

Sustainable Energy Watch 2005/2006

Energy and Sustainable Development in Iran



Report by:	Email:
Morteza Sabetghadam	<u>sabet@iies.org</u>

Summary of Report

Iran is heavily reliant on energy-intensive industries for domestic economic production and export. It also has a high dependence on oil products to meet primary energy needs and for its petrochemical and metal industries. Despite diversification of energy sources for domestic consumption, energy price reform has not been effectively pursued and energy intensity remains high, posing a serious threat to the economy.

Preface

This is the first Sustainable Energy Watch report for Iran.

Estimates have been developed for all eight indicators using 1990 data or similar benchmarks for all eight indicators. For each of these indicators, the value of 1 is either the global average or the historical trend for Iran, while the value of 0 is the sustainability target.

Iran provides a vast spectrum of statistics on energy. There are many organizations active in this field, namely:

- Management and Planning Organization: "Government Budget Documents";
- Ministry of Energy: "Annual Energy Balances";
- Central Bank of Iran: "National Accounts";
- Statistical Center of Iran: "Population Census" and "Family Budget Surveys"; and,
- Environment Preservation Organization: "Pollution Data

In addition to the above, many statistics from international sources such as IEA and the World Bank have reviewed and utilized.

Author

Morteza Sabetghadam of the Institute for International Energy Studies compiled the report. It is the author's hope is that these indicators will stimulate debate within Iran on energy and sustainable development goals – as well as on how Iran should track progress toward those goals. As a work in progress, we welcome comments from stakeholders and experts in Iran and beyond. This feedback will help to improve the accuracy of the data, as well as the quality of the policy conclusions that are drawn from the data.

Many people contributed to this report with data, insights and feedback. Those who helped with statistics and some of the analysis are: Ms. Fatemeh Nazari (Industrial Economist and Researcher, Private Consultant), and Ms. Poopak Alaeefar Researcher, IIES.

Morteza Sabetghadam Director, International Affairs Institute for International Energy Studies (IIES) 125 Dastjerdi (Zafar) Ave Tehran 19167 Iran Tel: + (9821) 2225 80 96 Fax: + (9821) 2222 1793 Email: sabet@IIES.org

Table of Contents

Preface 2

Executive Summary	. 5
Executive Summary Table 1: Eight Indicators of Energy Sustainability for Iran	
General Discussion of Iran Profile of Iran Table 2: Key Development Indicators for Iran and Other Countries/ Regions, 2003 Table 3: Human Development Index	7 8
Economic Background Figure 1: Real GDP and GDP Per Capita, 1967-2003, in 1997 Prices Government Subsidies on Energy Carriers	.10
Iran's Energy Sector Sources of Primary Energy Table 4: Production of Primary Energy in 2003 (MBCE) Figure 2: Source Distribution of Primary Energy in 2003 MBCE) Consumption of Final Energy Figure 3: Sources of Final Energy in 2003 Table 5: Sources of Final Energy in 2003 Energy Consumption over the Decades Table 6: Final Energy Consumption 1967-2003 Figure 4: Final Energy Consumption, 1967-2003 Other Energy Related Developments Evaluation of Policy/Program Implementation Table 7: Consumption of Electricity, 1990-2003 (million KWH) Table 8: Consumption of Oil Products and Natural Gas (MBCE) Table 9: Nominal and Real Price Oil Products, Rials / Litre	11 .12 .12 .13 .13 .13 .14 .14 .14 15 .16 .16
Environmental Sustainability Indicator 1: Per Capita Carbon Emissions Figure 5: Total CO2 Emission, 1980-2003 Table 10: Per Capita CO2 Emission 1980-2003 Table 11: Emission of Pollutants in 2003 (1000 Metric Ton) Table 12: Indicator 1- Per capita Carbon Emission 1980 and 2003 Indicator 2: Most Significant Energy-Related Local Pollutant Table 13: Cities with Heavily Polluted Air Quality	19 .19 .20 .21 .21 .21 22
Social Sustainability Indicator 3: Households with Access to Electricity Figure 6: Rural Electrification in Iran Table 14: Rural Electrification in Iran	24 .24

Indicator 4: Clean Energy Investment	26
Table 15: Total Investment in energy sector- 2003	
Table 16: Total Investment in Renewable energy- 2003	27
Economic Sustainability	28
Indicator 5: Resilience to External Impacts: Energy Trade	28
Table 17: Country's Exports (in Million US Dollars)	
Indicator 6: Burden of Energy Investments	
Table 18: Indicator 6 in 2003Values in Billion Rials, at Current Price	31
Technological Sustainability	
Indicator 7: Energy Intensity	
Figure 7: Per Capita Final Energy Consumption 1967 - 2003	
Figure 8: Ration of Final Energy Consumption to GDP	
Table 19: Energy Intensity (1000 Btu per 2000 U.S\$) Table 20: Energy Intensity in Iran	
Table 20: Energy Intensity in Iran Figure 9: Energy Intensity (1000 Btu per 2000 US\$)	دد ۲۸
Indicator 8: Renewable Energy Deployment	
Table 21: Production of Primary Energy in 2003 (MBCE)	
Presentation of Iran's SEW Star	36
Conclusions	37
Bibliography	20
יוטוט מאווא אווא אווא אווא אווא איז א איז איז א אווא אוו	59
Annex: Indicator Rationale	41

Executive Summary

This is the first Sustainable Energy Watch report for Iran.

Estimates have been developed for all eight indicators using 1990 data or similar benchmarks for all eight indicators. For each of these indicators, the value of 1 is either the global average or the historical trend for Iran, while the value of 0 is the sustainability target.

Iran is the closest to the sustainability target on the indicator (indicator 3) concerning access to electricity. This reflects the success of the ambitious mass electrification program

The relative share of investment in clean energy (indicator 4) and share of renewable energy (indicator 8) in total primary energy have both improved, although the magnitudes of the indicators are not satisfactory. Iran has a vast potential in renewable energy sources, solar, wind, geothermal, which is not being properly harnessed; Iran has a long way to go to utilize and optimize its potential sources in this field.

The vulnerability indicator (indicator 5) improved slightly, but the change in magnitude is not satisfactory. 80% of the foreign exchange revenue of the country originates mainly from export of crude oil and partially from export of petroleum products.

For the other indicators (indicators 1, 2, 6, and 7), there is deterioration in the sustainability: CO2 emission (indicator 1), ambient pollutants (urban air pollution, indicator 2) and energy productivity (energy intensity, indicator 7) are deteriorating on a large scale. It is clear that these three indicators are technically interrelated and result from deficiencies in the field of energy utilization and urban management. The solution requires an integrated strategy with corresponding policy options.

Indicator 6 reflects low participation of private sector in the energy field with government shouldering the burden of investment. Economic reform and liberalization of the economy, e.g. privatization of state-owned utilities and the opening up the economy to the public sector and foreign investment as declared in Five Year Development Plans (FYDP) are viable options. Energy price reform is an essential prerequisite for a successful economic reform.

Energy and emissions intensity of the economy are described in some detail in this paper as Iran has a heavy reliance on energy-intensive industries for domestic economic production and export. It also has a high dependence on oil products to meet primary energy needs as well as energy demands from energy-intense petrochemical and metal industries. This is compounded by low energy prices and poor energy efficiency. The continued high-energy intensity and rapid pace of consumption of oil products has been recognized as a serious threat to the economy. Diversification of energy sources for domestic consumption and specifically the substitution of natural gas for oil products have been adopted and successfully implemented. Yet energy price reform has not been effectively pursued and therefore there has not been a successful lowering of energy intensity.

As discussed in the paper, there is vast potential for private sector activity in energy sector and also in expanding capacity in renewable energy, especially for rural electrification. There are positive signs of private sector activities in the field of electricity generation. There also exists a commitment to increase investment in renewable energy and energy efficiency. The success in this challenge depends, among other things, on the implementation of rational energy prices. The indicators for renewable energy employment and public sector burden of investment illustrate the long road ahead for Iran in developing renewable energy sources. Challenges exist in moving beyond seeing these only as solutions to remote area energy problems and opening up the economy to the private sector.

