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Review Paper

Iran's energy policy: Current dilemmas and perspective for a sustainable energy policy

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Abstract

Iran is facing large challenges in the area of energy policy. In order to illuminate these challenges and the problems and possibilities, which are present, firstly, the current energy consumption patterns have been analyzed in Iran as well as the energy policy of the Iranian government. Based on this analysis, the alternative concepts have been then formulated for Iran's future energy. The increase in energy usage in Iran is distinctly out of proportion with the development of economic productivity. Negative structural characteristics of this system are: first, an above average energy intensity; second, an increase in energy consumption in the traffic sector; third, a high growth rate in usage of electric energy; and lastly, an above-average amount of stress to the environment. Traditionally, Iran's energy policy has focused on satisfying the growing demand for energy by oil and, in the last fifteen years, by successively expanding natural gas. However, the further development of the natural gas supply only makes sense within the context of a holistic energy policy, which takes into account the principles of sustainable development. In the short term, such a policy would take advantage of both considerable energy saving techniques, as well as potential renewable energy sources. In the long term, such a policy would strive for the complete transfer to renewable energy sources and technology.

Keywords: *Uncontrolled energy consumption, holistic and sustainable energy policy, energy consumption patterns*

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Introduction

This paper deals less with examining the trends related to Iran's general energy supply according to the production and consumption of various types of energy in a variety of sectors. Instead, it shall focus on presenting a critical analysis of the specific features of the energy consumption pattern in Iran and on disclosing the potential far-reaching structural problems for the future. Whilst, the empirical data that has now been made available does not suffice for the purposes of making detailed appraisals, it nevertheless provides a solid foundation for describing the energy political fundamental structures prevalent in the country. At the Fourth National Energy Congress, which was held in Tehran, on May 2003, international and Iranian scientists discussed and evaluated some important outcomes of the Congress. Some of the most energy policies and dilemmas of Iran were outline and discussed. As the results of the Congress, general views of energy policy and the main problems of energy productivity and application were analyzed. Some long-term sustainable solutions were also provided.

Energy consumption in Iran has risen almost eight-fold over the past thirty years, from around 90 million barrels oil equivalent (mboe) in 1971 to over 700 mboe in 2001. In the same period, the annual energy consumption growth rate was estimated to be 7.8% (Assali, 2003). This rapid increase in consumption is by no means the result of an ongoing industrialization process and an increase in the performance of Iran's economy. This trend rather reflects two intensifying structural problems: Firstly, the level of energy consumption in non-productive sectors has rocketed. Secondly, the energy intensity in every social sector has spited the global trend and risen dramatically. Both of these peculiarities will be discussed in greater details. As it is indicated in Table 1, in a 25-year period, the rise in the consumption of energy in households and commerce amounted to 558%; in the transportation sector it was 353%; in industry 385%, and in the agricultural sector, where the level is

extremely low, it was 254%. There is also clear evidence of a shift in energy consumption from the productive sectors of industry and agriculture to the non-productive sectors of households and commerce as well as transportation. In 2000, the share of these sectors in energy consumption amounted to 62.8% and was therefore significantly greater than the 39.3% recorded in 1976. Iran's energy consumption pattern is unquestionably unsustainable and typical of consumption-oriented, highly populated, oil-producing countries with low productivity. Figure 1 illustrates that, in the time from 1986–1995, productivity in Iranian industries and the country's entire economy only grew slightly, whilst the primary energy consumption soared. A typical feature of this non-sustainable energy consumption pattern is the extreme inefficiency in terms of energy utilization. Whilst, the energy intensity (energy consumption in monetary value/gross domestic product =GDP) has fallen significantly over the past 3 decades worldwide, in the years between 1981 and 2000, for example, by 93.6% in Japan; 64.2% in China; 63.3% in France; and even 27.8% in the USA and it rose dramatically in Iran: in the years between 1976-2001 from approximately 5% to 14%, i.e. by 280% (Omidkhan, 2003). Whilst, energy consumption worldwide has since detached itself from economic growth and is growing at a slower rate than the economy, energy consumption in Iran is rising significantly faster than the gross domestic product. Figure 2 exemplifies this negative feature in Iran's energy consumption pattern. This implies that Iran has a considerable energy savings capacity potential and that, if such energy services as light, heat, and power were to be made available to the consumers, in principle a fraction of the currently used primary energy would suffice. If the present energy intensity were to be lowered to its level of 1976, for example, the current primary energy demand could be reduced by two thirds without less useful energy being available to the consumers as a result. However, since it is highly likely that Iran did not make optimum use of its primary energy in 1976, it would not be too unrealistic to presume that only a sixth or an eighth of the primary energy utilized in 2001 would have sufficed to make the actually used energy services available: 84–88% less primary energy without a loss in prosperity.

Methodology

The method of this study is on energy policy and its focuses in Iran is practical assessment in the historical dimensions and processes of energy productivity and application with emphasis on the source types and energy application.Analysis of the energy problems and challenges of energy production and consumption has been performed as bolistic and sustainable energy development views.

