IIDS Policy Brief
On
Re-evaluating Fiscal Incentives on Electric Vehicles

Authors: Dr. Biswash Gauchan, Dilasha Joshi, Yajju Pradhan, Sudikchya Rai & Bibhuti Thapa

Summary

- *Fiscal Incentives and Duty Privileges:* Tax rates on EV imports have varied over the last five years, with rates dependent on peak motor power. Nepal's custom duties on EVs range from 15% to 80%, based on capacity (50kW to 300kW and above), contrasting with petroleum cars facing an import tax of up to 288%. These disproportionate policy incentives have led to a surge in EV imports. Nepal has implemented substantial incentives to promote EV adoption, including lowered customs duties, excise, and easier bank auto loans. Individuals can secure loan financing for EVs up to 80%, while for ICE vehicles, individuals are eligible for up to 50% financing.
- *REVENUE Implications:* In the FY 2023/24, Nepal imported 11,700 EVs worth NPR 29.47 billion equivalents of foreign exchange (FOREX), resulting in a revenue loss of NPR 15.59 billion for the entire financial year compared to ICE vehicles. Instead, if the same amount of foreign exchange had been used for importing ICE vehicles, the opportunity cost in terms of the foregone tax revenue would have been more than NPR 61 billion.
- *FOREX Implications:* The opportunity cost of importing EVs in FY 2023/24 considering the entire year's import number is an extra foreign exchange loss of NPR 17.07 billion.
- *Operational and Maintenance Costs:* While EVs demonstrate higher efficiency and lower operational costs over ICE vehicles, there are still challenges regarding battery replacement costs and waste management. Battery replacement costs for EVs over a 20-year lifespan range from NPR 11,00,000 to NPR 22,00,000, posing financial burdens on consumers and the country. Additionally, the lack of proper battery waste management infrastructure raises environmental concerns.
- *Electricity Consumption Demand:* If Nepal were to substitute all 260,000 imported light passenger vehicles (total vehicles imported until the pandemic) with electric vehicles, each with a daily electricity consumption of 2-3 units, the total demand would only be 54-81 MW. This figure is significantly lower than the electricity demand generated by electric cooking and the manufacturing industry such as the steel and cement factory in Nepal.
- Pollution Analysis: Air pollution in Kathmandu Valley is primarily driven by uncontrolled emissions from vehicles, brick kilns, and biomass burning, exacerbated by rapid urbanization, poor road infrastructure, wildfire smoke and the Valley's topography, which traps pollutants. The increasing number of vehicles, particularly two-wheelers, and diesel-powered vehicles like freight transport trucks, and public transportation significantly

contribute to the Valley's severe air quality issues. The air pollution in city like Lumbini is majorly attributed to the transboundary movement of air pollutants caused by agro-residue burning in the neighboring states of India such as UP, Haryana and Punjab and not by transportation.

- *Comparison with other countries:* Comparing EV incentives, Nepal offers some of the world's highest incentives despite insignificant value addition to the economy for not having a domestic manufacturing base. Norway leads global EV adoption, increasing sales from under 1% to 80% in 12 years (2010-2022). Nepal surged EV sales as a share of passenger vehicles from 5.5% in 2019 to 304% in the FY 2023/24 recording the highest growth in the world since 2022. Though high-income countries offer EV incentives to promote faster adoption of EVs, nothing compares to the extent of disproportionate incentives provided by a poor country like Nepal. Nepal's proactive stance toward EV adoption contrasts with all the EV producing countries including India as evidenced by a slower progress despite its manufacturing capabilities. The EV-friendly policy appears to primarily benefit the wealthy population, which is not the intended approach for effective policymaking.

Introduction:

The electric vehicle (EV) market in Nepal has seen significant growth, with a notable increase in registered vehicles over the past few years. The government has implemented measures to promote the adoption of EVs, including lowered taxes and purchasing subsidies. Furthermore, there are significant duty privileges granted for the import of EVs, resulting in a disparity that enhances affordability for consumers. Given the absence of a strong export base and limited purchasing power, subsidizing EV places Nepal in a precarious position, straining its foreign reserves and jeopardizing government revenue. As the country grapples with pressing economic issues, the prioritization of EV subsidies seems ill-suited to its current circumstances. This policy choice providing disproportionate fiscal privileges in favor of electric vehicles not only risks exacerbating financial challenges but also diverts resources away from more pressing economic concerns, raising questions about the feasibility and prudence of such a climate-conscious strategy in the context of Nepal's unique economic circumstances.

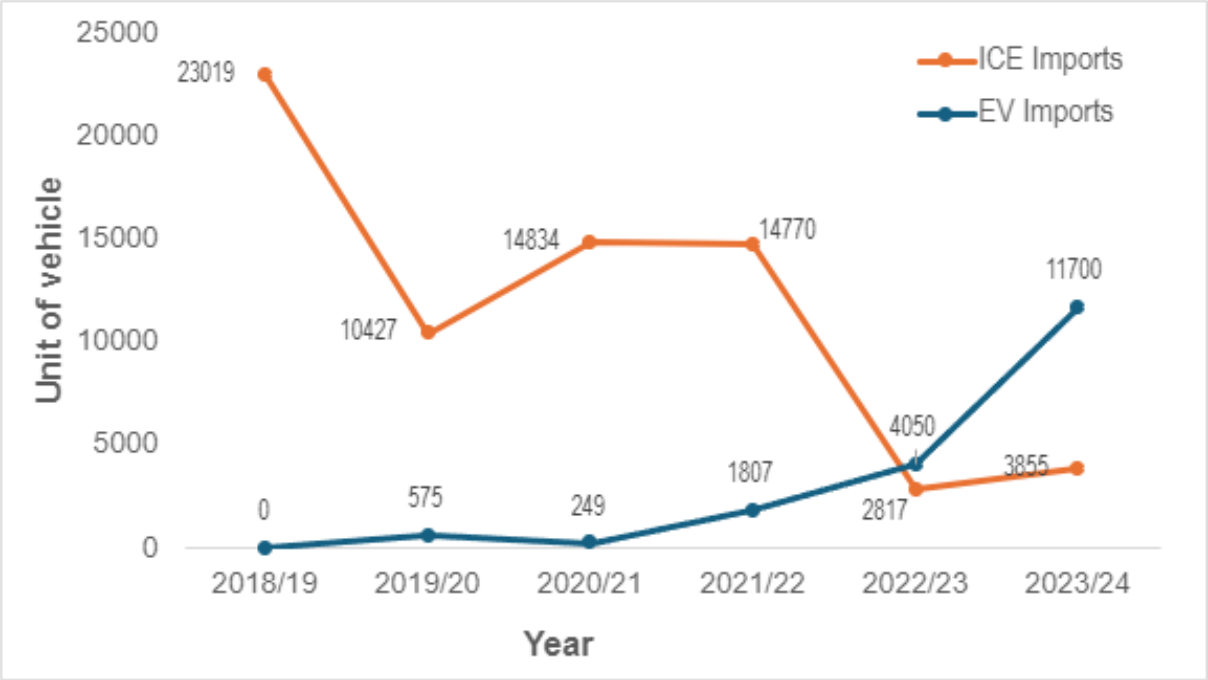
EV Scenario

Nepal witnessed a substantial increase in registered vehicles between 1989 and 2015, rising from 1.995 million to 3.591 million by FY 2018/2019, marking an 80% surge. Over the past three decades, out of the total 3.59 million vehicles imported, approximately 260,000 were light vehicles (cars, jeeps, and taxis), 2.814 million were motorcycles, and 517,000 were other heavy and transport vehicles (Economic Survey, 2020/21). In FY 2022/23, Nepal imported 4,050 electric cars valued at Rs 11.84 billion, compared to Rs 5.32 billion worth imported in FY 2021/22 (Department of Customs, 2022/23). FY 2020/21 saw a decline in EV imports due to the Covid-19 pandemic

and increased taxes (The Kathmandu Post, 2024). Despite these challenges, the EV market in Nepal has shown significant growth in recent years (Figure 1).

Nepal has increased the EV sales as a share of passenger vehicles from 220% in the second half of 2023 to 304% by the first half of 2024 (Figure 2). From the first half to the second half of FY 2023/24, EV imports increased by 129% (11,700 units), whereas ICE imports only grew by 66% (3,855 units), despite the duty increase from 25% to 35% for peak motor power between 50kW and 100kW. With 192% increase in the import of EVs since the last fiscal year, Nepal imported four-wheeler passenger EV worth NRs. 29.4 billion (Department of Customs, July 2024).

