Economics of transition to Euro 6/VI fuel

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Foreword

In a world where technology has been advancing, with focus shifting from industrialization to climate change, sustainability and saving the environment, most countries have implemented strict emission standards. Transport is a major cause of air pollution globally, and realizing this issue, countries across the globe have adopted either directly, or their own versions of the Euro Emission Standards, formulated by the European Union. Majority of the developed countries, like the EU, USA, China, Japan, Singapore, etc. are already following Euro 6/VI version of emission standards. The SMS, however, are lagging behind. Barring India, which recently implemented the BS VI (Bharat Stage VI) standards, which is equivalent to Euro 6/VI standards, all other countries are at Euro 2/ Euro 3 or Euro 4 standards.

Rising air pollution is a key concern in the SAARC region which needs to be controlled. The Euro 6/VI standards are a significant improvement over older standards, reducing emissions of SO_x, NOx, CO and PM significantly. However, it involves significant costs, which increases the price of fuel as well. Thus, SAARC Energy Centre has conducted this study, to examine the "Economics of transition to Euro 6/VI fuel" in SAARC region.

The study evaluates the current scenario of pollution and emission levels in SAARC Member countries, and the current emission standards and further evaluates the economic viability of moving to Euro 6 fuel standards for both petrol and diesel, in each SAARC Member State. It takes into consideration, all related factors such as costs/resources for refinery upgradation, impacts on end consumer and vehicle stock, fuel import strategies, and environmental/climate benefits etc.

Based on the assessment, the study recommends a detailed roadmap for each Member State taking into consideration its ground realities such as technical, financial, fiscal, and political situation; policy regulations, refinery readiness; pricing mechanism, allied industry; user/vehicle aspects etc. The study also assesses the time period for each SMS will require for an effective transition into euro 6 fuel in addition to the recommended roadmap. Moreover, the study also provides a benchmark of cost implication of transitioning to the upgraded standards of emission while highlighting the potential savings from reduced air pollution and fuel consumption.

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Abbreviations

ATF	Aviation Turbine Fuel
BAU	Business As Usual
bpd	Barrels per day
BRT	Bus Rapid Transport
BS	Bharat Stage
CAGR	Compound Annual Growth Rate
CASE	Clean Air and Sustainable Environment
CBU	Completely Built Units
CCR	Catalyst Regeneration
CDM	Clean Development Mechanism
CEA	Central Environmental Authority
CKD	Completely Knockdown Unit
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO_2	Carbon Di Oxide
COP	Conference of the Parties
CPC	Ceylon Petroleum Corporation
CSO	Central Statistical Organization
CVF	Climate Vulnerable Forum
CY	Calendar Year
DHDS	Diesel Hydro De-Sulphurising
DRC	Department of Revenue and Customs
EAC	Economic Affairs Committee
EPAs	Environmental Protection Agencies
EPD	Environment Protection Department
EPIC	Energy Policy Institute, Chicago
ERL	Eastern Refinery Limited
EU	European Union

EVs	electric vehicles
FCC	Fluidized Catalytic Cracking
FO	Furnace Oil
FY	Fiscal Year
GDP	Gross Domestic Product
GHG	Greenhouse Gases
HC	Hydrocarbons
HDV	heavy-duty vehicles
HOBC	High Octane Blending Component
HSD	High Speed Diesel
IBFPL	India-Bangladesh Friendship pipeline
ICCT	International Council on Clean Transportation
IMF	International Monetary Fund
INDC	Intended Nationally Determined Contribution
IOCL	Indian Oil Corporation
IRENA	International Renewable Energy Agency
kW	Kilo watt
kWh	Kilo watt hour
LEDS	Low Emission Development Strategies
LEVs	low emission vehicles
LMIC	low- and middle-income countries
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MNOC	Maldives National Oil Company
MoCC	Ministry of Climate Change
MPRD	Ministry of Petroleum Resources Development
MRT	Mass Rapid Transport
MS	Motor Spirit
MTPA	Million Tonne Per Annum
MW	Mega Watt
NAP	National Action Plan

NDC	Nationally Determined Contribution
NEPA	National Environmental Protection Agency, Afghanistan
NEQS	National Environmental Quality Standards
NEVP	National Electric Vehicles Policy
NO_x	Nitrogen Oxides
NPR	Nepal Rupee
PARCO	Pak Arab Refinery Limited
PEPA	Pakistan Environmental Protection Act
PEVMA	Pakistan Electric Vehicles Manufacturing Association
PM	Particulate Matter
PN	Particulate number
POL	Petroleum, Oil and Lubricants
PUC	Pollution Under Control
RRA	Renewable Readiness Assessment
SAARC	South Asian Association for Regional Cooperation
SHDP	Sustainable Hydropower Development Policy
SKO	Superior Kerosene Oil
SLCP	Short Lived Climate Pollutants
SMSs	SAARC Member States
SUV	Sport utility vehicle
THC	Total Hydrocarbon
UAE	United Arab Emirates
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	US Dollars
VOC	Volatile Organic Compounds
WHO	World Health Organization

Currency conversion rates used

Currency	Conversion Factor for 1 USD
Bangladeshi Taka (BDT)	85
Indian Rupee (INR)	70
Pakistani Rupee (PKR)	154

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Executive Summary

Introduction- high pollution and need for switch to stringent emission standards

SAARC region has the most polluted countries in the world. Bangladesh, Pakistan and India are amongst the highest polluted by particulate matter (PM2.5) globally. The World Health Organization's air quality guidelines recommend that the annual mean concentrations of PM2.5 should not exceed 10 µg/m^3 and 20 µg/m^3 for PM10. Barring Maldives, all other SMS are significantly above the WHO specified benchmarks.

[1]Table 1: PM 2.5 levels in SAARC Member States (in mg/m^3)

Countries	2015	2016	2017	2018	2019
Afghanistan	60.6	57.2	53.4	52.8	52.4
Bangladesh	69	67.8	62.8	63.3	63.4
Bhutan	44.5	43.6	40.2	40.4	40.3
India	88.4	92.2	81.8	83	83.2
Maldives	10.2	12.1	11.2	10.9	10.9
Nepal	88.7	91.5	80.6	82.7	83.1
Pakistan	66.9	68.7	61.8	62.4	62.6
Sri Lanka	19	20.7	19.9	19.7	20

Carbon emissions have been consistently increasing in the region for the last few years. There are several factors contributing to high level of emissions such as foreign investment, economic growth, energy consumption, rising labour force, urban population, inflation, tourism, transport, etc. Per capita CO_2 emissions have increased rapidly in the region over the last 10 years with increasing development.

[2]Table 2: Per capita CO_2 emissions in the SAARC region (in tonne)

Countries	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	CAGR %
Afghanistan	0.16	0.21	0.30	0.41	0.34	0.26	0.23	0.23	0.21	0.20	0.20	2.4%
Bangladesh	0.29	0.31	0.34	0.36	0.38	0.40	0.41	0.46	0.47	0.49	0.51	5.9%
Bhutan	0.60	0.55	0.69	0.97	1.08	1.20	1.31	1.32	1.67	1.78	1.83	11.9%
India	1.19	1.29	1.35	1.41	1.51	1.54	1.65	1.64	1.65	1.72	1.80	4.3%
Maldives	2.53	2.58	2.62	2.65	2.87	2.72	3.13	2.97	3.68	3.67	3.70	3.9%
Nepal	0.11	0.14	0.17	0.19	0.22	0.23	0.26	0.24	0.34	0.40	0.43	14.3%
Pakistan	0.83	0.83	0.78	0.77	0.77	0.76	0.79	0.82	0.89	0.95	0.98	1.7%
Sri Lanka	0.64	0.61	0.65	0.76	0.82	0.70	0.85	0.97	1.03	1.09	1.00	4.5%

[1] Source: State of Global Air Report 2020
[2] Source: World Bank

Brief about Euro 6/VI standards

The European Commission adopted a Thematic Strategy on Air Pollution in 2005 with an objective to reduce vehicular emissions to improve overall air quality. The Euro 6/VI emission standards specifically noted that a "considerable reduction in NO_X [oxides of nitrogen] emissions from diesel vehicles is necessary to improve air quality and comply with limit values for air pollution".

The regulations for light-duty vehicles are termed as Euro 6 while the regulations for heavy-duty vehicles are termed as Euro VI. Euro 6 are a significant advancement over earlier emission standards, especially with regards to NOx limits. According to ICCT (2016) A technical summary of Euro 6/VI vehicle emission standards, the NOx limit for diesel-based vehicles declines from 0.18 gm/km for Euro 5 to 0.08 gm/km in Euro 6, a reduction of 56%. Whereas, compared to Euro 3 levels, there is ~84% reduction in NOx emission. This has major implications on control technologies like the introduction of catalytic reduction, lean NOx traps, etc. For particle mass limits, the Euro 6 limits for diesel cars represent a reduction of 96% from Euro 1 limits.

[3]Table 3: European emission standards for passenger cars, g/km

Tier	Date (type approval)	Date (first registration)	CO	THC	VOC	NO*x*	HC+NO*x*	P	PN [#/km]
Diesel									
Euro 6d	January 2020	January 2021	0.50	-	-	0.080	0.170	0.0045	6×10^{11}
Petrol									
Euro 6d	January 2020	January 2021	1.0	0.10	0.068	0.060	-	0.0045**	6×10^{11}

*** Applies only to vehicles with direct injection engines*

**** 6×10^{12}/km within first three years from Euro 6b effective dates*

† Values in parentheses are conformity of production (COP) limits

For heavy-duty diesel vehicles, there is a reduction in NOx limits from Euro V to Euro VI by around 80%. The limits reduced from 2 gm/kWh to 0.4 gm/kWh in steady state testing, and from 2gm/kWh to 0.46 gm/km in transient testing. The particle mass limit was also significantly reduced, from 0.02 gm/kWh to 0.01 gm/kWh on steady-state testing, and from 0.03 gm/kWh to 0.01 gm/km on transient testing, a reduction of 66%. The Euro VI standards include for the first time a particle number limit.

[4]Table 4: European emission standards for heavy-duty diesel engines, g/kWh

Tier	Date	Test cycle	CO	HC	NO*x*	NH_3 [ppm]	PM	PN [#/kWh]	Smoke [m^{-1}]
Euro VI	31 December 2012	WHSC	1.5	0.13	0.4	10	0.01	8×10^{11}	
		WHTC	4.0	0.16	0.46	10	0.01	6×10^{11}	

[3] Source: International Council on Clean Transportation
[4] Source: International Council on Clean Transportation

Status of SAARC Countries in terms of emissions

Europe first introduced heavy-duty vehicle emission standards in 1988. The "Euro" track was established in 1992 with increasingly stringent standards implemented every few years. Many countries have since developed regulations aligned in large part with the European standards. Euro VI-equivalent standards are already in place in the United States, Canada, the European Union, Japan, South Korea, Singapore and Turkey. India has implemented Euro VI equivalent standards beginning April 1, 2020, and China and Mexico have planned to adopt in 2021.

[5]Figure 1: Status of Euro (or equivalent) emission standards across major countries

Year	2005				2010				2015				2020			
EU	Euro 4				Euro 5				Euro 6							
Australia	Euro 3				Euro 4				Euro 5							
Brazil	Euro 2	Euro 3				Euro 5										
Canada	Euro 4				Euro 5				Euro 6							
China	Euro 2				Euro 3				Euro 4				Euro 5			
India	Euro 2								Euro 3							
Indonesia									Euro 2							
Japan	Euro 3				Euro 4				Euro 6							
South Korea	Euro 3	Euro 4				Euro 5							Euro 6			
Singapore	Euro 2	Euro 4											Euro 5			
Mexico	Euro 3				Euro 4											
Russia	Euro 1	Euro 2			Euro 3								Euro 4			
Saudi Arabia					Euro 2											
Turkey	Euro 1				Euro 4				Euro 5							
United States	Euro 4				Euro 5				Euro 6							

In the SAARC region, as mentioned above, only India has moved to Euro 6/VI equivalent standards across the country for all vehicle categories. Sri Lanka has transitioned to Euro 4, whereas Pakistan, Bhutan and Bangladesh are following Euro 2 norms. Pakistan had planned to switch to Euro 5 standards and post August 2020, Euro V petrol was introduced in the country followed by Euro V diesel introduced in Jan 2021, through imports and a leading domestic refinery offering the upgraded fuel in addition to the euro 2 fuel. Bangladesh, which had earlier planned a transition from Euro 2 to Euro 3 by 2020, is now planning to leapfrog into Euro 5 by 2025.

[6]Figure 2: Status of Euro (or equivalent) emission standards across SAARC Countries

Year	2005				2010				2015				2020			
India	Euro 2								Euro 3				Euro 4			Euro 6
Pakistan					Euro 2[a]			Euro 2[b]								
Bangladesh	Euro 2															
Sri Lanka	Euro 1				Euro 2								Euro 4			
Nepal	Euro 1								Euro 3							
Bhutan	Euro 2															
Afghanistan													Euro 3			
Maldives*																

a: Gasoline; b: Diesel

**Maldives imports most of its fuel from UAE and Singapore, which are already at Euro 4 and Euro 6 standards.*

[5] Source: CRISIL Research
[6] Source: CRISIL Research

Assessment of transition to Euro 6/VI in SAARC Countries

The demand for automotive fuel is rising in the SAARC region led by the key developing countries. Some of the SMS have already planned for upgrading to newer fuels. These plans include:

- Pakistan is likely to implement Euro 5 emission standards. As a consequence of which the government of Pakistan ordered all fuel imports to be Euro 5 compliant in June 2020.
- Bangladesh has planned to shift to Euro 5 as against its earlier plans to switch to euro 3.
- Nepal has currently implemented Euro 3 standards ,however, with India's transition to Euro 6/VI in 2020, Nepal has already been switched to the newer fuels as it is dependent on India for the country's fuel imports.

However, currently only India is at Euro 6/VI standards while it is imperative for other countries to adopt similar standard in order to meet the NDC of Paris Agreement as well other environmental commitments.

Refining and auto industry in the SAARC Member States

Refining capacity is located only in Bangladesh, India, Pakistan, and Sri Lanka among the SAARC Member States. Out of these countries, Pakistan has a total refining capacity of about 20 mtpa, divided among Pak-Arab Refinery Ltd, National Refinery Ltd, Pakistan Refinery Ltd, Attock Refinery Ltd, Byco oil Pakistan Ltd, and Byco Petroleum Pakistan Ltd. Bangladesh and Sri Lanka have 1.5 and 2.5 mtpa capacity respectively. These countries will be required to undertake capacity upgradation for switching to Euro 6/VI standards.

The primary components of the additional per-gallon refining cost associated with meeting a new, more stringent gasoline or diesel Sulphur standard are:

- Capital cost associated with new or upgraded process capacity and support facilities.
- Cost of hydrogen supply: Hydrogen consumption in the various processes involved in sulphur control depends on the refinery crude slate and the operating severity in the various processes.
- Cost of replacing lost product yield: Hydrotreating processes always incur some yield loss, as a result of unwanted (but unavoidable) side reactions that convert hydrotreater feed material into light gases. The yield loss is small, usually on the order of ≈ 1 vol%), but increases with increasing hydrotreating severity.
- Cost of replacing lost gasoline octane: FCC naphtha hydrotreating results in a loss of ≈ 1½ octane numbers. The lost octane must be made up by increased output of upgrading units, primarily reforming, with attendant operating costs.

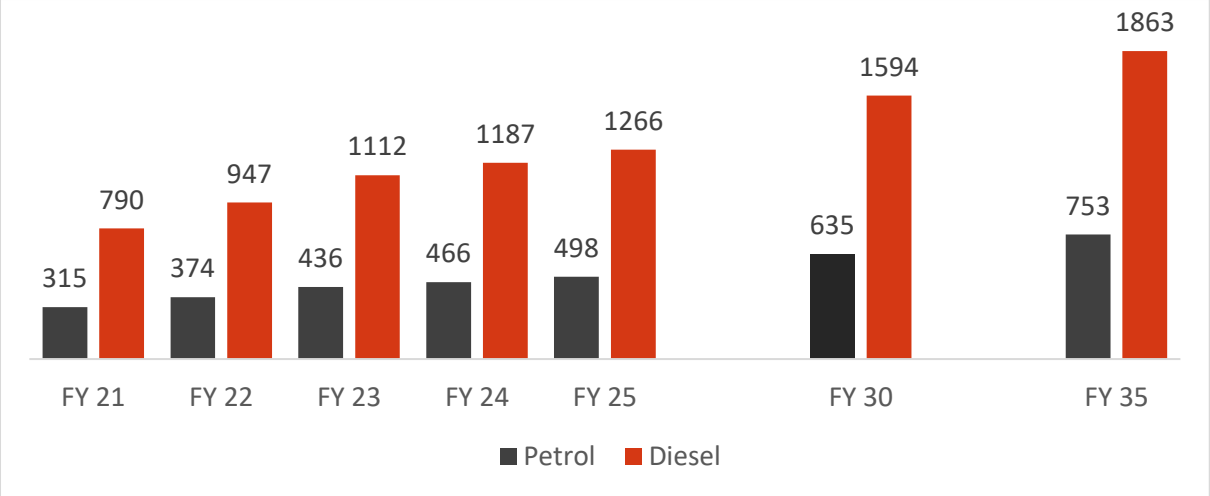
Finally, the refining cost of meeting a new, more stringent ULSF (ultra-low Sulphur fuels) standard is a function of the new Sulphur standard and the prior Sulphur standard. Other countries are likely to witness an escalation in price of the imported fuel.

Automotive industry in some SMS such as Afghanistan, Bhutan, Maldives, and Sri Lanka depends entirely on imported vehicles . While domestic manufacturing facilities are located in Pakistan, India and sparsely in Bangladesh and Nepal. The cost of vehicles complying with Euro 6/VI standards is high and therefore will cost the manufacturers or importers directly.

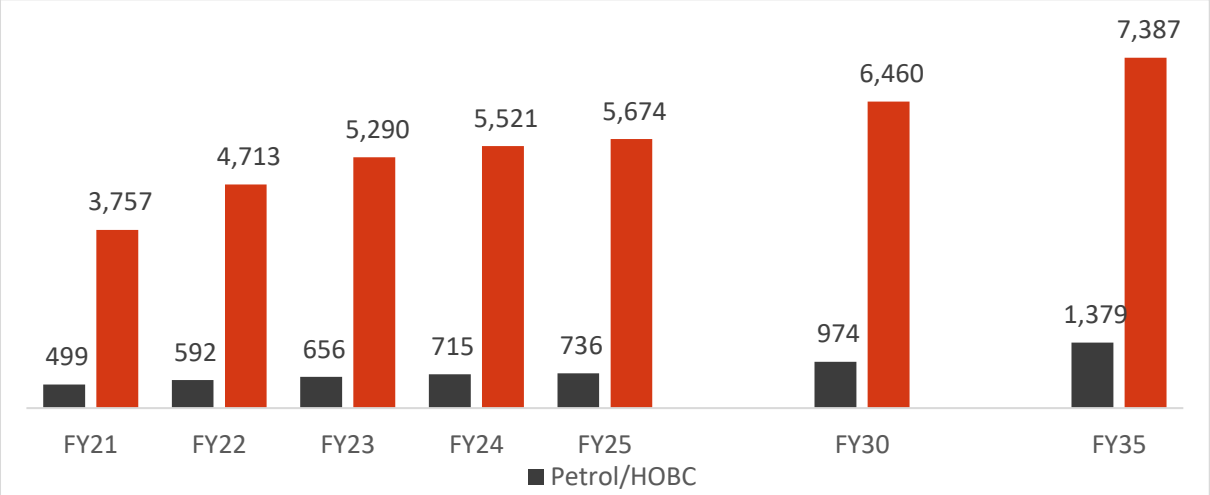
Outlook on fuel consumption and emissions

SAARC Region has major developing economies resulting in ever increasing demand for vehicles, civil construction, urbanization, etc. This has resulted in an exponential increase in the automotive fuel demand in the past and is expected to ride the same trend going forward. Demand forecast of petrol and diesel till 2035 is provided below:

[7]Figure 3: Outlook on petrol & diesel consumption in Afghanistan ('000 tonne)

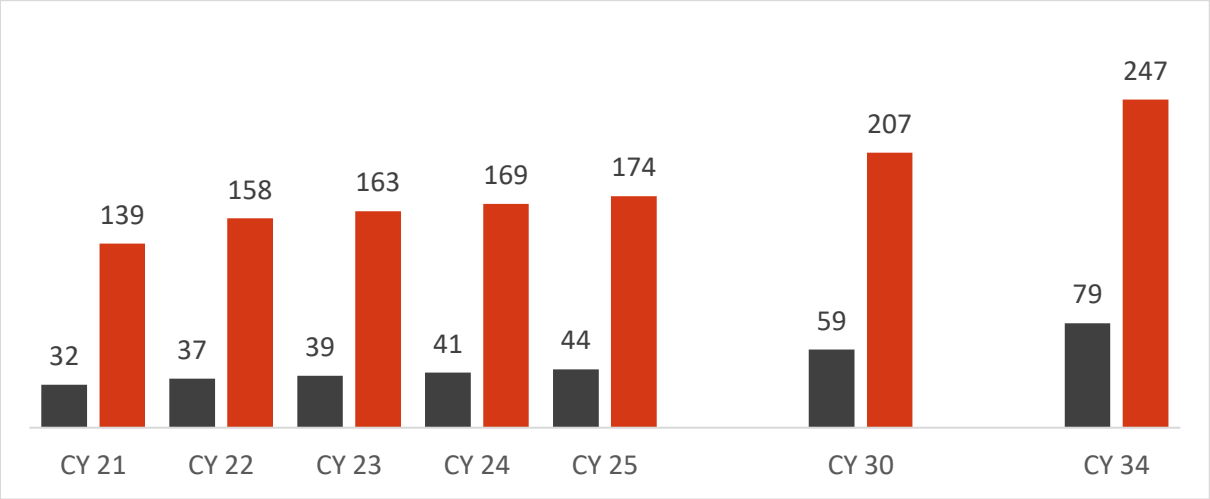


[8]Figure 4: Outlook on petrol, diesel consumption in Bangladesh ('000 tonne)

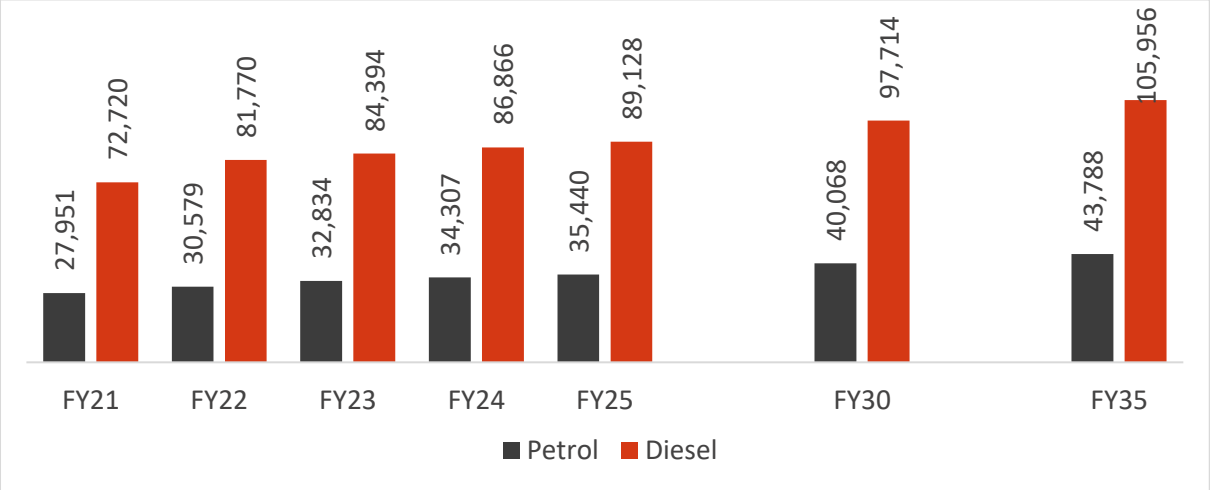


[7] Source: CRISIL Research
[8] Source: BPC, CRISIL Research

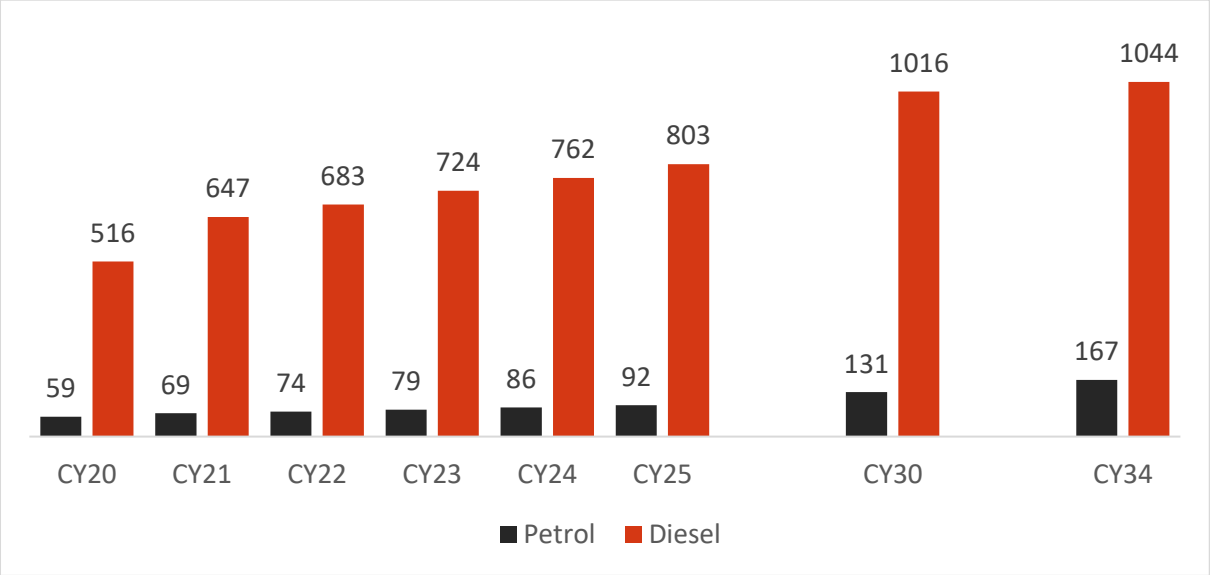
[9]**Figure 5: Outlook on petrol, diesel consumption in Bhutan ('000 tonne)**



[10]**Figure 6: Outlook on petrol, diesel consumption in India ('000 tonne)**

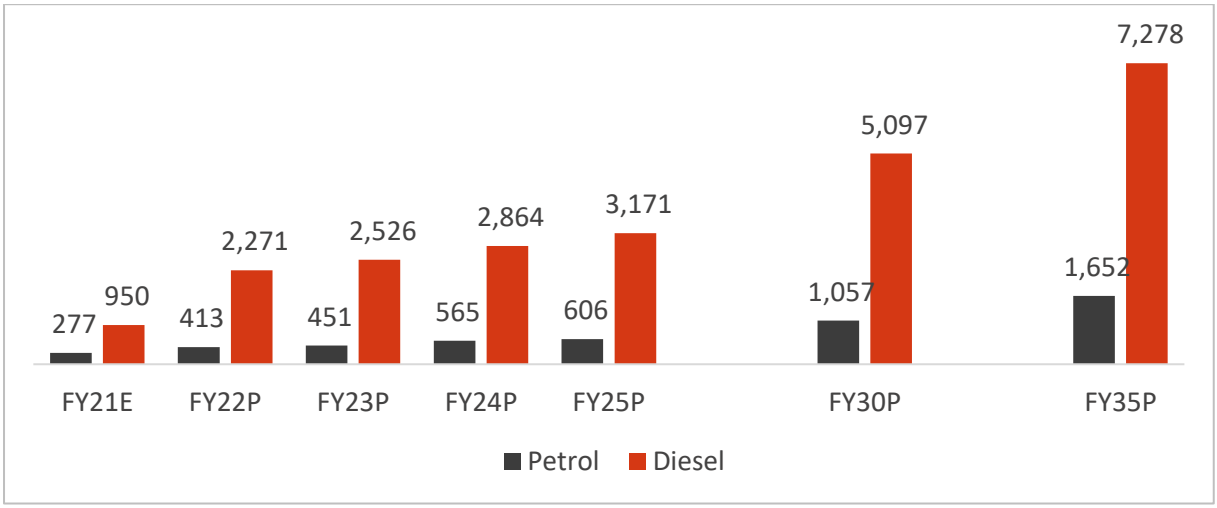


[11]**Figure 7: Outlook on petrol & diesel consumption in Maldives ('000 tonne)**

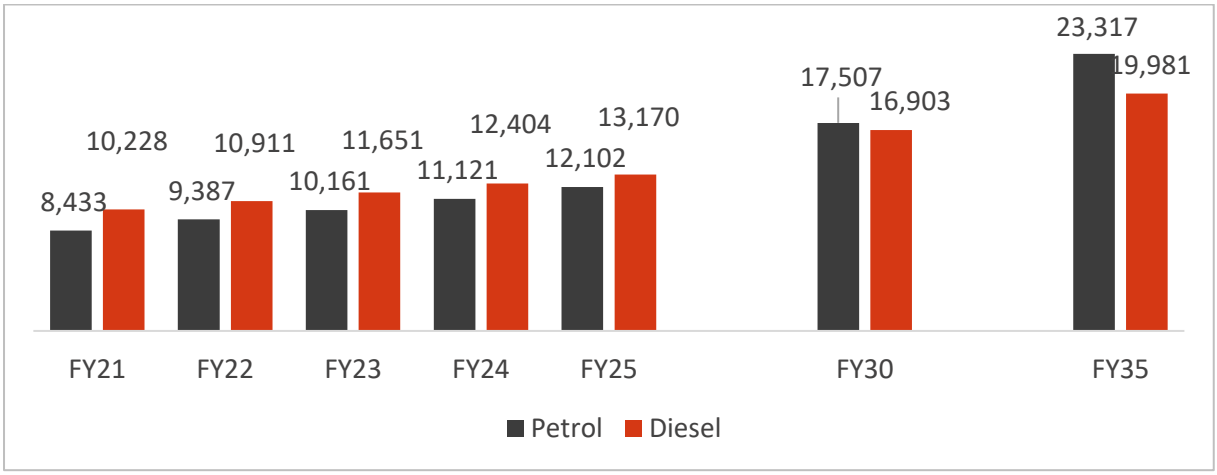


[9] Source: CRISIL Research
[10] Source: Petroleum Planning Analysis Cell, CRISIL Research
[11] Source: CRISIL Research

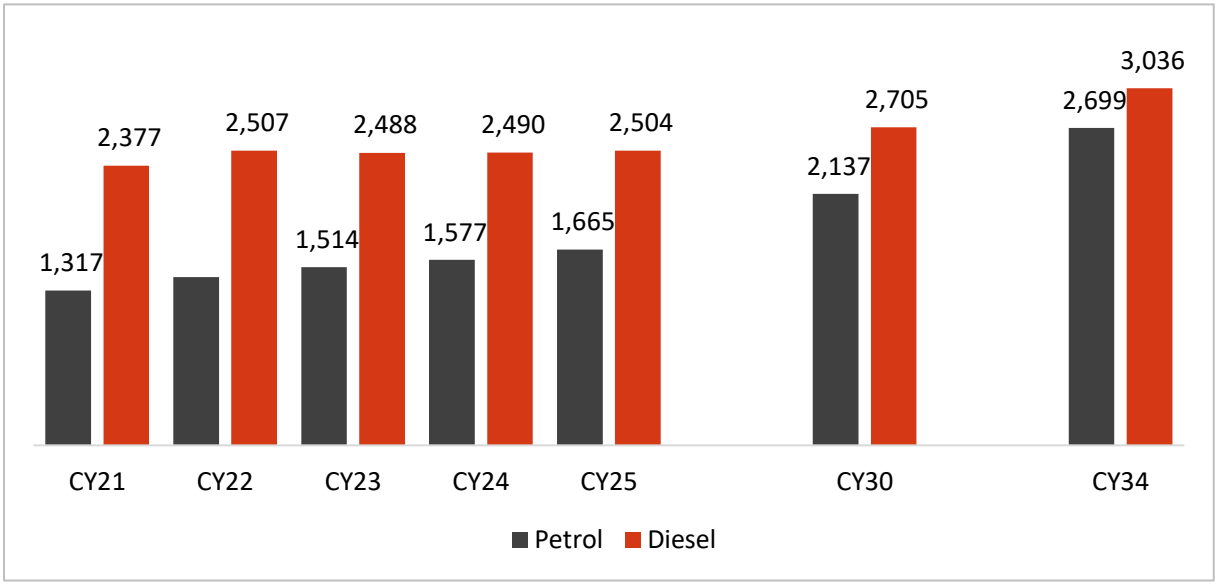
[12]**Figure 8: Outlook on petrol, diesel consumption in Nepal ('000 tonne)**



[13]**Figure 9: Outlook on petrol, diesel consumption in Pakistan ('000 tonne)**



[14]**Figure 10: Outlook on petrol, diesel consumption in Sri Lanka ('000 tonne)**



[12] Source: CRISIL Research
[13] Source: OCAC, CRISIL Research
[14] Source: CRISIL Research

Savings associated with transitioning to Euro6/VI standards

The saving from the adoption of Euro 6/VI standard will be in terms of increased fuel efficiency resulting in reduced fuel demand, reduction number of deaths due to air pollution, and thereby savings on health expenditure by the government.

Countries	Cumulative fuel savings by 2035 ('000 tonne)[15]	Savings on health expenditure by 2035 (USD)	Reduction in CO_2 emissions by 2035 (million tonne/annum)
Afghanistan	Petrol - 915 Diesel – 4,639	-	4-5
Bangladesh	Petrol - 449 Diesel - 1,777	6 billion	10-15
Bhutan	Petrol - 45 Diesel - 216	200 million	0.3-0.6
India*	Petrol - 18,350 Diesel - 46,450	30-50 billion	180-220
Maldives	Petrol - 44.4 Diesel - 12.7	104 million	0.3-0.5
Nepal	Petrol - 454 Diesel - 9,486	400 million	8-12
Pakistan	Petrol - 8,750 Diesel - 25,212	18 billion	120-150
Sri Lanka	Petrol - 2,872 Diesel - 3,815	3-3.5 billion	15-20

**savings for India are calculated from FY2021, when BS VI standards were implemented. The base case has been assumed to have BS-IV vehicles at large*

Headers for roadmap- Short, Medium and Long Term

The study has recommended short-term, medium-term and long-term action plans for the adoption of Euro 6/IV emission standard. For some of the countries these action plans are divided in short-term and medium to long-term so as to provide cushion in achieving the complete transition.

[16]Table 5: Roadmap for adoption of Euro 6/VI emission standard fuel

Countries	Short-term action plan	Medium-term action plan	Long-term action plan
Afghanistan	• Announcing the leapfrog to Euro 6/VI by April 2025 • Import agreement with Euro 6/VI grade fuel supplying country	• Ban on sale of Euro 5 or older vehicles and complete shift to Euro 6	• Vehicle testing and emission monitoring • Stringent regulation on vehicle registration and

[15] Source: CRISIL Research Estimates
[16] Source: CRISIL Research

Countries	Short-term action plan	Medium-term action plan	Long-term action plan
	• Making Euro 6/VI grade vehicles available	• Incentives on vehicle sales	monitoring of progress • Facilitation of data reporting at regular intervals
Bangladesh	• Vehicle scrappage policy introduction • Revamping domestic refining capacity • Domestic Manufacturing and Assembly facility	• Adding new refining capacity • Vehicle Emission Inspection System	
Bhutan	• Scrappage of older vehicles • Import of second-hand electric vehicles only • Restrict low emission standard vehicles	• Import of Euro 6/VI fuel • Vehicle Testing Facility / Emission Inspection System • Domestic Manufacturing and Assembly facility	
India	• Incentivize scrapping of vehicles more thereby decreasing the population of older vehicles • Enforcement of real world driving cycle emissions testing by PEMS and conformity for monitoring	• Intensify the adoption of electric vehicle and low emission fuel such as CNG and LNG for commercial vehicles thereby promoting competitive pricing of Euro 6 vehicles • Restricting usage of vehicles older than Euro 4	
Maldives	• Policy and regulation upgrade	• Testing facilities to bolster the effectiveness high quality fuel • Setting age criteria for reconditioned vehicles	
Nepal	• Scrappage of older vehicles: • Import of second-hand electric vehicles	• Reduction in duties and taxes • Import of Euro 6/VI fuel	• Vehicle Emission Inspection System • Domestic Manufacturing and Assembly facility
Pakistan	• Enabling imports of Euro 6/VI grade fuel and vehicles • Incentives to refinery upgradation • Scrappage Policy	• Ban on sale of Euro 5 or older vehicles and complete shift to Euro 6/VI • Incentives on vehicle sales	• Vehicle testing and emission monitoring • Facilitation of data reporting at regular intervals
Sri Lanka	• Mandate the import of Euro 6/VI • Introduction of vehicle scrappage policy • Ban the sale of all Euro 5 or older vehicles	• Establishing independent Fuel Quality Management Centre • Vehicle testing and emission monitoring	

Conclusion

General barriers

- **Heavy investments required to upgrade refineries**: The refineries in the SAARC Region (excluding India) have been running for several years without any significant upgradations. These refineries continue to produce Euro 1/Euro 2/Euro3 grade petrol and diesel. Hence, these refineries will incur significant costs of upgradation of about USD 5-6 billion. The respective governments have showcased their intent to upgrade the existing refineries capacity with substantial addition of the new capacity. Thus, the governments may still have to take initiatives via viability gap funding and attracting foreign investments to these capex intensive projects. There is lack of adequate funding, which creates a barrier towards the adoption of stringent emission standards in the region.
- **Automobile manufacturers/assemblers reluctant, due to rising vehicle manufacturing costs**: Automobile manufacturers also must undertake investments, to completely transform their production platforms. The task is more burdensome for companies that have products across several categories, ranging from cars and SUVs to two-wheelers and trucks. Such a portfolio means that the companies would have to invest more resources and time to build the requisite capabilities for successfully executing the programme. The transition will significantly increase the production cost of vehicles, which they may not be able to pass on to the consumer immediately. Even if they do, it will lead to increasing retail prices of their products, which may lead to declining sales in a country where vehicles are already dearly priced.
- **Custom duty and taxation:** The countries relying on the imports to meet the vehicular demand have levied high custom duty on imported vehicles. This has led to increase in the price of vehicle to 2x and in some cases 6x times. Transitioning to Euro6/VI standards will be accompanied by cost escalation for vehicles. This along with the taxation policies of some countries are likely to limit the sales of new vehicles

Heat Map

SMSs have different factors deciding the adoption of Euro 6/VI standard of fuel and vehicles. This is showcased in the heat map below:

[17]Table 6: SAARC Member States adopting Euro 6/VI emission standard

Countries	Ease of adoption	Government/ Policy Support	Investment Requirement	Support from Automotive Industry	Requirement of global assistance
Afghanistan					
Bangladesh					
Bhutan					
Maldives					
Nepal					

[17] Source: CRISIL Research

Countries	Ease of adoption	Government/ Policy Support	Investment Requirement	Support from Automotive Industry	Requirement of global assistance
Pakistan					
Sri Lanka					

Key	Normal	Hard	Challenging

Table 7: Country-wise detailed rationale

Country	Afghanistan
Ease of adoption	Lack of data availability and weak law enforcement are the major reasons for hard implementation of Euro/6 standards.
Government/ Policy Support	Limited or no regulatory push makes it more challenging for the country to switch to advanced standard of fuel and vehicles considering both of these commodities are imported.
Investment Requirement	Since the country is on Euro 3 standards, the investment requirement will be in the form of increased cost of fuel and technology when imported only which can be transferred to the consumers over a period of time.
Support from Automotive Industry	Most of the vehicles are imported in the country form Japan and other countries which have already shifted to Euro 6/VI so it would be easier to switch to newer class of vehicles.
Requirement of global assistance	Global assistance is definitely required in terms of shaping policy and regulation for the adoption of the fuel. Additionally, the country would also require financial assistance to achieve the target

Country	Bangladesh
Ease of adoption	The country has been planning to adopt Euro 5 standard; therefore, it would be easier for the regulators/government to target Euro6/VI standard.
Government/ Policy Support	Government has been pushing for new refinery complex and upgrading fuel standard, which provides the necessary push for faster transitioning to Euro6/VI standard. The country needs to offer some tax and duty relaxation on imported vehicles/parts to import technology of newer class of vehicles.
Investment Requirement	The country is planning a 3 mtpa greenfield refining capacity and would need upgradation of the existing facility therefore it would need considerable investment for this.
Support from Automotive Industry	The country has vehicle manufacturing and assembling facility for global automotive giants which can provide the already available technology deployed in many countries.
Requirement of global assistance	The country needs assistance in planning the capacity expansion for which it has already been in discussion with global experts. Additionally, the country would also require financial assistance to achieve the target.

