Energy efficiency potentials in Iran: a precise look to one of the biggest energy producers

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Abstract

The "Energy Efficiency Market report 2016" of the International Energy Agency (IEA) [4] estimates that global investment in energy efficiency, i.e. the additional investment required for efficient products, grew 6 % in 2015 to 208 billion Euros. Investment in buildings was over half of the total investment in efficiency and experienced the strongest growth at 9 % in OECD countries, compared to 2014. Investment in industry grew by 6 % and transport grew by 3 %.

In another report called "Capturing the Multiple Benefits of Energy Efficiency" [2], IEA focused on its benefits beyond just reducing energy use and emissions, including overall sustainability, economic and social development, and increasing prosperity.

Iran has one of the greatest resources of fossil energy in the world. Statistics show that Iran with having 21.4 billion metric Ton oil equivalent (Btoe) is in 4th place and 1st place in Natural gas and totally by having 82.5 Btoe, is the 3rd country in terms of possessing fossil fuels (oil, gas and coal) (BP, 2016) [1]. On the other hand, this country is the 3rd consumer of natural gas and 12th consumer of crude oil in the world. Based on IEA energy indicators, by comparing energy intensity of Iran between years 1998 to 2009 for supply of primary energy to GDP, it would be seen that energy intensity (without considering production losses) from 0.43 TPES/GDP[1] (toe/thousand 2010USD) has reached to 0.47 TPES/GDP in year 2009 with a slight slope, which shows economic growth and development from one hand and failure in energy efficiency on the other hand.

Based on Iran's policies for "General Policies of Consumption Reform" (2011), energy intensity should be halved till 2021 compared to amount of the base year 2011. In this way, the cumulative energy saving in the country is estimated to reach around 1,230 million metric Ton (Mtoe) which is approximately 5 times of the primary energy supplied to the country in 2009. As a result, Iran could avoid the threats of the energy shortage in buildings, industries, transportation, and agriculture sections.

This paper shows huge Energy Efficiency potentials in Iran and specially focuses on Building sector which is partially uncoupled from economic growth and this is in parallel global trend as mentioned above.

Introduction

As mentioned above, Iran has one of the greatest resources of fossil energy in the world while, on the other hand this country is one of the great energy consumers with high energy intensity (based on IEA statistics of energy indicators). By comparing energy intensity of Iran between years 1998 to 2009 for supply of primary energy to GDP, it would be seen that energy intensity (without considering production losses) from 0.43 TPES/GDP (toe/thousand 2010USD) in 1998 has reached to 0.47 TPES/GDP in year 2009 with a slight slope, which shows economic growth and development from one hand and failure in energy efficiency on the other hand.

Based on IEA statistics of energy indicators (2014), some important indicators are shown in Table 1.

1. TPES/GDP: total primary energy supply/gross domestic production.

Table 1. Key indicators.

Key Indicators:		Key Indicators:	
Population (millions)	78.14	**TPES/population** (toe/capita)	3.03
GDP (billion 2010 USD)	463.90	**TPES/GDP** (toe/thousand 2010 USD)	0.51
GDP PPP (billion 2010 USD)	1263.83	**TPES/GDP PPP** (toe/thousand 2010 USD)	0.19
Energy production (Mtoe)	316.25	**Electricity consumption / population** (MWh/capita)	3.00
Net imports (Mtoe)	-75.32	**CO2/TPES** (t CO2/toe)	2.35
TPES (Mtoe)	237.08	**CO2/population** (t CO2/capita)	7.12
Electricity consumption* (TWh)	234.11	**CO2/GDP** (kg CO2/2010 USD)	1.20
CO2 emissions** (Mt of CO2)	556.09	**CO2/GDP PPP** (kg CO2/2010 USD)	0.44

A 2009 IFC study called: "Energy Efficiency in Russia: Untapped reserves, IFC- World Bank" [3] which was designed to provide senior Russian policymakers with a comprehensive and practical analysis of energy efficiency in Russia: potential, benefits, and recommendations on how to fully tap into this resource shows that Russia has the potential to save 45 percent of its total primary energy consumption. This report was designed to provide senior Russian policymakers with a comprehensive and practical analysis of energy efficiency in Russia. Shortly after that, Russian President called for an action plan to halve Russia's energy intensity by 2020. This report also mentions that Iran is among the countries with similar status to Russia and can follow the same pattern.

In parallel with development of this report, Iran based on its historical experiences and studies has introduced "General Policies of Consumption Reform" (2011), in which energy intensity should be halved till 2021 compared to amount of the base year 2011.