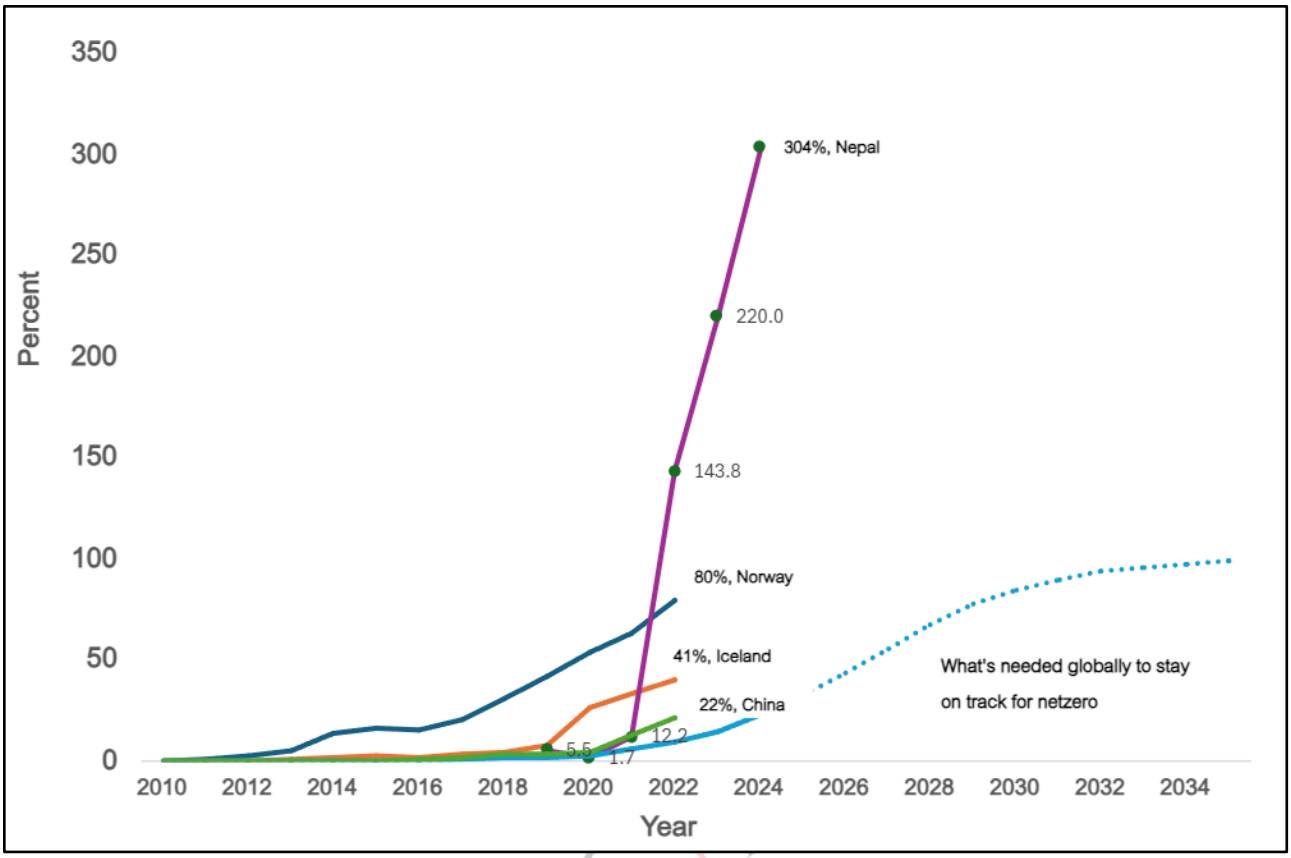
Figure 1: Annual imports of passenger EVs and ICE in the last 5 years (2019-2024)



Source: Department of Customs

Global Trends in EVs

Figure 2: EVs as a share of passenger vehicle sales



Source: Author, based on Jaeger, 2023; World Research Institute. Based on historical data from IEA. Global target from Climate Action Tracker and Department of Customs, Nepal

Norway leads the world in EV adoption, increasing sales from under 1 percent to 80 percent in just 12 years (Figure 2). Following Norway (80%), Iceland (41%), Sweden (32%), the Netherlands (24%), and China (22%) are among the top EV adopters as of 2022. These high-income countries can offer substantial incentives for EV adoption due to their robust regulatory frameworks, guidelines, and strong policies, or because they produce and export EVs themselves. In Nepal, the adoption rate of EVs seems to surpass all of them including India, attributed to reduced customs duties, which has significantly narrowed the price gap between electric and gasoline vehicles. Nepal has increased the EV sales as a share of passenger vehicles from 5.5% in 2019 to 144% in 2022 to 304% by 2024.The National Determined Contributions (NDC) target for Nepal includes achieving 25% of all private passenger vehicle sales and 20% of all four-wheelers public passenger vehicle sales through electric vehicles (EVs) by 2025. By surpassing these goals, Nepal has already exceeded its EV sales targets outlined in the NDC.

EV Incentives in Nepal

Nepal, despite relying majorly on imports, has introduced significant incentives to encourage EV adoption. Before the FY 2020/21 budget, all EV imports were taxed at 10 percent regardless of

motor power. However, as of 2023/24, import duties on electric vehicles are now determined by their peak power. Additionally, lower customs and excise duties have been implemented, and bank auto loans can cover up to 80 percent of the purchase price of an electric vehicle (The Kathmandu Post, 2023). These government incentives have led to a surge in electric car imports, with Nepal importing around 5,107 units within the first 6 months which increased up to 11,700 units in the FY 2023/24 (Figure 1). Our analysis is based on the import value and revenue generated from Tata Nexon cars with power ratings between 50kW and 100kW. While there are numerous electric vehicles (EVs) with power ratings up to 50kW imported at considerable value, we have not included them in our analysis. However, it's important to note that if this segment were included, the revenue loss would likely be even greater.

Table 1: Custom duties of light passenger EVs in Nepal for the last 5 years

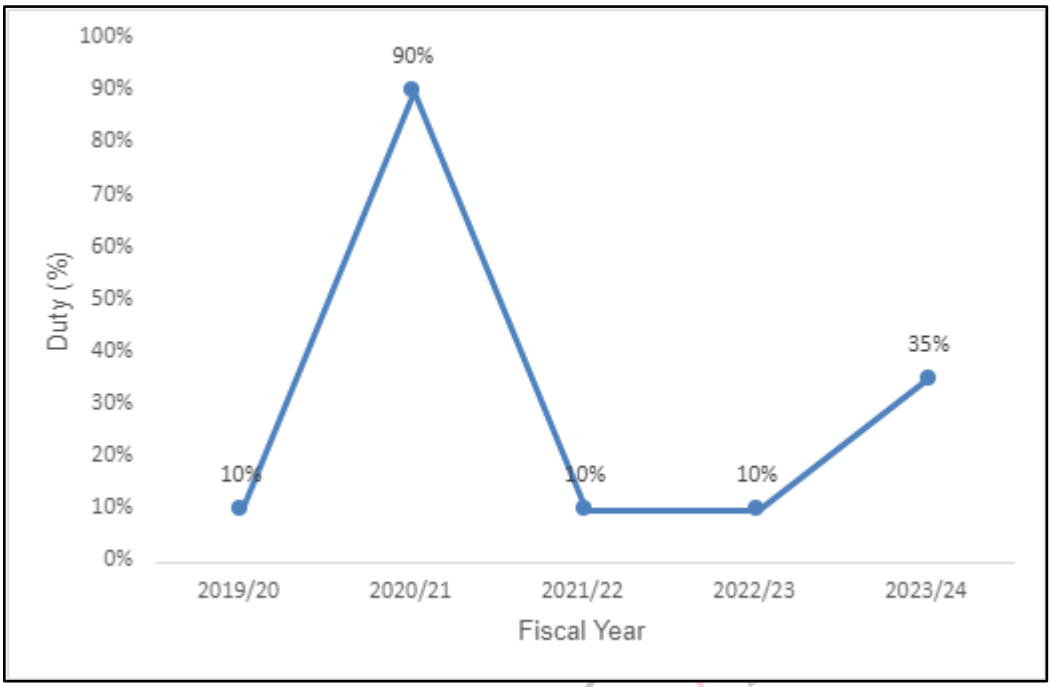
Particulars (Peak motor power)	**Import Duty (ID) and Excise Duty (ED) (%)**											
	2023/24 (80/81)				2022/23 (79/80)		2021/22 (78/79)		2020/21(77/78)			2019/20 (76/77)
	ID	**ED**	**ID***	**ED***	**ID**	**ED**	**ID**	**ED**	**ID**	**ED**	**ED***	**ED**
Up to 50 kW	15	5	10	0	10	0	10	0	80	30	6	10
> 50 kW to < 100 kW	20	15	15	10	10	0	10	0	80	40	10	
>100 kW to < 150 kW	-	-	-	-	-	-	-	0	80	50	15	
> 150 kW to < 200 kW	-	-	-	-	-	-	-	0	80	60	45	
> 100 kW to < 200 kW	30	20	20	20	30	30	15	0	-	-	-	
> 200 kW to < 300 kW	60	45	40	45	45	45	30	0	80	70	52.2	
> 300 kW	80	60	60	60	60	60	40	0	80	80	60	
ED in FY 2020/21 and ID*/ED* in FY 2023/24 was later revised after tax imposed on import of EVs.*												
VAT=13%, RDF = 5%												

Source: Department of Customs

The varying tax rates on EVs in the past five years, as shown in Figure 3, have exacerbated the financial strain on the country. This inconsistency in tax rates can contribute to economic instability and distort resource allocation, potentially leading to increased budget deficits.

Establishing a consistent tax rate for EV imports is essential to balance national savings and ensure stability.

Figure 3: Change in tax rates for passenger EVs (> 50 kW to < 100 kW*) for the last five years.*



Source: Department of Customs

The proactive promotion of EVs by the Nepal government stems from leveraging the surplus hydroelectricity generated during off-peak and wet seasons. This surplus power can be effectively utilized by EVs, thereby diminishing the dependency on imported petroleum products and easing the financial strain of such imports. In addition to this, the government has committed to installing 50 EV charging ports nationwide through signed contracts. Concurrently, efforts are underway to stimulate local manufacturing of electric cars, mopeds, batteries, and related components, aimed at bolstering the economy and generating employment opportunities. These incentives and initiatives have rendered EVs more economically viable in Nepal when compared to their internal combustion engine (ICE) counterparts. Nonetheless, it is imperative to conduct thorough analyses encompassing financial costs, electricity demand and consumption, necessary infrastructure, carbon and pollution assessments, fuel savings estimations, battery replacement expenses, waste management considerations, and overall economic and societal impacts before extending duty privileges, as elaborated in the subsequent sections.

Comparing the EV Incentives in Nepal with India

The Indian government has implemented various policies and incentives to bolster the production and uptake of electric vehicles (EVs) across the nation. One notable initiative is the Faster

Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme, which extends financial incentives to both manufacturers and purchasers of EVs. Despite being the third-largest emitter of carbon globally, India has seen a comparatively sluggish adoption of EVs, with only 53,000 units sold in 2022, in contrast to the 39 million passenger vehicles sold. The Government of India has implemented a policy where incentives under the Electric Vehicle (EV) policy are tied to battery capacity. Specifically, the incentive amounts to NPR 10,000 per kilowatt-hour (kWh) for electric three-wheelers (e-3W) and four-wheelers (e-4W), with a maximum cap set at 20% of the vehicle's cost (PIB-India, 2022).

The adoption of EVs in India lags, largely attributed to the significant upfront costs involved (refer to Table 2), which discourages price-sensitive consumers. Although EV production is localized in India, it has not reached a scale substantial enough to drive prices down significantly. Despite domestic manufacturing, adoption rates remain low due to limited incentives. In contrast, Nepal offers some of the world's most generous incentives for EVs (refer to Table 1), despite lacking a domestic manufacturing base and relying on imports for all its EVs (World Resources Institute, 2023; World Economic Forum, 2022).