Country	Bhutan
Ease of adoption	The country has been planning to adopt Euro 6/VI standard.
Government/ Policy Support	The country has developed a lot of policy and strategic initiatives to neutralize the GHG emissions from transportation sector along with plans to adopt Euro 6/VI standard.
Investment Requirement	The country is dependent on imported vehicles and fuel; therefore, investment requirement will be in the form of cost escalation of fuel and technology when imported only which can be transferred to the consumers over a period of time.
Support from Automotive Industry	Most of the vehicles are imported in the country form India, Japan and other countries which have already shifted to Euro 6/VI so it would be easier to switch to newer class of vehicles.
Requirement of global assistance	The country needs assistance in enforcement of the standards along with establishing vehicle and fuel testing facilities. Additionally, the country would also require financial assistance to achieve the target

Country	Maldives
Ease of adoption	The country has not outlined standards for curbing vehicle emission and most imported vehicles are of Euro2 or 3 standards to date.
Government/ Policy Support	There is limited push for the adoption of better automotive fuel. A major reason for this is most of the country's pollution is attributed to marine and air transportation.
Investment Requirement	The country is dependent on imported vehicles and fuel; therefore, investment requirement will be in the form of cost escalation of fuel and technology when imported only which can be transferred to the consumers over a period of time.
Support from Automotive Industry	Most of the vehicles are imported in the country form Japan and other countries which have already shifted to Euro 6/VI so it would be easier to switch to newer class of vehicles. However, the country lacks in vigil towards the population of vehicles that imported
Requirement of global assistance	The country would need global assistance in policy making, implementation and then monitoring to smoother adoption of Euro 6/VI standards. Additionally, the country would also require financial assistance to achieve the target

Country	Nepal
Ease of adoption	Nepal has very old fleet of vehicles and has inefficient scrappage policy leading to people driving aged and old fleet.
Government/ Policy Support	Government has outlined strategic initiatives to curb GHG emissions; however, it requires dedicated and stringent policy implementation to aid the transition and relaxation in taxation and duties on import of vehicles or components.

Country	Nepal
Investment Requirement	The country is dependent on imported vehicles and fuel; therefore, investment requirement will be in the form of cost escalation of fuel and technology when imported only which can be transferred to the consumers over a period of time.
Support from Automotive Industry	Most of the vehicles are imported in the country form India, Japan and other countries which have already shifted to Euro 6/VI so it would be easier to switch to newer class of vehicles while many companies are willing to set up facilities in the country, which could delay the transition for upgraded vehicles as it would require considerable shift.
Requirement of global assistance	The country needs assistance in enforcement of the standards along with establishing vehicle and fuel testing facilities. Additionally, the country would also require financial assistance to achieve the target.

Country	Pakistan
Ease of adoption	The country needs heavy investments required to upgrade refineries along with the policy push.
Government/ Policy Support	Government has outlined various policy and measure for GHG emission control. The transition requires stringent policy and laws implementation against vehicular emission
Investment Requirement	The country has a large refining capacity that requires upgradation along with new capacity additions planned. This would need substantial investment. Further, the automotive manufacturers would also need to upgrade their manufacturing facilities to upgrade the vehicular population in the country
Support from Automotive Industry	Automobile manufacturers are reluctant due to rising vehicle manufacturing costs and the country has to reroute their imports to Euro 6/VI compliant countries like Japan which would escalate costs further.
Requirement of global assistance	The country would need global assistance in terms of sourcing of compliant technology/components for domestic manufacturers.

Country	Sri Lanka
Ease of adoption	Sri Lanka needs to upgrade the refining and transportation infrastructure.
Government/ Policy Support	The government has developed various sector focused strategies and measure to tackle climate change, but requires effective planning & implementation.
Investment Requirement	The country has 2.5 mtpa of refining capacity that requires upgradation along with upgradation in fuel/crude transportation infrastructure. This would need substantial investment. Further, the country also explored to possibility of jointly adding refining capacity with companies from China, the Middle East and Russia.

Country	Sri Lanka
Support from Automotive Industry	Automobile manufacturers are reluctant due to rising vehicle manufacturing costs, while if the demand shifts entirely to imports it would escalate the vehicle cost further.
Requirement of global assistance	The country needs global assistance for planning and deployment of policy and regulation with stage-wise action plans. Additionally, the country would also require financial assistance to achieve the target.

1 Introduction

Carbon dioxide is (CO_2) at the top of the list of heat-trapping greenhouse gases, and is considered to be the chief contributor to the global rise in temperatures. Consequently, a substantial effort is under way to reverse atmospheric CO_2 levels to stop the worst impact of climate change. The transport sector contributes to 19% of carbon emissions, with diesel engines a key contributor. Demand for diesel in road transport remains strong around the world. Vehicles also contribute to sizeable emissions of Sulphur oxides and nitrogen oxides. Europe has been at the forefront of bringing legislation and regulations for cleaner transportation fuels, and has introduced various fuel emission standards.

European emission standards first came into force in 1993, with Euro 1 standards. This initial standard ensured diesel cars emitted no more than 780mg/km of nitrogen oxide, while the maximum for petrol engines was 490mg/km. The Euro 6/VI standard was introduced in September 2015, and all mass-produced cars sold from this date need to meet these emissions requirements. The aim of Euro 6/VI is to reduce levels of harmful car and van exhaust emissions, both in petrol and diesel cars. While several countries in the European Union have adopted these standards, very few countries apart from EU have adopted the latest emission standard, i.e., Euro 6/VI.

Within the SAARC Region, India is the only country which moved to Bharat Stage-VI (Euro 6/VI equivalent) in April 2020. All its refineries have been converted to BS-VI-complaint fuels. While Sri Lanka adopted Euro 4 standards in 2018, Bangladesh is still on Euro 2 and Pakistan has implemented Euro 5 standards imports of fuels. Hence, there is a need to identify the barriers to emission reduction in the SMS and develop a roadmap to enable a smooth and cost-effective transition to Euro 6/VI emission standards. Considering all of the SMS are developing economies, transitions to the upgraded standards of fuel is essential in order to curb the GHG emission, prevent exponential growth in the fuel demand form the SMS due to lesser consumption associated with Euro 6 standards. The study aims is to determine the economics and viability of transition to Euro 6 standard in SMS.

1.1 Rationale and objectives of the study

Apart from India, none of the SMS have transitioned to, or have any near-term plans to transition to, Euro 6/VI emissions. Rising pollution levels and global focus towards climate change necessitates a deep-dive addressal of economic, financial and political barriers with adoption of Euro 6/VI standards in each of these countries and develop a roadmap for a smooth transition. The key objectives of the study include:

- Identification of all barriers that have limited the transition of Member States towards Euro 6/VI fuel standard adoption
- Assessment of all types of costs and implications of the transition to the Euro 6/VI fuel standard
- Concrete and implementable recommendations for all relevant stakeholders on effective transition towards Euro 6/VI fuel specification.

1.2 Scope of the study

The following detailed scope of work was executed for achieving the aforementioned objectives of the study.

Introduction and establishing the need for moving to Euro 6/VI emission standards: This section

highlights how rising vehicular pollution is impacting the environment and the focus of the globe towards reducing climate change. It also highlights how Europe, the Unites States (US) and other developed countries have been frontrunners in adopting strict vehicle emission standards and worked toward reducing emission levels, how other countries have followed their footsteps.

Overview of Euro 6/VI standards: This section includes a detailed overview of the Euro standards (1 to 6) and specifications for emissions of various pollutants across vehicle and fuel types. The section includes how these standards are an improvement over the previous versions. It also highlights the level of adoption of Euro norms globally and the economic implications/ challenges, trends for stakeholders (government, refineries, vehicle manufacturers, consumers) across countries that have already adopted the standards.

Technology Upgradations and Refinery Operations for Euro-6 Fuel: Detailed assessment of the required technologies for refineries and vehicles associated with the transition to Euro 6/VI norms from Euro 2/3/4 norms. The section covers the associated costs of such a transition through actual case studies where such upgradations have taken place.

Global context of transition to Euro 6/VI fuel: The section covers global case studies of economies that have transitioned to Euro 6/VI. It also details the barriers they faced and how these were overcome and how these examples could be incorporated for better implementation in the context of SAARC Member States, including India.

Current situation in SMS: This section gives a detailed overview of the current situation of fuel emission standards in SMS. It also includes the key related regulations, fuel consumption trends, degree of import dependency, refineries and the fuel specifications, trend in category-wise vehicle stocks, extent of emissions in each of these countries, country-specific issues, and barriers towards transition to Euro 6/VI standards.

Assessment of the transition to Euro-6 fuel for SMS: This section entails a country-level analysis of the costs and benefits associated with the transition to Euro 6/VI. This is also carried out across stakeholders. The assessment comprises economic, political, technical, and social implications across stakeholders for each country over a short-, medium- and long-term period.

Country-wise roadmap and recommendations: This section includes a detailed comprehensive list of recommendations and roadmap to transition to Euro 6/VI norms in the coming years for each SAARC Member State. The recommendations also include various aspects such as policy framework, incentives across sectors and stakeholders, and specific recommendations for private and public sector entities that would bring about such a transition.

2 Approach and methodology of the study

The report has been prepared primarily by using inputs from secondary sources such as government websites, petroleum and natural gas ministry publications of the respective ***SMS***, annual reports of major companies, news articles, and other reliable sources. In addition, primary research has been conducted to arrive at ballpark capex estimates for various refineries and their transition to Euro 6/VI grade fuel. The following methodology has been used to assess various aspects of the study:

Step 1: Secondary research- CRISIL Research conducted extensive secondary research through various

sources such as government publications, company reports, automobile manufacturer associations, ministry websites, etc., to collect data for each SAARC Member State. This included data and information on emission standards, vehicle stock, fuel consumption, automobile specifications and emission standards, export/import for fuel and vehicles, government regulations, pricing policies, targets on climate change, technology changes, etc.

Step 2: Conducting primary survey to understand technical requirement, government plans and inputs from key stakeholders: Based on preliminary data collected through secondary research, CRISIL Research conducted extensive primary research with various market participants such as original equipment manufacturers (OEM), fuel retail companies, refineries, and government agencies/regulatory bodies in major SMS understand their perspective on the transition to Euro 6/VI norms. Some key parameters assessed were the price points of fuel sold, investment required to upgrade refinery, additional cost of vehicles, challenges faced, and individual stakeholder view on such a transition.

Step 3: Based on above, CRISIL Research assessed the short-, medium- and long-term strategies and action plan to transition to Euro 6/VI

- Outlook on vehicular growth and fuel consumption between 2021 and 2030 for each SAARC Member State.
- Outlook on increase in emissions and impact on environment with rising vehicular traffic.
- Global case studies of transition into Euro 6/VI and their impact and implications
- Assessment of additional capex requirement based on the technology available and requirements. These benchmarks are based on industry interactions and publicly available information for the refinery expansion and upgrades already in place
- Assessment of key challenges and barriers towards implementation.

Step 4: Development of a roadmap for the transition to Euro 6/VI

1. Technology requirements and investment outlay	• Additional units required at a refinery : diesel hydrotreating, hydrocracking, CRU upgradation, Sulphur recovery units, Isomerisation, FCC, etc. and associated costs. • Units required for diesel and gasoline vehicles: Common rail direct fuel injection, Diesel oxidation catalyst, turbocharger, lean nitrogen oxide traps, particulate filter, etc. and associated costs • Implications of cost on fuel price, vehicle price, and refinery capex
2. Organizational capacity building	• Assessing external and internal environmental challenges, incentive system, legal and regulatory framework, government and corporate level changes in each SAARC Member State
3. Potential timeline for transition	• Short term, medium term and long-term activities to be conducted, goals to be achieved.
4. Investment, business model and recommendations	• Assessment of total costs benefits of the planned transition to Euro 6 standard, detailed model to adopt changes and assessing the effectiveness of such model by looking at countries like India, China, and others. • Assessment of investment requirements and exploring funding options in form of public funding, fiscal incentives, etc. • Recommendations and key guidelines for a smooth transition

Additionally, we have calculated the savings in the fuel consumption for petrol and diesels. These savings are calculated based on the comparison of fuel consumption of current population and Euro 6/VI vehicles. As we know Euro 6/VI vehicles have low emissions and higher efficiency compared to

older population of vehicles, resulting in lower import of refined products and crude for SMS. Moreover based on the number of deaths due to air pollution we have also estimated the savings on healthcare expenditure post the transition to Euro 6/VI, The savings are incurred with reduced pollution and particulate matter 2.5 concentrations in ambient air resulting in reduction in diseases or deaths. This doesn't include lost output from premature deaths and morbidity attributable to air pollution and associated economic losses.

3 Limitations and assumptions of the study

This study has been undertaken through a detailed secondary research exercise. As such, the detailing, assumptions and outlook depend entirely on information available in the public domain. While undertaking this study, CRISIL Research has taken special care to cover all aspects of the terms of references. This study, however, has certain limitations including:

- The data utilized in this study has been sourced majorly from government documents of the respective SMS. However, in case of data constraints, especially in member states such as Afghanistan, reasonable assumptions have been taken based on further secondary reading and information available from reports of other multilateral funding agencies.
- The economic outlook for the country has been developed in line with International Monetary Fund (IMF) projections till 2025 and beyond.
- While developing the outlook, all possible developments in terms of infrastructure, policy change, investment, and technology have been incorporated based on information present in the public domain. These developments have been considered as the business-as-usual scenario. No specific disruptive scenarios or changes have been considered while developing this report that do not find mention in any policy or strategy documents.
- A detailed feasibility study for various refineries was beyond our scope. Hence, reasonable assumptions have been taken to understand capex and other costs.
- While developing calculating the CO_2 emission savings, fuel saving, and developing potential roadmap for transitioning to Euro-6 fuel, we have considered the policy initiatives, commitments of the country to international agreements/pacts, status of vehicular population/automotive sector resulting in emissions, along with public health-safety data pertaining to deaths, hazards etc.

4 Need for transitioning to stringent emission standards

4.1 Rising pollution levels necessitate need for stringent regulations

South Asia is the epicentre of ambient air pollution. According to the World Air Quality Report 2020, of the top 40 most polluted cities in the world, 37 are in South Asia. To be sure, air pollution in the region represents the third-highest cause of premature deaths, as compared with the ninth highest in Western Europe.

Within the SAARC Region, Bangladesh, India, and Pakistan are among the most polluted by particulate matter (PM2.5) globally. In fact, barring the Maldives, all other SAARC Member States (SMS) are

significantly above the World Health Organization (WHO)-specified benchmarks; WHO's air quality guidelines recommend that the annual mean concentrations of PM2.5 and PM10.0 should not exceed 10 µg/m3 and 20 µg/m^3, respectively.

[18]Figure 11: PM2.5 levels in SAARC Member States (in mg/m^3)

Countries	2015	2016	2017	2018	2019
Afghanistan	60.6	57.2	53.4	52.8	52.4
Bangladesh	69	67.8	62.8	63.3	63.4
Bhutan	44.5	43.6	40.2	40.4	40.3
India	88.4	92.2	81.8	83	83.2
Maldives	10.2	12.1	11.2	10.9	10.9
Nepal	88.7	91.5	80.6	82.7	83.1
Pakistan	66.9	68.7	61.8	62.4	62.6
Sri Lanka	19	20.7	19.9	19.7	20

[19]Figure 12: Per capita CO_2 emission in the SAARC region (in tonne)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	CAGR %
Afghanistan	0.16	0.21	0.30	0.41	0.34	0.26	0.23	0.23	0.21	0.20	0.20	2.4%
Bangladesh	0.29	0.31	0.34	0.36	0.38	0.40	0.41	0.46	0.47	0.49	0.51	5.9%
Bhutan	0.60	0.55	0.69	0.97	1.08	1.20	1.31	1.32	1.67	1.78	1.83	11.9%
India	1.19	1.29	1.35	1.41	1.51	1.54	1.65	1.64	1.65	1.72	1.80	4.3%
Maldives	2.53	2.58	2.62	2.65	2.87	2.72	3.13	2.97	3.68	3.67	3.70	3.9%
Nepal	0.11	0.14	0.17	0.19	0.22	0.23	0.26	0.24	0.34	0.40	0.43	14.3%
Pakistan	0.83	0.83	0.78	0.77	0.77	0.76	0.79	0.82	0.89	0.95	0.98	1.7%
Sri Lanka	0.64	0.61	0.65	0.76	0.82	0.70	0.85	0.97	1.03	1.09	1.00	4.5%

The per capita CO2 emission has increased rapidly in the region over the past 10 years. There are several contributing factors to the high level of emission, such as economic growth, and rising energy consumption, urban population, tourism, transport, etc. Growing vehicular population due to rising urbanization is a key factor contributing to emissions in the region.

As these economies grow, rapid industrialization and rising per capita income is expected to contribute to higher spending on personal as well as commercial vehicles. In the absence of climate control policies and emission-related regulations, air pollution levels are expected to increase rapidly. Hence, quality control measures and emission norms are vital in SAARC countries to limit pollutants. Apart from environmental benefits, controlling pollutants in ambient air is necessary for preventing premature deaths and morbidity because of air pollution. Major cities in SMS are some of the highest polluted cities in the world therefore it is imperative to take steps for reducing emissions from each contributing sector including transportation.

[18] Source: Health Effects Institute. 2020. State of Global Air 2020. Special Report, Boston, MA: Health Effects Institute.
[19] Source: World Bank

4.2 Significant action taken globally for climate change, SAARC region lagging

Significant steps are being taken globally to curb pollution and minimize the impact of human activity on the environment. One of the key initiatives binding majority of the global economies is the Paris Agreement, an international treaty on climate change, adopted in 2015. The agreement was negotiated by 196 parties at the 2015 United Nations Climate Change Conference near Paris, France. The agreement's long-term temperature goal is to keep the rise in mean global temperature well below 2°C (3.6°F) above pre-industrial levels, and preferably limit the increase to 1.5°C (2.7°F), recognizing that this would substantially reduce the impact of climate change.

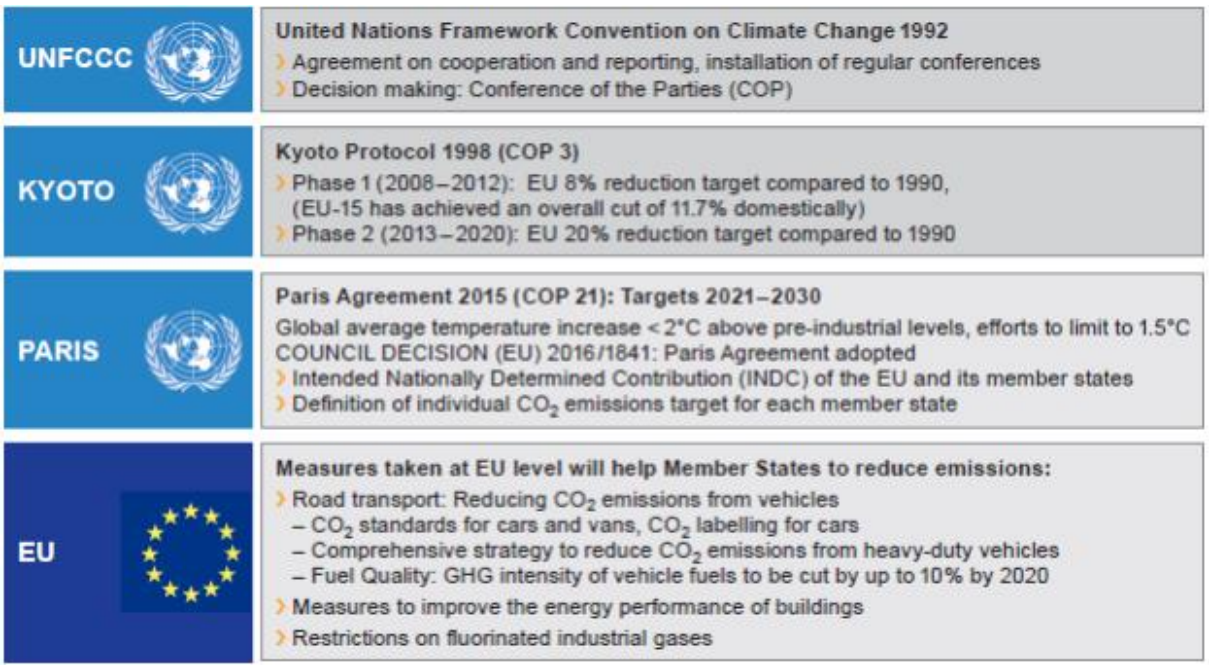
As of February 2021, 194 states and the EU have signed the agreement, with 190 states and the EU, representing about 97% of global greenhouse gas (GHG) emissions, ratifying or acceding to the agreement, including China and the US, the first and second biggest CO_2 emitters among UNFCC members. All SAARC Members are signatories of the agreement. In order to achieve their climate change targets, countries are taking significant steps to curb pollution levels

4.2.1 Emission standards and related regulations worldwide

Focus on reduction of GHG has been of prime importance in several nations in recent years, especially in Western economies, who are frontrunners in taking steps towards climate change.

The EU is a key region taking up activities to control its emissions. In the Paris Agreement, it has committed to reduce its GHG emission by 40% of 1990 levels. Finally, for 2050, the block has set itself a target of net-zero GHG emission. The road transport sector comprises a large part in the European energy consumption, contributing to CO_2 emission. Therefore, the EU continues to tighten CO_2 emission limits for vehicles.

[20]Figure 13: Key agreements by the EU driving its emission policies and regulations



[20] Source: EUROSTAT, UNFCCC, CRISIL Research

The European CO_2 emission target for 2020 and 2021 was defined in 2014 as Regulation (EU) No 333/2014 for passenger cars and Regulation EU 253/2014 for light commercial vehicles (LCVs). The regulations foresee for passenger cars a phase-in of the 95 gCO_2/km target, based on new European Driving Cycle test procedure during 2020 and 2021, allowing to remove the 5% most emitting vehicles during the first year. For LCVs, the target of 147 gCO_2/km was defined for 2020. For 2025, the CO2 reduction target is -15% compared with 2021 for passenger cars and LCVs. And for 2030, the targets compared with the 2021 baseline are -37.5% for passenger cars and -31.0% for LCVs.

4.2.2 US

In April 2010, the federal government finalized the first harmonized set of standards for light-duty vehicles. The Environmental Protection Agency (EPA) established GHG emission standards, and the National Highway Traffic Safety Administration (NHTSA) established Corporate Average Fuel Economy (CAFE) standards. The first CAFE standards were adopted in 1975, and the first GHG vehicle standards were set in 2010.

In August 2021, the EPA proposed GHG vehicle emission standards for model years 2023 to 2026 light-duty vehicles, i.e. passenger cars and light-duty trucks, and the NHTSA proposed fuel economy standards for model years 2024 to 2026 light-duty vehicles. Meanwhile, President Biden signed an Executive Order on Strengthening American Leadership in Clean Cars and Trucks, (August 05, 2021 - Presidential Actions - The white House Briefing Room), which sets a non-binding target of making 50% passenger cars and light-duty trucks zero emission vehicles by 2030. The executive order also directs the EPA and the NHTSA to develop standards for fuel economy and GHG emission for medium- and heavy-duty vehicles, as well as passenger cars for model years 2027 to 2030, to be finalized by December 2022.

In addition to the proposed vehicle GHG emission standards, the NHTSA has proposed new fuel economy standards for new passenger cars and light trucks for model years 2024 to 2026. The standards would increase in stringency by ~8% each year, reaching a fleet-wide average of 20.41 kilometres per litre by 2026.

If the average fuel economy of a manufacturer's fleet does not meet the standard set under the NHTSA rules, the manufacturer must pay a penalty. Automakers cannot opt out of reporting their fuel economies by choosing to pay a fine instead. The penalty for failing to meet the CAFE standards is based on the difference between the manufacturer's fleet average fuel economy and the annual standard, and costs $14 per tenth of a mile per gallon, multiplied by the number of vehicles in the manufacturer's fleet.

4.2.3 China

China is focusing on reduction of pollutant emissions, improvement in fuel consumption, and promotion of new energy vehicles. The country is progressing towards China VI (Euro 6/VI equivalent), with plans to implement it across the country by July 2023; certain key target cities have already implemented this. For medium- / heavy-duty engines and vehicles, China V emission standard has been phased in from 2016. The final version of China VI was published in July 2018, and phase-in implementation started in July 2019. All new vehicles are required to meet the norms by July 2023.

The phase IV fuel consumption standards for passenger vehicles were released together in International Council on Clean Transportation – Policy Update – 2014-2018, and enforced in 2016, targeting China average fuel consumption at 5 litres/100km (~119g/km CO_2) by 2020. Phase V standards were effective from 2021, targeting average fuel consumption at 4.0 litres/100km (~95g/km CO_2).

In addition to tightening regulation on pollution and fuel consumption, the Chinese government has attached importance to new energy vehicle development. In September 2016, the Ministry of Industry and Information Technology proposed dual CAFC (Corporate Average Fuel Consumption) and New Energy Vehicle Credit schemes to achieve a reduction in China's reliance on imported fuel and sustainable increase in new energy vehicle production/sales.

4.2.4 Japan

Japanese emission standards for engines and vehicles and fuel efficiency targets are jointly developed by multiple government agencies, including:

- Ministry of the Environment
- Ministry of Land, Infrastructure and Transport (MLIT)
- Ministry of Economy, Trade and Industry (METI)

On June 3, 2019, the MLIT and the METI issued new fuel economy standards for passenger vehicles, starting in model year 2030. The standards require an average fleet gasoline-equivalent fuel economy of 25 km per litre by 2030, which is a 32.4% improvement over the fleet average for FY2016 (April 2016 – March 2017).

Japan was the first to adopt a fuel economy programme for medium- and heavy-duty vehicles. Light-duty efficiency standards use the Top Runner programme, which pegs fuel efficiency standards to the top-performing vehicle in each class. Also, new heavy-duty vehicles are subject to 'Post New Long-Term Emissions Standards', which are similar in stringency to Euro 6/VI. Additionally, fuel standards meet the most stringent requirements for Sulphur content and impose substantial penalties for non-compliance.

4.2.5 Status of Euro standards and its implementation globally and in SAARC Region

Europe first introduced emission standards for heavy-duty vehicles in 1988. The 'Euro' track was established in 1992, with increasingly stringent standards implemented every few years. Many countries have since introduced regulations aligned in large part with the European standards. Euro 6/VI -equivalent standards are already in place in the US, Canada, the EU, Japan, South Korea, Singapore and Turkey. India implemented Euro 6/VI equivalent standards beginning April 1, 2020, and China and Mexico will do so in 2021.

[21]**Figure 14: Status of Euro (or equivalent) emission standards across major countries**

Year	2005				2010				2015				2020
EU	Euro 4				Euro 5				Euro 6				
Australia	Euro 3				Euro 4				Euro 5				
Brazil	Euro 2		Euro 3				Euro 5						
Canada	Euro 4				Euro 5				Euro 6				
China	Euro 2				Euro 3				Euro 4			Euro 5	
India	Euro 2						Euro 3					Euro 4	Euro 6
Indonesia									Euro 2				
Japan	Euro 3				Euro 4				Euro 6				
South Korea	Euro 3		Euro 4				Euro 5					Euro 6	
Singapore	Euro 2				Euro 4						Euro 5		Euro 6
Mexico	Euro 3						Euro 4						Euro 5
Russia	Euro 1		Euro 2				Euro 3				Euro 4		Euro 5
Saudi Arabia					Euro 2								Euro 3
Turkey	Euro 1				Euro 4				Euro 5				Euro 6
United States	Euro 4				Euro 5				Euro 6				

In the SAARC region, India is the only country that has moved to Euro 6/VI equivalent standards for all vehicle categories. Sri Lanka has transitioned to Euro 4, whereas Bangladesh, Bhutan and Pakistan are following Euro 2 norms. Bangladesh, which had earlier planned a transition from Euro 2 to Euro 3 by 2020, is now planning to leapfrog to Euro 5 by 2025. Pakistan is likely to implement Euro 5 emission standards; the government ordered all fuel imports to be Euro 5 compliant in June 2020 which came into effect in August 2020 for Euro 5 petrol and in Jan 2021 for diesel. Nepal has currently Euro 3 standards implemented; however, with India's transition to Euro 6/VI in 2020, Nepal has already been switched to the newer fuel category.

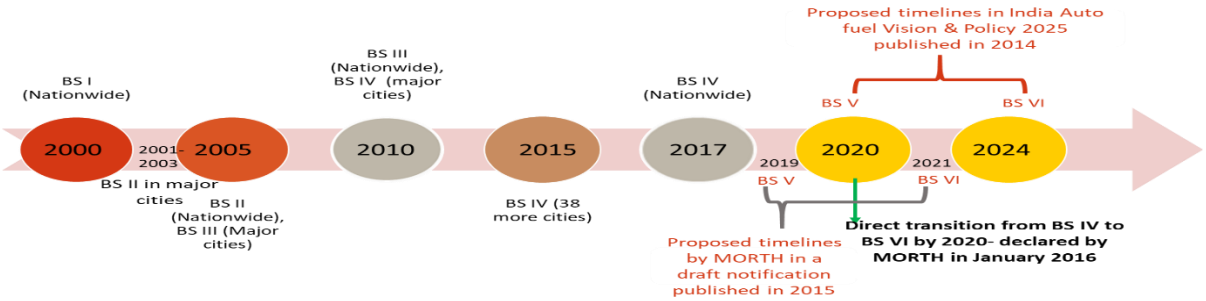
[22]**Figure 15: Status of Euro (or equivalent) emission standards across SAARC Countries**

Year	2005			2010			2015			2020
India	Euro 2			Euro 3				Euro 4		Euro 6
Pakistan				Euro 2[a]		Euro 2[b]				
Bangladesh	Euro 2									
Sri Lanka	Euro 1			Euro 2				Euro 4		
Nepal	Euro 1					Euro 3				
Bhutan	Euro 2									
Afghanistan							Euro 3			
Maldives										

a: Gasoline; b: Diesel

In India, in 2016, the Ministry of Road Transport and Highways announced its decision to leapfrog from BS-IV to BS-VI emission standards, with full implementation of BS-VI level emission standards beginning in 2020.

[23]**Figure 16: Timeline for India's transition to BS-VI**



[21] Source: CRISIL Research
[22] Source: CRISIL Research
[23] Source: CRISIL Research

5 Euro 6/VI fuel standard – overview and benefits

The Euro emission standards consist of six stages of increasingly rigid emission control requirements, starting with Euro 1/I in 1992 to Euro 6/VI in 2015. Euro 6/VI emission standards specifically note that a "considerable reduction in NOx [oxides of nitrogen] emissions from diesel vehicles is necessary to improve air quality and comply with air pollution limit." The proposal further notes that meeting the NOx emission standards "requires reaching ambitious limit values at the Euro 6/VI stage without foregoing the advantages of diesel engines in terms of fuel consumption and emissions of hydrocarbons and carbon monoxide." The regulations for light-duty vehicles are termed as Euro 6 and regulations for heavy-duty vehicles are Euro VI.

A key requirement for efficient operation of an exhaust after treatment devices in vehicles is the use of fuel with very low Sulphur content. Thus, Euro 6/VI standards regulate the Sulphur content requirement to meet the desired fuel quality standards. According to ICCT (2016) A technical summary of Euro 6/VI vehicle emission standards, before Euro 3 and 4 standards, standards required a minimum diesel cetane number of 51, and a maximum diesel Sulphur content of 350 ppm. Starting in 2005, the maximum diesel sulphur content was limited to 50 ppm. Gasoline Sulphur content was regulated to 150 ppm in 2000, and 50 ppm in 2005.

5.1 Euro 6 emission for light duty vehicles

European emission standards provide separate regulations for gasoline- and diesel-based vehicles. Euro 6 is a significant advancement over earlier emission standards, especially with regards to NOx limits. The NOx limits for diesel-based vehicles decline from 0.18 gm/km for Euro 5 to 0.08 gm/km in Euro 6, a reduction of 56%. Compared with Euro 3 levels, this is ~84% lower. This has major implications on control technologies, like the introduction of catalytic reduction, lean NOx traps, etc. For particle mass limits, Euro 6 limits for diesel cars represent a reduction of 96% from Euro 1 limits.

The Euro 6 standards target stricter reduction in emissions compared to earlier standards. While the NOx limit is similar to those of Euro 5 standards, it is 60% lower than Euro 1 limits. But particle mass limits on gasoline direct injection (GDI) engines introduced in Euro 5 are equal to limits set for diesel vehicles.

Table 8: European emission standards for passenger cars, g/km

Tier	Date (type approval)	Date (first registration)	CO	THC	VOC	NO*x*	HC+NO*x*	PM	PN [#/km]
Diesel									
Euro 1†	July 1992	January 1993	2.72 (3.16)	-	-	-	0.97 (1.13)	0.14 (0.18)	-
Euro 2	January 1996	January 1997	1.0	-	-	-	0.7	0.08	-
Euro 3	January 2000	January 2001	0.66	-	-	0.50	0.56	0.05	-
Euro 4	January 2005	January 2006	0.50	-	-	0.25	0.30	0.025	-
Euro 5a	September 2009	January 2011	0.50	-	-	0.180	0.230	0.005	-

Tier	Date (type approval)	Date (first registration)	CO	THC	VOC	NO*x*	HC+NO*x*	PM	PN [#/km]
Euro 5b	September 2011	January 2013	0.50	-	-	0.180	0.230	0.0045	6×10^{11}
Euro 6b	September 2014	September 2015	0.50	-	-	0.080	0.170	0.0045	6×10^{11}
Euro 6c	-	September 2018	0.50	-	-	0.080	0.170	0.0045	6×10^{11}
Euro 6d-Temp	September 2017	September 2019	0.50	-	-	0.080	0.170	0.0045	6×10^{11}
Euro 6d	January 2020	January 2021	0.50	-	-	0.080	0.170	0.0045	6×10^{11}
Petrol (gasoline)									
Euro 1†	July 1992	January 1993	2.72 (3.16)	-	-	-	0.97 (1.13)	-	-
Euro 2	January 1996	January 1997	2.2	-	-	-	0.5	-	-
Euro 3	January 2000	January 2001	2.3	0.20	-	0.15	-	-	-
Euro 4	January 2005	January 2006	1.0	0.10	-	0.08	-	-	-
Euro 5a	September 2009	January 2011	1.0	0.10	0.068	0.060	-	0.005**	-
Euro 5b	September 2011	January 2013	1.0	0.10	0.068	0.060	-	0.0045**	-
Euro 6b	September 2014	September 2015	1.0	0.10	0.068	0.060	-	0.0045**	6×10^{11}***
Euro 6c	-	September 2018	1.0	0.10	0.068	0.060	-	0.0045**	6×10^{11}
Euro 6d-Temp	September 2017	September 2019	1.0	0.10	0.068	0.060	-	0.0045**	6×10^{11}
Euro 6d	January 2020	January 2021	1.0	0.10	0.068	0.060	-	0.0045**	6×10^{11}

*** Applies only to vehicles with direct injection engines*

**** $\mathbf{6\times10^{12}}$/km within first three years from Euro 6b effective dates*

† Values in parentheses are conformity of production (COP) limits

Table 9: European emission standards for light commercial vehicles ≤1,305 kg reference mass g/km

Tier	Date (type approval)	Date (first registration)	CO	THC	NMHC	NO*x*	HC+NO*x*	PM	PN [#/km]
Diesel									
Euro 1	October 1993	October 1994	2.72	-	-	-	0.97	0.14	-
Euro 2	January 1997	October 1997	1.0	-	-	-	0.7	0.08	-
Euro 3	January 2000	January 2001	0.64	-	-	0.50	0.56	0.05	-
Euro 4	January 2005	January 2006	0.50	-	-	0.25	0.30	0.025	-

Tier	Date (type approval)	Date (first registration)	CO	THC	NMHC	NO*x*	HC+NO*x*	PM	PN [#/km]
Euro 5a	September 2009	January 2011	0.500	-	-	0.180	0.230	0.005	-
Euro 5b	September 2011	January 2013	0.500	-	-	0.180	0.230	0.0045	6×10^{11}
Euro 6b	September 2014	September 2015	0.500	-	-	0.080	0.170	0.0045	6×10^{11}
Euro 6c	-	September 2018	0.500	-	-	0.080	0.170	0.0045	6×10^{11}
Euro 6d-Temp	September 2017	September 2019	0.500	-	-	0.080	0.170	0.0045	6×10^{11}
Euro 6d	January 2020	January 2021	0.500	-	-	0.080	0.170	0.0045	6×10^{11}
Petrol (gasoline)									
Euro 1	October 1993	October 1994	2.72	-	-	-	0.97	-	-
Euro 2	January 1997	October 1997	2.2	-	-	-	0.5	-	-
Euro 3	January 2000	January 2001	2.3	0.20	-	0.15	-	-	-
Euro 4	January 2005	January 2006	1.0	0.10	-	0.08	-	-	-
Euro 5a	September 2009	January 2011	1.000	0.100	0.068	0.060	-	0.005*	-
Euro 5b	September 2011	January 2013	1.000	0.100	0.068	0.060	-	0.0045*	-
Euro 6b	September 2014	September 2015	1.000	0.100	0.068	0.060	-	0.0045*	6×10^{11}
Euro 6c	-	September 2018	1.000	0.100	0.068	0.060	-	0.0045*	6×10^{11}
Euro 6d-Temp	September 2017	September 2019	1.000	0.100	0.068	0.060	-	0.0045*	6×10^{11}
Euro 6d	January 2020	January 2021	1.000	0.100	0.068	0.060	-	0.0045*	6×10^{11}

** Applies only to vehicles with direct injection engines*

Table 10: European emission standards for light commercial vehicles 1,305–1,760 kg reference mass, g/km

Tier	Date (type approval)	Date (first registration)	CO	THC	NMHC	NO*x*	HC+NO*x*	PM	PN [#/km]
Diesel									
Euro 1	October 1993	October 1994	5.17	-	-	-	1.4	0.19	-
Euro 2	January 1998	October 1998	1.25	-	-	-	1.0	0.12	-
Euro 3	January 2001	January 2002	0.80	-	-	0.65	0.72	0.07	-
Euro 4	January 2006	January 2007	0.63	-	-	0.33	0.39	0.04	-

Tier	Date (type approval)	Date (first registration)	CO	THC	NMHC	NO *x*	HC+NO *x*	PM	PN [#/km]
Euro 5a	September 2010	January 2012	0.630	-	-	0.235	0.295	0.005	-
Euro 5b	September 2011	January 2013	0.630	-	-	0.235	0.295	0.0045	6×10^{11}
Euro 6b	September 2015	September 2016	0.630	-	-	0.105	0.195	0.0045	6×10^{11}
Euro 6c	-	September 2019	0.630	-	-	0.105	0.195	0.0045	6×10^{11}
Euro 6d-Temp	September 2018	September 2020	0.630	-	-	0.105	0.195	0.0045	6×10^{11}
Euro 6d	January 2021	January 2022	0.630	-	-	0.105	0.195	0.0045	6×10^{11}
Petrol (gasoline)									
Euro 1	October 1993	October 1994	5.17	-	-	-	1.4	-	-
Euro 2	January 1998	October 1998	4.0	-	-	-	0.6	-	-
Euro 3	January 2001	January 2002	4.17	0.25	-	0.18	-	-	-
Euro 4	January 2006	January 2007	1.81	0.130	-	0.10	-	-	-
Euro 5a	September 2010	January 2012	1.810	0.130	0.090	0.075	-	0.005*	-
Euro 5b	September 2011	January 2013	1.810	0.130	0.090	0.075	-	0.0045*	-
Euro 6b	September 2015	September 2016	1.810	0.130	0.090	0.075	-	0.0045*	6×10^{11}
Euro 6c	-	September 2019	1.810	0.130	0.090	0.075	-	0.0045*	6×10^{11}
Euro 6d-Temp	September 2018	September 2020	1.810	0.130	0.090	0.075	-	0.0045*	6×10^{11}
Euro 6d	January 2021	January 2022	1.810	0.130	0.090	0.075	-	0.0045*	6×10^{11}

** Applies only to vehicles with direct injection engines*

Table 11: European emission standards for light commercial vehicles >1,760 kg reference mass max 3500 kg, g/km

Tier	Date (type approval)	Date (first registration)	CO	THC	NMHC	NO *x*	HC+NO *x*	PM	PN [#/km]
Diesel									
Euro 1	October 1993	October 1994	6.9	-	-	-	1.7	0.25	-
Euro 2	January 1998	October 1999	1.5	-	-	-	1.2	0.17	-
Euro 3	January 2001	January 2002	0.95	-	-	0.78	0.86	0.10	-
Euro 4	January 2006	January 2007	0.74	-	-	0.39	0.46	0.06	-

Tier	Date (type approval)	Date (first registration)	CO	THC	NMHC	NO *x*	HC+NO *x*	PM	PN [#/km]
Euro 5a	September 2010	January 2012	0.740	-	-	0.280	0.350	0.005	-
Euro 5b	September 2011	January 2013	0.740	-	-	0.280	0.350	0.0045	6×10^{11}
Euro 6b	September 2015	September 2016	0.740	-	-	0.125	0.215	0.0045	6×10^{11}
Euro 6c	-	September 2019	0.740	-	-	0.125	0.215	0.0045	6×10^{11}
Euro 6d-Temp	September 2018	September 2020	0.740	-	-	0.125	0.215	0.0045	6×10^{11}
Euro 6d	January 2021	January 2022	0.740	-	-	0.125	0.215	0.0045	6×10^{11}
Petrol (gasoline)									
Euro 1	October 1993	October 1994	6.9	-	-	-	1.7	-	-
Euro 2	January 1998	October 1999	5.0	-	-	-	0.7	-	-
Euro 3	January 2001	January 2002	5.22	0.29	-	0.21	-	-	-
Euro 4	January 2006	January 2007	2.27	0.16	-	0.11	-	-	-
Euro 5a	September 2010	January 2012	2.270	0.160	0.108	0.082	-	0.005*	-
Euro 5b	September 2011	January 2013	2.270	0.160	0.108	0.082	-	0.0045*	-
Euro 6b	September 2015	September 2016	2.270	0.160	0.108	0.082	-	0.0045*	6×10^{11}
Euro 6c	-	September 2019	2.270	0.160	0.108	0.082	-	0.0045*	6×10^{11}
Euro 6d-Temp	September 2018	September 2020	2.270	0.160	0.108	0.082	-	0.0045*	6×10^{11}
Euro 6d	January 2021	January 2021	2.270	0.160	0.108	0.082	-	0.0045*	6×10^{11}

** Applies only to vehicles with direct injection engines*

5.2 Euro VI emissions for heavy-duty vehicles

For heavy-duty diesel vehicles, there was a reduction in NOx limits from Euro V to Euro VI by almost 77-80%. The limits were reduced from 2 gm/kWh to 0.4 gm/kWh in steady state testing and from 2gm/kWh to 0.46 gm/kWh in transient testing. The particle mass limit was also significantly reduced, from 0.02 gm/kWh to 0.01 gm/kWh on steady-state testing and from 0.03 gm/kWh to 0.01 gm/kWh on transient testing, a reduction of 66%. The Euro VI standards include a particle-number limit for the first time.

