Energy Efficiency in Road Transport Sector in the SAARC Member States




SAARC Energy Centre, Islamabad

2015

Energy Efficiency in Road Transport Sector

in the SAARC Member States

SAARC Energy Centre, Islamabad

December 2015

Author:

Suresh Shrestha
Research Fellow
SAARC Energy Centre

Reviewed by:

Engr. Asad Mahmood
Energy Efficiency Expert
Islamabad, Pakistan

Disclaimer:

Findings, interpretation and conclusions expressed in this report are based on information acquired from the SAARC Member States, the documents available in printed and online versions and also on the assumptions made by the author in developing the model. These do not necessarily reflect the views of SAARC Energy Centre and the author does not guarantee the accuracy, completeness or usefulness of information in this report, and as such not responsible for any errors, omissions, or losses which emerge from its use.

Published by:
SAARC Energy Centre
697, Street 43, NPF, E-11/4, Islamabad, Pakistan
Tel: +95 51 222 8802, +92 51 222 8804
Fax: +92 51 2221937
info@saarcenergy.org
www.saarcenergy.org

Foreword

SAARC Energy Centre (SEC) is mandated to initiate, coordinate and facilitate regional cooperation in South Asia. Among the various areas of the energy sector in which SEC is working, Energy Conservation and Energy Efficiency are one of its prime focuses. With a view to promoting and achieving energy conservation in an integrated approach, SEC published SAARC Action Plan on Energy Conservation in the year 2012.

Import dependence for petroleum products varies among countries in South Asia, but all of them are importers of petroleum products. With a rapid growth in population as well as in urbanization, transport sector in the region is growing at an unprecedented rate. The economic growth engendering increase in urbanization, mobility of goods and people, growing middle class segment and faster motorization and private vehicle ownership in each country in the region has put an increased pressure on the import dependence for petroleum products.

Improving energy efficiency and avoiding and reducing transport needs can bring about a significant reduction in the demand for petroleum products and the associated environmental impacts. Reduction in traffic congestion, reduction in noise pollution and reduction in accidents are some indirect benefits associated with these strategies. Realizing this, SEC has undertaken an in-house study to estimate the potential of energy saving in the road transport sector in each member state of SAARC with an objective to draw policy recommendations to reduce energy demand in the sector.

The study provides useful guidelines and actions required to be taken by the member states to relax its import dependence for petroleum fuels through adoption of efficient technologies and other non-engine related strategies in the road transport sector. The report and the energy demand model are available at our website www.saarcenergy.org. Suggestions and feedback from all stakeholders to improve the model shall be highly appreciated.

Muhammad Naeem Malik
Director,
SAARC Energy Centre, Islamabad

Acknowledgements

The study on **Energy Efficiency in Road Transport Sector in the SAARC Member States** has been carried out by Mr. Suresh Shrestha, Research Fellow (ETE), SAARC Energy Centre.

The author would like to extend gratitude to SAARC Energy Centre for providing the opportunity to carry out this study. Sincere thanks are extended to the member states that provided the requisite data for the study. The effort was also supported by all the professionals in the SAARC Energy Centre.

The contributions of Mr. Saqib Abbas Abbasi, BBA (Semester IV), COMSATS Institute of Information Technology, internee in the SAARC Energy Centre, are highly appreciated. Mr. Saqib extended support in the study by collection, organization and preparation of inputs for the energy demand model. The author would also like to extend sincere gratitude to Engr. Asad Mahmood, an energy efficiency expert who conducted peer review. His experienced remarks and suggestions have made a remarkable value addition in refining the report.

Contents

Foreword ii
Acknowledgements iii
Abbreviations vi
List of Figures vii
List of Tables vii
Executive Summary 1
1 Introduction 3
1.1 The Role of Transport 3
1.2 Objective of the Study 4
1.3 Methodology 4
1.4 Travel demand 6
1.5 Vehicle km 6
1.6 Calculating Passenger- km 6
1.7 Energy Intensity/ Fuel Economy 6
1.8 Calculating Energy Intensities 7
1.9 Energy demand 7
1.10 Limitations of the Study 8
1.11 Study Area 8
2 Global Transport Energy Situation 9
3 Road Transport in the SAARC Region 12
3.1 Afghanistan 12
3.2 Bangladesh 13
3.3 Bhutan 14
3.4 India 15
3.5 Maldives 16
3.6 Nepal 17
3.7 Pakistan 18
3.8 Sri Lanka 19
4 Drivers for Energy Demand in Transport Sector 20
5 Energy Consumption in Road Transport Sector in the SAARC Region 22
6 Scenario Analysis 25
6.1 BAU Scenario 25
6.2 GASELEC Scenario 25
6.3 EFF-TECH Scenario 25

6.4 MASSTRANS Scenario 26
7 Energy Demand in the Road Transport Sector in SAARC Region 28
8 Approaches for Reducing Energy Demand in the Road Transport Sector 33
9 Conclusions and Recommendations 35
9.1 Conclusions 35
9.2 Recommendations 35
References 38
Annexure-A 39
Annexure-B 47
Annexure-C 53

Abbreviations

ADB	Asian Development Bank
BAU	Business as Usual
CAGR	Compound Annual Growth Rate
CNG	Compressed Natural Gas
ED	Energy Demand
EFF-TECH	Transformation to Energy Efficient Systems and Technologies
FE	Fuel Economy
GASELEC	Compressed Natural Gas and Electricity
GDP	Gross Domestic Product
Km	Kilometer
KTOE	Kilo Tonnes of Oil Equivalent
LEAP	Long range Energy Alternatives Planning
LPG	Liquefied Petroleum Gas
MASSTRANS	Mass Transport
MTOE	Million Tonnes of Oil Equivalent
MVE	Motor Vehicle Examination
NV	Number of Registered Vehicles
SAARC	South Asian Association for Regional Cooperation
SEC	SAARC Energy Centre
SEDB	SAARC Energy Data Book
VKT	Vehicle Kilometer of Travel

List of Figures

Figure 1 Road Transport Energy Demand 7
Figure 2 Primary Energy Consumption 9
Figure 3 World CO_2 emissions by Fuel 10
Figure 4 Total Final Consumption Sector 11
Figure 5 Increase in Demand for road transport in Afghanistan 12
Figure 6 Increase in Demand for road transport in Bangladesh 13
Figure 7 Increase in Demand for road transport in Bhutan 14
Figure 8 Increase in Demand for road transport in India 15
Figure 9 Increase in Demand for road transport in Maldives 16
Figure 10 Increase in Demand for road transport in Nepal 17
Figure 11 Increase in Demand for road transport in Pakistan 18
Figure 12 Increase in Demand for road transport in Srilanka 19
Figure 13 Factors effecting Transport Demand 20
Figure 14 Population and GDP growth in SAARC region 22
Figure 15 Theurban rural split in the SAARC countries 22
Figure 16 Final Energy Consumption in the SAARC Region by Countries 23
Figure 17 Final Energy Consumption in the SAARC Region by country and by fuel types 23
Figure 18 Energy Consumption in the Road Transport Sector in the SAARC Region 24
Figure 19 Fuel-wise Energy Consumption in the Road Transport Sector in the SAARC Region 24
Figure 20 Road Transport Energy Demand: Afghanistan 28
Figure 21 Road Transport Energy Demand: Bangladesh 28
Figure 22 Road Transport Energy Demand: Bhutan 29
Figure 23 Road Transport Energy Demand: India 29
Figure 24 Road Transport Energy Demand: Maldives 30
Figure 25 Road Transport Energy Demand: Nepal 30
Figure 26 Road Transport Energy Demand: Pakistan 31
Figure 27 Road Transport Energy Demand: Sri Lanka 31
Figure 28 Road Transport Energy Demand: SAARC Region 32
Figure 29 Schematic Diagram of Efficient Transport Concepts 33

List of Tables

Table 1 Vehicle Classification and Fuel Type 5
Table 2 Comparative Analyses of Different Scenarios 27

Executive Summary

Transport is the sector with a high final energy consumption. Energy consumption in this sector is expected to grow significantly and emissions could increase at a faster rate if aggressive and sustained mitigation policies are not undertaken. The sector has direct and indirect linkages with all important sectors of the respective national economies.

As transport sector is the crucial driver of economic growth, all transport modes in SAARC countries are expected to show substantial increases in activity and fuel use in the future. Road transport (passenger and freight), in particular, will continue to dominate overall transport energy and oil use in the SAARC region although air travel and shipping too are expected to grow substantially. In view of the foregoing, Long range Energy Alternatives Planning Systems (LEAP) model was used to forecast energy demand in the road transport sector in the SAARC member countries upto 2040.

The study covers the global transport energy situation and road transport situation in the SAARC countries including information on different types of registered vehicle population and road infrastructure information upto some extent. An overview of the drivers for energy demand in transport sector in the context of SAARC countries has also been given.

The different scenarios such as BAU (Business as Usual), GASELEC (Compressed Natural Gas and Electricity Conversion), EFF-TECH (Transformation to Energy Efficient Systems and Technologies), MASSTRANS (Mass Transport) are analyzed in the Long range Energy Alternatives Planning System (LEAP) model by setting an interval of five years in between 2010 to 2040. LEAP is a widely-used software tool for energy policy analysis. The graphical trajectories of energy consumption in different scenarios for each member country are plotted and analyzed. Ultimately all the scenarios are combined as per the assumptions, which show a potential of about 35% of energy saving in the region by the end of year 2040 if best practices for energy efficiency in road transport sector are applied.

Approaches for reducing energy demand in road transport sector are also covered in the study with a focus on Reduce-Shift-Improve policies. This study concludes with the key findings drawn from the output of the model. Certain recommendations are also given at the end which the SAARC countries can consider while developing transport related policies, plans and strategies.

1 Introduction

1.1 The Role of Transport

Transport is strongly linked with economic activities. Economic growth triggers transport demand for the facilitation of movement of people and goods. Transport connects the economic activities and increases access to markets and services. Transport is a key to enhancing integration to global economy.

Today, the transport needs have changed drastically. Personal mobility today is a major energy-consuming activity. Mobility of individuals has increased by many folds and is expected to continuously increase in the future. New patterns of trade and businesses have evolved. The road networks within the countries and beyond the borders have increased. Freight transport has grown rapidly and is expected to continue to do so in the future.

SAARC region is the home of over 1.6 billion people, which is approximately one fourth of the world population. A long period of economic growth has translated into declining poverty and significant improvements in human development in the region. A large number of people continue to migrate to the urban areas from the rural areas of the country. This has resulted in the rapid growth in demand for transport in the urban areas. However, the region requires improvement in transport infrastructure.

The transport sector is a huge consumer of energy; it is indeed the largest consumer of petroleum-based fuels, accounting for 20% of global final energy consumption and 60% of total oil consumption. More than one third of the total greenhouse gas emission comes from the transport sector. With the economic growth of the SAARC countries, all transport modes have shown substantial increases in activity, which in turn has resulted dramatic surge in energy demand. Along with the growth of industrial, commercial and transport sectors, people are using energy at unprecedented rates. Demand for energy in all the sectors in the region is expected to grow significantly in the future. All modes of transport are expected to grow significantly and the road transport (passenger and freight), in particular, will continue to dominate overall transport energy and oil use in the region although air travel and shipping too are expected to grow substantially.

To unleash the region's economic potential, every country in South Asia is in a paradoxical situation between the economic growth and depleting energy resources. The consequent energy security and greenhouse gas emission implications of oil-dominated transportation imply that reducing the fuel used in this sector should be one of the highest priorities for all the SAARC countries.

1.2 Objective of the Study

The study aims to analyze the road transportation situation and trends in the SAARC countries. The road transport energy demand has been forecasted for each member state under different scenarios for thirty years with base year 2010 and the end year 2040, using Long range Energy Alternatives Planning System (LEAP). The study also aims to recommend strategy options for bringing about energy saving in the road transport sector, so that oil demands and hence the environmental impacts are minimized. The study deals with improvement in energy efficiency and also oil saving through fuel switch, non-engine components, modal shift and operational efficiencies.

1.3 Methodology

In order to achieve the objectives of the study, the Long range Energy Alternatives Planning (LEAP) model was used to analyze and forecast energy demand in the road transport sector in the SAARC countries for 30 years from 2010 to 2040. LEAP is a widely-used software tool for energy policy analysis and climate change mitigation assessment developed at the Stockholm Environment Institute, within which different energy system models can be created for demand and supply of energy. However, in this study, analysis focuses on the demand side only in order to estimate road transport sector energy demand in different scenarios. Various other attributes of LEAP could be seen at http://www.energycommunity.org.

The study was carried out in two parts. Historical analyses of energy with respect to travel demand was carried out using excel spreadsheets, while different analyses related to the future scenarios were carried out using LEAP software. In order to predict energy demand in the transport sector, a bottom-up approach was undertaken due to its capability to account for the flow of energy based on travel demand, fuel consumption and vehicle numbers. The energy demand function in the transportation sector was modeled as:

$$ED_{ij} = NV_{ij} \times VKT_j \times FE_{ij}$$

The energy demand can be determined by integrating the results over every fuel type "i" and vehicle type "j". However, the developing countries like the SAARC countries still lack many necessary time-series transport data. In addition to difficulty in data collection, some assumptions are necessary to be made to predict the future energy demand.

As a first step, the data pertaining to number of registered vehicles **(NV)** were gathered from the member countries and from the relevant web sites. Subsequently, the number of vehicles was categorized into different types and technologies as shown in the table below. This categorization of vehicles into different types and technologies was necessary as the annual travel activities vary according to the vehicle type/class and the fuel economy also varies accordingly. Wherever the vehicle category data was not available, some assumptions were made. Similarly the necessary data like Vehicle Kilometer of Travel **(VKT)** was not adequately available; assumptions were therefore applied in computation. Other associated data statistics, like Fuel Economy **(FE)**, were assumed as the function of engine size, engine technology and fuel used, which are dependent on vehicle type.

S. No.	**Vehicle Type**	**Sub-Classification**	**Fuel Used**				
1	Car		G	D	C	E	
2	Bus	Large (Seating Capacity, 26-40)		D	C	E	
		Medium (Seating Capacity 11-25)		D	C	E	
		Small (Seating Capacity upto 10)		D	C	E	
3	Motorcycle		G			E	
4	Three Wheelers		G		C	E	L
5	Truck	Large (Loading capacity above 10 tons)		D			
		Medium (Loading capacity 4-7 tons)		D			
		Small (Loading capacity upto 4 tons)		D			

G: Gasoline D: Diesel C: Compressed Natural Gas (CNG) E: Electricity L: Liquefied Petroleum Gas (LPG)

Table 1 Vehicle Classification and Fuel Type

1.4 Travel demand

The energy demand in road transportation was formulated as a function of the number of vehicles, average distance traveled, proportion of vehicle type and fuel economy or fuel efficiency of vehicle. However, in the LEAP framework, total passenger-travel demand was expressed in terms of Passenger-km and Ton-km for passenger and freight vehicles respectively.

1.5 Vehicle km

The vehicle kilometer of travel (VKT) is a parameter to reflect how heavily the considered vehicle is used. Hence, this parameter varies depending on the vehicle type and its driven distance. Moreover, it should be noted that the VKT is not constant with time because the gross road distance and/or traffic conditions change. Unfortunately, the VKT data are not recorded on a regular basis and these data were not available for the SAARC countries. Estimates were made on the basis of judgment.

1.6 Calculating Passenger- km

The Passenger-km for different passenger vehicle types was computed as per the following relations:

Vehicle Use (Vehicle-km) , A
Load Factor (Passenger-km/Vehicle-km), B
Total Passenger-km, C= A*B

The Ton-km for different freight vehicle types was computed as per the following relations:

Vehicle Use (Vehicle-km) , X
Load Factor (Ton-km/Vehicle-km), Y
Total Ton-km, Z= X*Y

1.7 Energy Intensity/ Fuel Economy

Energy intensity / Fuel economy is the relation between the distance traveled and amount of fuel consumed. Energy intensity of a vehicle depends on the vehicle size, vehicle type, vehicle's engine type and fuel type used. Fuel economy is commonly expressed in terms of Vehicle-km/L. The activity based energy intensity is the quantity of energy or fuel required to

produce a unit of travel activity, i.e., L/ Passenger-km for passenger transport activity and L/Ton-km for freight transport activity.

1.8 Calculating Energy Intensities

Energy intensities were computed as per the following relations:

Passenger Transport	**Freight Transport**
Fuel Economy (Vehicle-km/L), X	Fuel Economy (Vehicle-km/L), M
Load Factor (Passenger-km/Vehicle-km), Y	Load Factor (Ton-km/Vehicle-km), N
Energy Intensity(L/Passenger-km), Z=1/(X*Y)	Energy Intensity (L/Ton-km), O=1/(M*N)

1.9 Energy Demand

The energy demand of the vehicle by fuel types was formulated as a function of the number of vehicles, the average vehicle kilometer traveling and the fuel economy. Therefore, total energy consumption of vehicle was calculated by the following equation:

$$EDij = NVij \times VKTj \times FEij$$

The input data used for member countries could be seen at **Annexures A** along with assumptions taken.

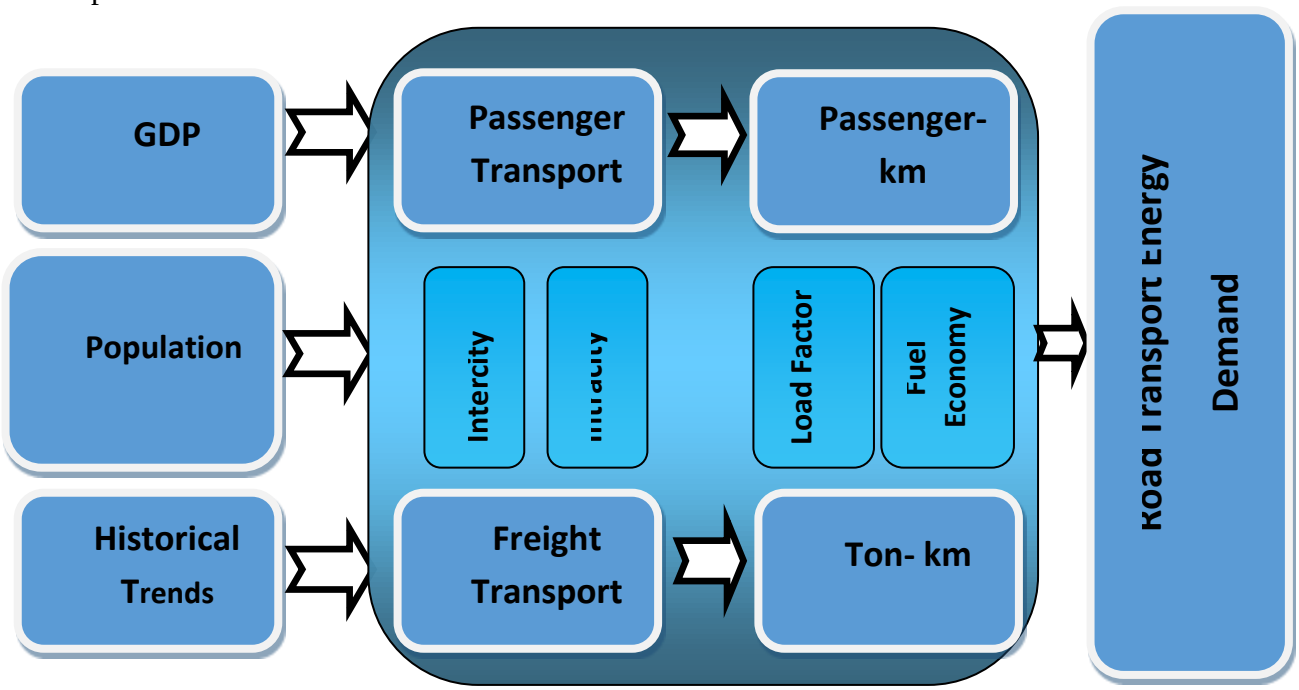

Figure 1 Road Transport Energy Demand

1.10 Limitations of the Study

Unavailability of accurate transport data was the biggest challenge for the study. Wherever the required data could not be acquired due to different limitations and barriers, assumptions were made in categorizing the vehicles into different types, the technology they use, the vehicle usage, load factors and energy intensity. The LEAP module developed in this study can be further improved as and when more accurate and authentic data become available.

1.11 Study Area

The study was carried out for all the eight countries of SAARC for a period of 30 years from the year 2010 as the base year to the year 2040. Energy demand in different scenarios with the intervals of five years between these years was computed and policy recommendations are made accordingly.