Comparing Retail Price in Nepal with India

The table below (Table 2) illustrates the retail price comparison between TATA electric and petrol vehicles in both India and Nepal. In India, EV prices range from approximately INR 8 lakhs to INR 19 lakhs, while their internal combustion engine (ICE) counterparts range from INR 5.5 lakh to 13.5 lakh. Conversely, in Nepal, EVs are priced significantly lower compared to their ICE counterparts, with EV prices ranging from NPR 22 lakh to NPR 45.5 lakh, whereas ICE prices start at NPR 30 lakh and go up to NPR 54.5 lakh. This parity in retail prices between EVs and ICE vehicles highlights Nepal government's support for EV policies. The contrast becomes evident when comparing the retail prices of Hyundai in India, where EVs start at 23 lakh rupees while ICE vehicles begin at just 11 lakh rupees. However, in Nepal, the prices for both EVs and ICE vehicles fall within the same range.

Table 2: Retail Price of EV vs. ICE in India vs. Nepal

Type of Vehicles	INDIA		NEPAL	
	EV Price Range (INR)	**ICE Price Range (INR)**	**EV Price Range (NPR)**	**ICE Price Range (NPR)**
Tata Nexon	14,49,000 ~ 19,29,000	8,14,990 ~ 13,59,000	38,99,000 ~ 45,49,000	43,99,000 ~ 54,49,000
Tata Tiago	7,99,000 ~ 11,89,000	5,64,900 ~ 7,39,000	21,99,000 ~ 27,99,000	29,99,000 ~ 38,99,000
Tata Tigor	12,49,000 ~ 13,75,000	6,29,000 ~ 7,99,000	32,49,000 ~ 33,99,000	33,49,000 ~ 41,49,000

Hyundai Kona EV/ Creta	23,84,000 ~ 24,03,000	11,00,000 ~ 20,15,000	59,96,000~ 64,96,000	49,96,000 ~ 79,56,000

Source: Tata Motors, Hyundai Motor

This suggest that the higher adoption rate of EVs in Nepal could stem from more favorable pricing and tax policies, which have narrowed the price difference between EVs and ICE vehicles. In contrast, the higher prices of EVs in India, coupled with price sensitivity among consumers, could be likely contributing to the lower adoption rate.

Despite not being a major hub for EV manufacturing or battery technology production like India and the USA, Nepal offers lower retail prices for EVs compared to ICE vehicles. This is significant, especially considering that India and the USA are significant contributors to global emissions but have been slower in adopting EVs. It's intriguing to note that Nepal, despite being a Least Developed Country (LDC) with a lower middle-income economy (~$1500) and heavily reliant on imports (importing 40 percent of GDP in 2022), actively promotes the purchase of environmentally friendly vehicles. This stands in contrast to the approach of the US federal government's Inflation Reduction Act, which provides an income tax credit of up to $7,500 to EV buyers, despite the country's much higher per capita income exceeding $70,000. Nepal's proactive stance toward mitigation measures, rather than solely focusing on adaptation, is particularly noteworthy given its vulnerability to environmental impacts.

Evidence-based Analysis:

The custom duty set by the Nepal government on EVs range from 10 percent to 80 percent depending upon their capacity which varies from 50kW to 300kW and above. This is significantly lower than the import tax on petroleum cars, which stands at approximately 288 percent. The excise duty on petroleum cars with engine capacity between 1500cc – 2000cc has been increased by 5 percent to 75 percent. Additionally, while the government has increased the custom and excise tax on electric cars between 50 to 100 kW by 5 percent respectively, the overall tax rates for EVs remain relatively favorable compared to petrol cars. Moreover, the removal of excise duty and reduction of custom duty to 10 percent in FY 2020/21 greatly contributed to the rapid proliferation of EVs in Nepal. The significant contrast in tax rates between electric vehicles and petrol cars creates an incentive for the adoption of electric vehicles, primarily benefiting a select group of individuals who may not necessarily require subsidies. This policy has resulted in disproportionate advantages to certain wealthy segments of the country's population.

TATA EV stands out as one of the leading EV imports in the country. Its availability in both EV and ICE versions makes it convenient and rational to conduct financial comparisons between the two. This analysis focuses exclusively on four-wheeler passenger vehicles, specifically EVs with a power range of 50kW to 100kW and internal combustion engine (ICE) vehicles with engine

capacities between 1000cc and 2000cc. However, Nepal encounters a twofold financial challenge due to its limited export capacity and purchasing power. This predicament burdens the nation with diminishing foreign reserves and a decline in government revenue, magnifying the trade deficit and fiscal deficit.

Table 3: Comparison between import price and tax between TATA Nexon EV and Petrol Car

Particulars	TATA Nexon EV (NPR)	TATA Nexon Petrol (NPR)	Remarks
Import Price	28,41,997	10,59,277	Difference in Import Price: **NPR 17,82,720** is the amount depleted from foreign reserve
Import Duty (ID)	4,04,985 at **14.25%**	8,21,999 at **77.6%**	
Excise Duty (ED)	3,24,698 at **10%**	12,22,829 at **65%**	
Value Added Tax (VAT)	4,64,318 at **13%**	4,03,534 at **13%**	
Road Development Fund (RDF)	2,01,800 at **5%**	2,80,611 at **8%**	
Total Duty	13,95,801	27,28,973	Difference in Duty: **NPR 13,33,172** is the loss of revenue
Total Price	**42,37,797**	**37,88,250**	

1. Impact on Foreign Exchange at the time of import

In the fiscal year 2021–22, Nepal saw a surge in imports of battery-powered cars, jeeps, and vans, reaching a record value of NPR 5.32 billion, according to the Department of Customs. The difference in import price leads to a significant depletion (~NPR 18 lakhs per unit of EV) of foreign reserves (Table 3). Each EV imported instead of an ICE vehicle results in substantial losses from the country's reserve due to the considerable disparity in import costs between the two types.

In the fiscal year 2023/24, Nepal imported 3,855 units of ICE vehicles at a cost of NPR 4,72,06,11,000 (4.72 billion), while 11,700 units of EVs were imported at NPR 29,47,00,43,000 (29.47 billion) (Department of Customs, July 2024). On average, Nepal is spending roughly 2.7 times the import price on EVs per unit (~28.5 lakhs) compared to ICE vehicles (~10.5 lakhs) (refer to Table 3). The elevated cost of batteries is a major factor contributing to the overall expense of

EVs. The upfront cost is likely to be high if we want efficient technology. However, as battery technology continues to evolve and improve, the cost of EV batteries is expected to decrease over time. This could potentially reduce the price gap between EVs and petrol cars in the future. As of now, the battery alone will cost 40-50 percent of an EV.

2. Impact on government revenues at the time of import

TATA Nexon EV faces a 64 percent tax, while the petrol car faces a 257.6 percent tax on import price. The Government loses more than NPR 13.33 lakh (NRs. 13,33,172) per unit of TATA EV imported compared to its petrol version (Table 3). The total cost of a TATA Nexon EV eventually exceeds 40 lakhs, even after incentives. This clearly indicates that the EV-friendly policy is geared toward the affluent, in a country where the per capita income is less than $1,500 USD. Incentivizing EVs in an import-dependent country may not be justifiable, particularly when substantial resources are allocated to importing these vehicles.

In the FY 2023/24, Nepal imported 11,700 EVs worth NPR 29.47 billion of FOREX. Assuming all were ICE vehicles, importing 11,700 ICE vehicles instead of EVs, the government revenues foregone is NPR 15.59 billion for the whole financial year. The opportunity cost of importing EV by numbers would be loss of extra FOREX worth NPR 17.07 billion. More than 27,000 units of ICE vehicles could have been purchased for the FOREX equivalent to 29.47 billion. However, this specific analysis is not included in this study and remains a limitation. Nevertheless, analyzing the pre-COVID trend, where an average of 24,000 ICE vehicles were imported over five years, suggests that maintaining this trend could have resulted in the import of 27,000 units. This study attempts to calculate and analyze the opportunity cost of importing EV based on FOREX.

Furthermore, had NPR 29.47 billion been used to import ICE vehicles instead of EVs, the total duty collected for the FY 2023/24 would have exceeded NPR 75 billion with a revenue loss of NPR 61.45 billion (Table 4). This is considering 49% duty is collected from 11,700 EVs.

Table 4: Opportunity cost in terms of the lost tax revenue in Financial Year 2023/24

Particulars	**Tax and Duties in % (for petrol)**	**Based on FOREX spent** *Case I: Import of 29.47 billion worth ICEs* ***(In billion NPR)***	**Based on Number of EVs** *Case II: Import of 11,700 ICEs* ***(In billion NPR)***
Total foreign exchange spent on importing EVs and ICEs (assumption) during the fiscal year (2023/24)		29.47	12.39

Import Duty (ID)	77.6	22.87	9.62
Excise Duty (ED)	65	34.02	14.31
Value Added Tax (VAT) at 13%	13	11.23	4.72
Road Development Fund (RDF)	8	7.81	3.28
Total Duty on ICE vehicles		75.92	31.93
Total duty on 11,700 EVs		14.47	16.33
Loss of revenue for the year		61.45	15.59
Loss of FOREX for the year			17.07

Assuming an import price of NPR 28,41,997 for one EV, the cost of importing 24,000 EVs in FOREX totals NPR 68,20,79,28,000 (~68 billion). The unit 24,000 is incorporated into the analysis as a four-year average number of ICE car/jeep/vans imported before the pandemic. In contrast, for the same NPR 68 billion, approximately 64,000 units of ICE vehicles can be imported. This highlights a substantial disparity in the number of vehicles that could be imported for the same amount of FOREX. Comparing the revenue generated from ICE and EV duties further highlights this gap, amounting to a staggering NPR 141 billion loss in revenue (Table 5). Similarly, even if the number of vehicles imported remains constant at 24,000, the revenue loss is approximately NPR 32 billion. Additionally, the difference in FOREX depletion between EVs and ICE vehicles amounts to approximately NPR 43 billion, emphasizing the financial leakages associated with transitioning to EVs.

