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Prepared by: Jurg Michael Grütter
Grütter Consulting AG
Reinach, Switzerland

For: South Asia Department
Asian Development Bank

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Asian Development Bank



Vehicle Emissions Roadmap Bhutan

cleaner vehicles for cleaner air

July 2017



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This roadmap summarizes major policy measures to control vehicle emissions which Bhutan intends to implement until 2025 to maintain clean air and achieve CO₂ reductions. They focus on vehicle emission control technologies without including other important measures such as fostering sustainable urban transport including an efficient public transport service and facilities for Non-Motorized Transit or measures to green the freight chain. The roadmap is based on an extensive technical and financial analysis report of multiple options to curb vehicle emissions and various public stakeholder meetings realized to discuss broadly potential measures. The technical assessment report was realized by Grütter Consulting with finance from the Asian Development Bank ADB. The full technical report is available for download.



Summary

Current Situation

1. Emissions of air pollutants and greenhouse gases are among the most pressing environmental challenges faced by Bhutan. Standards for Particulate Matter are being surpassed regularly in Thimphu. Most affected by bad air quality are children, elderly and the less affluent sectors of society. Vehicles, primarily trucks and diesel cars are the major source of vehicle emissions. If no action is undertaken emissions levels will triple by 2030 leading to severe air pollution problems in the country and to a massive increase in CO₂ emissions.

2. Bhutan has as national policy to preserve the environment. The country has also proclaimed to remain carbon neutral. Bhutan has undertaken various steps within vehicle emission controls to reduce transport emissions including notably the establishment of an air quality network, the ban of 2-stroke motorcycles, restricting the import of used vehicles, a maximum commercial life-span for taxis and buses, the setting-up of a vehicle emission inspection program and tax policies favouring electric and hybrid vehicles.

Vision for the Future

3. The vision is to maintain a pristine environment with clean air and with minimum emissions from the transport sector. Transport shall reduce significantly its environmental footprint. Measures to be taken shall be economically efficient, socially fair and non-discriminatory following the polluter-pays-principle.

Vehicle Emission Targets Bhutan

1. Average annual air quality levels of all air pollutants are by 2025 below WHO guideline standards.
2. Vehicle emissions of SO₂, NO₂ and PM are by 2030 65 to 95% lower than in 2015.
3. CO₂ emissions of the transport sector are by 2030 25% lower than under a Business as Usual scenario.

Challenges and Opportunities

4. Transforming Bhutan into an environmental leader with clean air and low emissions is an exciting challenge. It is also an opportunity that will lead to a resource efficient, resilient, equitable and greener economy in line with the pursuit of happiness for all. Actions to improve air quality will improve the health of the Bhutanese people, reduce suffering from respiratory diseases, save fuel and improve the quality of life and the attractiveness of Bhutan thereby fostering economic growth in a sustainable manner. Improving air quality will benefit many poorer people, better gender equality and will allow for a fairer sharing of scarce natural resources. Improving air quality and reducing CO₂ emissions also contributes towards preserving a pristine environment, and reduces the exposure risk to climate change. The targets of Bhutan are ambitious and serve the world as a role model for a sustainable society.

Future Focus

5. A long list of measures has been assessed based on their potential impact, costs and benefits. From this long list 5 core policies have been identified for implementation. These policies have a high impact and the monetary benefits due to improved health and environment are larger than the financial costs of adopting them. Bhutan does not need external technical or financial assistance to successfully implement these policies. The policies are in line with measures adopted in other countries and have proven their effectiveness.

