Strategic Analysis of Iran's Energy System

Alireza Heidari, University of Tehran
Alireza Aslani, University of Tehran
Ahmad Hajinezhad, University of Tehran
Seyed Hassan Tayyar, Science and Technology University of Tehran

ABSTRACT

Due to the importance of energy to societies, analysis of local, regional and national energy systems at different levels is salient for researchers and policy makers. This article considers Iran's extraction, processing, conversion, transmission, distribution, and consumption of energy. Iran is one of the world's fastest growing energy consumers and its economy is highly dependent on energy exports. The patterns of Iran's present energy system impact its economy and development. Our research assesses the energy system in Iran by identifying and analyzing its strengths, weaknesses, opportunities and threats (SWOT). The article considers these from internal and external perspectives and concludes that energy plays an important role in policy and development. This assessment can help policy makers and researchers identify challenges and create suitable and robust strategies.

INTRODUCTION

What role does energy play in policymaking and development of today's modern societies? The economies of most oil exporters, including Iran's, is highly dependent on oil and gas revenues. The impact of energy on economic growth, public policy, national security, and government revenues seems undeniable. To assess the influence and role of energy in Iran, analysis of its energy system is necessary [1]. Energy system analysis considers the types of energy carriers from energy resources to end use energy systems. It includes the processes of extraction, conversion, transmission, distribution, and consumption of energy. Energy system analysis can be divided based on sectorial, regional, national and global attributes [2]. The energy system in Iran is complex, requiring careful and systematic analysis [3]. It faces many challenges, including the following:

- Management of the country's vast oil and gas resources.
- The government's budgetary dependence on oil and gas revenues.
- Misappropriated funding and investment in the oil and gas sector.
- The country's low productivity and high energy intensity (especially in non-industrial sectors).
- High household sector energy consumption.
- Foreign policy issues such as sanctions on oil and gas exports.
- Low energy prices combined with high internal energy subsidies.
- The sharing of oil wells with neighboring countries.
- Complexity of energy production.
- Large geographic area and physical energy security issues.
- Inaccurate statistics and estimates regarding proven resources.
- Political behavior about resource extraction.
- Unpredictable behavior of consumers to energy price changes (price elasticity).

Given these challenges, an analysis of Iran's energy system requires a strategic and systematic approach. Such an approach must consider various aspects of the problem and the impact of any effects on the whole system and its environment. SWOT analysis is one methodology that meets these criteria. SWOT analysis is a strategic planning tool that provides a detailed analysis of the state of a system. It assesses the internal factors (strengths and weaknesses) and external factors (opportunities and threats) of a system from different levels (e.g., organizational, industry, or regional). The extracted factors help decision and policy makers develop appropriate strategies for different situations or conditions [4]. Identifying the internal aspects of the system as strengths and weaknesses and the external ones as opportunities and threats is an appropriate methodology to analyze Iran's energy system.

This article reviews Iran's present energy system and analyzes the interactions between the energy system and public policy in Iran. We consider the strengths and weaknesses of the system, the external opportunities, and the threats facing Iran's energy sector by using a SWOT analysis. Our analysis is applied for each segment of the energy system including management and energy economics, energy supply, transmission, conversion and energy demand.

IRAN'S ENERGY SYSTEM

A county's energy flow provides information on the primary parameters of production, conversion and final consumption. An energy flow diagram is a beneficial way to begin a status assessment and analysis of Iran's energy system, a country with large oil and gas reservoirs. As shown in Figure 1, much of Iran's energy demand in 2012 is supplied by domestic oil and gas resources.

Iran is ranked among the world's top five countries with the largest deposits of proven oil and natural gas reserves. It also ranks among the world's top ten oil producers and top five natural gas producers [5]. Iran produced 3.2 million barrels per day (bbl/d) of petroleum and related liquids in 2013 and more than 5.6 trillion cubic feet (Tcf) of dry natural gas in 2012. Iran's oil is consumed primarily by its power plants. The excess is exported. The majority of the country's foreign exchange earnings and government budget are dependent on oil exports [6,7].