Table 5: Comparison of Revenue Loss Analysis Under Different Scenarios

Scenario I: For NPR 68 billion (equivalent FOREX) worth import of 24,000 EV	
Revenue for ICE = 64000*total duty on 1 ICE vehicle (assuming NPR 68 billion FOREX can import 64000 units of ICE) Total duty on 1 ICE = NPR 27,28,973 Total Revenue from ICE = NPR 1,74,65,42,72,000 (174 billion)	Revenue for EV = 24,000*total duty on 1 EV Total duty on 1 EV = NPR 13,95,801 Total Revenue from EV = NPR 33,49,92,24,000 (33 billion)
Total Loss of revenue= Revenue from ICE-Revenue from EV= NPR 141,15,50,48,000 (NPR 141 billion)	
Scenario II: For 24,000 units of EV import	
Revenue from ICE = 24,000*duty on 1 ICE = NPR 65,49,53,52,000 (~65 billion) Revenue from EV = 24,000*duty on 1 EV = NPR 33,49,92,24,000 (~33 billion)	FOREX from EV = 24,000*Import Price of 1 EV = NPR 68,20,79,28,000 (~68 billion) FOREX from ICE =24,000*Import price of 1 ICE = NPR 25,42,26,48,000 (~25 billion)

Total loss of revenue = Revenue from ICE-Revenue from EV = NPR 31,99,61,28,000 (~32 billion)	Total additional depletion in FOREX = FOREX from EV - FOREX from ICE = NPR 42,78,52,80,000 (~43 billion)
For the import of 24,000 units of EV, the total loss of revenue is NPR 32 billion with an additional depletion in FOREX of NPR 43 billion.	

3. Analysis of foreign exchange outflows on the operations and maintenance cost

Table 6. Foreign exchange outflows on the operations and maintenance cost for Tata Nexon EV Vs Tata Nexon Petrol

Particulars	**TATA Nexon EV**	**TATA Nexon Petrol (NPR)**
Fuel import for a mileage of 1,50,000 km (10,000 liters @ NPR 80)	NA	8,00,000
Servicing and Maintenance cost (20 years @ NPR 20,000)	NA	4,00,000
Total foreign exchange outflows in operations and maintenance cost		**12,00,000**

According to a survey conducted by IIDS on 200 vehicles, the annual average distance traveled by the cars in Nepal is approximately 7,000 km, resulting in a total mileage of 1,40,000 km over the span of 20 years. However, for analytical reasons as outlined in Table 6, the vehicle's mileage life is considered 1,50,000 km.

Based on the specifications of the TATA Nexon petrol car (5.7 liter per 100 km), one liter of petrol can power the car for 17 km. For our study, we have considered 15 km per liter. The ICE car, therefore, requires 10,000 liters of petrol in its lifetime. Considering the imported cost of petrol as NPR 80 per liter, the total foreign exchange spent on operating the car is NPR 8,00,000. As electricity is produced domestically, no foreign exchange is spent on operating EVs.

Given that an ICE car spends NPR 20,000 foreign currency per year on servicing and maintenance, the cumulative cost throughout its lifespan (20 years) would amount to NPR 4,00,000. Thus, the total foreign exchange spent on operations (fuel) and maintenance of ICE in its lifetime is NPR 12,00,000 (Table 6) while it is assumed that no such cost is involved in the operation and maintenance of EVs. Now considering the mileage variation of 1,20,000 km on the lower end and 2,00,000 km on the upper end, on extrapolating the analysis, we get the foreign exchange outflow ranging from NPR 1.04 million to 1.47 million respectively. The outflow of foreign exchange over these vehicles' lifetime shall be put in the context of the import price differential of around NPR 1.8 million when importing EVs. Even when factoring in the operation and maintenance expenses

over its lifetime, an ICE vehicle still costs less than the initial import price paid for a single EV. Furthermore, the cost of battery replacement has not been accounted for in this analysis. This evidence challenges the common belief that importing EVs will conserve foreign exchange by reducing fuel imports. In fact, it suggests the opposite effect on the foreign exchange reserve.

It is important to note that this analysis does not utilize the concept of Net Present Value (NPV), typically employed in economic studies to discount future cash flows to simplify the analysis for the policymakers.

4. Operations and Maintenance Cost Analysis from the user's perspective

The same assumptions made in relation to Table 6 have been applied in mileage. With one unit of electricity, a 100 kWh EV can run 10 km. Considering the cost of NPR 10 per unit of electricity, the total operating cost of EV would be NPR 1,50,000. Similarly, considering unit cost of petrol of NPR 170, the total operations cost would be NPR 17,00,000. Further, the petrol car is assumed to spend NPR 20,000 per year on servicing and maintenance while no maintenance cost is considered for EV. The total servicing and maintenance cost in the lifetime of an ICE car is NPR 4,00,000. Hence, the total cost of operations and maintenance of EV and ICE in their lifetime is NPR 1,50,000 and NPR 21,00,000 respectively. The owner of the EV saves NPR 21 lakh in the entire life of the EV if the battery replacement cost is not considered. On extrapolating the analysis by considering the mileage of 1,20,000 km and 2,00,000 km, the saving would be NPR 1.84 million and NPR 2.67 million respectively.

Table 7: Case Specific O&M Cost Comparison of EV and ICE

Particulars	**TATA Nexon EV**	**TATA Nexon Petrol**
Fuel/Electricity cost for the mileage of 1,50,000 km (15,000 units of electricity @ NPR 10; 10,000 liters @ NPR 170)	1,50,000	17,00,000
Maintenance cost (20 years @ NPR 20,000)	NA	400,000
Total operations and maintenance cost	**1,50,000**	**21,00,000**

As presented in Table 7, EVs demonstrate high efficiency, and over the long run with lower electricity consumption, the running costs of EVs are much lower. Given the universal rationale that efficient technology would cost more, consumers should be prepared to bear higher initial costs for the adoption of highly efficient technology, the EVs. But with advancing battery technology the price of EVs is to fall naturally and therefore reducing its cost now by providing

disproportionate tax subsidy is nothing but a costly policy choice. The retail price of the two variants of TATA Nexon highlights that the price of EV is much lower than their ICE counterparts in Nepal (Table 2).

5. Estimation of Electricity Consumption

Table 8. Electricity Consumption Analysis for EVs

Particulars	**Estimated Annual Electricity Consumption**	**Annual Electricity Sales (FY 2022/23)**
1. Pre-covid Scenario Average imported Passenger Vehicles = 24,000 units	= 24,000 units *2.0 kWh*365 = 17,520,000 kWh per year = 17.5 GWh per year Equivalent in installed capacity (1MW = 3.5 GWh) = 17.5 GWh x (1MW/3.5GWh) = **5.00 MW**	Total electricity sales in FY 2022/23 = 12,369 GWh (Source: NEA Annual Report 2022/23) ~ (17.5 GWh/12,369 GWh) *100% = **0.14 %** of total electricity sales
2. Assuming all 2.6 lakh imported light passenger vehicles in last 30 years as EVs	= 260,000 units*2.0 kWh*365 = 189.8 GWh ~ **54 MW**	= (189.8/12,369) *100% = **1.5%** of total electricity sales
For 3 units consumption daily per electric car:	= 260,000*3 units*365 = 284,700,000 kWh = 285 GWh Installed Capacity: = 285 GWh x (1MW/3.5GWh) **= 81 MW**	

Nepal sees a surplus in electricity during the monsoon, with a 2,700 MW capacity that exceeds the peak demand of 1,750 MW. The country's largest cement industry, Hongsi Shivam Cement, requires 37 MW of electricity to produce 6,000 metric tons of cement daily and an additional 50 MW is anticipated with increased production ('Hongshi Cement Industry Receives Power Supply',2021). Similarly, Ambe Steel Group consumes 36 MW of electricity to produce 750 metric tons of billets per day (Gauchan, 2021). Combined, these industries will consume 123 MW of electricity.

For our calculation, we assume 2 units of electricity consumption per day with daily commute of 20 km in Kathmandu. Consequently, even with the pre pandemic level of passenger vehicles import of 24,000 units consume around 17.5 GWh of electricity annually equivalent to 5 MW of installed capacity. This amounts to only 0.14 percent of the total electricity consumption in FY 2022/23. Similarly, considering all 2,60,000 light vehicles imported in the last 30 years as electric vehicles, it constitutes only 1.5 percent of total electricity consumption (see calculation, Table 8). If Nepal were to substitute all 2,60,000 imported light motor vehicles with electric vehicles, each with a daily electricity consumption of 2-3 units, the total demand would only be 54-81 MW of

installed capacity (Table 8). This figure is significantly lower than the electricity demand generated by the manufacturing industry. For the purpose of converting annual energy production to installed capacity, the average energy production of three large hydroelectric projects (900 MW Arun III, 900 MW Karnali and 1200 MW Budhigandaki) have been used as a reference. Based on this assumption, 1 MW installed capacity of hydroelectric project in an average produces 3.5 GWh of electricity in a year.

With hydropower capacity expected to exceed demand during the monsoon season, measures are necessary to boost domestic consumption. This surplus presents a unique opportunity to prioritize the provision of reliable electricity to key industries such as electric cooking, cement factory, steel industry, and others, thereby catalyzing economic growth and development. Therefore, prioritizing the provision of reliable electricity should be the main strategy instead of subsidizing EVs to utilize Nepal's energy surplus.

