99% whereas the increment of the passenger-km demand is observed to be 4.15%. Due to the increase in the land transport demand the energy demand will increase from 11,609.7 TJ in 2022 to 34,113 TJ in the year 2050. Due to this, the emission will also increase from 0.79 million metric tonnes of CO_2 equivalent to 2.44 million metric tonnes of CO_2 equivalent in the time frame of 2022-2050.

Years	2022	2025	2030	2035	2040	2045	2050
Baseline Scenario	0.74	0.84	1.02	1.25	1.54	1.88	2.31
NDC	0.74	21.26	159.77				
SDG	0.74	30.84	53.85				
WAM	0.74	19.16	58.01	109.05	174.94	258.74	363.94
WEM	0.74	6.72	20.19	39.27	65.81	102.16	151.36

On the basis of scenario analysis, the NDC scenario was able to reduce the emission by 28.32% in the year 2030 along with an energy consumption reduction of 17.43% which is followed by the WAM scenario that reduced 14.45% emission with 7.52% energy consumption reduction. The WEM has the least emission reduction of 6.53% in 2030 with an energy reduction of 5.06% whereas SDG has an emission reduction of 8.91% in 2030 and an energy consumption reduction of 4.87%. On the Long-term analysis of the year 2050, we observe that the WAM scenario has an energy reduction of 26% and an emission reduction of 44.7% and the WEM scenario has a reduction of emission by 22.59% and a fuel consumption reduction by 17.48%

Thus, on the basis of the above analysis, a better efficient fuel mix of electricity can help in drastically reducing energy consumption and emissions. The EV vehicles can help drastically reduce energy requirements as well as emissions, so they are to be encouraged by the government. The fuel mix in the transportation sector is observed to be very hard to completely change to electric fuel due to a lack of public motivation at present to switch to EV. So, the transport sector alone cannot be net-zero as there is emission in the creation of vehicles and it is hard to get 100% electric fuel mix in the transportation sector so the emission of the transportation sector has to be cut off by other non-energy and sectors with negative emission.

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Annex:

Table 5 Elasticity factors

Parameters	Value
$\alpha 1i$	1.44
$\alpha 2i$	0.41
αi	0.6

Source: [27]