Table 1: Structural changes in Iran's energy consumption *(IIES, 2001)*

Final Energy Consumption/ Year	1976		1991		2000	
	mboe*	%	mboe	%	mboe	%
Households and Commerce	50.570	20.7	134.400	30.9	282.360	40.0
Industry	49.400	20.2	125.600	28.9	190.320	27.0
Transportation	45.400	18.6	102.400	23.6	160.510	22.8
Agriculture	9.760	4.0	31.350	7.2	24.820	3.5
Others	89.300**	36.5	40.850	9.4	47.270	6.7
Total	244.430	100.0	434.600	100.0	705.280	100.0

* mboe = million barrels oil equivalent

** The sources do not reveal details of the exact composition of this category. It is most likely that the countries own consumption was initially allocated to this category and subsequently to the industrial sector. Accordingly, industry in 1976 should be apportioned a significantly higher percentage. This means that the shift in consumption from industry to households and commerce was even greater than the table would suggest.

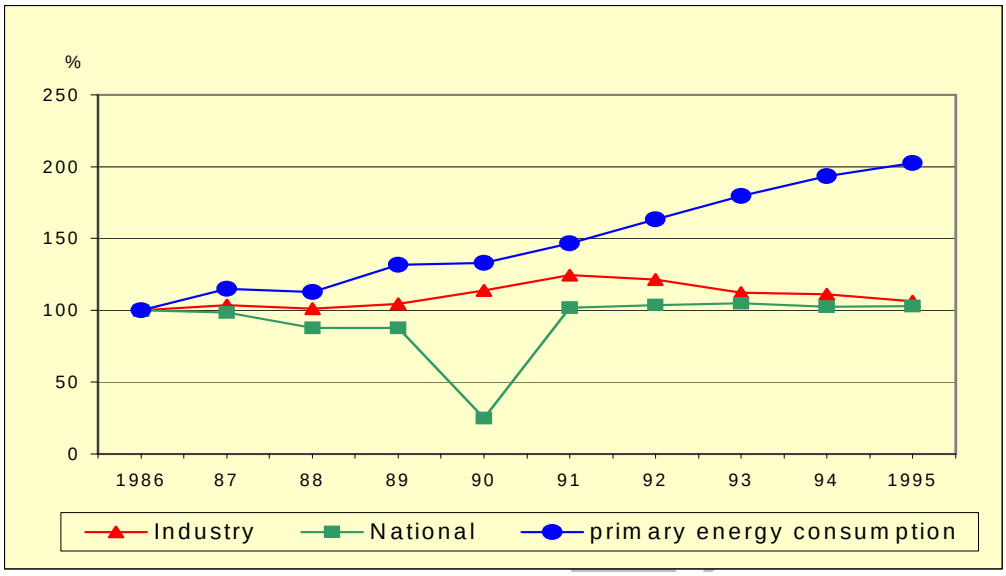

Figure 1: Development of work productivity and the primary energy consumption in Iran *(CII, 2002)*

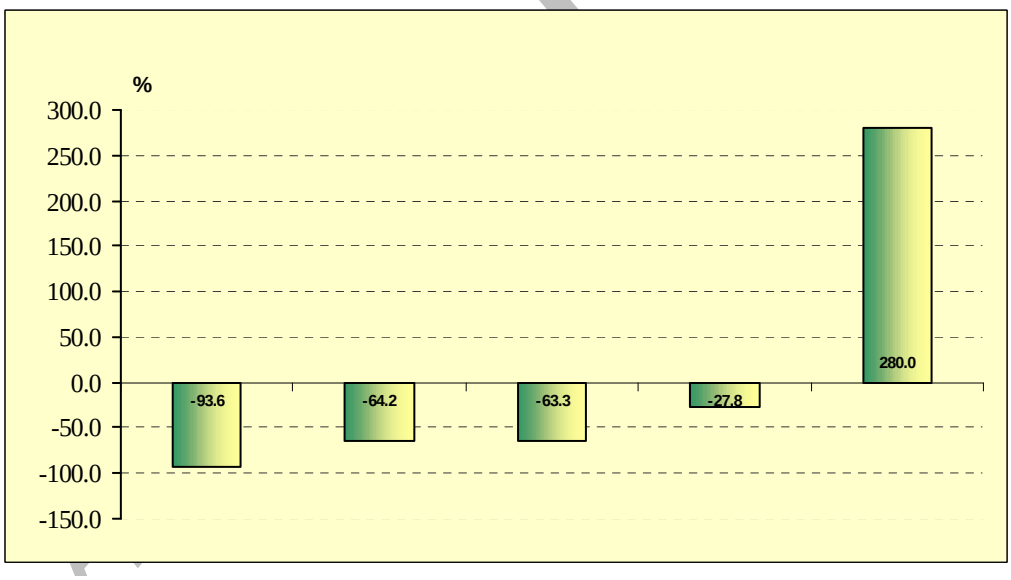

Figure 2: Development of energy intensity *(Omidkhah, 2003)*

Expanding transportation sector

Iran's energy consumption in the sectors of households and commerce as well as in transportation has risen to an over proportional degree. Whilst the percentage of energy consumed by the transportation sector is significantly lower than that of households and commerce, the transportation sector is of key importance to Iran's current and future energy policy on account of the following three reasons: firstly, because transportation systems are very cumbersome and structures related to them can only be changed long-term and at considerable cost to the national economy; secondly, because the transportation sector in Iran is the main cause of environmental damage, above all in the conurbations; and, thirdly, because the transportation sector is the largest oil consumption sector, accounting for approximately 40% (compared to industry with 15%) and therefore impacts Iran's oil export capacity and the oil revenue, a source of fundamental importance to the national budget, in proportion to the expansion of the