According to the International Energy Agency (IEA), from 310 million tons of oil equivalent oil (Mtoe) production in Iran in 2012, 168

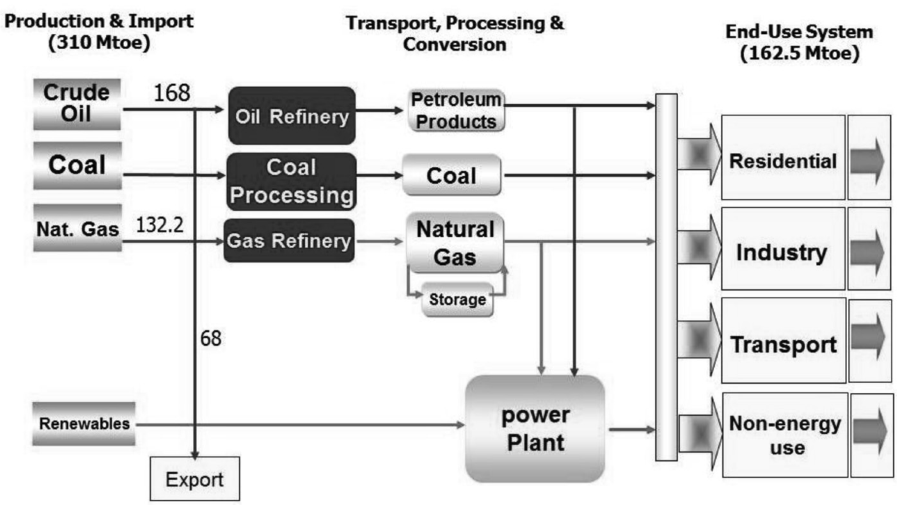

Figure 1. Energy flow diagram for Iran in 2012.

Mtoe was consumed by domestic oil production (54% of total) and 132 Mtoe was consumed by domestic gas production (42.5% of total). Sixty-eight Mtoe were exported, and 162.5 Mtoe were consumed by end users [8]. Figure 1 illustrates that while Iran had a small share of renewable sources in its primary energy supply, the export of crude oil is important to Iran's economy.

Due to sanctions against Iran and declining global oil prices, Iran's oil export revenues decreased over recent years. This directly impacted economic growth and social conditions in the country [9]. To understand the challenges of the energy system in Iran, our analysis takes two approaches. First we consider the efficiency of Iran's energy system and energy policy challenges in the current work. Second we assess the strengths and weaknesses, threats and opportunities of each sub-sector of Iran's energy system (including the management and economics of energy, energy supply, transmission and conversion and final demand).

Efficiency of Iran's Energy System

Efforts toward energy efficiency in oil exporting countries are often minimal. After the second oil crisis in 1978, oil importing countries planned projects to increase the efficiency of their energy systems. However, oil-exporting countries often failed to develop robust programs to increase their energy efficiency. More than 600 million barrels of crude oil per year were lost by Iran's energy sector during 2012. The losses were mainly from power plants that converted fossil fuels to electricity [10]. While many developed countries use systems such as combined heat and power (CHP), combined cycle processes, and renewable energy to minimize their losses, these technologies are not yet deployed in Iran [11,12].

More than a million barrels of oil equivalent daily is lost in transmission and distribution processes in Iran, which is equal to twice the energy consumption in Greece or the annual total primary energy supply in Sweden [13]. The losses in Iran's other economic sectors are also undesirable.

Since a country's energy consumption is highly dependent on its industrial and commercial sectors, developed countries often consume more energy. An indicator of a country's energy system is its per capita energy index. However, this index may not reflect the efficiency of a country's energy system. While Iran may have comparatively high per capita energy consumption, most energy is used by non-industrial sectors or processes with high rates of losses. Such energy consumption does not result in gross domestic product (GDP) growth but in wasted energy due cultural issues, dissipation and use of inefficient energy technologies.

For our purposes, an energy intensity index is a better indicator than the energy use per capita index [14,15]. This index reflects total energy consumption in tons of oil equivalent per gross domestic product (GDP) in thousands of U.S. dollars (USD). While the energy intensity index in Japan and the U.K. equaled 0.10 in 2012, the global average was 0.16. Using purchasing power parity (PPP) is useful for comparing domestic markets since PPP accounts for a county's relative cost of local goods, services and inflation. Turkey had a GDP of $1,015 billion (U.S.) PPP with a 2012 energy intensity of 0.12. Nearby Iran's was $1,053 billion (U.S.) with a PPP energy intensity of 0.21. This shows that energy efficiency in Iran is very low compared to Turkey. It requires about two million barrels of crude oil per day greater energy consumption in Iran, to produce a similar GDP purchasing power parity when compared to Turkey [16-18].

For Iran, a 20% energy reduction in consumption from a multi-year national program (using oil prices at $50 per barrel) offers more than $16 billion savings.