The Euro VI standards also set emission limits for ammonia, since the tighter NO_x standard will require the use of selective catalytic reduction after treatment, which in turn relies on the injection of urea into the exhaust stream. The Euro VI standards include a methane emission limit for **positive-ignition** vehicles (i.e., not diesel, but specifically natural gas and liquefied petroleum gas engines), based on the emergence of natural gas-powered vehicles in the heavy-duty vehicles sector and the potential impact of methane on the tropospheric ozone.

Table 12:European emission standards for heavy-duty diesel engines, g/kWh

Tier	Date	Test cycle	CO	HC	NOx	NH_3 [ppm]	PM	PN [#/kWh]	Smoke [m^{-1}]
Euro I	1992, < 85 kW	ECE R49	4.5	1.1	8.0		0.612		
	1992, > 85 kW		4.5	1.1	8.0		0.36		
Euro II	October 1995		4.0	1.1	7.0		0.25		
	October 1997		4.0	1.1	7.0		0.15		
Euro III	October 1999 EEVs only	ESC & ELR	1.5	0.25	2.0		0.02		0.15
	October 2000		2.1	0.66	5.0		0.10 0.13*		0.8
Euro IV	October 2005		1.5	0.46	3.5		0.02		0.5
Euro V	October 2008		1.5	0.46	2.0		0.02		0.5
Euro VI	31 December 2012	WHSC	1.5	0.13	0.4	10	0.01	8×10^{11}	
		WHTC	4.0	0.16	0.46	10	0.01	6×10^{11}	

** For engines of less than 0.75 dm^3 swept volume per cylinder and a rated power speed of more than 3,000 per minute*

EEV is enhanced environmentally friendly vehicle.

5.3 Technology upgradation and refinery operations for Euro VI fuel

Significant capex required at the refinery level to reduce the Sulphur content to the limit set by the emission standards

The key to achieve the desired targets in fuel quality is Sulphur content reduction. For various Euro standards, Sulphur emission limits are as follows:

[24]**Table 13: Sulphur limits in various Euro standards**

Emission norms	Sulphur in gasoline (ppm)	Sulphur in diesel (ppm)
EURO I	500	2000
EURO II	500	500
EURO III	150	350
EURO IV	50	50
EURO V	10	10
EURO VI	10	10

Refineries are required to reduce Sulphur content at every Euro stage. They can produce ULSG (ultra-low Sulphur gasoline) and ULSD (ultra-low Sulphur diesel) using the advanced versions of a few well-established refining processes.

There are three routes for upgrading an existing refinery to produce Euro 6 grade fuel:

- Adding a new grass-roots process unit for Sulphur control. This would most likely include adding a naphtha FCC (fluid catalytic conversion) for Sulphur reduction in gasoline and a distillate hydro-treating unit to reduce Sulphur in diesel
- Expanding the throughput capacity of existing Sulphur-removal process units
- Revamping the existing process units to enable more stringent Sulphur control

In several cases, the most practical and economic route to produce low-Sulphur fuel is using a combination of the above three routes. Each route requires upgrading or added capacity for hydrogen production and recovery, refinery energy supply, Sulphur recovery, oil movement and storage, and other support facilities, as well as new catalysts and new operating procedures.

Other important considerations to maintain the fuel quality are:

- Cetane number for diesel to be maintained at 51
- Octane number for gasoline to be maintained at 91

Reduction of Sulphur decreases cetane (diesel) and octane (gasoline) content, which needs to be enhanced using the upgradation units.

[25]**Table 14: Reduction in Sulphur content, increase in cetane content: major focus areas in refinery upgradation for diesel**

S. No.	Changes required in the process / operational units	Attributes
1	Distillate hydro-treating unit	Sulphur reduction
2	Hydrocracker unit	Sulphur reduction and limiting polycyclic aromatic hydrocarbon
3	Capacity revamp for hydrogen-generation units	Required for DHDT units

[24] Source: CRISIL Research
[25] Source: CRISIL Research

4	Catalytic reforming of upgradation units	Cetane number enhancement
5	Additional Sulphur-recovery units	Sulphur reduction

[26]Table 15: Reduction in Sulphur content, increase in octane content: major focus areas in refinery upgradation for gasoline

S. No.	Changes required in process units / operational units	Attribute
1	FCC gasoline desulphurisation unit	Sulphur reduction
2	CRU /alkylation	Octane number enhancement
3	Isomerisation unit	Olefins and aromatic management
4	VGO hydro-treating units	Sulphur reduction

In terms of capex, the following benchmarks can be used for a refinery upgradation to produce Euro 6 grade fuel. These benchmarks are based on industry interactions and publicly available information for the past upgrades.

[27]Table 16: Investments related to unit installations for moving to Euro 6 standards

Function	Process	Base capacity, kbpd	Base capacity ktpa	Base investment (2021), $ million	Investment, $ per bpd	Scaling exponent
Sulphur control	FCC feed hydrotreating	50	2490	322	6441	0.65
	Distillate de-Sulphurisation	50	2490	495	9910	0.65
	Hydrotreating (gas oil)	25	1245	87	3468	0.6
	FCC naphtha de-Sulphurisation	35	1743	121	3468	0.6
Benzene control	Benzene saturation	10	498	55	5450	0.65
Aromatics control	Distillate de-aromatisation	20	996	100	5017	0.65
Octane replacement	Reforming	25	1245	173	6937	0.6

[26] Source: CRISIL Research
[27] Source: CRISIL Research estimates

The standard approach for estimating the total investment required for expanding or retro-fitting the existing units is to take it as some fraction of the investment for the same increment of grassroots capacity in the same refining process and location. In this analysis, we assume that the total investment for expanding or retro-fitting the existing units is 50-60% of the investment for a grass-roots unit of the same capacity of Euro 6 grade fuel.

Scaling exponent is a factor that reflects economies of scale, recognising that the cost per barrel of the capacity declines, as process capacity increases. The scaling exponent denotes the factor by which the cost per barrel of produced petroleum liquid reduces to approximately 60-70%, when the production multiplies. Moreover, considering the location of SMS, a location factor of 0.9-0.95 has also been assumed for computing investments required for various refineries. A location factor is an overall total project factor for translating all of the project cost elements of a defined construction project scope of work from one geographic location to another. Considering the location of refinery and its associated cost in SMS, the location factor has been assumed for global benchmarks. The following table depicts the technological upgrades made by the Indian Refiners in order to adopt BS VI standards from the existing BS IV complaint refineries.

[28]Table 17: Some key technological upgrades or additions made by Indian refineries for moving from BS IV to BS VI include the following:

Refinery	Units to be added/upgraded
IOCL, Barauni	Diesel hydro treating revamp
IOCL, Koyali	New Diesel hydro treating to be added
IOCL, Haldia	New Diesel hydro treating
CPCL, Manali	Sulphur recovery unit. Diesel Hydrotreating catalyst replacement
BPCL, Mumbai	New Diesel Hydrotreating
BPCL, Kochi	New Diesel Hydrotreating
MRPL, Mangalore	Revamp of Diesel Hydrotreating, Sulphur Recovery Unit and new Diesel Hydrotreating & associated facilities
IOCL, Guwahati	New Catalytic Reforming Unit
IOCL, Barauni	Catalytic Reforming Unit revamp, hydrotreating unit revamp
IOCL, Koyali	New hydrotreating unit
IOCL, Bongaigaon	INDMAX (similar to FCC)
CPCL, Manali	Gasoline desulphurisation unit

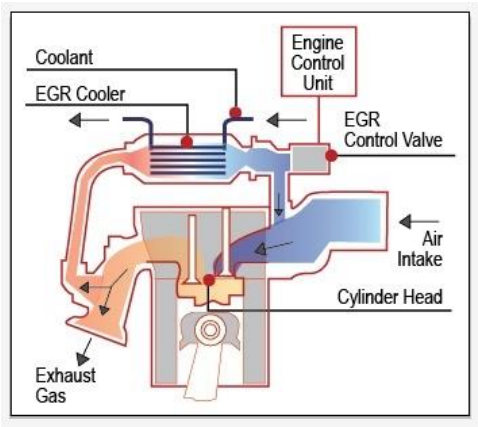
[28] Source: Company Reports, CRISIL Research

BPCL, Mumbai	Isomerisation unit stabilisation
MRPL, Mangalore	New Catalytic Reforming Unit, FCC units, revamp of Isomerisation unit

Changes required in automobiles to comply with Euro 6/VI standards

- Automobile makers are required to make changes in engine design, engine control systems and vehicle-exhaust systems to comply with stringent emission standards.
- Engine downsizing is the most fundamental method that aims at reducing emissions by cutting the fuel intake. Turbochargers are used in place of naturally aspirated engines.
- Exhaust-gas re-circulation (EGR) helps in reducing NOx emissions. Exhaust-gas recirculation system circulates some amount of exhaust in the intake mixture (after passing through an inter-cooler). This dilutes the air-fuel mixture, which further reduces the energy output from the combustion reaction, thus lowering the temperature and NOx emissions.

[29]Figure 17: Diagram showing the working of an EGR



- Urea injection / diesel exhaust fluid is an aqueous solution, made with 32.5% urea and 67.5% water. Diesel engines can be run with a lean burn air-to-fuel ratio to ensure the full combustion of soot and to prevent the exhaust of unburnt fuel. The excess of air necessarily leads to generation of NOx. Selective catalytic reduction is used to reduce the amount of NOx released into the atmosphere. Diesel exhaust fluid (DEF) from a separate tank is injected into the exhaust pipeline, where the aqueous urea vaporizes and decomposes to form ammonia and carbon dioxide. The NOx is catalytically reduced by ammonia into water and nitrogen, which are both harmless and these are then released through the exhaust.
- Gasoline direct injection (GDI): Gasoline is directly injected into the combustion chamber. This requires higher pressure at which the fuel is injected. Higher pressure ensures atomisation of fuel particles, which, in turn, increases 'surface area to volume' ratio of the fuel droplets, which reduces hydrocarbon emissions.
- Diesel-particulate filter helps in filtering the excessive soot materials.

[29] Source: CRISIL Research

Using all the above technologies substantially increases the cost of the vehicle. Also, installing some of them will increase the length of the car. If the length goes beyond 4m, the taxation rate also increases.

Currently, the world is witnessing a shortage of semiconductors worldwide. This is an aftershock of the Covid-19 pandemic that led to a drop in automotive demand. The drop in demand led to an oversupply of chipsets and further resulted in production cut by the semiconductor manufacturers. This disruption could impact the adoption of Euro 6/VI compliant vehicles in the short term and is likely to take 10-15 months to return back to normalcy.

6 Case study: India's transition to BS VI standards

India transitioned to Bharat Stage VI (BS VI) standards (an equivalent of Euro VI standards) on April 1, 2020, amid the Covid-19 pandemic and economic slowdown. The transition was a leapfrog directly from BS IV standards, which were introduced selectively in a few cities in 2010 and nationwide in 2017 . The jump from BS IV to BS VI will lead to emission reduction from the new vehicle fleet by 60-90%. It has been estimated that health benefits of this move are expected to be much higher than the actual costs of the makeover. According to ICCT (2016) A technical summary of Euro 6/VI vehicle emission standards, this leapfrog to BS VI fuel and emissions standards roadmap will help to avoid 280,000 cumulative avoidable deaths by 2030. While the actual cost of the makeover will be $10 billion, the health benefit will amount to $90 billion, nine times higher.

Key steps taken for implementation

The BS VI emissions standards represent fundamental shifts in several approaches to emissions control, monitoring and compliance. It is, therefore, important to understand the key elements of BS VI regulations.

1. BS VI minimises the difference in emissions between petrol and diesel cars

Nitrogen Oxide (NOx) emission standards until now have allowed diesel vehicles to emit much higher NOx compared with petrol vehicles. However, under BS VI, this gap has narrowed down significantly. NOx emissions for diesel cars, which were three times higher compared with their petrol counterparts, have now come down to about 1.5 times higher. Particulate emission standards have been introduced for petrol vehicles that are equipped with direct injection systems. It is also important to note that other countries are now fully equalizing the diesel and petrol standards to be fuel-neutral. The US has removed this difference. China has adopted a mix of Euro VI and California standards and applied to China VI, making it fuel-neutral.

2. Vehicles testing based on real-world emissions:

India has introduced the requirement of measurement of real-world emissions in their BS VI regulations. This implies that, in addition to lab-based tests and certifications, vehicle testing will also be carried out by driving them on roads, with portable emission monitors. The data collected from this monitoring will then be compared with the certification levels and the extent of deviation to be allowed on roads from 2023 will be evaluated. This is called conformity factor. Even as vehicles are driven in the real world, emissions monitored from the full range of driving conditions will be

measured to ensure that this does not exceed the specified limit.

3. Two-wheeler standards become increasingly stringent.

For two-wheelers, BS VI norms are aligned with Euro 5 standards. NOx and hydrocarbon measurements are now separate, compared with earlier when the two were measured together. Under BS VI, two-wheelers have on-board diagnostic systems (OBD) and specifications. All petrol vehicle models are required to meet a 1.5 g/test evaporative emissions limit, and no flexibility provisions are included for meeting tailpipe and evaporative emission limits.

4. Heavy-duty vehicles aligned with Euro VI

For heavy vehicles also, data collection is done to calculate real-world emissions and the conformity factor, which will be effective from 2023. Off-cycle laboratory-testing limits for gaseous and particulate exhaust emissions and not-to-exceed standards have been specified and will be implemented.

Costs associated with BS VI

When the BS VI plan was rolled out, it was announced that the standards would be implemented together across the country. For Indian refineries, this move was challenging, given that the government was keen on a 'single-phase' roll-out, rather than implementing in phases, targeting tier I cities in the first phase. This meant higher capital investments and stricter timelines. In the case of earlier transitions, the implementation was done in phases – tier-I cities were targeted first, followed by lower tiers.

Indian refineries invested more than $4,500 million to $5,000 million on upgrading their refineries, pipelines, and marketing and distribution networks to be able to introduce BS VI fuels, directly leapfrogging from BS IV fuels.

[30]Table 18: Approximate investments made by refineries to upgrade to BS VI grade fuel

Company	Investment (USD million)	Company	Investment (USD million)
IOCL	2267	CPCL	247
BPCL	796	RIL	240
HPCL	667	Nayara Energy	213
MRPL	241	NRL	150

Thus, huge capex was made available in a very short period of ~3 years. The transition took place amid a weak-demand scenario, where automobile sales are witnessing a slowdown and Covid-19 has led to lower fuel demand.

All the Indian refineries have switched to BS VI grade fuel successfully before the deadline, leading to an increase in the refining cost of INR. 1-1.5 per litre (or $0.013 per litre)[31] for the refining of petrol

[30] Source: CRISIL Research

[31]Conversion rate from USD

Bangladeshi Taka (BDT)	85
Indian Rupee (INR)	70
Pakistani Rupee (PKR)	154

and diesel in India on an average. However, refiners did not pass on the additional cost to the customers and adjusted it against the falling oil prices during April-May 2020.

In the automobile industry, automakers were required to make significant changes to comply with the BS VI standards. The technology required to comply with the fuel-emission norms can be divided into:

- **Engine management**: Changes required in engines to control fuel emission
- **Air fuel flow controls**: Technology/ components to maintain the optimal ratio of air and fuel in engines to control/ restrict emissions
- **After-treatment systems**: Additional components required to reduce the exhaust-gas emissions

Upgradation / modification to BS VI also needs major changes at the vehicle level, including low resistance rolling technologies, aero-dynamic improvements, and weight reduction.

Upgradation from BS IV to BS VI had major cost implications, and hence an impact on the selling price of the vehicle.

[32]Table 19: Cost differential in India for BS VI vehicles with older standards

Vehicle type	Cost increase per unit from BS III to BS IV	Cost increase per unit from BS IV to BS VI
Two-wheelers	INR 2,000 – INR 3,000	INR 3,000 – INR 4,000
Three-wheelers	INR 3,000 – INR 4,000	INR 6,000 – INR 8,000
Passenger cars - Gasoline	INR 3,000 – INR 5,000	INR 8,000 – INR 10,000
Passenger cars - Diesel	INR 10,000 – INR 30,000	INR 50,000 – INR 70,000
MHCVs - Diesel	INR 80,000 – INR 100,000	INR 150,000 – INR 250,000

The automobile industry suffered in FY 2021 due to the implementation of BS VI, which led to a significant rise in vehicle prices, and hence subdued sales. To further aggravate the situation, the implementation was done amid the Covid-19 pandemic, which sharply impacted vehicle demand.

The two-wheelers industry was negatively impacted by the disruption from Covid-19 and high ownership cost, due to BS VI emission norms that resulted in higher vehicle prices. The ownership cost grew 9-11% for motorcycles and scooters in fiscal 2021 due to BS VI norms along with an annual rise in vehicle prices. In times of subdued demand sentiment, financiers pushed for an increase in loan-to-value (LTV) to lure customers to make purchases. Automakers are also facing challenges in terms of catering to the export markets, as most markets they export to are not BS VI-compliant and, hence, manufacturers are expected to maintain separate production lines to cater to export demand.

For car markets, major OEMs have commenced the launch of BS VI petrol-only variants and diesel options are less attractive due to the diminishing price differential between petrol and diesel fuels. Maruti Suzuki, Tata Motors and Mahindra & Mahindra (M&M) have announced the discontinuation of diesel engines in certain models, as the price hike due to BS VI upgradation fails the cost economics test, impacting the revenues of automakers as diesel variants of cars are priced higher compared with petrol cars.

[32] Source: CRISIL Research

Leaping from BS IV to BS VI within three years was a challenging task for the industry, as it required significant changes for both refineries and automobile manufacturers. For automakers, numerous variables needed to be factored in – Indian driving conditions, load-carrying capacities, end-user perspective to meet long-drain durability and fuel economy expectations with testing and validation done in record time. It not only demanded heavy investments but a collaborative and focused approach across the value chain to ensure a smooth transition.

The transition happened in one step compared with European countries, which transitioned to Euro 5 compliant fuel before the final transitioning to Euro 6/VI. This resulted in a reduction in the cost of transitioning into two phases. Moreover, the transition was aided by the market dynamics of the fuel price market; the impact of higher-priced Euro 6/VI fuel was cushioned by the constantly rising fuel prices. Similarly, the expected price hikes due to BS VI-compliant engines coincided with the regular price hikes, due to the exchange-rate fluctuations and rising input and material costs. Therefore, the transition was comparatively easier in terms of consumer acceptance.

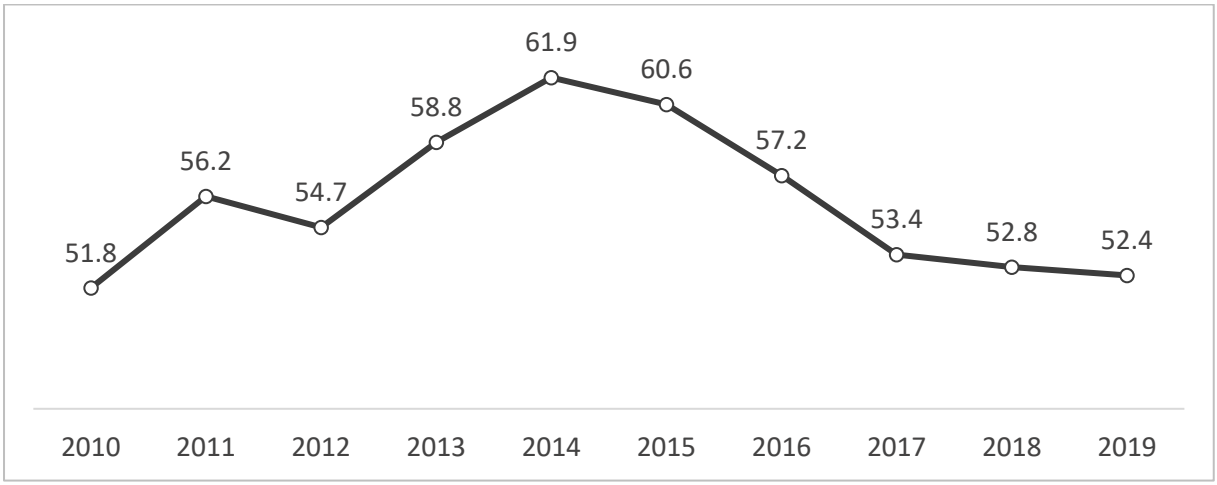
7 Assessment of economics of transition to Euro 6/VI standards in SAARC Countries

7.1 Afghanistan

Afghanistan is one of the least developed nations in the world, hindered by years of armed conflict and war. With annual per capita income of $1,824, the country is one of the poorest, with a vast majority of the population living in dire poverty. Fuel wood, charcoal, agricultural and animal waste still dominate in meeting energy needs for cooking and heating, with a large percentage of the population using kerosene, candles, and biogas for lighting.

According to WHO estimates, deaths due to environmental risks constitute 26% of all deaths in Afghanistan. Ambient air pollution (outdoor) causes over 11,000 deaths annually. According to IQair (2020), 2020 World Air Quality Report, Kabul has a PM 2.5 level of 46.5 µg/m³ as of 2020, much above the WHO-recommended 10 µg/m³. Air pollution has been on the rise in Afghanistan and the transport sector contributes to a significant share in overall pollution levels.

[33]Figure 18: Trend in Afghanistan PM 2.5 levels (µg/m³)



[33] Source: State of global air report 2020

7.1.1 Measures taken by Afghanistan to control air pollution

In April 2005, the National Environmental Protection Agency (NEPA) was established. Before this, Afghanistan had no legal tool for environmental management. Eight months later, however, on December 18, 2005, the Afghan cabinet approved a legislation known as the Environment Act.

The law clarifies administrative roles at the national level and coordination with provincial authorities. It spells out frameworks for managing natural resource conservation and biodiversity, drinking water, pollution control, and environmental education

7.1.2 Status of refining and automotive industries in Afghanistan

Private players have significant investments in midstream petroleum product infrastructure space by cumulatively owing seven refineries with a combined capacity of 1.6 million tonne as detailed below:

[34]Table 20: Refining capacity in Afghanistan

Company	Capacity ('000 MT)
Kaam Group	182.5
Kaam Group 2	182.5
Kaam Group 3	182.5
Ghazanfar	182.5
Inter Asia	365
Mazar Shareef Refinery	182.5
Asia Hareua Energy	365

These refineries, if operational at 80% utilization factor, will be sufficient to meet 60% of the current petroleum product demand in Afghanistan. However, these refineries are constrained due to prohibition on crude oil imports. Afghanistan, therefore, meets its entire petroleum product requirement through imports.

Afghanistan, being a landlocked country, imports petroleum, oil and lubricants (POL) products through road transport from its neighbouring nations, mainly Turkmenistan, Uzbekistan and Russia. It has seven major land ports that facilitate import and storage of petroleum products, with Herat, Nimrooz and Andkhoi being the major ports.

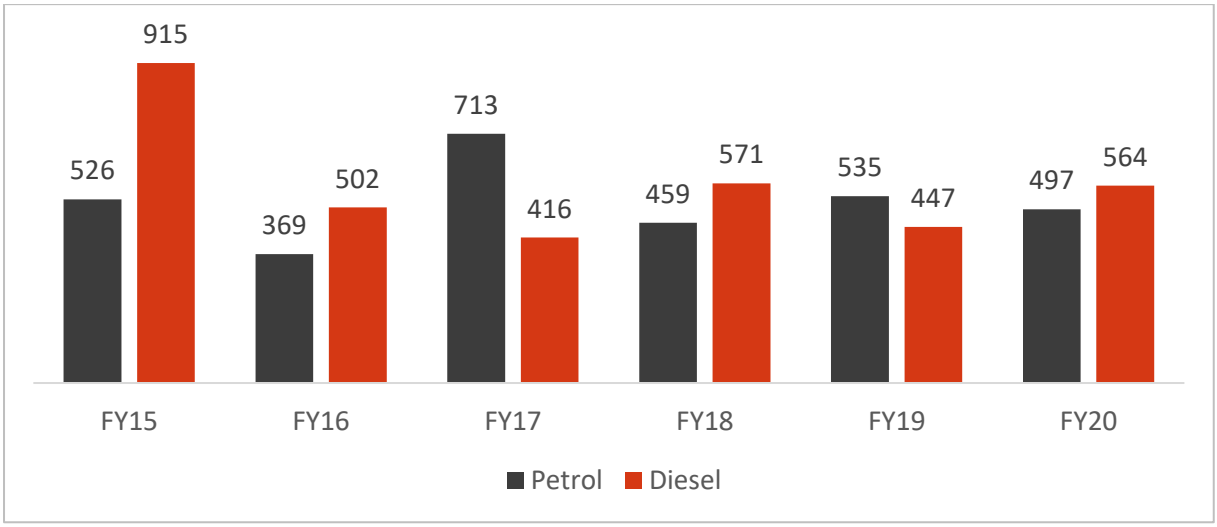
Afghanistan's overall demand for petroleum products is estimated to have remained stable between fiscals 2015 and 2020. The authentic data available for petroleum product demand is the import data from the Central Statistic Organization (CSO), which includes only private import data. Additionally, petroleum products have been imported and consumed by foreign vehicles of coalition forces, the data for which is not available. However, the report suggests there has been a significant dip in demand after political turmoil in the country. There is also a strong possibility of consumption of unreported POL products, which have been imported illegally into the country.

Diesel and petrol in overall terms comprise 51% of the total petroleum product demand in the country.

[34] Source: Afghanistan Oil and gas Industry overview report, 2019

More than 95% of demand comes from the transportation segment, which has seen a decent growth over the past five years. Both diesel and petrol-based vehicle population grew at 3-4% compound annual growth rate (CAGR) between fiscals 2014-19. However, the demand for petrol and diesel has remained stagnant during this period. In fact, diesel demand has declined since fiscal 2015, from 915 thousand tonne to 564 thousand tonne.

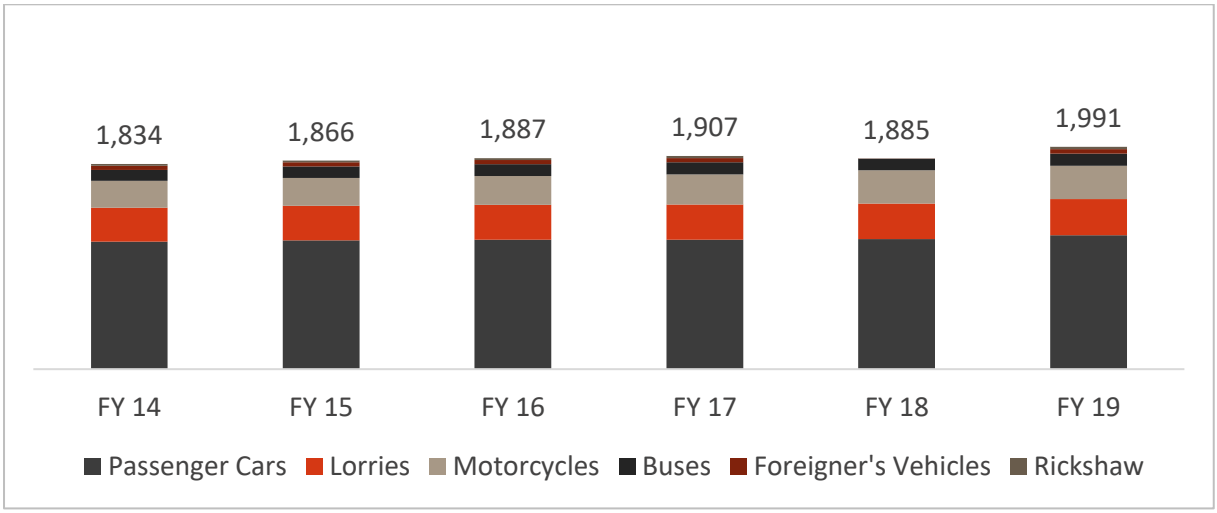
[35]Figure 19: Trend in petrol, diesel demand in Afghanistan ('000 tonne)



The automobile industry in Afghanistan is largely import-dependent, with a majority of these imports coming from Japan, China, India, etc. The automotive industry is a growing market, with annual vehicle sales of close to 40-50 thousand vehicles across categories. The total on-road population of vehicles was approximately 2 million as of fiscal 2019 as reported in the Afghanistan Statistical Yearbook, 2020.

Among various vehicle categories, passenger cars form the largest share, with nearly 1.2 million as of fiscal 2019.

[36]Figure 20: Trend in vehicles on road in Afghanistan ('000 units)

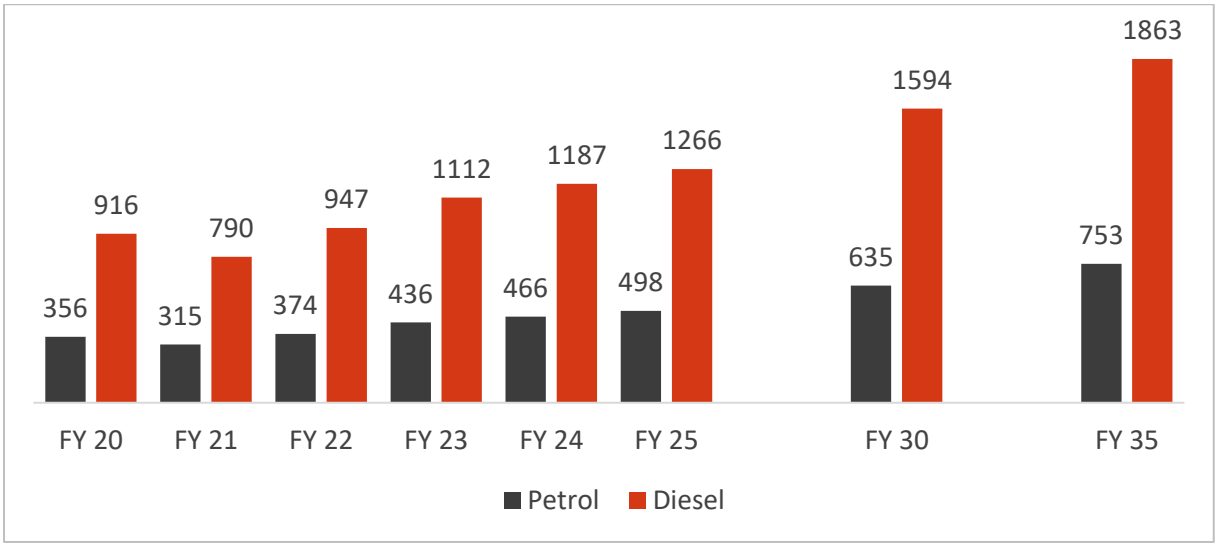


[35] Source: Afghanistan Statistical Yearbook, 2020
[36] Source: Afghanistan Statistical Yearbook

7.1.3 Outlook on auto-fuel demand and related emissions in Afghanistan

Strong GDP growth and resultant increase in per capita income is expected to boost car and two-wheeler sales between fiscals 2021 and 2035, thereby increasing overall demand for petrol by a projected 6-7% CAGR. Diesel demand is also expected to rise at 6-7% CAGR over the period, driven by higher demand from the transport segment. Demand from the power sector, though, is forecast to decline to zero owing to availability of cheaper imported power and increase in renewable energy supply.

[37]Figure 21: Petrol and diesel consumption in Afghanistan ('000 tonne)



With rising vehicle population, vehicular emissions are expected to increase sharply. Assuming that Afghanistan continues to use Euro 3 grade fuel and vehicles, and does not upgrade to Euro 6/VI in our base case, CRISIL Research forecasts the following emission levels for CO, NOx, PM2.5, and CO2 from the vehicular pollution:

[38]Table 21: Emissions forecast in Afghanistan

Pollutant	Emission in FY22 (kilo tonne)	Emission in FY35 (kilo tonne)	CAGR (FY22-FY35)
Carbon monoxide	40.8	85.5	5.9%
NOx	51.5	104.6	5.6%
PM 2.5	1.6	3.3	5.7%
Carbon dioxide	2951.9	6315.6	6.0%

Note: Emission factors have been taken from ICCT emission factor database for carbon dioxide, and others are based on Euro 3 emission standards

7.1.4 Transition to Euro 6/VI: Key considerations

Despite having refining capacities, Afghanistan imports 100% of its fuel requirement owing to restrictions on crude oil imports. Afghanistan also has two large crude oil and natural gas basins – in the Afghan Tajik Basin province and the Amu Darya Basin province – with total estimated crude oil reserves of 2,158 million barrels (~294 million tonne) as of July 2015, as reported by U.S. Geological

[37] Source: CRISIL Research
[38] Source: CRISIL Research estimates

Survey (2015), Statistics of Petroleum Exploration in the World Outside the United States and Canada Through 2015. However, because of prolonged political unrest in the country, no significant investments have been made to extract the resources. Going forward as well, we believe that Afghanistan will remain import dependent for its petroleum product requirement.

Hence, to move to Euro 6/VI standards, the country will have to start importing higher quality fuel as well as Euro 6/VI compliant vehicles.

7.1.5 Barriers to effective transition

- **Limited or no regulatory push:** Afghanistan has not implemented regulations pertaining to upgradation of fuel standard, because of which most vehicles are still sold with lower emission standards. The import of vehicles, though, are from China, India and Japan, which have already moved to Euro 6/VI standards. This implies that the country can easily switch to more stringent emission standards by banning the import of older standard vehicles.
- **Availability of fuel imports:** More than 90% of Afghanistan's petrol and diesel requirements are met from Iran. Iran is currently following Euro 4 standards. Hence, in order to meet Euro 6/VI standards, Afghanistan will have to switch its source of fuel supply from Iran to India or Japan, which already produce Euro 6/VI grade petrol and diesel. However, this may have certain cost implications. Moreover, the switch may not be easy due to ongoing political issues in the country.
- **Lack of availability of data and enforcement of regulations:** There is very limited data availability with respect to energy parameters or pollution emission levels in Afghanistan. To curb pollution, regular reporting and transparency of data is required. Moreover, even though certain laws and regulations are in place, enforcement of these is not strict. For instance, several vehicles in the country are driven without registration plates. These operational issues create a challenge towards implementing a strategy for controlling pollution levels.

7.1.6 Benefits of transition to Euro 6/VI

While the cost of transition to Euro 6/VI is significantly high, it is expected to provide benefits in the long run:

Savings on fuel consumption due to improving fuel economy

Euro 6/VI-compliant vehicles are a significant improvement over Euro 3 vehicles, not only in terms of emissions but also in terms of efficiency, as these provide higher fuel economy. Euro 6/VI vehicles have higher fuel economy, and, hence, consume lower volume of petrol and diesel. As per CRISIL Research projections, this will translate into cumulative fuel savings of 900-950 thousand tonne of petrol, and 4-5 million tonne of diesel between fiscals 2025 and 2035. This will lead to a cumulative savings of USD 3-4 billion for both petrol and diesel. These savings are calculated based on the comparison of fuel consumption of current population and Euro 6/VI vehicles. Also, as Afghanistan imports all of its fuel requirement, the lower fuel consumption would reduce the import bill.

[39]**Table 22: Outlook on savings on petrol and diesel consumption due to implementation of Euro 6/VI ('000 tonne)**

Fuel	FY25	FY30	FY35	Cumulative (FY25-FY35)
Petrol	26	88	104	915
Diesel	337	426	499	4,639

Reduced emission levels

Implementation of Euro 6/VI standards, though, will not significantly contribute to reduction in emission in the initial years of implementation, as majority of on-road vehicles will be still running on the old standards. However, as new vehicles replace old vehicles, there will be significant reduction in vehicular emission. CRISIL Research projects that within the overall vehicular population, 60-65% would comprise of Euro 6/VI-compliant vehicles by fiscal 2035 vis-à-vis 5-6% in fiscal 2026, the first year of implementation. Also, overall emission of various pollutants is expected to be lower by 40-60% in fiscal 2035 compared with the base case scenario.

