

An Introduction to Methods and Technologies Applied for Reduction of Energy Consumption in Transportation Sector and Air Pollution in Iran

Eshagh Rasouli Sarabi, Mir Saeed Moosavi

Abstract—In Iran, due to abundance of energy resources, energy consumption is extraordinarily higher than international standards and transportation sector is considered to be one of the major consumers of energy. Moreover, air pollution in urban areas as a result of high dependence on private vehicle and lower standards of vehicles, high subsidies spent on fuel and time waste due to traffic congestion in urban areas all have led to speculations on new strategies and policies in order to control energy consumption in transportation sector. These strategies and policies will be introduced in this paper and their consequences will be analyzed with consideration to socio-economic factors affecting the urban society of Iran. Besides, the intention is to suggest and analyze new approaches such as broader application of public transportation system, demand management in transport sector, replacement of deteriorated vehicles, quality improvement in car manufacture and introduction of substitute fuels.

Keywords—consumption, energy, fuel, transportation

I. INTRODUCTION

TRANSPORTATION sector is one of the major sectors of energy consumption and is regarded as the main consumer of oil products; it has different growth rate in different countries.

Iran enjoys existence of enormous energy reservoirs but unfortunately it faces the abundant consumption of energy. In this paper, the rate of fuel consumption in road transportation industry in Iran is studied and then this problem is analyzed through comparing our national standards with the international standards and strategies; incidentally the limitation of paper is considered.

II. STUDYING THE ENERGY CONSUMPTION IN IRAN AT TRANSPORTATION SECTOR

As in Fig. 1, a comparison of amount of energy subsidies consumed by main consumers in Iran indicates that the rate of subsidy allocated to the transportation sector is displayed which is a main rate [1].

E. Rasouli Sarabi is with the Department of civil engineering, Islamic Azad University, Shabestar Branch, Shabestar, Iran (phone: +984712225311, fax: +984172224927; e-mail: e_rasouli_sarabi@iaushab.ac.ir).

M. S. Moosavi is with the Department of Art and Architecture, Islamic Azad University, Tabriz Branch, Tabriz, Iran (e-mail: msmoosavi@iaut.ac.ir).

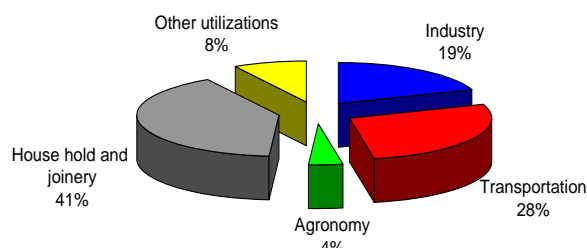


Fig. 1 Ratio of different consumers of energy subsidy in Iran until 2006

The rate of energy consumed by the subsets of transportation sector is as follows:

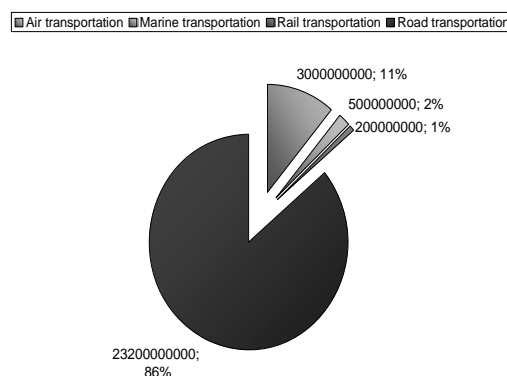


Fig. 2 Statistics of energy consumption in subsets of transportation in Iran until 2006

As in Fig. 2, the highest rate of energy consumption is in urban and suburban road transportation which is the main issue in the paper.

As in Fig. 3, major portion of the energy consumed in transport sector during last years is related to gasoline and gas oil sources [2].

Besides, as in fig. 4, the highest average portion of energy consumption by different types of vehicles is related to trucks, buses and passenger cars [3]. In addition to high rate of energy consumption, environmental pollution is still another consequence of transportation sector. Fig. 5 shows amount of environmental polluters from fossil fuels all over the country due to formal statistics and emission of polluting gases as well

as greenhouse gases due to energy consumption in transportation sector is indicated in Table I [3], [4].