Challenges of Policy-making

Policies are important for managing energy consumption. While an analysis of energy systems in terms of efficiency shows that the energy system is inefficient, this does not mean that policies are absent. There are policies in place that make Iran's challenges difficult to resolve.

Many energy exporting countries are challenged by high government subsidies for energy. These subsidies maintain low prices for energy to facilitate development, thus increasing production and employment. However, subsides can lower energy system efficiency. Consumers often benefit from energy subsidies when energy is subsidized by the government [19]. For example, the price of gasoline in Iran was $0.10 per liter (USD) in 2015. That same year the price of gasoline in the U.S. was $0.76 per liter, $2.52 in Turkey, $1.58 in Brazil, and $1.15 in India [20]. In many of these counties rather than gasoline being subsidized by the government it was being taxed.

Fuel subsidies result in increased demand. By 2010, despite large oil and natural gas reserves, Iran became one of the world's largest importers of gasoline [21]. In response, the Iranian parliament in 2011 enacted regulations to make oil and gasoline prices equal to the marginal cost or the free on board (FOB) price in the Persian Gulf. The revenues from the liberalization were allocated to industrial and welfare infrastructure development [22].

Iran's targeted subsidy plan failed to achieve its intended goals. Sanctions against Iran led to the devaluation of its national currency while the U.S. dollar had a three-fold increase in comparative value. The difference between energy prices in Iran and its neighbors caused pressure on the government. As energy prices increased, purchasing power declined and inflation ensued. As a result, the liberalization of prices for energy carriers was challenged.

A large part of the Iranian government's budget is derived from oil revenues which represent a large share of its GDP. As economic development in one sector increases other sectors may decline (the Dutch disease) and such is the case with in Iran's economy. It is a primary weakness of Iran's management system and its energy-based economy. One of the country's strategic priorities is to resolve this situation [6,23]. Strategies include attracting foreign and domestic investment, increasing non-oil products and exports, taxing production and forming a foreign exchange deposit bank [9,24].

Other challenges Iran faces include fuel smuggling, conflicts with neighboring countries, physical insecurities and market uncertainties.

The Importance of Strategic Approaches to Energy

Energy clearly effects economic development, national security, sustainable development, health and social welfare. Therefore, analysis of the energy system based on the strategic approaches is essential.

There are a variety of approaches to strategies. They include ways to meet required levels of achievement, ways to create opportunities for companies or industry, ways of creating strengths and avoiding pitfalls from weaknesses. For a strategy to be successful and meet targets, it is essential to identify opportunities and avoid threats. System strengths are used to overcome system weaknesses.

SWOT is a strategic planning tool used to analyze and evaluate the internal and external situation of systems. The SWOT analysis can be an effective tool for identifying environmental conditions and the ability of the system [4]. Figure 2 provides a SWOT analysis matrix.

Figure 2. SWOT analysis matrix.

A SWOT analysis can be implemented for different fields and levels. Due to the importance of a country's energy system and the variety of opportunities, threats, strengths, and weaknesses of such systems, SWOT analysis can be used to identify better strategies and tactics. After determining and evaluating a system's internal strengths and weaknesses and external opportunities and threats, suitable strategies can be identified and used to define action plans, schedules and budgets.

Research Using SWOT Analysis for Energy Assessments

Past research has been conducted using SWOT to assess energy systems for renewable energy (RE) and policy development. Wei-Ming Chen et al. used SWOT analysis to compare energy policies that promote RE in Japan, South Korea and Taiwan [25]. All three countries are considering RE as an alternative energy source to improve energy security. It examined these countries' strengths, weaknesses, opportunities, and threats in the context of advancing renewable energy policies and technologies, expanding domestic RE installations, and improving their strategic position in international markets as exporters of clean energy technologies [25]. Terrados et al. developed a regional energy plan using a SWOT analysis. This article explained the energy component of the strategic plan for the province of Jaén in southern Spain, which was squarely focused on the development of renewable energy resources, mainly solar and biomass [26].

Markovska et al. analyzed the strengths, weaknesses, opportunities and threats of the energy sector in Macedonia to identify its status and to plan future actions towards sustainable energy development [27]. Camille Fertel et al. used a SWOT analysis of Canadian energy and climate policies on the themes of energy security, energy efficiency, technology and innovation. Their analysis showed that there is a lack of consistency in the Canadian energy and climate strategies beyond the application of market principles. They suggested increasing cooperation among the various agencies by using a combination of intergovernmental policy tools [28].

