Government of Nepal
Ministry of Forests and Environment

Assessment of Electric Mobility Targets for Nepal's 2020 Nationally Determined Contributions (NDC)

March 2021

Government of Nepal
Ministry of Forests and Environment
Climate Change Management Division
Singha Durbar, Kathmandu, Nepal

Phone: (+977-1) 4211567
Fax: (+977-1) 4211868
Website: www.mofe.gov.np
E-mail: info@mofe.gov.np

Report Prepared by: Climate Analytics under the IMPACT project, supported by the German Federal Ministry for the Environment, Nature Conservation Building and Nuclear Safety; and under the Climate Action Enhancement Package (CAEP) initiative coordinated by the NDC-Partnership.

Contributors:

Ministry of Forests and Environment: Dr. Radha Wagle, Dr. Maheshwar Dhakal, Raju Sapkota, Dr. Keshab Goutam, Hari Laudari, Shreejana Bhusal
Climate Analytics: Bhushan Tuladhar (consultant), Eriko Shrestha, Manjeet Dhakal, Sneha Pandey, Dr. Jan Sindt, Rachel Pham
NDC Partnership Support Unit: Abhishek Yadav

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Electric tempo (three-wheeler) in the streets of Kathmandu Valley. Photo Courtesy: Bhushan Tuladhar.

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NDC PARTNERSHIP
CLIMATE ACTION ENHANCEMENT PACKAGE (CAEP)
NDCPARTNERSHIP.ORG/CAEP

IMPACT
SCIENCE BASED IMPLEMENTATION OF 1.5°C COMPATIBLE CLIMATE ACTION FOR LDC AND SIDS

CLIMATE ANALYTICS

based on a decision of the German Bundestag

Government of Nepal
Ministry of Forests and Environment
P O Box No. 3987
Singha Durbar, Kathmandu

Phone: +977 01 4211567
+977 01 4211892
Fax: +977 01 4211868
Email: info@mofe.gov.np
Website: www.mofe.gov.np

Ref. No.:

Foreword

Despite being among the smaller contributors of greenhouse gas emissions globally, Nepal remains deeply committed to addressing climate change by implementing both mitigation- and adaptation-related activities. As Nepal works to build its economy and graduate to a middle-income country by 2030, it also aims to mainstream Sustainable Development Goals in its development policies and plans.

With increasing economic growth and urbanization, Nepal's transportation sector has grown rapidly in the past few decades. Improvement in the quality of its citizen's lifestyles has dramatically increased the trend of purchasing petroleum-powered vehicles, which has contributed to increasing air pollution and greenhouse gas emissions in the country. Additionally, increasing import of petroleum products has also increased Nepal's trade deficit.

However, in the upcoming decade, as more hydropower plants come into operation and create an energy surplus, Nepal intends to shift its focus to electric mobility (e-mobility). This will not only help avoid the climate- and health-impacts of traditional vehicles but will also increase consumption of clean energy produced within the country and reduce the trade deficit by decreasing the import of petroleum products that is currently quite high compared to other imports.

As a Party to the Paris Agreement, Nepal communicated its 2020 NDC to the United Nations Framework Convention on Climate Change (UNFCCC) Secretariat on December 8, 2020. This report, based on review of existing policies and markets, and consultations with state and non-state stakeholders, helped inform Nepal's 2020 NDC targets on e-mobility as well as informed the corresponding reductions in national greenhouse gas emissions. Additionally, the report also provides an analysis of Nepal's transportation and energy policy and market landscape, to help inform the NDC implementation process. Finally, this report also acts as a valuable knowledge product that documents the development of the 2020 NDC's e-mobility targets for future reference.

On behalf of MoFE, I would like to express my sincere thanks to all those who were involved in the development of this report.

Bishwa Nath Oli, PhD
Secretary
Ministry of Forests and Environment

Government of Nepal
Ministry of Forests and Environment
P.O Box No. 3987
Singha Durbar, Kathmandu

Phone: +977 01 4211567
+977 01 4211892
Fax: +977 01 4211868
Email: info@mofe.gov.np
Website: www.mofe.gov.np

Ref. No.:

Acknowledgments

This electric mobility (e-mobility) assessment was commissioned by the GoN to help define e-mobility targets for the 2020 Nationally Determined Contributions (NDC) as well as to calculate the reductions in GHG emissions through the implementation of these targets. Furthermore, this report, which is grounded on assessment of national and provincial policies, and extensive consultations with key government and non-government actors, will be helpful during the implementation of the NDC as well. Additionally, this report will remain as a valuable future reference as it documents the development of the e-mobility targets of the 2020 NDC.

Various individuals and institutions have made remarkable contributions in developing and bringing this report to this stage. On the behalf of the Ministry of Forests and Environment (MoFE), I would like to thank the German Federal Ministry for the Environment, Nature Conservation Building and Nuclear Safety for supporting this study through the IMPACT Project, as well as the NDC Partnership for supporting this study through the Climate Action Enhancement Package (CAEP).

I would also like to express my gratitude to team members at CCMD, particularly Mr. Raju Sapkota, Dr. Keshab Goutam, Mr. Hari Krishna Laudari and Ms. Shreejana Bhushal for their help in reviewing the report.

I would like to express my gratitude to Climate Analytics for conducting this assessment. In particular, I express my thanks to consultant Mr. Bhushan Tuladhar, Ms. Eriko Shrestha, Ms. Sneha Pandey, Mr. Manjeet Dhakal, Ms. Rachel Pham and Dr. Jan Sindt from Climate Analytics for preparing this report. I would like to thank Mr. Abhishek Yadav of NDC Partnership for his important contributions to the document as well.

I would like to thank the following government agencies: National Planning Commission (NPC); Ministry of Finance (MoF); Ministry of Physical Infrastructure and Transport (MoPIT); Ministry of Energy, Water Resources and Irrigation (MoEWRI); Nepal Electricity Authority (NEA); Nepal Electricity Regulatory Commission (NERC); Water and Energy Commission Secretariat (WECS); and Nepal Investment Board (IBN) for their feedback and views that informed this assessment. Additionally, I would like to thank private sector representatives from Nepal Automobile Dealers Association (NADA); and Electric Vehicle Association of Nepal (EVAN) for their inputs. I also express my thanks to experts from Kathmandu University and Tribhuvan University as well from UNDP-Nepal; Global Green Growth Institute (GGGI); Oxford Policy Management (OPM); WWF-Nepal and Clean Energy Nepal (CEN) for their feedback. Finally, I would like to thank all the reviewers and experts who helped shape the document with their technical inputs.

Radha Wagle, PhD
Joint Secretary and Chief,
Climate Change Management Division

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Acronyms

AFOLU	Agriculture, Forestry and Other Land Use
BAU	Business As Usual
BMU	German Federal Ministry of the Environment, Nature Conservation and Nuclear Safety
BS	Bikram Sambat
CAEP	Climate Action Enhancement Package
cc	cubic centimetres
CDES	Central Department of Environmental Science, Tribhuvan University
CH_4	Methane
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide equivalent
COVID-19	Coronavirus Disease 2019
DoTM	Department of Transport Management
E-mobility	Electric mobility
EU	European Union
EV	Electric Vehicles
FAME	Faster Adoption and Manufacturing of (Hybrid&) Electric Vehicles in India
FY	Fiscal Year
GDP	Gross Domestic Product
Gg	Gigagrams
$GgCO_2e$	Gigagrams of CO_2 equivalent
GGGI	Global Green Growth Institute
GHG	Greenhouse Gases
GJ	Gigajoules
GoI	Government of India
GoN	Government of Nepal
HFC	Hydrofluorocarbon
ICE	Internal combustion engine
IEA	International Energy Agency

IMF	International Monetary Fund
IKI	International Climate Initiative
INR	Indian Rupees
kV	kilovolt
kWh	Kilowatt-hour
LEAP	Low Emissions Analysis Platform
LDV	Light Duty Vehicles
MoEWRI	Ministry of Energy, Water Resources and Irrigation
MoF	Ministry of Finance
MoFE	Ministry of Forests and Environment
MoPIT	Ministry of Physical Infrastructure and Transport
MW	Megawatt
NDC	Nationally Determined Contributions
NDC-P	NDC Partnership
NEA	Nepal Electricity Authority
N_2O	Nitrous Oxide
NOC	Nepal Oil Corporation
NPC	National Planning Commission
NPR	Nepalese Rupees
NRB	Nepal Rastra Bank
$PM_{2.5}$	Particulate Matter 2.5
SDG	Sustainable Development Goals
UNFCCC	United Nations Framework Convention on Climate Change
USAID	U.S. Agency for International Development
USD	United States Dollar
VAT	Value Added Tax
WECS	Water and Energy Commission Secretariat

About the Study

Globally, the transport sector is a major contributor to greenhouse gas (GHG) emissions and this contribution continues to grow rapidly with increasing urbanization and motorization, particularly in developing countries. It is therefore important for countries like Nepal, who have a small but rapidly growing vehicle fleet, to aggressively decarbonize the transport sector. In addition to reducing GHG emissions, decarbonization of the transport sector will also contribute towards lowering air pollution and its negative health impacts, reducing the budget deficit caused by the import of petroleum products, and increasing energy security. Realizing this opportunity, the Government of Nepal (GoN) included targets for electric mobility (e-mobility) in its first Nationally Determined Contributions (NDC) that was communicated to the United Nations Framework Convention on Climate Change (UNFCCC) Secretariat in October 2016 as well as the subsequent revised NDC which was communicated in December 2020.

Through analysis of national and international policy frameworks, markets, technologies, finance and electricity availability and through numerous expert and stakeholder consultations **(see Annex I)**, this report was prepared to help inform Nepal's 2020 NDC targets on e-mobility. Additionally, this assessment also helps inform NDC implementation by recognizing crucial gaps in Nepal's policy, markets, finance and energy sector and identifying solutions to meet them.

Chapter 1 and 2 of this report discuss the current status of transport and energy sector in Nepal. Chapter 3 tabulates past GHG emissions of Nepal and outlines emissions projected by Nepal's Third National Communication under various GDP growth rate scenarios. Chapter 4 analyzes policies related to e-mobility in Nepal and discusses gaps while Chapter 5 examines e-mobility related policies in other countries and identifies key lessons. Chapter 6 analyzes markets, technology, and financing trends both nationally and internationally and provides projections of electric vehicles (EV) prices in Nepal in the near future. Chapter 7 discusses key challenges and opportunities in policies; governance; technology, infrastructure and markets; financing; and knowledge management related to EV. Chapter 8 explores possible e-mobility targets for the 2020 NDC.

Chapter 9 lists the 2020 NDC targets and presents the Business as Usual (BAU) Scenario and the Ambitious E-Mobility Scenarios that informed these targets. The Ambitious E-Mobility Scenario informed the 2020 NDC targets on mobility while the BAU Scenario provided a basis for comparison. These scenarios were designed using the policy and trend analysis presented from Chapter 1 to Chapter 8 of this report, as well as the recommendations of numerous experts **(see Annex I)**, the GoN-appointed NDC Working Group, and other line ministries and government agencies. The impacts of these scenarios on vehicle fleet, fossil fuel usage and GHG emissions from 2020 to 2030 were projected using the LEAP modeling software. While this report presents the results of this analysis, the accompanying Nepal Mitigation Assessment Report (2021) describes this LEAP methodology in more detail.

To support MoFE in Nepal's 2020 NDC revision process, Climate Analytics has provided technical services, including this e-mobility sectoral assessment, through the IMPACT project with financial support from the German BMU and IKI cluster, as well as through the NDC-Partnership's Climate Action Enhancement Package (CAEP) initiative.

1. Transport Sector and E-Mobility in Nepal

The transport sector in Nepal is dominated by road transport, which accounts for about 90% of all trips (Acharya et.al, 2015). While aviation has gained some popularity, particularly for those travelling to rural mountainous areas or wanting to avoid long and often unsafe highways, the use of rail and waterways has been limited due to difficult terrain. Rail transport, however, may see an increase in the future as the GoN is planning several rail projects that would connect major cities and along the east-west corridor in the southern plains (NPC, 2019).

1.1 Vehicle Growth in Nepal

Although Nepal is still in the early stages of motorization, the number of vehicles is growing rapidly. The number of vehicles registered in the country grew at a rate of 14% per annum from 1990 to 2018 and in the past 10 years this growth rate has exceeded 16% per annum as demonstrated in **Figure 1**. This growth in the number of vehicles is expected to continue in the future with increasing road infrastructure, rapid urbanization and growing incomes. The growth in the number of vehicles is particularly high for two-wheelers, which grew at an annual rate of 17% from 1990 to 2018 (DoTM, 2019).

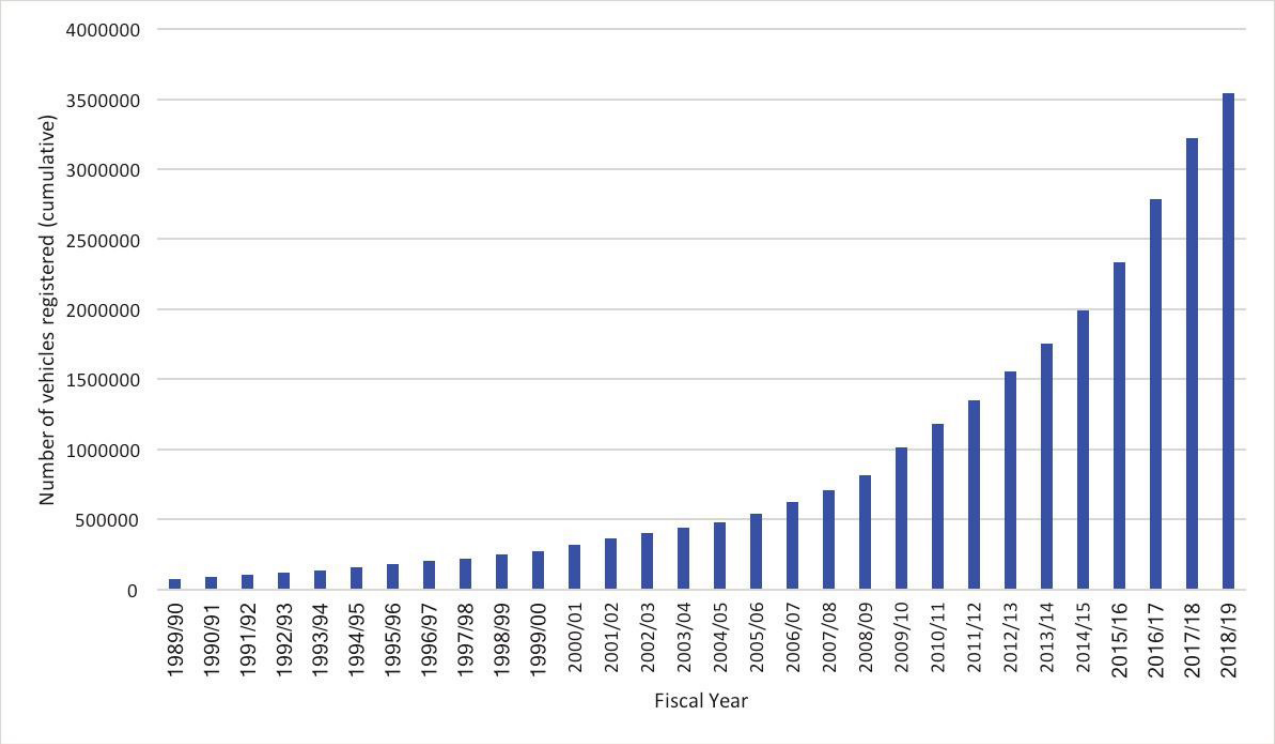


Figure 1: Growth of Registered Vehicles in Nepal (1989/90-2018/19)

Note: Data for FY 2018/19 only considers the first 9 months of the fiscal year.