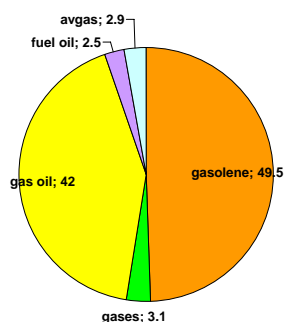


Fig. 3 Major sources of the energy consumed in transportation sector in Iran until 2006 (by percentage)

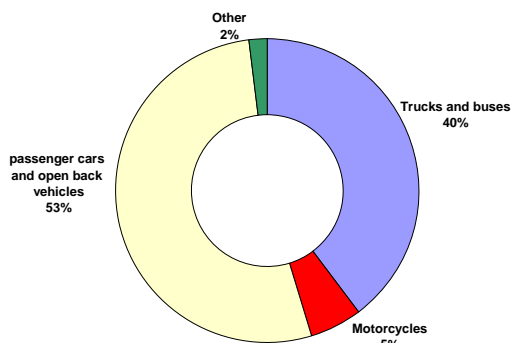


Fig. 4 Average portion of energy consumption by different types of vehicles in Iran until 2007 (by percentage)

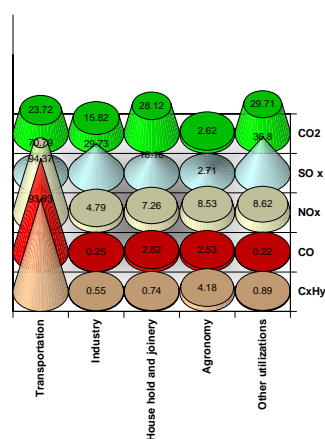


Fig. 5 Emission of air polluting agents across Iran indicating the related sector and percentage until 2006

TABLE I
 AMOUNT OF EMISSION OF AIR POLLUTING GASES AS WELL AS GREENHOUSE GASES DUE TO TRANSPORTATION SECTOR IN IRAN DURING PAST FEW YEARS(TON).

C _x H _y	CO	Sox	CO ₂	Nox	Gaz
					year
1026022	4335524	219907	59625116	484268	1997
1105169	4807584	217150	6202587	494946	1998
1152977	4999443	228850	64965968	519478	1999
1253665	5459195	245518	70269586	560357	2000
1342753	5886874	255273	74628450	592277	2001
1190042	6436098	259521	78257448	613494	2002
1601236	7218386	278382	85826758	668095	2003
1714532	7780513	290735	91080619	705431	2004
1876593	8579046	309176	98681980	759883	2005
2034336	9439575	313765	104591386	794813	2006

As it is observed the rate of energy consumption in transportation sector in Iran includes higher figures in which the rate of energy consumption in Iran is compared with the world standards consequently.

III. COMPARISON OF FUEL CONSUMPTION IN IRAN WITH SOME COUNTRIES AND STANDARDS

As in Fig. 6, it is distinguished that the rate of energy consumption in transportation sector is in upward trend [5]. This trend is compared with some important areas of the world and consequently the amount of energy consumption in different areas of the world is displayed in Table II.

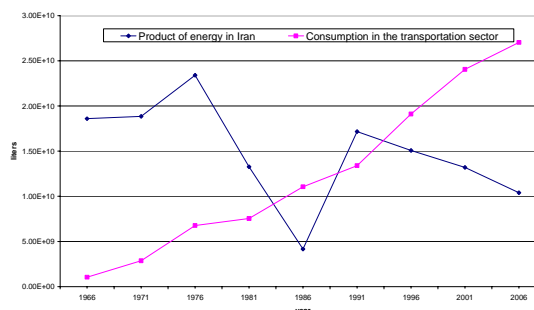


Fig. 6 The amount of energy production in Iran and consumption of energy in transportation sector

TABLE II
 COMPARISON PERFORMED BETWEEN THE RATE OF ENERGY CONSUMPTION IN EVERY SECTION OF THE SUBSECTIONS OF TRANSPORTATION IN IRAN WITH THE RATES OF WORLD CONSUMPTION

Zoon	Energy consumption in the transportation sector (Million liters of oil)			
	1991	2001	2011	2021
North America	1690	1950	2470	2990
West of Europe	780	910	1040	1170
East of Europe	390	260	390	520
Asia	390	780	1300	2080
Africa	130	130	260	260
South of America	260	260	520	780
Iran	33.8	65	127.4	195

Table II shows the comparison performed between the rate of energy consumption in every section of the subsections of transportation in Iran with the rates of world consumption.