This poses a major challenge to policy makers and the society. Five Year Development Plan (FYDP) documents recognize the importance of these issues but progress 'on the ground' has been slow. Simultaneously there are some reservations from a social perspective concerning energy price reforms and some constitutional reservations about opening up the economy.

It is hoped that these indicators and the discussion of their implications will provide a useful starting point for stakeholders to debate Iran's future and will help stimulate the development of coordinated policies and implementation to create a more sustainable energy sector that supports the development and welfare of all Iran.

		Data Points	5	Results	
Indicator Name	Unit	X(current)	X(1990)	I(current)	I(1990)
1) CO2 emissions	kgC/cap	1,515	1,010	1.486	0.848
2) Ambient pollutants	%	38.8	18.4	2.386	1.000
3) Access to electricity	%	96.7	82.8	0.033	0.172
4) Investments in Clean Energy	%	0.2	-	0.998	1.000
5) Vulnerability	%	80.0	85.8	0.800	0.858
6) Public sector investment	%	11.6	11.6	1.157	1.157
7) Energy productivity	MJ/\$	22.6	20.6	2.248	2.040
8) Renewables	%	2	1	1.077	1.088

Table 1: Eight Indicators of Energy Sustainability for Iran

General Discussion of Iran

Profile of Iran

Iran is located in the Middle East and is bordered by Iraq and Turkey to the west, Armenia, Azerbaijan, Russian Federation and Turkmenistan to the north, Afghanistan and Pakistan to the east. To the south, Iran borders Persian Gulf and the Oman Sea with a long coastline of 2440 kilometers. Iran also borders the Caspian Sea with a 740 km coastline to the north of the country. The country has an area of 1,648,000 square kilometers.

Iran is semi-arid and has diversity of climates. The "Alborz" mountain range is located in the north of the country with mount Damavand, its highest peak, at 5671 meters above the sea level. The "Zagros" mountains stretch from northwest to southeast. The middle and eastern parts of Iran are less mountainous with fewer peaks. Except for the northern and southern seashores, where high humidity is prevalent, humidity and rainfall are lower from north to south as well as from east to west.

In 2004, Iran's population was approximately 69 million, out of which 68% were in the 15-64 years old age group. The population growth rate is estimated at 1% per year. 63% of the population lives in cities, while the remaining 37% live in rural communities.

According to latest administrative divisions there exists; 30 provinces (Ostan); 939 cities ("Shahr"), and approximately 68,000 villages ("Deh" or "Roosta")

For many of the standard development indicators, Iran fits in the 'upper middle income' countries. As shown in Table 2, life expectancy and enrollment are similar the Asia-Pacific region but has a per capita GDP roughly 37% higher. Due to lower adult literacy rate, the HDI index is lower than that of some Asia-Pacific countries.

Country/ Region	Life Expectancy at Birth	Adult Literacy Rate	First, Second and Third Level Gross Enrolment Ratio	Real GDP/ Capita	Human Development Index
Iran	70.4	77	69	6,995	0.736
China	71.6	90.9	69	5,003	0.755
Turkey	68.7	88.3	68	6,772	0.75
Malaysia	73.2	88.7	71	9,512	0.796
Pakistan	63	48.7	35	2,097	0.527
Asia Pacific	70.5	90.4	69	5,100	0.768
OECD	77.7		89 & High-Income OECD 95	25,915	0.892

Table 2:Key Development Indicators for Iran and Other
Countries/ Regions, 2003

Source: (HDR 2005)

While key development indicators have improved over the past 25 years, gender inequality, in particular with respect to women's employment has not been satisfactory and needs to be improved. Rapid population growth has contributed to increasing unemployment rates and despite relatively high economic growth (of around 5% per year), unemployment remains a real concern.

Iran's human development index has steadily increased from 0.560 in 1975 to 0.736 in 2003. The Human Development Report (HDR, UNDP, 2003) classifies Iran as a middle-level, human development country and ranks it at the 99th global position.

Table 3:Human Development Index

Year	1975	1980	1985	1990	1995	2000	2003
Index	0.566	0.570	0.610	0.650	0.694	0.721	0.736

The HDR 2005 declares the share of GDP devoted to health and education as being equivalent to 2.9% and 4.9% respectively.

Iran's social agenda to protect the poor is supported via several mechanisms:

• **Social net**: insuring at risk social groups in the population.

- Subsidies and supports: The stated objectives are to protect the poor and vulnerable segments of the society, including households headed by women. However subsidy coverage is much wider, mainly due to the difficulties in identifying/ differentiating between the poor and vulnerable and targeting subsidies accordingly. Direct subsidies are still paid for many food and basics non-food items such as medicine and food staples such as bread and sugar. The most costly subsidy is the hidden/indirect subsidy allocated to energy carriers. This latter subsidy is not reflected in budgetary accounts and due to distorted and cheap domestic pricing of the energy carriers. The level of hidden subsidies can not be determined based on the opportunity cost of energy carriers at international prices.
- **Rural Development Programs**: The objectives are to manage physical rural development projects; provision of potable water and rural electrification, improvement of rural roads, promotion of rural industrial complexes, rural sanitation, and provide services to rural agricultural communities. Despite these programs there is still rural emigration to urban areas as the average income of rural to urban population is 0.6

Economic Background

Oil, one century since its discovery in "Masjed Soleiman"(the south-western part of the country), has dominated the politico-socio-economic life of the country.

During 1957-77 (between the second development plan formed after Nationalization of Oil Industry in 1953 until the onset of the Islamic Revolution of 1978), income from export of crude oil has been the main source of government funds for investment in infrastructure and industrial development. The result was reasonable economic growth over two decades.

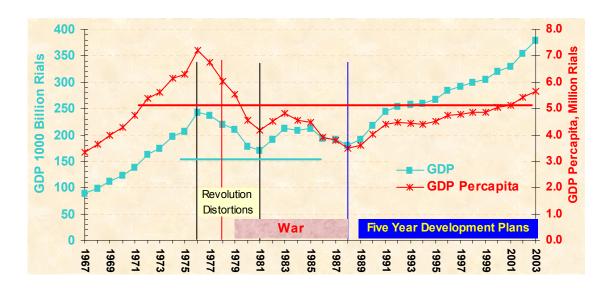


Figure 1: Real GDP and GDP Per Capita, 1967-2003, in 1997 Prices

After the Revolution, the ten-year war with neighboring Iraq placed enormous pressure on the economy. The economic effects of war, embargoes, nationalization of the financial and banking sectors and foreign exchange market along with state takeover of a large portion of production and distribution activities of large-scale companies led to severe economic policy distortions and inflated the government's size to an extraordinary level. The result was a severe drop in GDP in real terms and in GDP per capita.

Just after the end of the war, in 1989, government's strategies and policies in favor of a liberalized economy were formed in a series of new five-year development plans (FYDP). The first FYDP succeeded in reconstruction of the economy fairly quickly and the second initiated the capacity expansion.

Economic reforms began with privatization of state dominated enterprises and initiation of a centrally-managed, unified foreign exchange rate. However in 1993 the setting of a low foreign exchange rate and the increase of imports resulted in the rapid accumulation of foreign debt. This, coupled with a fall in oil revenue, caused a debt payment crisis. The crisis was exacerbated by a high inflation rate and led to the government's decision to control foreign trade through the restriction of imports.

As Iran emerged from its debt crisis (1999) and partially recover its foreign reserves, the government succeeded in establishing a government-managed, unified exchange rate system. Economic reform has slowly been occurring through the 3rd and fourth FYDPs (1999-2003 and 2003-2008).

While the country is benefiting from the steady increase in oil revenues and moderate economic development, some fundamental economic problems

remain: inadequate rate of investment, persistent unemployment, state takeover of a large portion of the economy and the burden of governmental bureaucracy as a result of its inflated size and low participation of private sector in the economy.

The social agenda to protect the poor, by direct and indirect subsidies, protected much of this population segment during the Iran/Iraq war but the absolute size of continued subsidies is enormous; particularly indirect subsidies allocated to refined oil products, which amounted to about 10% of GDP in early 2000.