2 Global Transport Energy Situation

Global energy demand has significantly increased over the last decades. According to IEA, the global energy demand has almost doubled from the year 1971 to 2012. Fossil fuel is the primary source of energy and will remain the primary source worldwide. 40% of the 8979 MTOE of the world's total energy consumption is contributed by oil and 35.3% of the total 31734 Mt of CO2 emission comes from oil[1].

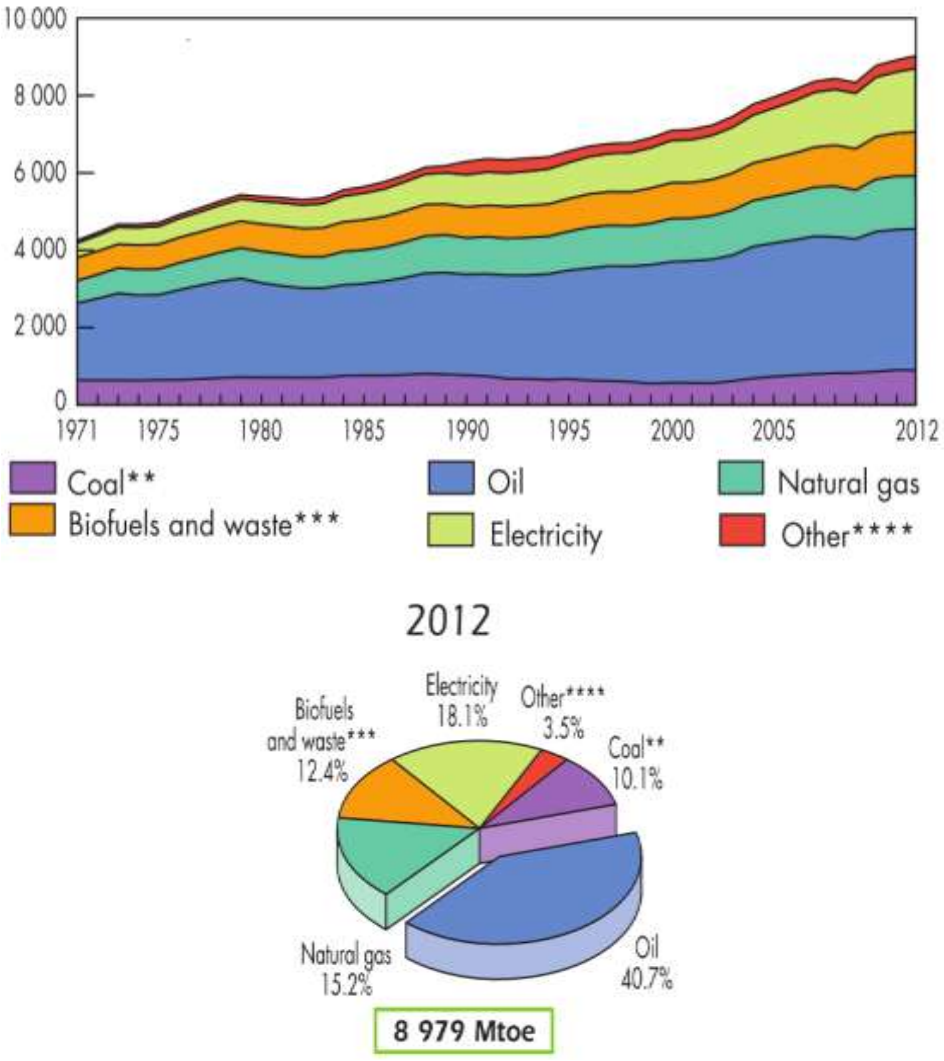

Figure 2 Primary Energy Consumption[2]

[1]IEA World Energy Outlook, 2012
[2]IEA World Energy Outlook, 2012

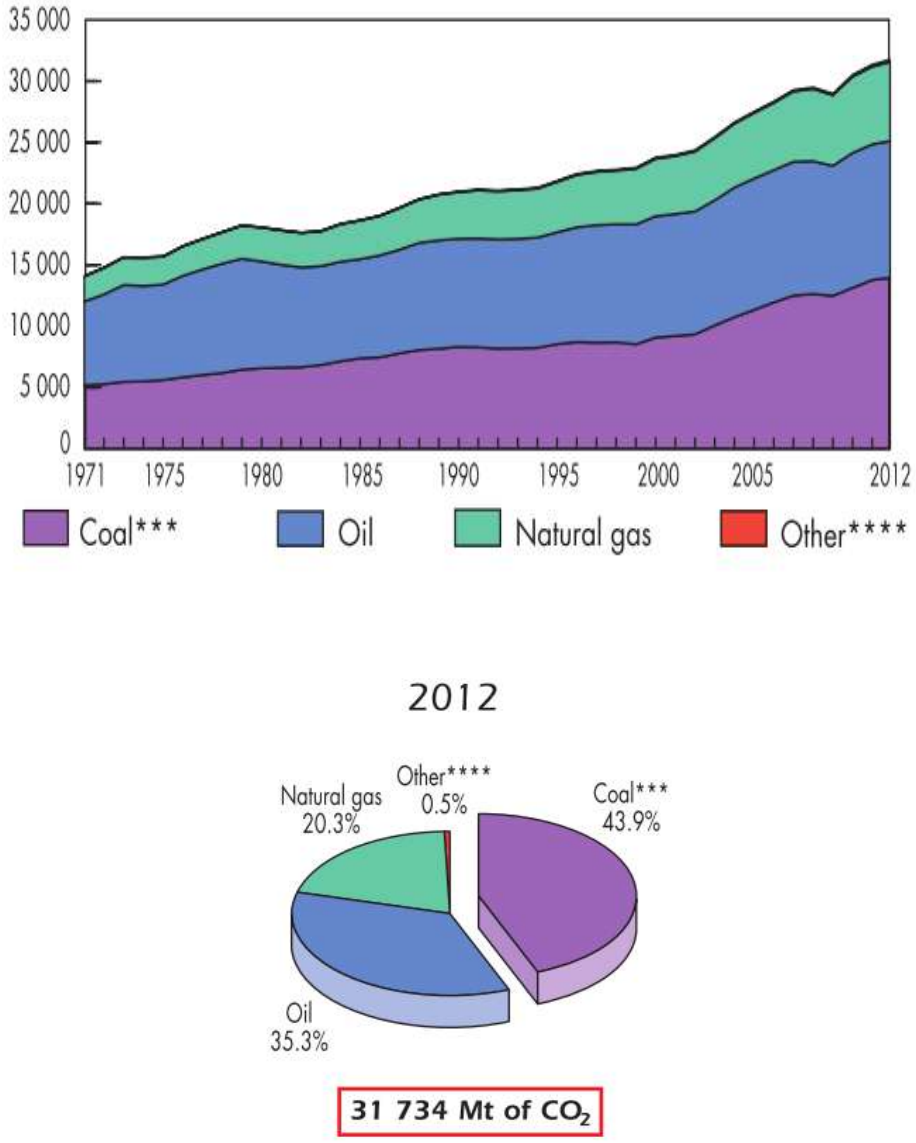

Figure 3 World CO_2 emissions by Fuel[3]

Mobility is an essential human need. The movement of people and goods is very important for social interaction and eventually for the survival of the human beings. The world in itself has become a global market particularly because of transport system. It cannot be denied that one of the preconditions for economic well-being is the accessibility of goods and services to the people. The different sectors of end use (households, industry, transport, service, agriculture) drive the growth but the transport sector will remain the single largest final energy consuming sector.

[3] IEA World Energy Outlook, 2012

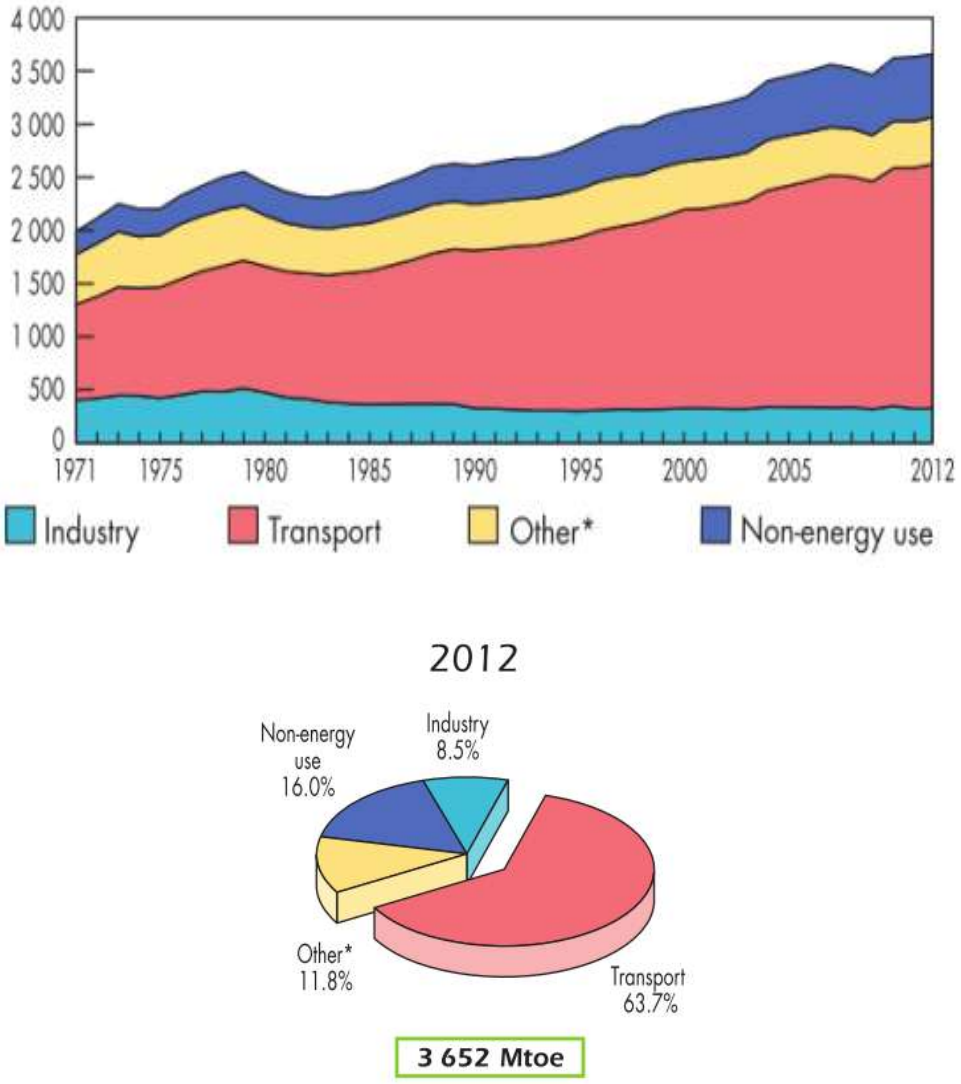

Figure 4 Total Final Energy Consumption by Sector[4]

According to IEA, 63.7% of 3652 MTOE oil consumption goes to the transport sector alone. Within Transport Sector, road transport consumes approximately 70% the total energy used in the global transport system. Road passenger transport alone accounts for 50% of this energy consumption. Only small proportion of energy used derives from natural gas, LPG, electricity or biofuels. It is estimated that the share of renewable energy will increase in future. However, energy consumption in the transport sector will come mostly from oil. This will therefore imminently lead to an increase in oil consumption.

[4] IEA World Energy Outlook, 2012

3 Road Transport in the SAARC Region

3.1 Afghanistan

Afghanistan is a landlocked country with a population of almost 30 million dispersed across the largely mountainous terrain of 652,000 square kilometers. Roads are the principal means of transport in the country. The regional highway network fosters regional trade and economic linkages.[5]

Demand for road transport is increasing rapidly, which is evidenced by the supply of registered vehicles. The vehicle population is increasing rapidly with an annual average growth rate of over 8 percent over the period between 2008 and 2010, with small vehicles including cars and motorcycles increasing annually at an average of 10%. Transport services in the country are inadequate, and of low quality.

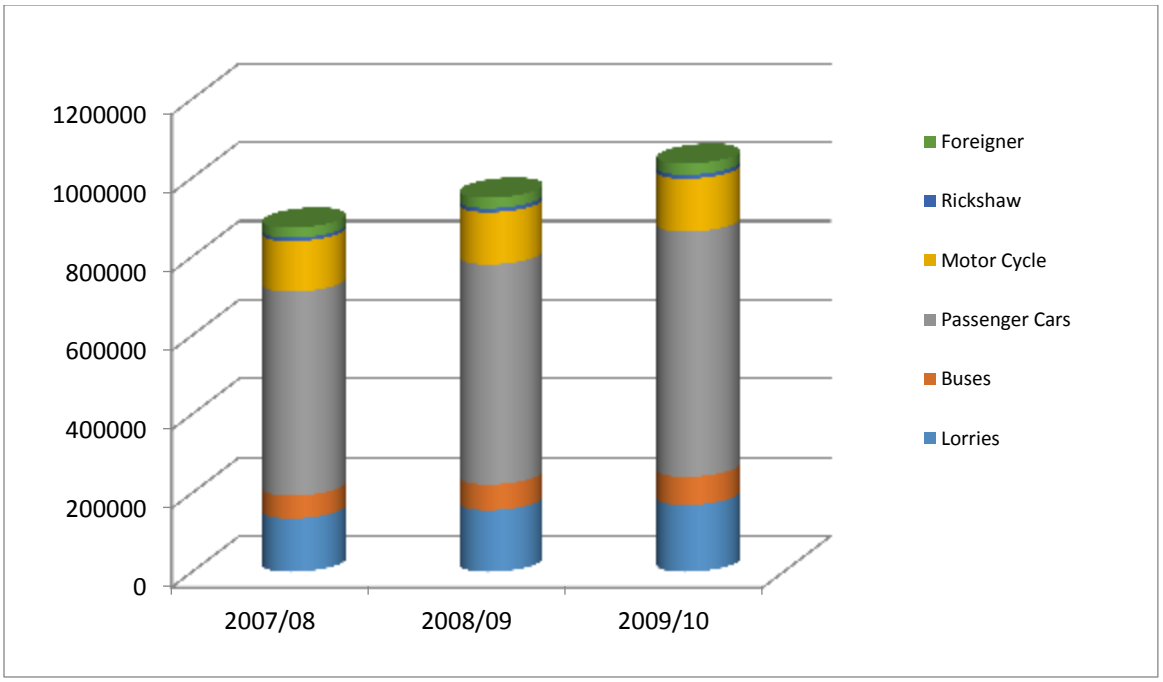

Figure 5 Increase in Demand for road transport in Afghanistan[6]

[5]ADB: Transport Network Development Investment Programme
[6]Afghanistan Statistical Year Book 2009/10

3.2 Bangladesh

According to the Roads and Highways Department of Bangladesh, the country has about 21,000 Km of major roads, of which National and Regional Highways constitute about 8000 Km and the remaining are Zilla roads.

The country has seen a rapid growth in the vehicular population in the last decade. Small passenger transport traffic grew at an average annual rate of 11.2 % in between the year 2009 and 2013. Motor cycle registrations increased by more than 150% during the period.

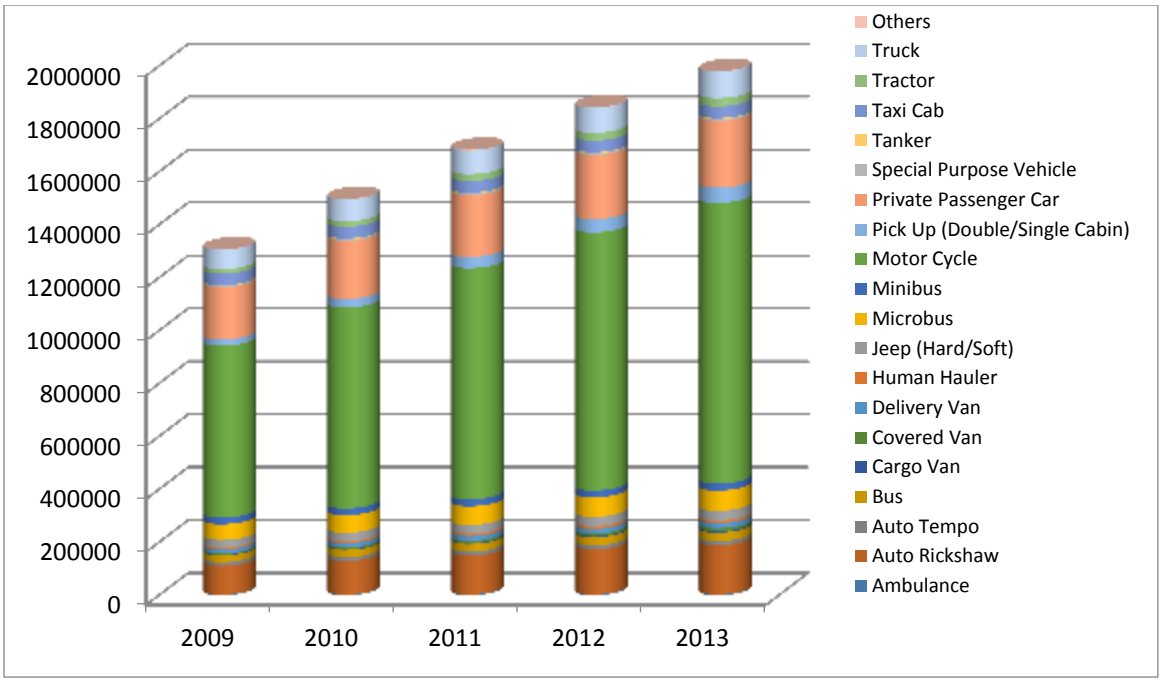

Figure 6 Increase in Demand for road transport in Bangladesh[7]

[7]Bangladesh Road Transport Authority

3.3 Bhutan

Roads are the main mode of passenger and freight transport within the country and with neighboring country, India. The current network comprises about 10,577 kilometers of roads. An estimated 80% of rural people have access to essential services in less than 1 hour of travel time.[8]

The use of motor vehicles is highly concentrated in the western region of the country, especially in Thimphu and Phuentsholing. Nationally, registrations increased sharply from 22,5274 in 2001 to 67,926 in 2013.

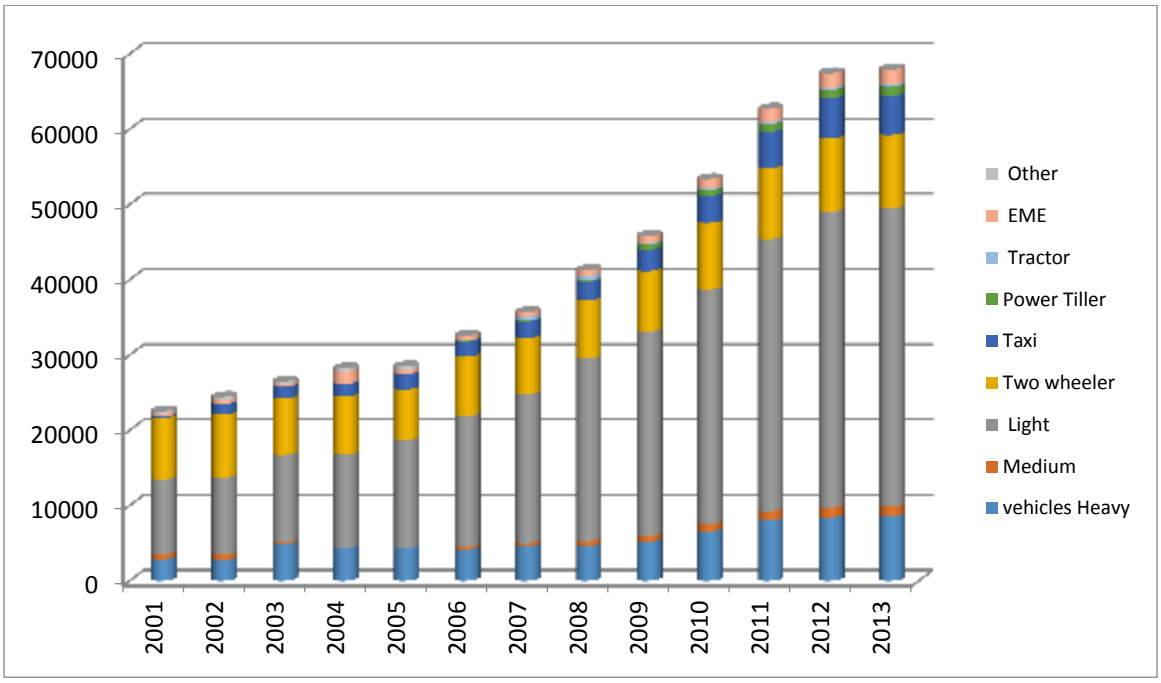

Figure 7 Increase in Demand for road transport in Bhutan[9]

Total traffic increased at an annual average rate of 9.6% in the period between 2001 and 2013. The motorcycles increased at an average annual rate of almost 15% and the light vehicles at the rate of more than 12% during the same period.