Comparison with the results of IFC report shows that Iran is in line of a correct path for targeting and halving the energy intensity but this remains a matter of time.

Iran's Energy Structure and Energy Intensity

Iran's energy structure comprises of three main sectors: Production (net export, production energy use, and losses), Transformation and distribution (energy use of power plants and refineries, energy distribution lines and losses) and consumption (buildings, industry, transportation, agriculture and petrochemical), the share of each main sector from 382 Mtoe[2] energy production being 28.7 %, 23.7 % and 47.6 % correspondingly [5].

As consumption sector is the largest energy user and most accessible for energy efficiency measures, in this article we focus on this sector. Figure 1 shows the share of each subsector in energy use [5].

As it is shown, industry, transportation and building subsectors are the major consumers (more than 55 % of total primary energy supply is consumed in these subsectors). Buildings are the most energy consumers and as this consumption is not productive and coupled to economy growth, it worth to be focused most.

Since 1999 energy intensity has been increased with a slight slope and if this increase continues, assuming 6 % economic growth (which has been planned for Iran in the development plans), Iran's energy consumption will increase 60 % by 2021 and this results in becoming a net importer of energy shortly after that and this is a threat for our energy security.

Energy policies and regulations

As mentioned in IEA's Energy Efficiency Market report (EEMR) 2016 government policies have been fundamental to improving energy efficiency and have had a major role in improving

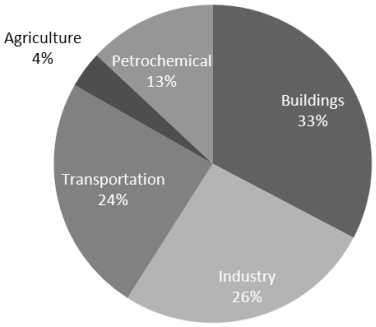

Figure 1: Share of Energy Consumption by Sectors

Figure 1. Share of energy consumption by sectors.

2. As IEA statistics do not shows the Iran energy consumption in sub-sectors, hereinafter energy statistics from Iran's Hydrocarbon Balance will be used in this paper. This report is based on Iranian year which starts from 21st March.

energy efficiency despite lowering of oil prices up to 60 % in the recent years.

The status of energy intensity in Iran is the consequence of several factors being the energy subsidies (as the most important), old equipment and bad behaviour of consumers (which is also consequence of low prices of energy). In the recent years, various acts and policies have been developed to decrease these negative impacts.

Iran has been working on development of policies, acts and regulation in the recent 15 years. Some of them being as follows:

1. **Third to Sixth National Economic, Social and Cultural Development Plan (2001–2020).** Diversification of Energy Supply, promotion of Energy Efficiency and Development of CCHP, Drivers for Energy Conservation and Application of Specific Energy Consumption (SEC) for Processes and Equipment, prioritizing of Research and Development on New EE/RE Technologies are Highlights of Energy Efficiency in this plan.
2. **General Policies of Energy Consumption Reform (2011).** Energy Intensity shall be halved till 2021 (with comparison to base year of 2011) with prioritizing improvement of Energy Efficiency and Productivity, Incentives and Penalties for improving Specific Energy Consumption (Process & Equipment), Development of Energy Standards and Labelling, enhancement of Energy Efficiency and Productivity awareness.
3. **Energy consumption reform Act (2011).** This Act has different outlines to result in reduction of energy intensity such as Supply and Demand Management, Standards and Criteria of Energy Consumption, Incentives for R&D, Energy Consumption in Industrial, Agricultural, Transportation and Residential Sectors, Energy Supply and Distribution, Renewable Energies, Awareness & Training.
4. **Targeted Subsidies Reform Act.** In December 2010, the Government of Iran undertook bold economic reforms to phase out subsidies to energy products and replace them with nationwide cash transfers as compensation for this phase out. The Iranian government called it "grand economic surgery" as it was expected to have dramatic economic and social impacts nationwide.

How can we translate our policies?

Based on the following assumptions, the quantification of Energy reform will be translated as Figure 2 for energy consumption in different sectors to reach the requirements of this act.

Methodology for Estimation: For estimation of saving potential in case of realization of halving the energy intensity, firstly we shall calculate energy consumption of future years based on the trend of past years as BAU. Secondly, we calculate energy consumption in case of realization of "General Policies of Consumption Reform" and implementation of energy conservation programs. The gap between these two is considered as saving potential. For estimation of energy consumption trend in case of halving energy intensity, two factors of GDP and target trend for reduction of energy intensity should be considered. Following assumptions have been made for producing of Figure 2:

- Halving of energy intensity by 2021 (in comparison to base year2011), the energy intensity reduction is linear.
- Average of GDP growth rate based on governmental policies till 2021 is 6 %.
- Population growth rate 1.47 % (to calculate Buildings energy consumption sector).

