

Privatization of the Electricity Sector in Afghanistan and Its Effects on Reducing Losses and Energy Prices in the Market

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Abstract: Privatization is one of the measures that the government must implement to reform its economy and administrative system. The development of society has always been accompanied by an increase in demand for electricity. One of the characteristics of a competitive market is the lack of power of market managers to exploit demand fluctuations. In countries where the electricity sector has been privatized, the supply and the bid price of electricity are competitive among suppliers. Electricity manufacturers and suppliers must have a high degree of energy quality in order to be highly reliable in a competitive electricity market. The main purpose of privatizing the electricity sector is to combat undesirable monopolies because imposing the power of a company disrupts a competitive environment in the market. In this article, the necessity and benefits of privatization of the electricity sector in the country and a practical method that in a competitive market, the amount of waste and energy prices are significantly reduced. By privatizing the electricity sector, we can manage the critical situation of the country's energy sector. If the electricity industry is monopolized by the Afghan government, it will not be possible to respond to the needs of society with good quality and reasonable and low prices, and the productivity in this industry will be lower than expected. By carrying out the restructuring of Breshna company, separating Breshna company into three major productions, transmission and distribution companies, creating competition in production and supply, free access, increasing and improving economic productivity in various sectors of the electricity industry, security of supply, reducing losses, consumption management, reducing the cost price, optimal use of financial resources, the balance between income and expenses, increasing the quality of services, developing technology, protecting the environment and the possibility of sustainable development of this industry will be realized.

Keywords: Competitive Electricity Market, Privatization of Electricity Sector, Healthy Competitive Environment, Energy Quality, Fight Against Monopoly

1. Introduction

Privatization is the process by which private institutions become more active. This process is typically accompanied by the breaking of state monopolies [1].

Privatization in the electricity industry in order to encourage the private sector to invest in this area and also the move of governments to the transfer of state property of generating and operating companies to private companies and privatization can be a kind of restructuring in the

electricity industry and exploitation of this industry. It was considered as a non-traditional system. Privatization is successful if it has two basic presuppositions and backgrounds, which are: [2].

- A. Existence of a free and fully competitive market.
- B. The voluntary search and participation of the people in order to address the management and ownership of various industrial sectors and the specialization of

bedding is appropriate, and if this bed is not provided, privatization will also face many problems and failures. The most important conditions of these conditions are the existence of free competition and the absence of a monopoly market [3].

The strategic privatization is the economic, social, and cultural development of the country, the elimination of monopolies, and the expansion of competition. Prerequisites such as improving private ownership, restructuring companies, liberalizing prices, regulating and reforming rules and regulations, freedom to enter and exit the market, reforming the financial structure and reforming the labor market are among the requirements of privatization [4].

Sustainable electricity supply is one of the challenges that the Afghan government has not yet overcome. Over the past two decades, the Afghan government has imported electricity from neighboring countries at low prices. For this reason, less attention has been paid to domestic resources and electricity production in the country [5].

Afghanistan's electricity industry has been in a state of monopoly for decades, and electricity consumers need to buy electricity from Afghanistan Breshna Company to buy electricity. In their country, it has a monopoly on electricity supply. Simultaneously with the production and import of electric energy, this company is responsible for its transfer from stations to load centers and distribution of energy among applicants [6-15].

Breshna's monopoly status reduces private sector investment, reduces incentives for efficient operation, and generally uneconomical and unsuitable performance in the generation, transmission, and distribution of electricity. Another factor is Breshna's lack of attention to domestic electricity production and reliance on electricity imported from neighboring countries. The people in charge of this sector in the management ranks considered the reliance on imported electricity as booty and did not make any effort to increase the domestic production capacity. The company's dependence on ministries and different regulated prices in most provinces, in turn, is the source of some of the problems and inefficiencies. Even energy prices in different provinces have different prices [7].