[8] ADB: South Asia Sub regional Economic Cooperation Road Connectivity Project (RRP BHU 39225)

[9] Road Safety and Transport Authority, Bhutan

3.4 India

The road transport sector in India has expanded many folds during the last five decades, both in terms of spread and capacity. Light motor vehicles and two wheelers dominate the road transport sector. An average annual growth rate of motorcycles from the year 2001 to 2011 was more than 10% and that of cars during the same period was also almost 11%. On an average overall road traffic grew at an average annual rate of 10% during the period.

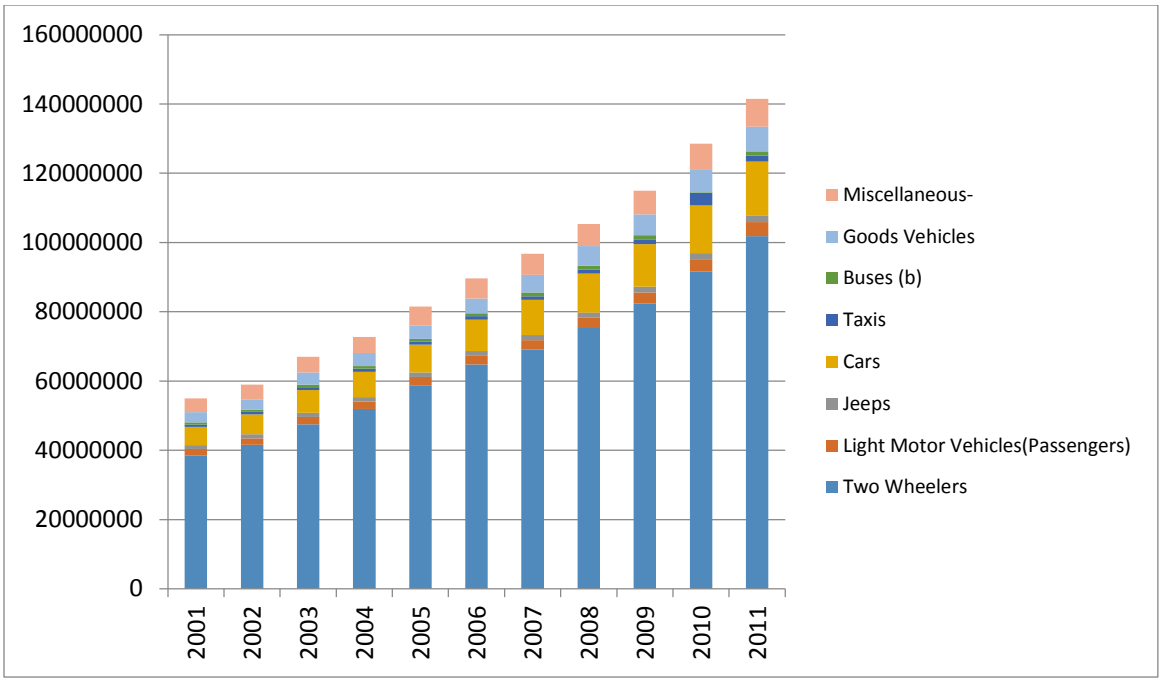

Figure 8 Increase in Demand for road transport in India[10]

[10]Road Transport Year Book (2009-2010 & 2010-2011)

3.5 Maldives

Maldives has a very few paved roads: some 60 km in Male, and 14 km each on the Laamu and Addu Atolls. Village roads are mainly of compacted coral. The rapid increase in vehicle ownership is a growing threat to passenger safety and the environment[11]. In the year 2011, the number of two wheelers registered was 42,393. Almost 4000 light motor vehicles and 128 buses were on road. As far as the freight transport is concerned, the number of registered goods vehicles was 4115 in the year 2011.

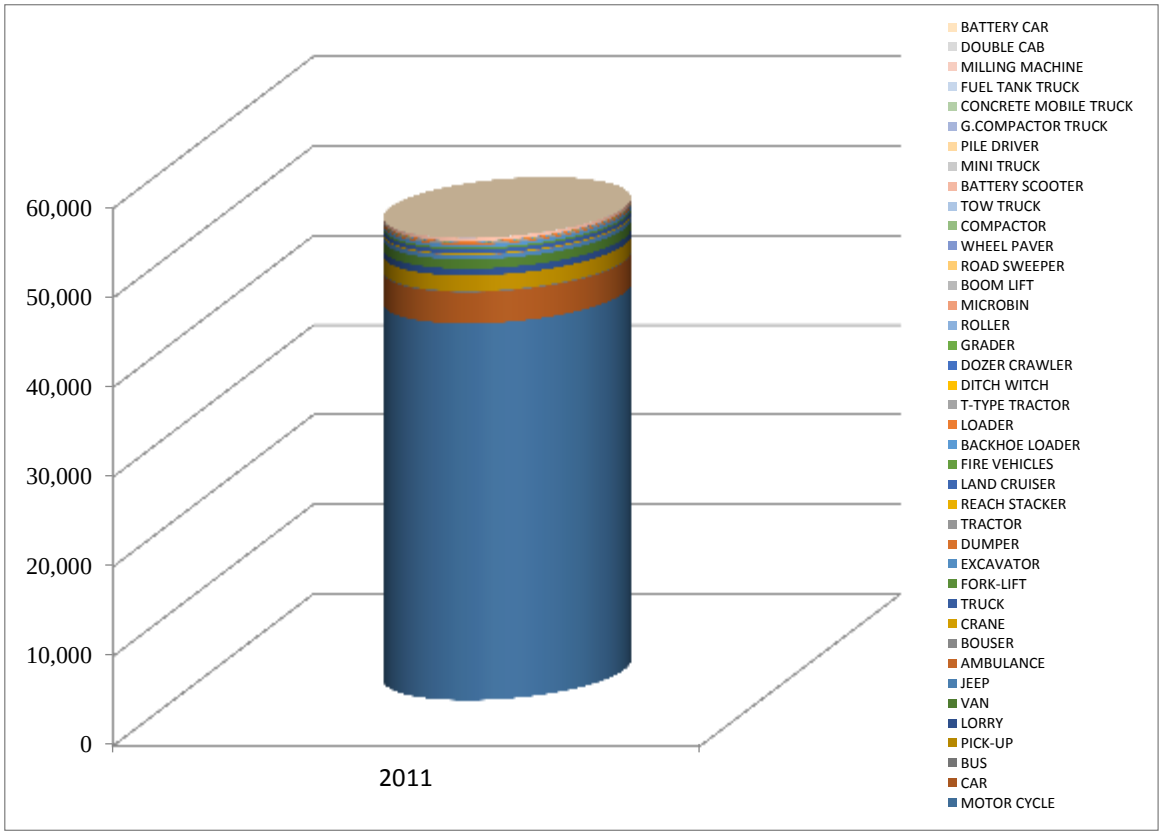

Figure 9 Increase in Demand for road transport in Maldives[12]

[11]ADB: Interim Country Partnership Strategy: Maldives, 2014–2015
[12]Transport Authority, Male, Maldives

3.6 Nepal

Nepal has a total of 25,599 Km long road with 10,810Km black topped; 5,925 Km graveled and 8,666Km earthen (fair weather) by the fiscal year 2013/14.[13] The number of transport vehicles registered between FY 1989/90 and FY 2012/13 across the country stood at 1,557,478.

The country has seen a very rapid growth in the light vehicles and two wheelers. The registered number of two wheelers grew at an average annual rate of almost 16 percent between the year 2001 and 2010. Similarly, the annual average growth of light vehicles was about 7.5 percent within the same period.

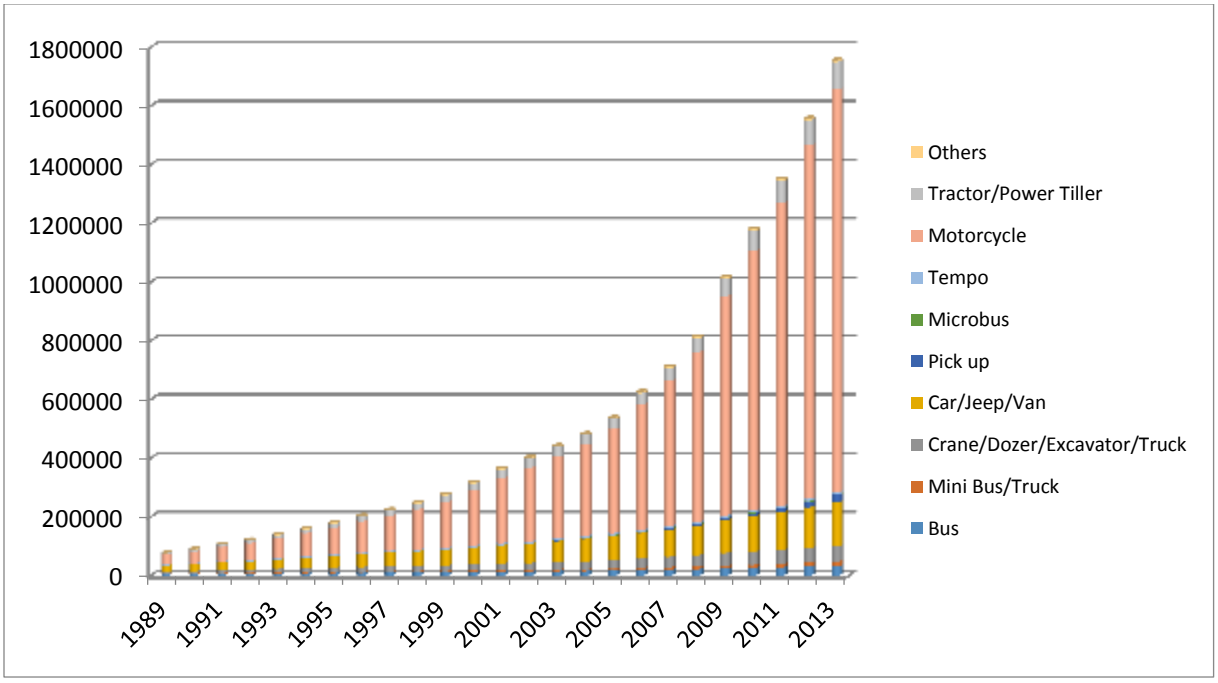

Figure 10 Increase in Demand for road transport in Nepal[14]

[13]Economic Survey of Nepal 2013-14

[14]Department of Transport Management, Nepal

3.7 Pakistan

The road network in Pakistan carries over 96 percent of inland freight and 92 percent of passenger traffic. About 63% of the population lives in villages. The topography of the region consists of hilly mountainous areas, far flung agriculture leveled lands and the productive resources. Roads provide easy and efficient means of transportation. The total road-network in Pakistan is about 263,415 km consisting of 9,324 km. (3.53%) of National highways and 2,280 km of motorways (0.87%). Strategic roads and Expressways contribute 262 km and 100 km respectively (i.e. 0.10%). The rest of the road network contains provincial highways and the roads under respective local administration e.g. cantonment boards, municipal corporations, local development authorities, etc.[15] The population of the two wheelers grew by an annual average rate of almost 8 percent between the year 2002 and 2010, while the annual growth rate of light motor vehicles remained at about 4% average.

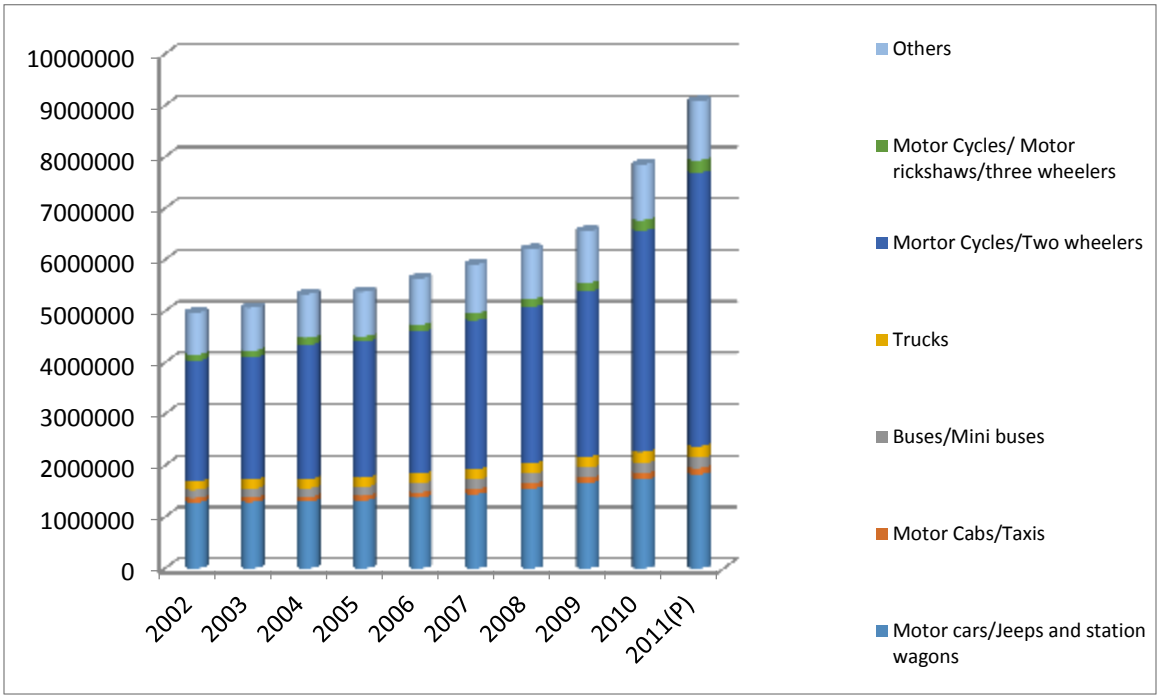

Figure 11 Increase in Demand for road transport in Pakistan[16]

[15]Economic Survey of Pakistan 2012-13

[16]Pakistan Statistical Year Book 2011

3.8 Sri Lanka

Sri Lanka relies heavily on road transport. About 97% of freight traffic is conveyed by road. The 113,000-km road network in the country includes about 11,900 km of national highways. The condition and the standards of these roads are inadequate to accommodate rapidly growing freight and passenger traffic.[17]

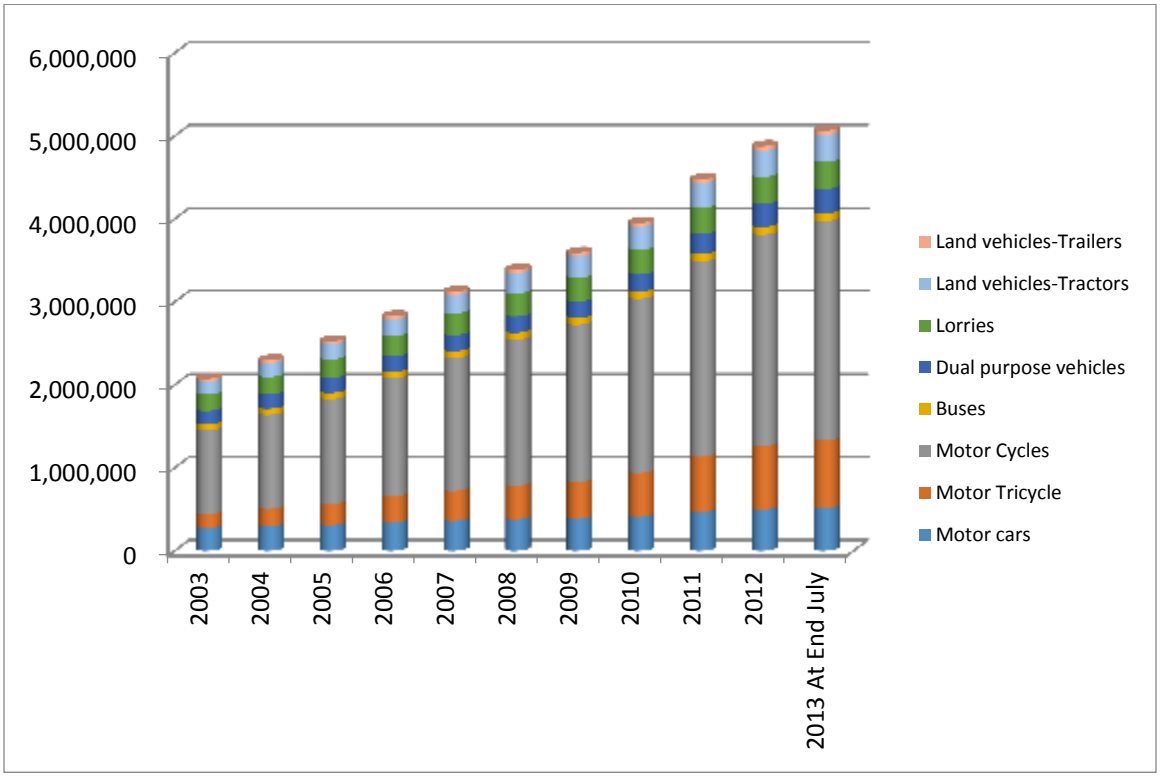

Figure 12 Increase in Demand for road transport in Sri Lanka[18]

An average annual growth of light motor vehicles was about 6 percent and that of motorcycles was about 11 percent between the year 2003 and 2010. In Sri Lanka also the population of light vehicles including motor cycles dominates the passenger transport sector.

[17]ADB's Support for the Transport Sector in Sri Lanka
[18]Department Of Motor Traffic, Sri Lanka

4 Drivers for Energy Demand in Transport Sector

A rapid motorization is taking place in the countries of South Asia due to the growth in socio-economic conditions. As a result of rising incomes, per capita vehicle ownership is rising exceptionally fast; motor vehicle fleets are doubling every 5–7 years. Since fleets are growing from a low base, very rapid growth will continue for the foreseeable future. Freight transport has also been growing rapidly and is expected to continue to do so in the future.

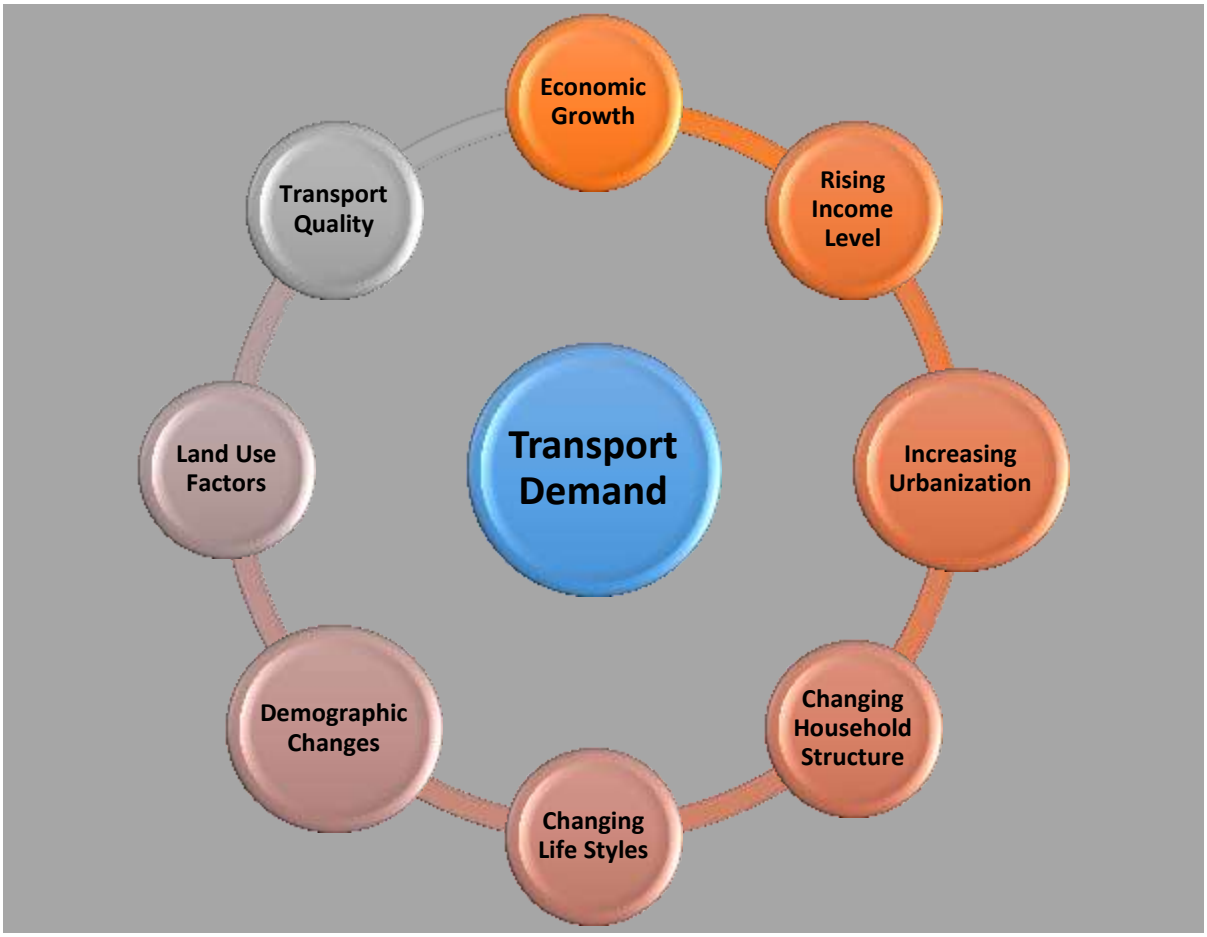

Figure 13 Factors effecting Transport Demand

Different people have different travel demands. People with higher income will have different travel demand as compared to those with lower income. Similarly, people of different ages have different preferences for travel modes and so travel demands can vary according to age as well.