It is argued that channeling of this amount of investment in the productive sectors and thereby generating employment, rather than distributing it via subsidies would be adequate to tackle Iran's most critical economic problem of extensive unemployment (of approximately 14%). The critical decision is which to favor: protective subsidies or investment and more growth.

Government Subsidies on Energy Carriers

Cheap energy prices stipulated by government as part its policy agenda to protect and serve the poor constitutes an indirect subsidy for energy carriers

Efforts over the past decade to improve pricing policy via *Price Reform Policies* have only slightly improved prices in real terms and have not succeeded in limiting demand. These subsidized low prices result in the irrational, over-consumption of energy which is reflected in the high energyintensity indicator compared to other countries and a sub-optimal energy mix.

Iran's Energy Sector

Currently Iran possesses proven reserves of approximately 133 billion barrels of oil and 24 thousand billion cubic meters of natural gas. These constitute 11.6% and 15.6% of the world's proven oil and gas reserves respectively. Iran has the second richest oil and gas reserves in the world.

Sources of Primary Energy

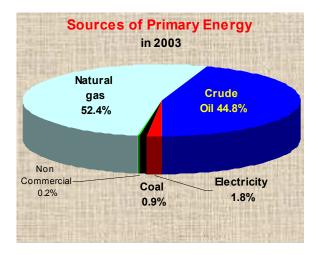
In 2003, Iran produced 1967 million barrels of crude oil equivalent (MBCE) of primary energy. Net of exports and imports around 1001 MBCE is available for domestic consumption. The dominant role of petroleum in supplying primary energy is illustrated in Table 4: 97.2% of domestic consumption of primary energy originates from petroleum, (44.8% from oil and 52.4% from gas).

	Production	Import	Export	Total
Crude oil	1431.8	59.7	1043.3	448.2
Natural gas	510.1	36.1	21.5	524.7
Coal	5.9	3.0	0.1	8.8
Non-commercial	1.8			1.8
Electricity (Hydropower)	17.3	0.9	0.5	17.7
Renewable	.04	0	0	.004
Production	1966.9	99.7	1065.4	1001.2

Table 4: Production of Primary Energy in 2003 (MBCE)

Source (Iran Energy Balance 2003)

Figure 2: Source Distribution of Primary Energy in 2003 MBCE)



Consumption of Final Energy

According to the document "*Iran energy balance-2003"*, out of the total energy, available to the nation as primary source of energy, 779.6 MBCE is available and consumed as final energy. The rest is assumed to be lost through energy conversion, transmission and distribution.

Figure 3: Sources of Final Energy in 2003

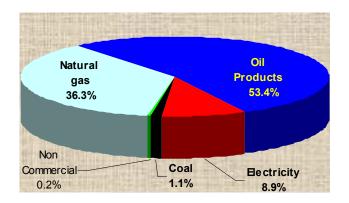


Table 5:Sources of Final Energy in 2003

	Final Consumption MBCE	% Share
Oil Products	416.3	53.4
Natural gas	283.1	36.3
Coal	8.7	1.1
Non commercial	1.8	0.2
Total Electricity	69.7	8.9
Production	779.6	100.0

Since a large share of natural gas is consumed in power generation plants, the share of natural gas in final consumption is less than its share in the primary energy mix. In 2003, 89.7% of final energy was comprised of petroleum products (oil & gas) and electricity providing only 8.9%.

Energy Consumption over the Decades

In the past four decades, total final energy consumption has growing at a rapid pace: from 1967-77, during the industrialization transformation period of the country, total final energy consumption grew at an annual rate of 14.2%. Just prior to the Revolution and during the Iran/Iraq war (1977-89), the rate of growth slowed to 5.2%. Over the course of three FYDPs, frim 1990 to 2003, growth has continued at an average annual rate of 5.3%.

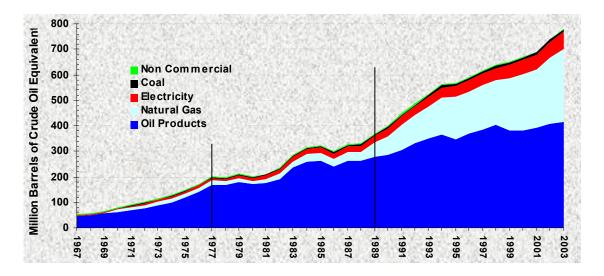
The energy mix has been evolving towards cleaner energies. From 1966-2003, the share of natural gas increased from 1.3% to 36.3% and share of

electricity has more than doubled from 4.1% to 8.9%. The share of oil products in domestic consumption has dropped from 84.3% to 53.4%.

	Year	Oil Products	Natural Gas	Electricity	Coal	Non- Commercial	Total
3	1967	45	0.7	2.2	1.0	4.5	53.4
BC	1977	168	17.1	9.8	3.5	3.3	201.7
m	1989	280	53.9	26.4	6.0	3.8	370.1
	1990	285	74.9	29.6	6.5	3.5	399.1
	2003	416	283.1	69.7	8.7	1.8	779.5
Sh	1967	84.3	1.3	4.1	1.9	8.4	100.0
Percen Share	1977	83.3	8.5	4.9	1.7	1.6	100.0
	1989	75.7	14.6	7.1	1.6	1.0	100.0
tag	1990	71.3	18.8	7.4	1.6	0.9	100.0
e	2003	53.4	36.3	8.9	1.1	0.2	100.0

Table 6:Final Energy Consumption 1967-2003

Figure 4: Final Energy Consumption, 1967-2003



It is worth noting that there was a significant decline in the share of noncommercial fuel from 1967 to 1977. The substitution of gas for oil products accelerated over the course of the three corresponding FYDPs.

Other Energy Related Developments

Historically, with a century of exploitation, extraction and refining, oil has been the predominant source of primary and final energy in Iran. In 1990, at the beginning of the after-war economic reforms, immense domestic consumption of oil products, combined with a rapid rate of growth, was recognized as serious threat to the economy particularly if the trend continued as it would leave sufficient crude oil for export.

To ensure the export of crude oil as the key source of foreign revenues, while simultaneously providing energy for domestic consumption, development and welfare, became the most crucial challenge.

The main goal was to substitute other sources of energy for oil products in domestic consumption (Diversification of Energy Mix). Investing in alternative sources of energy was also adopted as a key strategy.

Certain policies and programs, such as energy price reform and expanding production capacities and grids in gas and electricity were selected to support the main goal and strategy.

The main policies objectives of this diversification were:

- Provision of more clean energy, i.e. electricity, gas and renewable energy, on the assumption that, given the competitiveness of prices, they would be preferred and hence substituted for oil products by customers for indoor heating and cooking.
- Supporting expansion of renewable energies.
- Rationalizing energy carriers prices both with regard to each other and compared to general price indices.

Evaluation of Policy/Program Implementation

Expanding Electricity Capacity

In Iran 97.4% of electricity generation capacity belongs to the Ministry of Energy. The expansion of this production capacity and electricity grid has resulted in a rapid increase in the demand for electricity. In 2003, the total number of generators reached 363 and installed electrical capacity climbed to 34,328 MGW.

Electricity generation and consumption over the 13-year period from 1990 to 2003 increased at an average, annual rate of 7.4%, much higher than the population and economic growth rate, meaning a considerable improvement in industrial and agriculture utilization as well as per capita consumption of electricity. The corresponding rates for electricity consumption in industry and agriculture sectors were 10.4% and 10.7% respectively compared to 5.6% for household-commercial sector. This signifies an increase from 23% to 32% in the industry sector and an increase from 8% to 12% in the agriculture sector.