[40]**Table 23: Outlook on emissions with Euro 6/VI implementation ('000 tonne)**

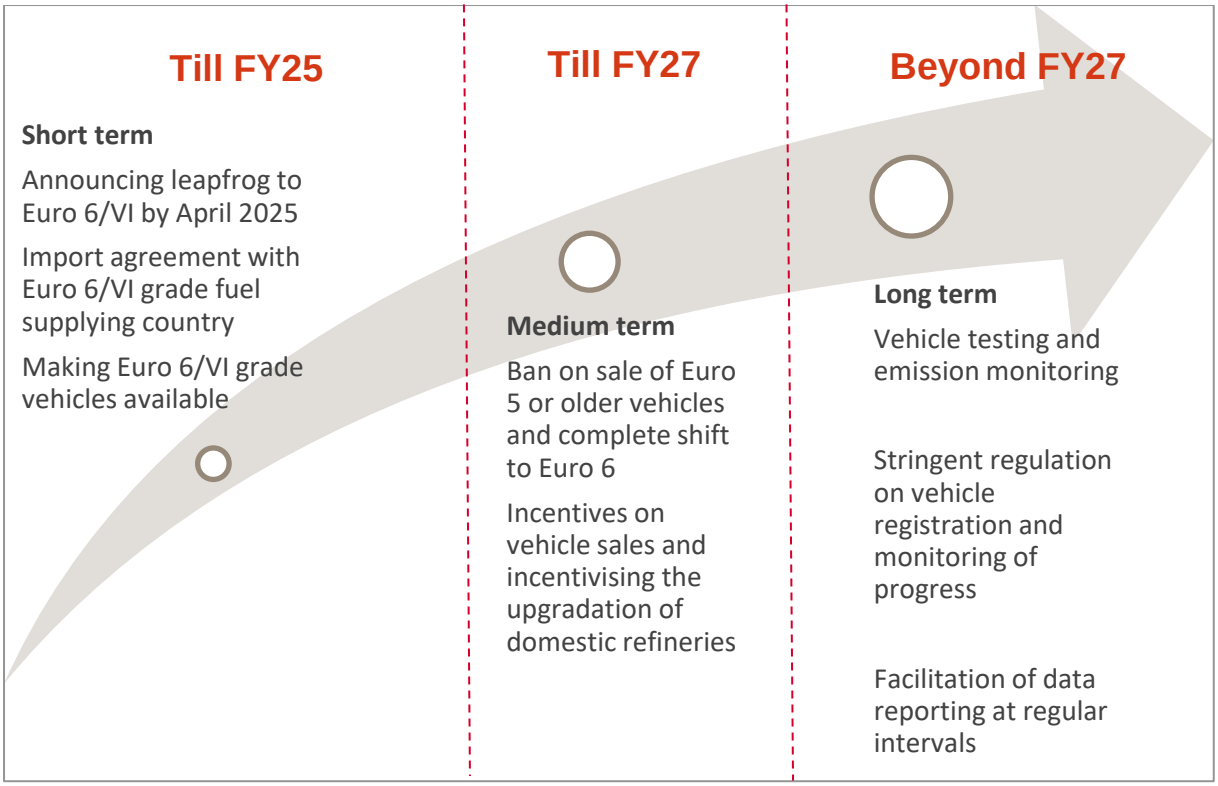
Pollutant ('000 tonne)	Base case		Euro 6/VI		FY26-FY35 CAGR	
	FY25	FY35	FY25	FY35	Base case	Euro 6/VI
Carbon monoxide	55.0	85.5	52.8	50.3	5%	0%
NOx	69.7	104.6	65.8	39.2	4%	-5%
PM2.5	2.2	3.3	2.0	1.1	4%	-6%
Carbon dioxide	3959.1	6315.6	3844.6	4608.0	5%	2%

Implementation of Euro 6/VI standards will not only reduce annual emissions when compared with the base case, but also lead to overall reduction in annual emissions by fiscal 2035.

7.1.7 Roadmap for adoption of Euro 6/VI standards[41]

Afghanistan will need to move to stringent emission standards, not just by passing laws or setting targets, but also ensuring ways to implement and execute such changes, along with monitoring progress of such policies and regulations. The roadmap for adoption of Euro 6/VI standards has been divided into short-, medium- and long-term activities and recommendations to ensure smooth transition.

[39] Source: CRISIL Research estimates
[40] Source: CRISIL Research estimates
[41] Source: CRISIL Research



Short-term: fiscals 2024 to 2025

Afghanistan imports most of the vehicles from China, India, and Japan, which are Euro 6/VI compliant. Thus, a switch to Euro 6/VI would not be a challenge as far as the import of vehicles is concerned. However, in the case of sourcing of compliant fuel, Afghanistan will need to shift to an alternate source of fuel supply, as, currently, all of its fuel requirement is met by Iran, which is still on Euro 4. For this purpose, Afghanistan can enter into a trade agreement with China, India, etc, which not only produce Euro 6/VI complaint fuel, but also have trade relationships with Afghanistan with respect to other products.

Introduction of a vehicle scrappage policy will also be a key factor in lowering emissions. New sales of vehicles only happens when customers scrap their old vehicles. Currently, there is no such policy in Afghanistan. Moreover, the country imports large volume of second-hand vehicles, which have high emissions. Afghanistan should introduce a comprehensive vehicle scrappage policy under which vehicles older than 15 years should not be allowed on the roads of big cities, as is the case in India, wherein customers scrapping old and polluting vehicles are provided with an incentive to buy a new vehicle. Moreover, there should be limits on the import of second-hand vehicles, such as banning the import of vehicles older than five years.

Medium-term: fiscals 2026 to 2027

By fiscal 2027, the government should ban the sale of Euro 5 standard or earlier vehicles, and mandate the sale of Euro 6/VI grade vehicles only. To encourage a smooth transition, the government should introduce incentives to purchase Euro 6/VI vehicles, such as duty concessions, subsidies, etc, which will ensure that automobile dealers/importers do not lose out on sales because of accompanying rising vehicle prices.

Long-term- Beyond fiscal 2027

A key issue that needs to be addressed in Afghanistan is reporting of pollution and other related data. Moreover, for consumption data for petrol and diesel, the only reliable source is the CSO, which reports only private imports/consumptions. Hence, one cannot be sure if all the data has been considered. This issue needs to be addressed on a larger scale, with regular monitoring of progress related to regulations, and setting up of institutional capacity for conducting such activities.

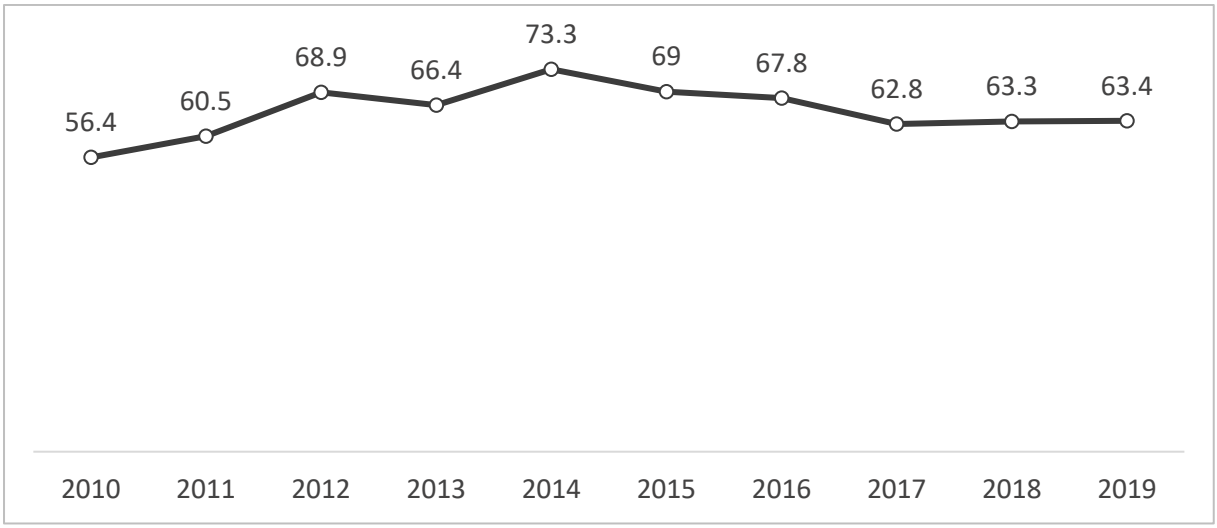
That said, vehicle emission testing facilities should be set up to continuously monitor emissions from vehicles across the country. Vehicle testing should be done at the time of registration and at regular intervals of three months. The benefit of this quarterly testing will be taking regular stock of emission form the operational fleet of vehicles. This can be further implemented with heavy penalties for offenders (high emission vehicles) and cancellation of registration of vehicles for repeat offenders. A sticker or digital tag-based monitoring can be introduced here for better implementation of the norms. An incentive can also be introduced for low emission vehicles at the time of insurance or road tax renewal. These will pave the way towards reducing emissions in the country.

7.2 Bangladesh

Bangladesh is a major developing economy among the SMS. The country has seen rapid increase in population and economic activity. With this, demand for vehicles, civil infrastructure and industries has increased, resulting in higher level of pollution in the country. Dhaka and Manikganj are the most polluted cities in the country, with dangerous levels of smoke, haze and pollutants in the atmosphere.

In Dhaka, the brick industry is a major air polluter. Also, there are other industries and vehicles contributing to rising pollution levels. According to the IQair (2020), 2020 World Air Quality Report Bangladesh is the most polluted country, based on annual average PM2.5 concentration (µg/m³). Urban areas of Bangladesh have heightened level of particulate matter in the air, especially in the dry season (November-April).

[42]Figure 22: Trend in Bangladesh PM 2.5 levels



[42] Source: State of global air report 2020

7.2.1 Measures taken by Bangladesh to control air pollution

According to World Resources Institute (2020) dashboard Bangladesh, which contributes ~0.41% to global GHG emission, is a signatory to COP21 targets. According to MoEFCC (2021), Nationally Determined Contributions (NDC) Bangladesh, the country submitted its first Intended Nationally Determined Contribution to the United Nations Framework Convention on Climate Change (UNFCCC) on September 25, 2015, with a GHG reduction target of 15% from a business as usual (BAU) level by 2030 as a commitment to reduce GHG emission. Of this, 5% emission reduction is unconditional target and the remaining 10% is conditional, based on financial and technical support from the global community.

The country has also prepared some key strategic policies to tackle climate change and GHG emission. However, most of the policies are targeted towards clean energy transition for power sector, whereas the transportation sector requires more policy and regulatory support.

- **Monitoring and reducing air pollution**

  The (Government of the People's Republic of Bangladesh) issued guidelines to government and non-government entities to control and monitor air pollution from major sources, including brick kilns, construction and excavation activities, transportation sector, open burning of biomass, and industries. In this regard, Clean Air Act, 2020 has been finalised and awaiting approval.

- **Clean Air and Sustainable Environment (CASE) project**

  The country's Ministry of Environment, Forest and Climate Change implemented the CASE project in 2010 with financial assistance from the World Bank. The project was aimed at proving technical and financial assistance to the most polluted sectors and improve the quality of ambient air. Subsequent to this, the project also targeted policy and regulation development in accordance with the respective governing bodies or ministries in the country. The project intended to strengthen the institutional, policy and regulatory framework for public transport, and help mainstream environmental considerations into general urban transport policy. The programme further focused on the deployment of mass rapid transport (MRT) and bus rapid transport (BRT) in cities with heavy traffic and congestion.

- **Mujib Climate Prosperity Plan up to 2030**

  Bangladesh has chaired the presidency of the 48-nation Climate Vulnerable Forum (CVF) for the second time (2020 to 2021), and the Vulnerable Twenty Group of Finance Ministers. As Chair to the CVF, the government launched a programme in October 2020 to develop the Mujib Climate Prosperity Plan for Bangladesh. The Draft plan identifies several key initiatives, which focus in renewable energy, energy storage infrastructure, power grid modernization, established carbon market regime, Bangladesh Delta Plan 2100 resilience bonds, training and skills development for future, future-proof Bangladesh's industries, locally-led adaptation outcomes, micro/small/medium enterprise financial protection and productivity enhancement, climate-resilient and nature-based agricultural and fisheries development, environment friendly transport, climate resilient well-being programs and accelerated digital revolution.

- **Bangladesh National Action Plan for Reducing Short Lived Climate Pollutants (SLCPs)**

The action plan was formulated to reduce SLCPs by implementing cost-effective measures for large scale deployment. Full implementation of the national SLCP plan is expected to reduce black carbon emissions by 40% and methane emission by 17% by 2030 compared with BAU scenarios.

Other strategic initiatives of the government include:

- Forest and Carbon Inventories
- Energy Efficiency and Conservation Master Plan up to 2030
- Clean Development Mechanism / carbon trading
- Renewable energy initiatives
- Promoting green technology

7.2.2 Status of refining and automotive industries in Bangladesh

Bangladesh had 1.5 million tonne of refining capacity as of fiscal 2020 operated by Bangladesh Petroleum Corporation (BPC). The refinery was set up in 1968, and at the time of commissioning was to be operational for 20-25 years. While the refinery has been subjected to repairs, maintenance and upgrades over the years, maintenance costs have increased as the economic life of the equipment has expired. Hence, the cost of refining has also increased significantly over the years.

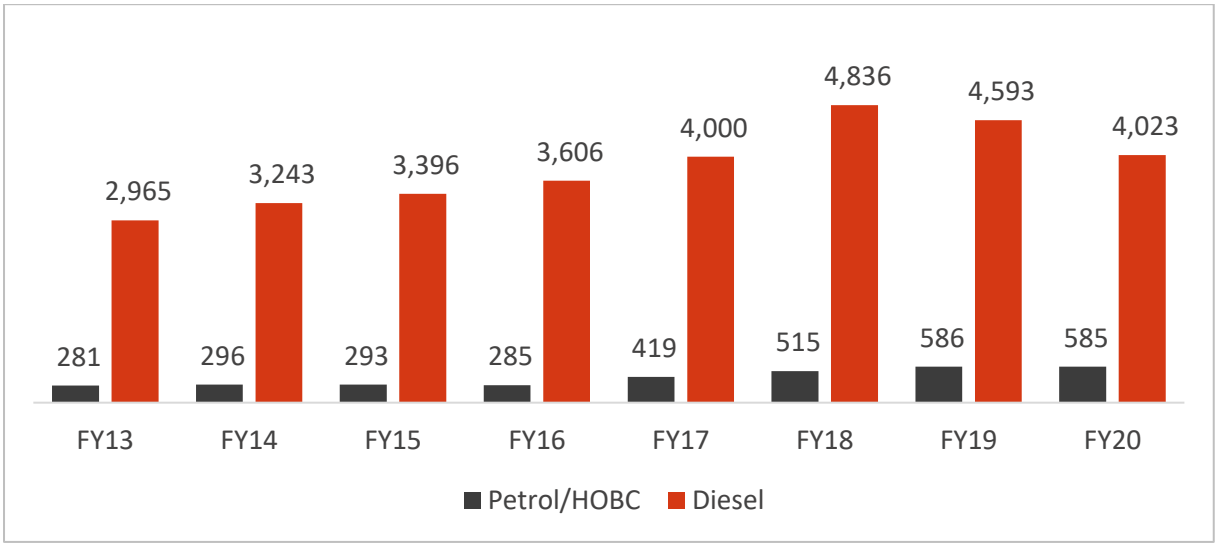
Currently, the refinery supplies $1/5^{th}$ of the country's requirement, with the remainder met via imports. According to Energy Scenario Bangladesh, 2019-20, the country imports ~1.26 million metric tonne of crude oil along with 4.04 million metric tonne of refined petroleum products per annum.

The government has planned another refining complex as an extension of the Eastern Refinery Ltd (ERL) refining complex, with a capacity of 3 million tonne. This will take the total refining capacity of the country to 4.5 million tonne. The capacity was proposed in 2010; however, the project is still at the planning stage. The capacity is critical for the country to reduce its import dependence of petroleum products. Apart from this, BPC has also planned other major projects to supplement the sector:

- India-Bangladesh Friendship Pipeline
- Installation of custody transfer flow meter at ERL tank
- Terminal automation of marketing companies of BPC
- Setting up of liquefied petroleum gas (LPG) terminal by BPC in the Maheshkhali-Matarbari area of Cox's Bazar district

To be sure, demand for petroleum products has increased considerably in the past five years, with petrol and high octane blending component posting growths of ~15%, and diesel registering an increase of 3% from fiscal 2015 to 2020. The increase in petrol demand is on account of rising number of cars and motorcycles on the country's roads.

[43]**Figure 23: Trend in petrol, diesel demand in Bangladesh ('000 tonne)**



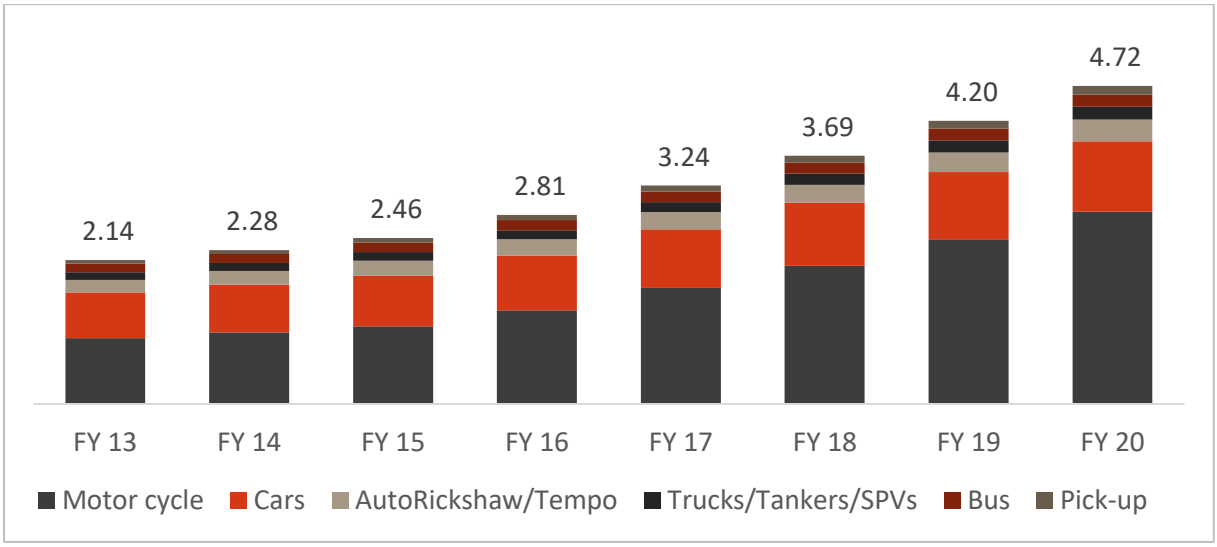
Growth of the automotive industry in Bangladesh is because of sharp growth of the industrial sector and per capita income levels. The country has 2.5 cars per 1,000 population, which is, however, modest compared with other SMS, such as India and Pakistan. According to Bangladesh Road Transport Authority, among the vehicle categories, two-wheelers comprise the largest share, with a population of ~2.85 million as of fiscal 2020.

There are several companies assembling or distributing vehicles in Bangladesh. These companies have tied up with major global manufacturers to assemble foreign models domestically. Companies such as Fair Technology Ltd, PHP Motors, and Pragati Industries are already manufacturing vehicles in the country or have announced plans for the same. Additionally, there are companies planning to introduce battery electric vehicles.

The country, however, lacks a scrappage policy, as a result of which most vehicles plying on the roads in Bangladesh are highly polluting. These vehicles are classified as super emitters, and are the main cause of pollution from transport sector. Of the vehicles, buses, trucks and motorcycles are the major contributors to emissions. According to the Department of Environment (2019), Clean Air and Sustainable Environment Project, 77.8% of motorcycles failed to maintain standards, while 84% diesel-powered buses and 69% of trucks did not meet emission standards. Further, lack of a scrappage policy has result in lower sales of new vehicles, impacting vehicle manufacturers and suppliers.

[43] Source: BPC, CRISIL Research

[44]**Figure 24: Trend in vehicles on road in Bangladesh (million units)**



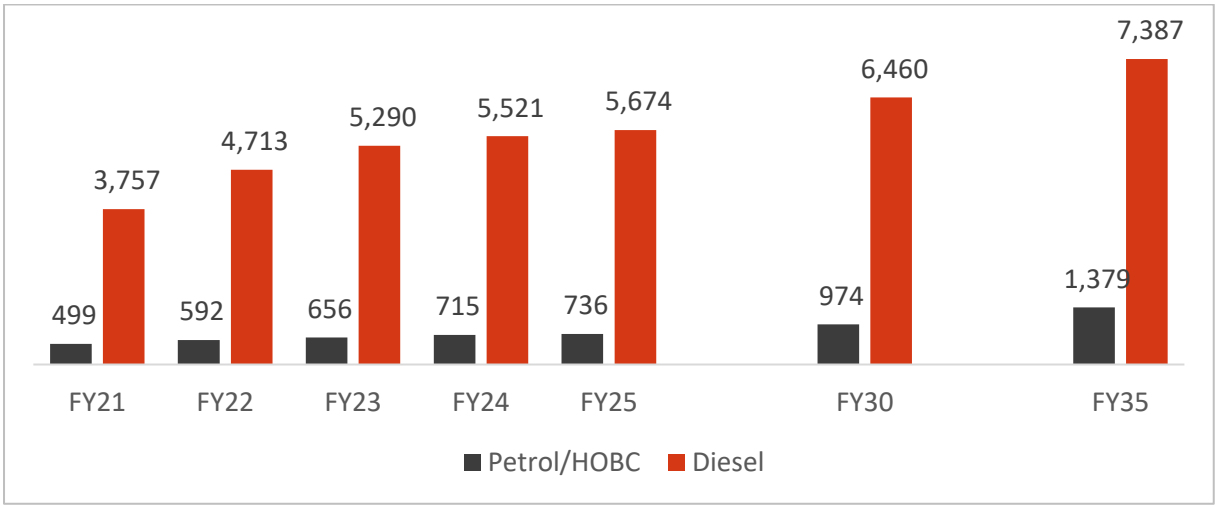
7.2.3 Outlook on auto-fuel demand and related emissions in Bangladesh

Increased economic activity has led to multi-fold growth in the country's vehicle population. With continued rising incomes, the number of vehicles is projected to rise sharply between fiscals 2022 and 2035. Moreover, with the government pushing BRT, commercial and public transportation is forecast to receive a major overhaul, thus boosting demand of commercial vehicles.

We forecast sales of cars and two-wheelers to rise at 2-4% and 9-10% CAGR, respectively, between fiscals 2022 to 2035. The three-wheeler population is expected to rise at 5-7% CAGR during the period.

As a result, petrol consumption is projected to increase at 6-7% CAGR up to fiscal 2035. However, in fiscal 2021, consumption is estimated to have declined 15% on-year amid challenges heaped by the Covid-19 pandemic. In the case of diesel, demand for the product is majorly dependent on economic activity in the country, including logistics, public transportation, agricultural requirement, etc. With sales of buses and trucks expected to post growths of 4-6% and 2-3% CAGRs, respectively, diesel demand is expected to rise 3-4% CAGR up to fiscal 2035.

[45]**Figure 25: Outlook on petrol, diesel consumption in Bangladesh ('000 tonne)**



[44] Source: Bangladesh Road Transport Authority, CRISIL Research
[45] Source: BPC, CRISIL Research

With rising income levels and vehicle population, vehicular emissions are expected to rise rapidly. Assuming that Bangladesh is continuing to use Euro 2 grade fuel and vehicles, and does not upgrade to Euro 6/VI, in our base case, CRISIL Research forecasts the following emission levels for CO, NOx, PM2.5 and CO2 from the vehicular pollution:

[46]Table 24: Emissions forecast in Bangladesh

Pollutant	Emission in FY22 (kilo tonne)	Emission in FY35 (kilo tonne)	CAGR (FY22-FY35)
Carbon monoxide	364	785	6.1%
NOx	218	323	3.1%
PM 2.5	8	16	5.0%
Carbon dioxide	19,949	39,503	5.4%

Note: Emission factors have been taken from ICCT emission factor database for carbon dioxide, and others are based on Euro 2 emission standards

7.2.4 Transition to Euro 6/VI: Key considerations

The transition to Euro 6/VI is requires changes in two major sectors - refinery and automobiles. Bangladesh is currently at Euro 2/3 standards for vehicular emission, based on revision in emission standards published in 2012. The country relies on imports to meet 4/5th of its POL demand, with imports from China, India, the Middle East, and Singapore. As most of these countries have already implemented Euro 6/VI standards in their refineries, Bangladesh only needs to upgrade the single domestic refining capacity of 1.5 mtpa to move towards Euro 6/VI standard fuel.

Plans for Euro 6

As the refinery has crossed its economic age, and has been upgraded to Euro 3 standards, it would be imperative for the refinery to upgrade the entire suite of equipment as well. These equipment include the diesel hydro desulphurising (DHDS) unit and the FCC unit, as well as the continuous catalyst regeneration (CCR) unit, hydrotreating (gas oil), benzene saturation, distillate de-aromatisation and octane replacement for producing Euro 6/VI-compliant gasoline and diesel.

Based on the benchmarks used in section 8.3, CRISIL Research estimates that the total capex for the conversion of the existing refineries in Bangladesh would be $**700-800 million**. This is still lower than the estimated capex required for establishing a new refinery of similar capacity, which would range $1.0-1.5 billion *(benchmarking the estimated capex for ERL-Unit 2)*

The break-up of this is:

[47]Table 25: Estimated capex of existing refinery in Bangladesh to upgrade to Euro 6/VI

Refinery	Estimated capex ($ million)
ERL	700-800

Also, Bangladesh is expected to add a 3 million tonne refining capacity as an extension to the ERL current capacity of 1.5 million tonne. The estimated capex for the refinery has almost doubled in the

[46] Source: CRISIL Research estimates
[47] Source: CRISIL Research estimates

past decade because of extensive delays in finalising the project. As the refining capacity is new, therefore, it is logical to add capacity based on the most advanced fuel standard, i.e. Euro 6/VI.

[48]Table 26: Upcoming greenfield refineries in Bangladesh

Entity	Location	Capacity (ktpa)	Estimated capex ($ bn)
ERL-Unit 2	Chattogram	3.0	2-2.5

Hence, transition to Euro 6/VI in Bangladesh will require an estimated capex of $3.0-3.5 billion. In addition to this cost, there are several other softer cost aspects that need to be considered, such as:

- Automobile manufacturers will have to switch to new production lines to make automobiles that are Euro 6/VI compliant. Additionally, considering that 70% of the vehicles in Bangladesh are imported, importing Euro 6/VI vehicles will lead to higher import bill on account of:
- Higher cost of imported vehicles compared with Euro 2 vehicles

7.2.5 Barriers to effective transition

The introduction of Euro 6/VI standards in Bangladesh would lead to the adoption of advanced technologies to ensure pollutants emitted by vehicles are reduced and comply with the specified limits. It would include required changes in the engine systems and significant investments to upgrade refineries.

The challenges and barriers to smooth implementation are detailed below:

- **Heavy investments required to upgrade refineries:** Established in 1968, the refinery in Bangladesh is very old. It requires regular maintenance and repair, and the upgradation to higher standard output is still pending. Bangladesh decided to implement Euro 3/4 in July 2019, but the plan was revised to Euro 5. The upgrade is still pending due to cost constraints and shifting of focus to a newer refinery complex. In the existing refinery, cost of refining has jumped by more than 80% compared with the cost of refining during its serviceable age. The cost of upgrading the 1.5 MTPA capacity is still less than the capex estimation for the new refinery, but due to lack of resources the plans for upgradation are a major challenge for a developing nation.
- **Automobile manufacturers reluctant due to rising costs**: Automobile manufacturers need to invest huge amounts to completely transform their production platforms. It is more onerous for companies that have products across several categories, from cars and SUVs to two-wheelers and trucks. Most of the car manufacturing and assembling facilities manufacture models for global automotive giants that have the Euro 6/VI technology at disposal. Such a portfolio means that companies would have to invest resources and time to source upgraded parts or components. The transition will significantly increase the production cost of vehicles, which they may not be able to pass on to the consumers immediately. Even if they do, it will increase the retail prices of their products, which may lead to declining sales in a country where vehicles are already dearly priced.

[48] Source: CRISIL Research estimates

7.2.6 Benefits of Euro 6/VI

Euro 6/VI standards are not without benefits, though achievable only in the long run. These benefits include:

Savings on fuel consumption due to improving fuel economy

Euro 6/VI compliant vehicles are a significant improvement over Euro ¾ not only in terms of emissions, but also in terms of efficiency, as they provide higher fuel economy. Euro 6/VI implementation would ensure new vehicles have higher fuel economy, thus consuming lower petrol and diesel. As per CRISIL Research estimates, this will translate into a cumulative fuel savings of 400-500 thousand tonne of petrol and 1.5-2 million tonne of diesel between fiscals 2026 and 2035. These savings are likely to translate into a cumulative savings of USD 1.7 billion by fiscal 2035. This is based on forecasted fuel demand considering base case Euro 2 and after transitioning to Euro 6 with higher mileage, leading to lower fuel consumption. Also, as Bangladesh imports a large volume of its fuel requirement, lower consumption would lead to lower import bill for the country.

[49]Figure 26: Outlook on savings on petrol and diesel consumption due to implementation of Euro 6/VI

Fuel	FY26	FY30	FY35	Cumulative (FY26-35)
Petrol	11	41	89	449
Diesel	35	178	314	1,777

Reduced emission levels

The primary objective of implementing stringent standards is to reduce emissions from vehicles, to check air pollution. With a GHG reduction target of 15% from a business as usual (BAU) level by 2030, transport sector remains one of the focused target in Bangladesh. The sector contributed of around 12 million ton of CO_2 emission in 2020. Euro 6/VI will not contribute to emission reduction significantly in the initial years of implementation, as majority of the on-road vehicles would still run on the old standards. However, over a period, as new vehicles replace old vehicles, there will be a significant reduction in vehicular emissions. CRISIL Research estimates that of total vehicular population, 65-75% would be Euro 6/VI compliant by fiscal 2035. This number is expected to be 6-9% in fiscal 2026, the first year of implementation.

Emissions of various pollutants are expected to be 50-70% lower in fiscal 2035, compared with the base case scenario. The pollutant emissions are calculated based on the current emission standards compared to the emissions after transitioning to Euro 6/VI standards.

[50]Table 27: Outlook on emissions with Euro 6/VI implementation

Pollutant ('000 tonne)	Base Case		Euro 6/VI		CAGR FY26-35	
	FY26	FY35	FY26	FY35	Base Case	Euro 6/VI
Carbon monoxide	453	785	384	384	6.3%	0.0%
NOx	248	323	214	143	3.0%	-4.4%

[49] Source: CRISIL Research estimates
[50] Source: CRISIL Research estimates

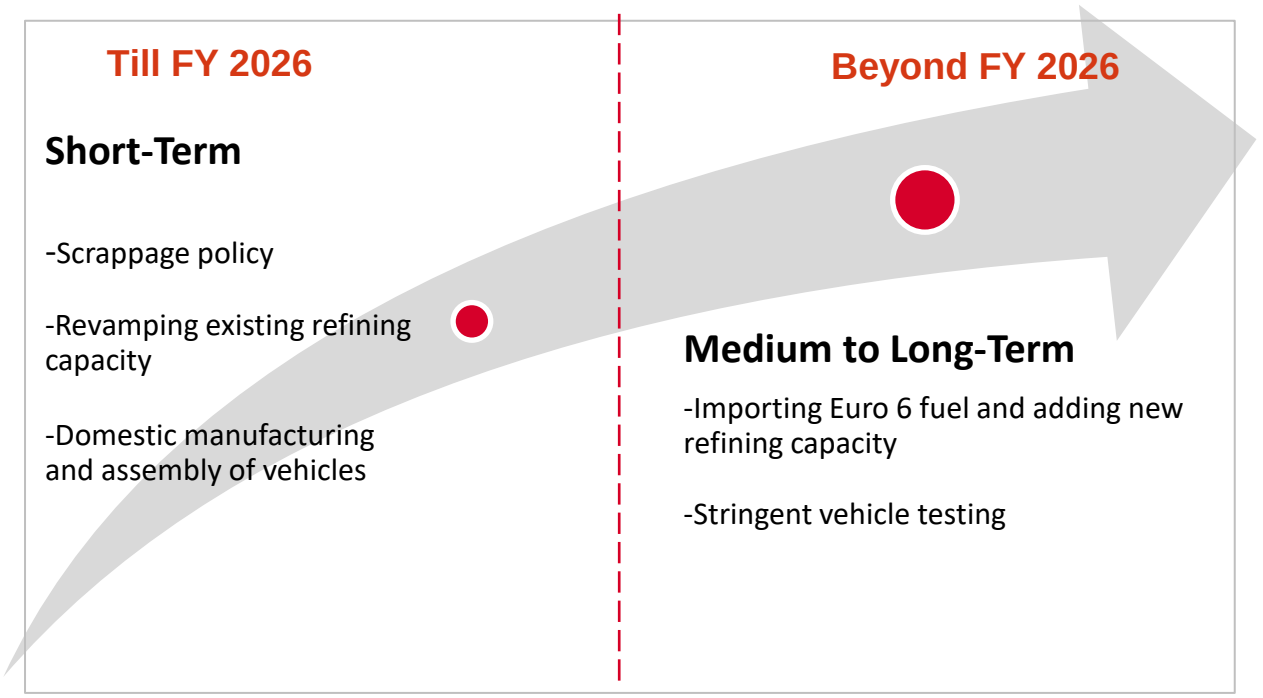
PM2.5	10	16	8	6	5.1%	-3.1%
Carbon dioxide	24361	39503	21701	25787	5.5%	1.9%

Implementation of Euro 6/VI standards will not only reduce annual emissions when compared with the base case scenario, but also lead to an overall reduction in annual emissions by fiscal 2035.

Savings on government health expenditure

While moving to Euro 6/VI requires significant time, effort and investments by various stakeholders, looking at the larger picture, it can help save a significant sum in the form of reduced deaths due to air pollution. We believe that implementation of Euro 6/VI would lead to lower CO_2 emissions, and cumulatively reduce the number of deaths caused due to air pollution by 60-70 thousand between fiscals 2025 and 2035. The number of deaths have been estimated by analysing the impact of current emission in the country compared to emissions associated with Euro 6/VI standards. Assessing the expenditure due to arising healthcare requirement as result of pollutants, we expect government healthcare expenditure to reduce by ~USD 1-1.2 billion, higher than the total envisaged investments.

7.2.7 Roadmap for adoption of Euro 6/VI standards[51]



7.2.7.1 Short term: policy and regulation upgrade

The policies and regulatory push would be the first step for transitioning to Euro 6/VI fuel, i.e. to establish policies to suppress the super emitters in the country. This will be possible by introducing a scrappage policy for the older fleet of various categories.

Vehicle scrappage policy

Bangladesh lacks a vehicle scrappage policy. Most of the vehicles in the country have crossed service life and, hence, are key pollution contributors. Therefore, for reducing emissions from the existing

[51] Source: CRISIL Research

vehicles, a scrappage policy needs to be introduced along with re-registration regulations. Under re-registration regulations, the vehicle will be registered for 10 years at the time of purchase. This will include annual pollution checks. After 10 years of service, the vehicle can be registered for another five years only. After 15 years, the vehicle would likely be scrapped. This policy will boost new vehicle sales and reduce the curb emissions from a long-standing fleet.

Furthermore, incentives on scrappage of vehicles, including discount on purchase of new vehicles or reduction in registration fee, will lure vehicle owners to replace the older vehicles with new ones. Higher incentives can also be given to vehicle owners transitioning to Euro 6/VI compliant vehicles at a later stage. Additionally, Bangladesh can consider tax relaxation of imports of new and reconditioned vehicles. In some cases, the price of a new vehicle appreciates by more than 100%, while for higher engine capacity vehicle it can go up to 500-600%. In case of reconditioned vehicles, taxation and duties peg the price at par with the new vehicles, resulting in people relying on an aged fleet.

Revamping domestic refining capacity

The domestic refinery of the country is very old and would need a complete revamp in order to decrease the cost of refining and produce better quality fuel, i.e. compliant to Euro 6/VI standards. This will further reduce the burden of imports as fuel consumption will decline with upgraded fuel and vehicles. In case of import of POL products, most of the supplier countries have already shifted to Euro 6/VI, making the transition in imports easier. Moreover, reduction in cost of refining after upgradation is likely to be a major outcome and avenue for savings.

Domestic manufacturing and assembly facility

The country can also introduce domestic manufacturing or assembling facilities for vehicles that will further reduce the cost of new vehicles, thereby attracting more buyers for locally manufactured vehicles. Most of the existing vehicle manufacturing/ assembling companies have shown interest to expand their presence and capabilities in Bangladesh. This could help the country lower its reliance on imports. Further, the companies tying-up with these manufacturers/ assemblers have ready technology for Euro 6/VI compliant vehicles. This could be an easy step to transition to advanced standards.

Incentives can be given on the purchase of Euro 6/VI vehicles in terms of subsidy or discounts to attract buyers. This move can bridge the cost difference between a regular vehicle and a Euro 6/VI compliant vehicle. Further, the manufacturer can add additional features in the Euro 6/VI model to further shift new sales to low polluting vehicles. This strategy can be implemented in the initial years when the government has not mandated the sale of Euro 6/VI fuel and vehicles only.

7.2.7.2 Medium to long term: vehicle testing facilities

Adding new refining capacity

The new refining capacity in Bangladesh is a major step towards self-reliance. The country had planned for the new unit of Eastern Refinery Ltd (ERL) in 2010. However, the unit is yet to be commissioned and has been delayed due to uncertainties over funding and the screening of various aspects of the project. The commissioning of this unit must be at top of the action plan for transitioning to Euro 6/VI compliant fuel. The refinery could offer an opportunity for the country to export processed petroleum products.

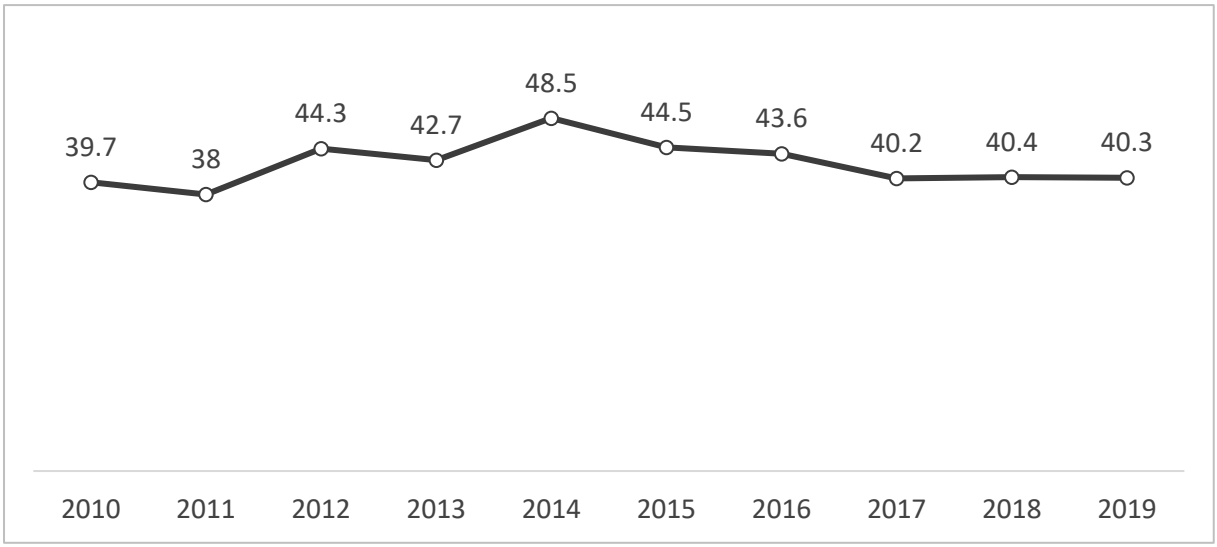
Vehicle emission inspection system

Currently, the biggest challenge for the country is lack of stringent vehicle and emission testing facilities. As a result, there are old vehicles with very high emissions in the country, mostly in the public transportation segment. After achieving short- and medium-term goals, Bangladesh can advance to stringent testing of imported vehicles. This testing can be done at the time of registration and further at regular intervals of three months. Quarterly testing would take regular stock of emissions from the operational fleet of vehicles. This can include heavy penalties for the offenders (high emission vehicles) and cancellation of registration of vehicles for repeat offenders. A sticker or digital tag-based monitoring can be introduced to achieve better implementation of the norms. An incentive can also be introduced for low emitter vehicles at the time of insurance or road tax renewal. This will strongly implement the emission parameters across the country and pave the way for meeting its COP21 commitments.

