

Effect of Energy Consumption on Air Pollution in I.R.Iran

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The economy of I.R.Iran is so related to oil that has had many environmental problems especially air pollution in urban areas in recent years. Statistics show that most of the time, the condition of air quality is in crisis level especially during fall and winter seasons. Rapid and high population growth has had large amount of fossil fuels consumption in all sectors including transportation, industry, agriculture, residential and commercial and public services and air pollution and healthy problems.

Iran's abundance of fossil fuel resources has tended to discourage the country's incentive to shift to cleaner alternative energy sources for its energy needs that must be considered in future programming. These are discussed in this paper.

Key words: Energy, Renewable, Non-renewable, Air, Pollution, Iran

1. Introduction

Iran is the second largest crude oil producer of OPEC that holds 9% of the world's oil reserves. It also has the world's second largest natural gas reserves that is estimated 812 trillion ft³ in proven natural gas and has also huge potential for gas development²⁾.

The world energy consumption from different sources is shown in figure 1. This figure indicates that the energy consumption is increased during the last century. The clean sources of energy are also shown to be used in recent years. In the last two decades, consumption of all available kind of energy has been increased (figure 2)³⁾. According to statistics, the total energy consumption was 5.18 quadrillion Btu, which is about 1.3% of the world energy consumed in 2001.

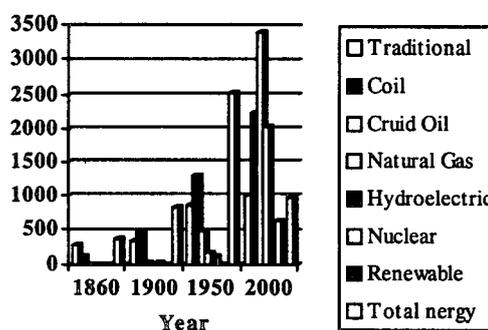


Fig. 1. World Energy Consumption from Different Sources

It is equivalent to the consumption of 80.3 million Btu per capita energy including 51% oil, 47% natural gas, 1% each coal and hydroelectric⁵⁾. An abundant of fossil fuel resources is available in Iran. This tends to discourage the pursuit of alternative renewable energy sources. Renewable energy consumption is very limited as compared to high world's oil and natural gas reserves in Iran.

Iran's 1997 renewable energy consumption including hydropower, solar, wind, tide, geothermal, solid biomass and animal products, biomass gas and

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liquids, and industrial and municipal wastes totaled 106 trillion Btu, a 6% increase over the previous year ^{1,3)}. In the following paragraphs, the situation of both energy sources including renewable and non-renewable in Iran are discussed:

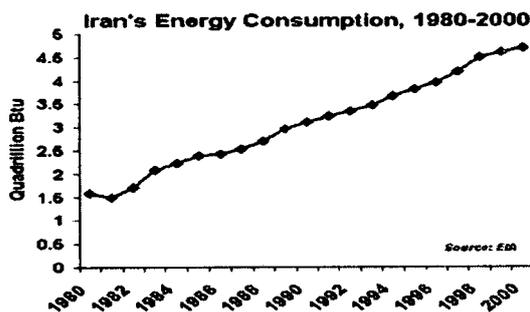


Fig. 2. Twenty Years Variation of Iran's Energy

2. Energy Sources

2.1 Wind Energy

Several turbines have been applied in some cities like Manjil, which have proper velocity of wind. The number of these turbines has been increased in recent years. They supply part of country electricity.

2.2 Solar Energy

Use of solar energy in Iran is so limited. Some investigations have been done about this kind of energy in Energy Department, which can be summarized as follows:

- Design and construction of a dish solar cooker (1997)
- Design and construction of solar linear concentrator in Yazd city (1995)
- The feasibility study of establishing the first solar power plant according to high solar radiation in Iran and good potential for solar energy by cooperation with Germany, which resulted in selection of Yazd as an appropriate site for installing the first solar-thermal combined cycle power plant (2000). ¹⁾

2.3 Biomass Energy & Waste to Energy

According to literature, the amount of biomass fuels consumption in 1999, which was consist of fuel wood and mineral fuels (crude oil and natural gas liquids) was 0.8 and 67.7 percent of total energy consumption, respectively. ²⁾ it was also shown that quantity of raw material available in municipal solid waste and forestry/wood-processing were 15.33 and 0.2 million tones, respectively. ⁵⁾

2.4 Geothermal Energy

Use of geothermal energy is also limited like solar energy. One of the geothermal investigations has been done in Khorasan province. ¹⁾

2.5 Fuel Cells

In Iran, 50 % of energy consumption is from natural gas, 48% is from oil, 1% is from coal and the rest is from other sources of energy. Per capita energy consumption in 2000 was 73.8 million Btu, but is still on the increase. ³⁾

2.6 Hydropower

Several hydropower plants are currently in operation, and several more are under construction. With power demand growing rapidly, Iran is adding significant generation capacity for thermal electric, too.

2.7 Nuclear Energy

The country has stated its aim of having 6,000 MW of nuclear power online by 2020, accounting for 10% of the country's power generation capacity at that point. Iran and Russia signed a protocol for peaceful cooperation in nuclear power. Iran would like to increase its nuclear power usage in order eventually to meet 20% of the country's electricity demand, but international concerns about Iran's use of nuclear power for purposes other than electricity generation have limited the country's nuclear capacity.