Source: DoTM, 2019

The Department of Transport Management (DoTM), which keeps a record of all vehicles in the country only has records of new vehicles registered in different years in the different

zones of the country. As the Department does not have any records on how many vehicles are removed from the roads, the data indicate cumulative numbers of registered vehicles.

Because the vehicle market is very price-sensitive, smaller vehicles, which are also less expensive, are generally preferred as private vehicles. While 79% of the registered vehicles are motorcycles, 7% are light-duty vehicles (LDV) consisting of cars, jeeps and vans, 3% are trucks and other heavy vehicles, 2% are buses and 1% are minibuses and mini trucks. Even among LDV, the preference seems to be towards small cars (CEN, 2019).

Of the 3.5 million vehicles registered in the country, over 90% are passenger vehicles, while only about 10% are freight and other vehicles. Among the passenger vehicles, 96% are private vehicles while the remaining 4% are public vehicles. The share of public transport vehicles (buses, minibuses, microbuses and three-wheelers) in the overall vehicle fleet of the country decreased from 11% in 1990 to 5% in 2018, indicating a shift towards private vehicles. **Figure 2** below shows the percentage of different types of registered vehicles in the country.

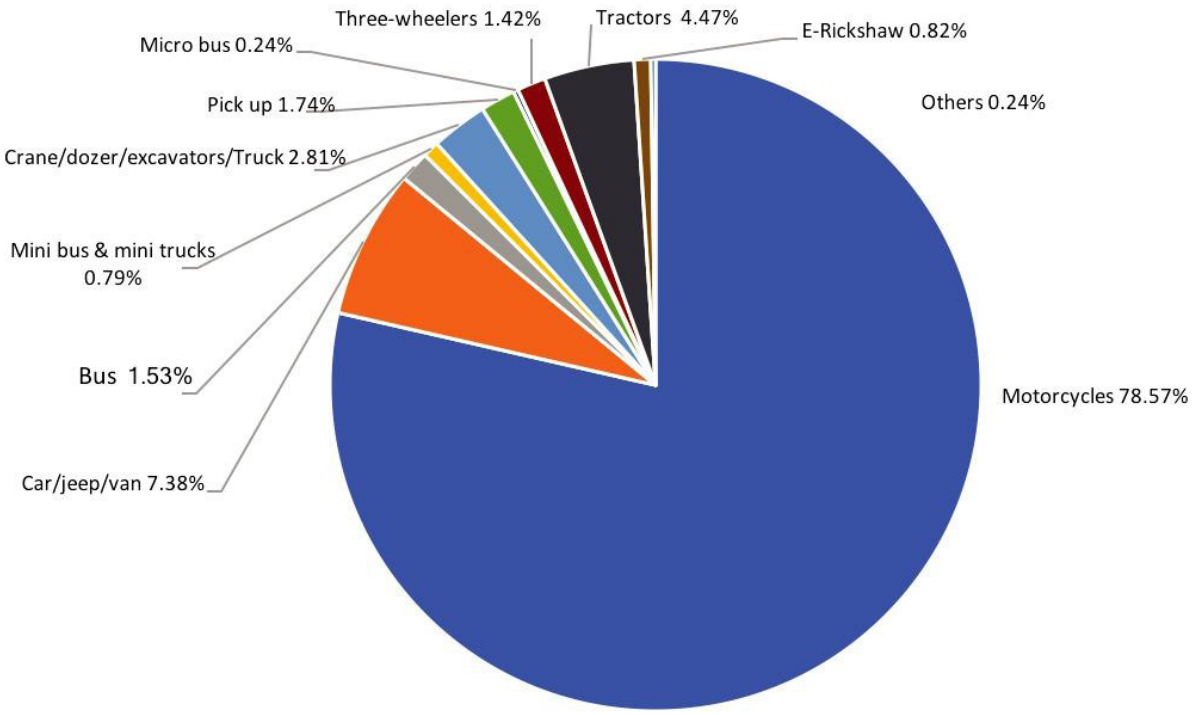


Figure 2: Types of Vehicles Registered in Nepal
Source: DoTM, 2019

1.2 EV in Nepal

E-mobility has a rich history in Nepal. The first ropeway connecting Kathmandu to Dhorsing was introduced in 1922 and was later expanded to Hetauda with the total length of 42 km in 1964. Electric trolleybuses were introduced in Kathmandu Valley with support from the Chinese government in 1975. These trolleybuses operated

successfully along a 13 km route between Kathmandu and Bhaktapur until 2001 when it was shut down due to management problems. It opened again partially in 2003 but closed again in 2008. The experience from the trolleybus demonstrates that electric bus technology can be suitable for Nepal, but operations must be run professionally. Simply having the buses operated by a government entity may not result in effective and efficient services.

In 1995, electric three-wheelers, locally known as Safa Tempo, were first introduced in the country by Global Resources Institute with the support of USAID. The project successfully operated the first seven Safa Tempos before handing them over to a private company. The number of Safa Tempos increased dramatically after diesel three-wheelers were banned in the capital city in the year 2000. Today, there are over 700 Safa Tempos operating as public transportation in 28 different routes in the Kathmandu Valley. The Safa Tempo has been a success story as they have been operating successfully as a means of public transport for 25 years without any government subsidy. However, except small scale initiative such as 10 Safa Tempos switch to Lithium-ion batteries, there has not been any improvement in the Safa Tempo technology over the years and their numbers have also not grown over the last few years. This demonstrates that although the private sector can operate electric vehicles (EV), they will need support initially when the technology is first being introduced. Additionally, the government also needs to prioritize research and development to ensure the technology can evolve and grow with time.

Besides Safa Tempos, in recent years many three-wheeler e-rickshaws are also running on the streets of Nepal, particularly in the cities located in the southern plains. Some of these e-rickshaws are assembled in Nepal while others are imported from India or China. Vehicle registration records of DoTM recorded e-rickshaws for the first time in the FY 2015/16 when 11,894 e-rickshaws were registered. By March 2019, there were a total of 26,466 e-rickshaws registered in the country (DoTM, 2019).

Recently, a private bus operator started to operate four electric buses in Kathmandu. Additionally, the GoN has also imported five electric buses for Lumbini but these have not yet come into operation. The GoN has also announced plans to procure 300 more electric buses.

Electric-two wheelers and electric cars have also been introduced in Nepal as private vehicles in the past few years. Electric Vehicle Association of Nepal (EVAN) estimates that at present there are approximately 6,000 electric two-wheelers and 1,000 electric cars in Nepal (Shrestha, 2020). This indicates that **altogether there are currently about thirty-four thousand EV in the country**, which would be about **1% of the total vehicle fleet in the country**. Among these, more than 80% are three-wheelers that operate as public vehicles.

2. Energy Sector in Nepal

2.1 Energy Sources

Traditional energy sources, such as firewood, dung and agricultural residue, continue to be the main energy sources in Nepal. However, the use of commercial sources such as fossil fuels and electricity is steadily increasing. As shown in **Figure 3**, biomass provides 69% of the total energy which is mainly used in households for cooking and heating, while petroleum products provide 17%, electricity provides 4% and other renewable sources provide 3%. **Figure 3** also shows that the residential sector has the highest energy consumption at 75%, followed by the industrial sector and the transportation sector at 10% each (MoF, 2019).

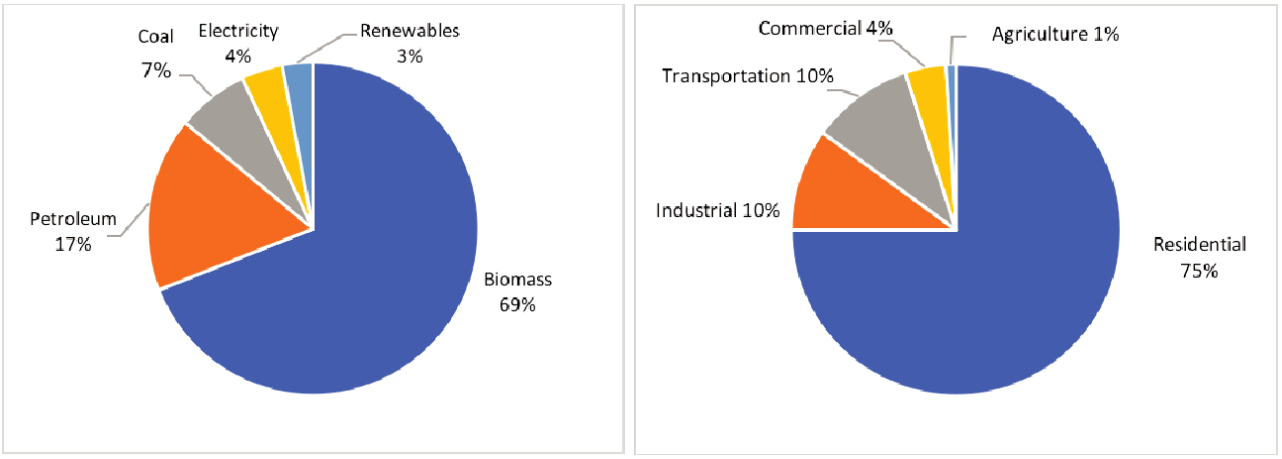


Figure 3: Source of Energy (left) and Energy Consumption by Sectors (right) in Nepal
Source: MoF, 2019

2.2 Consumption of Petroleum

The consumption of petroleum products such as diesel and petrol, which are primarily used in transportation, is growing at a rapid pace as seen in **Figure 4**. Over the past 10 years from 2008/09 to 2018/19, the consumption of diesel and petrol grew at a rate of over 21% per year. Although there was a slight reduction in consumption in 2015, mostly because of the mega earthquake and energy crisis[1], in subsequent years the growth has picked up again with increased economic activity.

Petroleum imports are the major contributors to Nepal's trade deficit, which was equivalent to 38.1% of the country's GDP in 2018/19, when the total value of imports was almost 15 times higher than the value of total exports. Petroleum products made up more than 15% of all the goods imported into the country. The total value of all the petroleum products imported in the country was more than double the value of Nepal's exports (NRB, 2019).

1 To meet its domestic needs, Nepal imports all petroleum products, including LPG, from India. The undeclared economic and transit embargo imposed by India, which began on 23rd September 2015 and lasted for over two months, sharply curtailed the supply of these petroleum products, including petrol and diesel in Nepal.

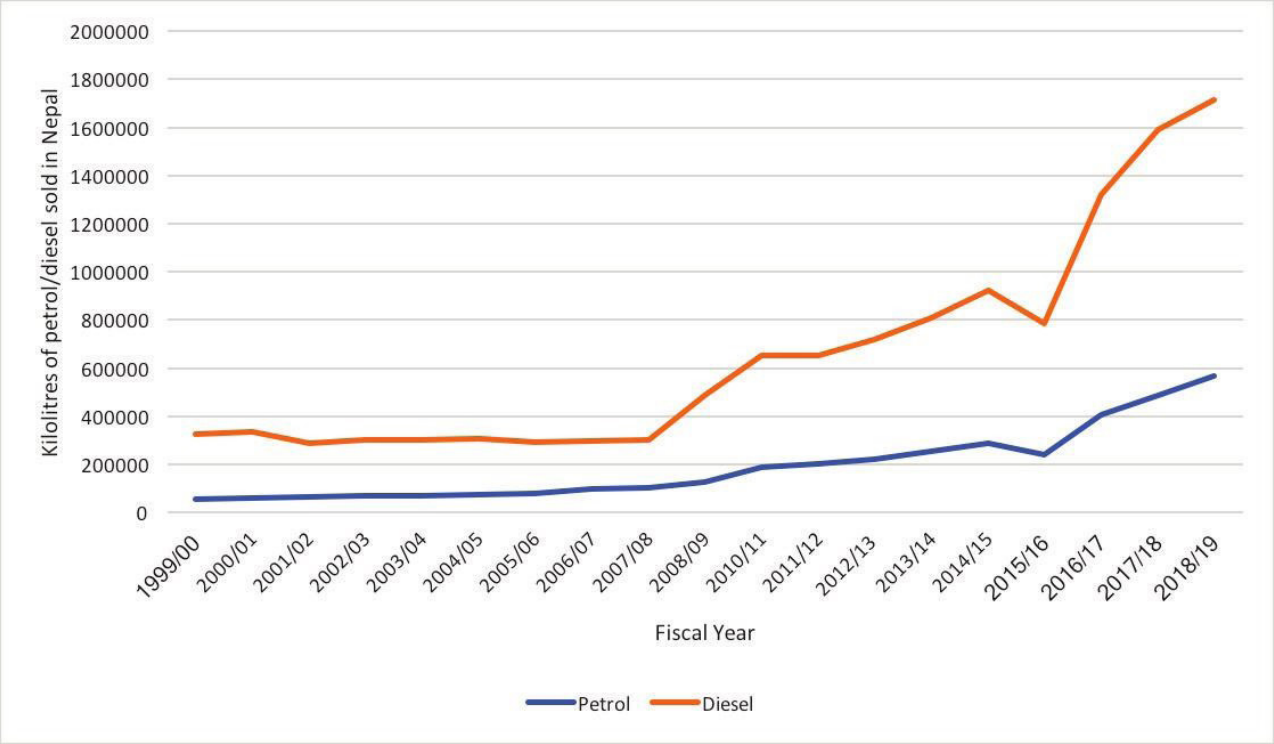


Figure 4: Consumption of Diesel and Petrol in Nepal Over the Past 20 Years
Source: NOC, 2020

2.3 Consumption of Electricity

Over the past 10 years, the amount of electricity sold in Nepal is increasing at an average rate of 11% per year. Nepal Electricity Authority (NEA) is the major generator and distributor of electricity in Nepal. According to the NEA, the rate of annual increase in electricity sold has been over 19% in the last three years. A total of 7,741 GWh of electricity was generated or imported in Nepal in 2019/20. Of this amount, approximately 39% was generated by hydropower plants owned by NEA, 39% were generated by independent power producers in Nepal and about 22% was imported from India. The amount of electricity imported from India decreased by 38.55% in 2019/20 compared to the previous year (NEA, 2020). As most hydropower plants are run-of-river type plants with very little storage capacity, electricity generation is significantly higher right after winter when the snow begins to melt and during the monsoon.