Land use factors such as roadway connectivity, road structure can also engender difference in travel demands. The rural populations with no road or less motorable roads might resort to walking more or the demand for manual and animal pulled vehicles would be more as compared to the urban areas where more engine vehicles would be used. Similarly, the density of pedestrians would depend upon the pedestrian-friendliness of the roads in the city areas.

Economic activities have a very positive relationship with the travel demand. Increased economic activities result in increase in transport demand both passenger as well as freight. Mobility of people and goods is not high in places where there are lesser economic and commercial activities.

Travel behavior also depends upon the variety of options available to people. Presence of affordable air transport would obviously have impact on the road transport and availability of railways and metros in the cities would have impact on the number of cars plying over on the roads.

Transport demand also depends upon the quality of transport options. In the places where there is quality public transport, people would opt for public transport instead of using private vehicles. Lack of adequate and quality public transport is generally a driving factor for increased number of private vehicles in economically growing developing countries. In the region, we can see a very rapid growth in the private vehicle ownership, particularly cars and two wheelers on account of public transport being insufficient and at the same time the quality being poor.

5 Energy Consumption in Road Transport Sector in the SAARC Region

The population in the SAARC region is growing at an average annual rate of 1.5%, while the GDP in the region is growing at a rate of 7.6% between the year 2001 and 2011.

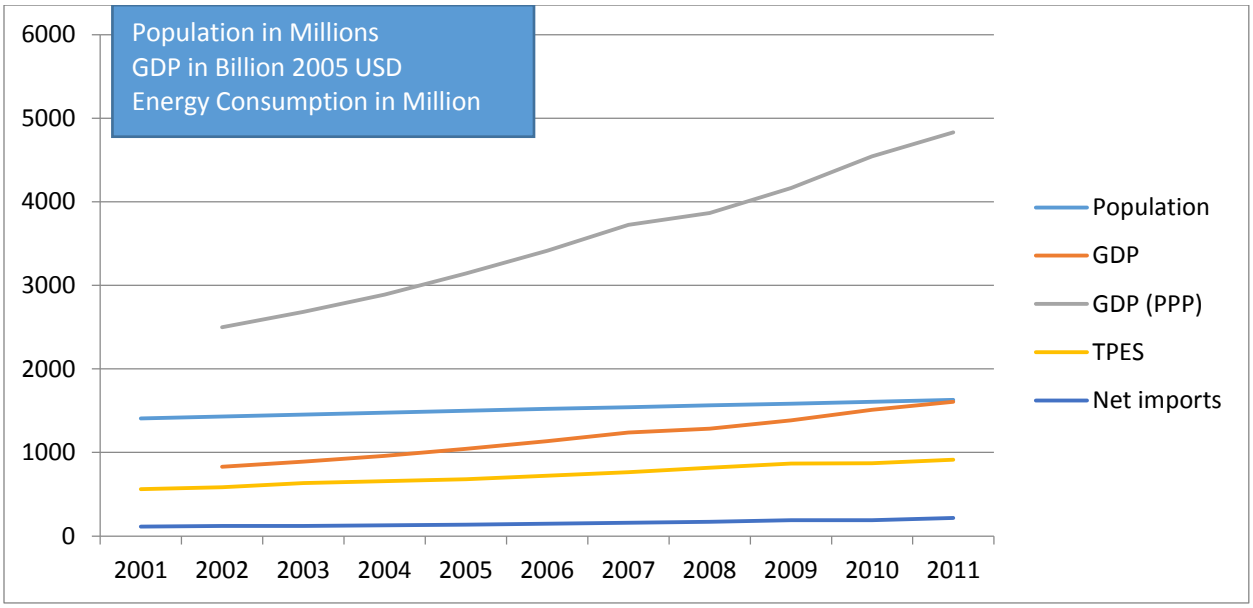

Figure 14 Population and GDP growth in SAARC region[19]

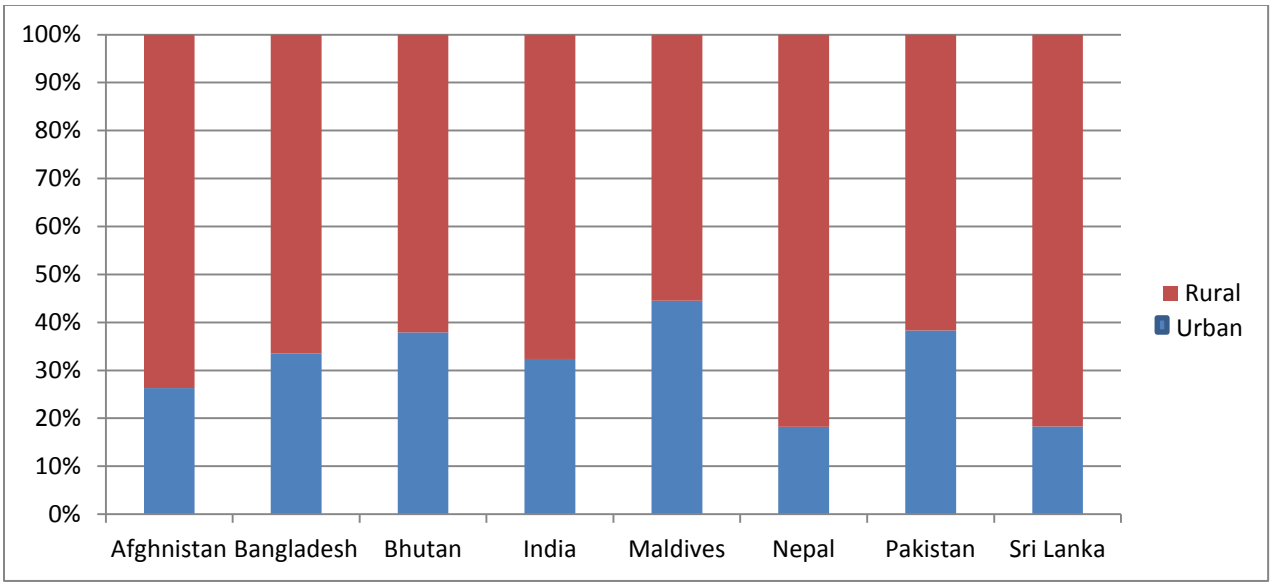

Figure 15 The urban rural split in the SAARC countries (Source: Central Intelligence Agency)

[19] SAARC Energy Data Book 2001-2011

The total final energy consumption in the SAARC region in the year 2010 was 570 Million Tonnes of Oil Equivalent[20]. The final liquid fuel consumption in the region in the year 2010 was 135 Million Tonnes of Oil Equivalent.

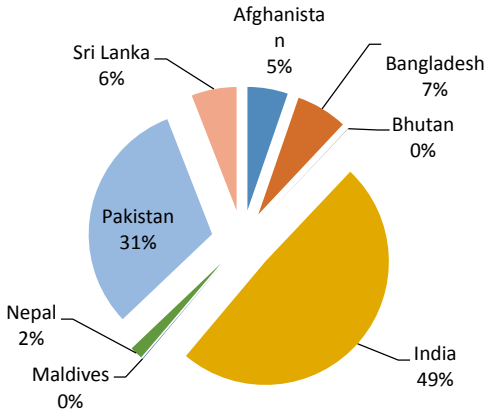

Figure 16 Final Energy Consumption in the SAARC Region by Countries[21]

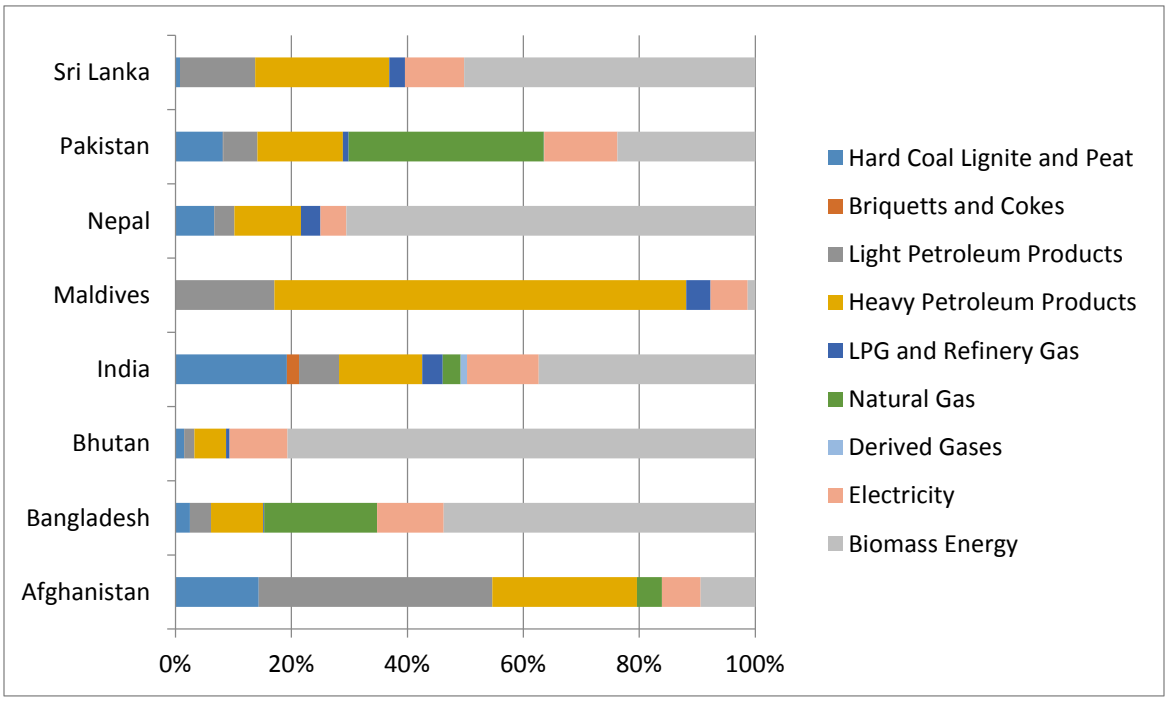

Figure 17 Final Energy Consumption in the SAARC Region by country and by fuel types[22]

South Asian countries are highly dependent on imported oil and petroleum products. The imports range from 25% of commercial energy consumption in the case of Bhutan to 100% in

[20]SAARC Energy Data Book 2001-2011
[21] SAARC Energy Data Book 2001-2011
[22] SAARC Energy Data Book 2001-2011

the case of Maldives. This pattern of energy consumption places an enormous burden on foreign exchange reserves, to the detriment of national economies of the region. While countries like Sri Lanka and Maldives, which lack indigenous fossil fuel sources, are especially hard hit, even countries like India, Pakistan, and Bangladesh now meet less of their demand with indigenous fuel sources and face increased dependence on energy imports.

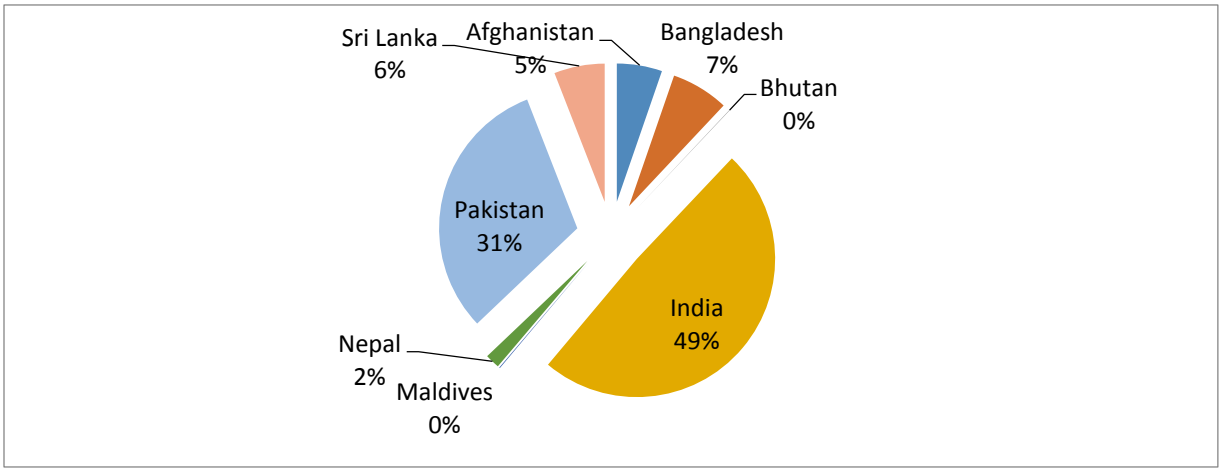

Figure 18 Energy Consumption in the Road Transport Sector in the SAARC Region[23]

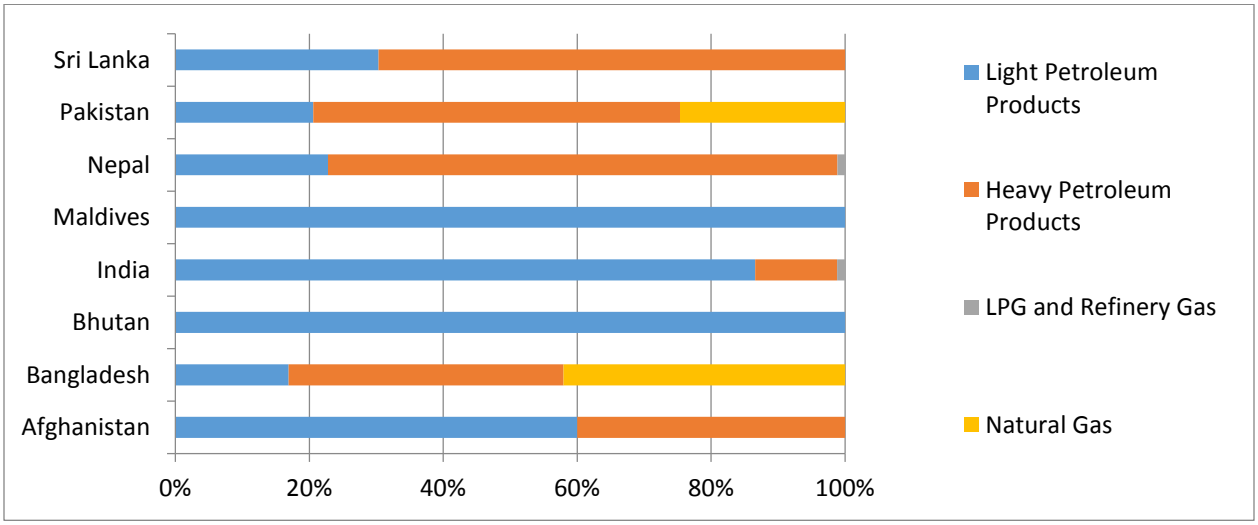

Figure 19 Fuel-wise Energy Consumption in the Road Transport Sector in the SAARC Region[24]

[23] SAARC Energy Data Book 2001-2011
[24] SAARC Energy Data Book 2001-2011

6 Scenario Analysis

Scenarios analyses are widely used to visualize possible energy futures. Scenarios are an appropriate means to analyse a complex dynamic system with many interdependencies.

This study on improvement of energy efficiency in road transport sector is based on a scenario analysis for the future development until the year 2040. The scenarios are analyzed for each member state and then for the SAARC region as a whole.

6.1 BAU Scenario

This describes the regular development based on the knowledge of the past. The BAU scenario can also be considered as an extrapolation of the historic development of the past with inclusion of presently taken measures and policies. The BAU-Scenario is also called baseline scenario.

The transport activity, i.e. the annual vehicle Passenger-km in case of passenger transport and annual vehicle Ton-km in case of freight transport are directly linked with population. As transport activities are correlated with the income level of the population and the overall GDP of a country, the future transport demand was forecasted with the average annual growth of income and GDP on the basis of elasticity that these variables have with transport demand. Transport activities and the energy intensity of each technology were used to calculate the energy consumption.

With the assumptions that the historic trend as seen at Annexure-B will continue to follow for various segments, energy consumption for the future years from 2010 to 2040 with an interval of five years is forecasted using LEAP model.

6.2 GASELEC Scenario

In this scenario a certain share of motor fuel is expected to be substituted by compressed natural gas in the countries where natural gas is indigenously available and by electricity in all the countries.

6.3 EFF-TECH Scenario

In this scenario, energy efficiency of vehicles is improved by phasing out old fleet of vehicles and replacing with newer and more energy efficient vehicle fleet. This is a scenario where

vehicles would be offered regular maintenance and also the import of second hand vehicles would be banned.

6.4 MASSTRANS Scenario

In mass transport scenario, part of travel activities of the small vehicles would gradually be replaced by large buses and interventions shall be made for modal shift to non-road means of transportation.

The assumptions were made for different scenarios for different countries as indicated in table 2 below.

Country	GASELEC	EFFTECH	MASSTRANS
Afghanistan	By 2040, 20% of small vehicle passenger-km will be replaced by electricity; 10% of bus passenger-km by electricity	By 2040, energy efficiency of all conventional vehicle technologies will improve by 10%	25% of small vehicle activities will be replaced by larger vehicles and non-road means of transportation.
Bangladesh	By 2040, 20% of small vehicle passenger-km will be replaced by electricity; 20% of bus passenger-km by 10% electricity and 10% CNG.	By 2040, energy efficiency of all conventional vehicle technologies will improve by 10%	25% of small vehicle activities will be replaced by larger vehicles and non-road means of transportation.
Bhutan	By 2040, 20% of small vehicle passenger-km will be replaced by electricity; 10% of bus passenger-km by electricity	By 2040, energy efficiency of all conventional vehicle technologies will improve by 10%	25% of small bus/truck activities will be replaced by large buses and that of small trucks by large trucks
India	By 2040, 20% of small vehicle passenger-km will be replaced electricity and CNG; 20% of bus passenger km by 10%	By 2040, energy efficiency of all conventional vehicle technologies will	25% of small vehicle activities will be replaced by large buses and Non-road

Country	GASELEC	EFFTECH	MASSTRANS
	electricity and 10% CNG.	improve by 10%	means of transportation
Maldives	By 2040, 20% of small vehicle passenger km will be replaced by electricity and 10% of bus passenger km by electricity	By 2040, energy efficiency of all conventional vehicle technologies will improve by 10%	25% of small bus/truck activities will be replaced by large buses.
Nepal	By 2040, 20% of small vehicle passenger km will be replaced by electricity and 10% of bus passenger km by electricity	By 2040, energy efficiency of all conventional vehicle technologies will improve by 10%	25% of small vehicle activities will be replaced by large buses and non-road means of transportation
Pakistan	By 2040, 20% of small vehicle passenger km will be replaced by electricity and 10% of bus passenger km by electricity	By 2040, energy efficiency of all conventional vehicle technologies will improve by 10%	25% of small vehicle activities will be replaced by large buses and non-road means of transportation
Sri Lanka	By 2040, 20% of small vehicle passenger km will be replaced by electricity and 10% of bus passenger km by electricity	By 2040, energy efficiency of all conventional vehicle technologies will improve by 10%	25% of small vehicle activities will be replaced by large buses and non-road means of transportation

Table 2 Comparative Analyses of Different Scenarios

7 Energy Demand in the Road Transport Sector in SAARC Region

The forecasted energy demand for transport sector in each SAARC member country keeping in view different scenarios is depicted in the graphs below and associated data sheets could be seen at **Annexure-C**.