6. Estimation of Battery Replacement Cost

Table 9. Battery Replacement Cost Analysis

Battery replacement (capacity 30.2 kWh lithium-ion battery pack)	**TATA Nexon EV (excluding taxes)**	**Total Cost**
Case 1 Price on higher end in India: = INR 7,00,000	Case 1 = NPR 11,20,000	Battery replacement cost for 20 years (10 years @ NPR 5.5~11.2 lakhs) = NPR 11,00,000 ~ 22,00,000
Case 2 According to global prices: $139/kWh For 30.2 kWh = $4198	Case 2 = NPR 5,50,000	

Lithium-ion batteries constitute 50 percent of the expenses in an electric vehicle, rendering them pricier than traditional vehicles. Globally, lithium-ion batteries cost roughly $250/kWh (Yadav, 2023). As shown in Table 9, the battery replacement cost in Nepal for Tata Nexon EVs having a battery capacity of 30.2 kWh is estimated to start from NPR 5.5 lakh and reach over NPR 11 lakh (excluding taxes). Tata Nexon EVs in Nepal with 30.2 kWh Li-ion battery capacity comes with an 8-year warranty. However, for our analysis, as outlined in Table 9, the battery life is considered 10 years. Battery replacement cost is estimated between NPR 5,50,000 to NPR 11,20,000 over a 10-year lifespan. Considering this, the battery replacement cost of EVs over a 20-year lifetime would amount between NPR 11,00,000 to 22,00,000 lakhs. The price on the higher side is comparable to the operation and maintenance costs of ICEs as shown in Table 7. However, according to Bloomberg NEF report, Li-ion battery pack prices fell to $139/kWh in 2023 (Lithium-Ion Battery Pack Prices Hit Record Low, 2023). With increasing advancements in battery technologies, battery costs are expected to lower and by the mid 2020s there will be price parity between EVs and ICE in most categories (Ministry of Forests and Environment, 2021).

7. Loss of revenue from tax on petrol

The government faces a loss in tax revenue due to decreased petrol sales, which would have been consumed by ICE vehicles. We consider an ICE vehicle that travels a total of 1,50,000 kilometers throughout its lifespan and consumes 15,000 liters of fuel, achieving a mileage of 10 kilometers per liter. With an assumed NPR 75 tax and additional charges per liter (Retail price NPR 170, Import price NPR 80), the estimated revenue loss per vehicle over its lifetime would amount to NPR 11,25,000. With 24,000 electric vehicle (EV) sales annually, covering an average distance of 7,000 km per year, the total petrol consumption is 16.8 million liters, leading to an annual revenue loss of NPR 1.26 billion. If all 2,60,000 light passenger vehicles transition to EVs, the annual loss in tax revenue from the non-utilization of petrol would amount to NPR 13.65 billion.

Environmental Implications

Battery Waste Management

Given the swift rise in the import and use of electric vehicles equipped with batteries in Nepal, it is inevitable that the number of batteries powering these vehicles reaching the end of their lifespan will also increase, leading to significant environmental implications. Nepal ratified the Basel Convention in 1996 and categorized any substance outlined in the convention including lithium as hazardous waste due to its highly reactive, explosive, and corrosive nature as metal (Manandhar, 2010). However, Nepal's waste management framework lacks sufficient precautions for the disposal of hazardous waste, such as lithium-ion batteries powering the EVs and does not mandate compulsory recycling where feasible. The majority of batteries are either discarded into the landfill or making their way into India through informal market (Pande, 2020). Battery technology is still evolving and considering Nepal's absence of policies and plans regarding battery waste management, caution should be exercised in deciding whether we ought for drastic EV adoption measures. In addition, the absence of proper battery waste management plan makes Nepal a potential testing ground for emerging technologies, questioning the long-term environmental effects of policies prioritizing private EVs in Nepal.

Carbon Emissions and Pollution Analysis

In 2019, Nepal recorded an overall emission of 23 million metric tons of carbon dioxide (CO_2), according to the Government of Nepal (2021). With a population of 29.7 million inhabitants, this translates to an average emission of 0.5 metric tons of CO_2 per person, as reported by the World Bank in 2020. The country, reliant on imports which constitute 40 percent of its GDP as of 2022, confronts the challenge of implementing stringent climate-conscious policies. While the country contributes negligibly to climate change, accounting for about 0.1 percent of total world

greenhouse gas emissions, its emission rate is increasing quickly (World Bank, 2022). Despite Nepal's minimal contribution to the total global greenhouse gas emissions according to the World Bank in 2022, the debate persists over the necessity of such significant measures.

Carbon emissions do not recognize border and emission from one part of the world have a significant impact on ecosystems, climate, and socioeconomic development in another. Nestled between China and India, Nepal finds itself amidst the world's two largest developing nations, both significant contributors to global carbon dioxide emissions. As a result, Nepal is being impacted by the enormous carbon emissions from the countries that surround it (Jiao et al., 2022).

Because there are fewer environmentally harmful commercial operations in Nepal than in its counterparts, the country has relatively lower GHG emissions. This puts Nepal on track to achieve net zero emissions by 2045 A.D., with its present GHG emissions at a meager 0.1 percent (World Bank, 2022). On the other hand, China and India, two neighboring nations, have emissions that are noticeably greater at 25.88 percent and 6.67 percent, respectively (Climate Watch, 2020).

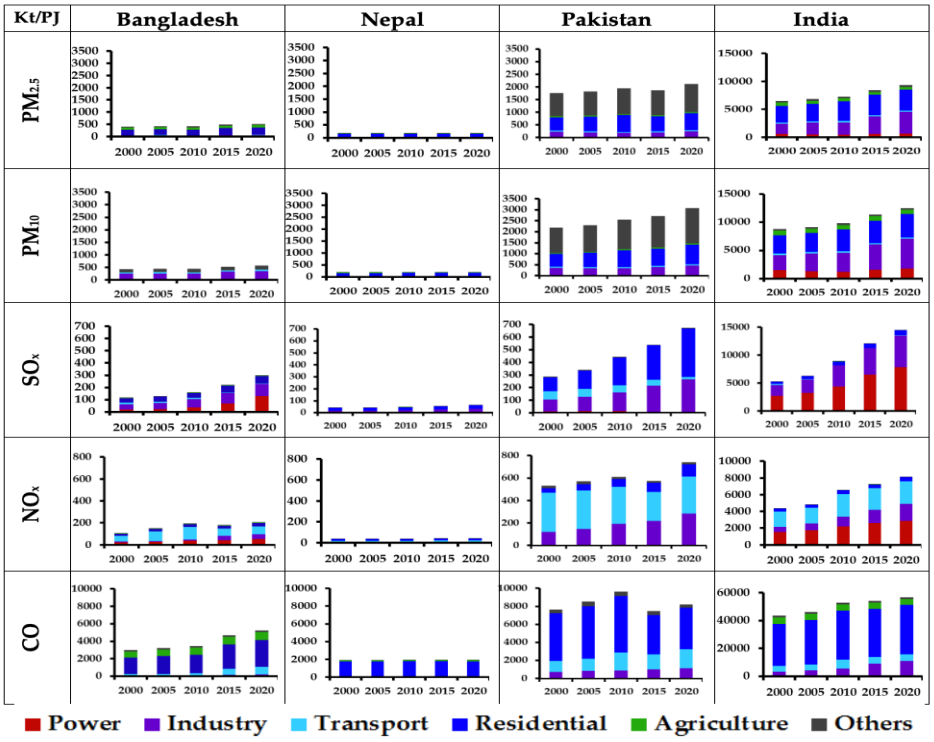
Air pollution in Kathmandu Valley is primarily driven by uncontrolled emissions from vehicles, brick kilns, and the combustion of biomass and garbage. This is compounded by dust from both local fugitive emissions and long-distance transport (Gronskei et al., 1996; Kim et al., 2015; Shakya et al., 2010; Stone et al., 2010, 2012). Identifying and understanding the sources of air pollution is crucial. Factors contributing to the Valley's high pollution levels include the increasing number of vehicles, rapid and unplanned urbanization, population inflow, Valley-centric industrialization, resuspension of dust particles from poor road infrastructures, fuel adulteration, faulty emission inspection programs, weaknesses in the maintenance system, ineffective transport management, and lack of regulations or their enforcement. The Valley's bowl-like topography, low wind speeds that hinder air pollution dispersion, and frequent thermal inversions also exacerbate the problem (Gurung et al., 2017; Saud and Paudel, 2018). Diesel exhaust, recognized as a deadly pollutant and carcinogen, contains 100 times more particulate matter than petrol (USAID, 2003). This is consistent with WHO's report stating that low- and middle-income countries suffer disproportionately from transport-generated pollution due to old and inefficient diesel-powered vehicles (WHO, 2017).

Freight transport trucks and public transportation are the leading contributors to carbon emissions within Nepal's transport sector. According to the TNCR (2021), although freight trucks make up just 9.5% of the total registered vehicle fleet in Nepal, they account for 31% of CO2 emissions from the transport sector (excluding aviation). Public transport also contributes 31%, while cars are responsible for 28% of these emissions. The use of poor-quality diesel with high sulfur content results in a higher concentration of sulfur oxides and particles in the exhaust. Diesel engines emit particles that are predominantly very tiny, with 90% being less than 1 micron in size. These particles, coated with toxic compounds such as polycyclic aromatic hydrocarbons (PAHs), are small enough to penetrate deep into the human body (USAID, 2003).

The rate of increase in vehicle numbers is highest for two-wheelers (motorcycles), which constitute 80% of the vehicle fleet in Kathmandu Valley. This is followed by private vehicles (cars, vans, and jeeps) at 12.42%, heavy-duty vehicles at 4%, public transport vehicles at 2.67%, and others, with an overall annual growth rate of 14% (DOTM 2019). Among public transport vehicles, low-occupancy vehicles like minibuses and microbuses represent 94%, while large buses make up only 6% (JICA 2017). Shrestha et al. (2013) identified low-speed buses and motorbikes as the main sources of emissions in the Kathmandu Valley.

Compared to its neighboring countries, Nepal contributes the least to air pollution. The GAINS source emission indicates significantly higher emission of major pollutants from different sources in India compared to other South Asian countries. The figure below (figure 4) shows the source emission of major pollutants from the four countries followed the order: India>Pakistan>Bangladesh>Nepal. If any country that must adopt stringent mitigation measures to curb their carbon emission, it is China and India. Nepal should be adopting ways to adapt to the impact that we are likely to bear because of their emission.