Electricity demand varies significantly with time over 24 hours. **Figure 6** shows a system load curve for NEA over 24 hours during the dry season. The graph shows that peak demand (load) was 1200 MW at around 7 pm in the evening, whereas the minimum demand was only 600 MW from 1 am to 5 am at night. The morning demand was 1000 MW around 6 am which decreased to 800 MW during the day time before peaking again in the evening.

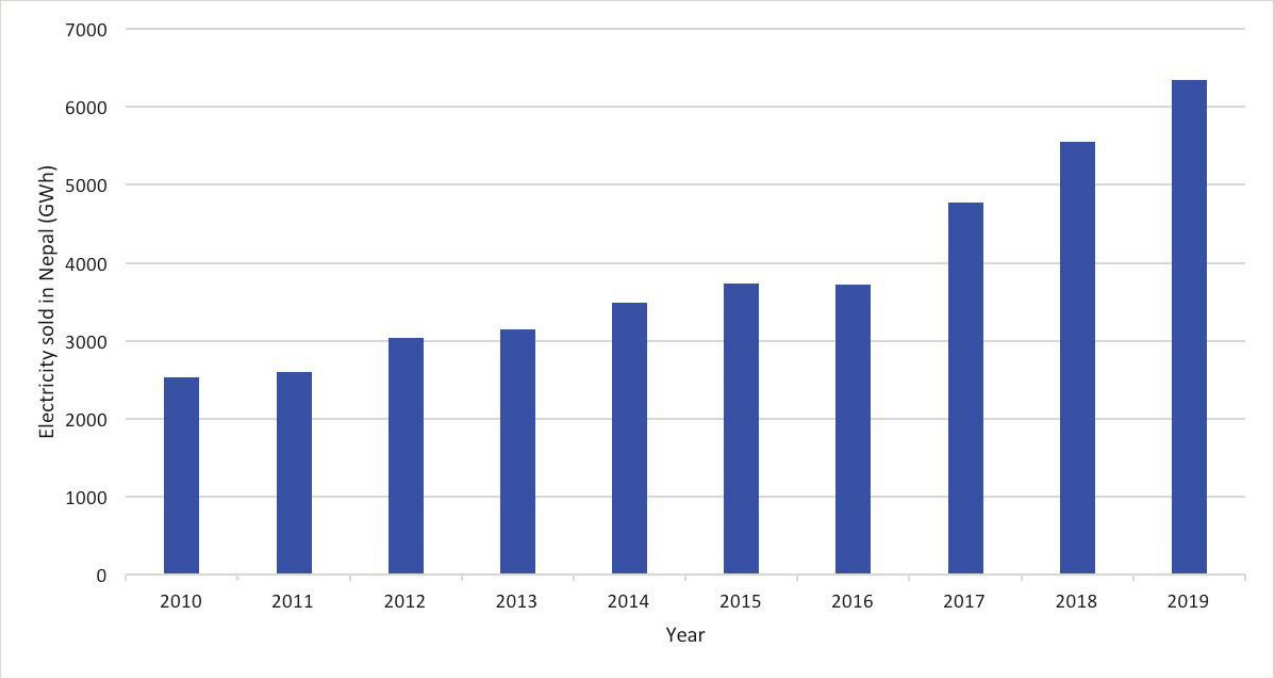


Figure 5: Electricity Consumption in Nepal (2010-2019)
Source: NEA, 2019

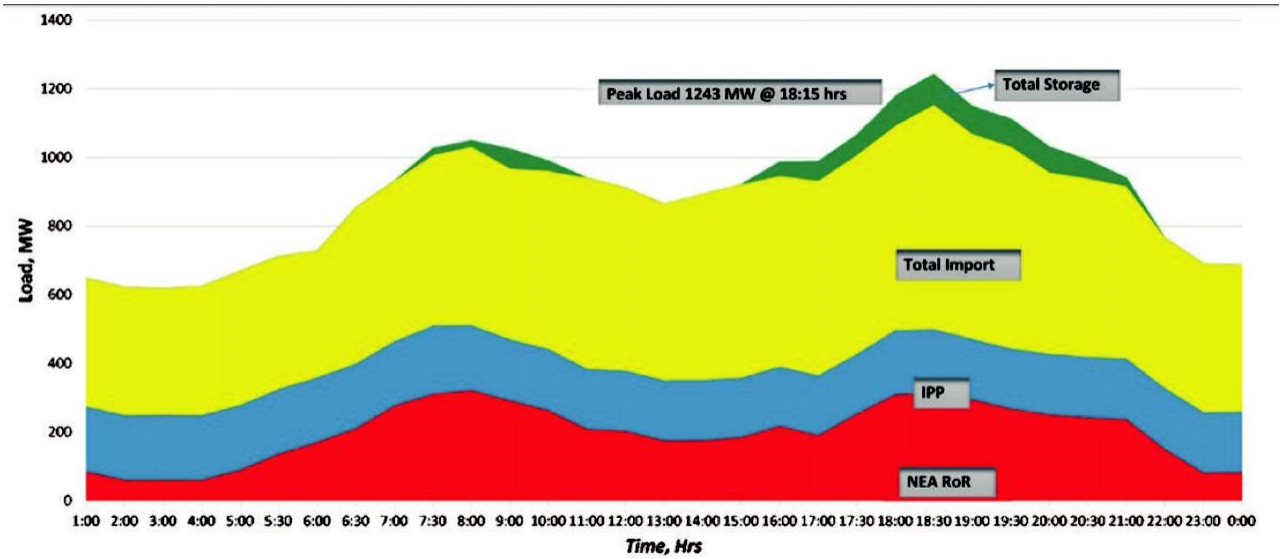


Figure 6: System Load Curve in Dry Season (10 January 2019)
Source: NEA, 2019

Similarly, **Figure 7** shows the system load curve in the wet season of 2019 when the peak demand was 1300 MW at around 8 pm in the evening, whereas the minimum demand was only 900 MW during the night. The morning demand was 1000 MW around 8 am which gradually increased over the day before peaking again in the evening.

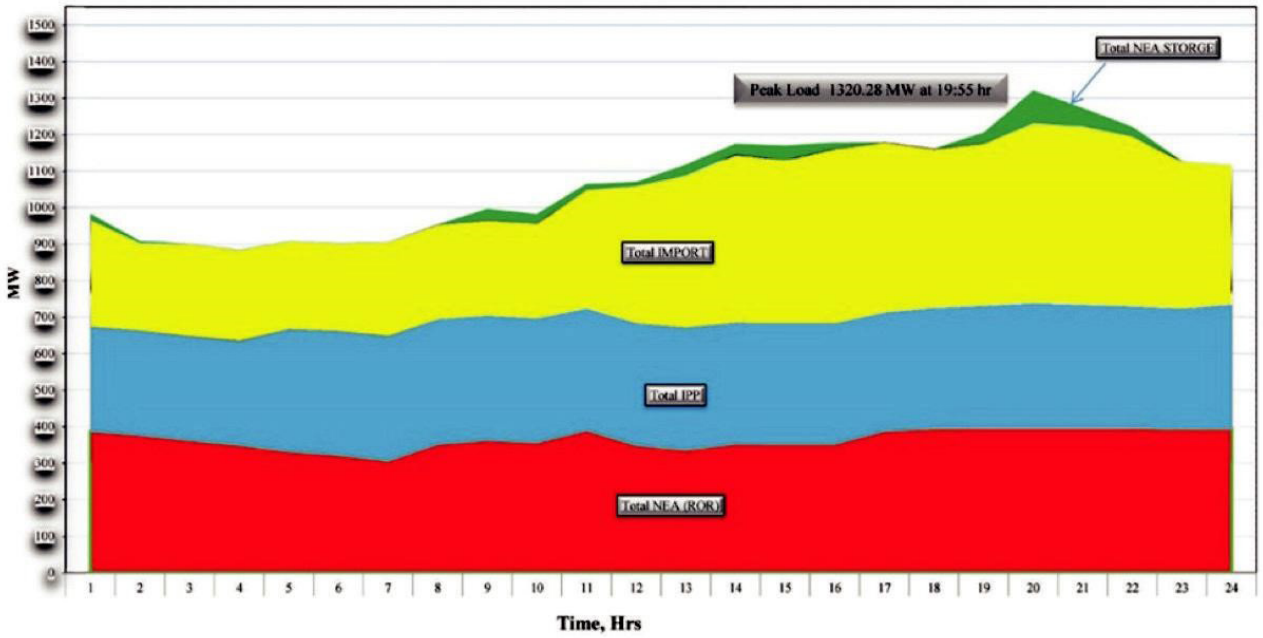


Figure 7: System Load Curve in Wet Season (30 June 2019)
Source: NEA, 2019

These system load curves show that there is a need to utilize electricity during off-peak hours from 10 pm to about 7 am to balance the load in the grid. NEA realizes that EV can be an effective way to utilize this electricity during off-peak hours. At an interaction programme organized by MoFE, the then-Deputy Managing Director of NEA, Hitendra Dev Shakya[2] stated that in the wet season of 2020, there would be excess supply in the grid and electricity may have to be spilled during the off-peak hours (MoFE, 2020b). This problem of excess electricity in the off-peak hours will probably increase as several new hydropower plants are scheduled to start operations soon (Ghising, 2020). NEA is therefore planning to promote EV to utilize the off-peak electricity by initially establishing at least 50 charging stations.

Nepal had an installed capacity of 1142 MW by mid-March 2019 which supplies electricity to 78% of the households (MoF, 2019). The Energy, Water Resources and Irrigation White Paper, (MoEWRI's White Paper) 2018 states that the GoN plans to increase the installed capacity to 3000 MW in three years, 5000 MW in five years and 15,000 MW in 10 years (MoEWRI, 2018 & NPC, 2019). The GoN also plans to increase the per capita electricity consumption from the current rate of 245 kWh to 700 kWh by 2023 and 1500 kWh by 2028. This is an ambitious target as WECS (2017) estimates that in the business as usual scenario (which assumes an annual GDP growth rate of 4.2%) the per capita electricity consumption will grow to 462 kWh in 2025 and 716 kWh by 2030. Only in high GDP growth rate scenario of 9.2% (alongside a series of policy interventions) WECS (2017) estimates the per capita electricity consumption to reach 867 kWh and 1474 kWh by 2025 and 2030 respectively. The policy interventions assumed for the high growth scenario consider 18% of the total passenger kilometres demand fulfilled by electric cars and 7% by electric metros in urban cities by 2025. WECS (2017) also estimates that to meet the electricity demand for the high

2 Hitendra Dev Shakya is currently the Managing Director at NEA. At the time of this interaction programme in July 2020, he was the Deputy Managing Director at NEA.

GDP growth rate scenario, the installed capacity needs to reach 10,803 MW by 2025 and 18,371 MW by 2030.

With the completion of new power plants, the amount of electricity imported from India is expected to decrease significantly this year, and over the coming years, it is expected that there will be surplus electricity in the grid. In FY 2019/20 the total energy imported from India was 1,729 GWh as compared to 2,814 GWh in FY 2018/19, a decrease of 38.55% (NEA, 2020). NEA estimates that the electricity consumption needs to grow at 25% per year, up from the current growth rate of about 19% per year to meet the GoN's targets (Ghising, 2020). This will necessitate a significant consumption of electricity by the transport sector as well. MoEWRI's White Paper issued by the Ministry thus has a target to ensure that 50% of new vehicles will be electric by 2023 (MOEWRI, 2018).

3. GHG Emissions from the Transport Sector

Currently, transport contributes almost a quarter of the global energy-related GHG emissions and is growing faster than any other energy end-use sector. Transport is the third-largest source of CO_2 emissions after the power sector and other forms of industrial combustion. GHG emissions from transport are anticipated to rise from today's levels by nearly 20% by 2030 and close to 50% by the year 2050 unless major action is undertaken. Within the transport sector, freight emissions are now growing faster than passenger transport emissions. The freight emissions share in total transport CO_2 emissions increased from 35% in 2000 to 41% in 2015 (SLOCAT, 2018).

3.1 GHG Emissions in Nepal

The First National Communication submitted by GoN to the UNFCCC in 2004 with base year 1994/95 estimated the emissions from the transport sector to be 456 Gg in 1994 (MoPE, 2004). This was 4.67% of the total emissions of the country and 14% of the emissions from the energy sector. Similarly, the Second National Communication submitted to UNFCCC in 2014 with base year 2000/01 estimated the emissions from the transport sector to be 818 Gg in the year 2000 (MoSTE, 2014). This was 6% of the total GHG emissions and 12% of the emissions from the energy sector. This shows that the emissions from the transport sector have increased annually at an average rate of about 10% from 1994 to 2000 and 7.1% from 2000 to 2011.[3]

Nepal's Third National Communication provides an inventory of GHG emissions by sources and their removal by sinks for the base year 2011. It estimated the net direct GHG emissions in the country to be 31,998.91 $GgCO_2e$[4]. Of this, 1,740 $GgCO_2e$ was from the transport sector, which accounts for 5.44% of the total net GHG emissions and 11.84% of net emissions from the energy sector (CDES, 2017). Nepal's GHG emissions and removal for the base year 2011 have been presented in **Table 1**.

3 It must be considered, however, that the methodologies for estimating GHG emissions were different in the first and second national communication reports.

4 This does not take into account direct GHG emissions under memo items, nor indirect GHG emissions.

Table 1: Nepal's Direct GHG Emissions and Removal, 2011

Sector / Subsector	Emission / Sink of Direct Gas (Gg)				
	CO_2	CH_4	N_20	HFC	CO_2e
TOTAL	**-7,335.82**	**1,259.61**	**26.25**	**0.01**	**31,998.91**
1. Energy	**4,678.20**	**354.90**	**3.90**		**14,713.36**
Energy industries	2.38	0.00	0.00		2.38
Manufacturing industries & construction	2,237.34	0.04	0.06		2,256.10
Transportation	1,708.92	0.27	0.08		1,740.97
Others (Commercial, Institutional, Residential, Agricultural)	729.58	354.59	3.89		10,753.00
2. Industrial Processes and Produce Use	**355.40**		**0.00**	**0.01**	**379.80**
3. AFOLU	**-12,371.79**	**882.36**	**21.12**		**15,982.16**
Livestock		705.49	0.09		17,665.29
Land (Forest and Cropland)	-16,436.14				-16,436.14
Land (Grassland, Settlement and Other Land)	3,253.36				3,253.36
Aggregate sources and Non-CO_2 Emission Sources on Land	810.99	176.87	21.03		11,499.68
4. Waste	**2.36**	**22.35**	**1.22**		**923.59**
5. Memo items					
International Bunker	**172.51**				
Biomass Combustion for Energy Production	**34,990.76**				

Source: CDES, 2017

The main sources of GHG emissions are heavy vehicles such as trucks, buses and other heavy equipment followed by light-duty vehicles such as cars, jeeps and vans. Although two-wheelers make up about 79% of the total vehicle fleet, their contribution to the overall GHG emissions from the transport sector is estimated to be only 8% as shown in **Figure 8** (CDES, 2017).

