# Developing Renewable Energies in Iran

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***Abstract***

*Destructible fuels, variety to energy resources developing constantly and secure the energy, ecosystem problems due to the consumption of clean fuel energy and being renewable energy sources like solar, wind, biomass and etc caused a global attention to expand and developed the consumption of renewable energies and have increased the number of global consumers. This article studies the situation and developing of renewable energies in Iran. These pages study the situation of power stations in Iran and different schemes about that.*

***Keywords:*** *Energy, Iran, geothermal, potential heated earth, Biomass, Wind*

## 1. Introduction

In general terms, energy sources are classified as renewable and non renewable energy types. Renewable energy is fuelled by a resource that is sustainable in economic, social and environmental terms. It is usually defined by the fuel source, for example geothermal, solar, wind, biomass, tidal, and etc. Renewable energy has the capacity to provide cost-effective energy to remote communities without the added investment of providing fossil generation [4]. Historically, the benefit of biomass energy returns to the primary historical periods. The most ancient gas exits and its incomplete combustion have been reported by digging of wastes in lower levels of the ground by Pillyni robin [2]. In 1667, Sherly discovered the lagoon gas but the major practical history started in 1776 by Metan gas as the major bio-gas composition from fermentation materials by Volta [3]. The start of major researches in the field of non-aerobic fermentation and its application in agriculture is relating to Davy in 1808. In 1884, Gine performed a plan through which the biomass energy supplied the lightening of all avenues in Paris city. Also in Iran there is a historical usage of biomass. Sheikh Bahaei was one of the first persons used biomass and applied it as a fuel in a bathroom in Isfahan. The first digester of Metan gas was recognized in Niaz Abad Lorestan in 1975. In 1980, there was an establishment of two small testing units in Boo Ali Sina University in Hamedan with consuming of slaughterhouse wastes and cow fertilizer [8]. About wind energy, we can said that the application of wind energy goes back to thousands of years, but its application to generate electricity was made prevalent in last century. The early provision of natural power to replace or augment human and animal

muscle power came from the widespread use of sail wind mills and water wheels of various designs used for grinding grain and for pumping irrigation water. Wind power is still used for pumping water, irrigating the farm lands, and grinding the food grains in addition to generation of electricity.

The state-run electric company of Italy (ENEL) with the accompaniment of Tehran Berkeley of Iran initiated the systematic study of Iran's geothermal fields in 1975 under a contract signed with the Ministry of Energy (hereinafter referred to as MOE) of Iran [1]. The studies terminated in the early 1980's and led to the introduction of four major prospects. Amid 1990's, following a long gap, the growing needs to explore the clean sustainable sources of energy resulted in the setting up of specialized state-run establishments such as Electric Power Research Center (EPRC) and Renewable Energy Organization of Iran (SUNA) (Geothermal office-Renewable Energies Office-Ministry of Energy-Islamic Republic of Iran, 2007). During recent years, the latter as an affiliate of MOE has been effectively engaged in the management and execution of a variety of renewable projects including geothermal [5]. This company plays a fundamental administrative role in most of the nationwide geothermal projects and turns over jobs to both government and private sectors as its executive arms. The idea of power generation from Sabalan geothermal prospect (officially named Meshkinshahr geothermal field) was initially proposed in 1994; thereafter emphasis has been put onto this field as the eminent priority [6, 7]. Upon detailed geo-based survey conducted by the joint collaboration of SUNA of Iran and Sinclair Knight Merz Ltd (SKM) of New Zealand within the time frame of 1998-2000, Meshkinshahr geothermal field was recognized satisfactory as a potential reservoir for power generation purposes. Based on their proposal, the exploratory drilling of three exploration wells started in 2002 [7].

## 2. Geothermal Energy

The heat energy existing on the crust is called earth heated energy. Core of the earth planet is the enormous source of this energy that comes up on the surface in different ways such as volcanic eruption hot water and due to the conductive feature. According to the speculations earth planet was a fire ball had been created about four billion years ago and has been cooling down gradually and be continued. Today this type of energy is used in different manner in different part of the world. By the time, the investigations apply the former energy supplying technology they have completed the new techniques of energy supplying. Endeavor to discover the sources of energy and technology transferring is important task should be done in the future. Exploiting of earth heated energy, as a potential source of energy at the depth of earth, is apart from the state of atmosphere and meets all the requirements of human being at present and future. The areas of earth having this energy potential are conforming to volcanic and seismic region.