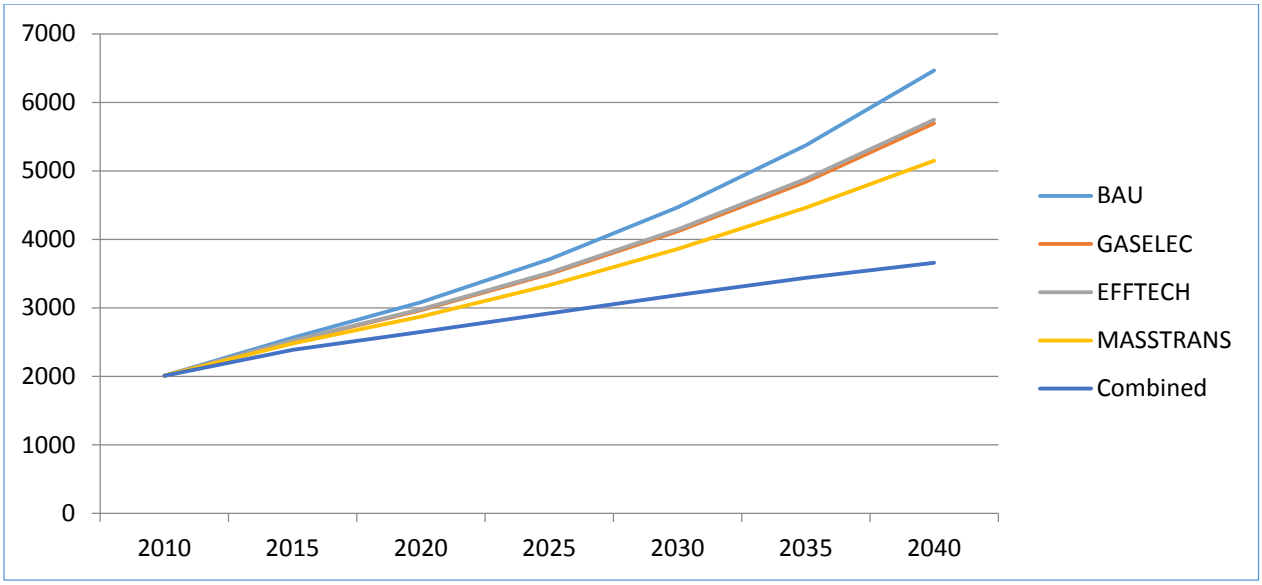

Figure 20 Road Transport Energy Demand: Afghanistan (KTOE)

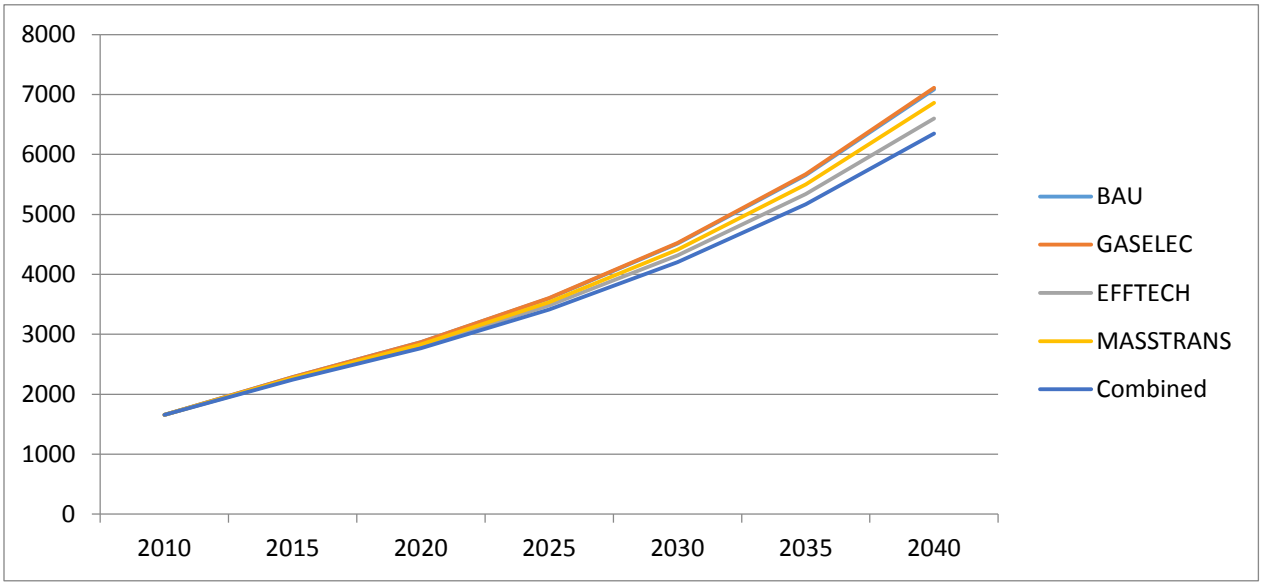

Figure 21 Road Transport Energy Demand: Bangladesh (KTOE)

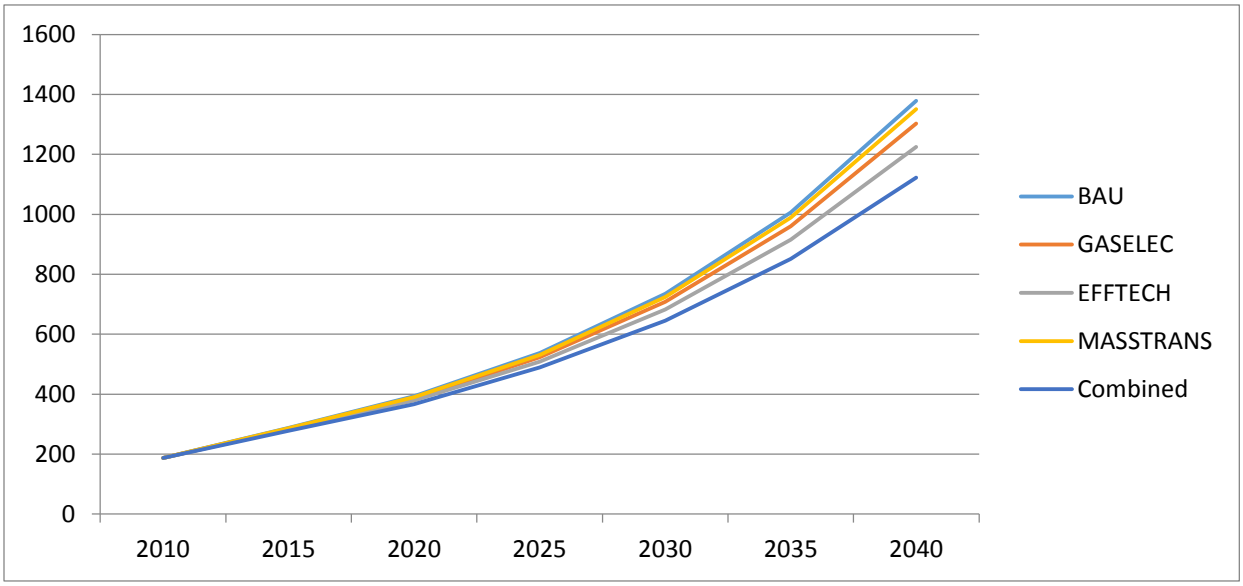

Figure 22 Road Transport Energy Demand: Bhutan (KTOE)

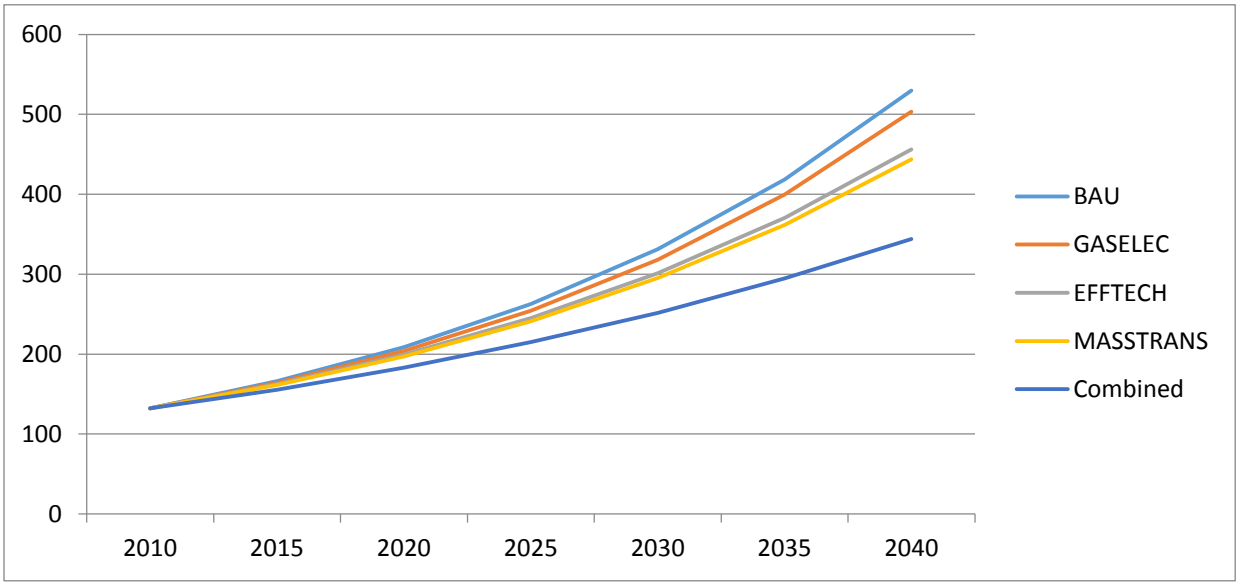

Figure 23 Road Transport Energy Demand: India (MTOE)

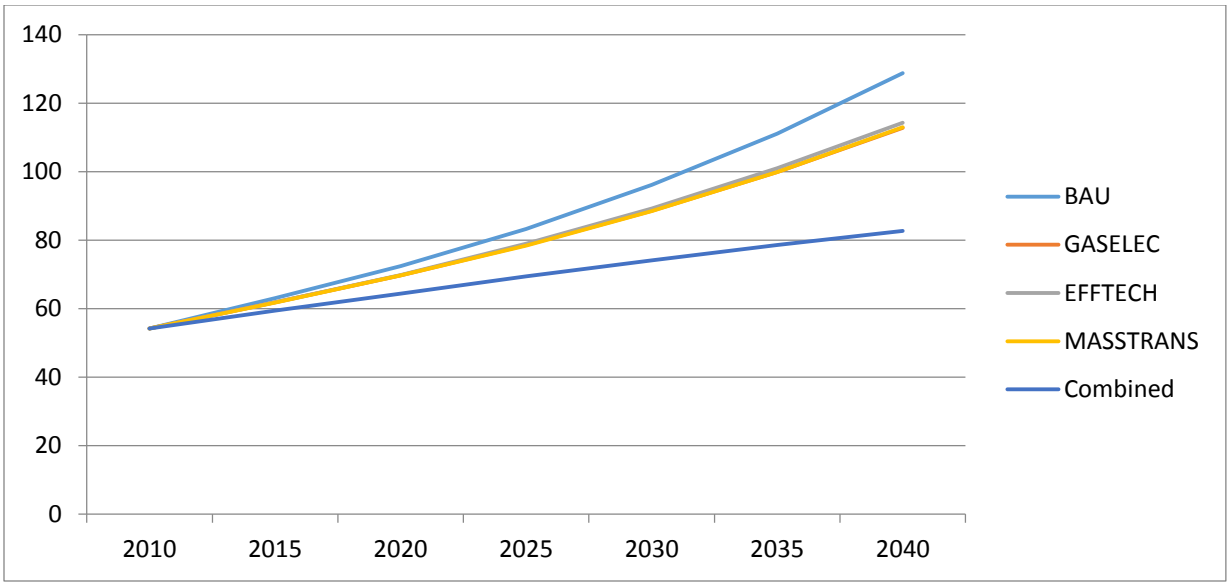

Figure 24 Road Transport Energy Demand: Maldives (KTOE)

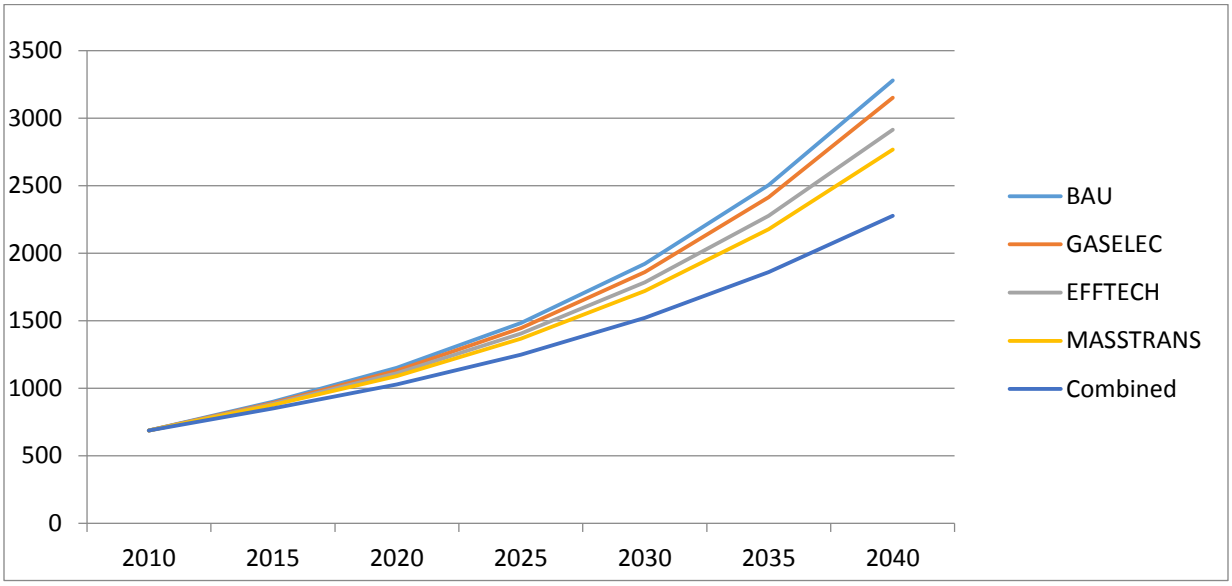

Figure 25 Road Transport Energy Demand: Nepal (KTOE)

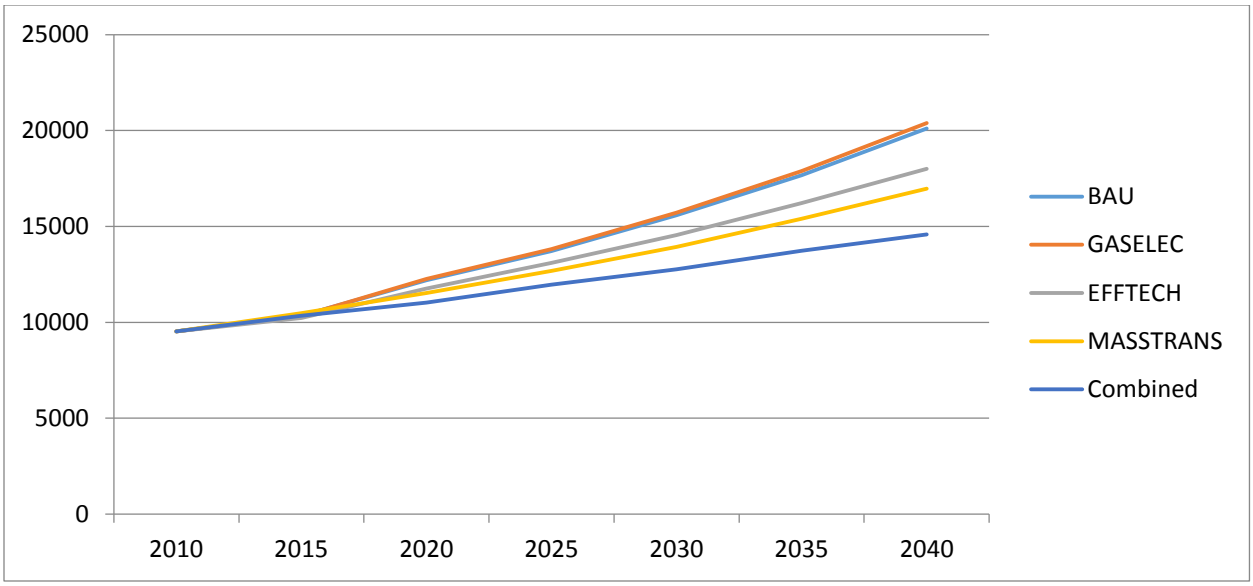

Figure 26 Road Transport Energy Demand: Pakistan (KTOE)

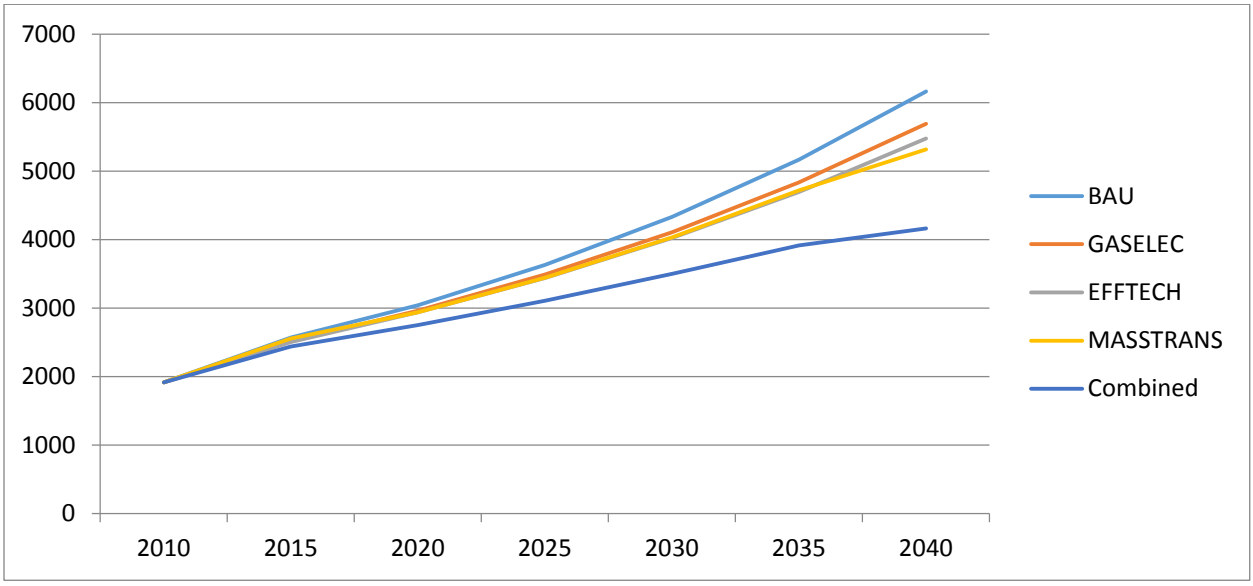

Figure 27 Road Transport Energy Demand: Sri Lanka (KTOE)

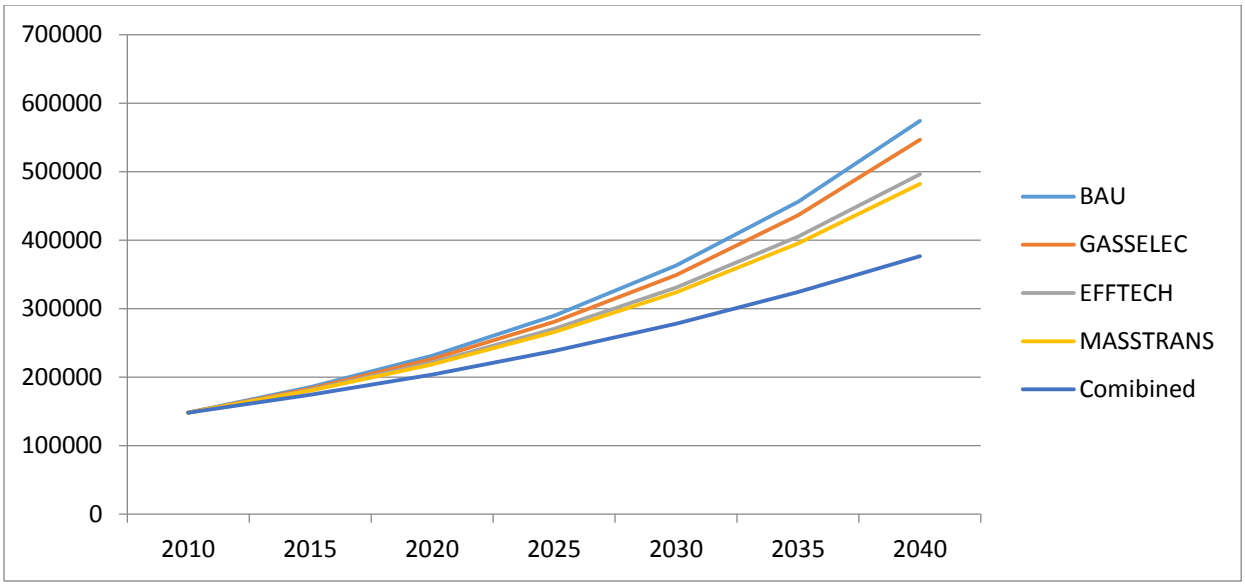

Figure 28 Road Transport Energy Demand: SAARC Region (KTOE)

It is seen from the model that with the penetration of electric vehicles, energy can be saved in the region by about 5%, while with more energy efficient technologies penetration and proper maintenance of the vehicles, the energy can be saved by about 14%. By moving towards mass transportation, as much as 16% energy can be saved. The graph curve obtained by combining all the model shift scenarios as per assumptions shows a potential of about 35% of energy saving in the region by the end of the model period.