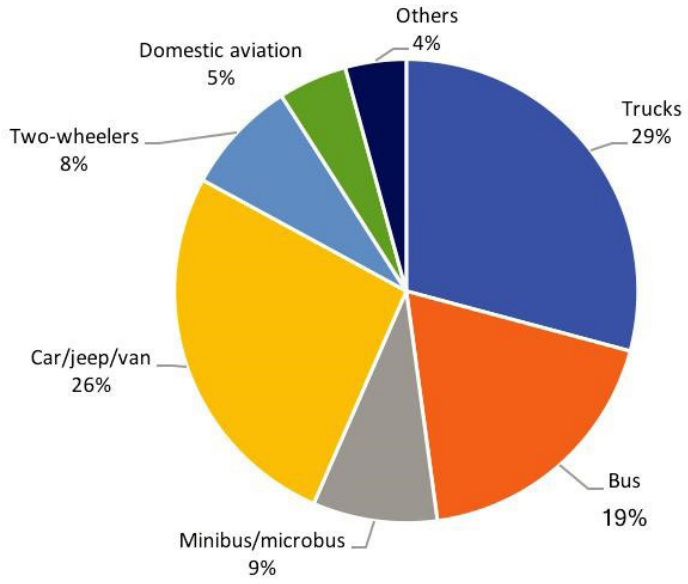


Figure 8: Emissions from Nepal's Transport Sector in 2011
Source: CDES, 2017

The GHG emissions from the transport sector have been calculated using standard emission factors. For more reliable estimates, however, it is important to develop national emissions factor as well as develop an inventory that accurately represents the national vehicle fleet and the distance travelled.

3.2 Emission Projections for Nepal

GHG emissions are closely related to economic activities. Therefore, future projections for emissions will depend on GDP growth rates. Following the mega earthquake of 2015, Nepal has managed to achieve a fair GDP growth rate of 7.3% per year. Although the GoN plans to increase average GDP growth rate of 9.6% per year during the 15th Five-Year Plan period (i.e. 2019-20 to 2023-24), COVID-19 induced economic downturn means that this target is not likely to be met. In fact, the GDP growth rate was predicted to decrease to 2.5% in the year 2020 (IMF, 2020) and will probably remain low in the near future.

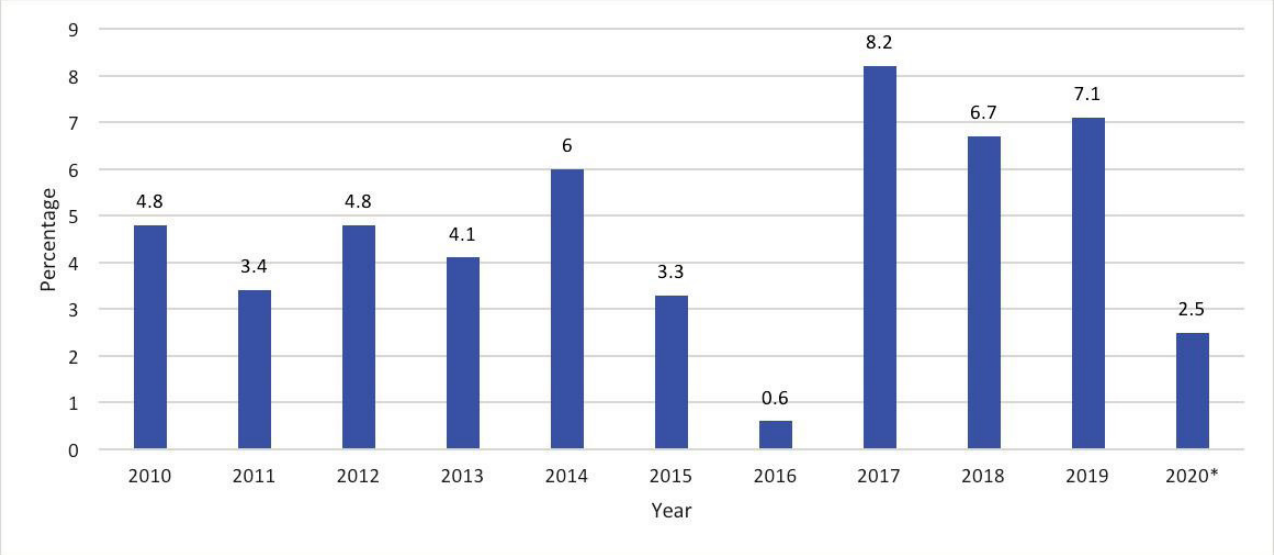


Figure 9: GDP Growth Rate (2010-2020)

*Projected

Source: IMF, 2020

The Third National Communication Report used LEAP modeling to estimate the projected energy demand and corresponding emissions under four different scenarios – (i) Business As Usual Scenario with GDP growth rate of 4.4%; (ii) Medium GDP Growth Rate Scenario of 5.6%; (iii) High GDP Growth Rate Scenario of 6.5%; and (iv) Combined Policy Intervention Scenario. The Combined Policy Intervention Scenario assumed a medium GDP growth rate of 5.6% together with introduction of mass transportation systems, and electric and bio-fuel transportation technologies among other initiatives. It showed a significant reduction in GHG emissions by 2030. Other interventions assumed in this scenario were the replacement of traditional biomass and fossil fuels with cleaner energy alternatives such as electricity, Liquefied Petroleum Gas (LPG), and improved cookstoves; promotion of electrification in all sectors for lighting, heating and other purposes; and adoption of efficient process technologies in industries.

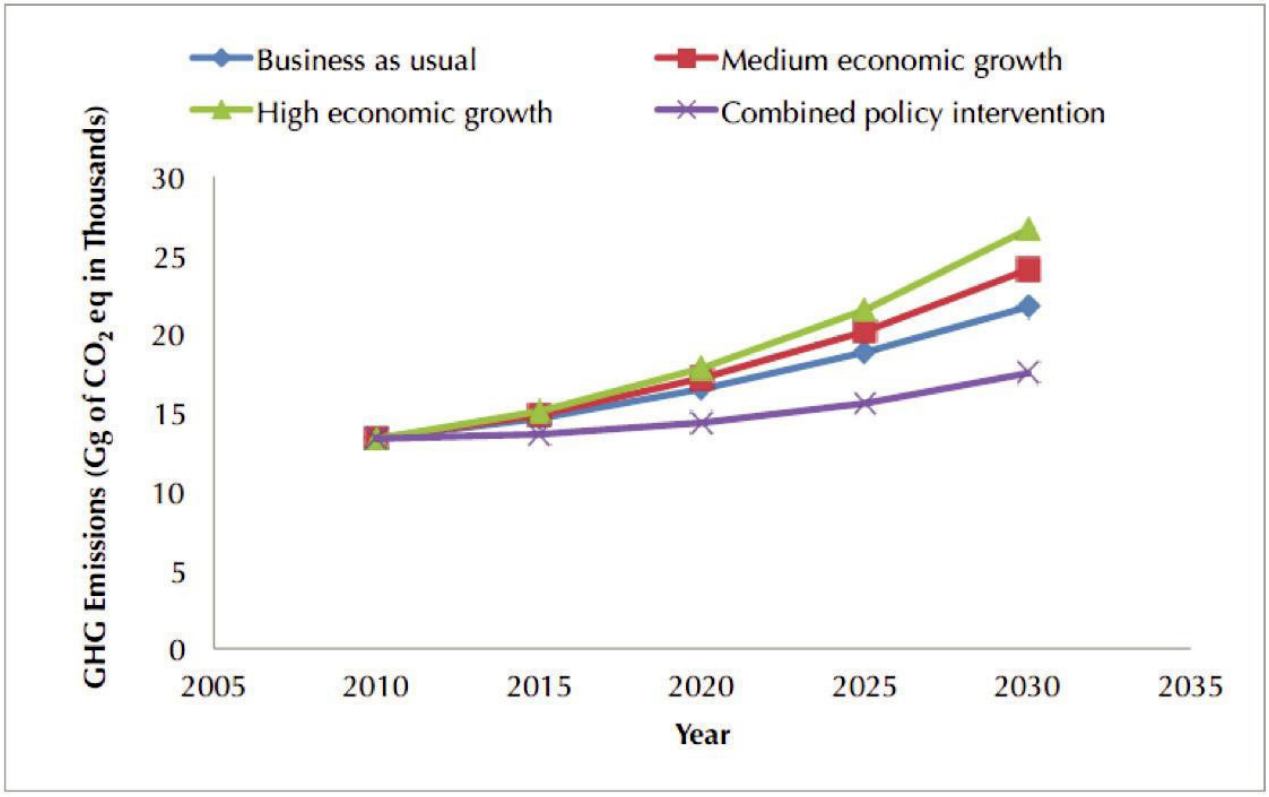


Figure 10: Projected GHG from the Energy Sector under Different Scenarios in Nepal
Source: CDES, 2017

4. Policies Related to E-Mobility in Nepal

Nepal has introduced several policies which include provisions related to e-mobility, as well as a National Action Plan for Electric Mobility. The challenge, however, is to implement these policies as well as identify and address gaps in the policy and legislative framework to promote e-mobility. Many of Nepal's policies and legislation are currently being revised to ensure that they are in line with Nepal's new constitution, which was promulgated in 2015. Part 3 Section 30 of Nepal's Constitution clearly mentions "Right to Clean and Healthy Environment" as a fundamental right of every Nepali citizen. Therefore, the GoN is obliged to develop relevant legislation, plans and programmes to ensure that all Nepali people can enjoy this constitutional right.

The Constitution of Nepal also mentions the responsibilities of the federal, provincial and local governments. Schedule 5 of the Constitution lists the responsibilities of the Federal Government while Schedule 6 of the Constitution lists the responsibilities of the seven Provincial Governments and Schedule 8 of the Constitution lists the responsibilities of the Local Governments. Transport management is primarily the responsibility of provincial governments with the Federal Government and local governments also sharing some responsibilities.

Some key policy measures related to e-mobility in Nepal are discussed in the sections below.

4.1 Periodic Plans

15th Five-Year Plan (2019/20 – 2023/24)

The National Planning Commission (NPC) has prepared a series of periodic National Plans over the past decades, which provide strategic guidance to the GoN for overall development and investment priorities. The latest in this series is the 15th Five-Year Plan (2019/20 – 2023/24) which has a vision of "Prosperous Nepal, Happy Nepali" that aims to have Nepal graduate to a developing country status from its least developed country status by 2022 and achieve the Sustainable Development Goals (SDG) before 2030.

The 15th Five-Year Plan has listed three National Objectives, one of which is, "Quality education and health, healthy and balanced environment". This plan has also listed seven strategies which include: (i) Sustainable development of human settlements; (ii) Conservation and utilization of natural resources; and (iii) Internalization of the SDG.

Among various national level indicators and targets, the plan has also listed one target related to pollution and clean environment which has an indicator related to air pollution control. The plan mentions the target of reducing the average PM2.5 level from 53 micrograms per cubic meter in 2017/18 to 40 micrograms per cubic meter by 2033/24. However, it is not clear if this target is for the whole country or Kathmandu Valley only, and any further details on how this target is to be achieved are currently missing.

Chapter 8 of the 15th Five-Year Plan deals with infrastructure and section 8.1 is related to energy. One of the three objectives related to energy is to reduce the import of petroleum products. The working policies related to energy include: (i) fixing an appropriate tariff for EV; and (ii) establishing charging stations for EV. The plan also mentions that the GoN aims to increase access to and utilization of electricity and states that "studies will be done and new tariff rate will be introduced to promote electric vehicles," but it neither provides detailed plans nor targets for EV promotion.

Section 8.2 of the plan deals with transportation under which Section 8.2.1 focuses on roads, Section 8.2.3 on railway, and Section 8.2.5 on transport management. The section on transport management recognizes that the transport services in the country are neither sustainable nor reliable and therefore in need of significant interventions. The vision for transport management is "competitive, safe and environment-friendly transportation systems that are accessible for all." The strategy listed under transport management includes "emphasize sustainable and environment-friendly transport system." Furthermore, the working policies related to transport management include (i) emphasize mass transit and bus rapid transit; (ii) prioritize EV; and (iii) encourage local governments and cooperatives to invest in public transport and effectively regulate the private sector.

Regarding rail transport, the plan focuses on preparing feasibility studies and detailed project reports for long-distance as well as urban rail systems. It mentions that during the five-year period of the plan, detailed project reports will be prepared and private

sector investment will be mobilized for the construction of metro- and mono-rail services in Kathmandu Valley and other possible cities. Similarly, it states that a detailed project report for the East-West train will be prepared and construction of rail service for the 200 kilometers section connecting Bardibas to Nijgadh and Birgunj will be completed. It also mentions that shorter railway lines connecting Jayanagar-Janakpur-Bardibas, Bathanaha-Biratnagar-Katahari, Jalpaiguddi-Kakadbhitta, Nautanuwa-Bhairahawa, and Nepalgunj Road-Nepalgunj, will be completed and operated. These five sections together add up to approximately 180 kilometers of railway lines.

Section 8.6 of the 15th Five-Year Plan, which deals with urban development recognizes that to achieve the national vision of "Prosperous Nepal and Happy Nepali" there is a need to establish modern, well-planned, environment-friendly, well-managed, economically vibrant and socially inclusive cities because 60% of the Nepali population already live in cities and urban areas continue to grow. One of the four strategies related to urban development as mentioned in the 15th Five-Year Plan is to develop Kathmandu Valley as an attractive, prosperous and environment-friendly cultural capital city. As vehicles are the major source of air pollution in cities, EV will be important for developing environment-friendly cities.

Periodic Plans of Local Governments

All seven provinces have prepared their first periodic plan as well as annual plans and budgets. Among the plans prepared by the different provincial governments, Bagmati Province (Province 3), which includes Kathmandu Valley, is the only one that mentions plans and targets for EV. The First Periodic Plan for Bagmati Province mentions that electric public transport will be introduced in public-private partnership and the provincial government will facilitate the promotion of EV and establishment of charging stations by municipalities (Province 3, 2018). It also states the target of replacing all petroleum-powered vehicles from its urban centres, mainly Kathmandu Valley, Chitwan, Hetauda and Dhulikhel/Banepa/Panauti by 1st Baishakh 2085 BS (mid-April, 2028 AD) by vehicles operating on renewable energy. The Province, however, does not have detailed plans on how this ambitious target is to be achieved. The annual budget for Bagmati Province has allocated funds for initiating electric mass transit through public-private partnership.