Policies

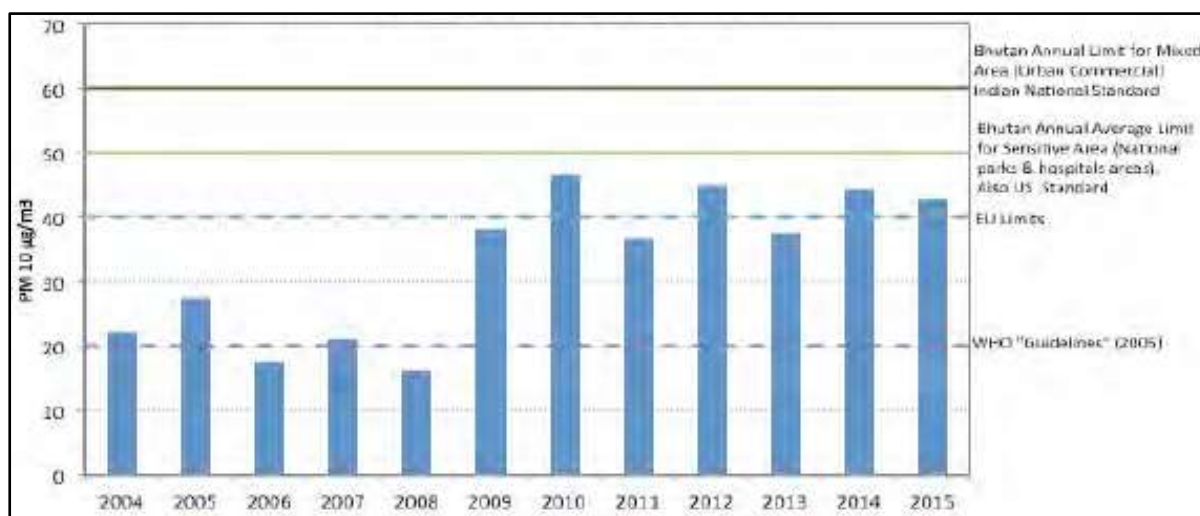
1. In line with the Indian fuel standard Bhutan will only import diesel and gasoline with less than 50ppm sulphur as of 01.2018 and diesel and gasoline with less than 10ppm sulphur as of 01.2021.
2. Bhutan will implement in line with India new vehicle emission standards for gasoline and diesel vehicles requiring as of 01.2018 BS-IV (equivalent to Euro 4) and as of 01.2021 BS-VI (Euro 6).
3. Bhutan will upgrade the current Inspection/Maintenance system improving impact and controls.
4. Bhutan will restrict the import of diesel powered cars and light vehicles of less than 3.5t as of 01.2018.
5. Bhutan will design a low-carbon vehicle strategy and tap international climate finance to assist in the implementation of latter.

1. Background

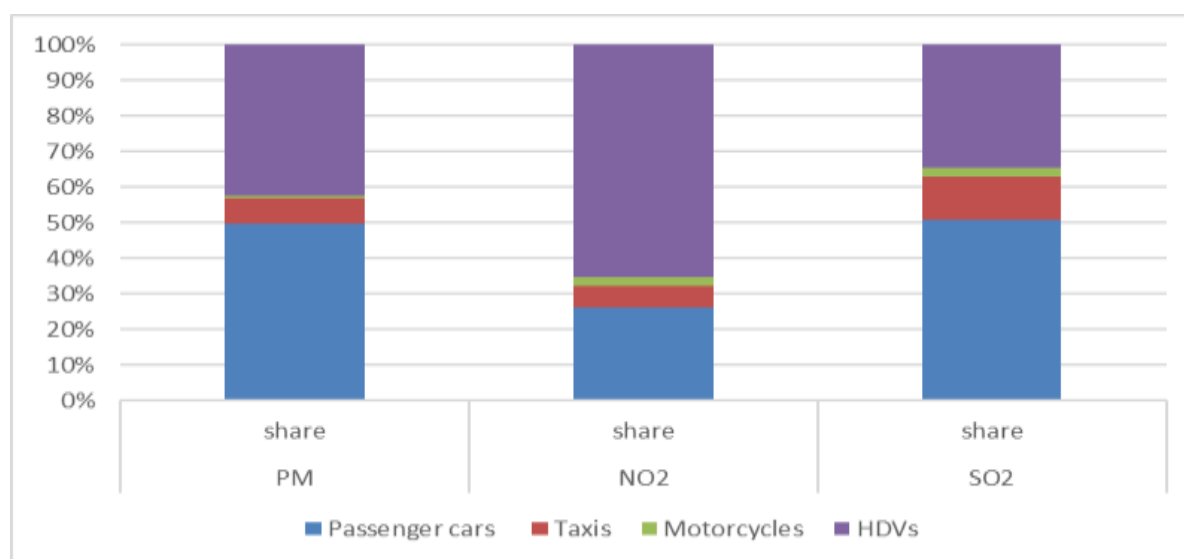
Emissions of air pollutants and greenhouse gases (GHGs) are among the most pressing environmental challenges faced by Bhutan.

Air Pollution

Air pollutants are substances in the air that can harm human health. The World Health Organization (WHO) has identified several air pollutants of major public health concern¹. Among these, the two of principal concern especially in urban areas of Bhutan are Particulate Matter (PM) and Nitrogen Dioxide (NO₂). The figure below shows that WHO guideline standards for PM are being surpassed in Thimphu.



Vehicles are a major source of these pollutants. In urban areas where air pollution is the most critical, the major source of air pollutants are passenger cars together with Heavy Duty Vehicles (HDVs; large trucks and buses; see figure below). Diesel vehicles are thereby by far the major contributor to all pollutants. Most affected by bad air quality are children, elderly and the less affluent sectors of society.