8 Approaches for Reducing Energy Demand in the Road Transport Sector

There can be three-pronged approaches to reducing energy consumption in the road transport sector—Avoid/Reduce, Shift and Improve policies.

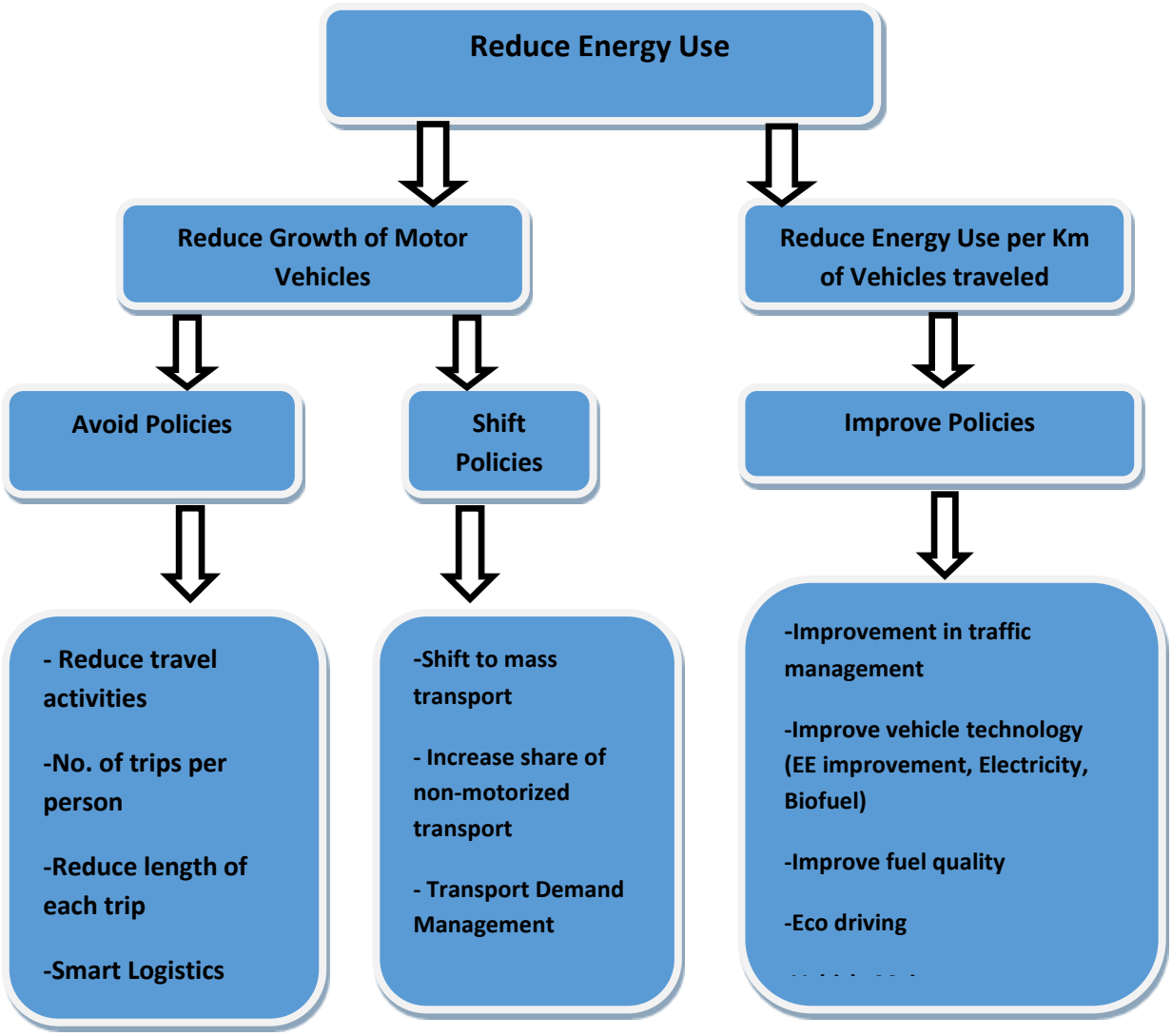

Figure 29 Schematic Diagram of Efficient Transport Concepts

As has been seen from the growth trend of vehicles in the region, one of the very important policies would be to reduce the growth in the use of motor vehicles. This can be achieved by Avoid and Shift policies.

“Avoid” policies aim to reduce the travel activities. Reduction in travel activities can be brought about by either reducing the number of trips per person or by reducing the length of each trip that a person makes. Through the integrated land use planning, the need to travel and length of trip may be reduced.

A modal shift from motorized transport to non-motorized transport also helps in reducing energy consumption. A shift to walking, cycling or mass transport leads to better environment as energy consumption per Passenger-km will decrease considerably with modal shift policy.

The “improve” policy focuses on vehicle and fuel efficiency. With improved technologies in the conventional internal combustion engine, improvement in energy efficiency can be brought about so that the mileage improves and energy consumption will be less with more energy efficient technologies. Another important aspect of improvement is through fuel efficiency. Proper traffic management, eco driving and proper vehicle maintenance also results in improvement in energy efficiency.

9 Conclusions and Recommendations

The following conclusions and recommendations are deduced from of this study.

9.1 Conclusions

SAARC region is in a rapid developing trend. The growth in economy is bound to result in the growth in the energy demand in the transport sector. The growth of urbanization level and of the middle class segment will certainly lead to the increase in vehicle ownership. It is very evident that the private vehicle ownership is increasing at an unprecedented rate in each member country of SAARC. The rate of growth of the light vehicles including cars and motor cycles is very fast. As all the SAARC countries are importers of petroleum products, each country needs to follow Reduce-Shift-Improve policy to minimize the dependence on imported petroleum products and to minimize environmental impacts.

Based on scenarios analyzed on LEAP model, up to 35 percent of energy demand reduction potential exists in transport sector in the region. The energy demands for each SAARC country in different scenarios at an interval of five years from the base year 2010 to the end year 2040 are placed in **Annexure C**.

9.2 Recommendations

- A wide set of data is necessary to have accurate transport energy efficiency indicators in SAARC member countries for developing realistic scenarios and minimizing assumptions taken in the model. Vehicle stock is the key indicator; but more detailed the characterization better would be the baseline for any model, and more effective policy levers can be developed. The SAARC countries need to conduct transport survey periodically and also energy consumption data in different modes of transport by vehicle type and fuel type for future planning purpose.

- The SAARC countries should focus on developing more viable projects for increasing the public transport capacity such as Bus Rapid Transport (BRT) under avoid/shift policies which have numerous advantages.

- Effective land use planning should be the main component for urban planning in the SAARC countries as mostly increase in urban density reduces per capita vehicle travel.

- The SAARC countries need to introduce or revise regulations for fuel efficiency standards for light and heavy duty vehicles, speed limits, fuel taxation and strengthen the motor vehicle examination systems. Many member countries do have the Motor Vehicle Examination (MVE) system in place but the present system of inspection of vehicles and issuance of fitness certificates is old and ineffective in many countries in ensuring vehicle road worthiness and mostly covers the commercial vehicles. There is a need to revise the MVE mechanism and introduce new completely automated and computerized system by bringing the private vehicles in the ambit of MVE regulatory regime.

- A major problem which SAARC member countries could face in requiring personal vehicles to obtain certificates of fitness is the setting up of the requisite number of inspection and maintenance centers for carrying out the tests and certified examiners availability. A detailed study of existing MVE system in member countries is required to be undertaken.

- Monetary incentives could be considered by the SAARC countries as per their respective policies to reduce annual vehicle taxation to be applied against fuel use or emissions, toll plazas tax exemptions, tax exemption on purchase of electric vehicles and battery banks, registration tax incentives for efficient vehicles and reduction in the MVE inspection fees for each efficient vehicle category for various safety and emissions tests.

- Many SAARC countries do have the Energy Efficiency Legislation and in some countries it is under promulgation but transport sector is not effectively being covered under the existing provisions. Under the Energy Standards & Labeling schemes in member countries, mostly the electrical appliances are being covered. However, there is a need to develop tyre-labeling and car-labeling scheme based on fuel use or emissions.

- Removal of fuel subsidies will lead towards usage of more efficient vehicles as fuel prices have strong influence on driving culture.

- Miscellaneous other measures/best practices could be adopted by SAARC countries pertaining to model shift such as pedestrian friendly policies: safe sidewalks, well-marked cross walks, car-free zones, traffic calming measures, better law enforcement, improving road surface, identifying infrastructure requirement to make non-motorized transport attractive such as biking lanes, bike parking, traffic signals & info-campaigns to make cycling & walking attractive.

- With the influx of latest technologies/fuels like fuel cell (hydrogen) and electric hybrid technology in transport sector, the SAARC countries should aim at taking capacity building initiatives to enhance knowledge and skill of automobile mechanics and electricians.

- The way a person drives a vehicle – whether a car or a truck – can have a major effect on fuel economy. The SAARC countries can establish driving training centers for drivers of all modes of transports offering short practical learning courses in respective local/national languages and the same platform could be used for dissemination of eco-driving tips to help drivers improve their driving style to save fuel.

References

1. *World Development Indicators 2014*, Washington, DC: World Bank. Doi: 10.1596/9781-4648-0163-1. License: Creative Commons Attribution CC BY 3.0 IGO

2. World Bank Group. 2015. *Global Economic Prospects, June 2015. The Global Economy in Transition*. Washington, DC: World Bank. Doi: 10.1596/978-1-4648-0483-0. License: Creative Commons Attribution CC BY 3.0 IGO

3. *BP Energy Outlook 2030*
South Africa, March 2012

4. *2015 World Population Data Sheet*
Population Reference Bureau, Washington, DC 20009 USA

5. Subhes C Bhattacharya and Gobinda R Timilsina, 2009, *Energy Demand Models for Policy Formulation,* The World Bank, Development Research Group, Environment and Energy Team

6. Susan Bohlar-Baedekar, Hana Huging, 2012, *Sustainable Transport and Energy Efficiency*, Federal Ministry of Economic Cooperation and Development (BMZ), Germany

7. J. Pongthanaisawan, C. Soraipipatana and B. Limmeechokchai, 2007, *Road Transport Energy Demand Analysis and Energy Saving Potentials in Thailand*, Joint Graduate School of Energy and Environment, Thailand

8. *Sustainable Transport Initiative, 2010,* Asian Development Bank, Manila Philippines

9. *SAARC Energy Data Book 2001-2010,* SAARC Energy Centre, Islamabad, Pakistan

10. *SAARC Energy Data Book 2001-2011,* SAARC Energy Centre, Islamabad, Pakistan

11. International Energy Agency, 2010, *Transport Energy Efficiency,* IEA, Paris, France

Annexure-A

Afghanistan		Number (Thousand)	Fuel	Share by Fuel	Average Annual Usage	Vehicle Km	Occupancy	Passenger Km	Average Fuel Economy	Energy Intensity	Fuel Use	Fuel Use	Fuel Use
					Km	Million	Persons	Billion	Vehicle Km/Litre	Litres/Pass-	Million	Million	KTOE
							Tons		Vehicle Km/Kwh	Litres/Ton-Km	Million		
										Kwh/Pass-Km			
Passenger						20108.16		80.85					1350.5
Car		649.76				16244.00		40.61					
		584.78	Gasolin	90%	25000	14619.60	2.5	36.55	11	0.04	1329.05	44.83	1070.6
		64.98	Diesel	10%	25000	1624.40	2.5	4.06	12	0.03	135.37	4.88	0.12
			CNG										
Bus		71.58				2093.74		37.04					
	Large	10.74											
		10.74	Diesel	100%	25000	268.43	40	10.74	4	0.01	67.11	2.42	57.78
			CNG										
	Mediu	17.90											
		17.90	Diesel	100%	30000	536.86	25	13.42	6	0.01	89.48	3.23	77.04
			CNG										
	Small	42.95											
		42.95	Diesel	100%	30000	1288.46	10	12.88	8	0.01	161.06	5.81	138.67
			CNG										
Motorcycle		134.60				1615.15		2.42					
		134.60	Gasolin	100%	12000	1615.15	1.5	2.42	35	0.02	46.15	1.56	0.04
			Electrici										
Three		10.35				155.27		0.78					
			CNG										
		10.35	Gasolin	100%	15000	155.27	5	0.78	20	0.01	7.76	0.26	6.25
			Electrici								0.00		
			LPG										
Freight						4243.43		18.88					487.15
Truck		169.74				4243.43		18.88					
	Large	8.49											
		8.49	Diesel	100%	25000	212.17	10	2.12	4	0.03	53.04	1.91	45.67
	Mediu	8.49											
		8.49	Diesel	100%	25000	212.17	7	1.49	6	0.02	35.36	1.27	30.45
	Small	152.76											
		152.76	Diesel	100%	25000	3819.08	4	15.28	8	0.03	477.39	17.21	411.03

Bangladesh		Number (Thousand)	Fuel	Share by Fuel	Average Annual Usage	Vehicle Km	Occupancy	Passenger Km	Average Fuel Economy	Energy Intensity	Fuel Use	Fuel Use	Fuel Use
					Km	Million	Persons	Billion	Vehicle Km/Litre	Litres/Pass-	Million	Million	KTOE
							Tons		Vehicle Km/Kwh	Litres/Ton-	Million		
										Kwh/Pass-			
Passenger						20692.9		98.91					1084.
Car		306.98				7444.19		20.91					1084.
		76.74	Gasoline	25%	25000	1918.61	2.5	4.80	12	0.03	159.88	5.39	128.8
		46.05	Diesel	15%	20000	920.93	2.5	2.30	14	0.03	65.78	2.37	56.64
		184.19	CNG	60%	25000	4604.66	3	13.81	18	0.02	255.81	4.85	115.9
Bus		119.80				2130.50		48.98					
	Large	27.78											
		27.78	Diesel	100%	20000	555.56	40	22.22	5	0.01	111.11	4.01	95.67
			CNG										
	Medium	25.64											
		25.64	Diesel	100%	20000	512.88	25	12.82	7	0.01	73.27	2.64	63.08
			CNG										
	Small	66.38											
		53.10	Diesel	80%	20000	1062.06	10	10.62	8	0.01	132.76	4.79	114.3
		13.28	CNG	20%	25000	331.90	10	3.32	10	0.01	33.19	1.12	26.74
Motorcycle		759.26				7592.57		11.39					
		759.26	Gasoline	100%	10000	7592.57	1.5	11.39	35	0.02	216.93	7.32	174.7
			Electricity										
Three		141.03				3525.73		17.63					
		42.31	CNG	30%	25000	1057.72	5	5.29	8	0.03	132.21	2.51	59.92
		98.72	Gasoline	70%	25000	2468.01	5	12.34	8	0.03	308.50	10.41	248.5
			LPG										
Freight						3788.80		27.09					681.6
Truck		166.31				3788.80		27.09					
	Large	85.58											
		85.58	Diesel	100%	23000	1968.27	10	19.68	3.5	0.03	562.36	20.27	484.2
	Medium	1.65											
		1.65	Diesel	100%	25000	41.17	7	0.29	6	0.02	6.86	0.25	5.91
	Small	79.08											
		79.08	Diesel	100%	22500	1779.37	4	7.12	8	0.03	222.42	8.02	191.5

Bhutan		Number (Thousand)	Fuel	Share by Fuel	Average Annual Usage	Vehicle Km	Occupancy	Passenger Km	Average Fuel Economy	Energy Intensity	Fuel Use	Fuel Use	Fuel Use
					Km	Million	Persons	Billion	Vehicle Km/Litre	Litres/Pass-	Million	Million	KTOE
							Tons		Vehicle Km/Kwh	Litres/Ton-	Million		
										Kwh/Pass-			
Passenger						829.812		7.60					86.51
Car		3.60				125.1		0.25					
		3.42	Gasoline	95%	35000	119.7	2	0.24	11	0.05	10.88	0.37	8.77
		0.18	Diesel	5%	30000	5.4	2	0.01	12	0.04	0.45	0.02	0.36
Bus		19.37				484.212		7.02					
	Large	3.28											
		3.28	Diesel	100%	25000	82.1	35	2.87	3.5	0.01	23.46	0.85	20.20
			CNG										
	Medium	0.50											
		0.50	Diesel	100%	25000	12.5875	20	0.25	5	0.01	2.52	0.09	2.17
			CNG										
	Small	15.58											
		15.58	Diesel	100%	25000	389.525	10	3.90	7	0.01	55.65	2.01	47.91
			CNG										
Motorcycle		8.82				220.5		0.33					
		8.82	Gasoline	100%	25000	220.5	1.5	0.33	25	0.03	8.82	0.30	7.11
			Electricity										
Three													
			CNG										
			Gasoline										
			LPG									0.00	0.00
Freight						539.862		2.88					93.10
Truck		21.59				539.862		2.88					
	Large	4.54											
		4.54	Diesel	100%	25000	113.6	10	1.14	2.5	0.04	45.44	1.64	39.12
	Medium	0.50											
		0.50	Diesel	100%	25000	12.5875	7	0.09	3.5	0.04	3.60	0.13	3.10
	Small	16.55											
		16.55	Diesel	100%	25000	413.675	4	1.65	7	0.04	59.10	2.13	50.88

India		Number (Thousand)	Fuel	Share by Fuel	Average Annual Usage	Vehicle Km	Occupancy	Passenger Km	Average Fuel Economy	Energy Intensity	Fuel Use	Fuel Use	Fuel Use
						Million	Persons	Billion	Vehicle Km/Litre	Litres/Pass-	Million	Million	KTOE
							Tons		Vehicle Km/Kwh	Litres/Ton-	Million		
										Kwh/Pass-			
						145889		3221.82					55371
Cars		22740.00				566226.		1415.57					
		454.80	Gasoline	2%	20000	9096.00	2.5	22.74	12	0.03	758.00	25.57	610.6
		13644.00	Diesel	60%	25000	341100.	2.5	852.75	13	0.03	26238.46	945.85	22591
		8641.20	CNG	38%	25000	216030.	2.5	540.08	14	0.03	15430.71	292.78	6992.
Bus		176.64				8832.10		253.92					
	Large	88.32											
		88.32	Diesel	100%	50000	4416.05	40	176.64	3.5	0.01	1261.73	45.48	1086.
			CNG										
	Medium	44.16											
		44.16	Diesel	100%	50000	2208.03	25	55.20	5	0.01	441.61	15.92	380.2
			CNG										
	Small	44.16											
		44.16	Diesel	100%	50000	2208.03	10	22.08	8	0.01	276.00	9.95	237.6
			CNG										
Motorcycle		91597.00				732776.		1099.16					
		91597.00	Gasoline	100%	8000	732776.	1.5	1099.16	35	0.02	20936.46	706.16	16866
			Electricity										
Three		7552.80				151056.		453.17					
		6797.52	CNG	90%	20000	135950.	3	407.85	15	0.02	9063.36	227.49	5433.
		755.28	Gasoline	10%	20000	15105.6	3	45.32	12	0.03	1258.80	49.08	1172.
			LPG										
Freight						321596.		2395.89					81486
Truck		6431.93				321596.		2395.89					
	Large	2894.37											
		2894.37	Diesel	100%	50000	144718.	10	1447.18	2.5	0.04	57887.33	2086.7	49841
	Medium	1607.98											
		1607.98	Diesel	100%	50000	80399.0	7	562.79	3.5	0.04	22971.16	828.07	19778
	Small	1929.58											
		1929.58	Diesel	100%	50000	96478.8	4	385.92	7	0.04	13782.70	496.84	11866