Province 1 states that it will encourage electrification of the public transport sector, but it does not have any specific programmes for this. The results framework presented in its periodic plan states that railways and bus rapid transit systems will be developed by 2079/80 (2022/23), although it is not clear if these will be electric (Province 1, 2018).

The periodic plan for Province 2 mentions the need for a well-managed and reliable transport system but does not specifically mention e-mobility (Province 2, 2018).

Among municipalities, Kathmandu and Lalitpur Metropolitan Cities have allocated some funds to introduce electric public transport in their annual budget. Details on how the funds from the municipality are to be utilized, however, still need to be worked out.

4.2 Environment and Climate Change Related Policies

National Climate Change Policy, 2019

The National Climate Change Policy, 2019, which replaces the earlier National Climate Change Policy from 2011, states that its main goal is to contribute towards the socio-economic prosperity of the nation by developing a climate-resilient society (MoFE, 2019a). To achieve this goal, the policy has listed seven objectives, one of which is to "promote green economy by reducing carbon emissions." The document also lists a set of policies and strategies grouped around eight themes. These include (i) agriculture and food security; (ii) forests, biodiversity and watershed conservation; (iii) water resources and energy; (iv) rural and urban settlements; (v) industry, transport and physical infrastructure; (vi) tourism and nature/cultural heritage; (vii) health, drinking water and sanitation; and (viii) disaster risk reduction and management.

Strategies and policies under the "industry, transport and physical infrastructure" theme include: (i) energy-efficient technologies and promotion of electrical energy in industry, transport and physical infrastructure sectors; (ii) promotion of electrical vehicles; and (iii) private sector mobilization for reduction of emissions in industry and transport. Similarly, one of the policies under the theme "Tourism and nature/cultural heritage", states that the "concept of zero-emission will be implemented by promoting the use of renewable energy and energy-efficient technologies in tourist spots."

Although the policy has explicitly mentioned that EV will be promoted and that a low-carbon economic development strategy will be formulated and implemented, it does not include targets and timelines for the timely implementation of these strategies.

National Environment Policy, 2019

The goal of the recently formulated National Environment Policy is to "control pollution, manage waste and promote greenery to ensure all citizens can enjoy their right to a clean and healthy environment" (MoFE, 2019b). The policy includes a list of 10 objectives, one of which is to minimize and control all sources of pollution, and 23 strategies including one that states that "clean vehicles such as electric vehicles, hybrid vehicles and hydrogen-powered vehicles will be promoted."

Kathmandu Valley Air Quality Management Action Plan, 2076 [2020]

On 24 February 2020, the cabinet approved the Kathmandu Valley Air Quality Management Action Plan, 2076 which has listed promotion of EV as one of four measures to reduce vehicular pollution. The following activities have been included to promote EV (MoFE, 2020):

- Within one year, establish charging stations and bus terminals with charging facilities in partnership with the private sector
- Within two years, develop legal measures for the conversion of old vehicles to EV
- Within five years, operate only zero-emission vehicles in tourist and culturally sensitive areas

Although these three actions are not enough by themselves to promote EV, it is still good that a timeline has also been proposed for the activities.

4.3 Transport Related Policies

National Transport Policy, 2001

The National Transport Policy is the main policy document related to the transport sector in Nepal. One of the objectives of the policy is to make the transport sector environment friendly. The policy lists the following activities related to e-mobility: (i) expansion of solar powered and electricity-driven transport means throughout the country; (ii) special attention to improving 'the comfort, reliability, safety, frequency, availability and affordability of public transport' to reduce the harmful emissions from mobility sources; and (iii) provision of economic instruments in the form of custom and tax incentives to promote private sector involvement in the construction, maintenance and rehabilitation of transport infrastructure and to encourage non-polluting vehicles (MOPIT, 2001).

Environment-Friendly Vehicle and Transport Policy, 2014

The Environment-Friendly Vehicle and Transport Policy, which was introduced to promote clean transport in the country aims to reduce air pollution from the transport sector by increasing the share of the electric vehicle up to 20% by 2020, promote the conversion of other regular vehicles to EV, and provide subsidies for the promotion of electric and non-motorized vehicles (MoPIT, 2014). It has a strategic approach to avoid unnecessary travel, reduce trip distance, promote the shift towards more sustainable transport modes such as non-motorized transport and further promote public transport systems.

The policy calls for an improvement in transport practices and technologies by diversifying to vehicles that run on electricity, hybrid and natural gases; by promoting progressive and affordable standard for fuel quality; and by regulating vehicle emissions to ensure compliance with air quality standards. The policy has also made provisions for the formation of a Central Committee for the operation and promotion of environment-friendly vehicles, headed by the Minister or State Minister of Physical Infrastructure and Transport and a Working Committee for the promotion of environment-friendly vehicles headed by the Secretary of Ministry of Physical Infrastructure and Transport (MoPIT). The policy also calls for the establishment of a fund to promote environment-friendly vehicles.

Whereas the National Transport Policy underlines the need for clean transport and sets out broad provisions, the Environment-Friendly Transport Policy sets out more detailed targets and directions. The following are specific provisions and targets for e-mobility included in the policy:

- Increasing the share of what the policy terms "environment-friendly vehicles" to a minimum of 20% of the total vehicle fleet by 2020.
- Encouraging manufacturing of environment-friendly vehicles, including EV.
- Encouraging the private sector to invest in the construction and management of electric vehicle parking stations and service centres.

- Facilitating land for the construction of ten charging stations in Kathmandu, under a pilot initiative.
- Installing charging stations in retail outlets such as shopping malls, hotels and large parking areas.
- Improving the possibility of local vehicle assembly by improving access to required vehicle parts, including batteries.

Overall, the policy is very progressive, but it has not yet been implemented. The policy needs to be followed up with plans and programmes, which has not been done and will require further investment from the GoN. The committees and funds envisioned by the policy to promote environment-friendly vehicles also have not yet materialized. Although the policy did have a target of 20% EV by 2020, this will not be met mainly because the GoN has not been able to prepare and invest in programmes to implement the policy.

National Action Plan for Electric Mobility, 2018

This plan, prepared with support from GGGI aims to chart a path for the achievement of the e-mobility target adopted by the [2016] NDC (GGGI, 2018). The action plan recognizes that robust policies and fiscal incentives are in place for the promotion of e-mobility but identified 15 different barriers for the promotion of EV. These were grouped into four key barriers: (i) policy and governance; (ii) infrastructure and markets; (iii) financing and resources; and (iv) data and monitoring.

To overcome these barriers, the action plan calls for three priority actions: (i) establish a unit for promoting e-mobility; (ii) develop and implement a national program for e-mobility; and (iii) establish financing mechanism for e-mobility. These priorities actions are broad and operate across both the supply and demand sides of the e-mobility sector. Each of these priority actions is designed to overcome four to five of the identified barriers and they also include several initiatives within them. The plan proposes a total of 24 initiatives which are activities with limited scope and respond to address the identified barriers.

Overall, the action plan is comprehensive and follows a logical pattern. However, it does not come with a timeline and an investment programme. The action plan was launched by the Prime Minister in 2018 but it was never implemented as it was not followed up with programmes and budgets from MoPIT or MoFE, two of the ministries which were originally involved in preparing the plan. As the goal of the plan is to achieve the transport targets set out in the NDC, this plan needs to be revised along with the 2020 NDC.

Road, Rail and Transport Development for Prosperous Nepal – Five Year Strategic Plan (2073-2078)

Prepared by MoPIT, the strategy focuses on the development and strengthening of the road network, expanding the rail network and making the transport management system effective. The strategy mentions that the government will formulate policies to promote public transport and walking, while discouraging the use of private vehicles, in order to secure safe, effective, pollution-free and accessible transport for all. While the strategy primarily focuses on expanding the road network, it has proposed the conversion of 20% of vehicles in Nepal to clean vehicles by the next five years.

4.4 Fiscal Policies and Incentives

Financial Incentives for Import of EV

In the budget for the FY 2016/17, the GoN reduced customs duty on the import of EV used for public transport to 1% from 30% and for private vehicles to 10% from 30%. Furthermore, EV were not required to pay excise duty and they only paid 4% road tax, compared to 8-10% paid by other vehicles. Internal combustion engine (ICE) vehicles had to pay 80% customs duty and 55-100% excise duty, depending on their size (MoF, 2016).

The budget for the FY 2020/21 has, however, increased the customs duty on private EV to 40%, added an excise duty ranging from 30-80% depending on the power of the motor and increased the road tax to 5% (MoF, 2020). Although the new customs duty for EV is still lower than that for ICE vehicles, the drastic increase in customs duty and excise duty will almost double the price of EV and make them less competitive in the market.

Reduced Tariff for Charging of EV

Nepal Electricity has announced reduced electricity tariff for charging EV, particularly during off-peak hours (11 pm to 5 am). The tariff rates vary depending on the time of year, the capacity of the charging station and time of day. However, overall rates for charging EV are lower than that for other segments such as households and industries. For example, during the eight months Baishakh to Mangsir (Mid-April to Mid-November), a charging station connected to a 33 kV line will pay Rs. 3.70 per kWh during off-peak hours (11 pm to 5 am), but during the same time, an industry would pay Rs. 5.25 and a commercial entity would pay Rs. 6.75 per kWh. Only community water supply schemes and streetlamps have a lower tariff than charging stations. The tariff is also lower for charging electric public transport vehicles compared to private vehicles (NEA, 2020).

Pollution Tax on Fuel

Ten years ago, the GoN introduced a pollution tax of NPR 0.50 per litre on petrol and diesel sold in Nepal. Last year this was increased to NPR 1.50 per litre. As a result, every year over three billion Nepali rupees is collected through this tax. However, this amount is not being used. This tax could be a regular source for funding programmes related to EV promotion. Furthermore, as the oil prices have decreased significantly in the international market, the pollution tax rate of NPR 1.50 per litre of petrol/diesel can be increased further to generate additional revenue without increasing the price of petroleum for consumers. Besides the pollution tax, the GoN also imposes an infrastructure tax of NPR 5 per litre of petrol, diesel and aviation fuel and road maintenance fee of NPR 4 per litre of petrol and NPR 2 per litre of diesel sold.

4.5 Energy Related Policies

National Energy Strategy, 2013

The National Energy Strategy aims to increase energy supply and ensure that the energy produced is clean and efficient. It has set goals to promote renewable energy technologies and energy efficiency and supply adequate energy at an affordable and reasonable price;

develop hydropower as the lead energy source; reduce dependency on fossil fuel imports; and ensure sustainability in the consumption of biomass energy resources (WECS, 2013).

Ministry of Energy Water Resources and Irrigation's White Paper, 2018
MoEWRI's White Paper mentions that the Ministry will prepare and implement a work plan to introduce appropriate policies and charging stations to increase the use of EV so that by 2023 half of the vehicles imported into the country are electric (MoEWRI, 2018).

4.6 Policy Gaps

Overall, Nepal has several policies related to EV, and the promotion of EV is also reflected in sectoral policies for transport, energy and environment. Furthermore, it also has a National Action Plan for Electric Mobility, and EV promotion is also mentioned in periodic plans for federal and provincial/local governments. However, although EV promotion is mentioned in several policies and plans, their implementation is fractured and weak, as shown by the slow deployment of EV. Some key policy gaps are as follows:

Lack of clear targets – Targets in the different policies vary from one another and are unclear. For example, while the Environment-Friendly Vehicle and Transport Policy mentions a target of 20% EV by 2020, the 2016 NDC mentions 20% increase in EV by 2020 compared to 2010. Similarly, MoEWRI's White Paper mentions that by 2023 half the vehicles imported in the country will be electric while Bagmati Province's Period Plan aims to have 100% EV by 2028 in four of its main urban centres, including Kathmandu Valley. Given such variability, it seems unlikely that these targets were identified through thorough market trend analysis or consultation with key stakeholders.

Lack of detailed plans, programmes and budget – Policies need to be followed up with detailed implementation plans and programmes and the budget needed to implement them has to be set aside. However, this has not happened as policies often lose traction once they are passed. Operational plans have not been prepared to implement the Environment-Friendly Vehicle and Transport Policy or the National Action Plan for Electric Mobility – two of the most important policy documents for promoting EV.

Poor coordination among key stakeholders – As promotion of EV is not the mandate of a single institution, there needs to be good coordination between several agencies within the federal government, provincial/local governments and the private sector. Both the Environment-Friendly Vehicle and Transport Policy and the National Action Plan for Electric Mobility have suggested that coordination committees be formed at the federal level. But this has not happened yet.

5. Policies to Promote E-Mobility Globally

5.1 EV Related Policies

Globally, the number of EV is growing rapidly and this growth is mainly driven by government policies, together with improvements in technology and falling prices of batteries. Countries are using a variety of policy measures such as providing incentives to promote EV; supporting the establishment of charging infrastructure; and introducing high emission standards and taxes to discourage fossil fuel vehicles. Governments are also supporting manufacturers of EV and components through research and development; formulation of standards; and provision of financial incentives and public procurement to stimulate demand and consumer confidence. Governments have either introduced specific policies to promote EV or included e-mobility as an integral part of their transport or environmental policies.

According to the International Energy Agency (IEA), at least 20% of all road transport vehicles globally need to be electrically powered by 2030, if global average warming is to be limited to 2°C or less. To achieve this, IEA models predict that EV (battery-electric, plug-in hybrid, and fuel cell vehicles) need to represent 35% of global sales in 2030.

Policies to promote EV typically start with a vision statement or targets. This is often followed by the adoption of standards for EV and charging infrastructure. In order to stimulate demand and support suppliers, public procurement often provides the impetus for the initial rollout of EV & charging infrastructure in the market. The most used fiscal support is a direct subsidy on the cost of EV, which is meant to partially offset the high initial cost of EV and assist market penetration by reducing perceived risk for buyers and rewarding early adopters. These subsidies are generally reduced over time as the cost of EV begins to decrease and the share of EV in the market increases. Other incentives include free parking and waiver to access restrictions. Besides incentives, regulatory measures such as EV charging requirements in buildings have also been introduced in some countries. Some relevant EV policies in selected countries have been identified in **Table 2**.

Table 2: EV Related Policies in Selected Countries

Policy		Canada	China	EU	India	Japan	USA
Regulations (vehicles)	Zero Emission Vehicle Mandate	√*	√				√*
	Fuel economy standards	√	√	√	√	√	√
Incentives (vehicles)	Fiscal incentives	√	√	√	√		√
Targets (vehicles)		√	√	√	√	√	√*
Industrial policies	Subsidy	√	√			√	
Regulations (Chargers)	Hardware standards	√	√	√	√	√	√
	Building regulations	√*	√*				√*
Incentives (chargers)	Fiscal incentives	√	√	√		√	√*
Targets (chargers)		√	√	√	√	√	√*

*indicates that the policy is only implemented at a state/province/local level.
Source: IEA, 2019

5.2 EV Related Targets

Many countries have introduced targets that increase the number or overall share of EV or ban sales of ICE within a target date. The Partnership on Low Carbon Transport lists over 77 countries that have announced targets or plans for EV (SLOCAT, 2020). Although some of these are intentions or plans announced by government officials, rather than official targets, many are ambitious targets set by governments. Some targets announced by governments are presented in **Table 3**.