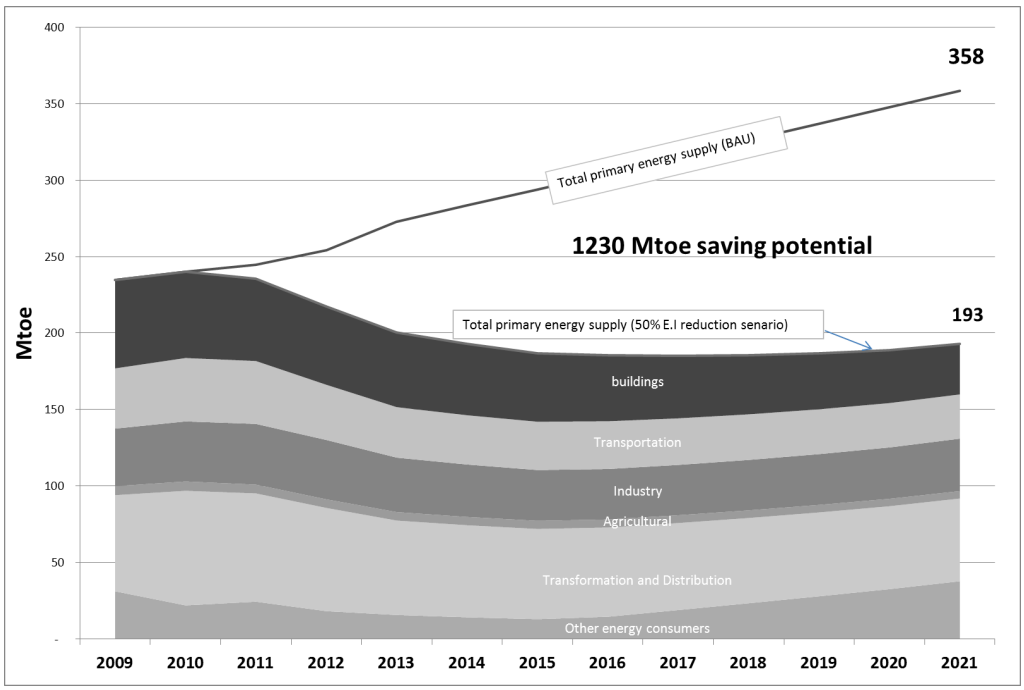

Figure 2. Projected energy consumption required by Energy Reform Act.

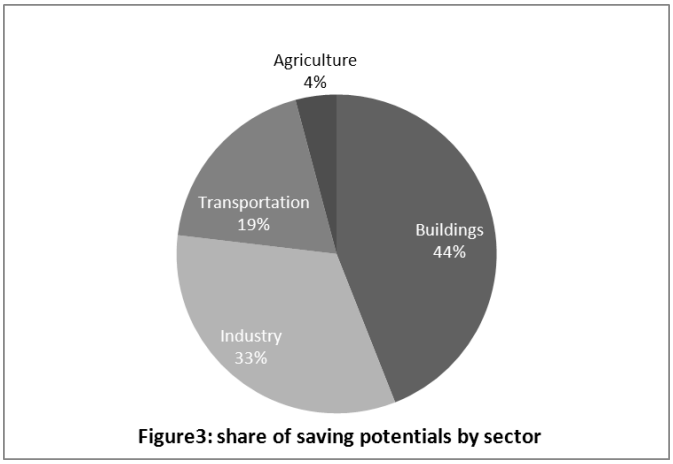

Figure 3. Share of saving potentials by sector.

The area of gap between two lines showing BAU (business as usual) and 50 % reduction scenario equals 1,230 Mtoe cumulative saving potential in total primary energy supply.

Unfortunately, due to different economic difficulties including sanctions and lack of finance, technology and expertise, the government failed to achieve all of what has been planned by the General Policies of Energy Reform but the potential still exists and even increased. Concerning the above mentioned methodology Figure 3 shows this potential for each sector in which the major role of building sector is clear.

Why Buildings?

As it is not possible to deal with all of the sectors at the same time in this article, we will deal with the building sector and its saving potentials and importance. Studies [6] show that by 2060, more than 70 percent of the global population will live in cities. Cities make up less than 3 percent of Earth's land area, but consume around 70 percent of global final energy and produce 75 percent of carbon emissions. Based on IEA World energy Outlook 2008, world's energy consumption in the year 2008 was 67 % in cities and till 2030 this amount will reach 73 % and building sector's energy consumption in year 2010 has been 34 % of world's energy consumption.

