

# Development of wind power plant technology using engines driving innovation in Iran

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## Abstract

Today, all over the world energy-related topics are followed with more sensitivity than in the past it is possible. The environmental consequences of fossil fuels and their limitation are two main problems that the world is facing it. One of the ways to reduce dependence on fossil energies is the development of renewable energies, one of the most important types of which for Iran is wind energy. The main goal of this article is to explain the development process of wind power plant technology based on the innovation system model technological and driving engines of innovation. In this regard by using the method of historical analysis of events and semi-structured interviews causal links between the functions of the technological innovation system or the same engines driving the innovation of wind power plants have been extracted in Iran. Then with the help of questionnaire survey and structural equation modeling the relationships between the innovation driving engines of wind power plants in Iran have been validated and these innovation engines have been presented.

key words: Wind power plants, technological innovation system, innovation driving engines, renewable energies, fossil fuels

## Introduction

Today, all over the world, energy-related topics are followed with more sensitivity than in the past in all economic, political and energy security dimensions. The importance of these topics is increasing day by day it is increasing and related studies have a special strategic necessity for all countries. The main reason for this is that energy is the main axis of development and progress of human societies and the rational development of these societies will be impossible without energy. A look at the problems of the past shows that the development of exploitation of fossil fuels in the short and long term has problems such as instability in energy sources and destructive environmental effects, as a result of which the move towards renewable energies has become definite and necessary.

Iran is one of the countries that has history and relative ability in production and development wind power plants. The significant point is that the experience of different countries shows that success in wind power plants is not a matter of following a single policy or mechanical copying of the experience of other countries, but there are several strategies to achieve this goal. Therefore, the formation of an industry based on the development of indigenous technology in each country requires a precise policy in that industry. The first step

for proper and quality policy is to explain the current state of the technology development process. Until now, many specialists have used the framework of the technological innovation system to policy the development of technology, especially renewable energy technology. Therefore, according to the approach of the technological innovation system, one of the first steps for formulating policies suitable for the development of a technological field is to identify functions that are of high importance in the development of technology have, and the extraction of causal loops is the function of the development of that technology in the country. Therefore, the main purpose of this article is to answer the question that the relationship between the technology development functions of power plants.

what is Badi in Iran based on the model of engines driving innovation? To answer the research question, first with wind power plants and the relationship of functions affecting the development of technology were described qualitatively, and in the continuation of these relationships it was slightly tested and validated. In fact, based on these causal relationships between functions It is possible to analyze the formation of the technological innovation system of wind power plants in Iran and some approaches provided for the development of this technology.

## Driving engines of innovation

### 1- Engine driving science and technology

The driving engine of science and technology with the aim of expanding theoretical knowledge about technology from every dimension. Feasibility knowledge, market knowledge, technical knowledge and managerial knowledge.

### 2-The driving engine of entrepreneurship

The goal of the entrepreneurial engine is to intensify the volume of entrepreneurial activities It will be done in the development of emerging technology.

### 3- Engine driving structure creation

This engine aims to create a coherent and integrated structure for the development of technology bringing opportunities for big plans to change the direction of the system's growth dependence and central project should be taken out and the development of technology in the general sense should be targeted.

### 4- Market driving engine

The goal pursued in this engine is to place the technological innovation system of a technology as part of the existing systems.

## Historical analysis of events and extraction of the drivers of innovation of wind power plants

To identify causal and causal loops, one of the ways is to relate data to ideas and use pattern matching as suggested by Campbell, in which several pieces of information in a historical study are linked to a theoretical idea. In fact, by identifying patterns repetition of existing information can be presented as patterns in theory. This method systematically analyzes the events that happened during a historical period alongside each other and in this way helps to discover patterns in the occurrence of events. One of the steps in describing the technology development process is to identify the events that occurred in a country to develop technology. which is done in this research using historical analysis.

### Technological innovation system of wind power plants in Iran (2003-1999)

In this period of the process of forming the technological innovation system of bad, activities have started continued But doing scattered and parallel activities and lack of coordination between organizations led to the failure of many activities. Among the organizations involved in the development process technology, the Atomic Energy Organization surpassed the rest. During a relatively short period of time, this organization managed to provide the preparations for the construction of a turbine factory by the private sector and bring the world's knowledge in turbine manufacturing into the country. Based on these activities, a primary market for turbines made by this factory was also created in the country. Also, the supply chain of turbine parts was formed in the country and companies were engaged in manufacturing these turbine parts. The Ministry of Energy started extensive studies to compile the country's wind atlas. It also defined the wind farm project.

### Emergence of wind power plants in Iran

Humans have used wind energy in different ways since ancient times. Iranians were the first to use windmills to grind grains in about 200 years before Christ, the traces of which can be seen today in the areas of Khaf and Taibad in the east of the country. Also, the ancient Egyptians used wind power to propel their ships on the Nile River, and in the 17th century, the Dutch people took a big step in this direction by improving the basic design of windmills. Early wind energy was used in the form of windmills to mill wheat and Corn, pumping water and cutting trees have been used and today wind energy is often used in electricity production using wind turbines. The first wind turbines were built at the beginning of the 20th century and the most a Wind turbines convert the kinetic energy of the wind into mechanical power, and this mechanical power is transferred to the generator through the shaft and finally electrical energy is produced. Wind turbines work on a simple principle; The wind energy rotates the two or three blades that are placed around the wind turbine rotor and is produced by the electricity

generator. Turbines are divided into two categories, turbines with vertical rotation axis and turbines with horizontal rotation axis. It should be said that turbines with horizontal rotation axis are more useful. Countries in this field are Germany, Italy, America, Denmark and India.

