

Renewable Energy Development in Tehran Municipality; Case Study Comparison with IEA Report

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Abstract: In recent years, most of the municipalities have focused on renewable energy as a straight way toward sustainability, lowering energy demand, protecting environment and society. Policies to promote renewable energy have become increasingly popular among municipalities in different parts of the world, especially somewhere role of municipalities is integrated city management. In this way, there are certain strategies to meet the targets which have been already set. Specifying certain green building standards for new construction and major renovation for any projects using public funds, creating inspiring demonstration projects that meet high green building standards, developing systems where certified green buildings can cut through the red tape in the approval process, tax credits which offset some of the cost for energy conserving projects, are some of proceeds of municipalities to develop renewable energies in action. Tehran municipality has tried a lot to set goals and action plans to promote renewable energy in the city in spite of lack of integrated management in Tehran. According to the guidance of the International Energy Agency report two municipalities with most similarity to Tehran were selected from the report to identify and compare some concepts and policies in this paper. The main goal in this article is arguing Tehran municipality targets and proceeds, compared to Tokyo and Cape Town in order to find out the feasibility and effectiveness. As the result, in comparison with Japan and South Africa, Iran is at the first steps to expand renewable energy and beside infrastructure problems by depending on high levels of renewable sources, it has planned to promote renewable energy at cities and rural. In this regard, according to action plans, Tehran municipality has done projects to increase citizens and authorities awareness about different ways to use renewable energy.

[Zohreh Hesami, Ali Mohamad Shaeri, Farshad Kordani. **Renewable Energy Development in Tehran Municipality; Case Study Comparison with IEA Report.** *Nat Sci* 2015;13(7):34-40]. (ISSN: 1545-0740). <http://www.sciencepub.net/nature>. 4

Keywords: Renewable energy, Tehran Municipality, IEA report

1. Introduction

In recent years, numerous municipalities in different parts of the world have taken measures to increase the share of renewable energy. Climate changes, economical problems and energy crisis are some of reasons that they do so. City government efforts need to address not only what they can do directly to reduce carbon emissions, but also how they can promote greater adoption of these technologies by consumers. Depending on the technology, this can come through changes in regulation, taxes, subsidies, access to capital and provision of trusted information, as well as marketing and campaigning to raise the awareness and encourage citizens to make choices that are both economically and environmentally sound. Cities could also help bring together different stakeholders that need to act jointly to make change happen. [Siemens, 2007].

This paper analyses whether potential, programs and activities of Tehran municipality in accordance to world vision or not. Two different cities are chosen (Tokyo and Cape Town) as case studies which their

proceeds, policies, strategies and targets are finally compared with Tehran municipality. Tokyo as a wealthy mega city and Cape Town as a poor mega city are good cases for comparison since Tehran is a mega city with same situation. These experiences can also help to identify some concepts and policies that may be worthwhile considering ascertaining whether they might be transferrable.

2- Case studies

2-1- Tokyo, Japan

Tokyo with more than 12.4 million populations is a mega-city funding its long-term vision for renewable energy potential. Renewable energy supplies around 2.7% of the total energy demand of Tokyo. In Tokyo 37% of electricity is used for lighting and electronics, 43% for hot water and 20% for space heating and cooling. The electricity market in Japan was partly liberalized in 2005. As a result, large power customers were able to choose their electricity supplier.

The Tokyo metropolitan Government (TMG) adopted the Tokyo Renewable Energy Strategy in

April 2006, setting the opportunity for discussions around a target of 20% from renewable energy supply for the city by 2020. It was felt that the purchasing power resulting from implementing the target would help to boost renewable energy deployment throughout the whole country. In order to achieve the target, the TMG requires all energy companies to publish the amount of carbon dioxide in order to make them to use green energy. The 10-year plan is to reduce the city's greenhouse gas emissions by 25% from 2000 levels by 2020. In the longer term, the goal is to reach a carbon-minus Tokyo by changing the structure of society. A fund of USD 4.3 billion was then agreed by the city leaders for fiscal year 2008 to promote measures against climate change. The aims are to create a mechanism to encourage large and small businesses and households to take responsibility to reduce their CO₂ emissions; and to use private and public funds, tax incentives and bold investments to achieve the desired CO₂ reductions.

2-1-1- Renewable energy technologies

Electricity

- The Tokyo Metropolitan Government has invested in two 2.5 MW wind turbines located on reclaimed land by the central breakwater at Tokyo Bay.

- The city water treatment plant uses electricity from one of Japan's largest solar PV generators.