Year	Household & Commercial	Industrial	Agriculture	Other	Total
1990	29274	10220	3716	1897	45107
1991	32737	10637	3792	2009	49175
1992	33513	13262	3576	1955	52306
1993	37127	15572	4023	1392	58114
1994	36220	20470	5169	1766	63625
1995	37232	21390	5402	1830	65854
1996	38210	22925	5731	2805	69671
1997	41410	23661	6009	2278	73358
1998	44247	24140	6782	2477	77646
1999	45943	26493	8030	4190	84656
2000	48528	28924	9160	3754	90366
2001	51236	30721	11097	4117	97171
2002	54501	33456	12448	4671	105076
2003	59142	36937	13873	4672	114625
Average growth rate per year %	5.6	10.4	10.7	7.2	7.4
1990	64.9	22.7	8.2	4.2	100.0
2003	51.6	32.2	12.1	4.1	100.0

Table 7: Consumption of Electricity, 1990-2003 (million KWH)

Expanding Production and Consumption of Natural Gas

Production of oil products over the 13-year period from 1990-2003 increased at an average annual rate of 2.8%. For gasoline, which has experienced the highest growth, the increase has been 7.2%; this still falls short of meeting demand meaning that gasoline imports are rising.

Table 8: Consumption of Oil Products and Natural Gas (MBCE)

Year	Liquefied gas	Gasoline	Kerosene	Gas oil	Fuel oil	Total Oil Product	
1990	31	130	135	314	219	829	309
1996	40	188	180	383	272	1063	736
2003	54	322	128	441	238	1183	1527
Average growth rate per year %	4.4	7.2	-0.4	2.6	0.6	2.8	13.1

Kerosene consumption, the dominant heating source of heating in rural areas and relatively poor urban population, increased to an all time high in 1996 and has been decreasing since. The overall average annual growth rate during 1990-2003 is -0.4%, which reflects the effectiveness of gas and electricity substitution programs.

In contrast, consumption of natural gas over the same period has increased at an outstanding rate of average annual 13.1% fur to the success in implementing gas substitution policies.

A portion of gas oil, fuel oil and natural gas is used in energy conversion for electricity generation (as primary sources of energy).

Expanding Renewable Energy (RE)

Iran possesses rich and diversified sources and potential for developing renewable energy, namely solar, wind, geothermal and biomass. However due to abundant sources of petroleum (oil and gas), the opportunities offered by renewable energy are neglected. This is reflected in the share of modern RE in final energy consumption, which is negligible.

Over the past ten years some research on solar energy have resulted in development and the establishment of a few small- and medium-scale electricity generation plants, powered via solar and geothermal energy. There has also been the development of solar water heaters and solar rural baths.

RE is new to Iran and there is a long way to go. Except for the few afore mentioned projects, small-scale technologies to bring power to remote villages have a better chance of being adopted than those implemented at the national level.

Price Reform Policies/ Programs

The energy market in Iran is a monopoly. The government, as the sole supplier, sets the prices of energy carriers. The government has historically set prices low.

Generally speaking, the government froze energy carriers' prices from 1978 to 1996, primarily in support of the poor (kerosene), and the transportation sector (gas oil). By 1996, given the inflationary state, the price freeze depreciated energy prices.

The resulting distortion in energy prices in Iran has had a two-fold effect: 1) energy prices are generally far bellow the competitive global market price; and 2) the relative prices of energy carriers are distorted with respect to each other.

In support of the FYDPs' goals, the government in 1996 started a gradual price reform on energy carriers. This reform aimed at correcting the relative prices of oil products and their relationship to the general consumer price index. However because of the gradual and insufficient increase in the price of energy, the policy has not been effective as is illustrated below:

- In 2006, the prices of energy carriers are too low by any standard; at the current exchange rate of around 9000 Rials for 1US\$, gasoline is sold at less than 9 US cents and gas-oil and kerosene for less than 2 US cents per liter. While one liter of potable bottled water is priced at 20 US cents (more than twice the price of gasoline). The price of kerosene and gas oil is very low compared to that of gasoline.
- From 1990 to 2004, the real price of gasoline (based on 1990 prices) has increased from 50 Rials per liter to 54.6 Rials which does not reflect a considerable change. For gas oil and kerosene, despite reflecting a higher increase in real prices from 4 to 11 Rials, the absolute price is very low.
- Relative prices have improved to some extent: in 1990 the ratio of the nominal price of gas oil and kerosene to the price of gasoline was "1 to 12.5". This ratio has improved to "1 to 4.8", which although an improvement is still very far from relative prices in international oil markets.

	Gasoline	Gas Oil	Kerose ne	Ratio of Gasoline to Gas Oil and Kerosene Price
1990 Nominal Price	50	4	4	12.5
2004 Nominal Price	800	165	165	4.8
2004 Real Price, in 1990				
Prices	54.6	11	11	-

Table 9: Nominal and Real Price Oil Products, Rials / Litre

The substitution policy, through expanding access to more clean energy (natural gas and electricity) has proved to be successful, at least in slowing down the rate of increase in consumption of oil products. However price policies were not successful in adjusting energy prices with respect to the long-term (1978-2004) price index. Nor were they successful in lowering the gasoline consumption rate. Many reasons account for this failure including the increased use of cars, insufficiencies in the public transportation system (as an alternative to private transportation) and insufficient price adjustments.

Environmental Sustainability

Indicator 1: Per Capita Carbon Emissions

Iran is one of the highest carbon emission-intensive countries in the world. Total CO2 emissions in 1990 were 201.8 MMT, which has increased rapidly at an average annual rate of 5.7% to 372 MMT by 2003.

Per capita carbon emission in 1990 was 1010 Kg, 10.6% less than the global average of 1130 Kg. This figure increased to 1514.5 Kg by 2003, 4.5 times higher than the global objective of 339 Kg/capita of carbon emissions

The high emission rates are partly due to: increasing wealth; to the low energy efficiency of many sectors; and to the over-consumption of energy as the result of cheap energy prices.

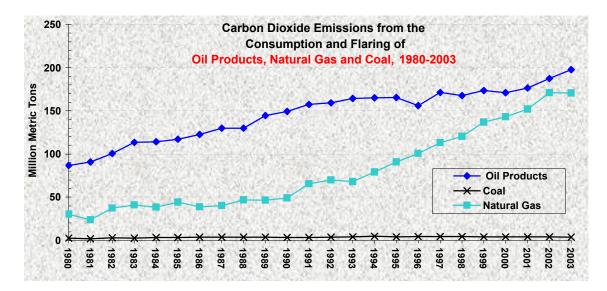


Figure 5: Total CO2 Emission, 1980-2003

Year	Total CO2 Emission MMT	Population (Million)	Per Capita CO2 Emission Kg	Per Capita Carbon Emission Kg	
1980	119.5	39.29	3042	829.6	
1981	116.4	40.83	2850	777.4	
1982	141.1	42.42	3326	907.2	
1983	156.9	44.08	3560	971.0	
1984	155.9	45.72	3409	929.7	
1985	164.7	47.54	3465	944.9	
1986	165.1	49.45	3340	910.9	
1987	174.0	50.65	3434	936.7	
1988	180.4	51.89	3477	948.3	
1989	195.0	53.17	3667	1000.1	
1990	201.8	54.48	3704	1010.1	
1991	226.2	26.2 55.84		1104.8	
1992	232.9	56.96	4088	1114.9	
1993	236.4	58.11	4068	1109.6	
1994	248.8	59.29	4196	1144.3	
1995	260.1	59.15	4398	1199.4	
1996	261.0	60.06	4346	1185.1	
1997	288.5	60.94	4734	1291.2	
1998	292.3	61.83	4727	1289.2	
1999	314.6	62.74	5015	1367.6	
2000	317.9	63.66	4993	1361.8	
2001	332.2	64.53	5148	1403.9	
2002	362.5	65.54	5531	1508.4	
2003	372.0	66.99	5553	1514.5	

Source of CO2 Emission: (IEA 2004)

In Iran, almost 30% of CO2 emission originates from the householdcommercial sector. Transportation accounts for 27.5% which is heavily reliant on petroleum products (Oil & Gas). Among other energy consuming sectors, power plants are responsible for 24.4% and industry for 15.1% of all CO2 emissions. The agriculture sector is low at 3% (see Table 11).