SWOT analyses have been performed to assess Iran's RE systems. Mahmood Haji-Rahimi and Hamed Ghaderzadeh introduced The Challenges of Sustainable Management in Renewable Natural Resources in Iran by gathering positive and negative aspects regarding the management of rangelands as a renewable resource using a SWOT framework [29]. Faezeh Moradzadeh used a SWOT analysis to study the RE situation in Iran. He discovered challenges including research and development (R&D), investments, green subsidies, strategic planning and innovation in RE. He also found substantial capacity for renewables and a skilled labor force [30, 31].

There are articles that discuss the different parts of Iran's energy system using SWOT analysis. Ali Faridzad published an article considering the strengths, weaknesses, opportunities and threats for oil and gas upstream sectors and political challenges for the production of oil and gas in Iran [32]. Numerous on-topic conference papers, collegiate research articles and academic reports have been published in Persian [24,33,34].

METHODOLOGIES AND RESULTS

To analyze the current situation of the energy system in Iran using SWOT, the internal strengths and weaknesses of the energy system plus the external opportunities and threats are identified. The study's methodology uses applied research. The research is descriptive since we wanted to explain the energy system in Iran based on strategic factors.

To perform our research, we reviewed the academic and practical papers, reports, and statistics related to Iran's energy system. After that, the opportunities, threats, strengths and weaknesses were identified by using available documentation and consultation with professionals and experts.

Energy systems are often divided into three main technical sectors: 1) the energy supply system; 2) conversion and transport; and 3) final energy consumption based on the reference energy system (RES). In addition to these sectors, study of the energy system's macro-management and macro-economy are essential for a comprehensive analysis. To identify and analyze Iran's energy system and perform our SWOT analysis, we divided it into four parts: 1) management and economy of energy; 2) primary supply; 3) processing, conversion and transport; and 4) end use system (final consumption). Next, the internal strengths and weaknesses, and external threats and opportunities, are identified based on a survey for each of four the parts (see Figure 3).

Factors of Energy Management and Economics

Management and economy of energy refer to the approaches of policy makers to energy problems, regulations, procedures, and the impacts of energy on a country's economy. This segment is important because it affects other sectors of the energy system including, production, exports, revenues and global rankings. A SWOT analysis of the management and economy of energy is found in Table 1.

Factors of the Primary Energy Supply

The primary energy supply system is the first part of the reference energy flow diagram. It shows energy resources, fossil energy reservoirs, and the country's renewable energy potential. This system includes the exploration and exploitation of oil and natural gas, sources of RE, imports of energy and use of energy resources. This is known as the upstream energy sector.

Due to the geopolitical position of Iran, as well as rich reserves of oil and gas and RE potential, an analysis of the effective factors on primary energy supply system is necessary. Our SWOT analysis of the primary energy supply in Iran is provided in Table 2.

To supply the northern power plants with gas and oil (e.g., Neka power plant) and residences in the northern provinces during cold seasons, Iran imports energy using a swap contract agreement with Turkmenistan.

Due to increasing energy consumption, and the inefficient technologies used for oil extraction, treatment, transfer and distribution, Iran faces future domestic energy supply challenges and decreasing oil exports. The country also needs to improve oil extraction technologies