Figure 4: Source Emission of Major Pollutants from South Asian Countries



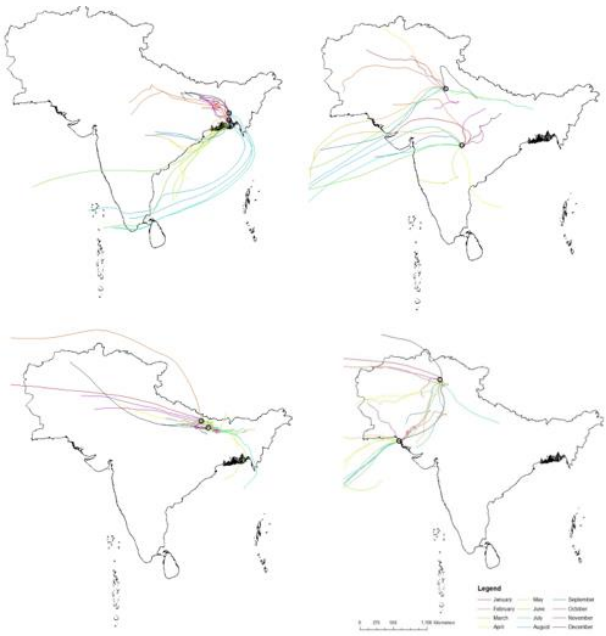
Source: (TERI, 2019)

Transboundary Air Pollution

While ICE is one of the major sources of pollution, it is crucial to understand the mechanism of air pollution first and if the pollution caused in two of the most polluted cities in Nepal, Kathmandu and Lumbini, is due to transportation.

According to DiGiovanni and Fellin (2006), airborne pollutants are classified as transboundary when they cross various geographic zones or geopolitical boundaries. Factors such as terrain, meteorology, and emission levels influence air pollution, particularly transboundary pollution, which is a global environmental concern (Hekmatpour and Leslie, 2022). The figure below illustrates air pollution pathways, indicating the potential for transboundary dispersion across multiple cities. Research suggests that non-South Asian nations may contribute to ambient air pollution in countries like Nepal and Pakistan (TERI, 2019).

Figure 5: Air Parcel back trajectory at different cities of South Asia during different months of the year 2018. Source: TERI (2019)



Meteorological factors like wind speed and direction facilitate the spread of pollutants over long distances from their sources. Communities downwind of this dispersion suffer from pollution originating in upwind areas. Agriculture residue burning, facilitated by transboundary pollutant movement, emerges as a significant cause of air pollution. Uttar Pradesh, Punjab, and Haryana are identified as major contributors to residue burning on farms, which contributes to air pollution (Jain et al. (2014), IPCC). Pollution sources in Lumbini include neighboring regions of India (Rupakheti et al., 2017). Findings in Annex A emphasize the significant role of transboundary air pollution, particularly from agricultural practices, in contributing to pollution levels.

The episodic hazardous pollution levels in the Valley are primarily attributed to wildfire smoke from both neighboring and transboundary areas, with a strong correlation between active fire counts and pollution levels (Kuikel et al., 2024). Particulate matter (PM) produced by wildfires can reach extremely high concentrations, travel vast distances, and impact densely populated areas far from the original source (Johnston et al., 2011).

Public EV Scenario

There may have been a steep growth in EVs in Kathmandu but there is an equally high demand for efficient public transport facilities, especially massive rapid transit system (Aryal et al., 2022). Entrepreneurs in Kathmandu Valley are hesitant to operate electric public vehicles due to high upfront costs, ranging from NPR 1.5 crores to NPR 2 crores per large electric bus (Kafle, 2023).

The cost of fuel over the lifetime of an ICE bus can be substantial. For example, if an ICE bus travels 3,00,000 km in its lifetime and consumes 1 liter of diesel for every 5 km, it would require 60,000 liters of diesel. At a cost of NPR 80 per liter, the total fuel cost would be NPR 48 lakhs. The import price difference in EVs and petrol cars is already high by nearly NPR 18 lakhs as observed in Table 3. This indicates that the upfront cost of an EV bus could be significantly higher than that of an ICE bus.

Given the substantial import costs of large public buses, even with significant duty concessions, private operators often struggle to ensure the financial viability of their investments. Moreover, the prospect of frequent and costly battery replacements due to extensive mileage and challenging road conditions further compounds these financial challenges.

Import of Reconditioned-Vehicles

The ban on reconditioned vehicle imports can be re-evaluated considering age limits and aligning standards with international practices (e.g., Bangladesh, Sri Lanka) to address aspirations for car ownership. Since the import price of second-hand cars is much lower, even if we impose the same duties of 270 percent, cars with very good condition are available at about less than half the price. It will create a very good market for low-priced cars in the country. It also applies to public transport.

Nepal has been importing vehicles that comply with Euro III emission standard since 2013 (CANN, 2012). However, the government has been considering upgrading the emission standard to Euro IV or Euro VI, following the global trend and the example of India, which is the source of most of Nepal's vehicle imports (The Kathmandu Post, 2022). Introduced in 2014, the latest emission standard, Euro 6, was succeeded by Euro 6d in 2017, which underwent further updates in 2020 (acea,2023). It has been updated several times since then to further reduce the emissions of nitrogen oxides (NO), carbon monoxide (CO), hydrocarbons (HC), and particulate matter (PM). In Nepal, the aspiration to afford a car is hindered by the high cost of new vehicles, contributing

to a low rate of car ownership. Taxation further exacerbates the issue. To address these challenges, this argument proposes allowing reconditioned ICE cars with specific criteria: makeup less than 5 years, Euro 6 emission standard, and mileage less than 1,00,000 km. This approach can not only make cars more affordable but also mitigate environmental and social impacts associated with transportation.

Norway maybe a world leader in EV adoption but Norway's favorable conditions for electric vehicle (EV) adoption, driven by high per capita income, a reliable hydropower-based grid, and consistent policy incentives, have made EVs more affordable and popular. With a developed charging infrastructure, consumer awareness, and strong environmental motivation, Norway stands in contrast to Nepal's challenges. Nepal faces hurdles like policy instability, limited resources, and low consumer awareness, hindering widespread EV accessibility and adoption. Addressing these issues could enhance Nepal's transition to EVs, aligning it with successful models like Norway's. Therefore, the shift to electric vehicles (EVs) is an organic progression, and there's no necessity to prematurely burden an economically challenged country like Nepal with an undue financial strain. As battery technology advances and costs align with internal combustion engine (ICE) vehicles, coupled with governmental measures phasing out ICE production to combat climate change, the transition to EVs will naturally occur.

Conclusion

The current approach to EV adoption in the country reflects an immature incentive policy. As the economy faces downturns and resources become scarce, prioritization becomes paramount. However, the current strategy seems to cater primarily to the wealthy and elite segments of society, neglecting the fundamental needs of a significant portion of the population. This pursuit of EV adoption overlooks equity and accessibility concerns, extending disproportionate privileges and incentives that surpass those implemented by EV-producing nations. Moreover, it places a twofold financial strain on the government, depleting foreign reserves and reducing revenue. The focus on catering to wealthy consumers exacerbates the inequity in EV adoption, further widening the gap between different socio-economic segments. Notably, in just eight months of fiscal year 2022/23, the government has incurred substantial losses in tax revenues, primarily benefiting affluent car owners who could have easily afforded higher taxes on their vehicles. The adoption of electric vehicles (EVs) will occur organically over time as advancements in battery technology leads to improved production and lower costs. Instead of relying on tax subsidies to encourage adoption, we should focus on implementing adaptation measures to mitigate the impacts of climate change that we will inevitably face.

Policy Recommendation

- Review fiscal and monetary incentives to analyze their impact on government revenues and foreign exchange reserves, considering the broader national interest.
- Balance fiscal incentives to promote EV adoption while ensuring sustainability of foreign reserves and government revenue.

- Introduce duty structure that will maintain import price differentials between EV and ICE. Our recommendation involves increasing duties to **45 to 50% in 100kW EV** from the existing 35%, which will help maintain the import price differentials.
- Re-evaluate the ban on the import of reconditioned vehicles considering the five-year age limit, less than 1,00,000 km distance travelled, and aligning with Euro 6 standard.
- Promote universal electric cooking. Achieving universal access to electric stoves by next decade, with an interim target of 60 percent by 2030.

References:

A third of the world's children poisoned by lead, new groundbreaking analysis says. (2020, July 29). UNICEF. https://www.unicef.org/press-releases/third-worlds-children-poisoned-lead-new-groundbreaking-analysis-says

Agencies. (2021, November 12). Nepal to construct 23 High-Capacity Transmission Lines across the country. *SpotlightNepal*. https://www.spotlightnepal.com/2021/11/12/nepal-construct-23-high-capacity-transmission-lines-across-country/

Aryal, T. R., Ichihashi, M., & Kaneko, S. (2022). How strong is demand for public transport service in Nepal? A case study of Kathmandu using a choice-based conjoint experiment. *Journal of Economic Structures*, *11*(1). https://doi.org/10.1186/s40008-022-00287-3

Boyle, R. (2024, Jan 22). Overview of carbon emissions produced by Nepal. https://www.emission-index.com/countries/nepal#:~:text=Emissions%20per%20capita%20in%20Nepal,on%20emissions%20produced%20per%20capita

CANN https://walkeasyktm.files.wordpress.com/2012/09/can_vol6_issue8_aug.pdf

Chandrakar, A. (2022, December 21). *Nepal's NEA to build T&D infrastructure in Banke*. Power Line Magazine. https://powerline.net.in/2022/12/21/nepals-nea-to-build-td-infrastructure-in-banke/

Clean Energy Nepal [CEN] & Environment and Public Health Organization [ENPHO]. (2003). Health Impacts of Kathmandu's Air Pollution. In *https://pdf.usaid.gov/pdf_docs/pnacw355.pdf*. USAID. Retrieved August 29, 2024, from https://pdf.usaid.gov/pdf_docs/pnacw355.pdf

Climate Watch Data (2024, Jan 22). Nepal Country Page. https://www.climatewatchdata.org/countries/NPL?end_year=2020&start_year=1990

Climate Watch Data. (2020). China Country Page. https://www.climatewatchdata.org/countries/CHN

Climate Watch Data (2020). India Country Page. https://www.climatewatchdata.org/countries/IND

Department of Customs. (2022/23). Nepal Foreign Trade Statistics Fiscal Year 2079/80.
Department of Customs. (2023/24). Nepal Foreign Trade Statistics Fiscal Year 2080/81.

DoTM (2019) Department of Transport management. Vehicle Registration Statistic Department of Transport Management, Government of Nepal, Kathmandu. Available online: www.dotm.gov.np.