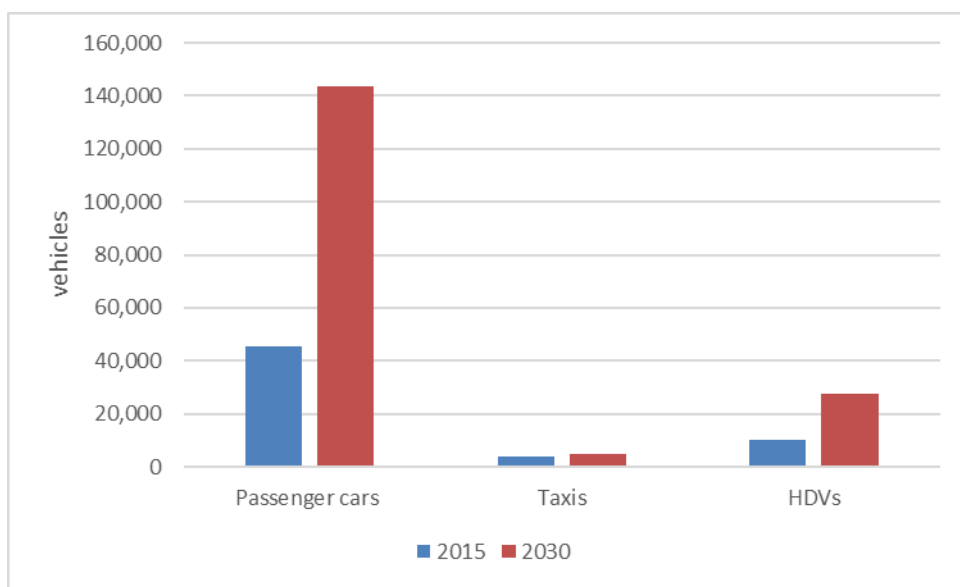
¹ http://www.who.int/phe/health_topics/outdoorair/outdoorair_agg/en/

Climate Change

CO₂ is the principal GHG related to climate change. Black Carbon emitted from diesel vehicles, is also a major contributor to climate change. Transport is a major source of GHG emissions in the country and by 2015 transport emissions of Bhutan were around 290,000 tCO₂. Around 60% of GHG emissions including Black Carbon are caused by trucks followed by passenger cars with 1/3rd.

Outlook

Vehicle numbers and emissions levels will triple by 2030 if no action is undertaken (see figure below).



For example, CO₂ emissions from the transport sector are projected to increase to more than 700,000 tons by 2030. Bhutan has internationally committed to remain carbon neutral or even get carbon negative i.e. absorb more CO₂ than emitting. However, to achieve this target emission mitigation measures are required.

Progress to Date

Bhutan has been doing many steps to preserve a clean environment and to reduce transport emissions. The most notable measures implemented include the establishment of an air quality network, the ban of 2-stroke motorcycles, restricting the import of used vehicles, a maximum commercial life-span for taxis and buses, the setting-up of a vehicle emission inspection program and tax policies favouring electric and hybrid vehicles.

