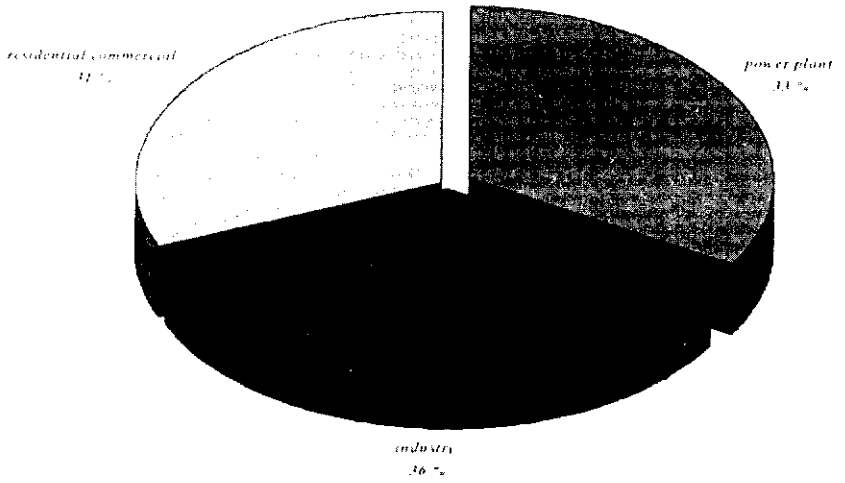
Fig3: Break down of Natural gas consumption in Iran (in 2004-end of third five-year plan)



In this decades Iran has not have any role in international gas market (as a gas exporter). In the other hand, gas injection to oil fields has had always consider as a priority in energy policy in Iran, although financial problem and especial condition of Iran in war periods were preventive factors.

In 1999, power plant sector has had dominant role on of natural gas consumption basket. Break down of gas consumption was Power plant 38.1%, Industry 28.5% and Residential/commercial 33.4 in 1999(Fig2).

But, in the third five-year plan, the share of industry in the gas consumption basket will increase considerably. In the end o this plan (in 2004) its share increase to 35.4% and instead the share of power plant decrease to 33.3% and residential/commercial received to 31.3% (Fig3).

It is worth to note, 31 power plants, more than 2200 industrial consumer, 150000 commercial consumer and 6 million of Iranian households (45 of total households) were consumed natural gas in 1999. In the end of third five-year plan near 80% of Iranian households will be supplied by natural gas.

Exporting of NG must be considered only on the condition that we met gas consumption in domestic sectors and injection plans

In two recent decades, the average of annual growth rate of NG consumption (16%) has been more than twice the total energy consumption (7%), versus oil products consumption grew lower than energy consumption (5%)

Conclusion:

This study shows that utilization of NG has a comparative advantage for the economy of Iran. Therefore, The policy of NG substitution (with other conventional energy carriers) as a strategic policy that meets long-run national benefits should always considered by energy decision makers. Evaluation of NB index for NG in different consuming sectors indicates that the injection sector has the first priority with respects to other economic sectors. Preservation of oil reserves and keeping the steady capacity of oil production and in turn oil revenue, in order to secure the Iran economy, which is closely dependent on oil, is very crucial.

The industry sector would be in second priority, while power plant and residential/commercial sectors would be in third and forth respectively. The study shows that NG (although it has comparative advantage in domestic economy) could be allowed to export when the NG has met the required NG for injection projects and domestic consumption supply.

References:

-The Economics of natural gas, pricing, planning, and policy - Deanne Julius & Afsaneh Mashayekhi, Oxford University, 1990

-Is the net back value of gas economically efficient? Corazon Morales Siddayao, OPEC Review, sep.1997

-Power system economics, the value of natural gas in electricity generation, energy economics, oct.1984

-Energy statistical bulletin - Ministry of energy - 1998

-Annual report of national Iranian gas company - 1997&1998

■

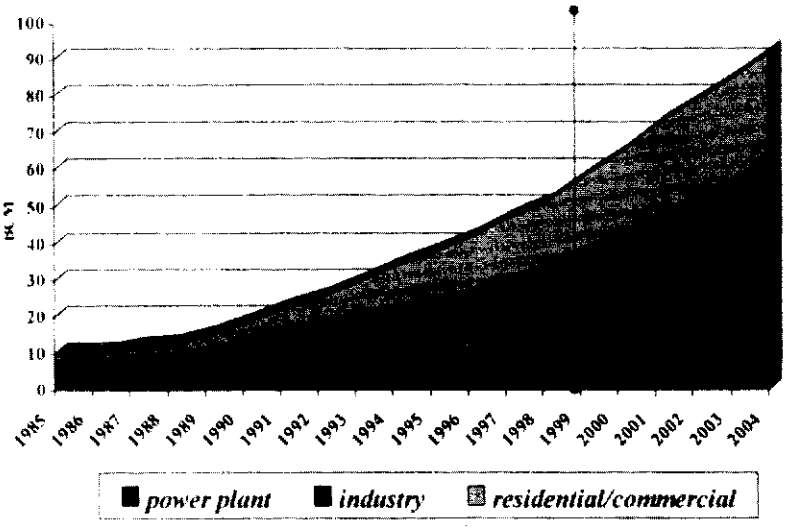
does not change. Net back index in injection, industry, power plant and residential/commercial sectors would be7 cent/cm, 6.4 cent/cm, 5.9 cent/cm and 3.5 cent/cm respectively. This index in exporting sector decreased too much and became negative. It is worth to note, we consider the net benefit of gas consumption in national economy as opportunity cost of gas exporting (Table3).