Given the above-mentioned problems of the energy sector in the country, a company alone cannot control everything properly, even in a country like Afghanistan, which is under severe security, economic and political pressures. The above can be measured by the level of people's satisfaction. The goal of profitability is to create the right of choice for customers, to provide investment conditions for national and international investors, transparency of costs, with the aim of making more rational planning of network and electricity development, price disclosure, with the aim of realizing rates [8-20]. Compensation for the lack of government resources for investment, compliance with international law, regional conditions and trusts, government decision-making and separation of governance activities from approval, creating

stable conditions in terms of reliability or electricity rates, development of public property Through the participation of shares in the companies of the electricity sector, the use of the resources obtained from the transfer to other sectors of the government [9]. The goal of privatization in the electricity industry is to increase utilization, achieve lower prices and provide better consumer services through enhanced competition [10]. Usually, the three goals of economic efficiency, equality and freedom for consumer consumption are the reasons for creating the electricity market, in addition to creating jobs for people.

The goals for privatization are summarized as follows [11]:

- 1) Reduce production costs by increasing productivity and advancement in the manufacturing industry.
- 2) Compensate for insufficient investment and attract more capital.
- 3) Reduce energy losses.
- 4) Increase innovation.
- 5) Generate more electricity.
- 6) Create more production capacity.
- 7) Ability to select more manufacturers freely by customers.
- 8) Provide reliable electricity.
- 9) Improving the quality of production and development of services for a wider segment of people in different regions and geographies.
- 10) Reducing the role of government in monopolizing rates and managing the electricity industry.
- 11) Increase social welfare.

Given that the increasing use of electricity in various economic and social activities has become an important issue and access to a prosperous life without electricity is difficult, so the sustainable supply and quality of electricity, a key role in the movement and progress It has various economic and social welfare dimensions. On the other hand, continuous and reliable supply of electricity requires domestic and foreign investment to upgrade capacity and improve the quality of operation. Therefore, to achieve this important demand, the electricity sector must be produced to create healthy competition and provide quality and cheap services. Private suppliers and suppliers. With the privatization of the electricity industry, generating companies will compete with each other for a healthy market in a competitive market, which is called the power exchange market. Therefore, in a competitive market, it is certain that the participants seek to gain more benefits, and in addition to their activities, they also pay special attention to the activities of other participants and determine their strategy based on the performance of their competitors. In this paper, using theoretical competition in the market, an attempt has been made to model a competitive market in the electricity sector and achieve a reasonable energy price by considering electricity generation and transmission systems and a suitable method for offering energy prices to share. Offered in the market. The entry of the private sector into the electricity industry can be through the simultaneous

expansion of hydropower plants, thermal power plants and electricity generation from renewable sources, reduction of electricity waste, price reform and digitalization of networks [12].

In the current situation where the private sector also needs guarantees and regulations to enter and participate in the electricity sector, therefore, encouraging investors and guaranteeing their capital seems necessary and inevitable.

2. Research Methodology

The present research is analytical-descriptive. Because the purpose of this research is to do a practical analysis of the current situation in the Afghan electricity sector and analyze them based on the purpose of the research. This research is applied in terms of the purpose of the research.

3. Electricity Market Structure

It is clear that the electricity market depends on a highly competitive outcome in the electricity industry. Which all customer providers and vice versa have access to. Customers can easily get electricity from any manufacturer that needs it. To avoid disputes between providers and technical constraints such as lane overload, power loss allocation and proper management of support services, and service providers should be connected and accepted by the Ministry of Energy and Water's Electricity Services Regulatory Authority. Your request to set up an electricity service provider. The structure of competition is such that in order to prevent a decrease or increase in production capacity per hour relative to demand, it acts as follows [13].