- A project to expand the use of solar energy was launched in March 2007 with the aim to achieve the greater use of solar thermal and solar PV for lighting in the Tokyo metropolitan area, up to around 1000 MW total capacity.

Heating

- The greater use of solar thermal systems for heating water and space in houses is encouraged by the TMG as one of its objectives.

Transport

- A project for the practical application of the 2nd-generation biodiesel fuel was launched in February 2007.

2-1-2- Current policies relating to renewable energy project deployment

- All power producers and supplier are required to release CO₂ emission reports and their targets to reduce it by renewable energy.

- The green building program which is under discussion by the TMG in order to encourage all building owners to consider renewable energy technologies.

- The TMG mandated a cap-and-trade scheme in June 2008 that will be the first urban scheme to give an emissions limit to office buildings, any organization that consumes over 60 TJ of heat, electricity and transport fuels per year is to be

included, such as large commercial buildings, 1100 businesses and 300 factories also covered. [1]

2-2- Cape Town, Western Cape, South Africa

Cape Town with 3.4 million populations is known as a mega-city in Africa exemplifying the difficulties involved with renewable. The city has a wealth of untapped renewable energy resources, yet 10200 GWh/year of electricity consumption relies heavily on thermal generation using coal and gas. In response to the calls for climate change mitigation, Cape Town became the first city in Africa to implement a ground-breaking integrated Metropolitan Environmental Policy (IMEP), which established the Energy and Climate Change Strategy (ECCS) that integrates renewable energy. Both the IMEP and ECCS have mission statements, sectoral campaigns, targets/goals and timeframes. The renewable energy focus for Cape Town is on wind generation and solar water heaters. The largest issue faced in implementing these environmental strategies is the financial challenge, since almost 40% of households in the city are living below the poverty line. Communication and increasing awareness are paramount for the success and further development of renewable energy sources in Cape Town.

2-2-1- Renewable energy strategies

Electricity

- A pumped storage plant consisting of two 200 MW turbine units located at the Steenbras Dam. The project was regarded and declared a Biosphere Reserve by UNESCO. It has reduced the number of black-out incidents in Cape Town and saved the city approximately USD 320000/month.

- The Darling wind farm, 70 km from Cape Town, is the first commercial utility-scale, renewable energy project in South Africa (other than hydro). Four 1.3 MW turbines generate a total output of 13.2 GWh/yr. the city has contracted to purchase the electricity from the independent power producer for 20 years.

Heating

- A target was met for 2010 by the Solar Water Heater Advancement Program consisting of equipping 10% of all households and 10% of all cities owned housing by solar water heaters.

Transport

- A little more than half the total energy in Cape Town is used by the transport sector. The city has created a goal of a fully operational "non-motorized" transport strategy by 2015. To meet this goal, the city is promoting bicycle and pedestrian transport with increased bicycle lanes and walkways; creating pilot projects for suitable cleaner transport fuels and options, including biofuels. And providing information to the public on feasible alternative transport energy sources.

2-2-2- Current policies relating to renewable energy project deployment

- 10% renewable energy supply by 2020
- Non-motorized transport to be in place by 2015
- Legislation for all new dwellings, construction development and city-owned housing to install solar water heaters
- The development of a "green tariff" is under consideration. [1]

2-3- Tehran

Tehran as the capital city of Iran and with a population of around 8 million is located in the northern half of Iran. As Iran is the world's third largest oil (website opec) and the second richest gas reserves, historically oil has been the predominant source of primary and final energy in Iran and also in Tehran.

2-3-1- Iran's solar irradiation and the share of installed solar systems

Iran has a great solar energy potential among other countries. Development of solar energy systems requires precise knowledge of Iran solar radiation. Solar thermal power plant site selection is possible by accurate knowledge about country. This project defined by Solar Energy Department to provide basic knowledge for planning solar projects.

In the first phase of project, solar irradiance of Iran has been concluded by data from Satellite pictures and solar study stations.

The main objectives of this project are:

- Providing Iran solar atlas
- Determining the place and capacity of appropriate sites for installing solar thermal power plants
- Fiscal and technical investigation and prioritize suitable sites for installing solar power plants
- Verifying appropriate sites for solar power plants in Iran
- Providing software algorithm for fiscal study of solar systems in Iran
- Developing Iran solar energy data base (website suna).