DiGiovanni, F., & Fellin, P. (2006). Transboundary air pollution. Eolss Publishers, Oxford, UK. https://www.eolss.net/sample-chapters/c09/E6-38A-03-04.pdf

Diwakar. (2022, February 25). Nepal wants to upgrade the emission standard to Euro6, but traders aren't ready - OnlineKhabar English. *OnlineKhabar English News*. https://english.onlinekhabar.com/upgrade-emission-standard-euro6.html

Economic Survey. (2020-21) *Government of Nepal. Ministry of Finance.* https://www.mof.gov.np/uploads/document/file/1633341980_Economic%20Survey%20(Engslish)%202020-21.pdf

FTS FY 2079/80 — customs.gov.np. (2016, December 15). customs.gov.np". https://www.customs.gov.np/page/fts-fy-207980

Fact sheet: 'Euro' pollutant emission standards. (2023, April 6). ACEA - European Automobile Manufacturers' Association. https://www.acea.auto/fact/fact-sheet-the-euro-pollutant-emission-standards/

JICA (2017) Japan International Cooperation Agency. The Project on Urban Transport Improvement for Kathmandu Valley in Federal Democratic Republic of Nepal Final Report May 2017. Available online: https://openjicareport.jica.go.jp/pdf/12289674.pdf.

Johnston, F., Hanigan, I., Henderson, S., Morgan, G., & Bowman, D. (2011). Extreme air pollution events from bushfires and dust storms and their association with mortality in Sydney, Australia 1994–2007. *Environmental Research*, *111*(6), 811–816. https://doi.org/10.1016/j.envres.2011.05.007

Gauchan, B. (2023, February 6). राष्ट्रिय प्राथमिकता बिजुली गाडी कि बिजुली चुलो? *Ukaalo*. https://www.ukaalo.com/opinion/230205-electric-vehicle-or-stove-priorities-nepal/3862

Gauchan, B.. (2021, November 19). *इभीमा सहुलियतले प्रचार गरेजस्तो अर्थ-वातावरणीय योगदानको सम्भावना छैनः अर्थशास्त्री गौचन*. BIZMANDU. https://bizmandu.com/content/20211119140417.html?fbclid=IwAR2yiyvX-rLP17fGYOjiBE5mQNqfGYbxl_kG9wAkigrtIUO2VjN9JC9uuWE

Global Trade in Used Vehicles Report. (2020, Dec 28). *UNEP*. https://www.unep.org/resources/report/global-trade-used-vehicles-report

GoN, (2021). Nepal's Long-term Strategy for Net-zero Emissions. https://unfccc.int/sites/default/files/resource/NepalLTLEDS.pdf

Government of Nepal. (2020, December 8). *Second Nationally Determined Contribution (NDC)*. climate.mohp.gov.np. https://climate.mohp.gov.np/attachments/article/167/Second%20Nationally%20Determined%20Contribution%20(NDC)%20-%202020.pdf

Government of Nepal. (2021, October). *Nepal's Long-term Strategy for Net-zero Emissions*. unfccc.int. https://unfccc.int/sites/default/files/resource/NepalLTLEDS.pdf

Gronskei, K. E., Gram, F., Hagen, L. O., and Larssen, S.: Urban Air Quality Management Strategy in Asia (URBAIR): Kathmandu valley report, Tech. Rep. 52906, World Bank, 1996.

Gurung, A., Levy, J. I., & Bell, M. L. (2017). Modeling the intraurban variation in nitrogen dioxide in urban areas in Kathmandu Valley, Nepal. *Environmental Research*, *155*, 42–48. https://doi.org/10.1016/j.envres.2017.01.038

Hakam, D. F., Nugraha, H., Wicaksono, A., Rahadi, R. A., & Kanugrahan, S. P. (2022). Mega conversion from LPG to induction stove to achieve Indonesia's clean energy transition. *Energy Strategy Reviews*, *41*, 100856. https://doi.org/10.1016/j.esr.2022.100856

Hongshi Cement Industry receives power supply from national grid. (2021, Nov 14). *myRepublica*. https://myrepublica.nagariknetwork.com/news/hongshi-cement-industry-receives-power-supply-from-national-grid

How Many Miles Does a Car Last?. Hearst Autos Research. https://www.caranddriver.com/research/a32758625/how-many-miles-does-a-car-last/

https://english.ratopati.com/story/30960#:~:text=Consumers%20in%20Nepal%20are%20looking,lakh%20in%20battery%20prices%20alone.

Imports of Fuel-Powered vehicles declines. (2023, July 30). https://www.newbusinessage.com/Articles/view/18591

Jaeger, J. (2023.). *These countries are adopting electric vehicles the fastest*. World Resources Institute. https://www.wri.org/insights/countries-adopting-electric-vehicles-fastest

Kafle, L. 2023, Sep 17. Growing use of EVs: Good for economy and environment. *The Rising Nepal*. Available at: https://risingnepaldaily.com/news/32523

Khanal, S., Pokhrel, R. P., Pokharel, B., Becker, S., Giri, B., Adhikari, L., & LaPlante, M. D. (2022). An episode of transboundary air pollution in the central Himalayas during agricultural residue burning season in North India. Atmospheric Pollution Research, 13(1), 101270. https://www.sciencedirect.com/science/article/abs/pii/S1309104221003329

Kim, B. M., Park, J.-S., Kim, S.-W., Kim, H., Jeon, H., Cho, C., Kim, J.-H., Hong, S., Rupakheti, M., Panday, A. K., Park, R. J., Hong, J., and Yoon, S.-C.: Source apportionment of PM10 mass and particulate carbon in the Kathmandu Valley, Nepal, Atmos. Environ., 123, 190–199, https://doi.org/10.1016/j.atmosenv.2015.10.082, 2015.

Lithium-Ion Battery Pack Prices Ht Record Low of $139/kWh. (2023, Nov 26). *BloombergNEF*. https://about.bnef.com/blog/lithium-ion-battery-pack-prices-hit-record-low-of-139-kwh/

Madhulatha, C., & Meena, D. C., (2020) Stubble Burning: A Major Cause For Air Pollution. https://agriallis.com/wp-content/uploads/2020/02/STUBBLE-BURNING-A-MAJOR-CAUSE-FOR-AIR-POLLUTION.pdf

Maharjan, R. (2024, Jan 22). Exploring Nepal's Green Finance Environment. Nepal Economic Forum. https://nepaleconomicforum.org/exploring-nepals-green-finance-environment/

Manandhar, A. B. (2010). Managing Hazardous Wastes: Final Report on Hazardous Waste Policy Study. *Asian Development Bank (ADB)*.

McGrath, M. (2020, Oct 26). Climate change: 'Dangerous and dirty' used cars sold to Africa'. *BBC*. https://www.bbc.com/news/science-environment-54665545

Ministry of Forests and Environment. (2021, March). Assessment of Electric Mobility Targets for Nepal's 2020 Nationally Determined Contributions (NDC)

Nepal Electricity Authority A Year in Review-Fiscal Year 2022/23. (2023, August). Nepal Electricity Authority. https://www.nea.org.np/annual_report

Nepal exports electricity to India after a gap of over five months. (2023, May 28). *The Kathmandu Post*. https://kathmandupost.com/national/2023/05/28/nepal-exports-electricity-to-india-after-a-gap-of-over-five-months

Nepal Rastra Bank. (2021, September 16). *Impact of privatization in Nepal - नेपाल राष्ट्र बैंक*. नेपाल राष्ट्र बैंक. https://www.nrb.org.np/er-article/impact-of-privatization-in-nepal/

Neupane, P. R., Bajracharya, I., Manandhar, B. R., Prajapati, M., Sujakhu, H., & Awal, P. (2020). Estimating Emission Load from Road Transportation within the Bhaktapur Municipality, Nepal. *Journal of Environmental and Public Health*, *2020*, 1–9. https://doi.org/10.1155/2020/2828643

Petrol prices. (n.d.). https://noc.org.np/petrol

Press Information Bureau (PIB) India, 2022, Electric Vehicles Manufactures registered under FAME-India Scheme phase-II. (n.d.). https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1806139

Pande, K.R. (2020). National Strategy for Electrification of Public Transport. https://www.unescap.org/sites/default/d8files/event-documents/Report_Strategy_on_electrifying_public_transport_0.pdf

Poudel, D. (2018, July 4). 3.1 million motor vehicles on Nepali roads: DoTM. *My Republica*. https://myrepublica.nagariknetwork.com/news/3-1-million-motor-vehicles-on-nepali-roads-dotm/

Prajapati, A., Bajracharya, T. R., & Bhattrai, N. (2017). *Driving factors of Energy consumption in Transport Sector*. conference.ioe.edu.np. https://conference.ioe.edu.np/publications/ioegc2017/IOEGC-2017-38.pdf

Prasain, K. (2022, February 2). *Nepal's electric vehicle imports surge after tax cuts https://tkpo.st/3L3eECj*. kathmandupost.com. https://kathmandupost.com/money/2022/02/02/nepal-s-electric-vehicle-imports-surge-after-tax-cuts

Prasain, K. (2023, March). Auto loans are back as cash crunch eases and import ban ends. *The Kathmandu Post.* https://kathmandupost.com/money/2023/03/23/auto-loans-are-back-as-cash-crunch-eases-and-import-ban-ends

Prasain, K.(2022, August). Electric vehicle imports see-saw as government policy fluctuates. *The Kathmandu Post.* https://kathmandupost.com/money/2022/08/08/electric-vehicle-imports-see-saw-as-government-policy-fluctuates

Rauniyar. T. 2022, Jun 25. Nepal's Big EV Bet: Is it a genuine push toward a cleaner—and safer—nation?. *Foreign Policy*. Available at: https://foreignpolicy.com/2022/06/25/nepal-ev-electric-vehicles-environmental-policy-traffic-congestion-roads-industry/

Rajput, A. (2023, August 29). "Next EV policy to focus on charging infra, making incentives attractive." *The Times of India*. https://timesofindia.indiatimes.com/city/delhi/next-ev-policy-to-focus-on-charging-infra-making-incentives-attractive/articleshow/103162051.cms

Regmi, R. P., Kitada, T., & Kurata, G. (2003). Numerical simulation of late wintertime local flows in Kathmandu valley, Nepal: Implication for air pollution transport. Journal of Applied Meteorology, 42(3), 389-403. https://journals.ametsoc.org/view/journals/apme/42/3/1520-0450_2003_042_0389_nsolwl_2.0.co_2.xml

Republica. (2023, Jan 22). Rising Carbon Emissions, Nepal and Its Neighbors. My Republica. https://myrepublica.nagariknetwork.com/news/rising-carbon-emissions-nepal-and-its-neighbors/

Rupakheti, D., Adhikary, B., Praveen, P. S., Rupakheti, M., Kang, S., Mahata, K. S., ... & Lawrence, M. G. (2017). Pre-monsoon air quality over Lumbini, a world heritage site along the Himalayan foothills. Atmospheric Chemistry and Physics, 17(18), 11041-11063. https://acp.copernicus.org/articles/17/11041/2017/acp-17-11041-2017.pdf

Sajha Yatayat bringing 37 new electric buses from China. (2022, Sep 30). *Onlinekhabar*. https://english.onlinekhabar.com/sajha-yatayat-37-new-electric-buses.html

Sales of EVs increasing in Nepal. (2023, January 17). https://www.newbusinessage.com/Articles/view/16765

Shakya, K. M., Ziemba, L. D., and Griffin, R. J.: Characteristics and Sources of Carbonaceous, Ionic, and Isotopic Species of Wintertime Atmospheric Aerosols in Kathmandu Valley, Nepal, Aerosol Air Qual. Res., 10, 219–230, https://doi.org/10.4209/aaqr.2009.10.0068, 2010.