## Advantages of wind power plant

### 1-Economic growth

Wind power is a purely domestic resource that boosts the economic growth of a country. In 2021, in the United States, wind turbines operating in all 50 states produced more than 9% of the country's total net energy. That same year, investment in new wind projects added \$20 billion to the US economy.

### 2- Environmental efficiency

Wind power is a clean and renewable energy source. Wind turbines harness wind energy using mechanical power to turn a generator and create electricity. Not only is wind an abundant and inexhaustible resource, it also provides electricity without burning any fuel or polluting the air. Wind remains the largest source of renewable energy, helping to reduce our reliance on fossil fuels. Wind energy helps prevent the emission of 329 million tons of carbon dioxide per year the equivalent of 71 million cars' worth of greenhouse gas emissions, which, along with other atmospheric emissions, cause acid rain, smog and greenhouse gases.

### 3- Affordability

Land-scale wind turbines provide one of the cheapest sources of energy available today. In addition, the cost competitiveness of wind energy continues to improve with advances in wind energy science and technology.

Wind turbines work in different configurations. Wind power generation is well suited in agricultural landscapes and multi-purpose work. Wind energy is easily integrated in rural or remote areas, such as farms or coastal and island areas, where high-quality wind resources are often found.

## Disadvantages and challenges of wind power plants

### 1-The problem of the location of the power plant

Ideal wind sites are often in remote locations. Installation challenges must be overcome to bring electricity from wind farms to urban areas, where it is needed to meet demand. Upgrading the country's transmission network to connect areas with abundant wind resources to population centers can significantly reduce the costs of land-based wind energy development. In addition, offshore wind energy transmission and grid connection capabilities are improving.

## 2-Sound and visual pollution

Turbines produce noise and change the visual beauty. Wind farms have different environmental impacts than conventional power plants, but there are similar concerns about both the noise produced by the turbine blades and the visual impact on the landscape.

## 3-Environmental challenges

Wind turbines can affect local wildlife. Although wind projects rank lower in terms of wildlife impacts than other energy developments, research is still needed to minimize wind-wildlife interactions. Advances in technology, proper siting of wind farms, and ongoing environmental research are working to reduce the impact of wind turbines on wildlife.

## Wind energy capacity in Iran

Iran, with an area of 1648,195 square kilometers and vast coastal areas in the north and south, has a lot of potential to exploit wind energy.

Iran's potential for using wind energy is estimated to be more than one hundred thousand megawatts (100 gigawatts).

According to the Renewable Energy and Electricity Utilization Organization (SATBA):

The eastern and southeastern regions have a desert climate with significant temperature changes during the day. In order to be able to use the available wind resources for electricity generation, the existence of reliable wind information regarding the wind potential of the target area is necessary for the construction of a wind power plant. In Iran, due to the presence of windy areas, there is a suitable platform for expanding the use of wind turbines. One of the most important projects carried out in the field of wind energy has been the preparation of the wind atlas of the country. According to the wind atlas prepared and based on the information received from 60 stations in different regions of the country, the nominal capacity of the sites is around 60,000 megawatts. Based on the forecasts, the country's economically exploitable wind energy is estimated at 18,000 megawatts, which proves the significant potential of the country in the field of building wind power plants, as well as the economic value of investing in the wind energy industry. Germany's Lameyer company also cooperated as a consultant in carrying out the wind potential measurement project in Iran, and based on the studies of the mentioned company, the exploitable wind potential in the country has been estimated at around 100,000 megawatts.

## Conclusion

One of the renewable energy technologies that should be taken into consideration considering Iran's conditions as well as domestic capabilities is wind power plants. In this article, an attempt was made to examine the development process of wind power plant technology in Iran. It can be said that the wind power plants in Iran are based on the driving engine of innovation that is developed. The degree of legitimacy of renewable energy and especially wind energy is an established and accepted thing for developed countries, while the use of renewable energy in developing countries with point reserves, considering the price of renewable energy technology compared to fossil fuels, is unjustified and therefore the function Legitimacy is very important and can be the beginning of technology development. On the other hand, the nature of some of the functions of the technology development system, including the function of production and development, and the explanation of the technology development process using engines that drive knowledge innovation, due to the historical backwardness in Iran, are changed to the function of technology acquisition. In fact, according to these facts and differences and the dynamics of the driving engine of wind power innovation in Iran, it is possible to design and implement appropriate policies to strengthen the links that lead to the development of this technology in the country. Therefore, in the future studies, it is necessary to draw the direction and the desired vision of this type of power plants for the country, and using analytical tools, strategies and policies to achieve the desired situation are formulated and the action plan for the development of technology is placed on the country's agenda.

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