Based on the solar atlas, the level of incoming global radiation (~2,200 kWh/m².year) in Iran is globally one of the highest (Tehran: 1800 KWh/m² per year) (website suna). Taking into account the size of the Iranian territory (~1,648,000 km²) the total amount of radiation in Iran is about 3.3 million TWh per year – this is thirteen times higher than the total energy consumption in Iran. (Fig. 1)

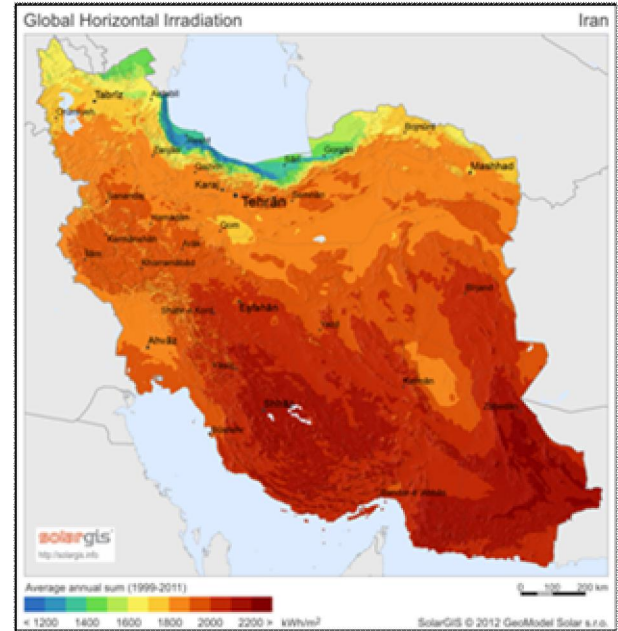


Figure 1. Iran's solar irradiation map (Source:website solargis)

Over the past twenty years some research on solar energy have resulted in development and the establishment of a few small- and medium-scale electricity generation plants, which are powered via solar energy. In addition, there has also been the development of solar water heaters [2].

Two main solar power plant projects of Iran Are: Yazd solar thermal power plant and Shiraz solar power plant which are described at table 1.

Table 1. Main Solar power plant projects of Iran

Name	Location	Capacity	Type	Operational	Notes
Yazd solar thermal power plant	Yazd	467 MW	Integrated Solar Combined Cycle	2009	Yazd solar thermal power plant is the world's first integrated solar combined cycle power station using natural gas and solar energy. It is the largest solar power plant in the Middle East and the eighth largest in the world.(website zawya)
Shiraz solar power plant	Shiraz	250 KW	Concentrating solar power	2009	Shiraz solar power plant is Iran's first Solar power station; Currently being upgraded to 500 kWh(website suna)

2-2-1- Iran's Strategy for utilizing solar energy

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. Due to this fact, the main goal was to substitute other sources of energy for oil products in domestic consumption and one of the main policies was: 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 (website helio-international).

Actually, Iran was the largest provider of fuel subsidies in the world by 2009 (Iran Investment Monthly, 2011) and its subsidy system has been inherited from the Iran-Iraq war era but was never abolished (United States Energy Information Administration, 2000). Generally, the high level of subsidies for heating as well as for electricity result in an inefficient use of energy and prevent the use of solar energy and other renewable energies. To solve this problem, the Iranian targeted subsidy plan was passed by the Iranian Parliament on January 2010 to manage subsidy in Iran [3]. 30% of the amount saved by the government will be directed towards improving the efficiency of the utility, fuel and energy production infrastructure; public transportation development, industry and farming [4].

Due to the significance of energy issues, Iran places on the agenda to move toward privatization and participation in power market with emphasis on the deployment of renewable energy [5].

2-3-2-1- Tehran's feed-in-tariff

Accomplishment of the energy plans needs legislations to regulate exchange in power market. Power tariff regulations may be the most effective one. Although, Tehran has feed-in-tariff directive (National directive of electricity trade in Iran's electricity grid, 2005). But this non-incentive directive belongs to the time before the targeted subsidy plan. Therefore, more sophisticated tariffs are necessary part of power market. Current state of residential power tariff in Tehran is based on rates weighted by summer factor (four months a year) and winter factor (three months a year) to take into account seasonal variations in different parts of the country. Currently, peak hours are considered to be between 19 and 23. Table 3 shows the current schedule for Iran's residential power tariffs, it has been regarded as reference power tariff structure [6].

Iran first introduced FIT in 2008 for purchasing renewable energy from investors. A price of 1300 Rials/kWh was set for renewable electricity. For 4

hours in the mid-night, the price is 900 Rials (Website solarfeedintariff).