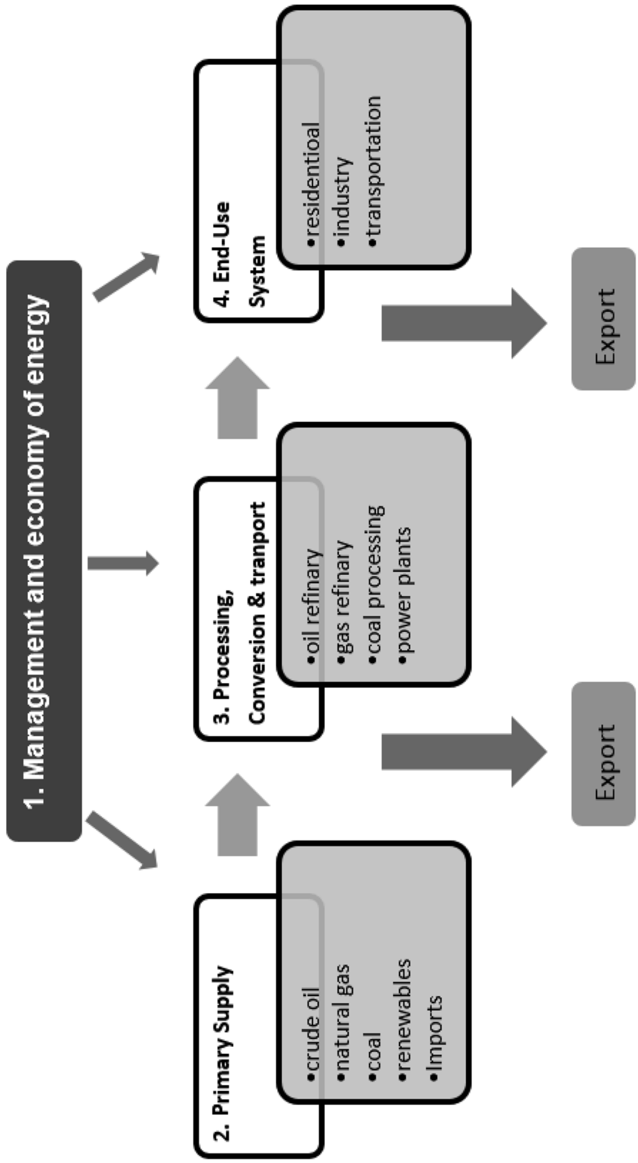

Figure 3. Four segments of Iran's energy system.

and improve renewable energy's share of total primary energy supply. About 25% of Iran consists of deserts which receive daily solar irradiation about 5kWh/m^2. If 1% of these areas were covered by solar collectors, the energy obtained would be five times more than annual gross electricity production in Iran [35].

Analysis of the Factors of Energy Transfer and Conversion

Transfer and conversion of energy is the central segment of the reference energy system and the interface between the primary energy supply system and the final consumer. The system consists of power plants, refineries and power transmission networks to deliver the energy to final consumption. This is also known as the middle-stream field of energy.

99% of energy sector in Iran is public and privatization efforts are remarkably slow. The infrastructure required for private investment does not guarantee a transparent and reliable situation. For example, for the construction of a private power plant the necessary infrastructure includes natural gas pipelines and connection to the electrical grid. The gas distribution network is exclusive and controlled by the government, the sole purchaser of electricity. This reduces the bargaining power of plant owners. The same is also true for refineries since prices, market structure, and regulations are government controlled. Finally, due to the lack of government funding to support law enforcement, unsuccessful experiences and projects, and high-risk market conditions, there is a lack of investor interest.

Factors in Final Consumption

The final consumption (end use) system is the last segment of the reference energy system. It contains all energy consumers. Domestic energy demand is determined by this sector. The SWOT analysis of this sector is provided in Table 4.

One of the problems with the energy demand system is the energy losses in the distribution network from theft. Stolen electricity is considered as illegal distribution network losses since it is not recorded by meters and fails to provide income.

Some locations in Iran have problems with the physical security of energy transfer. Indeed, energy inefficient technology in consumer equipment, lack of attention to the efficiency of energy, and improper use of equipment are the greatest problems facing the energy consumption system.

Table 1. SWOT matrix management and economy of energy.

	Strengths	Weaknesses
Internal factors	- Multiple sources of oil and gas - Comprehensive reservoir study in 2008, by the Presidential Technology Cooperation Office - Start of feasibility studies to evaluate the use of intelligent wells and reservoirs in the country - Start of preparing the reservoir database - Access to the high seas - Possession of the Strait of Hormuz - Low value of the domestic currency to foreign currency to boost exports - Develop a comprehensive system of research and technology in the oil ministry - Develop and implement policies, including short-term energy efficiency labeling and energy labeling - Large span geographic extent and borders for transit - Significant reserves of oil and gas fields in the Caspian and Zagros - Proximity of oil resources to the export terminals - Independency and political stability in comparison with neighbors and competitors	- Dependency on oil budget - High share of oil in GDP - Lack of liquefied natural gas (LNG) technology development for export - Lack of cooperation with regional competitors - Lack of international companies in the oil and gas industry - Marketing problems, especially in the field of natural gas - Political and non-technical production of resources - Improper pricing of petroleum products - Subsidies for petroleum products - Lack of attention to foreign investment - Unknown status of foreign investment - Investments in different areas, under the pressures of the members of parliament and officials - Inaccuracies in statistics and estimates about the established and proved resources - Idealism of the objectives and policies of the country's oil and gas and to ignore the facts - High dependence of economy on oil revenues - Lack of a comprehensive model of the energy vision - Lack of adequate training and upbringing of oil executives, and few managers - Rentier government with the Dutch disease - Low GDP (excessive imports) - No good extraction of shared wells with neighbors - Lack of interest in R&D - Lack of technology policy and planning in the country, particularly in the oil and gas sector. - Lack of long-term planning strategies for energy efficiency as well as comprehensive information and statistics - Legal barriers and lack of transparency of business rules in order to attract foreign investors, particularly in the oil and gas industry

Table 1 (*continued*). SWOT matrix management and economy of energy.