With due attention to this conclusion, if there has been potential gas consumption in national economy and potential supply infrastructure of gas (transmission system and distribution network), therefore utilization of natural gas to meet domestic consumption has been much more preferred to exporting it, in the framework of Iranian economy.

Since, exporting sector was in last priority in scenario of with taking into account gas opportunity cost, then if there has been gas injection project and possibility, exporting sector would not prefer to that. Therefore exporting of natural gas must be considered only and only on the condition that we met gas consumption in domestic sectors and injection plans.

Now, we discuss about natural gas consumption basket in Iran. Comparative advantage of especially natural gas in Iran is the important factor in the economic development trend and forming the energy consumption basket. Substitution of natural gas with the other kinds of energy carriers in addition to the self - sufficiency of the country and positive externalities, will cause the convenient social welfare.

Fig1: Natural gas consumption in Iran (1985-2004)



Utilization of NG has a comparative advantage for the economy of Iran and the injection sector has the first priority with respect to other economic sectors

In two recent decades, the average of annual growth rate of NG consumption (16%) has been more than twice the total energy consumption (7%), versus Oil products consumption grew lower than energy consumption (5%).

Penetration of NG in the energy consumption basket has been very fast in this period. Share of NG in energy consumption basket increased from 10% in 1980 to more than 39% in 1999, instead, share of Oil products decreased from 77% to 52% in this period (Fig1).

The analysis shows that, more utilization of gas in national economy has been as an important goal in energy policy in past decades. It was due to energy security, especially during the war and after that period.

Fig2: Break down of Natural gas consumption in Iran (in 1999)

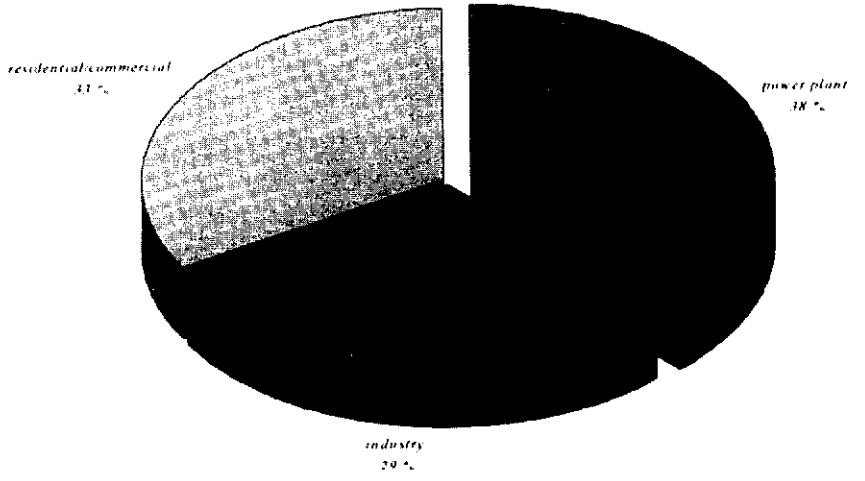


Table1: Average of DRC and RCR indexes of gas in Iran without taking into account opportunity cost

Sectors	DRC Index Rls/$	Average of DRC Rls/$	RCR Index
Injection	43.16	390.7	0.049
Export	453.86		
First type basket gas	674.98		

Table2: Average of Net back index of gas in Iran without taking into account opportunity cost

Sectors	First scenario	Second scenario	Third Scenario	Average of scenarios	Priority
Injection	.132	.081	.120	.111	1
Export	.033	.030	.058	.040	5
Residential/commercial	.089	.027	.067	.061	4
Power plant	.090	.066	.097	.085	3
Industry	.096	.067	.104	.089	2

Table3: Average of Net back index of gas in Iran with taking into account opportunity cost

Sectors	First scenario	Second scenario	Third Scenario	Average of scenarios	Priority
Injection	.091	.040	.079	.070	1
Export	.094	-.104	-.059	.086	5
Residential/commercial	.063	.001	.041	.035	4
Power plant	.065	.040	.072	.059	3
Industry	.070	.042	.079	.064	2

390.7 RLS/$ that is saved.

It is worth to note that, DRC of first type basket gas was 675 RLS/$ that is saved. Comparison DRC with SER (that is 8000 RLS/$) show that, there is NG relative advantage clause (DRC<SER).