Table 3: Announced Targets for 100% Zero-Emission Vehicles

Country	2025	2030	2035	2040	2045	2050
Costa Rica						
Denmark						
France						
Iceland						
Ireland						
Israel						
Netherlands						
Norway						
Portugal						
Slovenia						
Spain						
Sri Lanka						
United Kingdom						

Legend: ICE sales ban; 100% zero-emission vehicles sales target without ICE
Source: IEA, 2019

The country that has the most ambitious target is Norway, where it will be illegal to sell petrol or diesel cars from 2025. The government of Norway has introduced attractive incentives that encourage people to shift to EV in order to meet this target. As a result, the market share for EV continues to increase. In March 2020, over 75% of all passenger vehicles sold in Norway were electric, while 7.1% were hybrid and only 17.7% were petrol or diesel vehicles (Holland, 2020).

The 8th Clean Energy Ministerial meeting in 2017 launched the EV30@30 Campaign with a goal that all members of the Electric Vehicle Initiative (EVI), a multi-government policy forum, would achieve 30% market share for EV (except two-wheelers) by 2030. As of 2018, ten countries, which together represent around two-thirds of the global electric car stock, have endorsed the EV30@30 Campaign (IEA, 2019).

Besides countries, numerous cities have also announced bold targets and actions for promoting EV. For instance, Seattle is aiming for a 30% share for EV by 2030. Hong Kong wants to replace all conventional buses with zero-emission buses and London plans for a zero-emission transport system by 2050. A group of 35 cities have signed the C40 Fossil Fuel Streets Declaration, which aims to procure only zero-emission buses from 2025 and ensure that major areas of these cities are zero-emission by 2030.

5.3 Case Studies of EV Policies in Different Countries

The EV policies of Norway, which is the global leader in terms of electric car market share; China, which has the largest number of EV in the world; and India, which is the largest exporter of vehicles to Nepal, are briefly described below as case studies.

Norway

Norway has been promoting EV since 1990 when they also abolished any import tax on them. Its generous EV policy is now an integrated part of the so-called Climate Agreement ('Klimaforliket') among the parties in the Norwegian Parliament (Holtsmark B. and Skonhoft A., 2014). Some of the incentives offered to promote EV in Norway are as follows:

- EV are exempt from VAT and other taxes during purchase;
- Free parking is available for EV;
- EV can use most toll roads and several ferry connections free of charge;
- EV can use the bus and collective traffic lanes;
- Company car tax is 50% lower on EV and the annual motor vehicle tax/road tax is also lower; and
- Battery charging is free at a rapidly growing number of publicly funded charging stations.

China

China is by far the largest producer and consumer of EV. Its dominance in the EV market is mainly because of the strong support provided by the Chinese government to this industry over the past decade. China has set a target to have 5 million EV on China's roads by 2020. In order to achieve this, it has put EV quotas for vehicle manufacturers and importers, provided manufacturing subsidies and tax exemptions, implemented government procurement, and supported the construction of EV charging stations. Many provincial governments also support EV and provide preferential access to license plates and other incentives. These policies have three major goals: to clean the air in Chinese cities, to reduce China's oil import and to position China for global leadership in a strategic industry.

Since 2009, when the Chinese government decided to aggressively promote EV, several policies have been introduced to support the industry. Some of these, which may be relevant to Nepal, are as follows (Sandalow, 2019):

- Zero-emission vehicle mandates: In 2019, all Chinese vehicle manufacturers and importers were required to make or import at least 10% EV, which increased to 12% in 2020.
- Subsides to vehicle manufactures: Although in recent years, these subsidies have been gradually reduced as EV numbers rise, manufacturers still receive up to USD 3600 per vehicle.
- Tax exemptions: Government exempts EV from consumption and sales taxes, which can be thousands of dollars, and also waives 50% of vehicle registration fees.
- Public procurement: A May 2016 order required that half of the new vehicles purchased by China's central government be EV within five years.
- Support for charging infrastructure: Both central and local governments have set ambitious targets for setting charging infrastructure, provided funding and mandated standards.

India

Introduced in 2013, India's National Electric Mobility Mission Plan 2020 had a target of deploying five to seven million EV in India by 2020. Under this mission, in March 2015, the Scheme for Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME India) was launched for two years under Phase-I, which was subsequently extended up to March 31, 2019. FAME had a budget of INR 8.95 billion (USD 130 million) and focused on technology development, demand creation, pilot projects and charging infrastructure installations.

The Government of India (GoI) then launched FAME II in April 2019 with a budget of INR 100 billion (USD 1.4 billion) over three years. Of the total budget, 86% was allocated as demand incentives for procurement of EV, mainly public vehicles, while the remaining was for charging infrastructure. The amount of demand incentive provided is mainly based on battery capacity – INR 20,000 per kWh for buses and INR 10,000 per kWh for other EV. This would mean that an average bus would get an incentive of INR 5 million while an average two-wheeler with 2kWh battery would get an incentive of INR 20,000. The government will review each year. Altogether, FAME II will support one million two-wheelers, half a million three-wheelers, 55,000 four-wheelers, and 7090 electric buses (GoI, 2019).

NITI Aayog, a policy think tank of the GoI has proposed several policies related to EV in India. It states India's EV policy should initially focus on public vehicles and small vehicles, (NITI Aayog and World Energy Council, 2018) and it has also proposed that from 2023 onwards all three-wheelers and from 2025 onwards all two-wheelers sold in the country should be electric and that by 2030 all vehicles sold in India should be electric. In 2017, a senior minister announced that India was planning to go 100% electric by 2030 (Dash, 2019). These proposed targets are still being discussed and as of now, the GoI is still adhering to the target of EV30@30 Campaign that it has endorsed – 30% EV by 2030.

Besides the Federal Government, seven state governments, Karnataka, Maharashtra, Uttar Pradesh, Telangana, Andhra Pradesh, Kerala, and Uttarakhand as well as Delhi, have also introduced policies and plans to promote EV, which are quite ambitious. Many states such as Uttar Pradesh and Maharashtra have zero road tax for EV.

5.4 E-Mobility in NDCs

Different studies have shown that e-mobility can be an important part of NDCs. Although some of the initial NDCs address transport in a limited manner, there are possibilities to further expand and enhance the targets. Of the 166 NDCs submitted in the first round, 76% highlighted transport as a mitigation source, but only 35 NDCs included quantified targets for the transport sector (Climate Watch, 2019). Most NDCs did not offer measures to avoid unnecessary travel in carbon-intensive modes or shift to low-carbon modes of transport such as public transport, cycling, and walking. Only a few (under 15%) mention e-mobility. These have been identified by Fransen et.al. (2019) as one of the key gaps in the current NDCs.

Fransen et.al. (2019) mentions three opportunities to use transport sector for enhancing NDCs: (i) accelerate electrification; (ii) strengthen "avoid and shift" measures that support travel by low-carbon modes; and (iii) seize new opportunities to address freight emissions via electrification and use of information technology. These three opportunities are very relevant for Nepal and e-mobility can address all three of them.

5.5 Key Lessons from International Experiences Related to EV Policies

Some key lessons from international experiences related to EV policies are summarized below:

Targets and incentives are useful – Many countries have managed to stimulate growth in the EV market by introducing targets, mandates and incentives. In the initial stages, these are critical to ensure competitiveness and boost consumer confidence. Although Nepal may not be able to provide as much incentives as wealthy countries like Norway or China, in a price-sensitive market such as Nepal's even small incentives can stimulate the demand for EV.

Long term consistency in policies will give a clear message to the industry – Countries like Norway and China are world leaders in EV because they introduced policies favourable to EV a long time ago and continued over the years to support the industry and markets. The recent increase in customs duty and excise duty on EV and the impact that this has had in the private sector in Nepal is an example of how frequent changes in policy can discourage investment in EV and significantly slow down the progress made.

Set ambitious but realistic targets that are revised as needed – Countries have set ambitious targets to stimulate the EV industry and periodically revised these targets based on market trends and technology development. Nepal has also declared some targets but these are either unrealistic or are not ambitious enough. More analysis and stakeholder consultations need to be done and these targets revised accordingly.

Political commitment is necessary – Ownership, commitment and leadership are critical to converting policies into action. In Norway, the EV policy is integrated into the Climate Agreement among political parties, and in countries like China and India, EV are strongly promoted by the highest levels of government.

6. E-Mobility Market, Technology, and Finance Trends

The technology for EV, batteries and related accessories and systems are evolving rapidly and the global market for EV continues to expand in response to growing demand as well as favourable policies in many countries.

6.1 Global Market Trends of Different Vehicle Segments

Electric cars

In 2018 alone, over 2 million electric cars were added on roads globally taking the total number to more than 5 million electric cars (IEA, 2019). According to BloombergNEF (2020), this growth trend will drop in 2020, mostly due to the COVID-19 pandemic but after that annual EV car sales will likely increase to 8.5 million in 2025, 26 million in 2030 and 54 million by 2040. By 2040, it expects 58% of all passenger vehicle sales, and over 30% of the global passenger vehicle fleet to be electric. While China will continue to dominate the EV market, Europe and USA markets will also remain close behind in this race.

While the upfront cost of EV is still slightly higher than similar ICE vehicles, this cost is decreasing and BloombergNEF (2020) expects that by mid-2020s there will be price parity between EV and ICEs in most segments. One of the main reasons for the decreasing price of EV is the decrease in the price of Lithium-ion batteries, which are used in EV. Between 2010 and 2019, the price of these batteries came down by 86% from USD 1160/ kWh to USD 156/ kWh. The prices of batteries are expected to drop further to USD 87/kWh in 2025 and USD 62/kWh in 2030 (BloombergNEF, 2020).

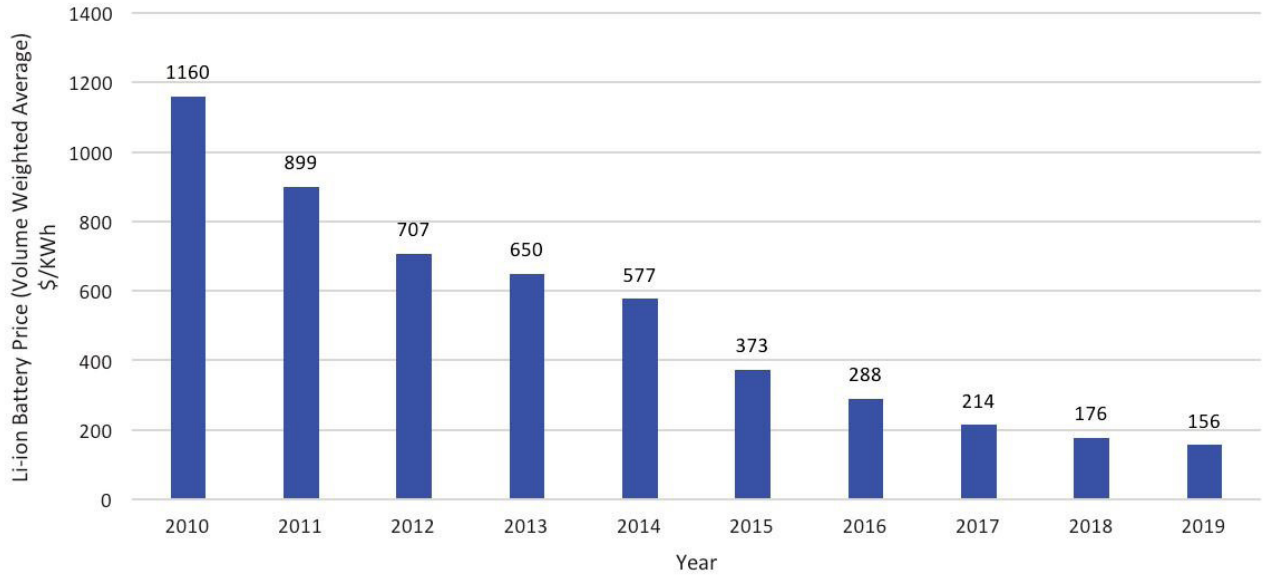


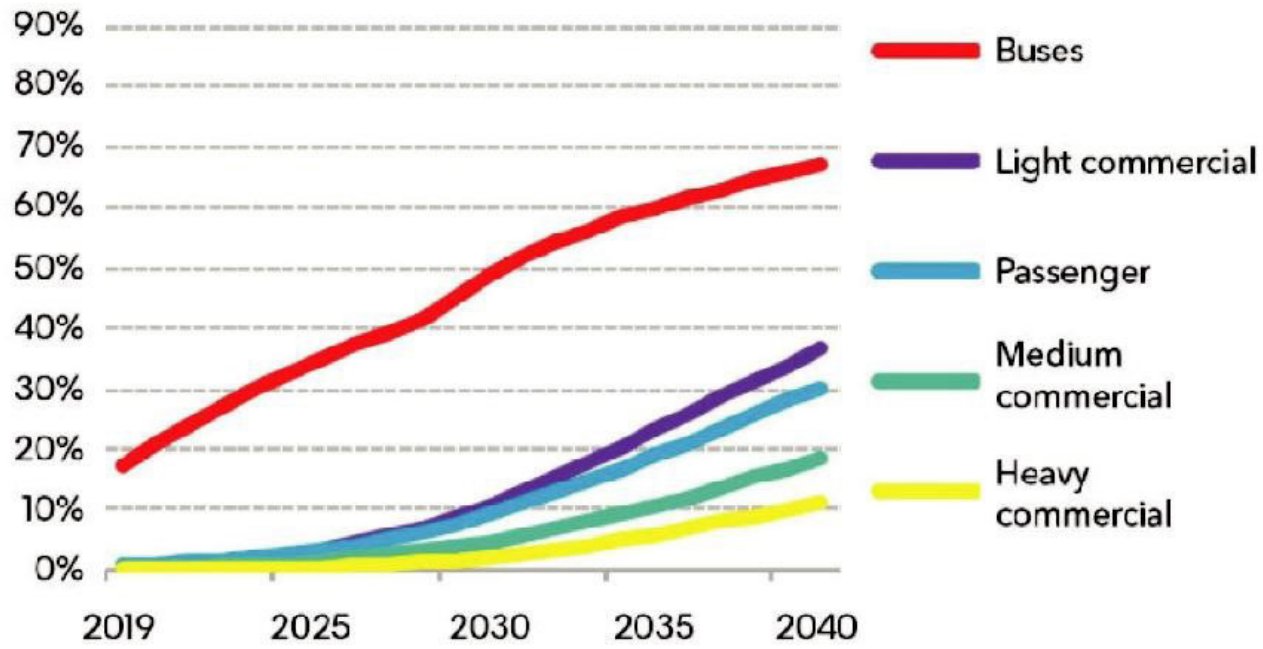
Figure 11: Fall in Lithium-ion Battery Prices

Source: BloombergNEF, 2020

Electric Bus

Among the different segments of EV, it is estimated that electric buses will most rapidly grab a large share of the total fleet as shown in **Figure 12**. This is mainly driven by government mandates and subsidies. China gave up to USD $150,000 per electric bus while India provided up to INR 10 million per e-bus during the first phase of FAME scheme. As public buses normally use diesel fuel and travel long distances throughout the day, they cause high levels of air pollution as well as emit GHG. Therefore, electrification of the bus fleet is a priority for many governments. In the city of Shenzhen, the entire fleet of over sixteen

thousand buses have been electrified and in India, the FAME II scheme plans to support the introduction of 7,090 public electric buses in three years (GoI, 2019).