	Opportunities	Threats
External factors	- Oil and gas sector has the largest economic advantage - The impact of Iran on the region's political and economic decisions - Europe's energy supply problems from Russia - High price of petroleum products at the border compared to domestic prices - The possibility of transferring oil to Asia - The potential of Caspian gas pipeline to Europe - Long-term contracts to sell gas to neighbors at guaranteed prices - Geopolitical situation in the Persian Gulf region - Increasing demand for oil and gas in the world - Worldwide oil peak production - Possibility of changing the oil and gas industry of Iran to a technology hub (hardware and software) - Uncertainty about the rate of RE substitution in place of oil and gas in developed countries	- A drop in world oil prices by harvesting unconventional technologies - Smuggling fuel out of the country - Lack of adequate security for foreign investors - Geographic tension from neighbors and lack of physical security of energy - Direct relationship between foreign policy and external sanctions on oil and gas supply - Lack of proper position in the global natural gas market - The lack of a strong position in oil producing and exporting countries (OPEC) - Powerful competitors and producers in the area (neighborhood) - Good relations between competitor countries and buyers - Sanctions about buying energy from Iran - Buyers hostile relations with Iran - The lack of regional cooperation in oil and gas projects - Lack of participation of international organizations in the financing of joint projects such as the natural gas pipeline project - Iran's poor relationship with the world's science and technology - Lack of proper communication with credible oil companies in the world - Absence in the global petrochemical market - The lack of experienced international contractors

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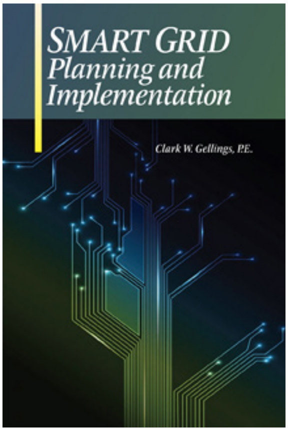

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Table 2. SWOT matrix of the primary energy supply system.

	Strengths	Weakness
Internal factors	- Number of engineers trained at different levels of BS, MS and Ph.D. - Significant reserves of oil and gas fields in the Caspian and Zagros - Multiple sources of oil and gas - Oil sector skilled manpower - Upstream rules to support the development of infrastructure - Potential of renewable energy - A vast desert with a high solar radiation, such as Yazd province - The potential of wind across the country - High biomass potential in provinces such as Khuzestan - Technical knowledge of wind turbines in the country - Renewable energy research centers and organizations in the country - Low cost of oil production due to land resources in southern areas of the country - Shallow waters of the Persian Gulf and low cost of production of offshore resources - A sufficient basic infrastructure in the oil sector - Over one hundred years of experience in the oil industries - Oil and gas development potential across the country. -Huge oil and gas and petrochemical projects -Enough gas for injection into oil fields for enhanced oil recovery (EOR) - Technical possibilities to recover the gas injected into oil reservoirs after the removal of oil - Safety of domestic gas production systems - Secure nationwide network of gas transmission and distribution	- Low extraction from the shared fields with neighbors - Low-efficiency technology and old equipment - Old oil fields and need to revive - Oil resource pressure falling - The lack of ownership for monitoring oil and gas reservoirs - Weakness in exploration - Weakness in extraction - Weakness in drilling - Weakness in operation - No possibility of rapid extraction of oil and gas shared fields - Lack of upstream enforcement to support the development of infrastructure - Lack of attention to the protection of reserves - Lack of adequate allocation of gas for injection into oil reservoirs - Lack of the necessary investments for optimized development of oil and gas fields - Failing to distinguish between types and how to invest in oil and gas sector with other sectors of the economy - Failure to attract foreign investment in the oil and gas industry - Weakness in completion of oil and gas and petrochemical projects and no more income - Centralized energy supply sources and lack of distributed generation - Lack of attention to issues of passive defense - Lack of development in the energy storage systems - Lack of the necessary investments for commercializing renewable energies.

Table 2 (*continued*). SWOT matrix of the primary energy supply system.