transportation sector. At the same time, both the transportation sector and its energy consumption have indeed expanded. In 1967, energy consumption in this sector amounted to 12.5 mboe in total (16.8% of the final energy consumption), (Assali, 2003). As it is indicated in Table 1, it amounted to 45.40 mboe (18%) in 1976; 102.40 mboe (23.6%) in 1991, and 16,051 mboe (22.8%) in 2001. Above the all, this development is due to the growth in motorized transportation, especially where private transportation is concerned. According to the Iran statistical yearbook, the number of all types of newly registered vehicles rose between 1986 and 2001 from 102,580 to 415,984, whereby the number of passenger cars increased from 39,448 to 271,886 and the number of motorbikes from 29,191 to 124,351. Public transportation rose at a slower rate. The number of newly registered buses in the same period increased from 1,735 to 2,689; minibuses fell from 2,479 to 1,306 (ISY, 2001). The entire inventory of vehicles rose from 1.6 million in 1990 to approximately 3 million today. Half of this figure is attributable to the capital, Tehran. The traits of Iran's vehicle fleet are great age, high fuel consumption and high pollution emissions. Iran evidently has decided to give priority to extending its road traffic. The asphalt road network for long distance traffic was extended over a two-decade period up to 1998 to cover over 70,000 km. whilst the country's rail network currently spans a mere 6,300 km (ISY, 1999).

Electrical energy with especially high growth rates

Between 1967 and 2000, the consumption of electricity in Iran rose from 2,220 GWh to approximately 100,000 GWh, thereby increasing about 45-fold (MOE, 2002). To achieve this, power plant capacity was hastily extended from approximately 1,000 MW to 31,000 MW. The annual growth rate for electricity production in the same period was recorded at 12.78% (Assali, 2003). Given these especially high growth rates, the share of electricity consumption in final energy consumption also rose from 3.5% to 8.6% in the period 1976-2000, as can be seen in Table 2. The main electricity consumer is not, as one might expect, the industry sector but households and commerce. The inefficient and consumption-oriented energy consumption pattern is also clearly reflected in the change in the electricity consumption structure. While industry accounted for 58% in 1976 and households and commerce 40% of all electricity consumption, the main emphasis for electricity consumption had shifted by the year 2000 from industry, which accounted for only 35% of all electricity consumption, to households and commerce which meanwhile account for 54% (Figure 3). This development is, above all, due to the use of household appliances and refrigeration units which are high consumers of electricity and whose number has raised dramatically in the cities in the service sector, in households, and among people in the upper income brackets.

Table 2: Share of electricity in final energy consumption

Final Energy Consumption/ Year	1976		1991		2000	
	mboe	%	mboe	%	mboe	%
Electricity	8.623	3.5	31.553	7.3	61,000	8.6
Total	244.431	100.0	434.599	100.0	705.277	100.0

Environmental impacts

Burning fossil fuels (oil, gas, coal), on the one hand, produces greenhouse gases such as CO_2 and CH_4 which have an impact on the catastrophes with unforeseeable consequences for mankind, the world's greenhouse gas emissions would need to be drastically lowered global climate, and, on the other hand, also environmental pollutants that severely impair people's health. CO_2 is the most important greenhouse gas. In order to avert climatic and reduced to zero towards the end of the 21st. century. In the long term, this would imply completely replacing fossil energies by other

energy forms, especially renewable energy sources. In Iran, approximately 364 million tons of CO_2 emissions were produced in 1994. The per capita quantity of emissions amounted to 5.69 tons (Abbaspour, 2003) and sank to 4.59 tons in the year 2000 (and Shafipour Motlagh, 2003). Accordingly, a significantly higher amount of CO_2 emissions is produced in times the per capita emissions amounts in India, Brazil, and China. Other pollutants such as sulfur dioxide (SO_2), nitrogen oxides (NO_x), hydrocarbons ($HC_{,s}$), heavy metals (such as Cd, Pb, Hg), and dust which also emerge hrough the burning of fossil energy sources are the cause of significant damage to people's health, above all in conurbations, and consequently of high external costs for the national economy. The 2.2 million vehicles in the transportation sector produce the largest portion of noxious pollutants in Teheran.