	NOx	SO2	CO2	SO3	СО	СН	SPM
Household- Commercial	97	143	100206	1.8	69	11.8	10.6
Industries	116	337	50208	5.1	19	6.7	12.9
Transportation	715	329	91835	3.7	7282	1642.6	238.6
Agriculture	59	60	9946	0.4	18	41.3	25.7
Power Plants	124	254	81268	3.9	0	4.2	13.4
Total	1111	1124	333464	14.7	7389	1706.5	301.3
Percentage Distr	ibution						
Household- Commercial	8.7	12.8	30.1	12.0	0.9	0.7	3.5
Industries	10.5	29.9	15.1	34.4	0.3	0.4	4.3
Transportation	64.3	29.3	27.5	24.8	98.6	96.3	79.2
Agriculture	5.3	5.4	3.0	2.5	0.2	2.4	8.5
Power Plants	11.2	22.6	24.4	26.4	0.0	0.2	4.5
	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 11: Emission of Pollutants in 2003 (1000 Metric Ton)

Source of CO2 Emission: (IEA 2004)

In support of the FYDPs goals, government has only been successful in lowering the pace of oil products consumption. This was mainly accomplished by the substitution of gas for household-commercial, industries and power plants through the expansion of gas refining capacities and access to the gas grid. However price reform policies failed to lower the overall demand for petroleum products, particularly gasoline, which is still growing at 7.2 % per year.

For indicator 1, the value for 1 on the vector is 1130Kg C/capita, which is the 1990 global average of carbon emissions from fossil fuel production. The value of 0 on the vector, or the sustainability goal, is 339Kg C/capita – a 70% reduction from 1990 levels.

Based on the IEA-2004 statistics for Iran's CO2 Emission, calculation of vector values for the years 1990 and 2003 are depicted in the following table:

Table 12:	Indicator 1- Per capita Carbon Emission 1980 and 2	2003
-----------	--	------

Year	Total CO2 Emission MMT	Population (Million)	Per Capita CO2 Emission Kg	Per Capita Carbon Emission Kg	Х-Ү	W-Y	Vector Value
1990	201.8	54.48	3704	1010.1	671.1	791	0.85
2003	372.0	66.99	5553	1514.5	1175.5	791	1.49

Indicator 2: Most Significant Energy-Related Local Pollutant

Energy production and consumption have diverse environmental impacts. As mentioned in the previous section, almost 30% of CO2 emissions originate from the household-commercial sector and 27.5% from the transportation sector.

Iran's rural population is widely distributed across the country and typically is not exposed to the emissions from heavy industries. Moreover, the majority of the rural population has access to clean energy for indoor heating, cooking and lighting; For indoor heating, almost 75% of rural families use kerosene and 9% in purchase gas oil. For cooking almost 92% of rural families' use gas, mostly cylinder gas with 4.5% using kerosene. 93.5% of the rural population is electrified. Therefore many of the indoor air pollution problems associated with the burning of locally available fuels, e.g, bio-mass, wood etc., are not an issue in Iran.

The most critical energy-related pollutant is air pollution in Iran's big cities. The rapid rate of urbanization due to rural migration to metropolitan areas, the rapid growth of vehicles and the associated consumption of petroleum, the use of older, poor burning vehicles, a poor public transportation system, the low price of petroleum products and a weak urban management are all contributing factors

Thus, contrary to the efforts to lower the level of air pollution, the number of cities recognized as being heavily polluted in terms of air quality, have increased from one, (Tehran, the capital) to eight. It is important to note that the share of urban population has also increased from 18.4% to 38.8% correspondingly.

City Name	% of Urban Population
Tehran	18.4
Ahvaz	2.2
Arak	1.0
Tabriz	3.2
Mashhad	5.1
Shiraz	2.9
Karaj	2.6
Isfahan	3.4
Total	38.8

Table 13: Cities with Heavily Polluted Air Quality

For this indicator air quality for urban areas, specifically the ratio of urban population of heavily air polluted cities to total urban population of the country was used. The "Environment Preservation Organization of Iran" Air Monitoring tracks ambient concentrations of particulate matter on a daily basis. There has not been much improvement.

Several policies in the fourth FYDP (2005-2009) seek to mitigate the problem. A long list of recommendations to lessen the air pollution level of the above cities to the standard levels previously approved by "Environment Preservation Organization of Iran" has been detailed. Major government bodies expected to cooperate on this issue are: the Environment Preservation Organization of Iran; the Management and Planning Organization; the Ministry of Petroleum; the Ministry of Industry and Mining; the Ministry of Health; and the Ministry of Roads and Transportation.

For this indicator, the value for 1 on the vector is the 1990 level of pollution. The value for 0 on the vector set at 20% of the base 1990 value, i.e. 3.7%. The actual percentage for 1990 is 18.4 and 38.8 for 2003.

The calculated value for vectors are 1.0 for 1990 and 2.4 for 2003, hence a deterioration in sustainability index.¹

¹ We suggest as well that the quotient of [number of critical days /365], if multiplied to the population of polluted cities, and the sum divided by total urban population will yield a much more realistic measure of air quality.

In this case, the index for each year will be equal to A divided by B while;

A =Sum [(number of critical days/365)*Population of the city], summation on the polluted cities,

B =Sum of the population of all cities (polluted and unpolluted).

Social Sustainability

Indicator 3: Households with Access to Electricity

Iran mass electrification plan contains a set of conventional programs which were accelerated in the FYDPs. By 2003 almost 100% of urban households and 92% of rural population have access to electricity.

From 1978 to 1988, just after the Revolution, rural electrification was continued and joined villages to the existing grid. Though technically not as reliable as the urban grid, the pace of expansion was as high as 18% per year. After 1989, and during the course of the third FYDP, TAVANIR decided to follow a slower pace electrification at an average annual rate of 5.1% but in a more technically reliable context.

50,000 **Rural Electrification** 1967-2003 40,000 Total Number of Electrified Villages (Statistics) Total Number of Electrified Villages (Estimate) 30,000 Villages Electrified Annually 20,000 10,000 200 1973 197! 1979 1993 86 983 985 66 99 66

Figure 6: Rural Electrification in Iran

As is illustrated in the above diagram and table, the overall task of rural electrification has been successful: By 2003, 99.7% of the villages with over 20 families and 34.8% of villages with less than 20 families have been electrified. These cover almost 21.05 million or almost 92.02% of the 23.3 million rural dwellers. There is still around two million of rural population inhabiting in almost 20 thousand remote and low populated villages to be electrified.

These remaining off-grid areas are geographically distant and grid based electrification is costly and slow. Even if the recent pace of electrifying 900 to 1000 villages per year continues, it would take approximately 20 years to complete the electrification process. Thus the adoption of small-scale RE technologies, to help electrify remote villages is anticipated to have a higher success rate.

Source: (Balance of Energy, Ministry of Energy, Iran 2003)

Year	Total Number of Electrified Villages
1967	148
1968	201
1969	273
1970	372
1971	505
1972	686
1973	933
1974	1268
1975	1723
1976	2342
1977	3184
1978	4327
1979	5254
1980	6379
1981	7745
1982	9404
1983	11418
1984	13863
1985	16832
1986	20437
1987	21436
1988	22484
1989	23333
1990	24215
1991	25130
1992	27017
1993	29046
1994	30878
1995	32710
1996	34315
1997	37094
1998	39654
1999	42640
2000	44204
2001	45359
2002	46235
2003	47359

Table 14: Rural Electrification in Iran

In 2003, 96.7% of the population of the country had access to electricity. In 1990, the population of the country was around 54.5 million, out of which

35% resided in rural areas and 65% in urban areas. The rural population with access to electricity was 50.9% and urban population for almost 100%, hence the overall access to electricity was 82.8%.

The value for 1 on the vector is 0% access, while the value for 0 is 100% access; the vector value for Iran in 2003 is therefore 0.033, and for 1990 is 0.172 (i.e. one minus the share with access).

Hence the metric (actual data) for 2003 is 96.7% and for 1990 is 82.8%.

Indicator 4: Clean Energy Investment

The energy sector in Iran is mainly dominated by state-owned organizations and public enterprises, namely the Ministry of Petroleum (responsible for oil & gas and products), the Ministry of Energy (responsible for electricity) including their subsidiaries as well as other government bodies and public enterprises.²

Investment in Energy Sector

Based on General Government Budget 2005 data, which reflects investment (development) funds and public sector enterprises' development funds, total investment budget for energy sector, for the year 2004 was equal to 14760 Million US Dollars (see Table 15).