	Opportunities	Threats
External factors	- The most attractive sectors for foreign investment - Ability to swap oil and gas with northern countries like Turkmenistan - Neighboring producer countries in the region to import energy (secure supply) - Possibility of changing to the oil and gas industry technology hub in the area (hardware and software) - Geopolitical situation in the Persian Gulf region - Ability to export technical and engineering services in the upstream field of oil and gas - Conventionalizing the unconventional technologies such as shale gas and sand oil - Ability to import modern technology, mining and oil and gas exploration - Ability to import the renewable energy technologies - Shared interests in the Persian Gulf to cooperate with neighbors - Attracting international oil companies for the supply of energy resources	- Poor quality of imported gas from Turkmenistan - Hostile relations with neighbors - Sanctions and international pressure by the western powers and the lack of modern technologies - Absence of large foreign investors in the oil and gas sector because of international political pressure - Lack of access to technologies in the oil and gas sector due to international sanctions by the western nations - High speed discovery and extraction of neighboring countries, especially in the shared field of oil and gas reservoirs (south Pars) - Weak foreign policy, especially in the region - Physical threats (e.g., foreign military attacks on vessels and oil wells) particularly in the Persian Gulf

CONCLUSIONS AND POLICY IMPLICATIONS

Today, energy plays an important role in policy and development. To assess the influence and role of energy in Iran, the study and assessment of the country's energy system is required. An energy system analysis considers the types of energy carriers from energy resources to end use energy systems. This study uses a SWOT analysis to evaluate the internal strengths and weaknesses of Iran's energy system and the external opportunities and threats it faces. The system is divided into four sectors and the SWOT analysis is applied for each sector of the energy system, including management and energy economics, energy supply, transmission and conversion, and the energy consumption system.

While the analysis shows that Iran's energy system is inefficient, system strengths can overcome weaknesses by exploiting available op-

Table 3. SWOT matrix of the energy transfer and conversion system.

Strengths	Weakness
- Developed transportation - Extensive network of gas pipelines - Widespread power grid - Placement of compressed natural gas (CNG) stations across the country to exploit the country's transportation system - High potential of energy and electricity production in the country - Diversification of production of oil products - Safe generation, transmission and consumption systems of gas - Replacement of oil and gas to fuel power plants in different seasons - The combined cycle gas power plants to increase the efficiency of thermal power plants - Power-trained specialists in universities - Infrastructure engineering and supply of raw materials in the interior of the country - High energy saving potential in consumption and waste by power plants and refineries - Numerous domestic cable and metallurgical industries	- Lack of development of renewable energy - Lack of LNG technology development - Low efficiency of power plants and equipment - Lack of safe development of rail transport - Remote areas of energy networks - Lack of development of renewable power to remote areas - Low capacity of oil products - Insufficient number of refineries and investment - Lack of proper transfer of gas and oil in cold seasons in the cold regions cause electricity and gas outages - Old gas pipelines - Inadequate inspection of gas and electricity transmission and distribution lines and products - Lack of construction of new and modern refineries - Usage of old technology, facilities and refineries and exhaustion - Lack of downstream petrochemical units that can bring petrochemical products into the global market. - Problems to convert natural gas into LNG and gas-to-liquid (GTL) - Increase of low efficiency gas turbine power plants - Lack of investment in R&D - Uneconomical petroleum products for domestic needs

Table 3 (*continued*).
SWOT matrix of the energy transfer and conversion system.

Opportunities	Threats
- Variety of available fuel for power plants - Growing Iraq and Afghanistan electricity markets to buy from Iran - Good market to offer petroleum products - Increasing demand for energy in developing countries - Ability to export technical and engineering services including construction, especially in the downstream oil and gas pipelines and oil refineries - Ability to export power plant technical knowledge to its neighbors - Opportunity to overhaul outdated power plants and refineries in the presence of renewable alternatives - The possibility of clean development mechanism (CDM) projects to attract financial support to improve efficiency and reduce pollution from power plants and refineries	- Sanctions and the impossibility of importing new technologies - Centralized power plants and refineries plus the risk of military attacks - Lack of development of passive defense - Reducing the amount of fuel going into power in cold seasons and the risk of electricity outages - Not responding to increasing demand from fossil fuel power plants if there are no renewable power plants constructed - No entry of foreign investors - No entry of private investors - The lack of an overhaul because of the full load demand on power plants and refineries

portunities. The strengths of the system include available fossil energy sources, high potential for renewable energy and a skilled workforce. Weaknesses of this system consist of misapplied policies, consumer behaviors and energy inefficient equipment. Systemic problems include disproportionate energy intensity, increasing levels of energy consumption in non-industrial sectors (e.g., transportation), high rates of growth in electricity consumption and excessive pressures on the natural environment.