According to this statistics, it can be said that in Iran the energy consumption doubles every 10 years whereas in the world it is in average 50 years; in comparing with the world average, the fuel consumption in Iran is "4-5" times more than its consumption in the world, it is mainly in the road transportation such that the average automobile consumption in Iran is 11 liters per day [6].

IV. MAIN REASONS FOR MORE CONSUMPTION OF ENERGY IN TRANSPORTATION SECTOR IN IRAN

The main reasons for higher consumption of energy in transportation system (specially the road system) in Iran are as follows:

- 1) Long lifetime of the fleet and fuel consumption loss.
- 2) Paying energy subsidy to the oil products and cheapness of energy cost leading to lower ratio of transportation expenses in expense package of family compared to other expenses.
- 3) Manufacturing automobiles with high fuel consumption and being more distance with the update technology of automobile manufacturing.
- 4) Lack of a suitable structure in the electronic government.
- 5) Paying less attention to the development of intelligent transportation systems.
- 6) Lack of a suitable development in the substructures and in the fleet of public transportation in the road and rail sector.
- 7) Low level of maintenance and repair in public transportation systems and their related equipment.
- 8) Inappropriate land use and unplanned development especially in city centers leading to heavy vehicular traffic in urban areas [7].

V. POLICIES MADE TO REDUCE THE ENERGY CONSUMPTION IN ROAD TRANSPORTATION SECTOR IN IRAN.

During last 3 years, due to high importance of problems related to transportation sector, collaboration among different institutions such as standard and environment institutions and ministries including ministry of interiors, industry, petroleum and transportation was speculated leading to some fundamental strategies and actions regarding fuel consumption management. Major features of these strategies and actions can be summarized under four titles which are as follows:

A. Optimization of Supply of Transportation Services

1) Extension and amendment of railroad transportation network as well as devising electrical railroad systems along with increasing the speed of the network. This is supposed to lead to higher passenger and goods attraction. The consequences of mentioned strategies was obvious during last 3 years which is illustrated in Table III along with the future consequences in table III [8], [9].

TABLE III
 RATIO OF RAIL TRANSPORTATION IN CARGO AND PASSENGER TRANSIT SHOWN IN PERCENT.

2011	2010	2009	2008	2007	year	rate of rail transportation in Iran (percent)
30	23	17	12	7.1		rate in carry of goods
18	13	9	6	4		rate in carry of passengers

2) Harmonization and organization of transportation management which will be mainly carried out by institute of optimization of fuel consumption and the organ for fuel consumption management.

3) Gradual omission of fuel from subsidiary package of government and modifying its price.

Price of gasoline and gas oil in Iran has been 0.09 & 0.02 US\$ per liter before 2006. Taking into account its average price in Persian Gulf to be almost 4 US\$, it can be concluded that it was being supported by government subsidiary. For the time being, removal of gasoline from subsidiary package has been started in a gradual pace and will lead to its supply with the average price of Persian Gulf.

4) Removals of deteriorated cargo and passenger vehicles the transportation network.

The average age of buses, trucks, taxi and personal vehicles was 22,19 and 15 years in 2005, and by removal of 758 trucks, 5502 buses and minibuses and 147475 taxi and the obligation from government along with loan and financial aid, the average age of these vehicles have reached 19, 13 and 15 years [10].

5) Obligatory plans for technical control of vehicles and heavy fines for those who do not obey.

This issue has led to increase in efficiency of vehicles as well as decrease in amount of fuel consumption.

6) Extension and development of highway & freeway networks in order to increase access rate and decrease travel time and fuel consumption. In this regard, 14417 kilometers of freeway, highway and main road has been constructed during last 3 years which indicates 161 percent increase [9].

7) More attention to development of Para transit networks including rail and road.

8) Extension and development of public transportation systems.

This issue is considered to be one of most important attempts in order to encourage usage of public transportation system which was hinder by under development of the network and general tendency to use of personal vehicles. In order to achieve this goal, bus factories have been increased from 2 to 7 and new vans and taxis have imported and manufactured. This has led to increase of bus to 6000 (2 times increase), taxi to 30000 (3 times increase) and almost 107000 personal cars have been converted to taxi.