The causes of Iran's energy policy dilemmas

The energy consumption pattern that has emerged over the past four decades is extremely inefficient, as has been discussed above, contributes towards the excessive consumption of scarce fossil reserves in the country, and generates enormous quantities of pollutants and climatic gases which dramatically impair both people's health and the environment. This estimation, which is not even disputed in Iran itself (Bitaraf, 2003), begs the question as to how such consumption pattern conditions and energy political guidelines, as have been followed by Iran to date, could have emerged. However, a distinction needs to be made between conditions such as how the demographics react to the energy policy and the causes for which politics itself should answer. Below, the most important causes of Iran's misguided energy policy developments will be analyzed.

Growth in population and urbanization

For all developmental societies, i.e. also for Iran, there are two typical causes of growing energy consumption: firstly, the growth in population and, secondly, urbanization. Whilst the size of Iran's population has risen from 19 million in 1956, when Iran first held a census, to approximately 64.5 million in 2001, in the other words, the population has increased almost three-fold in the last half century; the determining factor for the country's over-proportional growth in energy consumption has been the accelerated urbanization process. While, only 31% of the Iranian population in the cities in 1956, this percentage rose to 46% in 1976 and almost 65% in 2001. In 1986, there were 41 major cities with a population of more than 100,000 inhabitants. Ten years later (1996), 59 cities registered populations of more than 100,000 (Confederation of Iranian Industry, 2002).

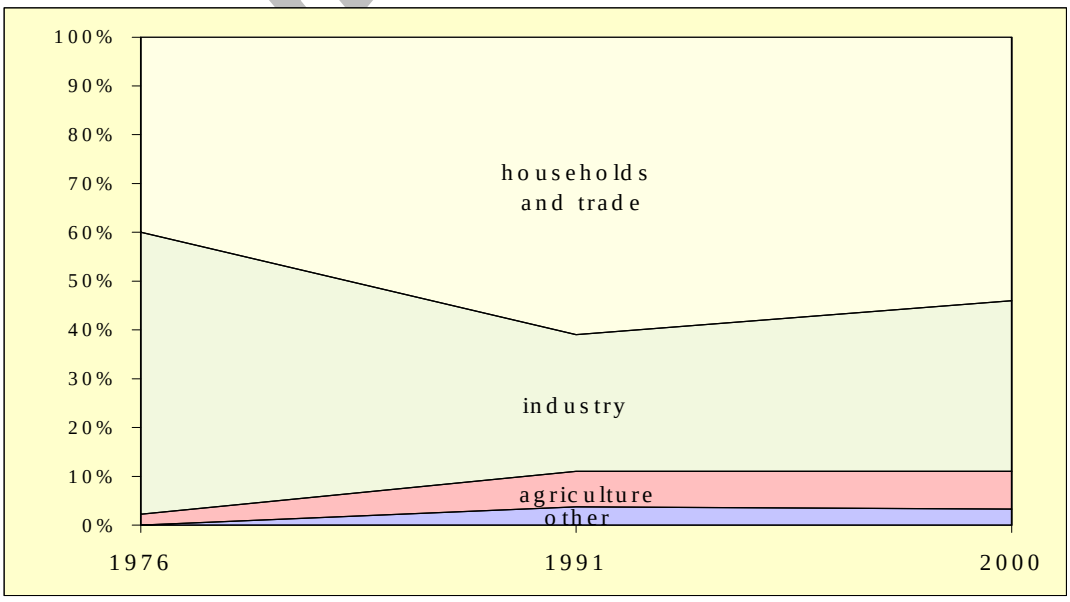

Figure 3: Share of electricity consumption *(IIES, 2001)*

This almost tripling of the population in conjunction with a rapid urbanization process and rising prosperity go some way to explaining the over-proportional growth in energy consumption. Responsibility for the misguided developments in energy policy must be borne to a great extent by the political structures.

High subsidization of energy consumption and lack of coordination on energy policy

Energy consumption in Iran is heavily subsidized. Fuel required for the transportation sector, gas and electricity for household's and commerce as well as for industry and agriculture, in other words, the country's entire energy consumption, is subsidized from top to bottom. In the budget of the year 1381, approximately 13 billion US dollars were apportioned for energy subsidies.

They devour the lion's share of oil revenue, which between 1977 and 2001 stood at between 10 and 24 billion US dollars per annum. Energy subsidies are counterproductive in every respect, since they

- Represent an effective incentive for wasteful consumption and accelerate the depletion of the country's own fossil energy sources;
- Generate additional pollutants and greenhouse gases due to the high levels of consumption;
- Diminish oil exporting capacities and oil export revenues;
- Prevent cost-covering prices and profitability from environmentally friendly, renewable energy sources;
- Are, after all, highly anti-social as they offer significantly more financial relief to the rich who have a comparably higher energy consumption rate than the poor with their comparably low energy consumption rate.