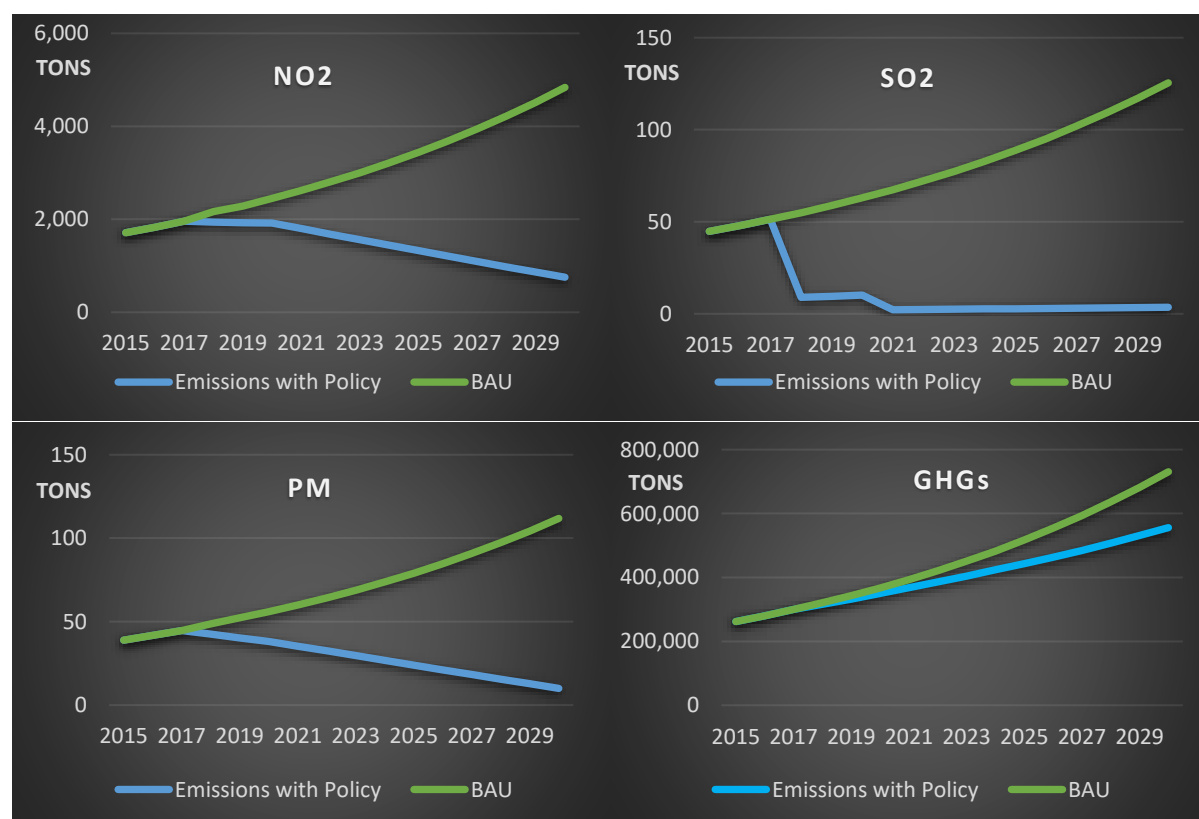
2. Vision and Objectives

The vision is to maintain a pristine environment with clean air and with minimum emissions from the transport sector. Transport shall reduce significantly its environmental footprint. Measures taken shall be economically efficient, socially fair and non-discriminatory following the polluter-pays-principle.

Vehicle Emission Targets Bhutan

1. Average annual emissions of all air pollutants are by 2025 below WHO guideline levels.
2. Vehicle emissions of SO₂, NO₂ and PM are by 2030 65 to 95% lower than in 2015.
3. Vehicle regulation measures reduce CO₂ emissions of the transport sector by 25% by 2030 compared to a Business as Usual scenario. The transport sector however requires additionally other mitigation measures to achieve a sustained reduction of GHG emissions including sustainable urban transport systems based on public and non-motorized transport, greening of freight logistics as well as a shift towards electrification of transport.

The following graphs show the projected impact of policies and measures proposed.



3. Challenges and Opportunities

Transforming Bhutan into an environmental leader with clean air and low emissions is an exciting challenge. It is also an opportunity that will lead to a resource efficient, resilient, equitable and greener economy in line with the pursuit of happiness for all.

Health

Scientific research shows that air pollution has a great impact on our health. Children, the elderly and poorer people are particularly vulnerable. Harmful effects caused by air pollution include premature mortality, respiratory and cardiovascular diseases and breathing difficulties.

Actions to improve air quality will improve the health of the Bhutanese people, reduce suffering from respiratory diseases and improve wellbeing and quality of life.



Jobs and Economy

Air pollution reduces the quality of life and the attractiveness of a country not only for its inhabitants but also for tourists which visit the Kingdom of Bhutan attracted by its precious environment. Increased pollution levels reduce happiness and thereby also productivity of the people. Also, pollution causes significant health and environmental costs which need to be borne by society.

Saving fuel and reducing emissions improves the quality of life and the attractiveness of Bhutan thereby fostering economic growth in a sustainable manner. The actions listed to reduce vehicle emissions have all proven to be economically viable which means that health and environmental savings are far larger than the costs of adjusting or upgrading vehicles. On balance, Bhutan can save nearly 300 Million BTN until 2030 by implementing the proposed measures.

Climate Change

The Kingdom of Bhutan is a highly vulnerable landlocked mountainous country which will be greatly affected by climate change. The country has made a commitment to remain carbon neutral with the vision of being carbon negative (with the sink capacity of the forests exceeding GHG emissions).

The targets of Bhutan are ambitious and serve the world as a role model for a sustainable society. By reducing GHGs from the transport sector Bhutan will help to mitigate climate change.