### Projects in Iran

#### A: Pre study of potential geothermal energy testing in all over Iran

This starts in 1996 an ended in 1999 in all over Iran. This contains 3 phases [3, 5]:

- First phase; study the discover techniques in different countries
- Second phase; introduce 10 regions having potential in Iran

- Third phase; do geology and geochemical studies and calculate the temperature of cylinders of two regions of 10 regions introduced in second phase.

The conclusions of this are;

- To Pre study of geology and geophysics
- To Introduce 10 regions having potential
- To calculate the temperature in Tafton, Bazman ,Bijar and Takab

**B: Pre study of potential heated earth energy testing in Khoi and Boshli**

The site of the project is located at Khoi and Boushli. Phase one of this research project was performed by Atomic Energy Organization of Iran, and completed in 2004. For performance of the next phases, the project was transferred to Renewable Energies Organization of Iran, and the results and recommendations are under consideration for performance of the next phases of the project. The results of discovery studies conducted in past years in geothermic regions of Boushli (southern Seilan) and Ghatour Valley (Khoi) suggest existence of geothermic reserves in this region. Drilling of a discovery well with depth of 600 m and operation conducted in that region showed that temperature rise per depth is higher normal (normal limit is about 3 degrees centigrade for every 100 meters), in such manner that temperature measured at depth of 500 m was higher than 100 degrees centigrade [5]. Other activities conducted in this project are as follows [5]:

- Preparation of 1/5000 topographic map of Ghatour Valley geothermic field
- Correspondences and negotiations on ammonium absorption chillers for use in geothermic refrigerators
- Studies and researches on power plants producing electricity from geothermic energy
- Study of the results obtained by Italian ENEL Company
- Study of hot springs
- Conducting complementary studies on potentiometry of geometric energy in Damavand

**C: Production, descriptive and injection Drilling Projects, and establishment of 3-5 MW geothermic package**

The site of this project was located in KM 35 of Meshkinshahr after Muyil Village, on northwestern hillsides of Sabalan.

Objectives of project include [5]:

a) Discovery of development of Sabalan Geothermic Field (Meshkinshahr) for establishment of power plant with capacity of 55 MW in two phases.

b) Achievement of technology of exploitation of geothermic resources in Iran and localization of knowledge associated with it.

c) Identification of non-fossil potentials of energy resources.

d) Diversity creation in Iran's energy basket.

e) Cultural, social and economical development of deprived areas.

f) Environment protection through use of clean and renewable energy resources, and consequently, reducing consumption of fossil resources.

Description of Project:

This project was conducted in two phases, the phase one included discovery and evaluation of power plant potential of geothermic field, and the second phase (development of geothermic field for establishment of power plant) included:

a) Drilling production, descriptive and injection well (20 wells in total)

b) Setting up of 3-4 MW pilot power plant.

c) Setting up of 50 MW power plant (after Fourth Development Plan)

d) Environmental scanning during development of field.

Abstract of activities conducted so far:

- Activities and results obtained in first phase [5]:
- Conducting preliminary studies in the region.
- Collection of environmental information.
- Location of discovery and injection wells.
- Drilling operation of discovery wells (preparation of geological and geophysical maps for locating discovery wells)
    - Site A: Drilling discovery well with depth of 3196 m and drilling injection well with depth 650 m.
    - Site B: Drilling discovery well with depth of 2265 m and drilling injection well with depth 650 m.
    - Site C: Drilling discovery well with depth of 3176 m.
- Conducting operation of well logging, its results as obtained in phase 1 are shown in Table 1.
- Conducting operations of test and exploration of well for obtaining parameters of outlet fluid.