7.3 Bhutan

Land-locked between India and China, Bhutan's mountainous terrains have led to scattered population settlement. The economy depends on hydropower generation, tourism and agriculture. Being one of the least developed countries, it requires assistance in resources and capacity to address the challenges of climate change. Bhutan's contribution to global emission is miniscule, but the ever-increasing emissions raise concerns over its emission targets.

[52]Figure 27: Trend in Bhutan PM 2.5 levels



7.3.1 Measures taken by Bhutan to control air pollution

Bhutan entered as a signatory party to the Paris Agreement on 19 October 2017. Since its ratification, the country has taken several steps to implement the priorities identified in the NDC. Some of the key measures are describe below:

[52] Source: State of global air report 2020

The Bhutan Sustainable Low-emission urban transport Systems (UNDP-GEF) project

The aim of the project is to facilitate low carbon transition in Bhutan's urban transport sector by promoting wider uptake of low emission vehicles (LEVs), in particular electric vehicles (EVs), as the preferred fuel source for transport in Bhutan.

The project has three main components:

1. Policy support for low-emission transport
2. Awareness and capacity development
3. Investment in low-emission transport systems and support services

Fiscal Incentives Act of Bhutan 2017

Under the Economic Development Policy 2016 of Bhutan, fiscal incentives were provided as a part of the Fiscal Incentives Act of Bhutan 2017. The objective was to stimulate economic growth, foster private sector development and generate employment. The incentives offered included tax rebates to industries adopting modern environmentally-friendly technologies, tax exemptions to hydroelectric projects, solar, wind, biogas, and other renewable energy plants and machineries. Energy efficient and environmentally-friendly equipment is also exempted from import duties for targeted sectors such as hotels. Waste management and recycling industries were provided income tax holidays and exemption of sales tax and customs duties on plant and machinery.

Low emission development strategies (LEDS)

To implement the priority programmes in the NDC, several low emission development strategies (LEDS) were developed to prioritise mitigation actions in the key sectors of agriculture, human settlement, industry and transport. LEDS will serve as the basis for the sector to integrate low carbon measures into development priorities. Further support for implementation is required to realise the identified priority programmes and actions in LEDS.

Bhutan EV Roadmap (2020-2025)

The Bhutan EV Roadmap (2020-2025) has been developed for transitioning to zero emission mobility with targets for 2035, 2045 and 2050. The Bhutan Sustainable Low Emission Urban Transport System project is being implemented to initiate the transition to EV mobility by focusing on taxis as the primary target for eventual market transformation.

The National Energy Efficiency & Conservation Policy and the Energy Efficiency Roadmap 2030

The policy and roadmap launched in 2019 cover buildings, transport and industries. The aim is to improve productivity and energy efficiency, while contributing to Bhutan's efforts to remain carbon neutral. Few measures have been implemented, but support and assistance are required to achieve the goals. Additionally, Bhutan has developed Renewable Readiness Assessment (RRA) in cooperation with IRENA to complement the measures and efforts towards vast deployment of renewable technologies in the country.

Sustainable Hydropower Development Policy (SHDP) 2021

The policy enhances and emphasises on support to hydropower generation during dry seasons via adaptation measures such as reservoir/ pumped storage schemes. In addition, the new policy

mandates hydropower value chain through ventures in energy storage technologies, such as hydrogen fuel, green ammonia and other emerging technologies. These energy storage and diversification measures for adaptation also contribute directly to Bhutan's carbon neutral efforts by providing clean energy for zero carbon transport and mobility.

LEDS for surface transport

Transport emissions are projected to increase by a factor of three by 2050 compared with 2020 levels under the business-as-usual scenario. LEDS for Surface Transport was developed to provide strategic intervention options for transport and mobility, as categorised below:

1. Mass transit though improvements in the bus system and the introduction of open-bus rapid transit (BRT) network (electric and diesel) and light rail transit
2. Promotion of passenger EVs (taxi, two-wheelers, light vehicles and buses)
3. Low emission freight transport system for heavy and commercial trucks and freight trains
4. Non-motorised transport system through public bicycle systems and improved sidewalks/ crosswalks
5. Improve fuel efficiency in internal combustion engines through stringent vehicle and emission standards
6. Private vehicle demand management through shared mobility, traffic system management carpooling, ride sharing, rental services, import restriction on internal combustion engine cars from 2030, and introducing the annual import quota system

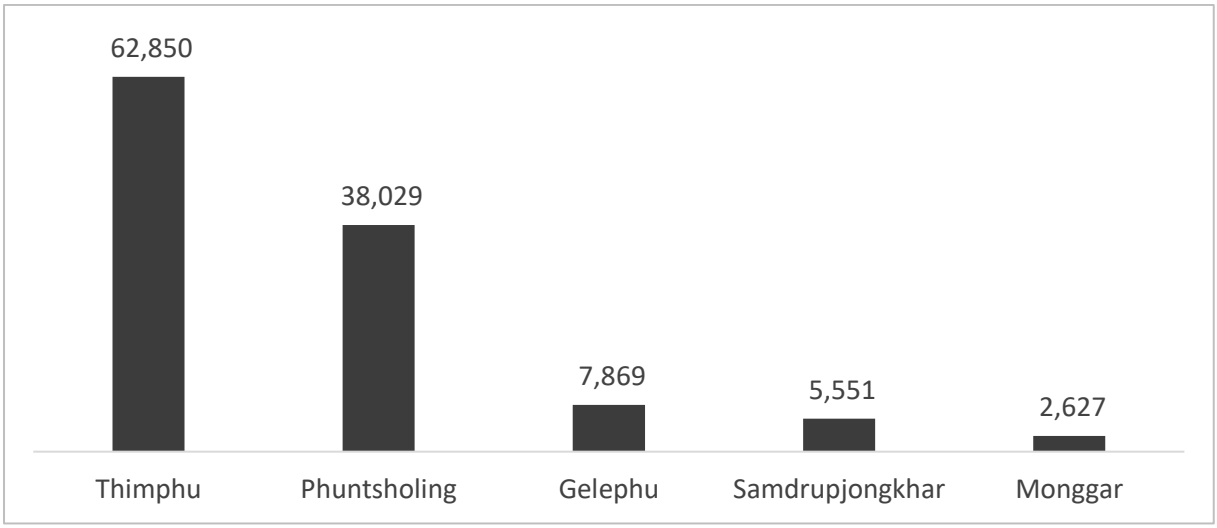
The mitigation options with varying levels of marginal abatement costs have been prioritised for implementation with activities across the short (2021-2025), medium (until 2030) and long (until 2050) terms. The mitigation measures have a cumulative mitigation potential of 5,283 Gg CO_2e and are a mix of investments from relatively inexpensive low-hanging interventions to large infrastructure investments up to an investment requirement of $3,233 million till 2030. Major expenditure in the transport sector is for infrastructure development to introduce low emission transport modes.

Apart from this, the country has outlined various policy measures to support its green energy targets and emission-free mobility. These include Bhutan EV Roadmap (2020-2025) for a transition to zero emission mobility with targets for 2035, 2045 and 2050.

7.3.2 Status of automotive industries

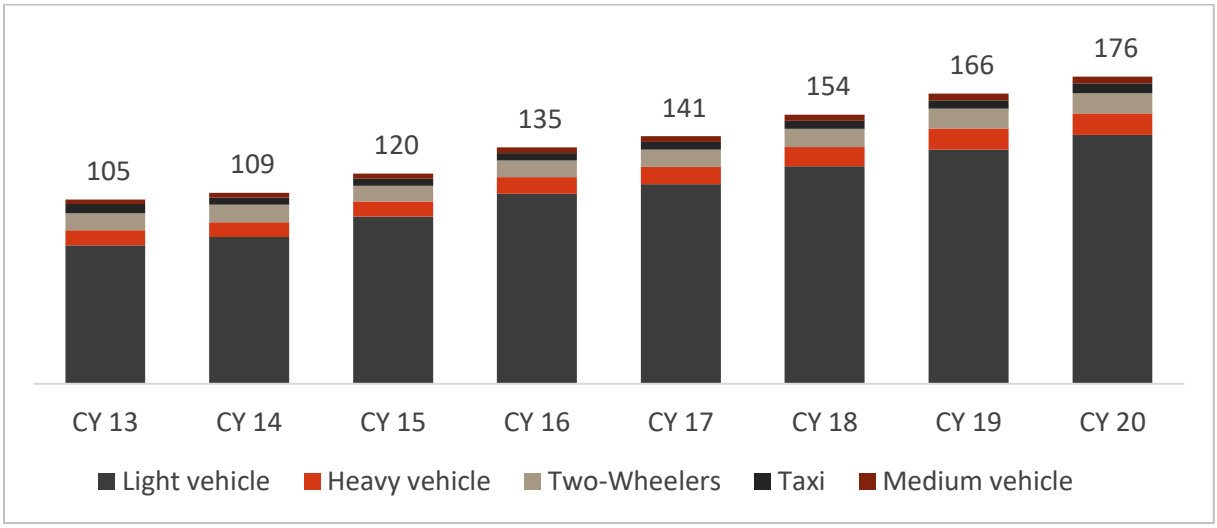
According to Road Safety and Transport Authority of Bhutan, the total number of motor vehicles registered with the authority as on June 30, 2021, is 114,646. Of this, 74,492 are light vehicles (65%) and only 152 are EVs (0.1%). New vehicle registration fell 15% on-year in fiscal 2021, with 5,616 new vehicles registered in the year.

[53]**Figure 28: Total number of vehicles across major cities as on September 30, 2021**



The country relies on vehicle imports from India, Japan and other countries. India is the key supplier due to lower import tariffs levied on Indian vehicles, availability of good quality vehicles at affordable prices and lower price of spare parts. As reported by Bhutan Trade Statistics 2020, DRC, Ministry of Finance, India accounted for 77% of the imports of vehicles in Bhutan. One of the other reasons for rise in the number of vehicles in the country can be attributed to the ease of availability due to growing number of dealers in the country. As per 2019 EAC Report, there were only two vehicle dealers in 2005 in the country; the number rose to 11 in 2015 and 31 in 2019.

[54]**Figure 29: Trend in vehicles on road in Bhutan (thousand units)**



Increase in demand for vehicles is due to rise in household incomes, more options for affordable cars and cheap loans. The government has designed policies and regulations to support the transition to cleaner mobility.

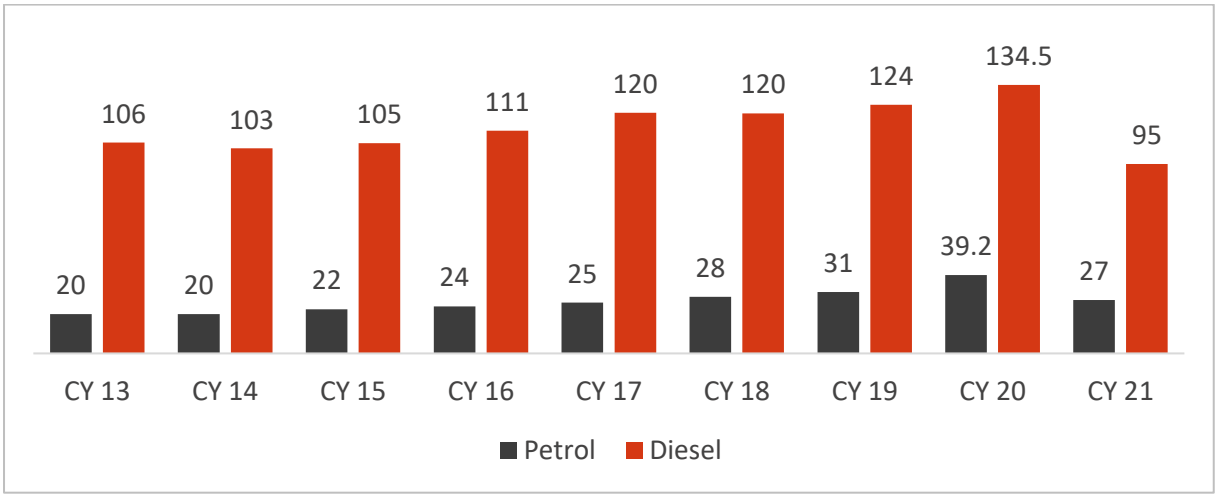
7.3.3 Auto fuel demand in Bhutan

The demand for petroleum products increased steadily at a CAGR of 6.4% from 2015 to 2020. Petrol demand jumped 12-13%, while that of diesel grew 2-3%. In 2021, demand for petrol fell 31% and that

[53] Source: Road Safety and Transport Authority, Bhutan
[54] Source: Road Safety and Transport Authority, Bhutan

of diesel dropped ~30% due to the Covid-19 pandemic. Bhutan meets its entire fuel demand through imports from India, via roadways.

[55]Figure 30: Petrol and diesel demand in Bhutan ('000 tonne)



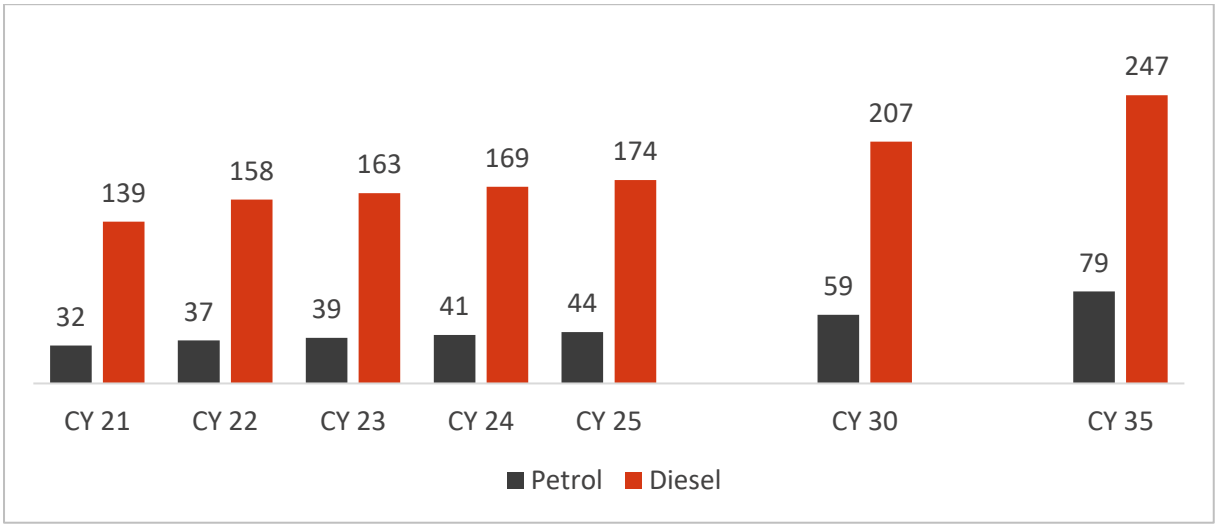
7.3.4 Outlook on auto fuel demand and related emissions in Bhutan

Bhutan's transport sector lacks efficient and reliable public transport, which is the main reason for higher utilisation of public vehicles. This is one of the main causes of increasing pollution in the major cities. The expansion of urban areas and urban lifestyles in the capital city Thimphu has led to a high demand for mobility. According to MoIC (2021), The Low Emission Development Strategy (LEDS) for Surface Transport and MoIC (2015), Economic and Social Commission for Asia and the Pacific for the drafting of the National Transport Policy, there are not enough buses to consider public transport for all. The study also estimated the number of buses required per 10,000 population to ideally be 60 buses, whereas the utilization of the available buses is 78%.

We believe that sales of cars and two-wheelers are expected to rise at 6-8% CAGR and 2-3% CAGR, respectively, from 2022 to 2035. Taxi population is expected to rise at 4-6% CAGR during the said period. As a result, petrol consumption is expected to increase at 5-7% CAGR from 2022 to 2035. Consumption of petrol is expected to reach 79 thousand tonne in 2035 versus 32 thousand tonne in 2020.

[55] Source: Ministry of Economic Affairs

[56]**Figure 31: Outlook on petrol, diesel consumption in Bhutan ('000 tonne)**



On the other hand, diesel consumption is likely to reach 247 thousand tonne by the end 2035. There has been a major expansion of road networks in Bhutan since 2008, resulting in a greater number of private and public transportation vehicles.

With rising income levels and vehicle population, emissions are also expected to rise rapidly. Assuming Bhutan continues to use Euro 3 grade fuel and does not upgrade to Euro 6/VI in our base case, CRISIL Research has forecast the following emission levels from vehicles.

[57]**Table 28: Emissions forecast in Bhutan**

Pollutant	Emission in 2022 (kilo tonne)	Emission in 2035 (kilo tonne)	CAGR (2022-2035)
Carbon monoxide	10	16	3.8%
NOx	12	19	3.1%
PM 2.5	0	1	4.0%
Carbon dioxide	417	1601	10.9%

7.3.5 Barriers for transitioning to Euro 6/VI

Lack of standardized/ stringent vehicle testing

Vehicle emission testing in the country is done by private agents who are concentrated near the cities, while other areas, such as small towns or villages, lack the availability of such agents or testing facilities. In 2006, the vehicle testing programme was contracted to two private companies in Thimphu and Phuentsholing. Moreover, the country lacks infrastructure to regularly monitor vehicular emission. This results in many polluting vehicles getting a by-pass from this testing, resulting in poor air quality and expensive operation of vehicles due to reduced fuel economy.

Import of reconditioned diesel vehicles

In 2013, Bhutan's government approved the exception of certain vehicles for public use, such as

[56] Source: CRISIL Research
[57] Source: CRISIL Research estimates. Emission factors have been taken from ICCT emission factor data base for carbon dioxide and the others are based on Euro 3 emission standards.

ambulances and firefighting trucks. In 2014, it approved the import of used electric Nissan Leaf's with mileage less than 30,000 km for commercial taxis. The ban on import of used vehicles for public use has been lifted, but these vehicles form a major part of pollution sources in the transport sector of the country. This also limits the adoption of Euro 6/VI compliant vehicles in the public transportation, essential services, etc.

7.3.6 Benefits of transitioning to Euro 6/VI

Since the population of vehicles in Bhutan is old, conforming to Euro 4 and with higher taxes/duties, transition to Euro 6/VI can reduce the greenhouse gas emission to an extent in the older fleet. Further, the sale of new vehicles limited to Euro 6/VI compliant engines will further drive the move towards cleaner transportation.

Euro 6/VI compliant vehicles are a significant improvement over Euro 2 vehicles not only in terms of emissions, but also in terms of efficiency, as they provide better fuel economy. Post Euro 6/VI implementation, all new vehicles will comply with the new standard and will have higher fuel economy, thus consuming less petrol and diesel.

As per CRISIL Research estimates, this will translate into a cumulative fuel savings of 40-50 thousand tonne of petrol and 200-230 thousand tonne of diesel between 2026 and 2035. These savings are likely to translate into a cumulative savings of USD 220-230 million by fiscal 2035. This is based on forecasted fuel demand considering base case Euro 2 and after transitioning to Euro 6 with higher mileage, leading to lower fuel consumption. Also, as Bhutan imports all of its fuel requirement, lower consumption would lead to lower import bill for the country.

[58]Table 29: Outlook on savings on petrol and diesel consumption due to implementation of Euro 6/VI ('000 tonne)

Fuel	2026	2030	2035	Cumulative (2026-2035)
Petrol	1	5	7	45
Diesel	6	19	37	216

Reduced emission levels

The primary objective of implementing stringent emission standards is to reduce emissions from vehicles, which lead to air pollution. Implementation of Euro 6/VI standards will not significantly contribute to emission reduction in the initial years, as majority of the vehicular fleet in Bhutan is old (close to 15-20 years) and the key sources of air pollutants are passenger cars and heavy-duty vehicles (HDVs), including diesel-powered large and medium-sized trucks and buses. However, over a period, as new vehicles replace the old ones, there will be a significant reduction in vehicular emissions. CRISIL Research estimates that 50-60% of all vehicles would be Euro 6/VI compliant by 2035. This number is expected to be ~10% in 2026, the first year of implementation.

Emissions of various pollutants are expected to be lower by 30-40% in 2035, compared with the base case scenario.

[58] Source: CRISIL Research estimates

The following table shows the base case emissions versus emissions post Euro 6/VI. The pollutant emissions are calculated based on the current emission standards compared to the emissions after transitioning to Euro 6/VI standards.

[59]Table 30: Outlook on emissions with Euro 6/VI implementation ('000 tonnes)

Pollutants ('000 tonne)	Base case		Euro 6/VI		CAGR CY 26-35	
	CY 26	CY 35	CY 26	CY 35	Base case	Euro 6/VI
CO	11	16	11	10	3.9%	-0.5%
NO_X	14	19	13	11	3.2%	-1.7%
PM	0	1	0	0	4.1%	-2.4%
CO_2	612	1,601	599	1,155	11.3%	7.6%

Implementation of Euro 6/VI standards would not only reduce annual emissions compared with the base case scenario, but also lead to an overall reduction in annual emissions by 2035.

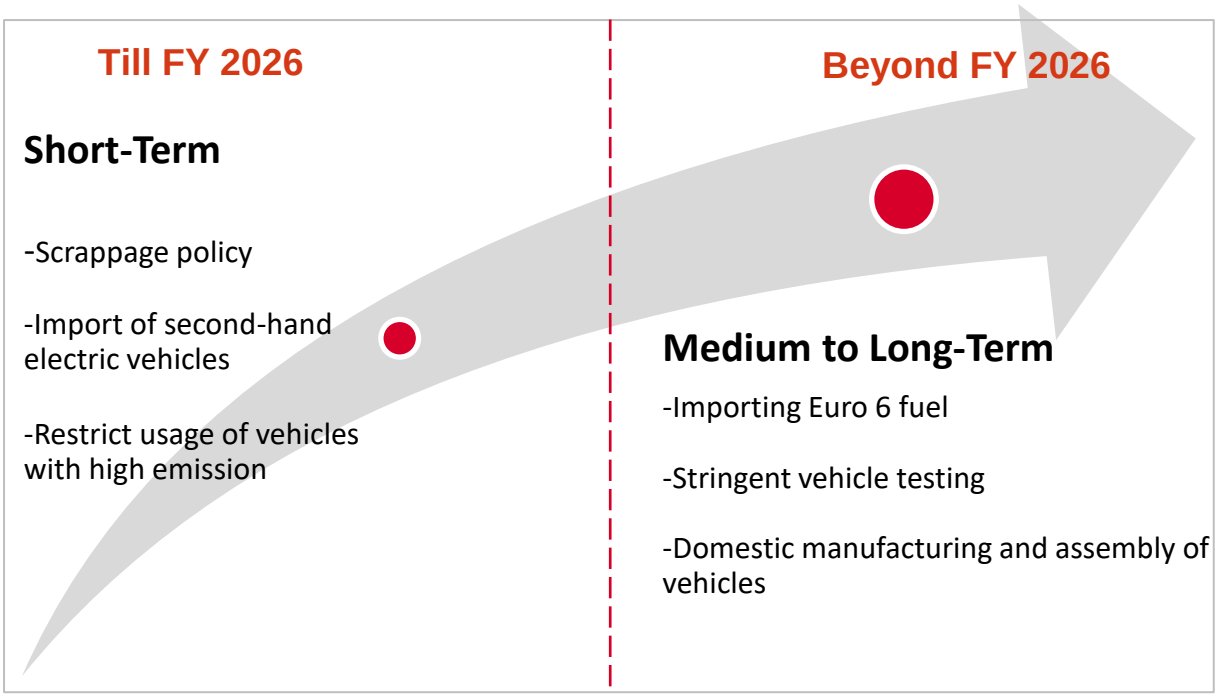
Savings on government health expenditure

While moving to Euro 6/VI standards requires significant time, effort, and investments by various stakeholders, these standards can lower government health expenditure by reducing deaths due to air pollution. CRISIL Research expects implementation of Euro 6/VI standards to lower CO_2 emissions, and cumulatively reduce the number of deaths due to air pollution by 500-700 between 2025 and 2035. The number of deaths have been estimated by analysing the impact of current emission in the country compared to emissions associated with Euro 6/VI standards. Assessing the expenditure due to arising healthcare requirement as result of pollutants, we believe that the total spends of the government healthcare expenditure will reduce by ~USD 150-200 million, higher than the total envisaged investments.

7.3.7 Roadmap for adoption of Euro 6/VI standards[60]

The transition to Euro-6 standards can be divided into short-term, medium- long-term action plans

[59] Source: CRISIL Research estimates
[60] Source: CRISIL Research



7.3.7.1 Short Term: Policy and regulation upgrade

The first step for transitioning to Euro 6/VI standards is to enable policy and regulatory mechanisms to check super emitters in the country. The target can be largely achieved by introducing a stringent scrappage policy for older fleet of various categories.

Scrappage of older vehicles:

The vehicle scrappage policy in Bhutan is lax, resulting in several old vehicles plying on the roads even after crossing their service life and hence becoming major contributors to pollution. Therefore, re-registration regulations need to be incorporated in the scrappage policy to reduce emissions from existing vehicles and further bolster the implementation of the scrappage policy. Under these regulations, the vehicle will be registered for 10 years at the time of purchase and its pollution under control certificate must be maintained annually. The vehicle can be registered for another five years only after 10 years and is likely to be scrapped after 15 years. This would help to track and curb the serving age limit of the vehicle on the road in the country. Further, this policy will boost the sales of new vehicles in addition to curbing emissions from longstanding fleet.

Furthermore, incentives such as discounts on purchase of new vehicles or a reduction in registration fee can encourage vehicle owners to scrap older vehicles. Higher incentives can also be given to vehicle owners transitioning to Euro 6/VI-compliant vehicles at a later stage. In addition, Bhutan can also consider tax relaxations on the import for new and reconditioned vehicles.

Import of second-hand electric vehicles only:

After banning the import of vehicles, Bhutan relaxed the norms for EVs, ambulances and firefighting vehicles. The import of diesel run vehicles results in higher pollution compared with new vehicles. Therefore, Bhutan needs to ban the import of vehicles running on fossil fuels, and encourage the import of EVs by offering subsidies for reconditioned EVs. Additionally, the country can also offer

attractive loans for the purchase of used EVs, thus motivating people to opt for new fossil fuel vehicles or used EVs.

Restrict low emission standard vehicles

Major cities in the country are witnessing traffic congestion and high pollution due to increasing vehicles. Despite the best available technologies, diesel engines result in high PM and NO_2 emissions, leading to environmental problems (air pollution) and health issues. Therefore, there should be stringent restrictions on low emission standard vehicles in the cities, especially old diesel vehicles, to boost the demand for vehicles with better emission standards i.e., Euro 6/VI norms. The restrictions can be implemented during weekends and scaled up to weekdays as well. Instead of taxis, buses or mass transportation can also be promoted near cities to reduce pollution levels. These means of mass transportation must also be encouraged to adhere to latest emission standards.

7.3.7.2 Medium and Long term: Transition to Euro 6/VI fuel and vehicles

Import of Euro 6/VI fuel:

Bhutan has no refineries and imports all its fuel from India, thus adhering to the originating country's fuel standards. Indian refineries have already moved their entire capacity to Euro 6/VI norms. Adopting a higher fuel standard will be easier for the country if there is government and policy intervention. The country should also upgrade from Euro 4 to Euro 6/VI standards and revise its agreements/commitments with the country supplying fuel. Further, Bhutan should regularly test imported fuel to ensure strict compliance.

Vehicle testing facility/emission inspection system

Currently, the biggest challenge for the country is lack of stringent vehicle and emission testing facilities. A vehicle emission inspection system confirms compliance by encouraging regular vehicle maintenance, identifying high emitters, and forcing them to conform to emission standards.

Lack of such provisions results in old vehicles with high emission levels plying in the country, especially in the public transportation segment. After achieving short-term and medium-term goals, Bhutan can promote stringent testing of imported vehicles at the time of registration and regularly at three-month intervals instead of the current timeframe of six months. Quarterly testing would ensure the operational fleet complies with emission standards. Heavy penalties for high emission vehicles and cancellation of vehicle registration for repeat offenders can ensure compliance.

Sticker- or digital tag-based monitoring or new vehicle technologies such as onboard diagnostics in new vehicles will also help simplify the emission inspection system, thereby ensuring better compliance with emission norms. Incentives for low emission vehicles at the time of insurance or road tax renewal can enable Bhutan to meet COP21 commitments.

Domestic manufacturing and assembly facility:

The country can introduce domestic manufacturing or assembling facilities to reduce new vehicle costs, thereby attracting more buyers for domestically manufactured vehicles and achieving self-reliance.

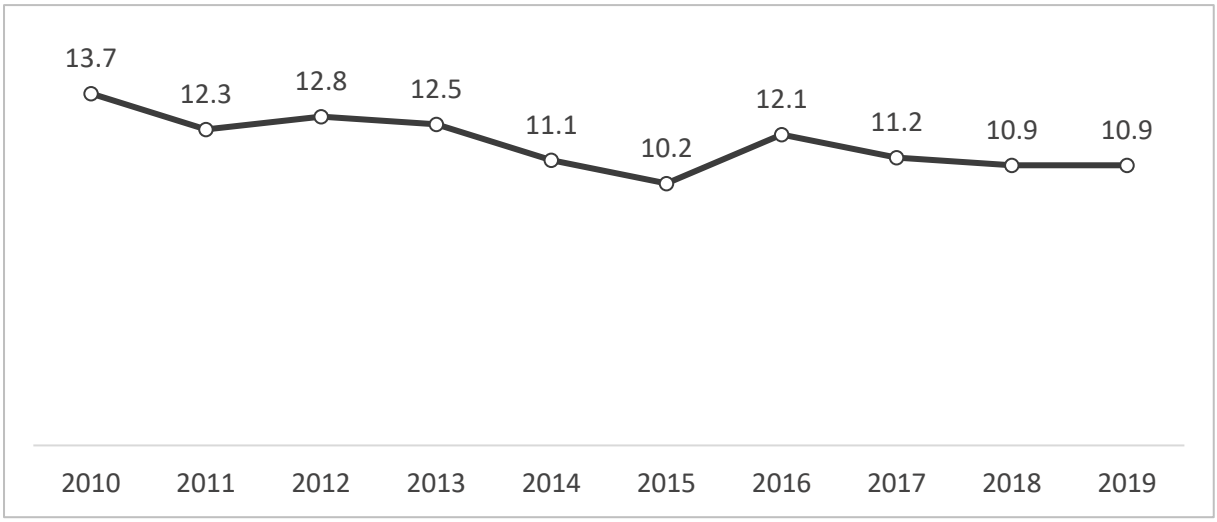
A two-part taxation or duty implementation system can be introduced for completely built units (CBUs) and completely knockdown units (CKDs). Already implemented in India, the policy led to a lower cost of CKD units assembled in India after the parts were imported into the country. Such a model can be beneficial for Bhutan with assembling facilities being easier to introduce compared with complete manufacturing facilities.

7.4 Maldives

Maldives, a country comprising 1,192 dispersed tropical islands spread over an area of 115,300 km^2 with a land area of only 224 km^2, is completely dependent on imports for meeting its energy needs. Urban air pollution is a growing concern in the country, especially in the greater Male region. Air pollution in Male is generally thought to stem from transport, waste and construction related activities. Maldives' average PM 2.5 in 2019 was 10.9 10 µg/m^3 as per the State of Air Index 2020. Even though it is only slightly above WHO recommended guidelines of PM 10, pollution levels have been on the rise over the past few years. Climate change is a major concern in Maldives due to the small, low-lying and dispersed nature of islands, coupled with economic factors such as high import dependency and a narrow economic base.

According to the Ministry of Environment in Maldives, annual average contribution to Male PM2.5 is 30% from local sources and 70% from distant sources. In the dry season, 90% of PM2.5 is from transboundary sources.

[61]Figure 32: Trend in Maldives PM 2.5 levels (µg/m^3)



According to the Malé Declaration Secretariat, RRC.AP (2013), Malé Declaration 1998-2013: a Synthesis-Progress and Opportunities, there was a significant increase in mean annual concentrations of NO_2 and ground-level ozone in Maldives from 2003 to 2012 recorded in Hanimaadhoo. While transboundary air pollution has been monitored well in Maldives, studies on urban air quality are limited due to the absence of long-term monitoring. Therefore, there is need for undertaking activities to curb pollution in the island. Road transport is a key contributor to air pollution in Maldives and can be controlled by enforcing stringent emission standards.

[61] Source: State of global air report 2020

7.4.1 Measures to control air pollution

Paris Agreement

Maldives is a signatory to COP21 commitments and submits its nationally determined contribution (NDC) on actions taken to achieve targets until 2030 and provide updates. Since submitting its first NDC in 2015, the country has been working towards achieving its goals. Some major points in the action plan as per the recent NDC submitted in 2020 are as follows:

1. Increase the share of renewable energy (RE) to 15% of overall power generation, along with storage and grid stabilisation
2. Plan to install an 8 MW plant in Thilafushi and a 1.5 MW plant in Addu city to convert waste into energy. These systems will be optimised for grid connection and electricity production.
3. Establish vehicle/vessel emission standards and an efficient transport management system and promote hybrid vehicles
4. Use liquefied natural gas (LNG) for electricity generation within the greater Malé region instead of diesel with the proposed LNG plant in Thilafushi and the interconnectivity bridge
5. Maldives targets to reduce emissions by 26% by 2030.

Vehicular emission related regulations

Maldives currently does not have any vehicular emission regulations. However, it imports a large volume of its petrol and diesel requirements from the United Arab Emirates (UAE) and Singapore. While the UAE currently follows Euro 4 standards, Singapore has already adopted Euro 6/VI. Hence, fuel imported into Maldives is at least Euro 4 grade.

National action plan on air pollution

The government came up with several versions of the “National Environment Action Plan”, highlighting targets and steps to be taken to protect the environment.

Maldives’ first national action plan on air pollutants developed by the Ministry of Environment was launched by Aishath Nahula, the Minister of Transport and Civil Aviation, on 12 June 2019. The plan contains 28 specific measures to reduce GHG emissions in three major polluting sectors: electricity generation, transport, and waste.

The overall objectives of the plan are:

1. Integrated analysis of air pollutants, greenhouse gases and short-lived climate pollutants to identify the major sectors responsible for air pollution and reduce pollution and GHG emissions simultaneously
2. Identify additional mitigation measures to reduce air pollution and emissions
3. Quantify the benefits of measures implemented to improve air quality and mitigate climate change
4. Identify possible ways to further integrate action on air and climate pollutants into existing planning processes
5. Prioritise action and pave the way for coordinated air quality management
6. Encourage implementation of existing plans and create new action plans in different sectors

A key target of this plan is to ensure all vehicles comply with Euro IV or Euro VI norms by 2030.

Measures to promote adoption of EVs

Maldives has removed customs duty on the import of EVs vis-à-vis a 200% import duty on petrol/diesel vehicles to promote adoption of EVs.

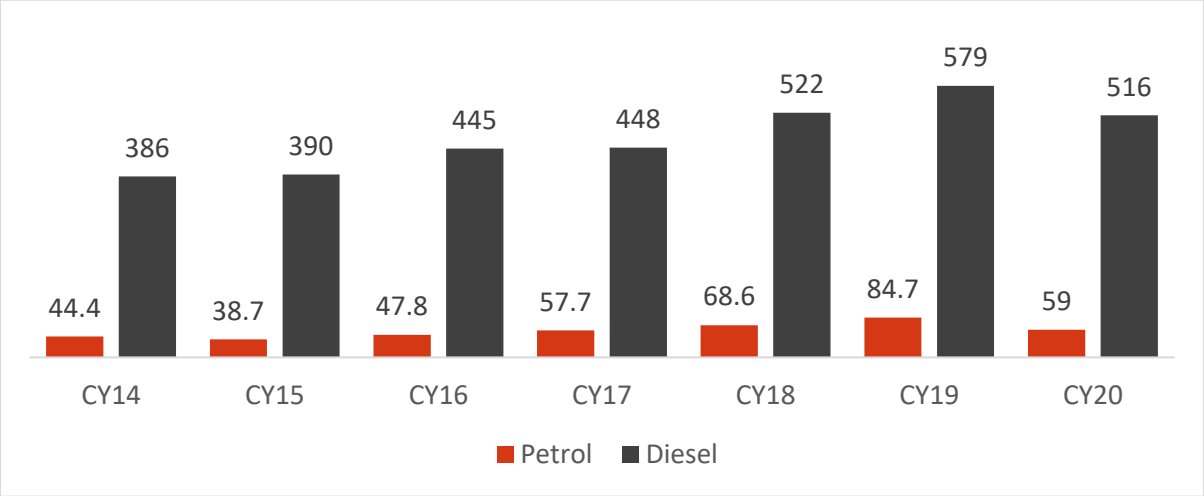
7.4.2 Status of refining and automotive industries in Maldives

Maldives is a 100% petroleum importer with no proven crude oil reserves and no refining infrastructure. The dispersed nature of its islands makes pipeline distribution unfeasible. The downstream infrastructure is, therefore, limited to import, storage, and distribution facilities.

Diesel serves as the primary energy source, accounting for more than 80% of total petroleum product imports in the country in 2019. Power generation accounted for more than 80% of diesel consumption. Passenger and cargo movement, undertaken using boats and barges, accounted for 8-9% of diesel demand in 2019 vis-à-vis land transport, which accounted for only 1% of the overall demand. Demand for diesel also comes from resorts for undertaking tourist ship excursions and fishing. Diesel demand grew at an 8.4% CAGR between 2014 and 2019. However, it declined 11% on-year in 2020 due to the Covid-19 pandemic, which restricted economic activity, tourism, and road transport.

Demand for petrol has risen significantly over the last five years, growing at a 13.7% CAGR between 2014 and 2019, as the number of motorcycles and passenger cars doubled during the period. Petrol demand for the speed boats segment utilised for tourist transit has also clocked a CAGR of 9%, led by growth in tourist arrivals. However, demand for petrol declined ~31% on-year in 2020, owing to the Covid-19 pandemic.

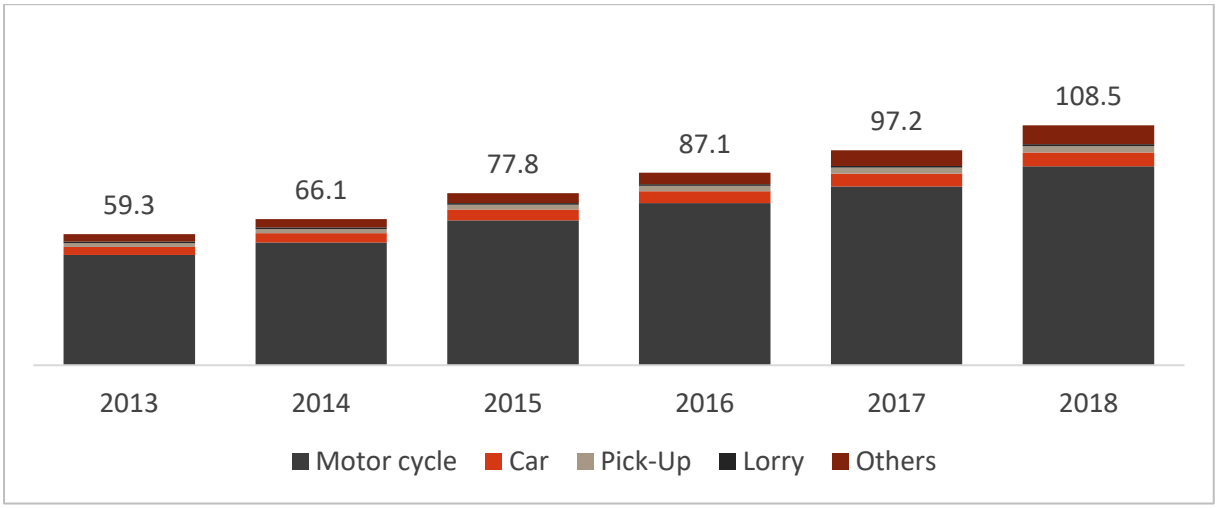
[62]Figure 33: Trend in petrol, diesel demand in Maldives ('000 tonnes)



The automotive industry in Maldives is also import dependent, with a majority of vehicle imported from Japan and Thailand. The number of vehicles has been growing rapidly in the Maldives, with a total of 110,000 vehicles as of 2018. The share of motorcycles is ~82% of overall vehicles, followed by cars at ~6%. Overall vehicle population is growing at 12-13% annually.