Total Investment via General Budget	In Million US Dollars
Total	676.4
Investment via Public Enterprises Budget	
Regional Electricity Generation Companies	2213.7
Oil & Gas Companies (upstream)	11869.8
Total	14083.5
Grand Total	14759.9

Table 15: Total Investment in energy sector- 2003

Based on Iran Energy Balance 2003, total anticipated investment in clean energy development projects is estimated to be around 150.8 Million US\$ (see Table 16). As this investment is accomplished in almost five years, a figure of 30 Million US\$ would reflect a fair estimate of investment in clean energy for 2003.

² For an overview of the institutional framework in Iran energy sector, please refer to section on Indicator 6.

The ratio of investment in Clean Energy for the year 2005 is equal to 0.203%.

As mentioned earlier, the Organization for Renewable Energies (SUNA) was established in 1995 and Iranian Fuel Conservation Organization (IFCO) in 2000. Prior to these dates there was no institution responsible for renewable and clear energy development. As such, the share of clean energy in 1990 can be assumed as zero.

For this indicator, the value for 1 on the vector is to be the 1990 share of clean energy investment out of total energy sector investment while the value for 0 would be 95% of clean energy investment relative to total. Because of the low levels of investment in clean energy, 1990 levels were was probably close to zero.

Although the share of clean energy has increased in recent years, there is not a large difference between the ratio of investment in clean energy to total investment in energy sector between 2003 and 2004.

Investment in Clean Energy in 2004	in 1000 US \$
Wind Energy	
Ministry of Energy	
10 KW Turbine	177.8
Data gathering	0.0
600 KW Turbine	43.9
Preparing Wind Maps	176.7
Binalood Power Plant	0.0
Atomic Energy Organization	
Technology acquiring	47352.7
Purchasing Instruments	2081.5
Estimating wind Potentials	78824.1
Total	128656.6
Solar Energy	
Ministry of Energy & Ministry of Petroleum	533.3
Geo-thermal	
Ministry of Energy	16380.8
Atomic Energy Organization	1227.8
Total	17608.6
Other RE including Bio-mass, Hydrogen, battery	
Ministry of Energy	3576.1
Atomic Energy Organization	403.1
Total	3979.2
Grand Total: wind, Solar, Geothermal,	150777.75

Table 16: Total Investment in Renewable energy- 2003

Economic Sustainability

Indicator 5: Resilience to External Impacts: Energy Trade

Iran is endowed with proven oil reserves of about 133 billion barrels and 24 thousand billion cubic meters of natural gas. These constitute 11.6% and 15.6% share of the world's proven oil and gas reserves respectively. Iran is ranked as the second richest oil and gas reserves in the world.

Year	Oil & Gas	Other Exports	Total Exports	Share of Oil & Gas %
1991	16012	2649	18661	85.8
1996	19271	3120	22391	86.1
1999	17089	3941	21030	81.3
2000	24280	4181	28461	85.3
2001	19339	4565	23904	80.9
2002	22966	5271	28237	81.3
2003	27033	6755	33788	80.0

Table 17: Country's Exports (in Million US Dollars)

Source: (Iran Statistical yearbook 2004)

Presently, Iran exports approximately 2.4 million barrels/day of crude oil. Natural gas, except for a substantial portion which is injected to the oil fields, is mainly used by household-commercial sector, domestic industry and power plants.

Export of crude oil is the main source of foreign exchange. It constitutes approximately 80% of total revenue from exports. The ratio however is dependent on the price on international oil markets.

For this indicator, the value for 1 on the vector is 100% non-renewable energy exports share of total national exports, while the value for 0 on the vector is 0%. The vector value for 1991 is therefore 0.855 and for 2003 is 0.080.

Metric (actual data) for 1991: 0.0855 Vector values for 1991: 0.0855 Metric (actual data) for 2003: 0.080.0 Vector values for 1998: 0.080

As the ratio of income from export of non renewable energy sources is heavily dependent on the price in international oil markets, the short term fluctuations do not necessarily reflect structural improvements in the economy, or economic vulnerability. Therefore for each base year an average of the three preceding years (including the base year) would be a much more reliable index.

Net export of electricity is negligible, compared with the export of crude oil and products. However, the ratio of electricity from those hydro plants under 10 MW³ should be differentiated from the portion of electricity generated by non-renewable energy.

Indicator 6: Burden of Energy Investments

The predominance of the government in the energy sector obviously means that the government shoulders the majority of the investment burden. The institutional framework of Iran energy sector is discussed here briefly:

Management and Planning Organisation (MPO) operates under the auspices of the President's Office. MPO prepares the Five Year Development Plans (FYDP) which encompasses the national development programmes and policies. The FYDPs require the approval of the Cabinet and the Islamic Assembly (Parliament). The Annual General Government Budgets (AGGBs) are also developed by MPO in the context of the FYDPs. The Budget documents also require the approval of both the Cabinet and the Islamic Assembly.

Ministry of Energy (MOE) is responsible for policy-making and management of generation, transmission and distribution of electricity. TAVANIR (Generation, Transmission and Distribution of Electricity Company) and its regional subsidiary companies: the Regional Electricity Generating Companies and Regional Electricity Distributing Companies are responsible for generation, transmission and distribution.

Organization for Renewable Energies (SUNA) was established in 1995 as an affiliate under MOE's Deputy for Energy Affairs. Since 2003, SUNA is responsible for the development of renewable energies within the MOE. SUNA operates under the auspices of TAVANIR and through its departments that deal with solar, hydrogen, geothermal and wind energy

Ministry of Petroleum (MOP) is responsible for both policy-making and management of the oil and gas sector. Management activities include production, refining, distribution, export and import of crude oil, gas and petroleum products as well as petrochemical industries. Management of upstream and downstream activities is mainly carried

³ According to the World Commission on Dams, hydro should only be considered supporting ecodevelopment if its capacity is less than 10MW. http://www.dams.org/

out through the operations of four large companies and their subsidiaries:

- National Iranian Oil Company (NIOC) is responsible for production, import and export of crude oil and gas;
- National Iranian Oil Products Refining and Distribution Company (NIOPRDC) is responsible for refining and distribution of oil products.
- National Iranian Gas Company (NIGC) is responsible for refining, distribution, import and export of natural gas; and
- National Petrochemical Company (NPC)

In addition, the promotion of energy efficiency and conservation as well as the dissemination of cost effective RE technologies is carried out by Iranian **Fuel Conservation Organization (IFCO)** which as an affiliate of MOP acts as a research and an executive organization. IFCO started operations in 2000 and its main mandate is to help promote energy efficiency and conservation. IFCO studies energy consumption standards and conducts research on ways to apply such standards. In addition, IFCO promotes fuel consumption efficiency.

In addition to above, there are other public sector bodies active in energy sector:

Ministry of Agriculture Jihad (MOA) which assists in the implementation of small scale energy projects, such as solar water heaters, in rural areas.

Agriculture Bank which in addition to its main role as a specialized banking system, performs a mediation role in transferring the subsidized funds provided by the MOP to beneficiaries of the "electrification of agriculture wells" program.

Atomic Energy Organization helps to carry out research projects on wind potentials and the like in addition to its own research.

Private Sector Activities in Energy Sector

According to Iranian law, oil and gas are regarded as national resources owned by the whole society and controlled by the government. This is the reason for the large public sector involvement in the oil and gas sector. An emerging trend has been to utilize the many talents and capacities of private sector companies in the areas of engineering and services. In addition, the involvement of private sector transportation companies at the tail end of the distribution system is now common.

Private Sector Participation in Electricity Generation

The rapid increase in electricity demand has put an enormous pressure on the MOE to finance new power sector projects and has highlighted the need to diversify financing sources. More use is now being made of "Participation Bonds" as well as Buy-Operate-Own (BOO) and Buy-Operate-Transfer (BOT) modalities (as opposed to using banking sector resources). Thus, the need to tap private sources of project financing as well as privatization are two important issues that the industry is currently facing. The outlook for private sector participation in electricity generation is very promising.