Nepal		Number (Thousand)	Fuel	Share by Fuel	Average Annual Usage	Vehicle Km	Occupancy	Passenger Km	Average Fuel Economy	Energy Intensity	Fuel Use	Fuel Use	Fuel Use
					Km	Million		Billion	Vehicle Km/Litre	Litres/Pass-	Million	Million	KTOE
									Vehicle Km/Kwh	Litres/Ton-	Million		
										Kwh/Pass-			
Passenger						8988.33		34.74					361.0
Car		120.43				1204.29		2.41					
		12.04	Gasoline	10%	10000	120.43	2	0.24	12	0.04	10.04	0.34	8.08
		101.16	Diesel	84%	10000	1011.60	2	2.02	13	0.04	77.82	2.81	67.00
			CNG										
		7.23	LPG	6%	10000	72.26	2	0.14	11	0.05	6.57	0.16	3.94
Bus		32.52				600.76		21.25					
	Large	24.79											
		24.79	Diesel	100%	18000	446.22	40	17.85	4	0.01	111.56	4.02	96.05
			CNG										
	Medium	5.40											
		5.40	Diesel	100%	20000	108.08	25	2.70	6	0.01	18.01	0.65	15.51
			CNG										
	Small	2.32											
		2.32	Diesel	100%	20000	46.46	15	0.70	8	0.01	5.81	0.21	5.00
			CNG										
Motorcycle		886.75				7093.96		10.64					
		886.75	Gasoline	100%	8000	7093.96	1.5	10.64	35	0.02	202.68	6.84	163.2
			Electricity										
Three		7.44				89.32		0.45					
			CNG										
		3.72	LPG	50%	12000	44.66	5	0.22	15	0.01	2.98	0.07	1.78
		3.72	Electricity	50%	12000	44.66	5	0.22	10	0.02	4.47	0.02	0.38
Freight						1976.64		12.25					310.1
Truck		131.78				1976.64		12.25					
	Large	45.53											
		45.53	Diesel	100%	15000	682.91	10	6.83	3.5	0.03	195.12	7.03	168.0
	Medium	5.40											
		5.40	Diesel	100%	15000	81.06	7	0.57	6	0.02	13.51	0.49	11.63
	Small	80.85											
		80.85	Diesel	100%	15000	1212.68	4	4.85	8	0.03	151.58	5.46	130.5

Maldives		Number (Thousand)	Fuel	Share by Fuel	Average Annual Usage	Vehicle Km	Occupancy	Passenger Km	Average Fuel Economy	Energy Intensity	Fuel Use	Fuel Use	Fuel Use
					Km	Million	Persons	Billion	Vehicle Km/Litre	Litres/Pass-	Million	Million	KTOE
							Tons		Vehicle Km/Kwh	Litres/Ton-	Million		
										Kwh/Pass-			
Passenger						873.15		1.39					32.22
Car		3.74				93.48		0.19					
		3.37	Gasoline	90%	25000	84.13	2	0.17	11	0.05	7.65	0.26	6.16
		0.37	Diesel	10%	25000	9.35	2	0.02	12	0.04	0.78	0.03	0.67
			CNG										
Bus		0.10				2.48		0.04					
	Large	0.01											
		0.01	Diesel	100%	25000	0.25	30	0.01	3.5	0.01	0.07	0.00	0.06
		0.10	CNG										
	Medium	0.02											
		0.02	Diesel	100%	25000	0.62	20	0.01	5	0.01	0.12	0.00	0.11
		0.25	CNG										
	Small	0.06											
		0.06	Diesel	100%	25000	1.61	10	0.02	8	0.01	0.20	0.01	0.17
		0.65	CNG										
Motorcycle		38.86				777.20		1.17					
		38.86	Gasoline	100%	20000	777.20	1.5	1.17	25	0.03	31.09	1.05	25.04
			Electricity										
Three													
			CNG										
			LPG										
			Electricity										
Freight						130.48		0.82					18.32
Truck		5.22				130.48		0.82					
	Large	1.30	0.25										
		1.30	Diesel	100%	25000	32.62	10	0.33	5	0.02	6.52	0.24	5.62
	Medium	1.30											
		1.30	Diesel	100%	25000	32.62	7	0.23	6	0.02	5.44	0.20	4.68
	Small	2.61											
		2.61	Diesel	100%	25000	65.24	4	0.26	7	0.04	9.32	0.34	8.02

Pakistan		Number (Thousand)	Fuel	Share by Fuel	Average Annual Usage	Vehicle Km	Occupancy	Passenger Km	Average Fuel Economy	Energy Intensity	Fuel Use	Fuel Use	Fuel Use
					Km	Million	Persons	Billion	Vehicle Km/Litre	Litres/Pass-	Million	Million	KTOE
							Tons		Vehicle Km/Kwh	Litres/Ton-	Million		
										Kwh/Pass-			
Passenger						188904.0		533.66					6086.
Car		3055.27				117016.9		351.05					
		305.53	Gasoline	10%	35000	10693.45	3	32.08	12	0.03	891.12	30.06	717.8
		305.53	Diesel	10%	28000	8554.76	3	25.66	14	0.02	611.05	22.03	526.1
		2444.22	CNG	80%	40000	97768.70	3	293.31	16	0.02	6110.54	115.94	2769.
			LPG										
			Electricity										
Bus		125.58				3566.59		77.26					
	Large	25.12							s				
		25.12	Diesel	100%	30000	753.50	40	30.14	4	0.01	188.38	6.79	162.1
			CNG										0.00
	Medium	25.12											0.00
		25.12	Diesel	100%	28000	703.27	25	17.58	7	0.01	100.47	3.62	86.50
			CNG										0.00
	Small	75.35											0.00
		75.35	Diesel	100%	28000	2109.81	14	29.54	8	0.01	263.73	9.51	227.0
			CNG										
Motorcycle		5468.85				65626.22		91.88					
		5468.85	Gasoline	100%	12000	65626.22	1.4	91.88	35	0.02	1875.03	63.24	1510.
			Electricity										
Three		89.81				2694.36		13.47					
			CNG										
		89.81	Gasoline	100%	30000	2694.36	5	13.47	25	0.01	107.77	3.64	86.82
			Electricity										
Freight						32450.88		232.02					5014.
Truck		1298.04				32450.88		232.02					
	Large	519.21											
		519.21	Diesel	100%	25000	12980.35	10	129.80	4	0.03	3245.09	116.98	2794.
	Medium	324.51											
		324.51	Diesel	100%	25000	8112.72	7	56.79	7	0.02	1158.96	41.78	997.8
	Small	454.31											
		454.31	Diesel	100%	25000	11357.81	4	45.43	8	0.03	1419.73	51.18	1222.

Sri Lanka		Number (Thousand)	Fuel	Share by Fuel	Average annual usage	Vehicle Km	Occupancy	Passenger Km	Average Fuel Economy	Energy Intensity	Fuel Use	Fuel Use	Fuel Use
					Km	Million	Persons	Billion	Vehicle Km/Litre	Litres/Pass-	Million	Million	KTOE
							Tons		Vehicle Km/Kwh	Litres/Ton-	Million		
										Kwh/Pass-			
Passenger						26354.7		99.94					1085.
Car		410.28				6154.23		18.46					
		82.06	Gasoline	20%	15000	1230.85	3	3.69	13	0.03	94.68	3.19	76.28
		328.23	Diesel	80%	15000	4923.38	3	14.77	14	0.02	351.67	12.68	302.7
			CNG										
			LPG										
			Electricity										
Bus		84.28				1264.20		38.24					
	Large	46.35											
		46.35	Diesel	100%	15000	695.31	40	27.81	4	0.01	173.83	6.27	149.6
			CNG										
	Medium	21.07											
		21.07	Diesel	100%	15000	316.05	25	7.90	7	0.01	45.15	1.63	38.87
			CNG										
	Small	16.86											
		16.86	Diesel	100%	15000	252.84	10	2.53	8	0.01	31.61	1.14	27.21
			CNG										
Motorcycle		2100.00				14700.0		22.05					
		2100.00	Gasoline	100%	7000	14700.0	1.5	22.05	45	0.01	326.67	11.02	263.1
			Electricity										
Three		529.54				4236.34		21.18					
			CNG										
		529.54	Gasoline	100%	8000	4236.34	5	21.18	15	0.01	282.42	9.53	227.5
			LPG										
Freight						4450.38		36.49					780.0
Truck		296.69				4450.38		36.49					
	Large	178.02											
		178.02	Diesel	100%	15000	2670.23	10	26.70	4	0.03	667.56	24.06	574.7
	Medium	59.34											
		59.34	Diesel	100%	15000	890.08	7	6.23	7	0.02	127.15	4.58	109.4
	Small	59.34											
		59.34	Diesel	100%	15000	890.08	4	3.56	8	0.03	111.26	4.01	95.79

Annexure-B

Countries	Years (2001-2010)	Population (Million)	No. of Passenger Vehicles	Transport Demand Passenger (Pass-Km)	No. of Freight vehicles	Transport Demand Freight (Ton-Km)
AFGHANISTAN	2001	21.30				
	2002	22.20				
	2003	23.10				
	2004	24.00				
	2005	24.90				
	2006	25.60				
	2007	26.30				
	2008	27.00	348614	66970037000	135446	15068367500
	2009	27.70	793167	73611820000	156469	17407176250
	2010	28.40	866288.00	80852220500	169737	18883241250
	Average Annual Growth Rate	3.25%	57.64%	9.88%	11.95%	11.95%
BANGLADESH	2001	134.70				
	2002	137.00				
	2003	139.20				
	2004	141.20				
	2005	143.10				
	2006	144.90				
	2007	146.50				
	2008	148.00				

Countries	Years (2001-2010)	Population (Million)	No. of Passenger Vehicles	Transport Demand Passenger (Pass-Km)	No. of Freight vehicles	Transport Demand Freight (Ton-Km)
	2009	149.50	1163462.00	90840905625	138078	23823227900
	2010	151.10	1327064.00	98914278125	164660	26024513000
	Average Annual Growth Rate	1.28%	14.06%	8.89%	19.25%	9.24%
BHUTAN	2001	0.60	15381.50	1549141125	7145	474814625
	2002	0.60	17108.00	1674486125	7322	485546250
	2003	0.60	17813.00	1936479875	8683	585653500
	2004	0.60	18162.00	1998536875	10067	677935000
	2005	0.70	18602.50	2188142000	9869	686472500
	2006	0.70	20901.00	2488264500	11680	798064875
	2007	0.70	22082.00	2755311625	13622	906569125
	2008	0.70	25008.50	3237792000	16269	1082960375
	2009	0.70	27450.50	3606709250	18368	1218634500
	2010	0.70	31787.50	4193128000	21594	1426209875
	Average Annual Growth Rate	1.73%	8.40%	11.70%	13.08%	13.00%
INDIA	2001	1060	51707810	972708573	7216527	19261159225000
	2002	1077	58953605	994350134	8053679	21960217862500
	2003	1094	64308066	1055608745	8409869	23954754585000
	2004	1111	72135801	1122435207	9365918	26870585872500
	2005	1127	79524637	1210090228	9093630	29622927282500
	2006	1143	85573812	1303992693	11133448	31876244970000

Countries	Years (2001-2010)	Population (Million)	No. of Passenger Vehicles	Transport Demand Passenger (Pass-Km)	No. of Freight vehicles	Transport Demand Freight (Ton-Km)
	2007	1159	93346244	1413772147	12006610	34771475890000
	2008	1175	100897103	1449722723	12883932	37584170867500
	2009	1190	102067103	1553351636	12883930	38019995867500
	2010	1206	114514439	1691249201	13984802	42656628527500
	Average Annual Growth Rate	1.44%	9.24%	6.34%	7.63%	9.24%
NEPAL	2001	23.70	303364	41849534	61080	42774324000
	2002	24.10	337217	42521064	64837	47547597000
	2003	24.50	346627	44897586	68579	48874407000
	2004	24.90	410850	47551502	71614	57929850000
	2005	25.30	462867	50804226	74572	65264247000
	2006	25.60	543835	54384022	82339	76680735000
	2007	26.00	621460	58512842	89454	87625860000
	2008	26.20	715502	60129283	97982	100885782000
	2009	26.50	901265	64119232	114006	127078365000
	2010	26.80	1054864	69427860	124047	148735824000
	Average Annual Growth Rate	1.38%	14.85%	5.79%	8.19%	14.85%
MALDIVES	2001	0.30				
	2002	0.30				
	2003	0.30				
	2004	0.30				
	2005	0.30				
	2006	0.30				

Countries	Years (2001-2010)	Population (Million)	No. of Passenger Vehicles	Transport Demand Passenger (Pass-Km)	No. of Freight vehicles	Transport Demand Freight (Ton-Km)
	2007	0.30				
	2008	0.30				
	2009	0.30	42698	1388637500	5122	800312500
	2010	0.30	46509	1517590000	5219	815468750
	Average Annual Growth Rate	0.00	8.93%	9.29%	1.89%	1.89%
PAKISTAN	2001	146.90				
	2002	149.70	3986614	310460983900	983513	175802948750
	2003	152.40	4052744	319697969400	1011902	180877482500
	2004	155.20	4302544	326343056500	1028415	183829181250
	2005	158.00	4330062	325522202500	1044367	186680601250
	2006	160.90	4547389	344585302000	1085964	194116065000
	2007	163.90	4767515	360982125000	1140298	203828267500
	2008	167.00	5037535	379824616900	1164220	208104325000
	2009	170.10	5342979	401993284700	1216385	217428818750
	2010	173.10	6554967	437372102900	1298035	232023756250
	Average Annual Growth Rate	1.84%	6.41%	4.38%	3.53%	3.53%
SRILANKA	2001	18.80				
	2002	18.90				
	2003	19.20	1670159	60037952000	585212	23107593750
	2004	19.40	1903037	64899354000	618516	24351817500
	2005	19.60	2095757	69592812000	661292	26009775000

Countries	Years (2001-2010)	Population (Million)	No. of Passenger Vehicles	Transport Demand Passenger (Pass-Km)	No. of Freight vehicles	Transport Demand Freight (Ton-Km)
	2006	19.90	2408656	76512545000	719768	28385460000
	2007	20.00	2658272	82315829000	765414	30525390000
	2008	20.20	2851802	87169450000	804390	32157307500
	2009	20.50	2988201	90666685500	810942	33113463750
	2010	20.70	3440959	98364946000	872595	34490445000
	Average Annual Growth Rate	1.08%	10.88%	7.31%	5.87%	`5.89%

GNI Per Capita (Current USD)										
	Year									
Countries	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Afghanistan				220	250	280	340	370	470	520
Bangladesh	430	420	450	490	540	560	590	650	710	780
Bhutan	820	860	950	1070	1220	1340	1630	1750	1830	1990
India	460	470	530	620	730	810	950	1030	1150	1260
Maldives			3500	4100	3770	4530	4570	5430	5460	5960
Nepal	240	240	260	290	310	340	380	440	490	540
Pakistan	500	520	560	640	740	820	910	1020	1060	1080
Sri Lanka	830	860	950	1070	1220	1350	1540	17770	1970	2360
Source: World Bank										

GDP (Current USD)										
Countries	Year									
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Afghanistan	2461666315	4.1E+09	4.58E+09	5.29E+09	6.28E+09	7.06E+09	9.84E+09	1.02E+10	1.25E+10	1.59E+10
Bangladesh	53991289844	5.5E+10	6.02E+10	6.51E+10	6.94E+10	7.18E+10	7.96E+10	9.16E+10	1.02E+11	1.15E+11
Bhutan	476360697.2	5.4E+08	6.22E+08	7.03E+08	8.19E+08	8.98E+08	1.2E+09	1.26E+09	1.26E+09	1.59E+09
India	4.93954E+11	5.2E+11	6.18E+11	7.22E+11	8.34E+11	9.49E+11	1.24E+12	1.22E+12	1.37E+12	1.71E+12
Maldives	884276170.9	9.1E+08	1.04E+09	1.2E+09	1.12E+09	1.47E+09	1.75E+09	2.12E+09	2.17E+09	2.33E+09
Nepal	6007061224	6.1E+09	6.33E+09	7.27E+09	8.13E+09	9.04E+09	1.03E+10	1.25E+10	1.29E+10	1.6E+10
Pakistan	72309738921	7.2E+10	8.32E+10	9.8E+10	1.1E+11	1.37E+11	1.52E+11	1.7E+11	1.68E+11	1.77E+11
Sri Lanka	15746224409	1.7E+10	1.89E+10	2.07E+10	2.44E+10	2.83E+10	3.24E+10	4.07E+10	4.21E+10	4.96E+10
Source: World Bank										

Countries	GNI/Capita Growth Rate				GDP Growth Rate			
	2011	2012	2013	2014	2011	2012	2013	2014
Afghanistan	9.6%	21.1%	0.0%	-2.9%	6.10%	14.40%	1.90%	2%
Bangladesh	11.5%	9.2%	6.3%	6.9%	6.50%	6.50%	6%	6.10%
Bhutan	9.0%	6.9%	12.9%	11.8%	7.90%	5.10%	2%	6.30%
India	11.9%	6.4%	2.0%	2.6%	6.60%	5.10%	6.90%	7.40%
Maldives	11.4%	0.5%	0.9%	6.5%	10.80%	1.50%	7.70%	7.60%
Nepal	13.0%	13.1%	4.3%	1.4%	3.40%	4.90%	3.80%	5.50%
Pakistan	6.5%	9.6%	7.9%	7.4%	2.70%	3.50%	4.40%	5.40%
Sri Lanka	14.2%	12.8%	9.3%	6.9%	8.20%	6.%3	7.20%	7.40%
Source: World Bank								

Annexure-C (Energy Demand in Different Scenarios)

AFGHANISTAN

BAU (KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	1174.2	1513	1844.5	2248	2739	3336.2	4062.1
Buses	286.1	368.6	449.4	547.7	667.3	812.8	989.7
Motor Cycle	36.5	47	57.3	69.9	85.1	103.7	126.2
Three Wheelers	6.1	7.8	9.6	11.6	14.2	17.3	21
Passenger	1502.9	1936.4	2360.8	2877.2	3505.6	4270	5199
Freight	508.7	629.9	724.8	833.8	958.9	1102.4	1267
Total	2011.6	2566.3	3085.6	3711	4464.5	5372.4	6466

GASELEC (KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	1174.2	1473.6	1749	2074.3	2458.3	2911	3444.4
Buses	286.1	361	431	514.3	613.2	730.7	870
Motor Cycle	36.5	45	52.3	60.8	70.6	81.1	94.6
Three Wheelers	6.1	7.6	9.1	10.7	12.7	15.1	17.8
Passenger	1502.9	1887.2	2241.4	2660.1	3154.8	3737.9	4426.8
Freight	508.7	629.9	724.8	833.8	958.9	1102.4	1267
Total	2011.6	2517.1	2966.2	3493.9	4113.7	4840.3	5693.8

EFFTECH (KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	1174.2	1487.3	1780.9	2129.7	2543.4	3032.9	3610.8
Buses	286.1	362.4	433.9	518.9	619.7	738.9	879.7
Motor Cycle	36.5	46.2	55.3	66.2	79.1	94.3	112.2
Three Wheelers	6.1	7.7	9.2	11	13.2	15.7	18.7
Passenger	1502.9	1903.6	2279.3	2725.8	3255.4	3881.8	4621.4
Freight	508.7	619.2	699.8	789.9	890.4	1002.2	1126.2
Total	2011.6	2522.8	2979.1	3515.7	4145.8	4884	5747.6

MASSTRANS (KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	1174.2	1449.9	1690.8	1967	2282.5	2641.1	3046.6
Buses	286.1	366.7	444.6	539	653.2	791.3	958.3
Motor Cycle	36.5	45.1	52.5	61.1	70.9	82.1	94.7
Three Wheelers	6.1	7.5	8.8	10.2	11.8	13.7	15.8
Passenger	1502.9	1869.2	2196.7	2577.3	3018.4	3528.2	4115.4
Freight	509.7	609.9	679.1	755.3	839.2	931.3	1032.3
Total	2011.6	2479.1	2875.8	3332.6	3857.6	4459.5	5147.7

(KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
BAU	2011.6	2566.3	3085.6	3711	4464.5	5372.4	6466
GASELEC	2011.6	2517.1	2966.2	3493.9	4113.7	4840.3	5693.8
EFFTECH	2011.6	2522.8	2979.1	3515.7	4145.8	4884	5747.6
MASSTRANS	2011.6	2479.1	2875.8	3332.6	3857.6	4459.5	5147.7
Combined	2011.6	2386.4	2649.9	2920.2	3188.1	3439	3657.1

BANGLADESH

BAU (KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	219.3	310.9	376.8	455.7	550	662.1	795.1
Buses	291.5	423.7	527.3	656	815.8	1014.2	1260.5
Motor Cycle	171.3	249	309.8	385.4	479.4	596	740.7
Three Wheelers	261.8	381	474.6	591.2	736.1	916.4	1140.5
Passenger	943.9	1364.6	1688.5	2088.3	2581.3	3188.7	3936.8
Freight	713.5	919.8	1178.9	1509.4	1930.4	2466	3146.2
Total	1657.4	2284.4	2867.4	3597.7	4511.7	5654.7	7083