Iran's energy policy has also suffered from the outset from the country's institutionalized parallel structures, competing responsibilities, and the lack of effective coordination. Admittedly, major government institutions such as the oil ministry, the energy ministry and the atomic energy agency have their functionally differing tasks, yet they also pursue differing energy political objectives with all the disastrous consequences that these entail. Added to this, there is a lack of coordination on energy policy with the ministries of trade, industry and mining, transportation and housing. The national environmental organization which, given its actual key task of protecting the environment by reducing energy pollutants, is also afforded a high degree of responsibility, has fallen into the bad ways of the three aforementioned major institutions and has de facto virtually no energy political competencies. Parallel structures have especially emerged with regard to strategies for raising efficiency and to renewable energy sources to the extent that these structures are paralyzing one another. The oil and energy ministries, for example, have each founded their own departments for raising the efficiency of energy consumption. Where renewable energy technologies are concerned, the energy ministry, the atomic energy organization, the ministry of agriculture and the organization for scientific research and technology are all performing their own investment and research activities at the same time (Gharashi, 2003). Structural problems, the problem of distorted pricing systems caused by subsidies and the coordination problem have been well known to the responsible authorities for some time. They were even openly and critically been discussed during the Fourth National Energy Conference in May 2003. Solutions were even drafted and proposed. Firstly, the energy consumption prices are to be raised gradually. Secondly, the Iranian government has since decided to set up Energy Supreme Council to coordinate all of the departments involved in energy. However, the success of these well-meant steps will largely depend on having a binding common energy strategy for all of the institutions. However, such a strategy does not yet appear to be in sight. It must therefore be feared that the present uncoordinated policy, one, which is geared to finding solutions short-term, and, consequently the existing energy path, will remain in force in the future.

Replacing oil with natural gas: A solution or a new problem

Iran has the fourth largest oil reserves in the world and is presently the second largest oil producer in OPEC. The energy consumption pattern, together with its negative features, has undoubtedly emerged primarily as a result of the country availing of extensive amounts of its own fossil resources and of not having to earn foreign currency for its energy

consumption. Nevertheless, it was to be expected that, given the continued high-energy consumption growth rate, the domestic primary energy demand would soon devour the country's entire oil production and that the country's oil exporting capacity and oil revenues, as depicted in Figure 5, would become fully depleted. By way of avoiding the expected bottleneck, which would have grave consequences for Iran's government, the economy and society, only two alternatives were ever up for debate: firstly, changing the energy consumption pattern, or, secondly, tapping new energy sources. Iran opted for the second alternative because the country not only has oil but also the second largest gas reserves in the world. Therefore, the production of natural gas was expanded at a massive rate and the first steps were taken to convert domestic primary energy demand for households and commerce, for industry and, above all, for the generation of electricity to gas.

country's most important domestic primary energy source (Torkan, 2003). By accelerating the expansion of natural gas production and its supply on the domestic market, the country has succeeded in meeting the growing domestic primary energy demand to date and, at the same time, also in maintaining its export share of oil production above the level of 60%. For this reason, the majority of Iran's politicians and experts as a positive move have evaluated the accelerated extension of natural gas production (Torkan, 2003 and Assalli, 2003 and etc.). Nevertheless, the question needs to be raised – and will be discussed at a later juncture – as to whether stepping up the production of natural gas is a solution to or partially the problem behind Iran's present energy policy.

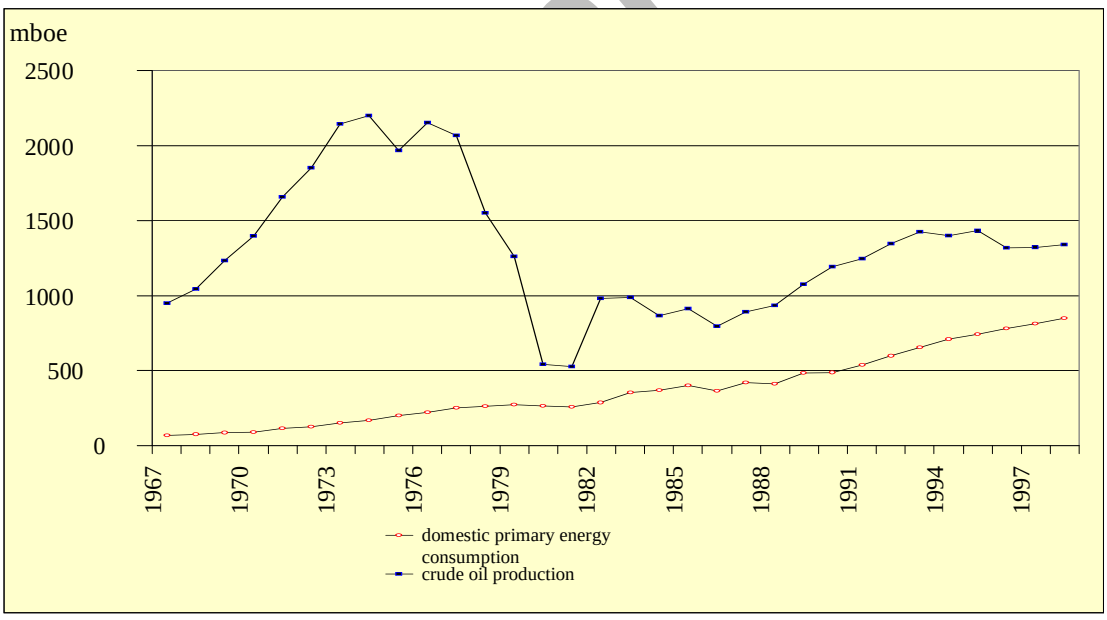

Figure 4: Domestic primary energy requirement and crude oil production *(MOE, 2003)*