Shrestha SR, Oanh NTK, Xu Q, Rupakheti M, Lawrence MG (2013) Analysis of the vehicle fleet in the Kathmandu valley for estimation of environment and climate co-benefits of technology intrusions. Atmos Environ 81:579–590

Shrestha, M. (2021, October 29). *Reducing Pollution from Motorcycles - ICIMOD*. ICIMOD - International Centre for Integrated Mountain Development. https://www.icimod.org/reducing-pollution-from-motorcycles/

Stone, E. A., Schauer, J. J., Pradhan, B. B., Dangol, P. M., Habib, G., Venkataraman, C., and Ramanathan, V.: Characterization of emissions from South Asian biofuels and application to source apportionment of carbonaceous aerosol in the Himalayas, J. Geophys. Res.-Atmos., 115, D06301, https://doi.org/10.1029/2009JD011881, 2010.

Stone, E. A., Nguyen, T. T., Pradhan, B. B., and Man Dangol, P.: Assessment of biogenic secondary organic aerosol in the Himalayas, Environ. Chem., 9, 263–272, https://doi.org/10.1071/EN12002, 2012.

Technology Khabar (2022, November 29). Nabil Bank will provide credit facilities for Hyundai EV and ICE vehicles. *Technology Khabar*. https://technologykhabar.com/2022/11/29/123939/

Thapa. B. 2023, Mar 24. Inclusive green growth. *The Kathmandu Post*. Available at: https://kathmandupost.com/columns/2023/03/23/inclusive-green-growth

'Nepal's Third National Communication to the United Nations Framework Convention on Climate Change (UNFCCC)'. Ministry of Forest and Environment, Nepal, June 2021.

What are countries doing to drive electric vehicle sales? (2022, May 20). World Economic Forum. https://www.weforum.org/agenda/2021/06/electric-vehicles-financial-incentives/

World Health Organization (WHO), Health and sustainable development, 2017, http://www.who.int/sustainable-development/transport/health-risks/air-pollution/en/.

World Bank Group. (2022, September 30). Integrating Climate Change into Nepal's Development Strategy Key to Build Resilience, Says New World Bank Group Report. *World Bank*. https://www.worldbank.org/en/news/press-release/2022/09/15/integrating-climate-change-into-nepal-s-development-strategy-key-to-build-resilience-says-new-world-bank-group-report

World Bank Group. (2022). *Country Climate and Development Report, Nepal.* https://hdl.handle.net/10986/38012

World | Total including LUCF | Greenhouse Gas (GHG) Emissions | Climate Watch. (n.d.). https://www.climatewatchdata.org/ghg-emissions?breakBy=regions&calculation=ABSOLUTE_VALUE&end_year=2020&start_year=1990

World Bank Open Data. (n.d.). World Bank Open Data. https://data.worldbank.org/indicator/EN.ATM.CO2E.PC?locations=NP

Yadav, S.N. (2023, Oct 4). Electric Vehicles' Future in Nepal. *Ratopati*.

चार महिनामा भित्रिए करिब ६ अर्बका २७ सय ८७ वटा विद्युतीय गाडी. (2023, November 27). Clickmandu. https://clickmandu.com/2023/11/277960.html

ANNEX A

Studies on Transboundary Pollutant Movement

Study	Key Findings
Regmi et al. (2003)	Meteorological models reveal that two different local flows approach the Kathmandu valley/basin in the afternoon, contributing to a double-layered structure. Colder southwesterly air mass from the Indian Plain forms the bottom layer, reducing midday ventilation and raising air pollution in the Kathmandu basin.
Jain et al. (2014), IPCC	**Uttar Pradesh, Punjab, and Haryana** identified as major contributors to residue burning on farms.
Dias (2017)	India's hazardous air, especially during the summer, enters Nepal, causing a heavy smoky haze. Transboundary air pollution is widespread in parts of Nepal sharing a border with India, impacting public health. Despite being outlawed, stubble burning continues, with lax enforcement by State Pollution Control Boards and opposition from manufacturers to anti-burning regulations.
Rupakheti et al. (2017)	Severe air pollution events in **Lumbini** caused by **agro-residue burning** and regional forest fires, amplified by meteorological conditions conducive to pollutant transmission. Main sources of pollution in Lumbini identified as the Ganges Valley, neighboring regions, and different parts of India and Nepal.
TERI (2019)	Research indicates that periods of high PM2.5 concentrations coincide with predicted **transboundary pollutant movement**, with pollutants from agricultural burning in upwind regions of India significantly contributing to heightened air pollution levels.
Madhulatha and Meena (2020)	Approximately 500 million tons of agricultural harvest products, known as stubble, burnt every winter in **Punjab and Haryana**, contributing to air pollution. Stubble burning outlawed since the 1990s, but enforcement is lax, with negative environmental effects.
Khanal et al. (2022)	Significant rise in PM2.5 levels in Nepal due to **transboundary aerosol movement** from **agricultural residue burning** (ARB) in northwest India. Periodic transboundary transfer of pollutants across the Mahabharat range to Kathmandu and higher elevations, influenced by regional synoptic and mesoscale dynamics. Cross-border air pollution negatively impacts public health, especially in areas sharing a border with India.

Table 5 lists literature on transboundary air pollution mainly accounting for the pollution caused in bordering cities caused by agro-residue burning in Uttar Pradesh, Haryana and Punjab.

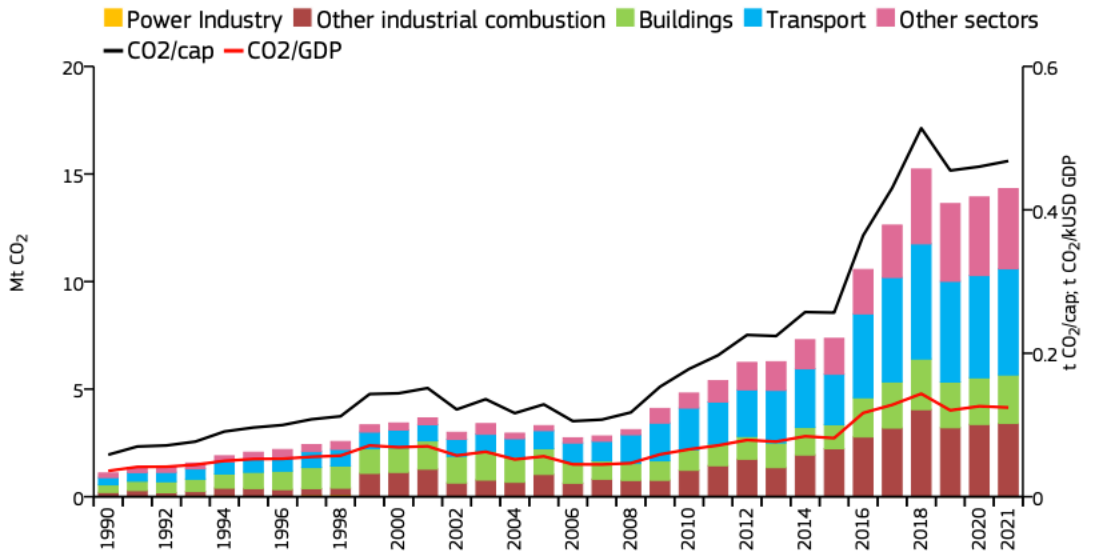
Extra literature FOR EC:

Nepal uses energy in agriculture, transportation, industry, and commercial and residential sectors. As per the 2019 baseline assessment, residential, transportation, industrial, commercial, and agricultural energy use contributes to emissions in descending order. Thus, to reduce carbon emissions in the residential sector the use of liquified petroleum gas (LPG) must be reduced and more electrical appliances e.g. electric cooking and biogas must be used.

https://unfccc.int/sites/default/files/resource/NepalLTLEDS.pdf

Nepal

Fossil CO_2 emissions by sector



Year	CO_2 emissions Mt CO_2/yr	CO_2 emissions per capita t CO_2/cap/yr	CO_2 emissions per unit of GDP PPP t CO_2/kUSD/yr	Population
2021	14.314	0.468	0.124	30.578M
2020	13.927	0.460	0.126	30.260M
2005	3.300	0.129	0.056	25.640M
1990	1.098	0.059	0.036	18.749M

	2021 vs 1990	2021 vs 2005	2021 vs 2020
Power Industry		-100%	+4%
Other industrial combustion	+1572%	+233%	+1%
Buildings	+539%	+88%	+4%
Transport	+1357%	+490%	+4%
Other sectors	+1733%	+1545%	+2%
All sectors	+1204%	+334%	+3%

Source:(Crippa et al., 2022)
https://edgar.jrc.ec.europa.eu/booklet/CO2_emissions_of_all_world_countries_2022_report.pdf