As it is expected that demand for energy will be doubled by middle of 21st century, so consideration of big cities and especially in building sector will have big impact on reduction of energy consumption and GHGs. On the other hand, only with successful on-the-ground implementation of SDG 11[3] we will truly achieve the desired outcomes to mitigate climate change.

Based on the studies and statistics that mentioned in methodology for estimation, in case of realization of 50 % of improvement of energy intensity in building sector in Iran, cumulatively in ten years has potential of 181 Mtoe saving and so the cumulative conservation opportunity equals to 62.3 bEuros. As the same in the past 15 years in Iran, energy consumption in buildings has grown 3.5 % annually while population growth has been 1.5 %. Despite energy efficiency improvement of home appliances, increasing energy consumption in buildings and related losses could explain the increase in the rate of energy consumption compared to the increase in population.

The other reasons for the focus on the building sector are: Most of the saving potential considering best practices is related to buildings.

1. Investment in energy conservation projects in buildings can range from 200 (for one single building) to some million Euros.
2. Utilisation of renewables for supply of energy in buildings is easier. (Based on a recent Iran's government directive all the governmental buildings shall supply 20 % of their energy consumption produced from renewables. In this case in besides enhancing energy efficiency of appliances and reduction of energy demand, for governmental building sector, much opportunities in investment in renewable energy is achievable)
3. Appliance energy consumption standards have improved a lot.
4. As buildings do not contribute in increasing of GDP, considering energy conservation in this sector will positively impact energy intensity.
5. Implementing energy conservation projects in buildings will enhance better energy consumption patterns and this can propagate to other sectors.
6. International experiences in implementation of energy conservation projects with energy Performance contracts (EPC) in buildings are higher than in other sectors.

During the past years, Iran's government has defined and supported many EE projects that improve energy intensity in all sectors (buildings, industries, transportation and agricultural), but according to what was said some of them has not been implemented yet.

Iran's Commitment for GHG in framework of UN-NDC

In Cop 21 Paris Iran among the other countries has committed to decrease its GHG emissions as follows.

On the basis of national capabilities, financial resources available and requirements of the national development program, taking into account GHGs emission scenarios, the Islamic Republic of Iran intends to participate by mitigating its GHGs emission in 2030 by 4 % compared to the Business as Usual (BAU) scenario.

Subject to termination and non-existence of sanctions and availability of international resources in the form of financial support and technology transfer, exchange of carbon credits, accessibility of bilateral or multilateral implementation mechanisms, transfer of clean technologies as well as capacity building, Iran has the potential of mitigating additional GHGs emission up to 8 % against the BAU scenario (which makes Iran's commitment 12 % in total).

If the aforementioned potentials for energy conservation happen, surely Iran can achieve much more GHG mitigation which could positively impact global warming.

3. United Nation's Sustainable Development Goal #11: Make cities and human settlements inclusive, safe, resilient and sustainable.

Conclusion

Iran has had the "General Policies of Consumption Reform" (2011) for halving its energy intensity until the year 2021. Comparison with the results of IFC-world bank's 2009 study for Russia shows that Iran is in line of a correct path but due to different problems including sanctions, lack of finance, technology and expertise, the government failed to achieve all of what has been planned.

IFC-world bank's 2009 study for Russia forecasts approximately two dollars of investment is required to achieve one dollar of saving per year. The situation is the same for Iran, so to reach 1,230 Mtoe of cumulative saving in ten years, 185 bEuro of investment is needed, but results will continue till 10 years later with 817 bEuro of saving value[4].

The amount of cumulative saving of 1,230 Mtoe of oil means a reduction of 2,820 million tons of carbon equivalent emission which will be released to the atmosphere in other way. The social expense of such emission with the current rate of 35 Euro per ton (which is calculated by US EPA) makes 98 bEuro whilst a study by Stanford University [7, 8] shows that the social expenses are 206 Euro per ton, not 35! This shows how much impact this reduction could make on the economy.

The facts and figures that have been presented show Iran's immense potential in energy conservation and GHG mitigation and the policies and commitments show Government's will and interest in this way. As the embargoes against Iran are majorly removed, this could make Iran the best and most profitable market for energy conservation. Building sector for the first step seems the most available but development of programs on other sectors could be feasible too.

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4. In this calculation, the price of one barrel of oil has been considered 50 USD (47 Euro).