[62] Source: Maldives Customs Service (Tariff & Statistics Section, 2019)

[63]**Figure 34: Trend of vehicles on road in Maldives (thousand units)**



7.4.3 Outlook on auto-fuel demand and related emissions in Maldives

The Maldives National Oil Company (MNOC) plans to source crude oil for refining and processing in refineries of neighbouring countries such as India, Sri Lanka, and Singapore. However, these plans are at a very nascent stage. No crude oil imports/re-exports are estimated to be undertaken till 2030. We believe that Maldives will continue to depend on imports to meet its primary petroleum product demand. The country's demand outlook has been estimated based on industry level benchmarks established in the Maldives Energy Supply and Demand Survey.

The power sector is a key contributor of diesel demand, whereas road transport forms ~1% of the overall demand. As part of its efforts to reduce the dependence on imported fuel, the government is pushing for renewable power generation. However, diesel is expected to remain the primary fuel to meet power demand with only 10-15% of total electricity demand estimated to be met from renewable energy sources by 2034.

In addition to 214 MW of centralised installed diesel-based power capacity in inhabited islands as reported by Ministry of Environment and Energy, Republic of Maldives, it is estimated that there is a cumulative distributed diesel-based power capacity of 260 MW with tourist resorts to meet their captive power requirements. The power sector is expected to continue to account for more than 80% of diesel demand in the country, with pick-up in passenger movement across islands through boats, yachts, launches and cargo movement using barges also expected to contribute towards additional diesel requirements.

Demand from land transport is expected to log a CAGR of 6-7% between 2020 and 2034, with the number of lorries and trucks expected to rise to 3,849 in 2034 from 1,876 in 2020. Overall, demand for diesel shall clock a CAGR of 5-6% in line with GDP growth to reach 1,000-1,100 thousand tonnes in 2034.

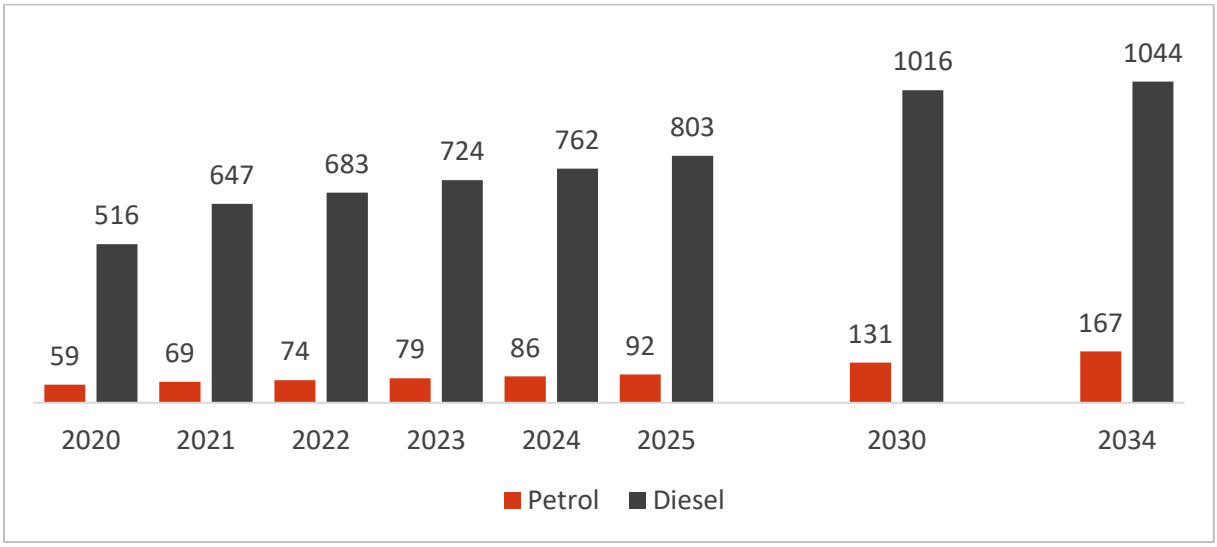
Despite the limited land mass, the number of cars and motorcycles grew at 11-12% CAGR over 2013 to 2018, primarily led by rising per capita income based on 6% GDP growth. We expect the number of cars and motorcycles to grow at 8% and 10% CAGR, respectively, between 2020 and 2034. Hence,

[63] Source: Maldives Statistical Pocketbook, 2019

demand for petrol from the transport segment should grow at a CAGR of 8-10% between 2020 and 2034.

Additionally, growth in the tourism segment (estimated based on an increase in tourist arrivals at a 7-8% CAGR) is expected to result in a higher demand of petrol from speed boats used for tourist transits. Demand from this segment is expected to clock a CAGR of 7% between 2020 and 2034. Overall, the demand for petrol is expected grow at 7-8% CAGR to 167 thousand tonnes by 2034.

[64]Figure 35: Outlook on petrol & diesel consumption in Maldives ('000 tonnes)



7.4.4 Transition to Euro 6/VI norms: Key considerations

Maldives imports 100% of its fuel requirements due to non-availability of domestic refining capacities and we believe import dependence will continue going forward. As Singapore has already implemented Euro 6/VI emission standards while UAE is on Euro 4/5 emission standards, hence, to move to Euro 6/VI standards, Maldives has to import higher quality fuel from Singapore majorly along with Euro 6/VI-compliant vehicles.

7.4.5 Barriers to effective transition

- **Lack of data and skilled resources:** Limited data on pollutant sources, emissions and air quality is a major challenge in Maldives. Moreover, technical expertise on air quality management is lacking within the government. These are key challenges in implementation of any policy to check air pollution.
- **Difficulty in communicating benefits to stakeholders:** Even though air quality management is a key issue in Maldives, most stakeholders such as fuel importers, automobile importers, local bodies, and end consumers often do not see the benefits of controlling pollution due to limited economic resources. Moreover, even within the government, it is difficult to communicate to various stakeholders that air quality management would eventually contribute towards their development goals. The lack of support from various stakeholders leads to gaps in implementation of various action plans.

[64] Source: CRISIL Research

- **Lack of a clear framework for implementation and enforcement:** Maldives is a very small country and lacks adequate frameworks and laws including regulatory and government mandates, institutional arrangements, and enforcement procedures. Hence, execution is lacking even if a policy or regulation is announced. The absence of a national policy or strategy on air quality also hinders incorporation of pollution related issues into larger developmental goals of the country.
- **High degree of import dependence:** Maldives relies on imports for all its resource requirements- both vehicles and transport fuel. Hence, its shift to Euro 6/VI norms is subject to availability of such resources from supplier countries. Even if vehicles and fuels compliant with Euro 6/VI norms are made available, their cost will determine the degree of adoption in the country.

7.4.6 Benefits of transition to Euro 6/VI norms

While the cost of transition to Euro 6/VI standards looks significantly high, these standards are expected to be beneficial in the long run. These benefits include:

Savings on fuel consumption due to better fuel economy

Euro 6/VI-compliant vehicles are a significant improvement over older vehicles, not only in terms of emissions, but also in terms of efficiency, as they enable higher fuel economy. Post Euro 6/VI implementation, all new vehicles would comply with the new standards and have higher fuel economy, thus consuming a lower amount of petrol and diesel. As per CRISIL Research estimates, this will translate into cumulative fuel savings of 44 thousand tonnes of petrol, and 13 thousand tonnes of diesel between 2025 and 2034. These numbers may seem low on an absolute basis, but considering a low base of consumption in Maldives, they imply fuel savings of 4-5% from the transport segment annually and a lower import bill for the country. These savings are likely to translate into a cumulative savings of USD 20-50 million by fiscal 2035. This is based on forecasted fuel demand considering base case Euro 2 and after transitioning to Euro 6 with higher mileage, leading to lower fuel consumption. The impact on diesel is relatively lower, as road transport forms <1% of the overall diesel demand. However, with the kind of growth expected in diesel vehicles, demand for the fuel from the transport segment is expected to rise further.

[65]Figure 36: Outlook on savings on petrol and diesel consumption due to implementation of Euro 6/VI standards ('000 tonnes)

Fuel	FY26	FY30	FY35	Cumulative (FY26-35)
Petrol	0.2	4.9	6.3	44.4
Diesel	0.2	1.4	1.6	12.7

Reduced emission levels

CRISIL Research estimates that Euro 6/VI-compliant vehicles will grow to 60-70% of the overall vehicular population by 2034 from 8-10% in 2025, the first year of implementation. Overall emissions of various pollutants are expected to be lower by 40-50% in fiscal 2034 compared with the base case scenario. The table below shows base case emissions vs emissions with Euro 6/VI standards in place. The pollutant emissions are calculated based on the current emission standards compared to the emissions after transitioning to Euro 6/VI standards.

[65] Source: CRISIL Research estimates

[66]**Table 31: Outlook on emissions with Euro 6/VI implementation ('000 tonnes)**

Pollutant ('000 tonne)	Base case		Euro 6/VI		CAGR FY26-35	
	2025	2034	2025	2034	Base case	Euro 6/VI
Carbon monoxide	4056	7701	3833	4800	7.4%	2.5%
NO_x	490	845	460	475	6.2%	0.4%
PM2.5	103	195	93	63	7.3%	-4.3%
Carbon dioxide	536491	1015257	507350	636412	7.3%	2.6%

Implementation of Euro 6/VI standards would not only reduce annual emissions compared with the base case scenario, but also lead to an overall reduction in annual emissions of particulate matter by 2034.

Savings on government health expenditure

While moving to Euro 6/VI standards requires significant time, effort, and investments by various stakeholders, these standards can help cut government health expenditure by reducing deaths due to air pollution. We believe that implementation of Euro 6/VI norms would lead to lower CO_2 emissions, and cumulatively reduce the number of deaths caused due to ambient air pollution. As a result, we believe that the government's healthcare expenditure will reduce by ~USD 104 million as a result of reduced deaths and diseases caused by air pollution. The reduction in expenditure is for decline in the demand for healthcare infrastructure and services

7.4.7 Roadmap for adoption of Euro 6/VI standards

Short term (2025): Policy and regulation upgrade

- **Establishing stringent protocols for vehicle maintenance for curbing emissions:** The government should focus on maintenance of vehicles by creating regulations or protocols for regular servicing of vehicles (in 3- to 6-month intervals), especially motorbikes which are large in number and comprise older models
- In its national action plan on air pollutants, Maldives targets to shift all its vehicles to Euro IV/Euro VI grade by 2030. To achieve this target, the government has to ban the import of vehicles with older standards and ensure all new vehicles comply with Euro 6/VI norms

Reduce the serviceable age of taxis from 25 years currently to 15 years. Older vehicles have higher emissions and consume more fuel. Hence, the serviceable age of taxis should be reduced.

Medium and Long term (beyond 2025):

- **Testing facilities to bolster the effectiveness of high quality fuel**

Regular testing of vehicles is a major step towards effective implementation of emission standards. Currently due to lack of stringent vehicle emission testing in the country, the transport sector is the second highest contributor of GHG emissions. The only restriction is levied on the import of used cards, which should be under 5 years of age. In order to maintain the health of vehicle fleet it is imperative for the regulators to mandate half yearly or quarterly vehicle checks and certification.

[66] Source: CRISIL Research estimates

The import regulations in the country has restricted the fleet to the older set of vehicles resulting in higher emission. In order to supplement the effective transition into Euro 6/VI emission standards, the country needs to boost the effective testing and scrapping of high emitting vehicles. Maldives can advance to stringent testing of vehicles that are being imported. This testing can be done at the time of registration and then quarterly, instead of the current timeframe of six months. The benefit of this quarterly testing would be taking regular stock of emissions from the operational fleet of vehicles. This can be further implemented with heavy penalties for the offenders (high emission vehicles), and repetition of such incidences can cancel vehicle registration.

The final step in maintaining a low emission vehicle fleet is to introduce a digital tag based system involving new vehicle technologies such as on-board diagnostics in new vehicles will also simplify the emission inspection system, ensuring better implementation of norms. An incentive can be introduced for low-emitter vehicles during insurance or road tax renewal. This will facilitate in implementing emission parameters across the country and meeting COP21 commitments

- **Setting age criteria for reconditioned vehicles**

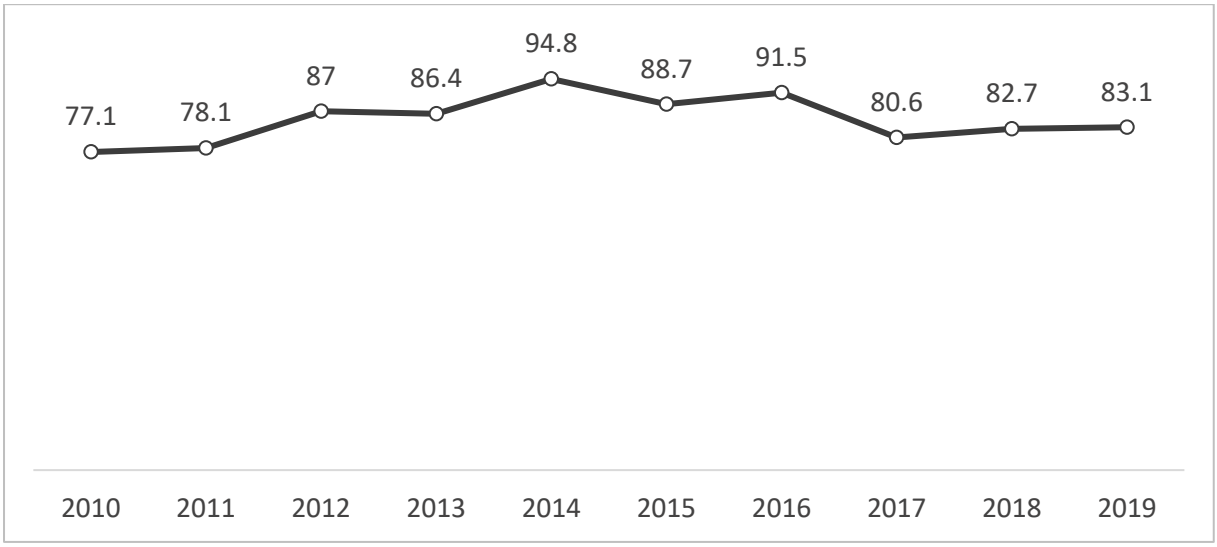
Reconditioned vehicles should be heavily taxed and vehicles older than 5 years should not be allowed. This would lower the number of older, highly polluting vehicles, minimising air pollution. Moreover, the government should reduce import duty on petrol and diesel vehicles to encourage the purchase of Euro 6/VI vehicles. At the current import duty of 200%, Euro 6/VI vehicles are much expensive, constraining their sale.

7.5 Nepal

Nepal is a land-locked country with no proven petroleum reserves. The country has a diverse geographic terrain, with most of the key cities and towns located at high elevations. The country's economy mostly depends on agriculture and remittances. According to World Bank (World Development Indicators), Nepal's GDP per capita annual growth averaged 4.3% over 2010-2019. However, the country's GDP per capita witnessed a 3.8% decline in 2020 amid Covid-19.

Kathmandu is the capital of Nepal and the most polluted city of the country, housing most of the economic activities. According to Aerosol and Air Quality Research, around 35% of the diesel fleet in Kathmandu has been visually classified as super-emitter, contributing a major portion of the shared transportation running on diesel. These super-emitters are identified visually by analysing the smoke from their tailpipes. An earlier study suggested that about 25-40% of Kathmandu's fleet was responsible for more than half of the city's pollution in 2003. According to US AQI, the pollution level in the country correlates with the weather pattern. The dry months have the worst pollution levels, leading to higher health hazards. Moreover, air pollution levels are extremely high in urban areas of low- and middle-income countries (LMIC), representing a significant threat to public health. The transport sector contributes around 4-7% of GHG emissions, based on the Central Department of Environmental Science 2017 estimates and the First National Communication submitted by the Government of Nepal to the UNFCCC in 2004.

[67]**Figure 37: Trend in Nepal PM 2.5 levels**



Nepal relies on the import of POL products to meet its domestic demand. Indian Oil Corporation (IOCL) is the single largest supplier of POL products, accounting for more than 98% of POL imports to Nepal under a five-year contract that was last signed in March 2017. Key petroleum products imported include motor spirit (MS), superior kerosene oil (SKO), high-speed diesel (HSD), liquefied petroleum gas (LPG) and aviation turbine fuel (ATF). Nepal has no POL-based mid-stream infrastructure, such as refineries, but has an operational cross-border pipeline from India. The POL products are directly imported from India through the pipeline commissioned in 2019 and distributed via road tankers. The pipeline starts from Motihari in India to Amlekhgunj in Nepal extending over 69 km and has a 2 million tonne of annual fuel wheeling capacity, Prior to this the trade was dependent on roadways alone. The region-wise segregation of supply sources to meet Nepal's POL demand is as follows:

[68]**Table 32: POL supply sources: Nepal**

Regions in Nepal	Supply sources (IOCL refineries/depots)
Eastern	Barauni refinery
Central	Raxual depot
Western	Betalpur depot, Mugalsari terminal
Mid-Western	Allahabad terminal, Gonda depot
Far-Western	Banthara depot

Nepal also imports vehicles and spare parts from neighbouring countries, such as India and China. The lack of domestic manufacturing capability has led to full dependence of the vehicular population on imports. The imports in the country are levied with high custom duties, increasing vehicle prices in the country. Due to high vehicle prices and low emission standards in Nepal, the vehicular population in Nepal is old and deteriorated with high pollutant emissions.

[67] Source: State of global air report 2020
[68] Source: Nepal Oil Corporation

7.5.1 Measures to control air pollution in Nepal

7.5.1.1 Environment-friendly Vehicle and Transport Policy, 2014

The Environment-friendly Vehicle and Transport Policy was introduced to promote lean transport in the country. The policy aims to reduce air pollution from the transport sector by increasing the share of EVs to 20% by 2020, promoting the conversion of other regular vehicles to EVs, and providing subsidies for the promotion of electric and non-motorised vehicles. The policy aims at improving the technologies and transport practices to ensure clean, and standard of fuel quality. This policy outlines clear objectives to boost environment-friendly vehicles and their manufacturing in Nepal compared with the National Transport Policy. Additionally, in 2019, the government of Nepal increased the pollution tax on the sale of petrol and diesel from USD 0.004 to USD 0.012

7.5.1.2 The Paris agreement

Nepal became a part of the Paris agreement on 5 October 2016. Under this, the country has set a target limit of global warming below 1.5^{o}C. According to UNFCCC, Nepal is formulating a long-term low greenhouse gas emission development strategy by 2021. As a part of the NDC declared in 2020, the mitigation component targeted towards reducing GHG emission for Nepal included -

- By 2030, expand clean energy generation from approximately 1,400 MW to 15,000 MW, of which 5-10% will be generated from mini and micro-hydro power, solar, wind and bio-energy. Of this, 5,000 MW is an unconditional target. The remainder is dependent upon the provision of funding by the international community.
- By 2030, ensure 15% of the total energy demand is supplied from clean energy sources
- By 2025, EV sales to form 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) in 2025. Due to this, EV sales target, fossil fuel energy demand for the transportation sector will decrease from approximately 40 million GJ in the BAU scenario in 2025 to 36 million GJ. This would be around a 9% decrease in fossil fuel dependency. This target will reduce emissions from a projected BAU of 2,988 Gg CO2 equivalent in 2025 to 2,734 Gg CO2 equivalent, which is around an 8% decrease in emissions.
- By 2030, sales of EVs to cover 90% of all private passenger vehicle sales, including two-wheelers and 60% of all four-wheeler public passenger vehicle sales (the public passenger target does not take into account electric-rickshaws and electric-tempos). As a consequence, the energy demand for fossil fuels will decrease from approximately 48 million GJ in the 2030 BAU scenario to 34.5 million GJ, which is around a 28% decrease in fossil fuel dependency. This target will reduce emissions from a projected BAU of 3,640 Gg CO2 equivalent in 2030 to 2,619 Gg CO2 equivalent, around a 28% decrease in emissions.
- By 2030, develop 200 km of the electric rail network to support public commuting and mass transportation of goods

7.5.1.3 Road, rail and transport development for prosperous Nepal – five-year strategic plan (2073-2078)

The plan focuses on developing the road and rail network and making the transport management system effective. The objective of the policy is to promote public transportation while offering safe, and accessible transportation service to discourage private transportation. Apart from the primary objective, the plan also outlined converting 20% of vehicles in Nepal to environment-friendly vehicles in the next five years, from the date of announcement.

7.5.2 Status of automotive industries

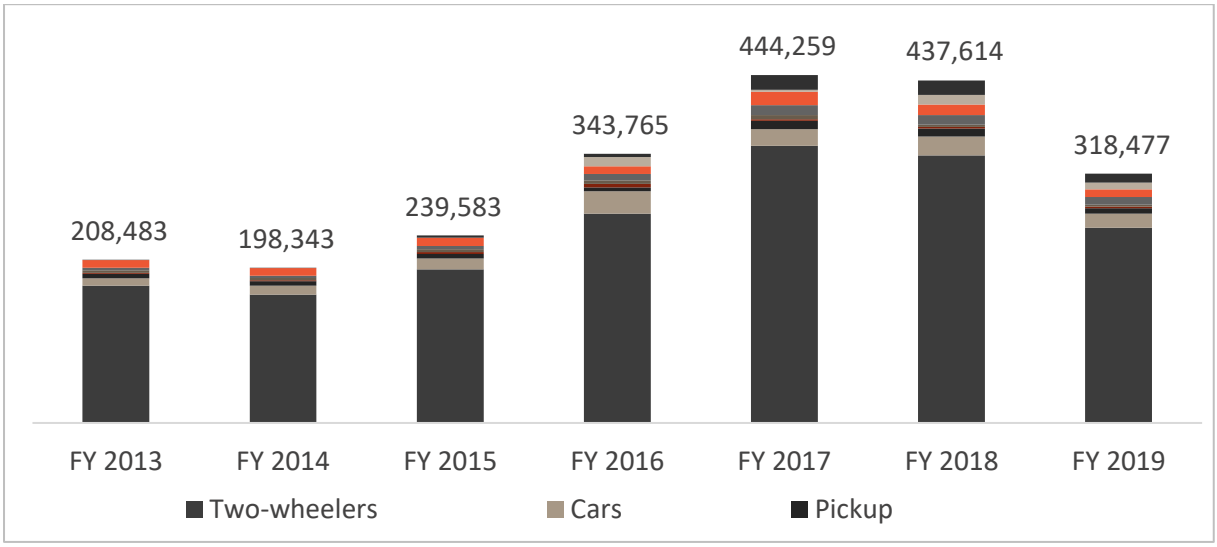
According to the Department of Transport Management, in fiscal 2019, 35,39,519 vehicles were registered in Nepal, around a 15% increase in the past 10 years. Moreover, rising disposable incomes and availability of more vehicle models kept the vehicular population on an upward trajectory in the past four years. The data for the production of vehicles in Nepal by fiscals 2075-2076 shows that 20 different companies have been registered for the opening manufacturing industry, as following:

[69]Table 33: Status of automotive industries

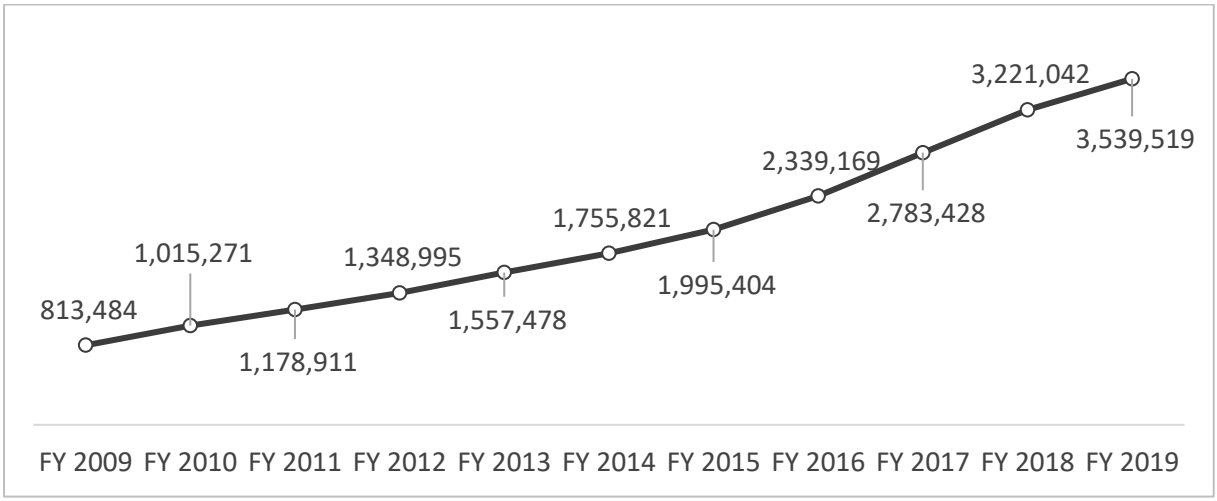
Industry	Vehicle type
Ever Star Motors Pvt. Ltd.	Three-wheelers
Hulas AutoCraft Pvt. Ltd.	Motorcycles
Laxmi Motor Corporation	Four-wheelers
Nepal EV Company Pvt. Ltd.	Two-wheelers to six-wheelers
CEC Vehicles Company	Two-wheelers to six-wheelers (Electric)
Hidong New Energy Industry	EVs
Bela Motors Pvt. Ltd.	EVs
Belin Motor Technology Company	Three-wheelers
HangFau Motorcycle Assemble Company	Motorcycle
Trust Electric Bike Pvt. Ltd.	Electric motorcycle
Chungaliya International Trading	Electric motorcycle
CND Company Pvt. Ltd.	Electric motorcycle
Nejong Udhyog Pvt. Ltd.	Two-wheelers to six-wheelers
Heroin Auto Electric Industry Pvt. Ltd.	Three-wheelers to mini-truck
Mithila AutoCrafts Pvt. Ltd.	Three-wheelers
Great Wall Electric Vehicle Pvt. Ltd.	EVs
Sharp Vision Enterprises	Two-wheelers and three-wheelers (Electric)
Global Automobile Pvt. Ltd.	Motorcycle
Belta Electrical Auto Pvt. Ltd.	Electric motorcycles
Nepal Giant Car Industry Pvt. Ltd.	Electric motorcycles and cars

[69] Source: CRISIL Research

[70]**Figure 38: Annual registration of vehicles in Nepal, fiscals 2013-2019 (number of vehicles)**



[71]**Figure 39: Growth in vehicular population in Nepal, 10-year trend (number of vehicles)**



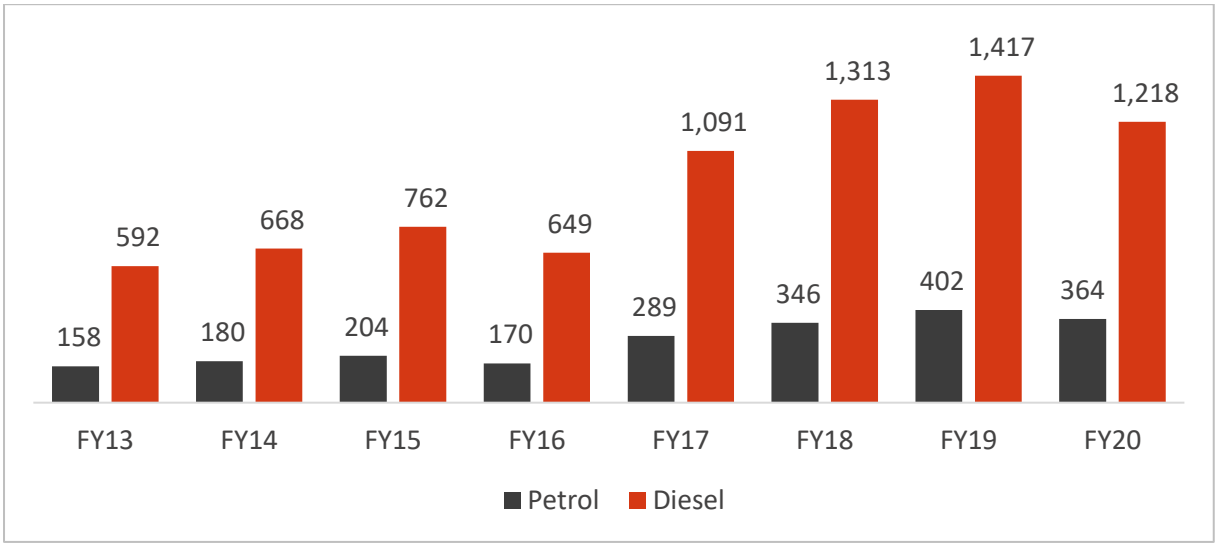
On the other hand, the growth in eco-friendly vehicles has been timid, with only around 35,000 e-rickshaws registered between fiscals 2016- 2019. In fiscal 2019, e-rickshaw sales dropped by 30% from the previous year to around 8,000 vehicles. To address this, the Nepal government completely waived the excise duty on EVs from 30% for 50 KW capacity vehicle, 40% for 51 to 100 KW, 50% for 101 to 150 KW and 60 to 80% for 151 KW and above in the 2021-22 budget. Additionally, the customs duty on EVs has been deducted to a maximum of 40%, which was 60% in the previous fiscal year. This is likely to boost the move of the nation towards its goal of net-zero by fiscal 2050.

7.5.3 Auto-fuel demand in Nepal

The demand for auto-fuel in Nepal grew steeply over fiscals 2013-2020, on account of rising sales in cars, motorcycles, buses and trucks. Diesel is the most consumed petroleum product in Nepal, with a consistent demand rise. However, the demand for diesel declined in fiscal 2020 due to the commissioning of oil pipeline that reduced the requirement of tanker trucks for the POL liquid transportation.

[70] Source: Department of Transport Management, Nepal
[71] Source: Department of Transport Management, Nepal

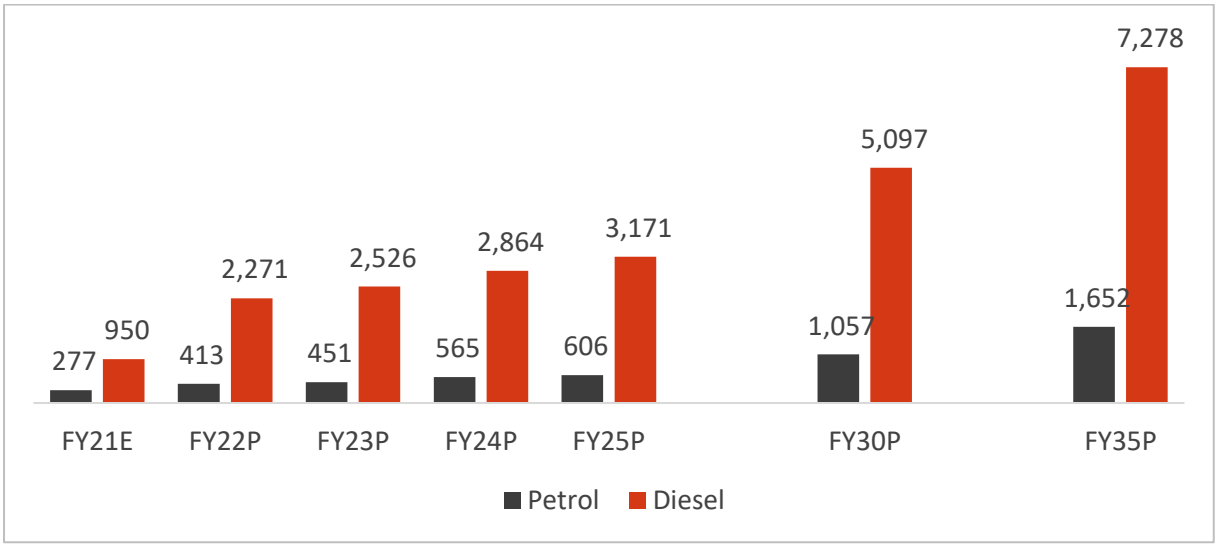
[72]**Figure 40: Trend in petrol, diesel demand in Bangladesh ('000 tonne)**



7.5.4 Outlook on auto-fuel demand and related emissions in Nepal

Nepal's vehicle market is underpenetrated with the entire demand being met by the imports of vehicles from countries, such as India and China. We expect sales of cars and two-wheelers to rise at a CAGR of 7-9% and 12-13%, respectively, between fiscals 2022-2035. The pickups population is also expected to rise at a 9-11% CAGR during the said period. As a result, petrol consumption is expected to increase at a 9-10% CAGR over this period. Overall petrol consumption is expected to reach 1,632 thousand tonne in fiscal 2035 (vs 364 thousand tonne in fiscal 2020).

[73]**Figure 41: Outlook on petrol, diesel consumption in Nepal ('000 tonne)**



On the other hand, diesel consumption is likely to reach 7,278 thousand tonne by the end of fiscal 2035. With rising income levels and vehicle population, vehicular emissions are expected to rise rapidly. Assuming that Nepal is continuing to use Euro 3 grade fuel and vehicles and does not upgrade to Euro 6/VI in our base case, CRISIL Research forecasts the following emission levels for CO, NOx, PM2.5 and CO2, coming from vehicular pollution.

[72] Source: Nepal Oil Corporation
[73] Source: CRISIL Research

[74]Table 34: Emissions forecast in Nepal

Pollutant ('000 tonne)	Emission in FY22 (kilo tonne)	Emission in FY35 (kilo tonne)	CAGR (FY22-FY35)
Carbon Monoxide	129	427	9.6%
NOx	132	400	8.9%
PM 2.5	3	9	9.8%
Carbon dioxide	10,141	33,484	9.6%

7.5.5 Barriers for transitioning to Euro 6/VI

Limited or no policy/regulatory push

Nepal has not implemented any regulation pertaining to the upgradation of fuel, as a result of which most of the vehicles are still sold with lower emission standards. Currently, Nepal has population with Euro 2 or Euro 3 standards, while the vehicle supplying country India has already shifted to Euro 6/VI compliant vehicles. Additionally, the government has directed the operational age of vehicles to be 20 years - the major reason behind older population of vehicles plying in Nepal. Both of these factors have increased GHG emissions in the country.

The Ministry of Environment, Science and Technology in Nepal specified vehicular testing parameters under Nepal Vehicle Mass Emission Standards 2069 (2012). These standards are Euro 3 compliant and have not been revised to the advanced versions after that. Whereas, India, the major vehicle supplier country to Nepal, moved to Euro 6/VI standards in 2020. As a result, Nepal can transition smoothly to more environment-friendly fuel and vehicles with policy intervention.

Custom duty and taxation

The country has levied high customs duty on imported vehicles. This has increased vehicle prices by 2x, and even 3x in some cases. Moreover, the annual road tax makes owning personal vehicles expensive in Nepal. Recently, the price of two-wheelers multiplied after the government increased the excise duty and road construction charges on two-wheelers in its revised budget for fiscal 2022. The government increased the excise duty on 125cc to 200cc two-wheelers by up to 50%, Before this, the government charged a 40% excise duty on 155cc two-wheelers and 40% on 155cc to 250cc two-wheelers. The 155cc to 250cc segment forms the majority of the population in Nepal. Hence, this is likely to cut down the sales for ICE driven vehicles, increasing reliance on the older population.

7.5.6 Benefits of transitioning to Euro 6/VI

Since the population of vehicles in Nepal is old, conforming to lower emission standards (Euro 2) and with higher taxes/duties, transition to Euro 6/VI standards can reduce the greenhouse gas emission to an extent and in the older fleet. Further, the sale of new vehicles, limited to Euro-6 compliant engines, will further encourage cleaner transportation.

Euro 6/VI compliant vehicles show significant improvement over Euro 2 vehicles, by emissions and efficiency, as they provide higher fuel economy than Euro 3. Post Euro 6/VI implementation, as all new

[74] Source: CRISIL Research Estimates; Emission factors have been taken from ICCT emission factor data base for CO2 and the others are based on Euro 3 emission standards.

sales of vehicles would comply with the new standard and will have higher fuel economy, they would consume lower amount of petrol and diesel.

As per CRISIL Research, this will translate into a cumulative fuel savings of 400-500 thousand tonne of petrol, and 9-10 million tonne of diesel between fiscals 2026-2035. These savings are likely to translate into a cumulative savings of USD 8-10 billion by fiscal 2035. This is based on forecasted fuel demand considering base case Euro 2 and after transitioning to Euro 6 with higher mileage, leading to lower fuel consumption. Also, as Nepal imports the entire volume of its fuel requirement, lower fuel consumption would lead to lower import bill for the country.

[75]Table 35: Outlook on savings on petrol and diesel consumption due to Euro 6/VI ('000 tonne)

Fuel	FY26	FY30	FY35	Cumulative (FY26-35)
Petrol	36	45	53	454
Diesel	695	930	1,226	9,486

Reduced emission levels

The primary objective of implementing stringent emission standards is to reduce emissions from vehicles, leading to air pollution. However, Euro 6/VI would not significantly reduce emissions in the initial phase, as most of the vehicular fleet in Nepal is old close to 15-20 years, while 35% of heavy vehicles in Kathmandu are super-emitters, according to a study. However, over a period, as new vehicles replace old ones, there will be a significant reduction in vehicular emissions. CRISIL Research estimates that ~73-77% would comprise Euro 6/VI compliant vehicles within the overall vehicular population by fiscal 2035. This number is expected to be around 1-3% in fiscal 2026, the first year of implementation. Overall emissions of various pollutants are expected to be lower by ~15-25% in fiscal 2035, compared to the base case scenario.

The below table shows the base case emissions compared with emissions with Euro 6/VI standards in place. The pollutant emissions are calculated based on the current emission standards compared to the emissions after transitioning to Euro 6/VI standards.

[76]Table 36: Outlook on emissions with Euro 6/VI implementation ('000 tonne)

Pollutants ('000 tonne)	Base case		Euro 6/VI		CAGR FY26-35	
	FY26	FY35	FY26	FY35	Base case	Euro 6/VI
CO	199	427	190	235	8.9%	2.4%
NO_X	197	400	186	161	8.2%	-1.6%
PM	4	9	4	3	8.8%	-2.9%
CO_2	15,868	33,484	15,268	23,471	8.7%	4.9%

Implementation of Euro 6/VI standards would not only reduce annual emissions compared with the base case scenario, but it would also overall lessen annual emissions by fiscal 2035.