Equality

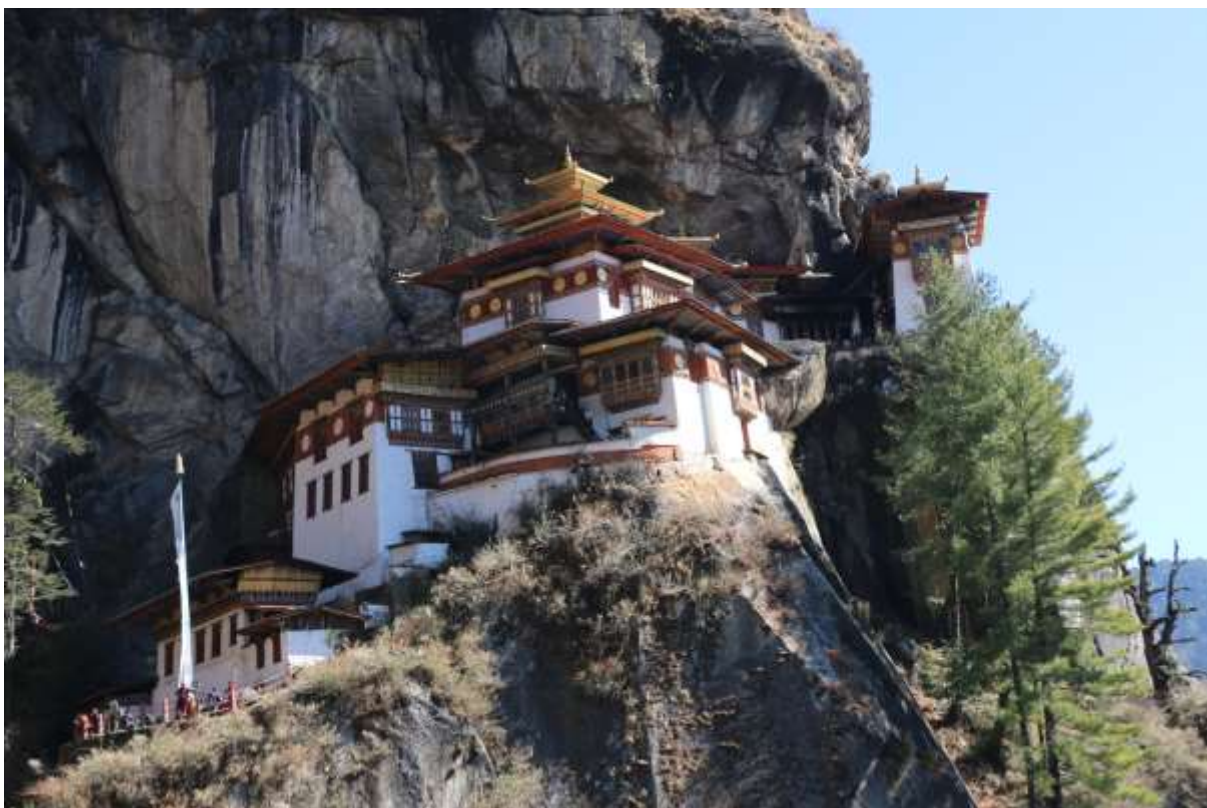
Poorer people are disproportionally affected by air pollution as they tend to be located closer to its sources. At the same time, they contribute less to the air pollution problem as they do not own private cars. Recent studies also reveal that women are affected more by poor air quality than men.

Improving air quality will benefit many poorer people, better gender equality and will allow for a fairer sharing of scarce natural resources.

Biodiversity and Built Environment

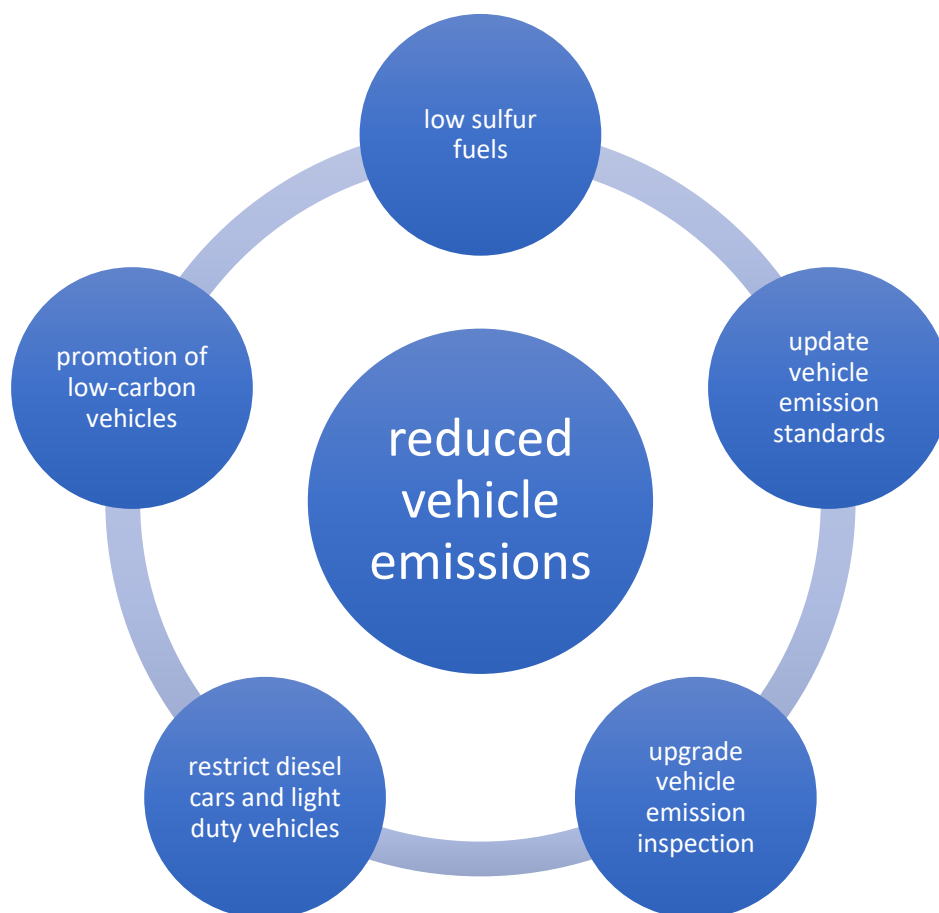
Air pollution and climate change adversely affect vegetation and animals reducing biodiversity and endangering species. It also poses serious risks to the built environment for example due to more frequent weather extremes whilst also increasing the maintenance and cleaning costs of buildings affected by particulates and NO_x emissions which cause discolouration and higher vulnerability to weathering.