GASELEC (KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	219.3	310.8	377	457.2	554.3	671.9	814.2
Buses	291.5	419.9	517.9	638.7	787.8	971.6	1198.4
Motor Cycle	171.3	244.1	297.6	362.5	441.2	536.6	652
Three Wheelers	261.8	390.6	498.2	634.7	807.4	1025.7	1301.2
Passenger	943.9	1365.4	1690.7	2093.1	2590.7	3205.8	3965.8
Freight	713.5	919.8	1178.9	1509.4	1930.4	2466	3146.2
Total	**1657.4**	**2285.2**	**2869.6**	**3602.5**	**4521.1**	**5671.8**	**7112**

EFFTECH (KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	219.3	307.3	367.6	438.4	520.7	615.8	724.7
Buses	291.5	416.5	509.1	621.4	757.5	922	1120.5
Motor Cycle	171.3	244.8	299.2	365.2	445.1	541.8	658.4
Three Wheelers	261.8	375	459.4	562.2	687.3	839.1	1023
Passenger	943.9	1343.6	1635.3	1987.2	2410.6	2918.7	3526.6
Freight	713.5	916.8	1170.9	1493.4	1902.3	2419.5	3072.4
Total	**1657.4**	**2260.4**	**2806.2**	**3480.6**	**4312.9**	**5338.2**	**6599**

MASSTRANS (KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	219.3	293	333.5	377.2	423.6	471.9	521
Buses	291.5	415.4	506.6	617.4	751.9	914.9	1112.4
Motor Cycle	171.3	267.1	355	469.8	619.2	813.4	1064.9
Three Wheelers	261.8	374.1	457.5	559.2	683	833.7	1017
Passenger	943.9	1349.6	1652.6	2023.6	2477.7	3033.9	3715.3
Freight	713.5	919.8	1178.9	1509.4	1930.5	2466	3146.2
Total	**1657.4**	**2269.4**	**2831.5**	**3533**	**4408.2**	**5499.9**	**6861.5**

(KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
BAU	1657.4	2284.4	2867.4	3597.7	4511.7	5654.7	7083
GASELEC	1657.4	2285.2	2869.6	3602.5	4521.1	5671.8	7112
EFFTECH	1657.4	2260.4	2806.2	3480.6	4312.9	5338.2	6599
MASSTRANS	1657.4	2269.4	2831.5	3533	4408.2	5499.9	6861.5
Combined	1657.4	2244.6	2768.1	3411.1	4200	5166.3	6348.5

BHUTAN

BAU(KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	9	15.6	20.7	27.4	36.4	48.3	64
Buses	73.5	126.9	168.5	223.6	296.7	393.5	521.7
Motor Cycle	7	12.1	16	21.3	28.3	37.5	49.7
Three Wheelers							
Passenger	89.5	154.6	205.2	272.3	361.4	479.3	635.4
Freight	97.4	132.9	187.6	264.8	373.6	527	743
Total	**186.9**	**287.5**	**392.8**	**537.1**	**735**	**1006.3**	**1378.4**

GASELEC (KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	9	15.1	19.5	25.2	32.4	41.7	53.7
Buses	73.5	123.9	160.7	208.2	269.8	349.4	452.4
Motor Cycle	7	11.9	15.6	25.2	32.4	41.7	53.7
Three Wheelers							
Passenger	89.5	150.9	195.8	258.6	334.6	432.8	559.8
Freight	97.4	132.9	187.6	264.8	373.6	527	743
Total	**186.9**	**283.8**	**383.4**	**523.4**	**708.2**	**959.8**	**1302.8**

EFFTECH (KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	9	15.3	20	26	33.8	43.9	56.9
Buses	73.5	124.7	162.7	211.8	275.5	357.7	463.7
Motor Cycle	7	11.9	15.5	20.2	26.2	34.1	44.2
Three Wheelers							
Passenger	89.5	151.9	198.2	258	335.5	435.7	564.8
Freight	97.4	130.6	181.1	250.8	346.9	479.1	660.5
Total	**186.9**	**282.5**	**379.3**	**508.8**	**682.4**	**914.8**	**1225.3**

MASSTRANS (KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	9	15.6	20.7	27.4	36.4	48.3	64
Buses	73.5	125.3	164.2	215.1	281.7	368.7	482.2
Motor Cycle	7	12.1	16	21.3	28.3	37.5	49.7
Three Wheelers							
Passenger	89.5	153	200.9	263.8	346.4	454.5	595.9
Freight	97.4	133.2	188.6	267	377.7	534.2	755.3
Total	**186.9**	**286.2**	**389.5**	**530.8**	**724.1**	**988.7**	**1351.2**

(KTOE)	2010	2015	2020	2025	2030	2035	2040
BAU	186.9	287.5	392.8	537.1	735	1006.3	1378.4
GASELEC	186.9	283.8	383.4	523.4	708.2	959.8	1302.8
EFFTECH	186.9	282.5	379.3	508.8	682.4	914.8	1225.3
MASSTRANS	186.9	286.2	389.5	530.8	724.1	988.7	1351.2
Combined	**186.9**	**277.5**	**366.6**	**488.8**	**644.7**	**850.7**	**1122.5**

INDIA

BAU (MTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	26.3	31.8	37.3	43.6	51	59.6	69.6
Buses	1.8	2.2	2.5	3	3.5	4	4.7
Motor Cycle	16.6	20.1	23.5	27.5	32.2	37.6	43.9
Three Wheelers	2.2	2.7	3.1	3.6	4.2	5	5.8
Passenger	46.9	56.8	66.4	77.7	90.9	106.2	124
Freight	85.2	109.5	142.3	185	240.4	312.3	405.6
Total	**132.1**	**166.3**	**208.7**	**262.7**	**331.3**	**418.5**	**529.6**

GASELEC (MTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	26.3	30.3	33.7	37.4	41.3	45.6	50.1
Buses	1.8	2.1	2.5	2.9	3.3	3.9	4.5
Motor Cycle	16.6	19.8	22.7	26.1	30	34.5	39.6
Three Wheelers	2.2	2.5	2.7	2.9	3.1	3.3	3.4
Passenger	46.9	54.7	61.6	69.3	77.7	87.3	97.6
Freight	85.2	109.5	142.3	185	240.4	312.3	405.6
Total	**132.1**	**164.2**	**203.9**	**254.3**	**318.1**	**399.6**	**503.2**

EFFTECH (MTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	26.3	31.3	36.1	41.5	47.6	54.6	62.5
Buses	1.8	2.1	2.4	2.8	3.2	3.7	4.2
Motor Cycle	16.6	19.8	22.7	26.1	29.9	34.2	39.1
Three Wheelers	2.2	2.6	3.1	3.5	4.1	4.8	5.5
Passenger	46.9	55.8	64.3	73.9	84.8	97.3	111.3
Freight	85.2	106.7	135.2	171.1	216.4	273.3	344.7
Total	**132.1**	**162.5**	**199.5**	**245**	**301.2**	**370.6**	**456**

MASSTRANS (MTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	26.3	30.5	34.2	38.1	42.5	47.2	52.2
Buses	1.8	2.5	3.4	4.5	5.8	7.5	9.5
Motor Cycle	16.6	19.3	21.6	24.1	26.8	29.8	33
Three Wheelers	2.2	2.5	2.8	3.2	3.5	3.9	4.4
Passenger	46.9	54.8	62	69.9	78.6	88.4	99.1
Freight	85.2	106.7	135.2	171.1	216.4	273.3	344.7
Total	**132.1**	**161.5**	**197.2**	**241**	**295**	**361.7**	**443.8**

(MTOE)	2010	2015	2020	2025	2030	2035	2040
BAU	132.1	166.3	208.7	262.7	331.3	418.5	529.6
GASELEC	132.1	164.2	203.9	254.3	318.1	399.6	503.2
EFFTECH	132.1	162.5	199.5	245	301.2	370.6	456
MASSTRANS	132.1	161.5	197.2	241	295	361.7	443.8
Combined	**132.1**	**155.6**	**183.2**	**214.9**	**251.7**	**294.9**	**343.8**

MALDIVES

BAU (KTOE)	2010	2015	2020	2025	2030	2035	2040
Cars	6.7	8.3	9.9	11.8	14.1	16.8	20
Buses	0.4	0.4	0.5	0.6	0.7	0.9	1.1
Motor Cycle	24.5	30.2	36	42.9	51.2	61	72.7
Three Wheelers							
Passenger	31.6	38.9	46.4	55.3	66	78.7	93.8
Freight	22.6	24.2	26	28	30.1	32.4	34.9
Total	**54.2**	**63.1**	**72.4**	**83.3**	**96.1**	**111.1**	**128.7**

GASELEC (KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	6.7	8	9.3	10.8	12.5	14.5	16.7
Buses	0.4	0.4	0.5	0.6	0.7	0.8	1
Motor Cycle	24.5	29.3	33.9	39.2	45.3	52.2	60.2
Three Wheelers							
Passenger	31.6	37.7	43.7	50.6	58.5	67.5	77.9
Freight	22.6	24.2	26	28	30.1	32.4	34.9
Total	**54.2**	**61.9**	**69.7**	**78.6**	**88.6**	**99.9**	**112.8**

EFFTECH (KTOE)							
	2010	2015	2020	2025	2030	2035	2040
Cars	6.7	8.1	9.5	11.2	13	15.2	17.7
Buses	0.4	0.4	0.5	0.6	0.7	0.8	0.9
Motor Cycle	24.5	29.6	34.7	40.7	47.5	55.5	64.7
Three Wheelers							
Passenger	31.6	38.1	44.7	52.5	61.2	71.5	83.3
Freight	22.6	23.8	25.1	26.5	28	29.5	31
Total	**54.2**	**61.9**	**69.8**	**79**	**89.2**	**101**	**114.3**

MASSTRANS (KTOE)							
	2010	2015	2020	2025	2030	2035	2040
Cars	6.7	7.9	9.1	10.3	11.7	13.3	15
Buses	0.4	1.1	2.2	3.5	5.4	7.8	11
Motor Cycle	24.5	28.9	33	37.6	42.7	48.3	54.6
Three Wheelers							
Passenger	31.6	37.9	44.3	51.4	59.8	69.4	80.6
Freight	22.6	23.9	25.4	27	28.7	30.5	32.4
Total	**54.2**	**61.8**	**69.7**	**78.4**	**88.5**	**99.9**	**113**

(KTOE)	2010	2015	2020	2025	2030	2035	2040
BAU	54.2	63.1	72.4	83.3	96.1	111.1	128.7
GASELEC	54.2	61.9	69.7	78.6	88.6	99.9	112.8
EFFTECH	54.2	61.9	69.8	79	89.2	101	114.3
MASSTRANS	54.2	61.8	69.7	78.4	88.5	99.9	113
Combined	**54.2**	**59.4**	**64.4**	**69.4**	**74.1**	**78.6**	**82.7**

NEPAL

BAU (KTOE)	2010	2015	2020	2025	2030	2035	2040
Cars	78.6	101.8	120.4	142.5	168.5	199.1	235.3
Buses	121.9	157.9	186.9	221.1	261.4	309.1	365.3
Motor Cycle	160	207.3	245.3	290.2	343.1	405.6	479.3
Three Wheelers	2.2	2.8	3.4	4	4.8	5.6	6.7
Passenger	362.7	469.8	556	657.8	777.8	919.4	1086.6
Freight	323.9	430	596	825.8	1143.8	1583.8	2192.4
Total	**686.6**	**899.8**	**1152**	**1483.6**	**1921.6**	**2503.2**	**3279**

GASELEC (KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	78.6	99.4	114.8	132.6	153	176.3	203.1
Buses	121.9	156.6	183.7	215.6	252.9	296.8	348.2
Motor Cycle	160	201.6	231.8	266.3	305.7	350.6	401.6
Three Wheelers	2.2	2.9	3.4	4	4.8	5.7	6.7
Passenger	362.7	460.5	533.7	618.5	716.4	829.4	959.6
Freight	323.9	430	596	825.8	1143.8	1583.8	2192.4
Total	**686.6**	**890.5**	**1129.7**	**1444.3**	**1860.2**	**2413.2**	**3152**

EFFTECH (KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	78.6	100	116.2	134.9	156.4	181	209.2
Buses	121.9	155.3	180.5	209.5	242.9	281.2	325.1
Motor Cycle	160	203.8	236.9	274.9	318.6	368.7	426
Three Wheelers	2.2	2.8	3.3	3.8	4.5	5.2	6.1
Passenger	362.7	461.9	536.9	623.1	722.4	836.1	966.4
Freight	323.9	422.7	575.4	782.3	1062.1	1439.9	1948.8
Total	**686.6**	**884.6**	**1112.3**	**1405.4**	**1784.5**	**2276**	**2915.2**

MASSTRANS (KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	78.6	97.6	110.4	124.7	140.4	157.6	176.5
Buses	121.9	157.8	186.5	220.5	260.6	307.8	363.5
Motor Cycle	160	198.7	224.8	253.9	285.9	321.1	359.2
Three Wheelers	2.2	2.8	3.1	3.5	4	4.5	5
Passenger	362.7	456.9	524.8	602.6	690.9	791	904.2
Freight	323.9	419.3	566.2	763.8	1029.4	1385.9	1863.6
Total	**686.6**	**876.2**	**1091**	**1366.4**	**1720.3**	**2176.9**	**2767.8**

(KTOE)	2010	2015	2020	2025	2030	2035	2040
BAU	686.6	899.8	1152	1483.6	1921.6	2503.2	3279
GASELEC	686.6	890.5	1129.7	1444.3	1860.2	2413.2	3152
EFFTECH	686.6	884.6	1112.3	1405.4	1784.5	2276	2915.2
MASSTRANS	686.6	876.2	1091	1366.4	1720.3	2176.9	2767.8
Combined	**686.6**	**851.7**	**1029**	**1248.9**	**1521.8**	**1859.7**	**2277**

PAKISTAN

BAU (KTOE)	2010	2015	2020	2025	2030	2035	2040
Cars	**2058.1**	**2251.4**	**2445.5**	**2655.7**	**2883**	**3128.7**	**3394.2**
Buses	497.1	544.1	591.1	642	697	756.5	820.9
Motor Cycle	1484.1	1264	1764.3	1916.2	2080.5	2258.2	2450.2
Three Wheelers	85.4	93.2	101.3	110	119.4	129.6	140.6
Passenger	4124.7	4152.7	4902.2	5323.9	5779.9	6273	6805.9
Freight	5400	6200	7300	8400	9800	11400	13300
Total	**9524.7**	**10352.7**	**12202.2**	**13723.9**	**15579.9**	**17673**	**20105.9**

GASELEC (KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	2058.1	2278.6	2507.7	2761.9	3044.4	3358.3	3707.5
Buses	497.2	543.7	590.7	641.5	696.5	756.0	820.3
Motor Cycle	1484.1	1624.0	1764.3	1916.2	2080.5	2258.2	2450.2
Three Wheelers	85.4	90.5	94.9	99.4	103.9	108.4	112.9
Passenger	4124.8	4536.8	4957.6	5419.0	5925.3	6480.9	7090.9
Freight	5400.0	6200.0	7300.0	8400.0	9800.0	11400.0	13300.0
Total	**9524.8**	**10736.8**	**12257.6**	**13819.0**	**15725.3**	**17880.9**	**20390.9**

EFFTECH (KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	2058.1	2228.1	2394.2	2570.5	2757.5	2955.3	3164.3
Buses	497.2	534.9	570.7	608.2	647.2	687.8	729.7
Motor Cycle	1484.1	1596.5	1703.5	1815.3	1931.9	2052.9	2177.9
Three Wheelers	85.4	91.6	97.8	104.2	110.9	117.8	125
Passenger	4124.8	4451.1	4766.2	5098.2	5447.5	5813.8	6196.9
Freight	5400	6100	7000	8000	9100	10400	11800
Total	**9524.8**	**10551.1**	**11766.2**	**13098.2**	**14547.5**	**16213.8**	**17996.9**

MASSTRANS (KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	2058.1	2157.6	2241.7	2323.7	2402.5	2476.9	2545.6
Buses	497.2	583.9	677.7	783.2	901.5	1034	1182.1
Motor Cycle	1484.1	1556	1617	1676.4	1733.6	1787.6	1837.6
Three Wheelers	85.4	89.6	93.1	96.5	99.8	103	105.9
Passenger	4124.8	4387.1	4629.5	4879.8	5137.4	5401.5	5671.2
Freight	5400	6100	6900	7800	8800	10000	11300
Toal	**9524.8**	**10487.1**	**11529.5**	**12679.8**	**13937.4**	**15401.5**	**16971.2**

(KTOE)	2010	2015	2020	2025	2030	2035	2040
BAU	9524.7	10352.7	12202.2	13723.9	15579.9	17673	20105.9
GASELEC	9524.7	10336.6	12257.6	13819.0	15725.3	17880.9	20390.9
EFFTECH	9524.7	10225.2	11766.2	13098.2	14547.5	16213.8	17996.9
MASSTRANS	9524.8	10487.1	11529.5	12679.8	13937.4	15401.5	16971.2
Combined	**9524.7**	**10343**	**11038**	**11959**	**12760**	**13734**	**14577**

BAU (KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	391.3	561.6	669.8	798.6	951.8	1134.1	1350.8
Buses	225.6	323.8	386.2	460.4	548.8	653.9	778.8
Motor Cycle	258.4	390.9	442.3	527.4	628.6	749	892.1
Three Wheelers	223.1	320.3	381.9	455.4	542.8	646.7	770.3
Passenger	1098.4	1596.6	1880.2	2241.8	2672	3183.7	3792
Freight	815.5	973.3	1163.4	1390.2	1660.8	1983.4	2367.9
Total	**1913.9**	**2569.9**	**3043.6**	**3632**	**4332.8**	**5167.1**	**6159.9**

GASELEC (KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	391.3	548.3	638	742.1	862.8	1002.6	1164.5
Buses	225.6	321.1	379.8	449.2	531.3	628.4	743.1
Motor Cycle	258.4	361.2	419.5	486.8	564.4	654	757.2
Three Wheelers	223.1	312.2	362.9	421.6	489.4	567.7	658.2
Passenger	1098.4	1542.8	1800.2	2099.7	2447.9	2852.7	3323
Freight	815.5	973.3	1163.4	1390.2	1660.8	1983.4	2367.9
Total	**1913.9**	**2516.1**	**2963.6**	**3489.9**	**4108.7**	**4836.1**	**5690.9**

EFFTECH (KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	391.3	552.1	646.7	756.5	883.8	1031	1200.7
Buses	225.6	318.3	372.9	436.2	509.6	594.4	692.3
Motor Cycle	258.4	364.6	427.1	499.6	583.7	680.9	793
Three Wheelers	223.1	314.6	368.8	431.4	504	587.9	684.7
Passenger	1098.4	1549.6	1815.5	2123.7	2481.1	2894.2	3370.7
Freight	815.5	956.8	1123.3	1317.1	1542.2	1803.1	2104.8
Total	**1913.9**	**2506.4**	**2938.8**	**3440.8**	**4023.3**	**4697.3**	**5475.5**

MASSTRANS (KTOE)							
	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Cars	391.3	538.2	614	698.7	793.2	897.8	1013.1
Buses	225.6	381.5	404.4	493.1	600.7	731.2	889.4
Motor Cycle	258.4	355.4	405.5	461.5	523.8	592.9	669.1
Three Wheelers	223.1	306.9	350.1	398.5	452.3	512	577.7
Passenger	1098.4	1582	1774	2051.8	2370	2733.9	3149.3
Freight	815.5	973.3	1163.4	1390.2	1660.8	1983.4	2167.9
Total	1913.9	2555.3	2937.4	3442	4030.8	4717.3	5317.2

(KTOE)	2010	2015	2020	2025	2030	2035	2040
BAU	1913.9	2569.9	3043.6	3632	4332.8	5167.1	6159.9
GASELEC	1913.9	2516.1	2963.6	3489.9	4108.7	4836.1	5690.9
EFFTECH	1913.9	2506.4	2938.8	3440.8	4023.3	4697.3	5475.5
MASSTRANS	1913.9	2555.3	2937.4	3442	4030.8	4717.3	5317.2
Combined	1913.9	2438	2752.6	3108.7	3497.2	3916.5	4163.8

Published by:

SAARC Energy Centre

697, Street 43, NPF, E-11/4, Islamabad, Pakistan

Tel: +95 51 222 8802, +92 51 222 8804

Fax: +92 51 2221937

info@saarcenergy.org

www.saarcenergy.org