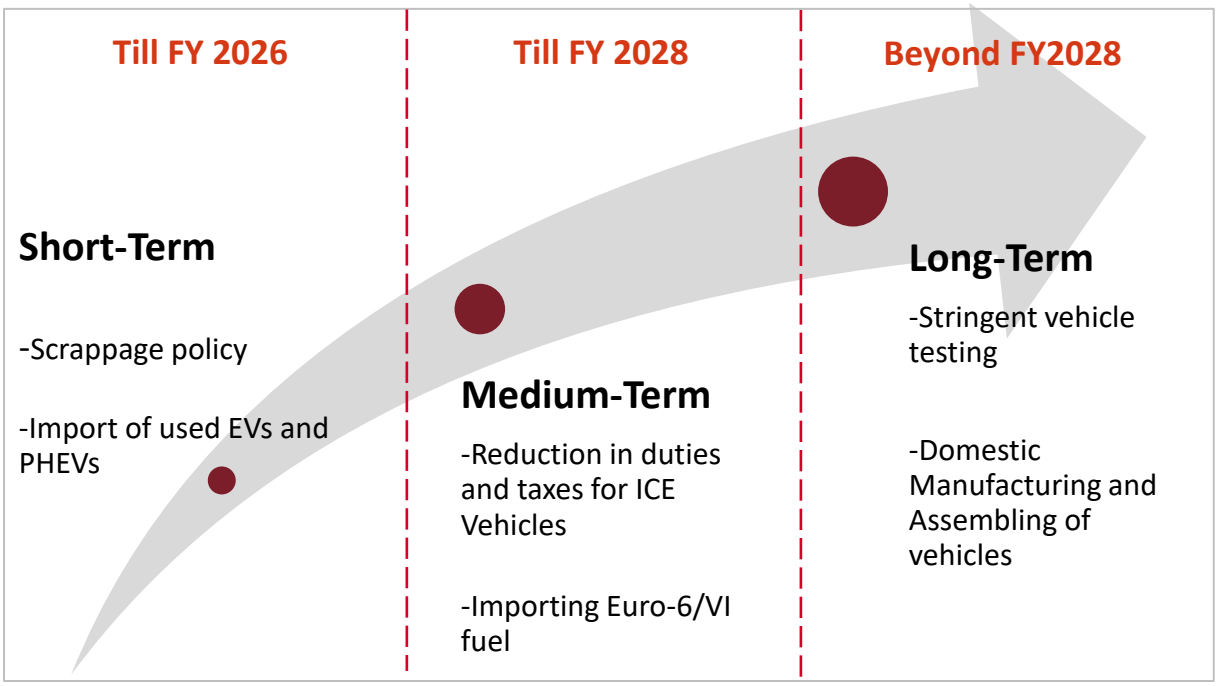
[75] Source: CRISIL Research estimates
[76] Source: CRISIL Research estimates

Savings on government health expenditure

While moving to Euro 6/VI requires significant time, effort, and investments by various stakeholders, it can reduce the number of deaths due to air pollution. CRISIL Research expects Euro 6/VI implementation to result in lower CO2 emissions, and cumulatively reduce the number of deaths caused due to air pollution by 20-25 thousand between fiscals 2025-2035. As a result, the government healthcare expenditure would reduce by ~USD 18 billion, higher than the total envisaged investments.

7.5.7 Roadmap for the adoption of Euro 6/VI standards[77]

The transition to Euro 6/VI standards can be divided into short-, medium- and long-term action plans



7.5.7.1 Short-term: policy and regulation upgrade

The first step for transitioning to Euro 6/VI fuel is to establish policies to suppress the super emitters in the country. This would largely be possible by introducing a scrappage policy for the older fleet of various categories

Scrappage of older vehicles

Vehicle scrappage in Nepal is at 20 years of service life. There is no grading of vehicles based on age. Therefore, for reducing the emissions from existing vehicles, the scrappage policy of the country needs a revision with re-registration regulations to be incorporated. Under these regulations, the vehicle will be registered for 10 years at the time of purchase. This will also include pollution under control checks maintained annually. Further, after 10 years the vehicle can be registered for another 5 years only and after 15 years the vehicle is likely to be scrapped. This policy will boost the sales of new vehicles and reduce the impact of super emitters on the environment.

Further, incentives on the scrappage of vehicles, including a discount on the purchase of new vehicles or reduction in registration fee can attract residents or vehicle owners to change the older vehicles

[77] Source: CRISIL Research

with newer ones. Higher incentives can also be given to vehicle owners transitioning to Euro 6/VI compliant vehicles later.

Import of second-hand EVs:

Nepal had banned the import of second-hand vehicles in 2015. Previously, Nepal had a provision for the imports of used vehicles, but it was later withdrawn considering the environment degradation used vehicles could cause. This has curbed the addition of polluting vehicles into the existing fleet. This regulation has not specified for electric vehicles and hence it would be beneficial for the country to allow the import of second\hand or used electric vehicles. This is likely to reduce the cost burden on the consumers as the cost of vehicle in the country is 3 times compared to the cost of vehicle in India. Additionally, the import of EV component such as batteries, motors can also be incentivized for better repair or replacement after purchase.

7.5.7.2 Medium-term: transition to Euro 6/VI fuel and vehicles

Reduction in duties and taxes

As highlighted earlier, the country is largely dependent on India for vehicles and fuel. Therefore, Nepal must start relaxing regulations pertaining to excise and customs duty on the import of fossil-driven vehicles. The taxation policy requires a revision to boost the sale of newer vehicles with higher emission standards. This will be further aided by the scrappage policy suggested as a part of short-term action plan to transition to Euro 6/VI fuel.

Import of Euro 6/VI fuel

The full potential of the Euro 6/VI fuel is realised with the compliant engine. With both engine and fuel compliant with Euro 6/VI, the actual reduction in the GHG or pollutant emission is clearly visible. Whereas, if the fuel transition is not accompanied by the upgrade in vehicle, the savings on emissions are likely to be indistinguishable. Hence it is recommended to adopt vehicle and fuel transitions simultaneously. Moreover, Indian refineries supplying fuel to Nepal have already moved their entire capacity to Euro 6/VI. Adopting higher standard fuel will be easier for the country, provided there is government and policy intervention in this regard. For this, the country is required to upgrade the standards first from Euro 3 to Euro 6/VI, and subsequently revise the fuel supply agreements/commitments with supplying countries.

7.5.7.3 Long-term: vehicle testing and manufacturing facilities

Vehicle emission inspection system

Currently Nepal has an annual system of vehicle testing post which a sticker is allocated to each vehicle. However, the testing is less stringent leading to many high polluting vehicles plying on the roads of the country. This has been mostly observed in the public transportation segment. There is a crucial need of more frequent testing of vehicles starting from the time of registration and further at regular intervals of three months. The benefit of this quarterly testing would be taking regular stock of emissions from the operational fleet of vehicles. This can be further aided by levying heavy penalties on the offenders.

Additionally the current tags issued in the country can be easily replicated or can be dodged. A digital tag can be issued to the vehicles with remote monitoring capabilities similar to toll collection tags.

With this the country can also incorporated colour coding of vehicles based on the emissions. Based on the colour of the tags, incentives can also be introduced for low-emitter vehicles during insurance or road tax renewal.

Domestic manufacturing and assembly facility

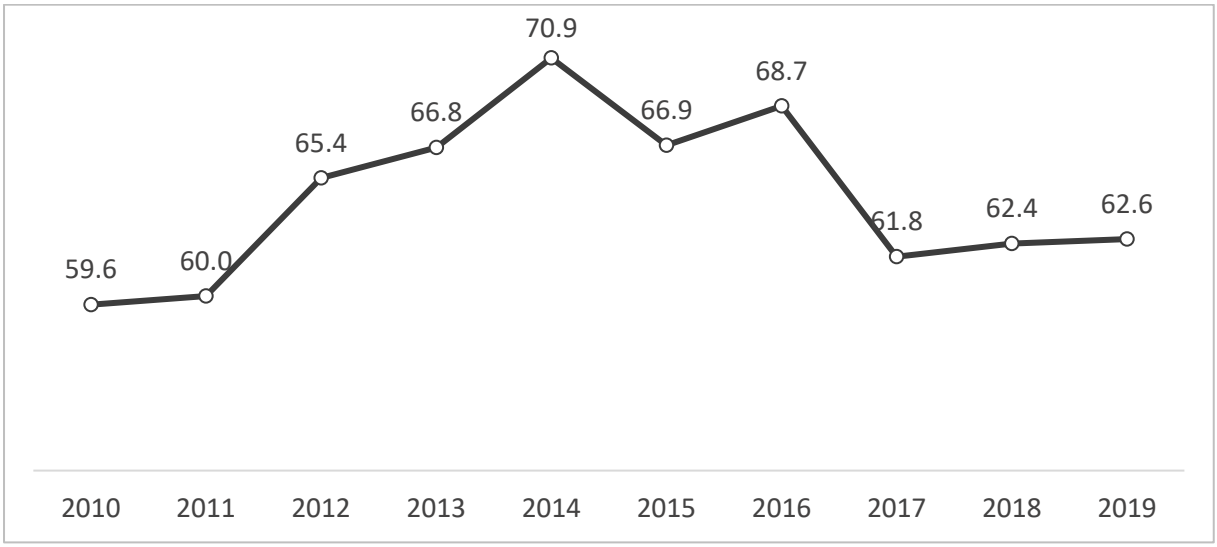
Further to the above action plan, the country can also move to introduce domestic manufacturing or assembling facilities for vehicles that can further reduce the cost of new vehicles thereby attracting more buyers for domestically manufactured vehicles. Around 20 companies have shown interest in establishing manufacturing or assembling facilities in Nepal in the past years. Therefore, this could help the country to achieve self-reliance from vehicular imports.

A two-part taxation or duty implementation can be introduced for Completely Built Units (CBU) and Completely Knockdown Unit (CKD). Such policy is already implemented in India which has resulted in cost reduction of the CKD units that are assembled in India after the parts are separately imported in the country. Such model can be beneficial in the country with assembling facilities being easier to introduce compared to complete manufacturing facilities

7.6 Pakistan

Pakistan is a major contributor to global air pollution among the SMS. With air quality deteriorating over the past few years, Pakistani cities like Lahore, Bahawalpur and Faisalabad figure among the 30 most polluted cities in the world, as per the *IQair "World most polluted cities 2020 (PM 2.5)"* rankings. Lahore, the capital of Punjab province, is Pakistan's second most populated city, and among the country's most polluted regions. PM 2.5 levels in Lahore averaged 79.3 µg/m³ in 2020, significantly exceeding above the WHO-recommended level of 10 µg/m³.

[78]Figure 42: Trend in Pakistan PM 2.5 levels (µg/m³)



The transport sector is a key contributor to air pollution in Pakistan. Increasing economic activity has led to rapid industrialisation and urbanisation, leading to increased primary energy consumption. According to the BP Statistical Review of World Energy, primary energy consumption in Pakistan clocked 2.8 % CAGR between 2010 and 2020, with transport accounting for a majority share of overall

[78] Source: State of global air report 2020

consumption. This has led to a significant rise in carbon emissions over the years, with per capita CO_2 emissions clocking 4-5% CAGR between 2010 and 2018, according to World Bank Data.

Rising emission levels have necessitated a regulatory and policy push to curb pollution, with measures like the establishment of vehicle emission standards, the introduction of electric vehicles and a reduced dependence on petroleum product imports needing to be undertaken at a country-wide level.

7.6.1 Measures taken by Pakistan to control air pollution

Along with other SMSs, Pakistan is a signatory to the COP21 targets to reduce global greenhouse gas emissions. While Pakistan has taken several measures to control air pollution in the recent past, the country's air quality has been deteriorating due to rapid urbanisation and increasing economic activity, which has led to an increased dependence on fossil fuels.

Some key policy initiatives to curb air pollution in Pakistan include:

The Pakistan Environmental Protection Act (PEPA):

PEPA was formulated in 1997 and is a key piece of legislation to protect the environment. PEPA not only created federal and provincial Environmental Protection Agencies (EPAs) to implement and supervise rules and regulations under the Act, but an ISO introduced National Environmental Quality Standards (NEQS) that mandated limits on industrial emissions and ambient air quality. PEPA falls directly under the Federal Ministry of Climate Change (MoCC).

The Pakistan EPA has notified several rules and regulations to implement its responsibilities under PEPA. The table below lists the rules directly linked to air pollution. These rules involve the NEQS for ambient air, motor vehicle exhaust and industrial gaseous emissions. They also include procedures to measure and calculate pollution charges for industrial emitters. However, the rules regarding pollution charges have remained dormant since their inception.

[79]Table 37: PEPA rules on air pollution

Rule No.	Description
3	NEQs for ambient air
4	NEQs for motor vehicle exhaust
9	The pollution charge for industry
12	NEQS self-monitoring and reporting by industries
14	NEQS for industrial gaseous emissions

Current ambient air standards cover several major pollutants, including PM2.5, PM10, suspended particulate matter (SPM), sulphur dioxide (SO2), nitric oxide (NO), ozone (O3), lead (Pb), and carbon monoxide (CO). The table below shows the existing limits on PM2.5 under the NEQs for ambient air.

[80]Table 38: NEQs for ambient air (PM 2.5)

Period average	Allowable limits (µg/m³)
Annual	**15**

[79] Source: Pakistan Environment Protection Agency
[80] Source: Pakistan Environment Protection Agency, The International Growth Centre

24 hours	**35**
1 hour	**15**

Further, various provinces in Pakistan can define legislation as per their own standards, as well as develop their own systems to monitor and enforce their rules and regulations, although the federal government still retains the power to regulate environmental concerns in the areas of oil and gas, electricity, airports, shipping, and marine resources. Various provinces have their own legislation with respect to environmental pollution such as the Punjab EPA, the Sindh Environmental Provincial Act 2013, the Baluchistan Environmental Protection Act 2013, and the Khyber Pakhtunkhwa Environmental Protection Act 2014. The transport departments possess the authority to inspect and certify vehicles.

However, implementation of these legislations has been lagging, as is evident by the PM limits set by PEPA and actual figures, which are way above the set limits. Stricter implementation is very important to achieve the set targets.

Court orders:

Courts play a key role in enforcing environmental regulations. In 2003, the Lahore High Court appointed the Lahore Clean Air Commission after entertaining a writ petition filed by Justice Mansoor Ali Shah, who had filed the petition as a citizen, six years before joining the judiciary. The commission comprised high-level representatives from the city, the national government and other stakeholders. After concluding its proceedings, the commission recommended that the provincial government introduce 4-stroke rickshaw engines, expand public transport, and adopt Euro II, Euro III, and Euro IV fuel and emission standards for motor vehicles.

In November 2017, Justise Mansoor Ali Shah, the Chief Justice of the Lahore High Court at the time, accepted a writ petition (W.P No. 34789/2016) to investigate the provincial government's failure in controlling Lahore's air pollution and smog. As part of the proceedings, the court institutionalised the action plan, which lists the steps that government departments must take under different colour-coded categories of PM 2.5 levels. Later, a smog commission was constituted, to formulate a smog policy for Punjab. To limit air pollution in Punjab, its report, issued in May 2018, recommended 17 measures, including voluntary and mandatory actions and steps to increase public awareness and to implement the measures.

National Electric Vehicle Policy

Pakistan approved an ambitious National Electric Vehicles Policy (NEVP) in November 2019, with targets and incentives aimed at seeing electric vehicles capture 30% of all passenger vehicle and heavy-duty truck sales by 2030, and 90% by 2040. It set more ambitious goals for two and three-wheelers and buses at 50% of new sales by 2030 and 90% by 2040 as per ICCT Blog (2020), Pakistan's National Electric Vehicle Policy: Charging Towards the Future.

Pakistan already has a nascent electric vehicle (EV) industry. The five domestic electric vehicle manufacturers recently formed the Pakistan Electric Vehicles Manufacturing Association (PEVMA) and have been making significant investments in the sector, often partnering with established international automobile companies. The NEVP incorporates new foreign direct investment incentives to stimulate investment in EVs. The general sales tax on locally manufactured electric cars - those with

batteries holding less than 50-kilowatt hours (kWh) of power - has dropped from 17% to nearly zero, At the same time, the customs duty on imported electric car parts - such as batteries, controllers and inverters - is down to 1% whereas the duty on importing fully built electric cars also has fallen from 25% to 10% for one year . The import duty for charging equipment is also being slashed to 1%. Additionally, the government will lower the unit rate of electricity for charging station operators to encourage private investments in charging stations. The government will also install at least one DC fast-charging station every 10 square kilometres in all major cities (targeting the more than 3,000 defunct CNG stations as locations) and every 15–30 kilometres on all motorways.

Vehicle emission standards

In Pakistan, Euro-1 petrol was introduced in 1992; however, relevant institutions kept ignoring the upgradation of petrol and could introduce only Euro-2, that too in 2012. Internationally Euro-1 standards were phased out by 1996 and Euro-2 became obsolete in the year 2000 when Euro-3 came into effect, which means Pakistani adapted to Euro-2 almost 12 years after it was phased out from the rest of the world.

According to the World Health Organization (WHO), air pollution accounted for 9 % of deaths in Pakistan in 2017. With this perspective, the Government of Pakistan ordered the switch from Euro 2 to Euro 5 in June 2020. The target was to achieve these standards by August 2020 for petrol and by January 2021 for diesel. However, only Pakistan State Oil (PSO) and National Refinery Limited (NRL) have switched Euro 5 standards while Byco Petroleum has started the upgradation to Euro5/6. The introduction of Euro 5 will require the installation of expensive specialised Euro 5-compliant parts such as particulate filters and accessory equipment to meet the new emission standards across all refineries in the country. This will increase costs and raise retail prices for vehicles that are already priced expensively in the market. The government also ordered in July 2020 that all import of petrol and diesel should be Euro 5-compliant.

Pakistan also drafted a new refinery policy in July 2020, offering a series of tax holidays for new deep conversion refinery projects with a minimum capacity of 100 thousand barrels per day (bpd). The policy was finalised in August 2021. Tax incentives include a 20-year income tax holiday for all taxes under the Income Tax Ordinance, 2001; no import duties and sales tax on import of crude oil by refineries, as of July 1, 2022, for existing refineries investing in upgrades and for new deep-conversion refinery projects. The new policy will apply to existing refineries committing to upgrading or modernizing their facilities and to potential investors seeking to set up a deep conversion refinery and petrochemical complex worth USD 10-15 billion in Pakistan.

Refineries with upgrading programmes will be granted tariff protections (10% import duty on motor gasoline and diesel) from January 1, 2022, to December 31, 2027, while new refinery projects will benefit from a new pricing mechanism. The Pakistan Oil Refinery Policy, 2021, also revises the product pricing formula of refineries, which will be based on the "True Import Parity Price" (derived from the Arab Gulf Mean FOB price or from the Singapore Mean FOB price). The government will not provide any product offtake guarantees and refineries will be allowed to sell products to any marketing companies.

7.6.2 Status of refining and automotive industries in Pakistan

Pakistan had 19.37 million tonnes of refining capacity, as of fiscal 2020 (as per the Pakistan Economic Survey). It has both government-run and private refineries. Overall, the throughput levels are low at 55-60% utilisation on average, since most of these refineries are old, lack efficiency and require upgradation. Except for PARCO, all refineries produce more than 40% furnace oil (FO) and hence, run on very low margins. As a result, 70% of petroleum product demand in Pakistan is met via imports.

The following table details the company-wise refining capacity:

[81]Table 39: Installed refining capacity in Pakistan

Name of the refinery	Govt/private	Capacity (mtpa)
Pak-Arab Refinery Ltd	60% govt, 40% private	4.5
National Refinery Ltd	Govt	2.7
Pakistan Refinery Ltd	Private	2.1
Attock Refinery Ltd	Private	2.7
Byco oil Pakistan Ltd	Private	1.8
Byco Petroleum Pakistan Ltd	Private	5.5
Total		**19.37**

Demand for petroleum in Pakistan has been increasing rapidly, due to rising economic activity and rapid urbanisation, with the transport and power sectors being the primary drivers.

Within petroleum products, petrol demand clocked 17% CAGR between fiscals 2015 and 2020 due to rising demand from the transport sector (largest consumers of MS in volume terms), largely on account of the growing number of motorcycles and cars, and partially because of lower prices of petrol over the years.

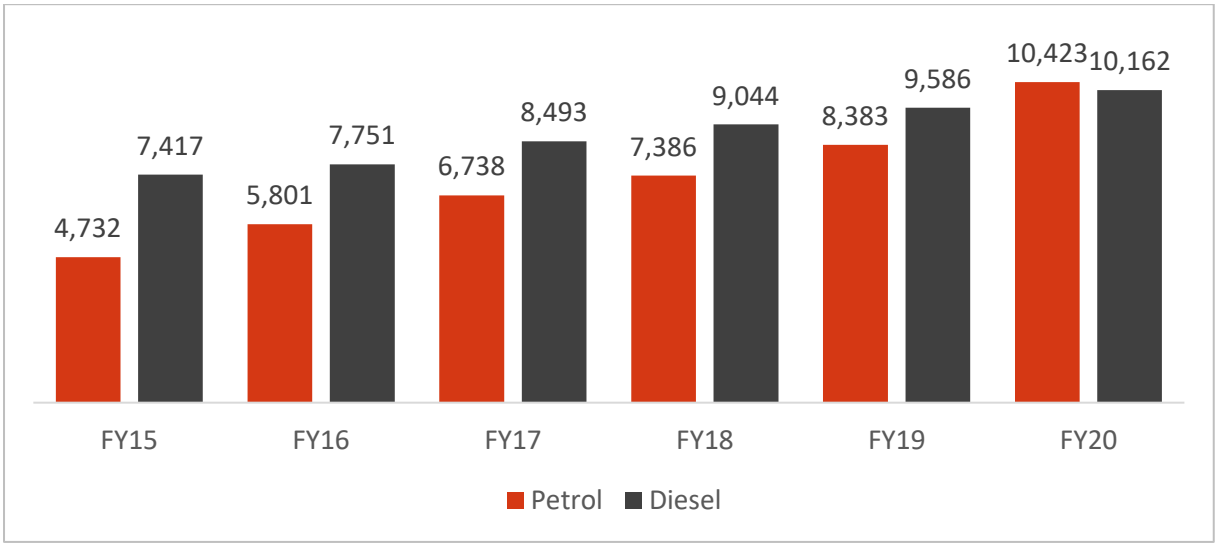
In fact, demand from the transport sector has risen steeply over the years, primarily due to rising sales of cars, two-wheelers, and three-wheelers, which have been growing rapidly over the last five years.

Further, low crude oil prices, along with reduced availability of CNG, owing to lack of domestic gas availability, boosted petrol consumption in recent years. In 2011, the government had banned the import of CNG kits and cylinders to reduce CNG usage.

Diesel demand clocked ~6.5% CAGR between fiscals 2015 and 2020, mainly on account of higher utilisation by the transport sector, led by increased economic activity in the country. Consumption growth was muted till fiscal 2014, declining annually from fiscal 2008. However, with a pick-up in economic activity and subdued crude oil prices, along with a ban on CNG usage in public transportation, diesel consumption rose rapidly post fiscal 2015.

[81] Source: Pakistan Economic Survey

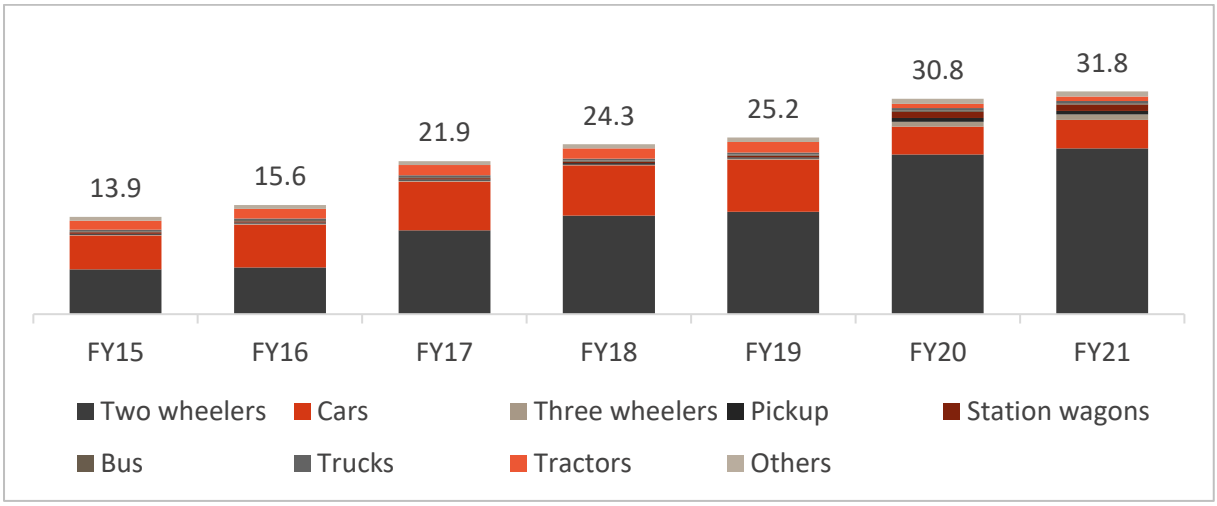
[82]**Figure 43: Trend in petrol, diesel demand in Pakistan ('000 tonne)**



The automotive industry is a rapidly growing market, with annual vehicle sales of 60-70 lakh vehicles across various categories. Total on-road population of vehicles is approximately 31.8 million, as per *the compendium on environment statistics* in Pakistan, as of fiscal 2021.

Amongst various vehicle categories, two-wheelers form the largest share, with a population of nearly 23.7 million as of fiscal 2021. Not only is it the largest, but also the fastest growing market, with annual sales clocking 7-8% CAGR between fiscals 2015 and 2020. The next largest market is that for passenger cars, with a population of ~4 million, as of fiscal 2021.

[83]**Figure 44: Trend in vehicles on road in Pakistan (million units)**



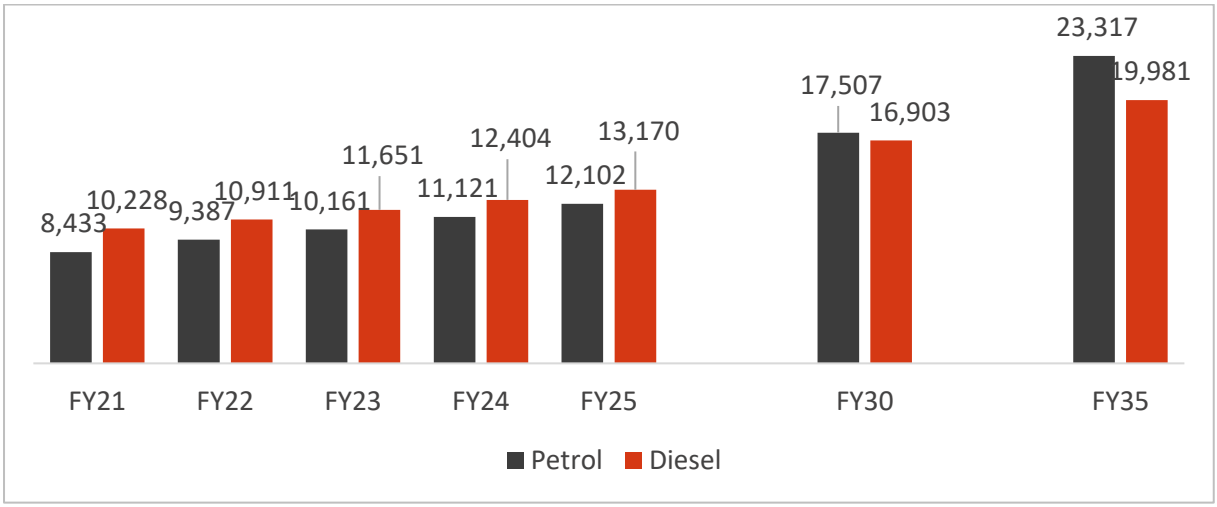
7.6.3 Outlook on auto-fuel demand and related emissions in Pakistan

Pakistan's vehicle market is underpenetrated, with only 20 vehicles per 1,000 people. Rising per capita income is expected to boost vehicle sales (particularly cars and two-wheelers) in the coming years. Moreover, with rising economic activity, we should also see a significant boost in terms of sale of commercial vehicles and buses (key drivers of diesel demand).

[82] Source: Oil Companies Advisory Council, Pakistan
[83] Source: Compendium on Environment Statistics

We believe that sales of cars and two-wheelers are expected to clock 7-8% CAGR and 2-4% CAGR, respectively, between fiscals 2022 and 2035. Three-wheeler population is also expected to rise at 2-3% CAGR during the said period. As a result, petrol consumption is expected to increase at 7-8% CAGR between fiscals 2022 and 2035. Consumption is estimated to have declined in fiscal 2021 by 19% on-year, owing to the impact of the Covid-19 pandemic and the consequent economic slowdown. Overall consumption of petrol is expected to reach 23.5 million tonnes in fiscal 2035 versus 10.4 million tonnes in fiscal 2020.

[84]Figure 45: Outlook on petrol, diesel consumption in Pakistan ('000 tonnes)



For diesel, economic activity is a key determinant of demand, as diesel is largely consumed by commercial vehicles. Diesel demand is expected to clock 4-6% CAGR between fiscals 2022 and 2035, driven by higher demand from the transport segment and industries. Transport constituted over 90% of diesel demand in fiscal 2020. We believe that Pakistan's GDP growth is expected to average 5% CAGR until fiscal 2035.

As a result, the commercial vehicle market is forecast to grow at 7-8% CAGR, thereby supporting diesel demand. In particular, diesel demand is expected to see robust growth over the next 2-3 years, rising 5-7% per annum, and, thereafter, moderating over the longer term.

Diesel demand is also expected to see marginal growth from an improvement in industrial activity. Further, in 2014, the Ministry of Railways launched Pakistan Railways Vision 2026, which also includes the China–Pakistan Economic Corridor Rail Upgrade. The plan includes new locomotives, and development and improvement of rail infrastructure. This is expected to improve diesel demand from the railways. However, diesel demand from the power sector is expected to decline owing to a lower power deficit and a shift to alternate fuels.

With rising income levels and vehicle population, vehicular emissions are also expected to rise rapidly. Assuming that Pakistan continues to use Euro 2 grade fuel and vehicles and does not upgrade to Euro 6/VI in our base case, CRISIL Research forecasts the following emission levels for CO, NOx, PM2.5 and CO2, due to vehicular pollution.

[84] Source: OCAC, CRISIL Research

[85]**Table 40: Emissions forecast in Pakistan**

Pollutant ('000 tonne)	Emission in FY22 (kilo tonnes)	Emission in FY35 (kilo tonnes)	CAGR (FY22-FY35)
Carbon Monoxide	2,645	4,906	4.8%
NOx	849	1,373	3.7%
PM 2.5	54	106	5.3%
Carbon dioxide	135,252	276,581	5.6%

7.6.4 Transition to Euro 6/VI: Key considerations

The transition to Euro 6/VI requires changes in two major sectors- refineries and automobiles. Pakistan has five operational refineries that currently produce high Sulphur fuel. These refineries need to be upgraded to enable production of Euro 6/VI grade fuel. Of these refineries, Byco Petroleum Limited already has plans to upgrade its refining complex with the installation of two major new additions, namely the DHDS (Diesel Hydro De-Sulphurising) Unit, and FCC (Fluidized Catalytic Cracking) Unit. Further, Attock Refinery Limited also has plans to install a hydrocracking unit, as well as a Continuous Catalyst Regeneration (CCR) Unit to produce Euro V-compliant gasoline and diesel.

Based on the benchmarks used in section 8.3, CRISIL Research estimates that the total capital expenditure involved in conversion of the existing refineries in Pakistan would total **USD 3.2-3.7 billion**.

The break-up of this is shown below:

[86]**Table 41: Estimated capex of existing refineries in Pakistan to upgrade to Euro 6/VI**

Refinery	Estimated Capex (USD billion)
Byco Petroleum Ltd	1-1.2
Attock Refineries	0.5-0.7
Parco Refinery	0.8-1
National Refinery Ltd	0.3-0.5
Pakistan Refinery Ltd	0.2-0.4
Total	**3.2-3.7**

Additionally, Pakistan also has plans to add refinery capacities. To encourage investments in the refineries sector, Pakistan finalised the National Refining Policy in August 2021, which will provide several tax incentives and duty concessions to refineries that invest in the upgradation of their existing units. Moreover, with the change in the pricing of fuel, upcoming refineries are also expected to benefit. Accordingly, CRISIL Research expects three new refineries to be added over the next 5–7 years, with a total capacity of 310 thousand barrels per day (bpd). These refineries are expected to produce fuel which will be Euro 6/VI-compliant, entailing a total capex of USD 10.2-10.7 billion. Details of refinery-wise capex are given below.

[85] Source: CRISIL Research Estimates; Emission factors have been taken from ICCT emission factor data base for carbon dioxide and the others are based on Euro 2 emission standards.
[86] Source: CRISIL Research estimates

[87]**Table 42: Upcoming greenfield refineries in Pakistan**

Entity	Location	Capacity (ktpa)	Estimated Capex (USD billion)
PARCO	Baluchistan	5.0	9.0
Falcon Oil Private Limited	Dera Ismail Khan	0.8	1.0
Khyber Refinery Limited	Kohat	0.4	0.5
Total		**6.2**	**10.2-10.7**

Hence, the transition to Euro 6/VI will take place in Pakistan with a total estimated capex of USD 13-14 billion.

In addition to the above costs, there are several other softer cost aspects that need to be considered. These include the following:

- Automobile manufacturers will have to switch to new production lines, to produce units to be added to automobiles, which are Euro 6/VI-compliant. Additionally, considering that 50% of the vehicles in Pakistan are imported, importing Euro 6/VI vehicles will lead to higher import bill on account of the following:
  - Higher freight costs, if the country must switch to supply sources that are also Euro 6/VI-compliant, like Japan from countries such as Thailand and Indonesia
  - Higher cost of imported vehicles compared with Euro 2 vehicles

7.6.5 Barriers to effective transition

The introduction of Euro 6/VI standards would imply the introduction of advanced technologies in Pakistan to ensure pollutants emitted by vehicles are reduced and comply with specified limits. It will also mean several changes to be made to the engine systems, along with significant investments to upgrade refineries. There are several challenges and barriers to smooth implementation:

- **Heavy investments required to upgrade refineries**: Almost all refineries in Pakistan have been running for several years, without any significant upgradations. These refineries produce nearly 40% furnace oil in their product slate. As these refineries have not undergone upgradations in the past, they continue to produce Euro 1/Euro 2 grade petrol and diesel. Hence, these refineries will have to bear significant upgradation costs of USD 3.2-3.7 billion. The Pakistan government has stated that they would provide significant tax benefits to refineries that undertake deep upgradation projects. This could encourage refineries to undertake investments and upgrade. However, the government may still have to take initiatives via viability gap funding and attracting foreign investments to fund these capex-intensive projects. There is lack of adequate funding, which creates a barrier to the adoption of stringent emission standards in Pakistan. For a developing country, coping with high public and foreign debt, the challenges to the implementation of standards are substantial, given the lack of resources.
- **Automobile manufacturers reluctant, due to rising vehicle manufacturing costs**: Automobile manufacturers also must undertake investments, to completely transform their production platforms. The task is more burdensome for companies that have products across several categories, from cars and SUVs to two-wheelers and trucks. Such a portfolio means that the

[87] Source: Industry, CRISIL Research estimates

companies would have to invest more resources and time to build the requisite capabilities to successfully execute the programme. The transition will significantly increase the production cost of vehicles, which they may not be able to pass on to the consumer immediately. Even if they do, it will lead to increasing retail prices of their products, which may lead to declining sales in a country where vehicles are already expensively priced.

- Countries like Pakistan which also import automobiles form Thailand and Indonesia would have to reroute their imports through Euro 6/VI-compliant countries like Japan, which would escalate costs further. Thailand and Indonesia account for ~40% of Pakistan's unassembled automobile imports and are still following Euro 4 standards.

7.6.6 Benefits of transitioning to Euro 6/VI standards

While the costs of transitioning to Euro 6/VI look significantly high, these standards are expected to provide benefits in the long run. These benefits include:

Savings on fuel consumption due to improving fuel economy

Euro 6/VI-compliant vehicles are a significant improvement over Euro 2 vehicles, not only in terms of emissions, but also in terms of efficiency, as they provide higher fuel economy. Post Euro 6/VI implementation, as all new vehicle sales would comply with the new standard and have higher fuel economy, thus consuming lower amounts of petrol and diesel. As per CRISIL Research estimates, this will translate into cumulative fuel savings of 8-9 million tonnes of petrol, and 25-25.5 million tonnes of diesel between fiscals 2026 and 2035. These savings are likely to translate into a cumulative savings of USD 20-25 billion by fiscal 2035. This is based on forecasted fuel demand considering base case Euro 2 and after transitioning to Euro 6 with higher mileage, leading to lower fuel consumption. Also, as Pakistan imports a large volume of its fuel requirements, lower fuel consumption would lead to a lower import bill for the country as well.

[88]Figure 46: Outlook on savings on petrol and diesel consumption due to implementation of Euro 6/VI ('000 tonnes)

Fuel	FY26	FY30	FY35	Cumulative (FY26-35)
Petrol	576	888	1166	8750
Diesel	2071	2480	3001	25212

Reduced emission levels

The primary objective of implementing stringent emission standards is to reduce emissions from vehicles, which lead to air pollution. Implementation of Euro 6/VI standards will not significantly contribute to emission reduction in the initial years of implementation, as a majority of on-road vehicles will be still running on the old standards. However, over a period of time, as new vehicles replace old vehicles, there will be a significant reduction in vehicular emissions. CRISIL Research estimates that within the overall vehicular population, 75-80% would comprise Euro 6/VI-compliant vehicles by fiscal 2035. This number is expected to be around 7-9% in fiscal 2026, the first year of implementation. Overall emissions of various pollutants are expected to be lower by 50-70% in fiscal 2035, compared with the base case scenario. The pollutant emissions are calculated based on the

[88] Source: CRISIL Research estimates

current emission standards compared to the emissions after transitioning to Euro 6/VI standards. The below table shows the base case emissions vs emissions with Euro 6/VI standards in place:

[89]Table 43: Outlook on emissions with Euro 6/VI implementation ('000 tonnes)

Pollutant ('000 tonne)	Base Case		Euro 6/VI		CAGR FY26-35	
	FY26	FY35	FY26	FY35	Base Case	Euro 6/VI
Carbon Monoxide	3269	4906	2792	2217	5%	-3%
NOx	995	1373	877	653	4%	-3%
PM2.5	69	106	57	33	5%	-6%
Carbon Dioxide	176625	276581	152816	143016	5%	-1%

Implementation of Euro 6/VI standards would not only reduce annual emissions when compared with the base case scenario, but also lead to an overall reduction in annual emissions by fiscal 2035.

Savings on Government health expenditure

While moving to Euro 6/VI requires significant time, effort, and investments by various stakeholder, looking at the larger picture, it can help save a significant sum in the form of reduced deaths due to air pollution. We believe that implementation of Euro 6/VI would lead to lower CO2 emissions, and cumulatively reduce the number of deaths caused due to air pollution by 2.6-2.8 million between fiscals 2025 and 2035. As a result, we believe that the total government healthcare expenditure will reduce by ~USD 18 billion, higher than the total envisaged investments.