Improving air quality and reducing CO₂ emissions contributes towards preserving a pristine environment, reduces the exposure risk to climate change and lessens degradation of buildings including precious monasteries.



4. Future Focus

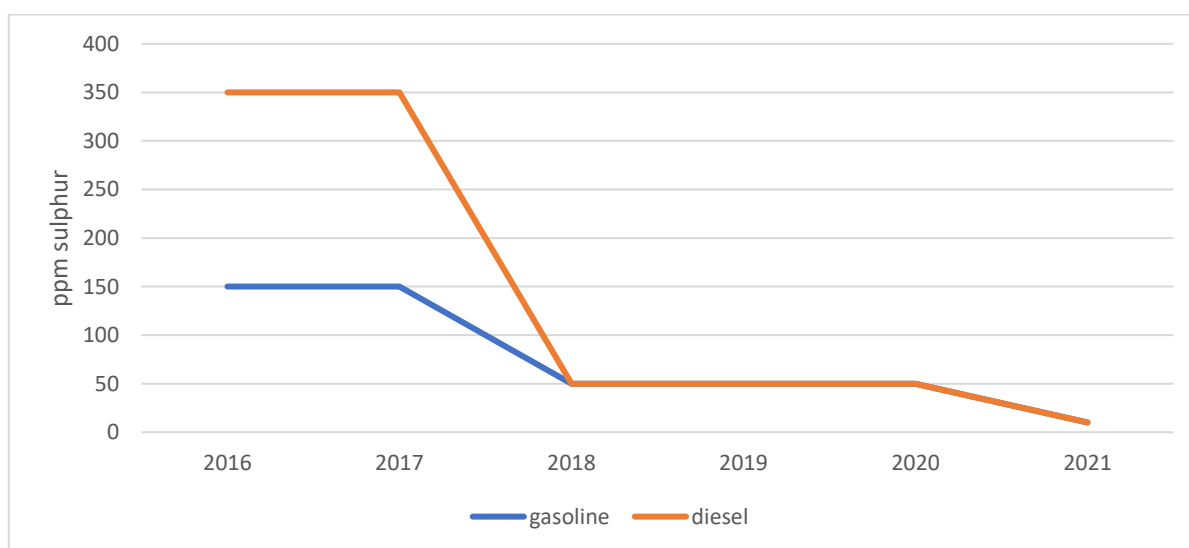
A long list of measures has been assessed based on their potential emission reductions, technical feasibility and cost/benefit. From this long list 5 core policies have been identified and shall be implemented. These policies have a large emission impact and are economically beneficial i.e. the monetary benefits due to improved health and environment are larger than the financial costs of adopting the policy. The policies are in line with measures adopted in other countries and have proven their effectiveness.



1. LOW SULPHUR FUELS

To achieve clean air, it is imperative to get sulphur out of fuels. Sulphur is a pollutant directly, but more importantly, sulphur prevents the adoption of major pollution control technologies. Advanced emission control technologies again are required to reduce basically PM, NO_x and hydrocarbons.

Bhutan imports all its fuels from India. It has no refinery and cannot import tailor-made fuels from India due to logistical issues. Therefore, Bhutan adheres to the national fuel quality standards of India. In line with the upgrading of fuel standards in India, Bhutan will only import from 01/2018 onwards diesel and gasoline with a sulphur content of less than 50ppm and all fuels imported from 01/2021 onwards will be with 10ppm or less of sulphur content (see figure below).



With this policy by 2018 80% of vehicle SO₂ emissions can be avoided and by 2021 SO₂ emissions of vehicles will be 95% lower than today. It can be expected that fuel costs at the petrol station will increase by around 1-2 NU per litre of fuel. The economic benefits of the measure are primarily due to allowing the usage of more advanced low-emission vehicle technologies.