3. Energy Consumption

Table 1 indicates energy production and consumption by source in 1999. ⁴⁾ As shown in the table, the consumption amount of renewable energy in Iran is not considerable as compared to other

three main energy sources of fossil, oil and gas. Table 2 shows production, consumption amount and their ratio for different energy sources. It can be seen that natural consumption of gas and electricity is larger than production²⁾ that means Iran imports some kind of energy.

Table 1- Energy Consumption by Source (in thousand metric tons oil equivalent)

Kind of Energy	Iran	% of Middle East & North Africa	% of the world
Total Fossil Fuels	102422	20.47	1.13
Coal & its products	1271	4.11	1.29
Crude oil & natural gas liquids	70184	17.01	2.5
Natural Gas	49671	24.21	1.2
Hydroelectric	427	7.5	1.14
Renewable, excluding hydroelectric	786	6.58	1.11
Primary solid biomass (includes fuel wood)	786	7.16	1.2
Biogas & liquid biomass	0	3	14931
Geothermal	0	202	43802
Solar	0	756	2217
Wind	0	2	1748
Tide, wave & ocean	0	0	53
Nuclear	0	0	661901

Table 2-Energy Production and Consumption by Source

	Production	Consumption	Ratio
Oil (2002E)	3.5	1.0	0.286
MMBD			
Natural Gas (2001E) Tcf	2.17	2.32	1.06
Coal (2001E) Mmst	1.5	2.3	1.53
Electricity (billion KWH) (2001E)	30.6	115.9	3.78

By encouraging and training people, it is possible to save energy and money and expand it in solving air pollution problem. In addition, by decreasing energy consumption especially in transport section, emitted pollutants will be decreased.

4. Environmental Problems

Iran has had many environmental problems especially air pollution in urban areas in recent years. Statistics show that most of the time, the condition of air quality is in unhealthy and crisis level especially in fall and winter.

Rapid population growth over the past two decades that has resulted in more consumption of fossil fuels (annually demand growing is about 7%-8%)²⁾ is an important factor in increasing environmental and healthy problems. The amount of carbon, different hydrocarbons, ozone, etc is on unhealthy level in industrialized and populated cities like Tehran, Tabriz, and Ahvaz.

Major air pollution sources especially in urban areas are vehicle emissions, refinery operations, and industrial and power plants.⁶⁾ Table 3 shows energy consumption by different sectors in 1999.

Regarding to 5.18 quadrillion Btu total energy consumed, per capita carbon emissions is 0.4 metric tons. This means that fuel share of carbon emissions is oil, natural gas and coal is 53, 45, 1 percent, respectively.

Table 3- Energy Consumption by Different Sectors (%)

Sector	%	% in the World
Industry	29	31.69
Transportation	28	25.99
Agriculture	5	2.46
Commercial and public services	7	7.58
Residential	26	27.33
Other	5	4.95
Total	100	100

CO₂ is the most abundant gas formed in thermal decomposition of fuels. Since 1980, carbon emissions in Iran have risen by 240%, from 33.1 million metric tons emitted in 1980 to 80.8 million metric tons emitted in 2000.³⁾

According to statistics, energy related carbon emissions are 90.1 million metric tons that is about 1.4% of world total carbon emissions. It has been shown that among four main pollutant sources including transportation, industry, power plants and buildings, the share of transportation in PM-10 and hydrocarbons (HC) emission is 87.3 and 70.2 percent, respectively. In addition industries emit the most amounts of SO_x and NO_x, which is about 64 and 42 percent, respectively. This means that transportation is the main sources of pollution in Tehran and all cities of Iran.

Statistics shows that 70% of air pollution in Tehran is resulted from automobiles. The ages of automobiles in Tehran are from 10 to 22 years (average age is 15.9 years) that have an important role on air pollution. Unfortunately, the amount of fuel consumption in private cars is very high as 26 percent of them are old and consume 50 percent of total fuel. ⁶⁾

5. Conclusions

Iran imports a considerable amount of fuels especially gasoline every year. A huge amount of pollutants are also emitted to the urban air. In conclusion some suggestions are given as follows:

- The amount of energy consumption especially gasoline must be optimized by the authorities as soon as possible.
- The government has considered this problem, but more emphasize and high activities and researches must be done to achieve the objectives.
- Plan for substituting old cars with new cars by the government must be seriously implemented.
- Programs for encouraging people to use equipment with low energy-consumption must be done by NGOs by full support of government.
- Rapid implementation of "Green Government Plan" for determination and optimization of the amount of energy consumption in the governmental organizations and offices and encouraging other offices to implement it. In this plan, the amount of energy and waste must be

determined to minimize the use of paper, water, energy, and etc. ⁷⁾

- More attention must be considered in use of clean energies by the authorities.
- A comprehensive environmental assessment of fuels should be done not only the end-uses but also the production, conversion and transport of energy into consideration. For example, energy production from biomass including lignocelluloses crops, grains, sugar crops, oil seeds, terpenoid crops and algae are good research topics.
- More investigation on biofuels is necessary. As they can use for internal combustion engines, they may replace fossil fuels in some cases.
- Production of biogas from animal dung and other organic residues has a number of theoretical advantages. It produces a proper fuel for uses such as cooking and lighting that can be used in the small communities which are far from cities in which transportation of energy is difficult and expensive especially during winters. This will be a good source of energy with the least cost and difficulties.

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