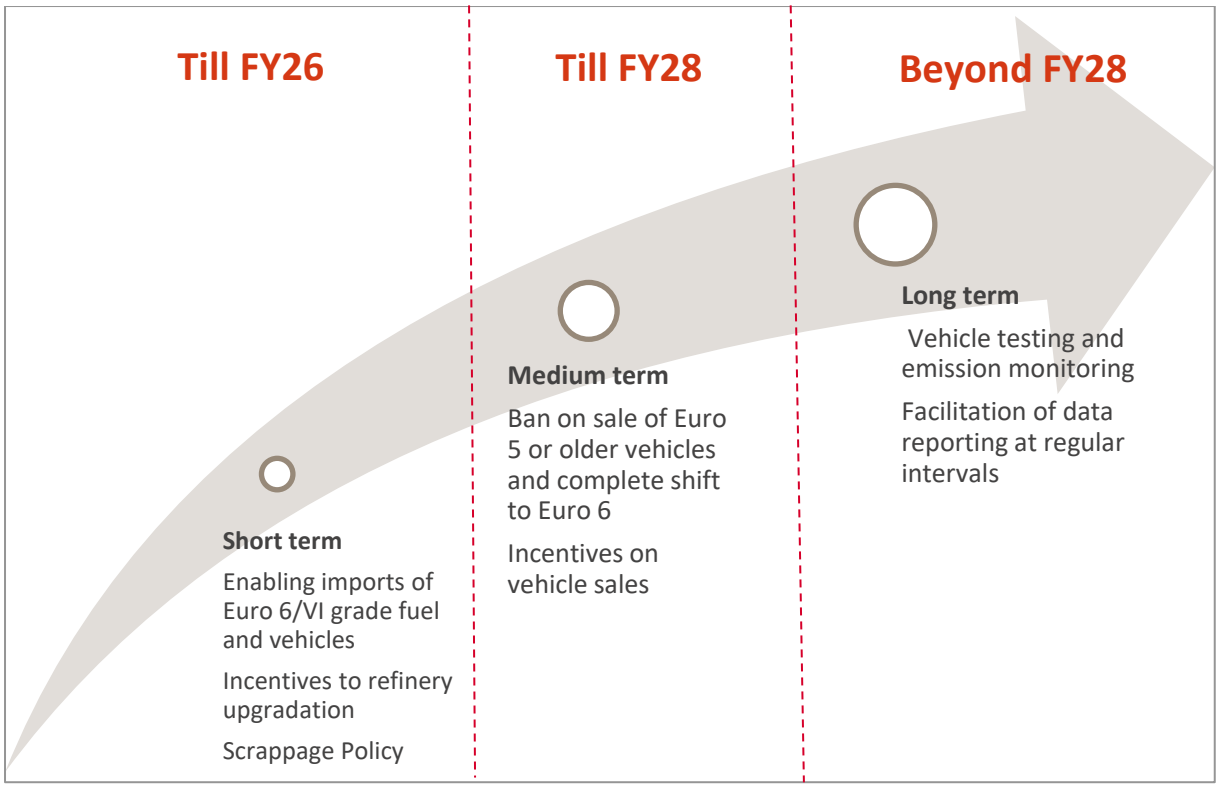
7.6.7 Roadmap for adoption of Euro 6/VI standards[90]

Pakistan is already taking steps towards stringent emission standards. In June 2020, it announced the switchover from Euro 2 straight to Euro 5 by August 2020 and January 2021 for petrol and diesel, respectively. However, the switchover has not been implemented due to bottlenecks with the domestic refining and automobile industry.

With its New Refining Policy finalised in August 2021, Pakistan has taken major steps to encourage existing refineries to upgrade to higher quality fuel. Moreover, it plans to deregulate fuel pricing and make it market-linked, thus encouraging new investments in the refining space. The Government of Pakistan mandated the import of Euro 5 standard compliant high-speed diesel from January 2021. Pakistan State Oil has already started imports of Euro 5 grade diesel and gasoline in the country.

CRISIL Research believes that instead of shifting to Euro 5, Pakistan should directly leapfrog to Euro 6/VI, since the two standards have similar Sulphur limits and upgradation to the latter can be done with minimal changes. The same thought process was adopted by India, which leapfrogged from BS IV emission standards to BS VI in April 2020. To enable a smooth transition, the country can have short, medium, and long-term plans:

[89] Source: CRISIL Research estimates
[90] Source: CRISIL Research



Short Term: Fiscal 2026

Pakistan has already started importing Euro 5 grade fuel and banned the imports of lower quality fuel. Over the next 2-3 years, Pakistan can switch to Euro 6/VI grade imports of fuel. Although a large share of petrol and diesel requirement in Pakistan is imported, domestic refineries will also need to upgrade their existing fuel production. Nearly all the existing refineries have plans to upgrade to Euro 5 grade fuel in the next 4-5 years. Moreover, three new refineries are upcoming which are expected to be Euro 5/Euro 6/VI ready. What could accelerate this transition is the government mandating refineries to produce Euro 6/VI grade fuel by fiscal 2026. A similar transition took place in India, where the announcement to switch to BS VI fuel was made in 2016 and all the Indian refineries had upgraded their facilities to produce BS VI grade fuel by April 2020.

However, while availability of Euro 6/VI fuel is a key requirement to reduce emissions, it is not sufficient to reach the desired emission levels. Vehicles also need to switch to Euro 6/VI standards to meet the desired emissions. Availability of Euro 6/VI compliant vehicles is vital in such a scenario. To achieve this, regulations need to be made to mandate the import of Euro 6/VI grade fuel by fiscal 2026. This would ensure that at least 50% of vehicles sold in the country are Euro 6/VI-compliant.

Introduction of vehicle scrappage policy is also a key factor in achieving improved emissions. New sales of vehicles only happens when customers scrap their old vehicles. Pakistan should introduce a comprehensive vehicle scrappage policy under which vehicles older than 15 years should not be allowed on the roads of big cities. In order to encourage scrapping of vehicles in India, customers scrapping their old and polluting vehicles will be provided with an incentive to buy a new vehicle. A similar approach can be implemented in Pakistan, encouraging sales of newer, less polluting vehicles.

Medium term: 2027-28

By fiscal 2028, the government should put a ban on sale of vehicles that are compliant with Euro 5 or earlier standards, and mandate the sale of Euro 6/VI grade vehicles only. To encourage a smooth transition, the government should introduce incentives to purchase Euro 6/VI grade vehicles, such as duty concessions and subsidies, which will ensure automobile manufacturers do not lose out on sales because of increasing vehicle prices.

Long term: beyond 2027-28

A key issue that needs to be addressed in Pakistan is reporting of pollution data. It fails to disclose reliable data on a regular basis. However, the Punjab Environment Protection Department (EPD) has gradually begun to publicly report ambient air quality data. India's and China's push to publicly disclose air quality information and make emissions reporting more transparent form the backbone of their pollution management. In collaboration with the Energy Policy Institute at the University of Chicago (EPIC), the Indian states of Maharashtra, Odisha and Jharkhand have instituted the Star Rating Program. As per Tata Centre for Development at UChicago (2018), Research Project: Star Rating Program: Improving Pollution Monitoring and Enforcement in Odisha under the programme, each state discloses information about how much firms emit through a star rating scheme – firms that pollute the most receive a 1-Star rating, while firms that perform the best receive a 5-Star rating. The programme puts pressure on polluting firms and recognises the efforts of firms that comply with emission regulations. A similar approach needs to be taken by Pakistan to closely monitor air quality data. Additionally, Pakistan lacks the institutional capacity to comply with international emission standards. Emission testing, smog testing, or emission inspection is the protocol that repeatably allows the comparable measurement of exhaust emissions for different vehicles.

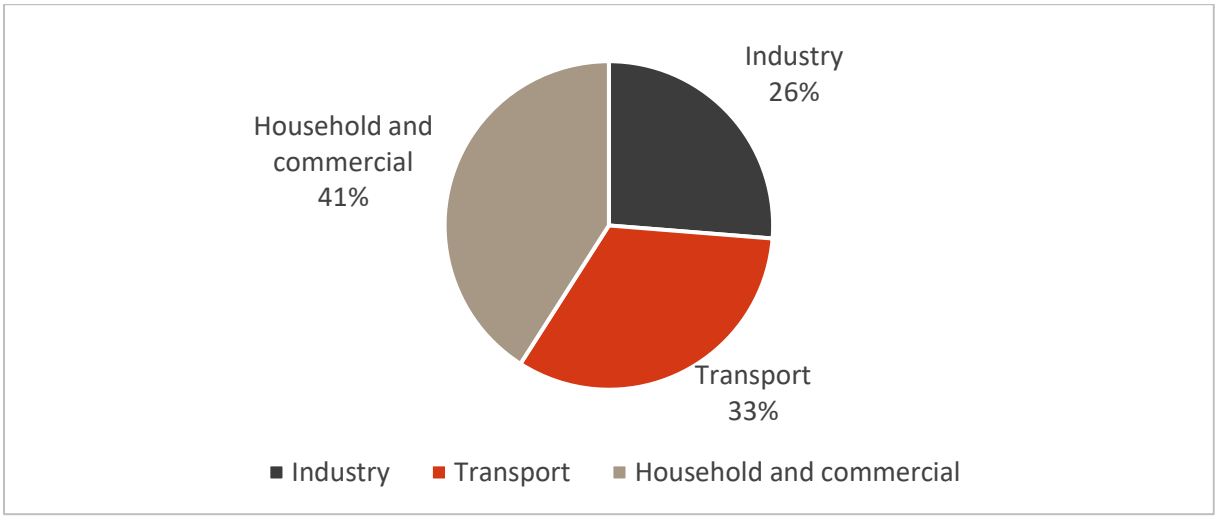
Vehicle testing should be done at the time of registration and further at regular intervals of three months. The benefit of this quarterly testing would be taking regular stock of emissions from the operational fleet of vehicles. This can be further implemented with heavy penalties for offenders (high emission vehicles) and cancellation of registration of vehicles for repeat offenders. A sticker or digital tag-based monitoring can be introduced to achieve better implementation of the norms. An incentive can also be introduced for low emitting vehicles at the time of insurance or road tax renewal. This will lead to strong implementation of the emission parameters across the country and pave the road for emission reduction.

7.7 Sri Lanka

Sri Lanka, an island country in the Indian Ocean, is transitioning to an upper middle-income economy. As per the IMF, its annual average economic growth was 5.25% from 2010 to 2019. However, in 2020, the economy de-grew 3.6% due to the Covid-19 pandemic.

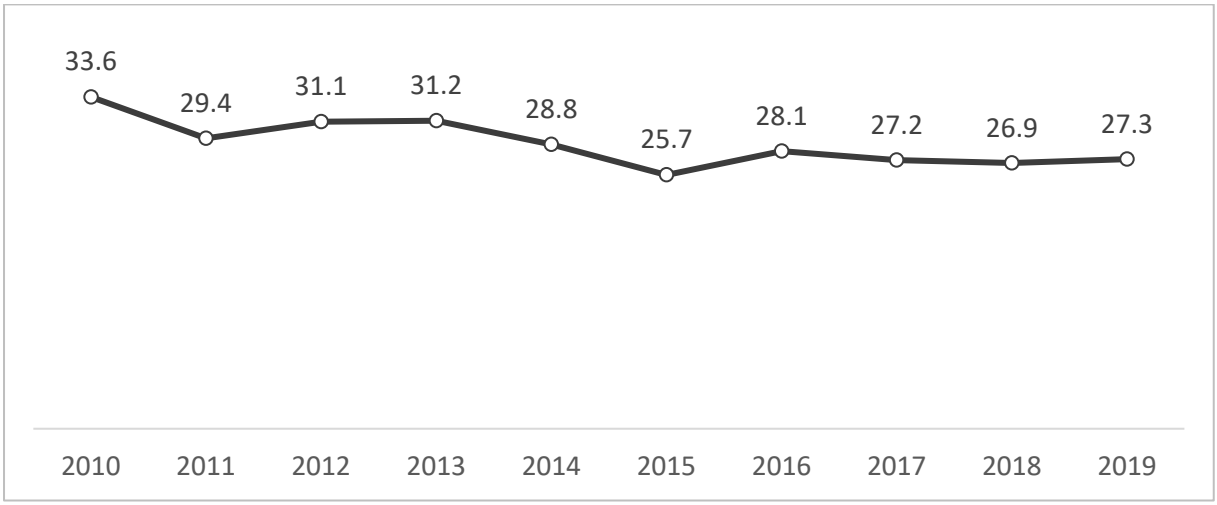
Air pollution is a rising issue in Sri Lanka, mainly due to rapid motorisation and industrialisation. Trends in energy consumption show increases in petroleum consumption compared with other renewable sources such as biofuels and hydropower. According to BP Statistical Review of World Energy, petroleum products contributed to nearly 63% of Sri Lanka's primary energy consumption. In terms of demand, the transport sector contributes to 33% of the overall energy requirement in the country.

[91]**Figure 47: Sector-wise contribution in Sri Lanka's energy consumption**



As a result, pollution levels in Sri Lanka have been rising over the years. Pollution has been the highest in the Greater Colombo area, where a significant proportion of the country's population resides, and most of the industrialisation has occurred. The transport sector is contributing about 60% to air pollution, especially in Colombo City, according to the Ministry of Environment and Renewable Energy in Sri Lanka. PM 2.5 levels have seen a rise in the country, and averaged 27.3 µg/m³ in 2019.

[92]**Figure 48: Trend in Sri Lanka's PM 2.5 levels (µg/m³)**



This necessitates stringent steps to control pollution levels. Since the transport sector is a key contributor of air pollution in Sri Lanka, it is necessary to implement emission standards to control vehicular emissions.

7.7.1 Measures taken by Sri Lanka to control air pollution

Along with other SAARC Member States, Sri Lanka is a signatory of the COP21 targets to reduce global greenhouse gas emissions. The country has taken several measures over the last couple of years to control air pollution levels. However, air quality has been deteriorating due to rapid urbanisation and increasing economic activity, which have led to increased dependence on fossil fuels over the years.

[91] Source: Sri Lanka Sustainable Energy Authority, Sri Lanka Energy Balance 2018
[92] Source: State of Global Air report 2020

Some key policy initiatives to curb air pollution in Sri Lanka include:

Sri Lanka Energy Sector Development Plan 2015-2025

In March 2015, the Sri Lanka Energy Sector Development Plan 2015-2025 established a series of thrust areas and targets. The thrust areas include:

- Integrated national energy policy formulation
- A cleaner future through green energy
- Conservation and efficient use of energy
- Customer satisfaction in service and quality
- Timely development of infrastructure
- Efficient energy sector institutions and good governance
- Innovative financing for a diverse energy sector
- Investment in research and development for cutting-edge product development

The targets according to the plan include:

1. Make Sri Lanka an energy self-sufficient nation by 2030
2. Increase the share of electricity generation from renewable energy sources from 50% in 2014 to 60% by 2020, and finally meet the total demand from renewable and other indigenous energy resources by 2030
3. Increase the electricity generation capacity of the system from 4,050 MW to 6,400 MW by 2025
4. Generate a minimum 1,000 MW of electricity using indigenous gas resources discovered in Mannar basin by 2020
5. Increase generation capacity of low-cost thermal power plants fired by natural gas and biomass to 2,000 MW to reduce generation costs and diversify the generation mix by 2020
6. Provide affordable electricity coverage to 100% of the people of the country on a continuous basis before the end of 2015
7. Reduce the technical and commercial losses of the electricity transmission and distribution network from 11% to 8% by 2020
8. Reduce annual energy demand growth by 2% through conservation and efficient use
9. Reduce the petroleum fuel use in the transport subsector by 5% by introducing alternative strategies such as efficient modes of transport and electrification of transport by 2020
10. Produce the total petroleum product demand of the country through the local refinery by 2025
11. Upgrade quality of gasoline to Euro 6/IV and diesel to Euro III by 2018
12. Further enhance the quality and reliability of electricity and fuel supply
13. Broaden energy sector investment windows to include bonds, debentures, public–private partnerships, and other novel financial instruments
14. Reduce the carbon footprint of the energy sector by 5% by 2025

Sri Lanka has already moved to Euro III and Euro IV standards as per the above-mentioned targets.

Taxation for vehicles

Sri Lanka introduced a revised carbon tax through the government's 2019 budget to generate about USD 14 million a year. According to this carbon tax, older and hybrid vehicles would be heavily taxed, while EVs are exempted from taxation. The government, eager to phase out petrol and diesel powered vehicles and incentivise the use of EVs, revised the tax on a range of motor vehicles. As per the law, EVs are completely exempted from the new tax, while gasoline-electric hybrids from Japan, a category of vehicles extremely popular in Sri Lanka, will be hit with a 20% tax.

However, this new taxation is not popular in Sri Lanka, as the taxes are levied on the year of car manufacture and engine capacity, and not on emission levels. Moreover, cars in Sri Lanka are already expensive due to heavy taxation of imports. The new taxation will trigger a further increase in vehicle prices.

Vehicular Emission Test Trust Fund

The Department of Motor Traffic, through its **Vehicular Emission Test Trust Fund**, together with the Central Environmental Authority (CEA), has set up centres island-wide to assess vehicular air pollution in Sri Lanka. This fund conducts tests at regular intervals to monitor emission levels across the country.

100% renewable energy pledge

In 2015, 52% of Sri Lanka's electricity was generated through fossil fuels (primarily diesel and fuel oil). Sri Lanka, at the 22nd UNFCCC Conference of Parties held in Morocco, pledged that it will switch to renewable energy completely for its electricity needs by 2050.

In addition to the 100% renewable energy pledge, Sri Lanka's Nationally Determined Contributions (NDCs), resubmitted to the UNFCCC on April 25, 2016, targets increasing the adoption of renewable and sustainable forms of energy. Highlights of Sri Lanka's energy sector NDC targets include:

- Establishing large-scale wind power farms (514 MW), replacing planned thermal power plants generating equivalent amounts of electricity
- Broadening the solar power electricity generation capacity of the country with increased participation by the private sector and adoption of advanced technologies available around the world. Sri Lanka aims to establish solar power plants of up to 115 MW
- Promoting use of biomass (fuel wood) and waste (municipal, industrial and agricultural) by increasing their use in power generation, adding 104.62 MW by 2025
- Promoting mini and micro hydropower generation projects as an environment-friendly option with a targeted additional capacity of 176 MW

The Government of Sri Lanka has prioritised the implementation and enforcement of sustainable energy policies to absorb more renewable energy in the system and increase its contribution to at least 50% by 2030. Additionally, the government announced, in its 2018 budget, that the country targets to switch to all-electric vehicles by 2040. In the medium term, the government announced a target of converting all government vehicles to electric by 2025.

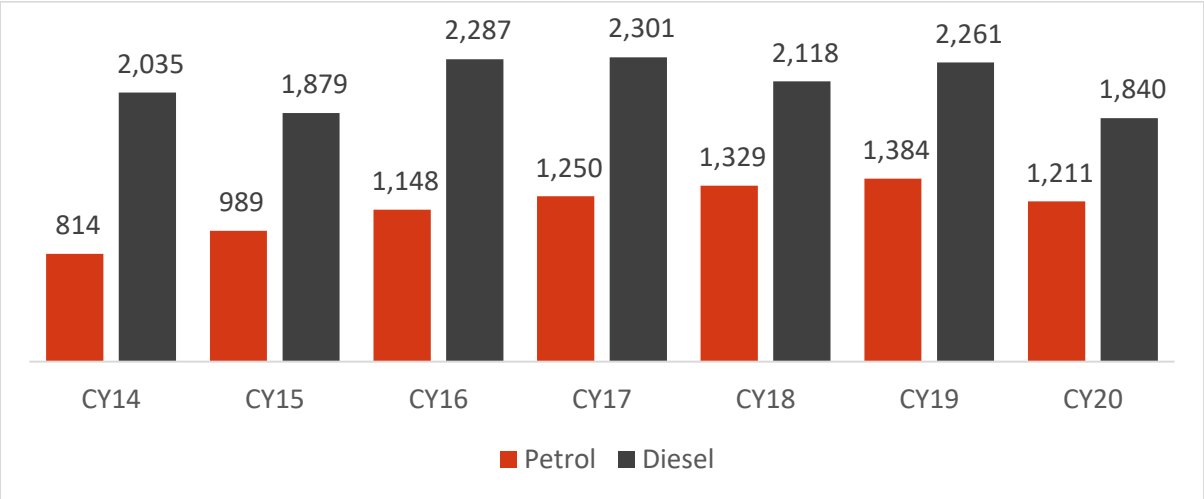
7.7.2 Status of refining and automotive industries in Sri Lanka

Sri Lanka's only refinery with a capacity of 2.5 million tonne was built in 1969 in Colombo. This refinery caters to 30-35% of the country's petroleum products demand – the remainder is via imports. The refinery is owned by Ceylon Petroleum Corporation (CPC) and was designed to process light Iranian crude. However, owing to unavailability of Iranian crude oil post US sanctions, the refinery started importing from Middle East countries, including Oman and the UAE.

Demand for petroleum products in Sri Lanka rose considerably from 2015-2018, particularly driven by 11.2% CAGR for petrol demand between 2015 and 2019. Petrol demand surged ~75% on-year in 2016, driven by significantly low prices, revised downwards in 2015, along with increasing vehicle population. However, such demand growth is expected to be an anomaly, which is estimated to have corrected in 2017 with rise in fuel prices. Rising demand from the transport sector was driven by the increasing population (number of registered vehicles) of cars, two-wheelers and three-wheelers, which grew at 9.1%, 9.3% and 4.8%, respectively, from 2014 to 2019.

Diesel consumption logged 2.7% CAGR between 2014 and 2019, due to increased transportation activity as a result of GDP growth. However, demand growth was slower than that of petrol, as diesel demand witnessed de-growth in 2015 and 2018 due to a sharp decline in demand from the power sector. Additionally, both petrol and diesel demand plummeted in 2020, by 12.5% and 18.6% on-year, respectively, due to the Covid-19 pandemic and a consequent slowdown in economic activity.

[93]Figure 49: Trend in petrol, diesel demand in Sri Lanka ('000 tonne)

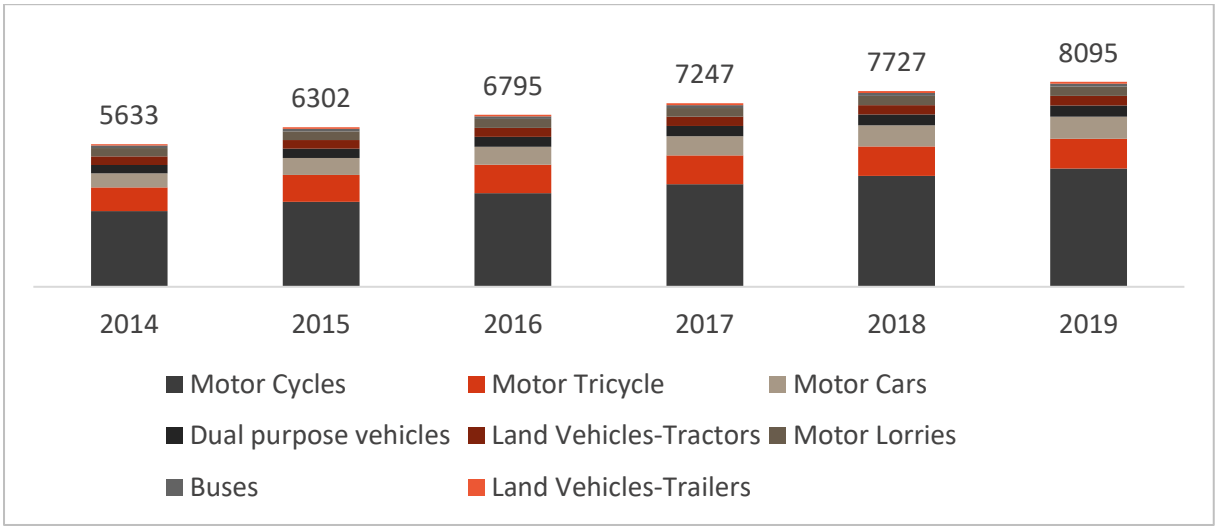


The automotive industry is a rapidly growing market, with annual sales of 3-4 lakh vehicles across various categories. The total population of vehicles was approximately 8.1 million as of 2019.

Among various vehicle categories, two-wheelers form the largest share (population of ~4.6 million as of 2019), followed by passenger cars (~0.8 million).

[93] Source: Sri Lanka Sustainable Energy Authority, Department of Census and Statistics

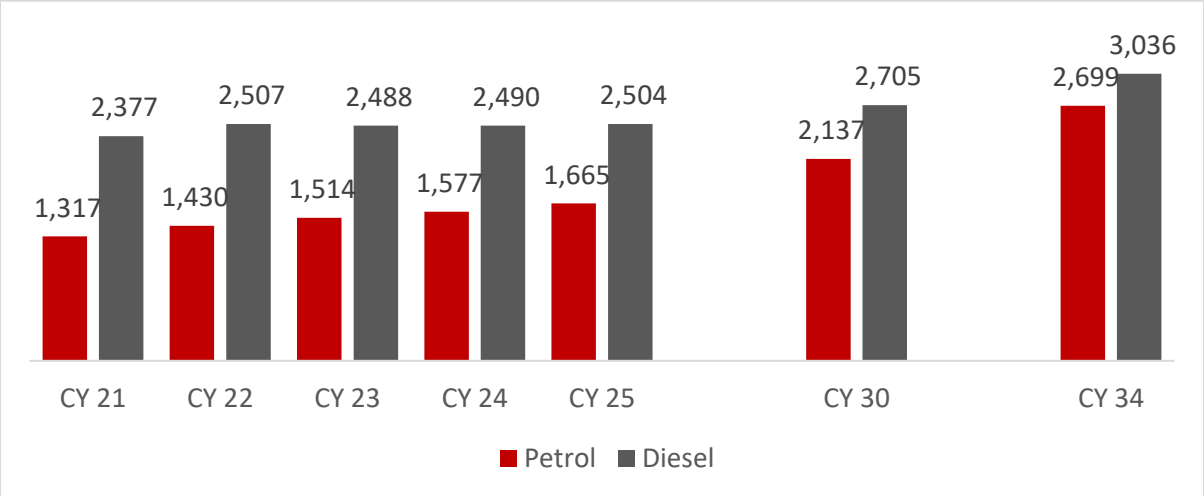
[94]**Figure 50: Trend in vehicles on road in Sri Lanka ('000 units)**



7.7.3 Outlook on auto-fuel demand and related emissions in Sri Lanka

Sri Lanka's vehicle market is currently underpenetrated with only 24 cars per 1,000 people. Rising per capita income is expected to boost overall vehicle sales (particularly of cars and two-wheelers) in the coming years. Cars and two-wheelers are expected to grow rapidly from 2020 to 2034, clocking 5-8% CAGR and boosting overall demand for petrol, which is expected to record 5.9% CAGR. While demand is expected to remain strong growing at more than 6% until 2025, rising EV penetration, along with the development of infrastructure and government support towards purchase of EVs, is expected to moderate demand growth until 2034.

[95]**Figure 51: Outlook on petrol, diesel consumption in Sri Lanka ('000 tonne)**



Diesel demand is expected to clock 3.9% CAGR between 2020 and 2034, driven by demand from the transport segment and industries. Transport constituted 84% of diesel demand as of 2017. With a pick-up in economic activity, the commercial vehicles market is expected to clock 4-5% CAGR during the period, supporting diesel demand. However, diesel demand from power is expected to decline due to the fall in power deficit and shift to alternative fuels.

[94] Source: Sri Lanka Department of Motor Traffic
[95] Source: CRISIL Research

With rising income levels and vehicle population, vehicular emissions are also expected to rise rapidly. Assuming Sri Lanka continues to use Euro 3/4 grade fuel and vehicles and does not upgrade to Euro 6/VI in the base case, CRISIL Research forecasts the following emission levels for CO, NOx, PM2.5 and CO2 from vehicular pollution:

[96]Table 44: Emissions forecast in Sri Lanka

Pollutant ('000 tonne)	Emission in 2021 (kilo tonne)	Emission in 2034 (kilo tonne)	CAGR (2021-2034)
Carbon monoxide	117	258	6.3%
NOx	249	568	6.5%
PM2.5	2	4	5.6%
Carbon dioxide	22,569	46,180	5.7%

7.7.4 Transition to Euro 6/VI: Key considerations

The transition to Euro 6/VI requires changes in two major sectors: refinery and automobiles.

Sri Lanka has one operational refinery, which currently produces Euro 3/Euro 4 grade fuel. It needs to be upgraded to enable production of Euro 6/VI grade fuel. Moreover, Sri Lanka is planning to expand its existing refinery to double its capacity to 5 million ton. In addition, Ceylon Petroleum Corporation is evaluating bids for a new oil pipeline to complement the existing 5.8-km pipeline. In early-2018, the Ministry of Petroleum Resources Development (MPRD) began drafting a tender to expand Sapugaskanda. The project would include replacement of the refinery's crude distillation column, gas oil hydrotreater unit reactor, and platforming unit. The cost of expansion and upgradation to Euro 6/VI is estimated to be USD 1.8-2 billion. Further, in the second quarter of 2018, companies from China, the Middle East and Russia were in preliminary discussions to develop a refinery with the CPC (Ceylon Petroleum Corporation). The Chinese bid, which was submitted jointly by two unnamed companies, was for a refinery near the Chinese-controlled Hambantota Port. Expected to cost approximately USD 3.85 billion, the facility would have an annual output of some 9 million ton. Hence, the transition to Euro 6/VI will take place in Sri Lanka with total estimated capex of USD 5-6 billion.

In addition to the above cost, there are several other softer cost aspects that need to be considered. Automobile manufacturers will have to switch to new production lines in order to produce Euro 6/VI compliant engines. Additionally, considering that 20-30% of the vehicles in Sri Lanka are imported, importing Euro 6/VI vehicles will lead to a higher import bill on account of higher price of imported vehicles. Moreover, domestic manufacturers may suffer due to an increase in manufacturing cost, and hence loss of sales due to rising price of their products.

7.7.5 Barriers to effective transition

The introduction of Euro 6/VI standards would imply the introduction of advanced technologies in Sri Lanka to ensure pollutants emitted by vehicles are reduced and comply with the specified limits. It will also mean several changes in engine systems, along with significant investments to upgrade refinery. There are several challenges and barriers to a smooth implementation:

[96] Source: CRISIL Research estimates; emission factors have been taken from ICCT emission factor data base for carbon dioxide, and the others are based on Euro 3/4 emission standards

- **High refinery capex:** With the existing refinery configuration, Euro 6/VI grade petrol and diesel cannot be produced unless it is revamped. If high quality standards are imposed without modification / expansion of the refinery, the existing refinery would have to be shut down and all the products imported. As discussed in the above section, the estimated capex for the existing refinery to expand its capacity as planned and upgrade to Euro 6/VI is approximately USD 1.8-2 billion. Further, accounting for the cost of the new refinery, this capex would increase to ~ USD 5-6 billion. Funding such heavy investments will be a challenge in a country such as Sri Lanka. The plan of expanding and upgrading its existing refinery has been ongoing since 2010, but no progress has been made so far due to lack of funding. Private participation and foreign funding are two ways the government can encourage investments in the sector.
- **Lack of infrastructure to transport fuel:** Crude oil movement in Sri Lanka from the port to refinery is through a 5.8 km long pipeline, which is more than 40 years old and suffers occasional ruptures, and hence requires replacement. In addition to this, there are three product pipelines that transport petrol, diesel, ATF and FO from the port to the Kolonnawa storage terminal. Only one out of the three pipelines is currently operational as these pipelines are already past their useful life and need replacement. Hence, Sri Lanka also needs to revamp its distribution infrastructure to continue importing high-quality fuel.
- **Reluctance of automobile manufacturers due to rising vehicle manufacturing costs**: Automobile manufacturers also must undertake investments, to completely transform their production platforms. The task is more burdensome for companies that have products across several categories, ranging from cars and SUVs to two-wheelers and trucks. Such a portfolio means that the companies would have to invest more resources and time to build the requisite capabilities for successfully executing the programme. The transition will significantly increase the production cost of vehicles, which they may not be able to pass on to the consumer immediately. Even if they do, it will lead to increasing retail prices of their products, which may result in declining sales in a country where vehicles are already dearly priced.

7.7.6 Benefits of transition to Euro 6/VI standards

While the costs of transition to Euro 6/VI look significantly high, these standards are expected to provide benefits in the long run. These benefits include:

Savings on fuel consumption due to improving fuel economy

Euro 6/VI-compliant vehicles are a significant improvement over Euro 4-compliant vehicles, in terms of not only emissions but also efficiency, as they provide higher fuel economy than Euro 4. Post-Euro 6/VI implementation, all new sales of vehicles would comply with the new standard and have higher fuel economy, thus consuming lower amount of petrol and diesel. As per CRISIL Research estimates, this will translate into cumulative fuel savings of 2-3 million tonne of petrol and 3.5-4 million tonne of diesel between fiscals 2025 and 2035. These savings are likely to translate into a cumulative savings of USD 4-5 billion by fiscal 2035. This is based on forecasted fuel demand considering base case Euro 2 and after transitioning to Euro 6 with higher mileage, leading to lower fuel consumption. Also, as Sri Lanka imports a large volume of its fuel requirement, lower fuel consumption would lead to lower import bill for the country as well.

[97]**Figure 52: Outlook on savings on petrol and diesel consumption due to implementation of Euro 6/VI ('000 tonne)**

Fuel	FY25	FY30	FY35	Cumulative (FY26-35)
Petrol	136	260	386	2,872
Diesel	349	338	368	3,815

Reduced emission levels

The primary objective of implementing stringent emission standards is to reduce emissions from vehicles, which lead to air pollution. Implementation of Euro 6/VI standards will not significantly contribute to emission reduction in the initial years of implementation, as the majority of the on-road vehicles will still be running on the old standards. However, over a period, as new vehicles replace old vehicles, there will be significant reduction in vehicular emissions. CRISIL Research estimates that within the overall vehicular population, 60-70% would comprise Euro 6/VI-compliant vehicles by fiscal 2035. This number is expected to be 5-6% in 2025, the first year of implementation. Overall emissions of various pollutants are expected to be lower by ~40-70% in fiscal 2034, compared with the base case scenario. The pollutant emissions are calculated based on the current emission standards compared to the emissions after transitioning to Euro 6/VI standards.

The below table shows the base case emissions versus emissions with Euro 6/VI standards in place:

[98]**Table 45: Outlook on emissions with Euro 6/VI implementation ('000 tonne)**

Pollutant ('000 tonne)	Base case		Euro 6/VI		CAGR 2025-2035	
	2025	2035	2025	2035	Base case	Euro 6/VI
Carbon monoxide	153	258	146	199	6.0%	3.5%
NOx	332	568	283	174	6.2%	-5.2%
PM2.5	3	4	2	2	5.3%	-1.7%
Carbon dioxide	28,912	46,189	21,780	26,080	5.3%	2.0%

Implementation of Euro 6/VI standards would not only reduce annual emissions compared with the base case scenario, but also lead to overall reduction in annual emissions by fiscal 2035.

Savings on government health expenditure

While moving to Euro 6/VI standards requires significant time, effort and investments by various stakeholders, looking at the larger picture, it can help save a significant sum in the form of reduced deaths due to air pollution. We believe that implementation of Euro 6/VI would lead to lower CO2 emissions, and cumulatively reduce the number of deaths caused due to air pollution by 19,000-20,000 between fiscals 2025 and 2035. As a result, we believe the total government healthcare expenditure will reduce by USD 3-3.5 billion. This is much higher than the cost of upgrading the existing refinery to produce Euro 6/VI-grade fuel, which is about USD 1.8-2 billion. .

[97] Source: CRISIL Research estimates
[98] Source: CRISIL Research estimates

7.7.7 Roadmap for adoption of Euro 6/VI standards

Sri Lanka implemented Euro 4 standards from July 2018. The CPC refinery produces super diesel and 95 octane petrol to comply with the set standards. Currently, there are no plans of switching to Euro 5 or Euro 6/VI standards. However, considering that Sri Lanka has already moved to Euro 4, the transition to Euro 6/VI could be implemented faster.

CRISIL Research believes instead of shifting to Euro 5, Sri Lanka should directly leapfrog to Euro 6/VI, since the two standards have similar Sulphur limits and upgradation to the latter can be done with minimal changes. The same thought process was adopted by India, which leapfrogged from BS IV emission standards to BS VI in April 2020. To enable a smooth transition, the country can have short, medium and long-term plans:

Short term: 2025

Sri Lanka imports 60-70% of its fuel requirement, owing to its limited refining capacity. A large part of these imports (45-50%) comes from India, which has already moved to producing Euro 6/VI-grade fuel. Moreover, Sri Lanka imports vehicles from Japan and India, which are both Euro 6/VI compliant. Thus, a switch to Euro 6/VI would not be a challenge as far as import of fuel and vehicles is concerned.

Although a large share of petrol and diesel requirement in Sri Lanka is imported, domestic refineries will need to upgrade their existing fuel production. The CPC refinery in Sri Lanka is already planning to upgrade its existing unit to produce higher-grade fuel. If the government mandates a switch to Euro 6/VI, then the upgradation and expansion can be planned in a manner so as to comply with Euro 6/VI standards. However, this announcement needs to be made soon in order to enable the various stakeholders to undertake investments. A similar transition took place in India, where the announcement to switch to BS VI fuel was made in 2016 and all the Indian refineries upgraded their facilities to produce BS VI-grade fuel by April 2020.

While availability of Euro 6/VI fuel is a key requirement to reduce emissions, it is not sufficient for reaching the desired emission levels. Vehicles also need to switch to Euro 6/VI standards to meet the desired emission levels. Availability of Euro 6/VI-compliant vehicles is, thus, vital in such a scenario. To achieve this, regulations need to be introduced to mandate the import of Euro 6/VI-grade fuel by fiscal 2022-23 and later ban the sale of all Euro 5 or older vehicles by fiscal 2025. To encourage sale of Euro 6/VI vehicles in the initial years, Sri Lanka can provide taxation benefits (such as reduction in registration tax, road tax and customs duty) to people buying Euro 6/VI-compliant vehicles. Worldwide experiences indicate that governments can accelerate the introduction of cleaner fuels and their uptake in the fuels market through a balanced and thoughtful combination of tax and pricing policies. This would ensure that compliant vehicles start coming into the market before the standards are implemented, and automakers are also given time to change their manufacturing platforms.

Introduction of a vehicle scrappage policy is also a key factor in achieving improved emissions. New sales of vehicles only happen when customers scrap their old vehicles. Sri Lanka should introduce a comprehensive vehicle scrappage policy under which vehicles older than 15 years should not be allowed on the roads of big cities. The Sri Lankan Ministry of Environment and Renewable Energy and that of Transport had suggested scrapping of high polluting vehicles as part of an environmental sustainability report.

Medium to long term: beyond 2025

Establishing an independent fuel quality management centre is essential to prevent fuel adulteration. It is important to routinely monitor the fuel quality at the pump and along the distribution chain to ensure that the actual fuel supplied in the market meets the required specifications.

Vehicle testing should be done at the time of registration and further at regular intervals of three months. The benefit of this quarterly testing would be taking regular stock of emissions from the operational fleet of vehicles. This can be further implemented with heavy penalties for offenders (high emission vehicles) and cancellation of registration of vehicles for repeat offenders. A sticker or digital tag-based monitoring can be introduced to achieve better implementation of the norms. An incentive can also be introduced for low emitting vehicles at the time of insurance or road tax renewal. This will lead to strong implementation of the emission parameters across the country and pave the road for emission reduction.

8 Conclusion

The SAARC Region comprises the fastest growing economies in the world, which will result in strong growth in energy demand and, subsequently, higher demand for transportation activities in the future. SAARC region has been following conventional emission standards while in order to meet the NDC targets set by the SMS. Barring India, which recently shifted to BS VI (Euro 6/VI) standards, all other SMS implementing much older standards. There are some key challenges in transitioning to the upgraded standards of emissions These include:

1. Lack of funding for capex investments in refinery upgradation
2. Lack of domestically available fuel and vehicles, and a high degree of dependence on imports
3. Higher cost of upgraded vehicles which are Euro 6/VI compliant
4. Lack of institutional capacity and framework to implement such regulations
5. Irregular/ no monitoring of physical progress of such projects
6. Unavailability of data to track markets and make projections in an efficient manner

Each country, collaboratively and individually, will need to make efforts to efficiently implement stringent emission standards. Considering the case of India, the other SAARC Member States can undertake similar steps to achieve desired targets. There should be collaboration between all stakeholders, including the government, automobile manufacturers and importers, fuel producing and distribution companies, and end-consumers, in order to achieve smooth implementation of Euro 6/VI. Government support in the form of tax benefits and other incentives is essential to promote initial adoption and create awareness.

Inter-regional collaboration would also go a long way in providing economic benefits of such projects. For instance, a common policy framework or set of guidelines can be established at the regional level appliable for all SAARC ***Member States***, to act as a common framework for implementation of Euro 6/VI. Improving trade ties with countries such as India, which is a net exporter of vehicles as well as fuel, can help accelerate achievement of targets, as India has the manufacturing capabilities to produce Euro 6/VI-grade fuel and automobiles. However, support from the governments of both the exporting and importing ***Member States*** is vital to remove any political differences that obstruct trade operations.

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