Source: BloombergNEF. Note: Commercial vehicle adoption figures include the main markets of China, Europe, and the U.S.

Figure 12: Share of Different Types of EV in Global Vehicle Fleet

Note: Commercial vehicle adoption figures include the main markets of China, Europe and the U.S.

Source: BloombergNEF, 2020

Electric Two-wheelers

As almost 80% of the vehicles sold in Nepal are two-wheelers, this segment is important for the Nepalese market. Globally, the electric two-wheelers market is dominated by China, which produced 26 million electric two-wheelers in 2018 and has about 250 million units on its streets, which is over a quarter of the global motorised two-wheeler stock of around 800 million units (IEA, 2019). Vietnam has about 0.9 million and India has 0.6 million electric two-wheelers. Two-thirds of two-wheelers in China, however, have limited range (0.5-0.8 kWh batteries that give about 50 km per charge) and low-speed (typically 20-25 km per hour). Although this is generally sufficient for urban traffic, many Nepalese consumers find this insufficient as the existing ICE motorcycles and scooters in Nepal give higher range and speeds. Now, however, several models of large and small electric scooters from China and India have entered the Nepalese market and there is a possibility that at least some of them will meet these market desired characteristics in the future.

In India, 0.1 million electric two-wheelers were sold in FY 2018-19, which was double the volume from the previous year (IEA, 2019). This indicates that although electric two-wheeler sales in India make up less than 1% of the vehicle market share, their uptake is increasing, mainly due to supportive policies. The first phase FAME scheme gave a rebate of INR 7 500

– 22 000 (USD 110 – 320) for the purchase of 62 eligible models from 11 manufacturers. About 40% of the eligible models were low-speed (25 km/h max) and low range models that typically use a lead-acid battery and do not require a driving license or vehicle registration and they represented 80% of electric two-wheelers sales (Society of Manufacturers of Electric Vehicles, 2019 as quoted in IEA, 2019). However, this category of electric two-wheelers has been excluded from FAME since the scheme's revision (FAME II) which has a provision to support up to 1 million electric two-wheelers. Therefore, it is expected that the Indian two-wheeler market for bigger two-wheelers will increase in the future. This will also mean more models of these electric two-wheelers will be available in the Nepalese market.

Because of the increasing interest in electric two-wheelers in India, in the past two years, Indian electric two-wheeler companies have been able to raise over USD 600 million of new investment. The market for electric two-wheelers in India is likely to grow from 0.15 million units in FY 2020 to about 3.45 units by FY 2025, which represents a compound annual growth rate of 87% (Gulia and Thayillum, 2020).

Freight

Compared to passenger vehicles, the market for electric freight vehicles, particularly the large heavy-duty trucks have not grown significantly. Overall, the use of smaller light commercial vehicles for freight transportation is growing because of increasing urbanization, city restrictions and rise of e-commerce. This segment could see significant growth in EV in the future. The use of rail and ropeways for freight transport is, however, well established and widely used globally.

6.2 Market Trends of Different Vehicle Segments in Nepal

Most of the vehicles sold in Nepal are motorcycles and small cars, which fall under 1,500 cc category with the average engine capacity of 1,400 cc (CEN, 2019). Although in recent years, the average size of the vehicles has increased slightly with some customers preferring larger SUV-type vehicles, small cars still dominate the car market in Nepal. This is mostly because it is a price-sensitive market where most people prefer vehicles with lower capital and operating costs. Therefore, EV need to be competitive in these consumer segments for it to able to claim a significant market share. In the past few years, the number of models of electric two-wheelers and cars entering the Nepalese market is increasing, and due to lower custom duty and financing provided by banks, their prices are becoming competitive in the market. However, the market is still dominated by ICE vehicles and most consumers are not confident about investing in EV just yet. Additional incentives and effective marketing and public procurement of EV could assist in stimulating the market further.

A few companies have started to assemble electric two-wheelers in Nepal and one Nepali start-up, Yatri Motorcycles, has also designed and built a premium electric motorcycle. These initiatives are praiseworthy and need support from the government. Because EV technology is relatively simple compared to ICE and because the technology is continuous, there is a possibility to expand local assembly and manufacturing. The GoN should, therefore, invest in research and development as well as support local initiatives.

As for electric buses, their prices are still much higher than diesel buses and government subsidies would be required to make them competitive in the market.

Shared mobility systems such as those offered by Tootle and Pathao, have recently been introduced and they have grown significantly in recent years. Experience from other countries indicates that this form of mobility will probably continue to grow in the future (BloombergNEF, 2019). The growth of shared mobility will lead to an increase in vehicle utilization rates. Vehicles used in such shared mobility need to run more per day compared to ordinary private vehicles. So EV, which have lower operating costs, would be beneficial under these circumstances.

6.3 Future EV Projections for Nepal

The number of EV in Nepal is increasing and this trend will continue in the future. However, it is difficult to assess future projections or scenarios because of lack of reliable data and because of economic uncertainties created by the COVID-19 pandemic.

As the GoI is also focusing on scaling up the use of small and public e-vehicles and most of the vehicles sold in Nepal come from India, there is a strong possibility that different models of electric two-wheelers, three-wheelers, light-duty vehicles and buses will be more widely available and affordable in the Nepalese market in the near future. If GoN takes advantage of this trend to boost the demand for two-wheelers, small e-vehicles and buses through attractive incentives, then within the next five years, the market share for EV in these segments could increase dramatically.

The GoN has already taken the initiative to start the procurement of 300 e-buses, which is a good move. If the GoN can come up with a good financing scheme along with operational guidelines similar to the FAME and FAME-II schemes in India, this could significantly boost the demand for electric buses. As the operational cost of e-buses will be substantially lower than of diesel buses, private operators will likely show interest in e-buses if the initial cost is affordable.

A 2017 cost comparison of diesel and electric buses in Nepal, recorded in **Table 4** below, showed that while the initial cost of an electric bus was 7-13 times higher than a similarly-sized diesel bus, if the lifetime fuel and maintenance costs, along with environmental, social and ensuing economic costs were considered, then electric buses were cheaper (GGGI, 2018). As the economic, social and environmental benefits provided by the electric bus are benefits that the society receives and not the bus operators, the GoN can justify subsidy provision during e-bus procurement. It should also be noted that the estimated cost of diesel buses was the actual cost based on a competitive bidding process done by Sajha Yatayat while the costs of electric buses were based on estimates provided by local dealers. Therefore, the cost of electric buses may be lower if there were also based on competitive bidding. Furthermore, in the past three years since this study was done, the price of electric buses has dropped internationally.

Table 4: Comparison of Cost of Diesel and Electric Buses in 2017

Cost Component		Cost for different e-bus models (NPR)		
	Diesel (Viking)	Electric (K7)	Electric (K9)	Electric (Circuit)
Acquisition cost	3,198,345	23,104,100	30,618,500	42,738,500
Lifetime fuel cost	13,087,901	2,861,036	2,861,036	2,861,036
Lifetime maintenance cost	6,576,587	3,288,293	3,288,293	3,288,293
Economic cost	10,393,303	-	-	-
Social cost	11,723,683	-	-	-
Environmental cost	3,338,927	-	-	-
Total (NPR)	48,318,746	29,253,429	36,767,829	48,887,829
Total (USD)	470,027	284,566	357,664	475,563
% cheaper than diesel	-	39 %	24%	-1%

Source: GGGI, 2018

7. Challenges and Opportunities for Promoting E-Mobility in Nepal

Nepal's Electric Mobility Action Plan identified 15 different barriers, which were grouped into four key categories: (i) policy and governance (ii) infrastructure and markets (iii) financing and resources, and (iv) data and monitoring. These continue to be the main challenges in promoting e-mobility. A slightly modified list outlining challenges identified by the Action Plan or by consulted key stakeholders, alongside key opportunities, is presented in **Table 5**.

Table 5: Key Challenges & Opportunities Related to E-Mobility in Nepal

ISSUES	CHALLENGES	OPPORTUNITIES
Policies	• Absence of clear targets based on key indicators, such as the sale of different types of EV, or market share of EV, and ownership of targets by all levels of government and private sector • Lack of operational plans and budget to implement policies • Lack of standards for EV, charging systems, conversion of ICE vehicles to EV, and testing protocols	• Some policies, such as Environment Friendly Transport Policy, and plans such as National Action Plan for Electric Mobility, are in place • Few targets on e-mobility have been identified by federal and provincial governments
Governance	• Poor planning, management and monitoring of the public transport system • Inadequate political support for e-mobility • Poor coordination among key stakeholders	• A new bill on establishing a National Transport Authority is being prepared • The new Constitution gives significant responsibilities related to transportation to local governments • Some local governments such as Bagmati Province and Kathmandu and Lalitpur Metropolitan Cities have made commitments to promote EV

ISSUES	CHALLENGES	OPPORTUNITIES
Technology, Infrastructure and Markets	• A limited number of suitable vehicle models are available in the market • Insufficient charging facilities • Low consumer confidence and demand, particularly for two-wheelers and small cars	• EV technology is improving globally and prices are falling, particularly in India and China from where Nepal imports most of its vehicles • NEA has started the process of establishing charging stations • Entrepreneurs in Nepal are working on local manufacturing, assembling and converting EV
Financing and Resources	• Lack of comprehensive financing package with adequate incentives from the government for entrepreneurs, consumers and operators • Lack of investment in e-bus and mass transit • Insufficient human resources	• Pollution tax currently imposed on fossil fuel can be a source for financing EV • Increased supply of electricity from domestic hydropower plants to meet increased demand • Decreased off-peak electricity charges
Knowledge Management	• Insufficient data on transport demand, travel patterns, vehicle operation and emissions from different types of vehicles • Inadequate processing and dissemination of transport data • Limited research and development on various aspects of mobility, including e-mobility	• Some local universities such as Tribhuvan University and Kathmandu University and other institutions such as National Innovation Centre are conducting research on EV

8. Review of Existing E-Mobility Targets to Inform the 2020 NDC

8.1 Types of NDC Targets

Based on international practices and Nepal's own experiences, Nepal can set different types of targets related to e-mobility in its 2020 NDC. Some of these have been listed below:

Examples of targets related to GHG reduction

- Economy-wide emission reduction target that also takes into consideration ambitious emission reduction in the transport sector
- Transport specific GHG target (e.g., reduce GHG emissions from the transport sector by X% by 2030)

Examples of targets related to vehicle electrification

- Total number of EV in the vehicle fleet
- EV as a percentage of the total number of vehicles
- Change in market share or sales over a period
- Phase-out of ICE
- Targets related to charging infrastructure

Examples of targets related to policies and measures

- Financing support for production, procurement or operation of different types EV
- Lower taxes for EV
- Electricity pricing policies that reward off-peak charging or charging of public vehicles
- Establish standards for different types of EV, charging stations and conversion of ICE vehicle to electric ones
- Mandates for public procurement of EV
- Increase in fossil fuel taxation and mobilization of other sources for promotion of clean transport
- Preparation of comprehensive plans for e-mobility

Among these, GHG related targets may be difficult to monitor in the absence of reliable data and established monitoring systems. Targets related to the electrification of vehicles would be more tangible and easier to measure. Because of the lack of reliable data on existing vehicle stock and how it changes over time, targets based on EV sales over a period would be most the relevant and easy to monitor. Many other countries have also used this as an indicator for targets. Additionally, other supporting policy targets may also be included in the 2020 NDC.

8.2 Existing E-Mobility Targets in Nepal

The **Environment-Friendly Vehicles and Transport Policy, 2014** set a target that 20% of the total vehicle fleet in the country would be electric by 2020. This was an ambitious target to begin with and in the absence of any implementation plan, Nepal is nowhere close to meeting this target. Globally, EV constitute only 0.5% of the vehicle fleet and in Nepal, this number is close to 1%. Achieving this jump to 20% by 2020 is not feasible.

The **2016 NDC** set a target of increasing the share of EV in 2020 up to 20% from the 2010 level. This target is not as ambitious as the number of EV in 2010 was very low, probably close to 1000. Therefore, assuming there were 1000 EV in 2010, increasing it by 20% means adding only 200 EV in 10 years. This has already been achieved quite effortlessly.

Another target in the 2016 NDC is "by 2050, Nepal will decrease its dependency on fossils in the transport sector by 50%." This target is a bit unclear as the base year is not mentioned. If the target meant to say 50% of the total energy used by the transport sector in 2050, then this again should be an easy target to meet considering the global trend in the sale of EV and future projections. BloombergNEF (2019) predicts that by 2037 half of the passenger cars sold globally will be electric and by 2040, 57% of the passenger vehicles sold and over 30% of the total vehicle fleet will be electric. Nepal should be able to electrify its transport sector faster than the global average considering the fact that it does not have a fossil fuel or ICE vehicle industry and NEA claims that it will soon have excess electricity in the national grid (NEA, 2020). At an interaction programme organized by MoFE, the then-Deputy Managing Director of NEA, Hitendra Dev Shakya[5] stated that a lack of electricity will not be a barrier for the growth of EV sector in Nepal (MoFE, 2020b). Therefore, it should be possible to decrease transport sector dependency on fossil fuels by 50% by 2050.

5 Hitendra Dev Shakya is currently the Managing Director at NEA. At the time of this interaction programme in July 2020, he was the Deputy Managing Director at NEA.

A third target in the 2016 NDC is to "develop electrical (hydro-powered) rail network by 2040 to support mass transportation of goods and public commuting." This target can also be met considering that work on constructing a rail network in the Terai region is already underway and studies for other railway lines, including a metro system for Kathmandu Valley is also being done. While the target does not specify how long the rail network should be or which locations will be connected by the network, as the target date is still 20 years away, this target should be fairly easy to meet.