In addition, a plan was conceived to convert the transportation sector to natural gas. The share of natural gas in Iran's primary energy demand consequently increased from a moderate 14% in 1976 to 40% in 1998. Figure 6 shows the structural changes in the country's domestic primary energy supply. In 2001, more natural gas was consumed than oil for the first time in Iran's history. As a result, natural gas has since overtaken crude oil as the

In order to maintain its oil exporting capacity without compromising its present energy consumption pattern, it was necessary to re place oil as the primary energy for generating electrical energy with natural gas. As can be seen in Table 3, the share of natural gas as the primary energy source for producing electricity rose from 2.5% (1967) to over 70% (1988), whilst the share of crude oil fell from 72% to 23%. Electrically generated energy is usually

the most expensive form of energy since the production of electricity involves a series of complex process chains. At the same time, it is linked to the highest forms of environmental impact, as the generation of one kilowatt hour of electricity, on account of its low degree of efficiency of 30–40%, requires approximately three kilowatt hours of primary energy which therefore also release three times more CO2 and other pollutants than if oil or natural gas were to be used directly to generate other forms of energy.

Guidelines for Iran's current energy policy: In summary

The issue of Iran's guidelines for its energy policy can best be addressed by analyzing the result of the developments that have taken place over the past few decades. A policy was followed that essentially consisted of two objectives whereby each objective is intertwined with the other:

Firstly, meeting the rising demand for energy in every sector of consumption by raising the primary energy supply whilst maintaining the lowest prices possible, and, secondly, upholding the country's oil exporting capacity at a certain level. The diversification of fossil-based primary energy supply and stepping up of natural gas production follow exactly these objectives. The energy strategy previously pursued and the barriers described above, i.e. subsidizing the consumption of fossil energy and the lack of effective energy policy coordination, seem to be responsible for the fact that new regenerative energy technologies could not gain a foothold in Iran as yet. The presently installed power of the Iranian wind energy plants, for example, amounts to only approximately 10 MW.

Table 3: Primary energy sources of electrical energy in Iran *(MOE, 2003)*

Primary energy	1967		1988	
	mboe	%	mboe	%
Crude oil	2.90	72.50	42.06	23.22
Natural gas	0.10	2.50	128.10	70.73
Water	1.00	25.00	10.94	6.04
Total	4.00	100.00	181.10	100.00

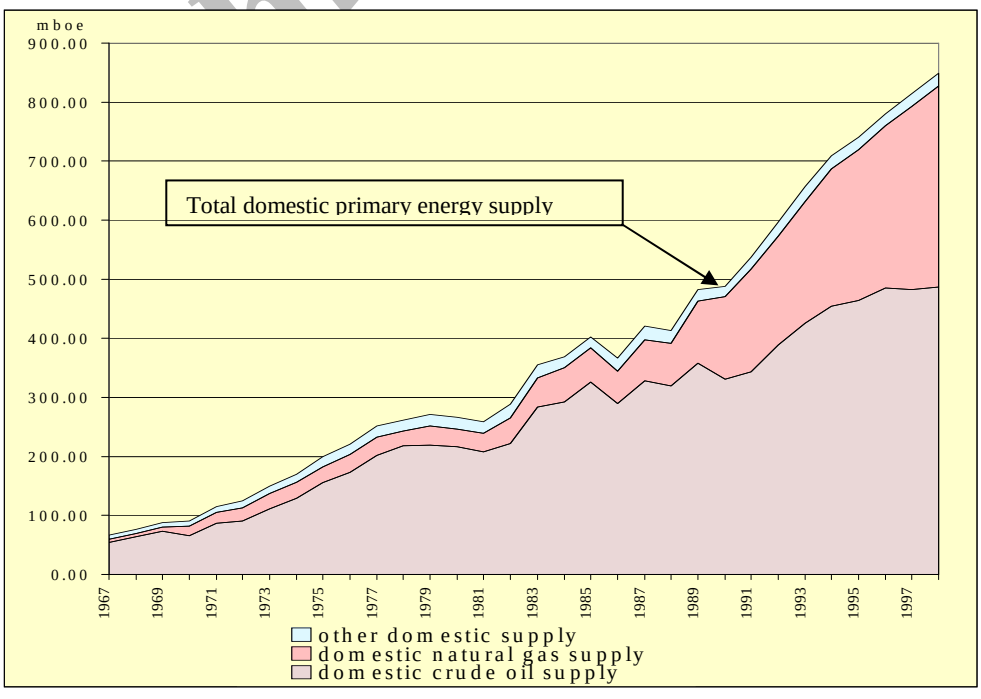

Figure 5: Composition of domestic primary energy supply *(MOE, 2003)*

Further projects, like 120 wind energy plants with a total power of 79 MW in the Gilan province, a wind farm with 23 MW in the Khorasan province and a geothermal energy plant with 100 MW in the Ardabil province, are planned for some years; however, their realization is progressing very slowly.