**Table 1. Results of Sampling of Wells of Sites A and B**

| Name of well and its location | Depth of well (meter) | Temperature of well | Pressure of well (Bar) | Temperature of fluid | Enthalpy |
|---|---|---|---|---|---|
| NWS2 Sit A | 3196 | 250 | 3/3-4/1 | 110 | 980 |
| NWS4 Sit B | 2265 | 245 | 5-10/5 | 130 | 1000 |

Having calculated geometric parameters, the results mentioned in Table 2 were obtained:

**Table 2. Results of Sampling of Wells of Sites A and B**

| | |
|---|---|
| Estimated power from well in sit A | 1/5-2 (MWe) |
| Estimated power from well in sit B | 3/5-4 (MWe) |

Activities and results of phase 2 [5]:

- Locating new wells for developing geothermic field.
- Conducting repair, snow cleaning and pavement of roads.
- Repairing sites A, B and C.
- Revival of production wells of site A.
- Drilling of the first descriptive well with depth of 2400 m at site D.
- Drilling of the first injection well with depth of 1900 m at site B.
- Collection of information of hot springs in the region with aim of evaluation of probable environmental effects due to development of plan during drilling operation.

**Figure 1. A View of the Power Plant under Construction in Meshkinshahr**

## 3. Biomass Energy

The destruction of fossil fuels, variability of sustainable development energy resources and energy security, ecological problems due to consumption of fossil fuels in one hand, and restoration of new energy resources like the sun, wind, biomass, etc. on the other hand, has caused people to pay closer attention to the development and increase in the use of renewable energies and the increase of share of these resources in the global basket. The significant increase in activities and budget expenditure by the governments for research and study has finally led to total cost of renewable energies to decrease and made them more capable of competing with current traditional systems. This has been carried out in wind energy affairs and some applications of biomass energy and we are witnessing rapid decrease in the prices of other renewable energies.

According to available data, in 2005, 13.3 percent of the world's initial energies were supplied from different types of renewable energies the share of which were as follows [1, 2]:

- Biomass energy 79.7%
- Water energy 16.5%
- Geothermal energy 3.1%
- Sun energy 0.29%
- Wind energy 0.48%

Also, in the same year, renewable energies were the second source of electricity of the world. Their share in this regard was 17.9%, 16.1% of which was the electricity produced by water, 1% was produced by biomass, and the remaining 0.8% was produced by other renewable energies of the world. The amount of electricity produced by renewable energies, except electricity produced by water, was more than625 Tetra Watt/hour (billion kilowatts electricity in an hour). In 2005, the total amount of installed capacity of different types of biomass in the world was more than 44,000 Mega Watts and the electricity produced by these sources amounted to more than 250 Tetra Watt per hour. It should be mentioned that a major part of biomass energy share in the supply of initial energy of the world is allocated to thermal applications and direct combustion, especially in the developing countries [4].

## Technologies Used for Energy Production (Electricity/Heat) from Urban Waste Materials

At present time, there are different technologies and methods for management of waste materials and energy production. In some of these technologies, energy production has priority and in some others, destroying the waste materials. In general, the following technologies are currently used worldwide individually or in combination with other technologies [1, 2]:

- Burning waste material including mass burning, modular, and PDF
- Burying locations of waste materials
- Mechanical methods of MBT
- Gasification
- Digestion of anaerobic
- Plasma

## Research Projects Undertaken in Iran

### A: An Study for Establishment of a Biogas Unit in Capacity of 460 KW in Saveh City

The goals of this project are [3, 5]:

A: Establishment of the first biogas power house(biogas reactor) for energy production from solid and liquid organic wastes including domestic wastes and urban sewage,

slaughter house waste water for establishment of electricity power house in capacity of 46 KW.

B: Environment protection

C: Display performance and prepare documentations required to motivate private and public sector to invest in this regard; attaining managerial experience to manage process of designing and construction of bio-gas power plant.

D: The execution of this pilot project allows a feasibility study to be conducted for the purpose of developing such systems in various part s of the country

E: Fertilizer and water are the side products of this project and play significant roles in development of green space and agriculture.

This project will soon be ready for exploitation.


**Figure 2. View of Saveh Site**

**B: Assessment of the Potential of Biomass Sources in Mashhad and Shiraz**

The project was executed in several stages listed below [3, 5]:

A: Preliminary Studies

Preliminary studies included presentation of bases of garbage engineering design, biogas transfer and collection terminals, and technologies generating energy from biogas emitting from garbage area.

**C: Feasibility Study**

The feasibility study stage, included assessment of the existing potential for producing biogas from Mashhad City's urban garbage, making gas production models in garbage burial, prediction of the future trend of gas production, assessment of the electric power installable in Mashhad Garbage Burial, technical assessment of the equipment used to produce power from the gas emitting from garbage burial, introduction of the most proper commercial generating engines installable over urban garbage burial.