The 2016 NDC also mentions that "Nepal will formulate the Low Carbon Economic Development Strategy." This should not have been a difficult target to meet, considering that a draft version of the Low Carbon Economic Development Strategy was prepared in 2015 before the 2016 NDC had been submitted. There was plenty of time to finalize the strategy but the process has stalled.

MoEWRI's White Paper (2018) mentions that by 2023, half of the vehicles imported in the country will be electric. This is a very ambitious target, although not an impossible one. As about 80% of the vehicles imported in the country are currently two-wheelers, in order to achieve this target, the import of electric two-wheelers will have to be increased significantly. Although electric two-wheelers are available in the market at reasonable costs, the demand for these is still relatively low. Therefore, substantial investment would be required, in the form of incentives and regulations, to boost the demand for EV, particularly electric two-wheelers to meet this target. As not much was done to meet this target in the first two years after the white paper was published, and now because of the economic consequences of COVID-19, it has become difficult to meet this target.

NPC published the **National Preliminary Report on SDG in 2015**, which proposed various targets and indicators for achieving these goals. One of the indicators for achieving SDG 7 'Ensure access to affordable, reliable, sustainable and modern energy for all' was 'Electric vehicles in public transport systems (%).' Initially, the baseline for this indicator was estimated to be 1% in 2014 and targets were set at 19.4% by 2017, 37.8% by 2020, 50% by 2022, 68.8% by 2025 and 100% by 2030 (NPC, 2015). In 2017, NPC revised the target as 5% by 2019, 20% by 2022, 35% by 2025 and 50% by 2030 (NPC, 2017). However, the latest review of SDG does not mention this target for EV in the public transport system (NPC, 2020).

Bagmati Province has set a target of removing all petroleum-powered vehicles from its urban centres, mainly Kathmandu Valley, Chitwan, Hetauda and Dhulikhel/Banepa/Panauti by mid-April, 2028. This is a very ambitious target as many of the fossil fuel vehicles that are on the streets now or those that will be added in the upcoming years will continue to operate beyond 2028 and converting all of them to electric will not be easy. Furthermore, in the last two years since the policy was announced, the Provincial Government has not yet introduced any plans or schemes for implementing this policy. This seems more like a political statement or vision rather than a carefully thought out strategy. A more detailed analysis will be required to assess the feasibility of this strategy and what can be done to accelerate the movement towards petroleum-powered vehicle free Province.

Overall, among the five sets of targets related to EV that have been announced by the GoN in various policy documents, the targets in the 2016 NDC are not very ambitious and therefore do not inspire any new innovative actions for promoting EV, while the other sets of targets are probably too ambitious. These targets, and their strengths and weaknesses, have been discussed in **Table 6**.

In addition to the targets mentioned in the policies discussed above, in April 2018, the Finance Minister had announced the GoN's intention to replace all vehicles with EV by 2030. This target was, however, never formally adopted by the government.

Table 6: Targets Related to EV in Nepal

POLICY	TARGET	COMMENTS
Environment-Friendly Vehicles and Transport Policy, 2014	20% of the total vehicle fleet in the country to be electric by 2020	No follow up plans and programs. So far, only about 1% of the total vehicle fleet is electric.
NDC	(i) Increase share of EV up to 20% from 2010 level. (ii) By 2050, Nepal will decrease its dependency on fossils in the transport sector by 50%. (iii) Develop electrical (hydro-powered) rail network by 2040 to support mass transportation of goods and public commuting.	(i) Already achieved because of very low number of EV in 2010. (ii) Neither clear nor ambitious. (iii) Neither clear nor ambitious.
MoEWRI's White Paper, 2018	By 2023, half of the vehicles imported in the country will be electric.	In the absence of follow up plans and programs, this will be difficult to achieve.
Bagmati Province Periodic Plan	Remove all petroleum-powered vehicles from four urban centres (Kathmandu Valley, Chitwan, Hetauda and Kavre) by 2028.	Very ambitious target which is not backed by analysis and plans.
SDG Targets & indicators	7.3.1: Share of EV in public transport systems 2015: 1% 2019: 5% 2022: 20% 2025: 35% 2030: 50%	The target was set initially set in 2015 and revised in 2017. These targets are realistic, provided that the GoN provides support to public transport operators.

9. E-Mobility Targets in the 2020 NDC and Background LEAP Analysis

Taking into considerations the findings and recommendations of this report (discussed in the chapters above), as well as the subsequent feedback provided by numerous experts (see **Annex I**), the GoN-appointed NDC Working Group, and other line ministries and government agencies , two e-mobility scenarios were developed. The impacts of these scenarios on vehicle fleet, fossil fuel usage and corresponding GHG emissions was then modeled using the LEAP software. This chapter discusses in brief the e-mobility targets of the 2020 NDC and the scenarios these targets were based on.[6]

Nepal's 2020 NDC (GoN, 2020) set the following targets for the transportation sub-sector of the energy sector:

- By 2025, sales of electric vehicles will be 25% of all private passenger vehicles sales including two-wheelers and 20% of all four-wheeler public passenger vehicle sales (this public passenger target does not take into account electric-rickshaws and electric-tempos)[7]
- By 2030, increase sales of e-vehicles to cover 90% of all private passenger vehicle sales including two-wheelers and 60% of all four-wheeler public passenger vehicle sales (this public passenger target does not take into account electric-rickshaws and electric-tempos)
- By 2030, develop 200 km of the electric rail network to support public commuting and mass transportation of goods.

LEAP modeling software was used to make projections for every year from 2020 (year of NDC submission) till 2030 (the final target year of the 2020 NDC and SDG Roadmap). The projections are made for two possible scenarios: i) Business-as-usual (BAU) Scenario, and ii) Ambitious E-Mobility Scenario. The BAU Scenario involves higher taxes and other fees on EV as currently imposed by the GoN leading to a high share of fossil fuel vehicles and low penetration of EV. This scenario is a conservative scenario that means a continuation of the current trajectory that yields minimum achievement in the stipulated timeframe. The Ambitious E-Mobility Scenario, on the other hand, is an optimistic scenario based upon aspirations envisaged in the policies and programmes of the GoN. In this scenario, policy intervention, technological innovation and market penetration is expected to drive the sales of EV. The 2020 NDC targets on e-mobility are based on this ambitious scenario. BAU projections were included in the NDC for comparison.

The vehicles considered in this study are as follows:

- **Fossil fuel based:** two-wheelers; cars; pickups; heavy duty trucks; taxis; bus; microbus; minibus; tempo; tractors.
- **Electricity based:** electric two wheelers; electric cars; electric pickups; electric heavy duty vehicles; electric bus; electric microbus; electric minibus; electric tempo; electric tractors

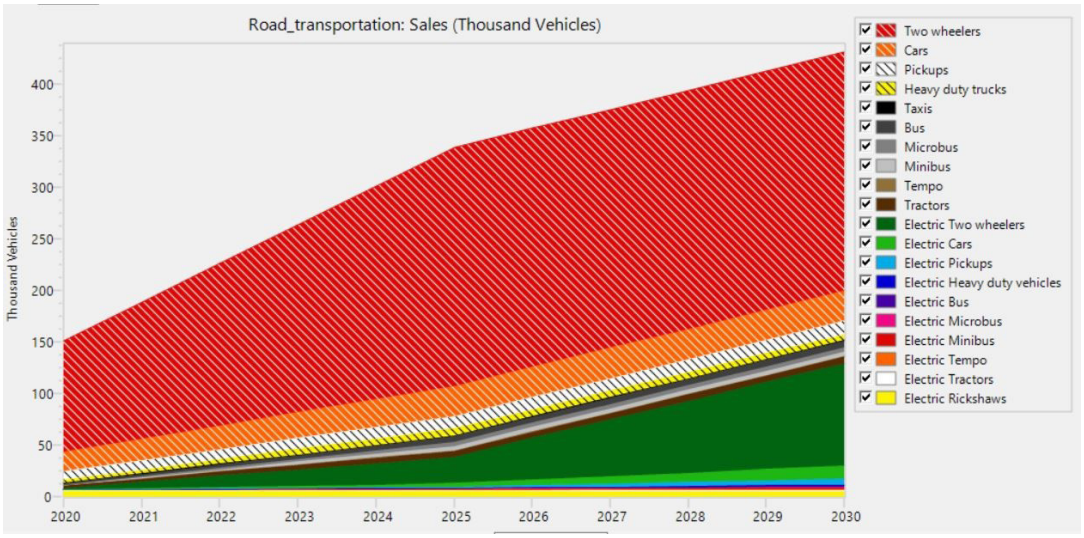
6 The LEAP modeling methodology has been described in detail in the accompanying Nepal Mitigation Assessment Report (2021).

7 A large proportion of tempos and rickshaws in Nepal are predominantly electric while other types of vehicles run on petroleum fuels. In order to prioritize the electrification of these fossil fuel-based vehicles, the 2020 NDC does not include rickshaws and tempos in its e-mobility targets.

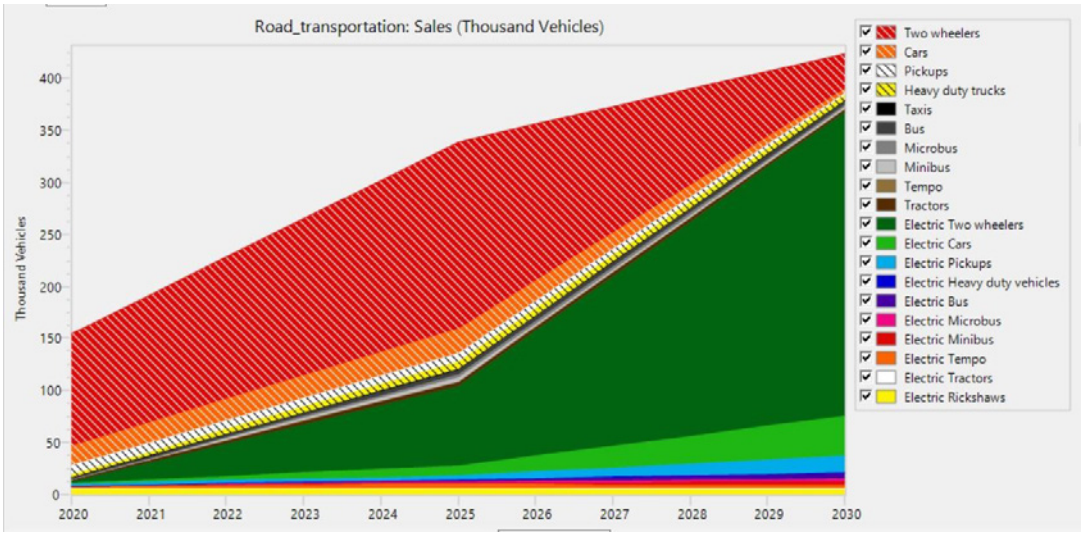
The data for the baseline (2010 -2019) was obtained from vehicle registration data provided by the DoTM. The two scenarios (2020 -2030) were synthesized using expert judgement based on targets set in the 15th Five-Year Plan, MoEWRI's White Paper, EV tax policy in the Budget Speech 2020/2021, and trends in the BloombegNEF Electric Vehicle Outlook 2020 and IEA's Global EV Outlook 2020. Estimations in both scenarios are made for the total population of Nepal considering an annual population growth rate of 0.8% (CBS, 2014).

9.1 Future Vehicular Sales Under BAU Scenario vs. Ambitious E-Mobility Scenario

As seen in **Figure 14** below, sales of fossil fuel-based vehicles are gradually decreasing in the BAU Scenario but it still accounts for the dominant share of new vehicle sales. On the other hand, the sales of passenger EV increases more rapidly in the Ambitious E-Mobility Scenario and accounts for the dominant share of new vehicle sales by 2030.



a) BAU Scenario



b) Ambitious E-Mobility Scenario

Figure 13: Projection of Vehicle Sales Under (a) BAU Scenario and (b) Ambitious E-Mobility Scenario

9.2 Fossil Fuel Usage Reductions Attributable to Ambitious E-Mobility Scenario

Transport related fossil fuel energy demand in the BAU Scenario is approximately 39.4 million GJ in 2025 and 48.4 million GJ in 2030; whereas, transport related fossil fuel energy demand in the Ambitious E-Mobility Scenario is around 36 million GJ in 2025 and 34.7 million GJ in 2030. Compared to the BAU Scenario, the Ambitious E-Mobility Scenario decreases fossil fuel dependency from the transportation sector by around 9% in 2025 and 28% in 2030.

9.3 Emission Reductions Attributable to Ambitious E-Mobility Scenario

Compared to the BAU Scenario, the Ambitious E-Mobility Scenario reduces petrol and diesel usage in the transportation sector, leading to substantial decrease in emissions. The transport related emissions in the BAU Scenario is approximately 2,988 $GgCO_2e$ in 2025 and 3,640 $GgCO_2e$ in 2030, whereas, the transport related emissions in the Ambitious E-Mobility Scenario is around 2,734 $GgCO_2e$ in 2025 and 2,619 $GgCO_2e$ in 2030. Compared to the BAU Scenario, the Ambitious E-Mobility Scenario decreases emissions from the transportation sector by around 8% in 2025 and 28% in 2030. This decrease in emissions comes from the replacement of fossil fuel-based passenger vehicles like two wheelers, pickups, cars, buses, microbuses and minibuses with their electric alternatives.

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Annex I: List of Experts and Stakeholders Consulted During the Study

Person	Affiliated Institution
Dr. Arun Prakash Bhatta	Ministry of Forests and Environment
Muna Neupane	Ministry of Forests and Environment
Somnath Gautam	Ministry of Forests and Environment
Yam Nath Pokharel	Ministry of Forests and Environment
Ram Prasad Awasthi	Ministry of Forests and Environment
Suresh Ghimire	Ministry of Forests and Environment
Subhadra Bhattarai	Ministry of Forests and Environment
Jyoti Prajapati	Ministry of Energy, Water Resources and Irrigation
Parsu Ram Pokhrel	National Planning Commission
Narayan Khatiwada	National Planning Commission
Kiran Gautam	Water and Energy Commission Secretariat
Hitendra Dev Shakya	Nepal Electricity Authority
Ashish Gajurel	Investment Board Nepal
Yunchao Yang	United Nations Development Programme-Nepal
Apar Paudyal	United Nations Development Programme-Nepal
Ms. Anantaa Pandey	Global Green Growth Institute (GGGI)
Prof. Bhim P. Shrestha	Kathmandu University (KU)
Abhisek Karki	Kathmandu University (KU)
Mr. Deepak Agrawal	Nepal Automobile Dealers Association (NADA)
Mr. Subhashish Thapaliya	Nepal Automobile Dealers Association (NADA)
Mr. Umesh R. Shrestha	Electric Vehicle Association of Nepal (EVAN)
Mr. Bijaya Man Sherchan	Pashupati Energy Development Company

Government of Nepal
Ministry of Forests and Environment