However, it is pleasant that many responsible politicians and experts in Iran have recognized the dilemmas of Iran's energy supply system and are making serious efforts to implement a change. This was especially discernible at the Fourth National Energy Conference in May 2003. Both the keynote speech made by Iran's minister of energy, Bitaraf, 2003, in opening the conference and the final communiqué issued by the conference itself are testimony to the clear desire to effect change. In the final resolution, both the minister of energy and the conference came out in favor of the principles of sustainable development with the aim being to fight poverty and attain social equality in the present day as well as to preserve the environment in the interests of future generations.

The key cornerstones of the communiqué for Iran's future energy policy are as follows:

1 Oil products are to be replaced by natural gas in every sector whereby uppermost priority is to be given to the transportation sector.
2 The energy pricing structure is to be reformed by amending and adjusting the subsidization policies, ranging from price subsidies to purposeful subsidies.
3 The structures for the provision of oil, natural gas, and electricity are to be renewed by enabling greater competition and closer means of cooperation within the private sector.
4 New engineering and scientific capacities are to be created in educational and research institutes.
5 Comprehensive measures are to be taken to apply modern technologies to energy utilization and to raise energy efficiency as well as to implement standards.
6 The doings of the Energy Supreme Council, as determined by the Iranian parliament, are to begin forthwith with a view to coordinating every energy political activity in Iran.
7 A comprehensive energy plan for Iran is to be drafted with the cooperation of every sector of the economy and taking environmental aspects into account whereby the plan shall form the basis for determining long-term strategies.

However, it is both striking and confusing that the conference communiqué makes no reference to the status of renewable energy technologies in Iran's future energy policy although Iran's minister of energy specifically underlined that the "expansion of renewable energy sources such as hydro, wind and solar energy as well as geothermal energy all form an additional part of Iran's energy policy given their levels of profitability." (Bitaraf, 2003: 8)

Perspectives for a sustainable energy policy

There is a perceptible change in awareness in Iran of the need for a new and sustainable energy supply strategy. Even the steps recommended by the ministry of energy and the final communiqué of the most recent National Energy Conference lean in this direction. However, they might well prove to be insufficient or even ultimately result in the present energy consumption pattern and the primary energy supply structure remaining in a slightly modified form. Assuming that the uppermost energy political measures were to be realized over the next ten years, namely that of largely replacing oil with natural gas in every sector of the economy and society, a measure which is never the subject of dispute in Iran and is being pushed on all sides, would Iran, in doing so, be able to put behind it its unsustainable past measures and would the country then be on a path towards a sustainable energy policy. Of course not, if, by doing so, the entire fossil-based primary energy supply continues to increase as it has done to date, and if, as a result, the present vehicle fleet, for example, doubles from approximately 3 million – of which 1.5 million are found in Teheran alone – to 6 million, or to 3 million in the case of Teheran. Although natural gas is clearly more environmentally friendly than oil and oil-based products, the absolute amounts of pollutants will continue to rise dramatically, the health of millions of people will be impaired even more greatly than before, and even the CO_2 emissions which cause global climate changes will soar. A policy of unbridled expansion of the fossil-based primary energy supply resulting from a rise in the share of natural gas supply would most

likely cement the present consumption behavior, restrict the rise in energy efficiencies and energy savings measures, and extrapolate into the future the current transportation network in Iran, which has been geared towards expanding the road network and private transport, thereby defining the policy for decades to come. It therefore becomes apparent that replacing oil with natural gas, which, if analyzed selectively, may seem economically rational and ecologically meaningful, could well overall prove to be the wrong path and result in irreparable consequences. On the other hand, such a policy of replacement could easily make good sense providing that it is affected as part of a long-term energy strategy; it meets the relevant criteria of sustainability and is conceived as an integral part of such a strategy. However, no overall strategy of this kind is in sight for Iran, or at least is not in sight yet. In the sections that follow, the principles, central ideas, and elements for a sustainable energy strategy for Iran will be mapped out and presented for discussion. They are oriented to the central issue of sustainable development. They involve linking economic growth and economic development to overcoming poverty, attaining a social balance and equality for today's generations as well as preserving the natural bases for life and therefore attaining equality for future generations. Based on this, the following four central issues can be formulated as integral elements of a strategy of a sustainable energy policy for Iran. This is an indispensable requirement for restructuring Iran's energy supply network and for determining the binding conditions for all concerned. The liberalization process that has been triggered as a result of globalization pressure often gears itself against social and ecological standards and sets of rules that accentuate the social and ecological displacements, including in the energy sector. This central issue does not contradict the need to optimize the energy supply flows by creating more competition and extending the leeway for the private sector. The technology and economic systems as well as the consumption pattern in industrialized nations are, by and large, unsustainable, since the prosperity achieved in these countries, which is currently at a very high level, serves to block sustainable development in developing countries for ecological reasons.