On the demand side, large consumers, such as major industries, provide the Department of Electricity Services as the market organizer, estimating their required power per hour in the coming days, based on previous records of their power consumption and known variables such as heat. they give. The required power of urban consumers, whether household or otherwise, per hour, is also estimated by the distribution companies of the same city or region as the representative of consumers, and announced in advance to the Department of Electricity Services. Of course, this estimate is also based on the records of power consumption, temperature and other related variables such as day, week, hour, day off or not, etc. Is calculated and announced.

On the supply side, each unit from each individual station announces in advance a maximum ten-step list of bid prices for different supply quantities for each given day-hour, called the bid or supply mapping or supply curve.

The electricity market must be designed in such a way that, like other goods, electricity is produced and purchased by the consumer in the competitive environment of various companies. The reason for this is that the transmission network is a natural monopoly and the multiplicity of

transmission networks is uneconomical and unsuitable.

The government should follow the following steps to reform the electricity structure and privatize it:

- 1) Separation between production, transmission and distribution sectors.
- 2) Review regulatory rules and regulations.
- 3) Creating a competitive environment in which electricity is supplied and purchased.
- 4) Complete privatization.

4. Some Advantages of Electricity Market

- 1) Creating a healthy competition environment and preventing monopolies by a specific body.
- 2) Increase the quality of electricity.
- 3) Transparency of development costs for the expansion of the network and electricity facilities.
- 4) Contribute to investment deficits by the public sector.
- 5) Create a choice for customers.
- 6) Using the experiences of other countries that have made significant progress in the field of electricity industry by creating an electricity market.
- 7) Advances in technology and the possibility of decentralized energy production.
- 8) Favoring the ground for the construction of high-efficiency stations and reducing the price of energy production, which has made it possible to become competitive, while our country has a large amount of fossil energy and it is possible to build thermal power stations to generate electricity. Some stations in our country are self-sufficient in the field of electricity generation.
- 9) Companies have to provide better and cheaper services to maintain a competitive market.
- 10) Attracting domestic and foreign investment. With the creation of the electricity market, private companies have been encouraged to invest in the electricity industry and will undoubtedly make a significant contribution to the production of electricity and provide cheap, high-quality electricity to our people and industrial plants.

The electricity market consists of Energy sellers, energy buyers, head office and regulatory committee. They are sellers of national and international power companies and owners of power generation facilities, as well as national and international power companies [14-19].

Power plants are represented by the seller and the supply companies are represented by the buyer. The representative of the Electricity Services Regulation Department of the Ministry of Energy and Water is also a unit in order to create a suitable platform for conducting sales and purchasing operations, organizing information exchange and financial exchanges.

The center is also a unit for managing the country's electricity network and ensuring safe operating conditions.

Energy Services Regulatory Office Continuous monitoring of the implementation of laws in the best possible way and removing ambiguity and making decisions in unforeseen cases and formulating and communicating executive procedures and the procedure for determining damages and approving FIMA contracts between the representative of the Electricity Services Regulatory Department of the Ministry of Energy and Water. The center is responsible for buyers and sellers and the development of market efficiency indicators and monitoring of healthy and efficient market circulation and the development and proposal of market expansion and the proposal to amend or supplement the provisions of the law.

5. The Effects of Electricity Market on Power Losses

Due to the fact that losses in distribution networks have a larger amount compared to transmission networks, so its reduction is of great importance. Privatization of the electricity sector connects distributed generation resources to distribution systems. Which can have a positive or negative effect on the performance of the network. One of the positive effects of connecting distributed products to the network is to reduce the losses of the distribution system [15-17].

In the economic dimension of power systems, electrical waste is an important part that in general the cost of losses per kilowatt of electricity is considered equal to its consumption, but in special cases, for example in the transformer, the loss price of one kilowatt of electricity is different.

6. Calculate the Problem Using the Mathematical Formulas

In a competitive market, a manufacturer strives to maximize its profits by offering a price equivalent to its marginal cost. We show the cost function in the following general form:

$$C_n = a_n + b_n P_n + c_n P_n^2 \quad (1)$$

In the above formula:

C_n - N_m Generator production cost;

P_n - capacity of N_m generators;

c_n, b_n, a_n - Fixed coefficients.