In the other hand, analysis of RCR index show that it was .049 in all of sectors and in the first type basket gas was .084. With regard to this study, we concluded, relative advantage of natural gas in whole of economy is very crucial (Table1).

Preferring of gas consumption within different sectors, especially due to limited production and supply, is the second step toward the optimal allocation of gas. It has a great deal of impacts on macro economy. Studying such a subject can be performed by evaluation of the NG benefits consumption in each sector, both in productive and in non-productive (residential/Commercial, industry, power plant, injection and export) sectors. **Net Back (NB)** index generally indicates economic efficiency of each unit of NG consumption. This index contains two variables including benefit and cost. In other words, it considers net benefits of each unit of gas by sector.

$$NB_{gi} = PVB_{gi} / PVQ_{gi}$$

NB_{gi} : net back of natural gas in sector i

PVB_{gi} : net present value of benefits sector i

PVQ_{gi} : net present value of gas consumption in sector i

The results of studies show that, the injection sector has been preferred to other sectors. Because, net back index in this sector was more than the others in scenario of without taking into account opportunity cost. It was 11.1 cent/cm. The industry and power plant sectors that their netback indexes were 8.9 cent/cm and 8.5 cent/cm have been in second and third priority respectively.

Net back index in residential/commercial sector was 2.4 cent/cm less than power plant sector (6.1 cent/cm) and it was in exporting sector one-third of injection sector (4 cent/cm), therefore this sector in compare with the others was in the last priority (Table2).

With taking into account opportunity cost of natural gas, although net back index decrease in all of sectors, but the priority of gas consuming sectors

Optimal Allocation of Natural Gas in Sectors in Iran

Shahla Khaleghi
Energy Economist-senior expert of planning
Submitted by 24th IAEE international conference

ABSTRACT

Special characteristics of Natural Gas (NG) from economic and environmental point of views has made NG as an important energy-input in production and intermediate sectors and also, a suitable energy carrier in all economic sectors. These characteristics would be important factors to form an increasing trend for NG consumption.

More usage of NG could be a long-run policy in the frame of development goals, especially in countries with rich NG endowments. However, analysis of comparative advantage on NG consumption in domestic economy must be taken into consideration.

In this paper as a prime step, the comparative advantage of NG within different sectors has evaluated by Domestic Resource Cost (DRC) and Resource Cost Ratio (RCR) indexes in the framework of Iranian economy.

Optimal allocation of NG in different sectors performed by the Net back (NB) index in the next step. This study shows that utilization of NG has a comparative advantage for the economy of Iran and the injection sector has the first priority with respects to other economic sectors. The industry sector would be in second priority, while power plants and residential/commercial sectors would be in third and forth, respectively. The study shows that NG (although it has comparative advantage in domestic economy) can be allow to be exported when the NG has met the required NG for injection projects and domestic consumption supply.

Evolution of relative advantage of natural gas in different economic sectors should be considered in the first step of energy policy making. This index is one of the important assumptions to optimal allocation of gas supply with respect to unlimited desires of a society. Each energy carrier (e.g. NG) as an input product or intermediate goods and /or a final product impressed consumption and production pattern.

Generally, availability of input production and share of each input in the basket of inputs (capital, labor, technology and energy) will be effective role in investment trend and forming the production pattern in industrial and non- industrial sectors. Therefore Evolution of relative advantages of gas in different sectors and in whole of the economy can accelerate development of gas infrastructure and promote investment toward NG industry.

Relative advantage of NG has evaluated by Domestic Recourse Cost (DRC) index. It usually has been discussed in international economy issues, which defines ability of producing or exporting goods by a country. DRC method can be used as a practical criterion for opportunity cost in economy. This method is very similar to cost-benefit analysis. The difference is that, the latter compares real cost with benefit but in DRC method, net domestic resource cost is compared with the net foreign exchange conservation.

DRC of NG interprets as the opportunity cost of domestic resources, which can use to get international value added from domestic input in a specific activity (domestic currency that might be paid in exchange for foreign currency which is saved- in this study exchange rate is considered to be 8000 Rls/$). This index in comparison with shadow price of exchange rate (SER) can be a criterion for comparative advantages analysis of gas. NG will have relative advantage where DRC < SER.

$$DRC_i = DC_i / NVA_i$$
$$DRC < SER$$

DC_i: domestic opportunity cost of input in ith activity in exchange for each product

NVA_i: international value added of domestic input in ith activity in exchange for each product

Resource Cost Ratio (RCR) is other index, which is used to assess the comparative advantage of NG. That is evaluated by the ratio of DRC over shadow price of exchange rate. NG will have relative advantage where RCR < 1

$$RCR = DRC / SER$$
$$RCR < 1$$

In this study we have defined the **first type basket gas** that includes residential/commercial, industry and power plant sectors. The studies show that weighted average of DRC in all of sectors (residential/commercial, industry, power plant, injection and export) was