**D: Economic Studies**

At this stage, based on the findings achieved at the feasibility study stage, the economic aspects of using biogas collection networks for the purpose of power generation were studied.

**E: Conceptual Design**

At the stage of designing gas transfer lines linking 10 devices to the power plant, Voltage amplification station, central torch for burning redundant gases, general process of gas refinement, building where generator is located and where installation damages are dealt with, electric protection terminal, and power plant-network link were designed.

Now, the executive operation of the project is in process and the project will be ready for exploitation by 2015.

C: Assessment of Potential and Feasibility Study of Urban Solid Wastes and Establishment of 10 Power Plant Operating on Waste-Based Fuels

The project which is being executed across the country, seeks the following goals [5]:

A: Assessment of the potential of urban solid waste sources in different cities (cities with population of more than 250000)

B: Primary feasibility study of 20 sites, prioritizing and selection of 10 superior sites, selection and design of two power plants with two different technologies to set up 10-megawatt power plant in two cities.

C: Study various energy production technologies and selection of the most proper technologies that suites native conditions and factors best.

D: Carrying out economic and environmental studies to establish two power plants

**F: Establishment and Running of Electricity Production Power House from the Gas Produced at Burying Places in Mashhad City in Capacity of 600 KW**

**G: Establishment and Running of Electricity Production Power House from the Gas Produced at Burying Places in Shiraz City in Capacity of 1000 KW**

**H: Establishment and Running of Tehran Sewage Refinery in Capacity of 4800 KW**

**I: Execution of Two 6-Megawatt Power Plants Operating on Waste-Based Fuels in Mazandaran Province**
This project now is in process.

**J: Execution of Waste Water Treatment Center in the North of Isfahan with the Capacity of 1 megawatt**
This project now is in process**.**

**K: Execution of a 3-Megawatt Power Plant Operating on Waste-Based Fuel in Tehran**
This project now is in process.

**L: Execution of a 2-Megawatt Digestive Power Plant in Tehran**
This project now is in process.

## 3. Wind Energy

Human's abundant need to energy resources has always been a fundamental and important issue of life and trying to achieve an unlimited source of energy has long been a desire of human. The engraved pictures of the cave walls can imply that the primeval man could use his muscular energy as a mechanical source. However, since this force is limited and feeble, human has always sought in his imaginations for an infinite source of energy accessible anytime and anywhere. This can be found in various stories made up by primitive human's mind and imagination. Gradually, with the improvement of civilization, wood, charcoal, oil and gas entered energy market. However, due to the daily increasing demand for energy and due to the limited fossil resources, and because of daily increasing environmental pollution caused as a consequence of burning such energies, making use of recyclable energies is becoming more significant. Wind energy is one of the main recyclable energies on which human have been focused for long so that he has always sought to use this energy industrially. Human has used wind energy to drive arks, sailboats and mills. Under current conditions and compared with other novel sources of energy, wind is much more cost effective and being able to use this energy seems vital. In Iran, there are proper potentials to install and set up turbines that operate with wind energy and taking the study findings into account and with regard to the investments that have been made in this domain, application and development of this technology seems promising to the policy makers.

### Situation of Wind Energy in Iran

Altogether the situation of Wind Energy in Iran can evaluated from four viewpoints.

### A: Established Plants

Based on statistics obtained from Iranian New Energies Organization the situation of established plants in Iran are as Table 3 [5]:

**Table 3. Situation of Established Plants in Iran**

| Power plant location | Capacity of power plant | Number of Turbines | Kind of turbine |
|---|---|---|---|
| Manjil | 61.18 MW | 111 Turbines | From 300 to 660 KW |
| Binalood | 28.34 MW | 43 Turbines | 660 KW |
| Ovn Ebne Ali Tabriz | 1.98 MW | 3 Turbines | 660 KW |
| Baba Kohi Shiraz | 0.66 MW | 1 Turbines | 660 KW |
| Lootak Zabol | 0.66 MW | 1 Turbines | 660 KW |
| Mahshahr | 0.66 MW | 1 Turbines | 660 KW |

### B: Under Establishing Plants

Based on obtained information from New Energies Organization currently 35 mega watt plant are establishing in different places of Iran and used turbines in these plants oftenly are 550 KW turbines and the most of these turbines are establishing in Manjil area [3].