This prosperity is largely responsible, for example, for the concentration of greenhouse gases, which represent a danger to the earth's climate. The prosperity that has been gained in industrialized countries at the expense of the Third World and future generations is equivalent to "ecological aggression" in the opinion of the Directors of the United Nations Environmental Program (UNEP), (Töpfer, 2003). Both the developing countries and Iran have the historic opportunity to learn from the errors of the industrialized nations and to avoid them wherever possible. There is no economically or ecologically rational reason for developing countries to undergo every technological development stage that the industrialized nations have gone through, or to copy their highly centralized and expensive energy supply systems and material and energy-intensive transportation systems. Sustainable development in Iran especially means shortening the development paths by bridging future-compliant technologies and systems, in other words, creating prosperity with fewer human and natural resources in a shorter period of time which is of benefit to today's generations and does not compromise future generations. Iran still has good prospects for achieving this. Establishing upper limits for the supply of fossil-based primary energies in Iran is a strategic goal that should determine the framework, the direction and the speed at which the change in energy structure should take place. In doing so, the change in structure can be formed and driven forward with a purpose, and, furthermore, it can set in motion an effective means of coordination that transcends the sector and players at comparably low transaction cost. Especially for a country like Iran, with its inefficient energy supply system, the establishment of upper limits ought to prove to be a particularly efficient, macroeconomic top-down objective that will enable the coordination of otherwise awkward, paralyzing bottom-up structures to be implemented and barriers to be overcome. In doing so, it is completely realistic to expect that the growth rate of the fossil-based energy supply could be moderately decelerated and that in the time period between 2004–2024 (1380–1400 according to the Iranian calendar), for example, it could be frozen at the level

presently achieved. This objective is not only necessary for ecological and social reasons in line with the criteria of sustainability but also possible and meaningful from an economic point of view: Amory Lovins and Peter Hennicke have furnished convincing proof in their scenario entitled "Factor Four Strategy for a Future-Compliant Energy Policy" that it is technologically and economically possible to reduce the present consumption of fossil-based primary energy worldwide to a quarter of the current level without compromising prosperity and taking into account a globally just distribution and additional requirements in the developing countries as well as fully relinquishing nuclear energy (Lovins and Hennicke, 1991). Given the over-proportionally high-energy intensity, it can be presumed that Iran even has a factor-six or even factor-eight strategy.

This means that Iran's gross domestic product can be raised six- or eight-fold on the basis of the current fossil-based primary energy supply and on account of the considerable energy efficiency and savings potential. This strategic objective creates the beneficial pressure for utilizing energy savings potentials for households and commerce, in the transportation sector and in industry. It also generates the pressure required to efficiently coordinate the energy policy. Not even the prospect of replacing oil and oil-based products with natural gas, a measure that in its present, selective form does not represent a suitable solution, gains a positive standing within this holistic strategy in economic and ecological terms. This strategic goal also favors the framework conditions for extending environmentally friendly, renewable energy sources, the use of which is only in the initial stages in Iran.

Not least of all, this objective also represents, on the one hand, an indispensable contribution to restricting pollutants and their disastrous consequences for the health of the population in conurbations and to avoiding significant follow-up costs for the national economy which would be levied on future generations in Iran, and, on the other hand, to reducing CO_2 emissions and averting the economic and social costs for present and future generations around the globe.

Discussion and Conclusion

Wrong developments occur through subsidization; however, they can also eliminate wsrong developments again. To achieve this, the goals of the energy subsidization policy in Iran would need to be redefined to tally with the principles of sustainability. This would entail gradually reducing the subsidization of energy prices whilst phasing in direct subsidies, (a) for disadvantaged social groups, with the aim of raising their level of prosperity despite rising energy prices, (b) for the industrial sectors that produce basic foodstuffs, (c) for disadvantaged regions in Iran and (d) for renewable energy sources. Whilst the strategic objective of limiting fossil-based primary energy supplies sets the macroeconomic framework for an energy supply that is sustainable since, as a result, the principle of equality between generations is taken into account, the energy and income flows between social groups, between conurbations and wealthy regions on the one hand, and the depopulated and poor regions, on the other, could be controlled by the change in direction and objectives of the subsidization policy so that the social balance could be promoted in the present generations and at the same time the possibility of future technologies being implemented in lieu of outmoded technological systems could be raised.

Macroeconomic framework conditions and strategies are decisive if a change in a system is to be effected; however, they also need to be supported at micro level by the relevant strategies, paths and instruments.

The following represents some select rules for effecting a change in the system at micro level which are being put forward for discussion in addition to the basic principles at macro level that have been mentioned above:

1. Gradual change in the transportation system where long-distance traffic is concerned, from road to rail traffic in accordance with the rule: use as much rail-bound traffic as possible and as little road traffic as absolutely necessary; and gradual change in the system, even in conurbations, from private to public transport, whereby here, too, as much public transport as possible should be used and as little private transport as absolutely necessary.

2. Use electrical energy exclusively for the generation of light and to run electric motors, but not to generate heat.

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