For 2003, based on Government Budgets total public non-renewable energy investment, including regional electricity production & distribution companies and the transport/pipeline companies, amounted to126758 billion Rials. According to the Central Bank of Iran "National Accounts", GDP in 2003 was 1,095,303 billion Rials, both at current prices. Non-renewable energy public investments was therefore 11.573% of GDP.

For this indicator, the value for 1 on the vector is non-renewable energy investment as 10% of GDP. This is taken as the benchmark for unsustainability. The value of 0 on the vector – the sustainability goal – is zero public investment in non-renewable energy.

Iran's vector for 2003 is therefore 1.1573 (i.e. 0.11573/0.1). Metric (actual data) for 2003: 11.573% Vector values for 2003: 1.1573

Table 18: Indicator 6 in 2003Values in Billion Rials, at Current Price

% Investment Ratio	GDP	Investment in Energy Sector		
11.573	1095303	126758		

Technological Sustainability

Indicator 7: Energy Intensity

Iran economy's is highly energy intensive. The main reason for this is low energy prices that have led to over-consumption of energy and low efficiency. Meanwhile the presence of energy-intensive industries such as metals, and petrochemical plants are also contributing factors.

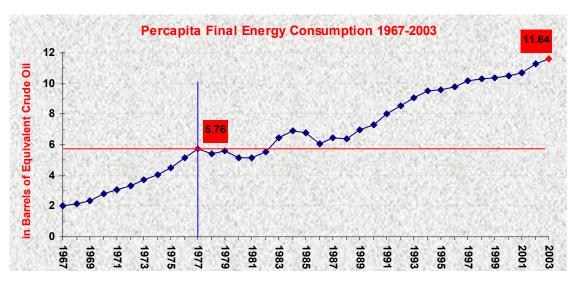
The other aspect of energy intensity in Iran is its increasing growth. Although this may be partly justified as a measure of welfare improvement (in household consumption), mismanagement is undoubtedly the main cause.

Energy intensity by any standard has elevated dramatically.

Per capita Final Energy Consumption

The following diagram depicts the very rapid growth from 1967 to 2003. The decrease in growth after 1977 was due to the drop in socio-economic activities (and hence a corresponding drop in energy consumption) that occurred during the course of Revolution. The rise in growth around 1983 was the result of a rapid increase in oil revenue due to increased oil prices on the international market.





Ratio of Final Energy Consumption to GDP

Figure 8 illustrates the change in the ratio of energy consumption to real GDP. Again the changes in the mentioned periods are due to in socio– economic activities and the subsequent alterations in GDP. But as the GDP is in the denominator, the changes in this index are in the opposite direction, compared with the previous figure (Figure 7).

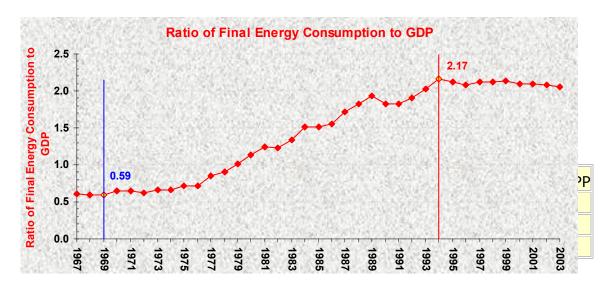


Figure 8: Ration of Final Energy Consumption to GDP

Countries Comparisons

Comparison of energy intensity between some countries is expressed as the ratio of primary energy to GDP in Figure 8 and Table 19. As is illustrated Iran's energy intensity indicator is ever increasing.

Table 19: Energy Intensity (1000 Btu per 2000 U.S\$ using MarketExchange Rates)

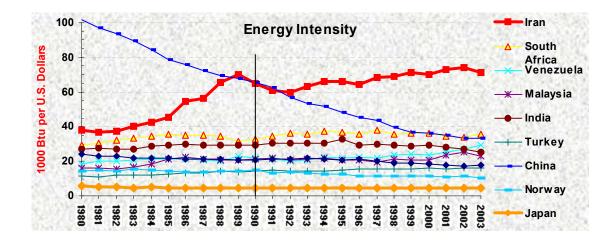
	Canada	Japan	Norway	China	Turkey	India	Malaysia	Venezuela	South Africa	Iran
1980	24.1	5.5	14.6	101.9	11.7	26.8	16.2	18.2	29.4	38.1
1990	20.8	4.5	14.7	65.5	14.1	29.4	21.4	21.7	32.7	65.2
2003	17.9	4.6	10.2	33.2	15.9	25.5	23.3	29.3	35.3	71.3

Source : (Energy Information Administration, International Energy Annual 2003)

Table 20: Energy Intensity in Iran

Year	Million Jules per US Dollar PPP
1980	12.1
1990	20.6
2003	22.6

Figure 9: Energy Intensity (1000 Btu per 2000US\$ using Market Exchange Rates)



For a producing and exporting country such as Iran, "primary energy" is not a relevant indicator, because a major part of its primary energy source is exported. In addition, due to differences between the nominal exchange rates and purchasing power parities, total primary energy supply (TPES) divided by GDP at "nominal exchange rates", is not an accurate indicator for comparison of countries with each other at a given point in time. However it does allow for the comparison of changes in a time span, as is seen in Figure 9.

The energy intensity for Iran is measured for 1990 and 2003 as the ratio of primary energy to real GDP, based on purchasing power parity of US\$. Again a rapid increase in the indicator is observed.

The value for 1 on this indicator is the 1990 global average energy intensity of 10.6 MJ/US\$1990.

The value for the zero on the vector is 1.06 MJ/US\$1990, or 10% of the 1990 world average.

This means that the vector value for Iran, like other countries such as South Africa is considerably greater than 1, or more than twice that. There is also deterioration in the sustainability index from 2.040 in 1990 to 2.248 in 2003.

From the above table Metric (actual) data, for 1990 is 20.6 MJ/US\$1990 GDP PPP and it is 22.6 for 2003.

Indicator 8: Renewable Energy Deployment

Due to abundance of oil and gas products, renewable energy in Iran has been neglected for a long time. In 1960's almost 0.4% of total primary energy came from non-commercial fuels, mostly traditional biomass and wood and coal wood, consumed as fuel for indoor heating and cooking. 0.1% came from hydropower. The share modern renewable energy such as solar energy was nil.

In 1990 the share of modern renewable energy was still nil. Hydropower contributed to 0.7% and non-commercial fuels, wood and traditional biomass supplied 0.26% of the total primary energy of the country making the share of renewable energy only 0.96% of the total energy mix.

By 2003 there was slight improvement in the share of renewable energies in total primary energy supply. The share of hydropower increased to 1.8%, with the share of wood and traditional biomass increasing to 0.18% and modern renewable to 0.004%. Renewable energy comprised 2% of total primary supply of energy.

	Production	Import	Export	Total	Share
Crude oil & Gas	1431.8	59.7	1043.3	448.2	44.8
Natural gas	510.1	36.1	21.5	524.7	52.4
Coal	5.9	3.0	0.1	8.8	0.9
Non commercial	1.8			1.8	0.180
Electricity (hydropower)	17.3	0.9	0.5	17.7	1.8
Renewable	0.04			0.04	0.004
Production	1966.98	99.7	1065.4	1001.3	100.0

Table 21: Production of Primary Energy in 2003 (MBCE)

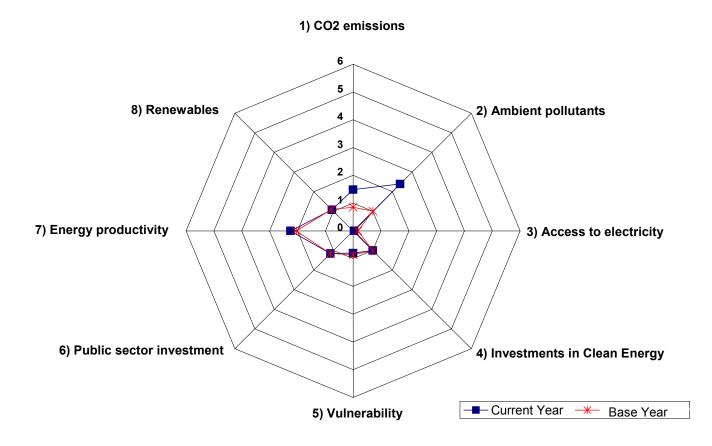
For this indicator, the value for 1 on the vector is the world average renewable energy supply as a share of total primary energy supply (TPES) in 1995, which was 8.64% (HELIO International 2000). The value for 0 on the vector, which is our sustainability goal, is 95%. This means that Iran's value on this vector is 1.04.