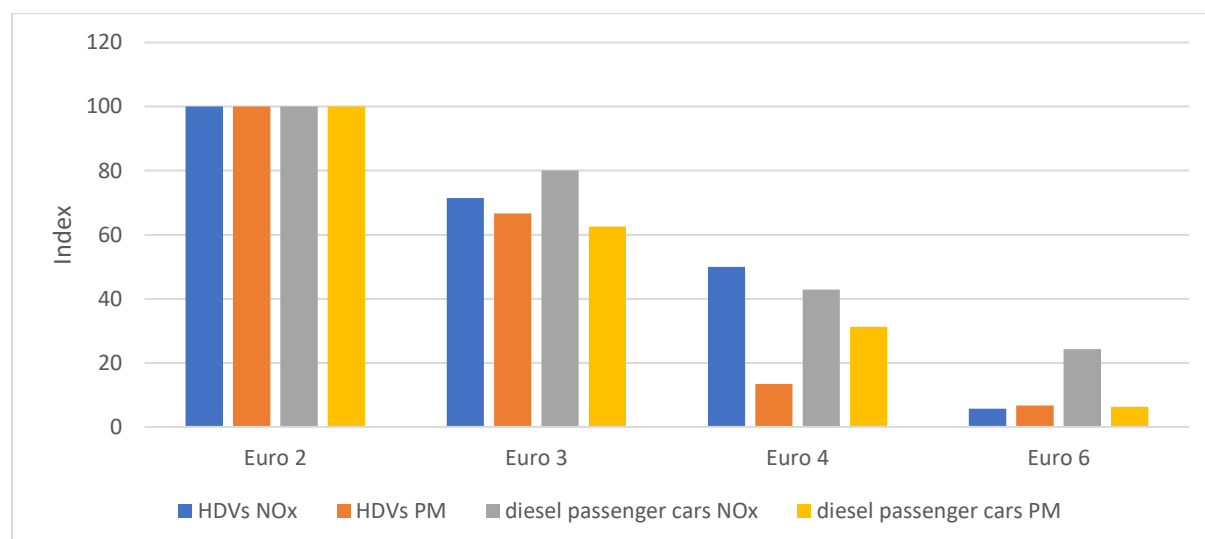
The existing fuel testing laboratory at the Petroleum, Oil and Lubricant (POL) section of the Ministry of Economic Affairs will continue performing quality tests of fuels sold and will upgrade its procedures to strive for a ISO certification. It will publish results of random tests of fuel quality performed at stations and will also open a channel for public complaints concerning fuel quality.

Fuel Policy Proposal:

From 01.2018 onwards gasoline and diesel imported has a maximum sulphur content of 50ppm
From 01.2021 onwards gasoline and diesel imported has a maximum sulphur content of 10ppm

2. ADVANCED VEHICLE EMISSION STANDARDS

Vehicle emission standards are established for new vehicles and are controlled for each model and type of vehicle to be sold in a country ("type approval test"). Currently Bhutan requests Euro 2 as emission standard. The following graph compares for diesel passenger cars and for Heavy Duty Vehicles (HDVs, composed of large trucks and buses) the reduction of PM and NO_x from Euro 2 to Euro 6. Emissions can be reduced by more than factor 10 with new emission control technologies².



Bhutan imports its vehicles basically from India. Therefore, the standards adopted by India are crucial. India has introduced as of 2017 the BS-IV standard (equivalent to Euro 4) and will introduce as of 04/2020 the BS VI standard (equivalent to Euro 6). Bhutan will follow this policy to also avoid becoming a dumping ground for obsolete vehicles.

By implementing this policy PM emissions are by 2030 65% lower than 2015 and NO_x emissions fall by 40%. GHG emissions can also be reduced through less emissions of Black Carbon by around 60,000 tCO₂ by 2030 compared to a scenario without this policy.

The economic benefits of reduced health and pollution costs outweigh the slightly higher cost of vehicles using the new technologies. The net economic benefits of Bhutan from implementing this measure are estimated at 800 million NU cumulative by 2030.

Vehicle Emission Standard Policy Proposal:

From 01.2018 onwards Bhutan requires all new vehicles sold in the country to comply with the vehicle emission standard BS-IV (Euro 4).

From 01.2021 onwards Bhutan requires all new vehicles sold in the country to comply with the vehicle emission standard BS-VI (Euro 6).

² The Euro 5 standard has not been included in the graph as many countries, including India, have opted to directly move from Euro 4 to Euro 6.

3. UPGRADE VEHICLE EMISSION INSPECTION SYSTEM

Emission controls of in-use vehicles is a policy made to ensure that vehicles remain compliant (within normal degradation levels) with original emission standards for which they were certified. The inspection system shall ensure that maintenance is made appropriately and shall identify high emitters to oblige latter to realize the corresponding repairs.

The current inspection system used in Bhutan shall be upgraded based on the experience of other countries and based on an analysis of emission levels of vehicles circulating in Bhutan. The new maximum emission levels for gasoline vehicles will be:

- 4.5% Vol. CO for vehicles registered prior 03/2008
- 1.5% Vol. CO for vehicles registered after 03/2008 and prior 03/2018
- 0.5% Vol. CO for vehicles registered after 03/2018

For diesel vehicles, the new maximum emission levels are:

- 70 HSU for vehicles registered prior 03/2008
- 65 HSU for vehicles registered after 03/2008 and prior 03/2018
- 50 HSU for vehicles registered after 03/2018

Additionally, new regulations concerning measurement procedure, periodic equipment calibration and improvements in the verification and enforcement including automatic data transfer to RSTA, on-line camera supervision of inspections and random covert auditing of the emission control centres will be performed to ensure that all controls are realized following approved procedures and standards.