Table 2. Tehran FIT (source: Website solarfeedintariff)

Iran- FIT	
Peak and medium load 20 hours per day	1300 IRR
Low load 4 hours per day	900 IRR

Regard to all mentioned policies, Iran has promoted some actions to develop solar energy at its capital city that has been described below:

Reviewing the action of Tehran Municipality in the field of developing solar energy Tehran with a population of around 12 million is the capital city of Iran. It is also Iran's largest urban area and city, the largest city in Western Asia and the 5th-largest city globally.

Regardless of great potential to use solar energy (the annual average of solar irradiation in Tehran is 4/58 KWh/m² (Website NASA), Tehran is suffering from high rate of air pollution that is mainly because of fossil fuels overuse. Regarding to the escalating trend of air pollution and the great solar irradiation in Tehran, city planners and managers increasingly consider different use of clean energy instead of fossil fuel, which are not environmentally friendly.

To decrease air pollution and have an environmentally friendly city, Tehran mayor and his counselors have taken some promising actions, which are positive signals that indicate a growing awareness of a structural change in the energy system in Tehran. Some of these actions have been described below:

2-3-2-2- Legislation for developing solar lighting



Figure 2. Velayet park, Tehran, Region 19 (Source: Tehran municipality's archive)

In 2008, Tehran city council approved an obligation in the subject of replacing 10 percent of conventional power generation in city parks with solar power annually (*website shora-tehran*). In this regard, up to now, Tehran municipality has equipped 118 (which are 7% of total) of 1808 city parks with solar lighting. (Fig. 2 & 3)



Figure 3. Khavaran cultural complex, Tehran, Region 15 (Source: Tehran municipality's archive)

2-3-2-3- Installing solar heating systems

Solar heating systems could be an important step towards a sustainable restructuring of the energy supply. In this regard, by this time The Tehran municipality has installed 456 solar water heaters around the city at public spaces, which had no access to other kind of thermal energy.



Figure 4. Mellat Park, Tehran, Region 3 (Source: Tehran municipality's archive)

2-3-2-4- Creating energy parks

To mobilize the potential of a complete city quarter, strong incentives are needed in order to get people involved. In this regard, Awareness of the possibilities of PV systems within urban space, and particularly in combination with urban renewal creates many chances to install PV in public spaces.

An energy park is a separate area used and planned for the purpose of clean energy development,

like wind and solar generation facilities. Energy parks make people familiar with various ways of using solar energy in a tangible and practical manner that is effective.



Figure 5. Polis Park's mosque, Tehran, Region 4 (Source: Tehran municipality's archive)

In 2009, Tehran Municipality equipped one of the existing parks with solar facilities and now there are seven Energy Park at different regions of Tehran.

Generally, Facilities such as: solar cooker, solar cabin, Solar Fruit Dryer, Solar water desalination, solar water heater and photovoltaic modules have been installed at common energy Parks. (Fig. 6&7)



Figure 6. Alghadir Energy Park, Tehran, Region 4 (Source: Tehran municipality's archive)



Figure 7. Bahman Energy Park, Region 16 (Source: Tehran municipality's archive)

2-3-2-5- Equipping urban element with PV

By the purpose of indirectly training citizens to promote the idea of using solar energy in their daily life, Tehran Municipality, has equipped more than 500 bus stops with PV to provide solar lighting and In this regard, Tehran municipality's energy experts have designed urban element-equipping plan by inspiration of mixture of traditional architecture and renewable energy use. In addition to bus stops, some pedestrian bridges are also equipped with PVs to provide lighting.



Figure 8. Solar Bus Stop, Tehran, Region 3 (Source: Tehran municipality's archive)

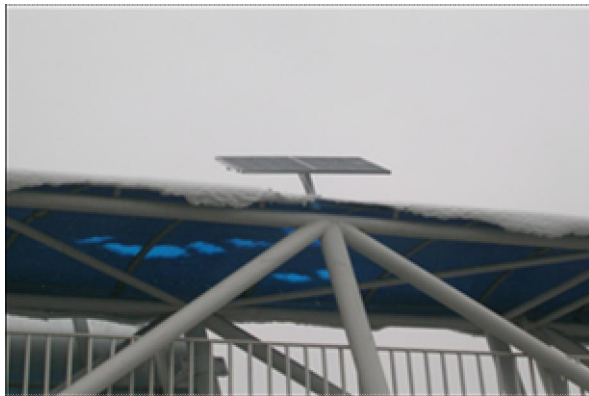


Figure 9. Solar Pedestrian Bridge, Tehran, Region 16 (Source: Tehran municipality's archive)