Metric (actual data) for 1990 is 1% and for 2003 is 2%

The vector value for 1990 is 1.088 and for 2003 is 1.077, a slight improvement in the index.

Presentation of Iran's SEW Star

Eight Sustainability Indicators



Conclusions

To summarize the results for Iran on the indicators, it is helpful to review how the vectors were created. In each case, the value of 1 on the vector represents the 'status quo' – either by reflecting world averages in the last decade or the actual country's performance in the last decade. The value of 0 on the vector represents the sustainability goal. Moving all the way to zero on a given vector means that the country's energy system is highly sustainable along that particular dimension, whether it is economic, social, environmental or technological. Vector values greater than 1 either means that the country is even more unsustainable than the global average, or is performing worse than a decade earlier.

Description	Data Points		Results		Evaluation		
Indicator Name	Unit	X(current)	X(1990)	I(current)	I(1990)	Change	Value
	kgC/ca						
1) CO2 emissions	р	1,515	1,010	1.486	0.848		
2) Ambient pollutants	%	38.8	18.4	2.386	1.000		
3) Access to electricity	%	96.7	82.8	0.033	0.172		
4) Investments in Clean							
Energy	%	0.2	-	0.998	1.000		
5) Vulnerability	%	80.0	85.8	0.800	0.858		
6) Public sector investment	%	11.6	11.6	1.157	1.157		
7) Energy productivity M		22.6	20.6	2.248	2.040		
8) Renewables	%	2	1	1.077	1.088		

Iran is the closest to the sustainability target for access to electricity (0.33). This reflects the success of the ambitious mass electrification program.

The relative share of investment in clean energy (indicator 4) and share of renewable energy (indicator 8) in total primary energy have both improved, although the magnitudes of the indicators are not satisfactory. Iran has a vast potential in renewable energy sources, solar, wind, geothermal, which is not being properly harnessed; Iran has a long way to go to utilize and optimize its potential sources in this field.

The vulnerability indicator (indicator 5) improved slightly, but the change in magnitude is not satisfactory. 80% of the foreign exchange revenue of the country originates mainly from export of crude oil and partially from export of petroleum products.

For other indicators (indicators 1, 2, 6, and 7) there is a deterioration in the sustainability index and the change in magnitude is uniformly unsatisfactory: CO2 emission (indicator 1), ambient pollutants (urban air pollution, indicator 2) and energy productivity (energy intensity, indicator 7) are deteriorating on a large scale. It is clear that these three indicators are technically interrelated and result from deficiencies in the field of energy utilization and urban

management. The solution requires an integrated strategy with corresponding policy options.

Indicator 6 reflects low participation of private sector in the energy field with government shouldering the burden of investment. Economic reform and liberalization of the economy, e.g. privatization of state-owned utilities and the opening up the economy to the public sector and foreign investment as declared in Five Year Development Plans (FYDP) are viable options. Energy price reform is an essential prerequisite for a successful economic reform.

Bibliography

Central Bank of Iran: http://www.cbi.ir/

Central Bank of Iran, "National Accounts Annual Reports", CBI, Tehran

Central Bank of Iran, "Economic Indicators Quarterly Reports-('Namagarhaye eghtesadi')", CBI, Tehran

Central Bank of Iran, "Price Index, Quarterly Reports", CBI, Tehran

Sustainable Energy Watch 2002 Reports, "Energy and Sustainable Energy in South Africa", Randall Spalding-Fecher - HELIO International: <u>www.helio-international.org</u>

International Energy Association, "IEA Energy Statistics, Annual Report, 2004", IEA

Management and Planning Organization: <u>http://www.mporg.ir</u>

Management and Planning Organization, "General Government Budget Act and Annexes, 2005", MPO, Tehran

Management and Planning Organization, "General Government Budget Act and Annexes, 2004", MPO, Tehran

Management and Planning Organization, "General Government Budget Act and Annexes, 2003", MPO, Tehran

Management and Planning Organization, Macroeconomics Office, "First FYDP Act and Annexes", MPO, Tehran

Management and Planning Organization, Macroeconomics Office, "Second FYDP Act and Annexes", MPO, Tehran

Management and Planning Organization, Macroeconomics Office, "Third FYDP Act and Annexes", MPO, Tehran

Management and Planning Organization, Macroeconomics Office, "Evaluation Report on achievements of the second FYDP", Morteza Sabetghadam, Tehran

Management and Planning Organization, Macroeconomics Office, "Evaluation Report on achievements of the third FYDP", Macroeconomics Office, Tehran

Ministry of Energy, Deputy for Energy: <u>http://www.iranenergy.org.ir/</u>

Ministry of Energy, Deputy for Energy, "Energy Balance 2003", Ministry of Energy, Tehran

Ministry of Energy, Deputy for Energy, "Energy Balance 2002", Ministry of Energy, Tehran

Ministry of Energy, Deputy for Energy, "Energy Balance 20031, Ministry of Energy, Tehran

Ministry of Energy, Iran New Energies Organization, "SUNA": <u>http://www.suna.org.ir/</u>, Reports

Ministry of Housing and Urban Development, Center for research and Urban Development", A Guide to Iran Cities' Population -2003", Tehran, <u>http://www.mhud.gov.ir/</u>

Ministry of Petroleum: <u>http://www.nioc.org/</u>

Ministry of Petroleum, "Oil and Development- Annual Reports of 2003, 2002, 2001", MOP, Tehran

Statistical Center of Iran: <u>http://www.sci.org.ir/farsi/default.htm</u>

Statistical Center of Iran, "Iran Statistical Yearbook- Annual Reports", SCI, Tehran

Statistical Center of Iran, "Family Budget Surveys-Annual Reports", SCI, Tehran

UNDP, Human Development Report: <u>http://hdr.undp.org/</u>

United Nations Development Program, UNDP, "Human Development Report-2005", UNDP

United Nations Development Program, UNDP, "Human Development Report-2003", UNDP

United Nations Development Program, National Reports, "Human Development Report: Iran, 1999", UNDP, <u>http://www.undp.org.ir/reports/hdr/e-NHDR.pdf</u>

Annex: Indicator Rationale

The Sustainable Energy Watch (SEW) reports measures progress toward energy sustainability in individual nations as well as globally. A set of indicators of such progress (or, in many cases, regress) have been selected by SEW's Steering Group with input from several members of its Scientific and Technical Advisory Group. These eight indicators – two for each of four segments; Environment, Society, Economy, and Technology – are used by an expanding network of Reporters to file reports on the status of the indicators in each country.

Selecting indicators at once meaningful for a wide range of conditions and do-able by a network of dedicated non-specialists is a difficult task. The indicators have been chosen without reference to a comprehensive and unassailable definition of sustainability: the project's coordinators are less interested in what is ultimately sustainable regarding energy and societal/environmental impacts than simply measuring progress toward carefully chosen interim goals. The objectives may change, but there will exist accurate, meaningful, and documented measurements to adjust as goals and definitions are fine-tuned.

The criteria for selecting indicators were to derive a small number of meaningful indicators, clearly definable (even if sustainability eludes definition), for which data is available in or for every country, and, if calculation is required, it must be simple to accomplish. Other objectives include using a consistent set of indicators with applicability to most if not all countries. Naturally, the results – for each country as well as for the world – must be clearly communicated to decision-makers, the media, and the general public. For all of these reasons the involvement, critiques, and support of readers is encouraged.

For each of the indicators, a vector is presented with the value of 1 indicating some measure of 'status quo', either as a global average or historical national data, and the value of 0 being the sustainability goal. In other words, the underlying metric (e.g. energy use per unit of GDP) is normalized so that we can compare across indicators how close the country is to sustainability goals. The metric values that correspond to 1 and 0 on the vector are presented in each indicator section.