Table IV indicates the increase in mentioned rates [10].

TABLE IV
 VALUE OF INCREASING RATIO WITH PUBLIC TRANSPORTATION

2011	2010	2009	2008	2007	Ratio of Public Transportation (Percent)	
57	56	55	54	53	Ratio of public transportation to carry Suburban of passengers	
75	64	55	47	41	Ratio of public transportation to carry of passenger in interurban trips	
40	35	31	27	24	Ratio of buses, midi buses and minibuses	Average of ratio in country Inter urban
25	22	20	18	16	Ratio of vans and taxis	
10	7	4	2	1	Ratio of subway	
0.7	0.8	0.9	1	101	Usage of fuels (liter for one person per day)	

B. Optimization of Transport Demand

Another policy which is being formulated by ministry of interiors and cooperation of police is different methods of transportation system management which is as follows:

- 1) Correction of administrative process for different affairs.
- 2) Application of IT, communication and development of E-government.
- 3) Training in order to improve traffic behavior.
- 4) Improvement of land use with traffic considerations.
- 5) Application of methods for increase in demand of trip by traffic restrictions and work hour change.

C. Optimization of Energy Consumption

1) Multilateral support for inventions and innovations regarding decrease in fuel consumption.

2) Construction of compressed natural gas CNG stations increasing their number from 132 to 255 one in 3 year.

3) Supply of fuel by intelligent card its rationing.

These cards have been issued for a million vehicles and 4500000 motorcycles and despite some problems such as lack of data base, prior experience, and lack of preparation for the application of the system. The system is being applied leading to some obvious achievements such as fuel management policies, network and station management and fuel smuggling control as well as a national information bank.

Besides, in order to control the high rate of fuel consumption until its removal from subsidiary package (2012), rationing of fuel is applied and only 100 liters of fuel is supplied for each vehicle per month. The ration is supplied in the price of 0.1 US\$ and the extra is supplied in 0.04 US \$. The supply is being controlled by the intelligent cards and has led to 21000000 liters decrease in consumption per month.

D. Optimization of Car Manufacture

1) Manufacturing dual-fuel cars and CNG consuming cars instead of gasoline and gas oil consuming cars.

Since there exist a great amount of natural gas resources in Iran, new policies on car manufacture are focusing on dual fuel or CNG consuming cars. In the first stage, urban buses were converted to CNG consuming buses in 2002 and in the second stage, taxis and personal vehicles were converted to CNG cars.

This action included both manufacture of new vehicles in dual- fuel system and converting the existing vehicles into dual – fuel system which was implemented by a funding of almost 30000 US\$ including the expenses for purchase and import of new equipment and machinery as well as the buildings and construction works necessary for the installations. All these policies and actions led to a great increase in number of dual- fuel vehicles. The number of manufactured dual fuel vehicles increased from 15500 to 511000 in a duration of 3 years and the number of converted vehicles increased from 85700 to 256400 simultaneously [10].

2) Standardization of vehicles in order to decrease the pollution Due to substandard quality of cars manufactured domestically and their high fuel consumption, the committee for formulation of domestic standards has formulated the criteria for fuel consumption with an acceptable level.

Besides, the label of energy consumption rating for each vehicle has become obligatory which helps the buyer of car to get familiar with the energy consumption rate of the purchased vehicle. All above mentioned features along with some punishments for manufacturer of low quality vehicles have led to gradual movement towards the international standards (See Table V) [1], [3].

TABLE V
 RATIFICATION STANDARDS IN FUEL CONSUMPTION IN VEHICLES IN IRAN (LITER IN 100 KILOMETER)

Group 5	Group 4	Group 3	Group 2	Group 1	manner of testing	date of performance
13.4	11.1	10.5	9.2	8.4	TA	2004
12.7	10.4	9.9	8.8	8	COP	2005
11.9	9.5	9.2	8.4	7.6	COP	2006
11	8.8	8.3	7.9	7	COP	2007

TA = Sample Choose via maker , COP = Sample Chosen Randomize, Group 1: Mini compact , Group 2: Subcompact , Group 3: Compact , Group 4: Mid size , Group 5: Large

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