Opportunities in Iran's energy system include following the principles of sustainable development to develop and implement a comprehensive energy policy. Others include a reasonable extension of fossil energy sources, importing and using high efficiency technologies and equipment, reducing excessive energy consumption, and developing RE resources.

The threats facing Iran's energy system include international sanctions and energy policy challenges with its neighbors and customers.

Table 4. SWOT matrix of the final consumption (end use) system.

Strengths	Weakness
- Developed transportation - Extensive network of gas pipelines - Widespread power grid - Placement of CNG stations across the country to exploit the country's transportation system - High potential of energy and electricity production in the country - Diversification of production of oil products - Safe gas generation, transmission and consumption systems - Replacement of oil and gas to fuel power plants in different seasons - Combined cycle gas power plants to increase the efficiency of thermal power plants - Power-trained specialists in universities - Infrastructure engineering and supply of raw materials in the interior - High energy saving potential in consumption and waste by power plants and refineries - Numerous domestic cable and metallurgical industries	- Lack of development of renewable energy - Lack of LNG technology development - Low efficiency of power plants and equipment - Lack of safe development of rail transport - Remote areas of energy networks - Lack of development of renewable power to remote areas - Low capacity of oil products - Insufficient number of refineries and investment - Lack of proper transfer of gas and oil in cold seasons in the cold regions causes electricity and gas outages - Old gas pipelines - Inadequate inspection of gas and electricity transmission and distribution lines and products - Lack of construction of new and modern refineries - Using old technology, facilities and refineries and exhaustion - Lack of downstream petrochemical units that can be closer to petrochemical products in the global market. - Problems converting natural gas into LNG and GTL - Increase of low efficiency gas turbine power plants because of the quick launch - Lack of investment in R&D - Uneconomical petroleum products for domestic needs

Table 4 (*continued*).
SWOT matrix of the final consumption (end use) system.

Opportunities	Threats
- Variety of available fuel for power plants of the country - Growing Iraq and Afghanistan electricity market to buy from Iran - Good market to offer petroleum products - Increasing demand for energy in developing countries - Ability to export technical and engineering services including construction, especially in the downstream oil and gas pipelines and oil refineries - Ability to export power plant technical knowledge to neighbors - Opportunity to overhaul outdated power plants and refineries in the presence of renewable alternatives - The possibility of CDM projects to attract financial support to improve efficiency and reduce pollution from power plants and refineries	- Sanctions and the impossibility of importing new technologies - Centralized power plants and refineries coupled with the risk of military attacks. - Lack of development of passive defense - Reducing the amount of fuel going into power in cold seasons and the risk of electricity outages - Not responding to the increasing demand for fossil fuel power plants if there will be no renewable power plants - No entry of foreign investors - No entry of private investors - The lack of a full overhaul because of the full load demand on power plants and refineries

Iran needs to increase its GDP and reduce dependence on oil revenues to overcome its internal energy challenges. The country needs to reform its approach to foreign diplomacy to enable an increase in oil and gas exports while importing technical knowledge and more efficient energy technologies.

SWOT results are a primary input for strategic plans. The results of this article can be used to develop strategies that will enable Iran to improve its energy system efficiency and attract foreign investment. To this end, Iran needs to liberalize its energy prices and subsidies.

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ABOUT THE AUTHORS

Alireza Heidari is a doctoral student of energy systems engineering at the University of Tehran. He has received his MS and BS degrees in energy systems engineering and mechanical engineering. His research interests include energy modelling, mathematical and dynamic programming in energy systems. Email: alirezaheidari@ymail.com.

Alireza Aslani is an assistant professor of the renewable energy and environment department at the University of Tehran. He also studied at the University of Vaasa, Finland. His research interests include energy modelling, policy analysis of energy technologies. Email: alireza.aslani@ut.ac.ir.

Ahmad Hajinezhad is an assistant professor in the renewable energy and environment department at the University of Tehran. He has several research experiences related to energy studies. His research interests include bio-fuels and renewable energy technologies. Email: hajinezhad@ut.ac.ir.

Seyed Hassan Tayyar has a Master of Science degree in Industrial Engineering. He is a researcher at the Science and Technology Park of the University of Tehran. He is also a lecturer of Payam Noor University. His research interest includes strategic and technology management. Email: tayyar@ut.ac.ir.