### C: Planned Plants for Establishing

A 1000 mega watt plant that Mapna company (private sector) intends to establish.

A 5000 mega watt plant that Hesa company (private sector) intends to establish.

A 400 mega watt that New Energies Organization intends to establish [5].

### D: Researched Projects and Under – Research Projects

### Providing Wind Map

In 2002 Iranian New Energies Organization execute National project for potential measurement and providing wide atlas of country. This atlas has several usages in different industries such as metropolitan planning's, agriculture, environment, etc.

The main purpose of providing the wind atlas of country in power ministry is recognizing windy areas and distinguishing them from low wind and inappropriate areas for wind turbines or establishing and using wind plants.

The summary of operated action during this project includes [5]:

- providing zero edition map by using global meteorologic information
- installing wide measuring stations with irregular dispersion in country's area and obtaining and analyzing information
- analyzing obtained information from wide measurement stations by computer software's
- providing new edition (phase one) of country's wide atlas (fig 1)
- providing new edition (phase one) of country's wide atlas (fig 2)

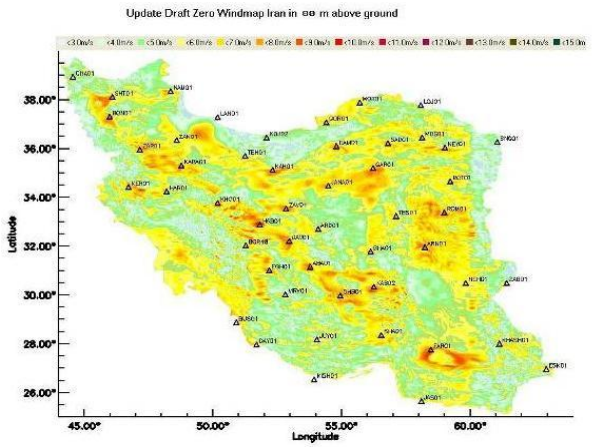


**Figure 3. Zero Edition of Iran Wind Atlas**

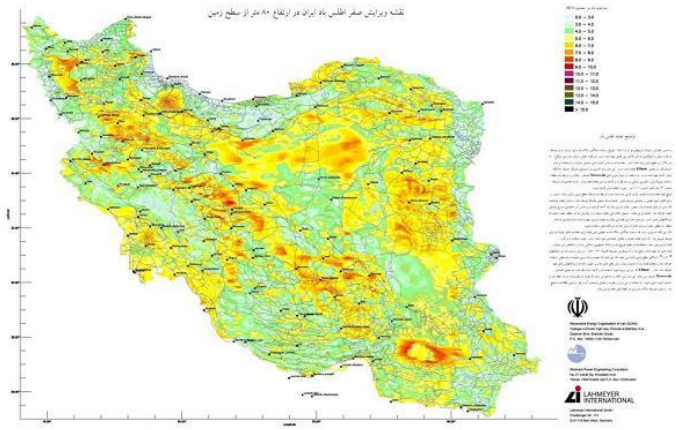

**Figure 4. First Edition of Iran Wind Atlas**

**Design and Manufacturing 600 KW Wind Turbine**

In this project in first stage, the research was operated for selecting site that according to available information and by research on the wind statistics of metrology organization, Manjil area considered for executing project and finally by field studies and considering ownership problems of land a point in the proximity of Babaeean village of Manjil selected for installing turbine [5].

Then design of several parts of turbine operated by designer institute and the technical specifications of parts identified and it specified that which parts should provide in Iran and which parts should provide in outsider and in the next stage concurrent action for providing and manufacturing of parts was started.


**Figure 5. An Image of Designed and Manufactured Turbine**

The main specifications of manufactured turbine are as follows

- 3 blades with 19.1 meters length from fiber glass material
- Helical gearbox additive type
- Asynchronous generator، double state، 690 volt ، 50 Hz
- Conical 42 meters tower

**Design, Manufacturing and Installation of Sahand of Tabriz 10 KW's Turbine**

This project was a research and executed in the Sahand of Tabriz industrial university, and it used in order to providing necessary energy for illumination of projector (fig 4).

Development of technology of manufacturing wind Turbines in Iran and operating basic research in wind turbines field are the result of this project [5].

**Figure 5. An Image of Manufactured Turbine in Sahand of Tabriz Industrial University**

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