The policy has a positive impact on the emissions of vehicles and ensures that vehicles are properly maintained. The introduction of new vehicle technologies including On-Board Diagnostics (OBD) in all cars will allow to simplify the system in the mid-term future towards a remote sensing system and controls during a roadworthiness test (also called road fitness test). Bhutan will review the options for conducting roadworthiness tests and will establish an appropriate system in the near future.

4. RESTRICT DIESEL PASSENGER CARS AND LIGHT DUTY VEHICLES

The usage of diesel vehicles shall be limited to large trucks, buses and mobile machinery. No more passenger cars, taxis and light vehicles up to 3.5t using diesel fuel shall be allowed to be registered in Bhutan. For these vehicle categories gasoline or electric vehicles with comparable characteristics are easily available. Already registered diesel vehicles however will be allowed to continue operations.

This policy is being put in place due to the following reasons:

- 98% of PM, 95% of NO₂ and 87% of SO₂ emissions of Bhutan are caused by diesel vehicles although they only represent 40% of all vehicles. The air pollution caused in urban areas is nearly entirely caused by diesel vehicles.
- Introducing low-sulphur diesel and adopting stricter vehicle emission standards reduces diesel related air pollution emissions. However, actual emission values of diesel cars often surpass significantly official values due to widespread fraud of manufacturers, type-approval tests which do not reflect actual driving conditions, and a low effectiveness of emission control devices at low ambient temperatures, during cold start conditions and at high altitude. Also, vehicle degradation and lack of appropriate maintenance affects pollution levels of diesel cars far more than those of gasoline ones.

Diesel vehicles are dirty and will also in the future be a major headache. Even with best available diesel technologies, the real-world performance of diesel engines results in high PM and NO₂ emissions creating air pollution and health problems. This fact is increasingly being recognized worldwide. As example Mexico City, Madrid, Athens and Paris will by 2025 completely ban diesel cars and vans from circulating in the city. The Institute for Public Policy Research of the UK has also indicated in a report that it is likely that diesel cars must be completely phased out on London's roads over the next decade to reach compliance with safe and legal levels of air pollution.

Diesel is the preferred fuel for heavy duty vehicles like buses and trucks. For passenger cars and light duty vehicles however comparable alternative exist. Any diesel car can be replaced with an equivalent gasoline unit. The US, the world's largest car market, has less than 3% diesel passenger cars; Brazil banned diesel cars in the 70^{ies} and Bolivia, a high-altitude and land-locked country like Bhutan does not allow anymore registration of small diesel vehicles. It is therefore obvious that there is no technical requirement for using diesel except for large trucks and buses.

The environmental impact of the policy is that urban air pollution of PM and SO₂ can be reduced by more than 50% and NO₂ emissions by around 1/3rd by 2030 without a negative impact on Greenhouse Gas emissions.

The policy has a positive cost-benefit relation. The economic benefits of reduced air pollution and health costs surpass clearly the additional cost born by the car owner.

Diesel Vehicle Policy:

From 01.2018 onwards Bhutan will not allow the registration of diesel vehicles with a Gross Vehicle Weight of less than 3.5 tons. Previously registered diesel vehicles can continue to circulate.

5. FOSTER LOW-CARBON VEHICLES

Given the small domestic market and the high diversity of vehicles in Bhutan it is recommended to promote low CO₂ emitting vehicles based on technology standards. Hybrid, plug-in hybrid and electric vehicles shall be fostered as these vehicles emit far less CO₂ over their commercial life-span than gasoline or diesel powered units. This is true especially in the case of Bhutan which generates all electricity based on renewable energy. The environmental impact including those caused by battery production and disposal are far lower of hybrid and electric vehicles than those of fossil powered vehicles.



Bhutan has already made initial steps towards promoting low carbon vehicles by reducing taxes on hybrid and electric cars. However, this step has not been sufficient to promote wide-spread usage of such vehicles. More substantial incentives for procuring low carbon vehicles are required. The focus shall be on taxis, buses and urban freight vehicles as these have the largest impact on air quality and circulate in urban surroundings making re-charging simpler. Also, these vehicles have a high annual mileage resulting in a large environmental impact per replaced vehicle.

Bhutan is currently realizing a low-carbon commercial vehicle strategy including financial instruments to mass deploy low carbon vehicles. Bhutan intends to tap available international climate funds to assist the country in implementing a low-carbon vehicle policy.

Low-Carbon Vehicle Policy:

Develop in 2017 a low-carbon commercial vehicle strategy and implement the strategy in 2018/2019 tapping international climate finance.

5. Roadmap to Implementation