2-3-2-6- Publishing Hand books

To inform municipality's employees who are involved in Solar projects around the city, Tehran municipality has initiated a committee to manage the city solar projects and has published 4 handbooks to promote the knowledge of citizens and related stuffs.(Fig 10&11)

2-3-2-7- Current policies relating to renewable energy project deployment

Tehran Municipality has planned to:

1- Providing at least 10 percent of energy need using renewable energy in Tehran's building by the end of 2019



Figure 10: Rules and Regulations for energy optimization, Number 1(Source: Tehran municipality's archive)

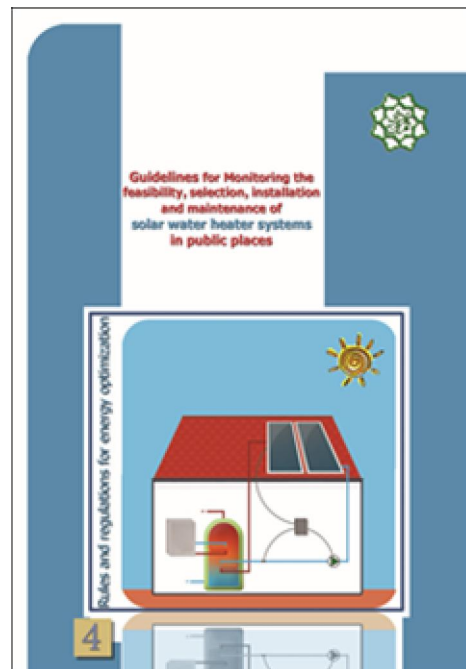


Figure 11: Rules and Regulations for energy optimization, Number 1(Source: Tehran municipality's archive)

2- Providing at least 20 percent of energy need using renewable energy in Tehran's public spaces by the end of 2019

3- Equipping 10 percent of Tehran's public transportation using renewable and clean energy by the end of 2019

4- Increasing Energy extraction from waste to 20 MW by the end of 2019

5- Promoting the use of renewable energy among public people by education and culture

3- Result

As Tokyo renewable energy strategy states that 20% of city energy must be supplied by renewable energy by 2020, Tehran municipality has also planned to provide 10 percent of building's energy need, 20 percent of public space's energy demand, and 10 percent of public transport's energy use by renewable energy by 2019, and this is an outstanding targeting considering the little portion of renewable energy production in Tehran in comparison with 2.7% energy supply by renewable energy in Tokyo.

To achieve Sustainable urban planning and management, Cities around the world should promote the use of renewable energy sources and build low-carbon eco-cities. In this regard, solar energy is expected to play a crucial role in meeting future energy demand because it is constituted the most abundant renewable energy resource available.

Town planning with infrastructure without solar targets is the first barrier to promote solar energy in cities; to solve this problem city needs Integration in the preliminary planning phase and Town planning should focus on solar potential and consider it in the planning process from the beginning, in this regard Tehran city parliament is passing a comprehensive law in order to develop the renewable energy according to justified targets considering both sources and infrastructures. Economic concerns are the second barrier that should be noticed. To solve this problem city needs subsidy and feed in tariff programs and government also should investigate in producing PV and related stuff to decrease their price. Weak legal instruments to prescribe solar targets are the third main barrier, and to solve this, the city needs Commitments in building code and energy. In addition, the fourth factor which is a barrier to the solar urban planning is the unwillingness of private companies to invest. To mobilize the potential of a complete city quarter, strong incentives are needed in order to get people involved. Awareness of the possibilities of PV systems within urban space can create many chances to install PV in public spaces. Finally, some weakness in solar energy technology also leads the unsuccessful solar energy development. To solve this problem, producers should increase the efficiency of PV modules and other related stuff and they should

train their workforce professionally to operate solar project skillfully.

City planners should notice that a mix policy for developing solar energy result the best and although some policy instruments have leading roles in promoting solar energy in some countries, a mix of policy instruments, instead of a single policy, would be more effective.

In summary, the discussion presented in this study indicates the impetus behind the recent growth of renewable energy technologies is attributed to sustained policy support in countries such as Japan and South Africa. In comparison with Japan and South Africa, Iran is at the first step to expand renewable energy and beside infrastructure problems by depending on high levels of renewable sources, it has planned to promote renewable energy at cities and rural. In this regard, Tehran municipality has done some projects to increase citizens and authorities awareness about different ways to use renewable energy.

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