Marginal costs include the costs of fuel, repair, maintenance, and other items that vary with the power generated by each generator. Now if it is derived from the above relation and $\frac{dC(P_n)}{dP_n}$

Consider the price of point (π) equal to the power of such a price Becomes:

$$p(\pi) = \frac{1}{2c}(\pi - b) \quad (2)$$

Or the price is based on the power produced as follows:

$$p(\pi) = 2cP + b = CP + b \quad (3)$$

Equation (3) The price proposition equation is based on the marginal cost to a producer. In practice, loading a generator is much more complicated than what can be achieved by using the above equations, taking into account the marginal cost as a selling price.

for example, P^{\max} Is the maximum power that a generator can produce, in this case according to what was said above if

$\left. \frac{dC(P_n)}{dP_n} \right|_{P^{\max}} \leq \pi$ so, the generator must always produce P^{\max} .

On the other hand, if the minimum sustainable production of this generator is as follows:

$$\left. \frac{dC(P_n)}{dP_n} \right|_{P^{\min}} > \pi \quad (4)$$

In this case, the above generator cannot reach a profitable production at this price, as a result of which the work of the above generator must be stopped.

So, manufacturers do not decide based on the comparison between the market price and the marginal cost of producing the electricity they sell, because if the activity of a generator is such that its marginal cost is equal to the market price, Reaching the stage of obtaining the contents of the generator will not guarantee. Suppose a manufacturing company has signed a contract to supply a capacity equivalent to L MW and wants to supply this amount of power with its N generator. It is clear that the company is trying to produce this amount of power at a minimum cost. So, the price area function and its definition area are presented as follows:

$$\begin{aligned} \text{Subject To } & \sum_{i=1}^N P_i = L \\ \text{Min } & \sum_{i=1}^N C_i(P_i) \end{aligned} \quad (5)$$

where in P_i Generation of n_m generator and $C_i(P_i)$ The amount of production cost is this amount of power. The formation of the Lagrange function \mathcal{L} , which combines the objective function and constraints, is the easiest way to solve the above function. So, we have that:

$$C_i(P_i) + \lambda(L - \sum_{i=1}^N P_i) \quad (6)$$

$$\mathcal{L}(P_1, P_2, \dots, P_N, \lambda) = \sum_{i=1}^N C_i(P_i) + \lambda(L - \sum_{i=1}^N P_i) \quad (7)$$

In the above equations is the Lagrange coefficient. If we derive the LaGrange function and set it to zero, then we have:

$$\frac{\partial \mathcal{L}}{\partial P_i} = \frac{dC_i}{dP_i} - \lambda = 0 \quad (8)$$

$$\frac{\partial \mathcal{L}}{\partial P_i} = (L - \sum_{i=1}^N P_i) = 0 \quad (9)$$

From the above conditions, we conclude that all generators must be operated at a margin cost, and this margin cost is equal to the value of the Lagrange coefficient.

$$\frac{dC_1}{dP_1} = \frac{dC_2}{dP_2} = \dots = \frac{dC_N}{dP_N} = \lambda \quad (10)$$

Therefore, the LaGrange coefficient is equal to the production cost of one megawatt hour of each generator produced.

When losses in the transmission network are taken into account, the price of electricity will depend on how many times the power is injected into or taken from it. If we consider the resistance of the transmission line as R and ignore the effect of the passing reactive power, we can write the line losses as follows:

$$P_{Loss} = \delta T^2 \quad (11)$$

Where the (T) power passing through the transmission line and $\delta = \frac{R}{V^2}$ The line loss coefficient is. Instead of dealing with production and load separately, it is better to consider net power injection at each node or node. If the net injection in the coefficient node.

Line losses. Instead of dealing with production and load separately, it is better to consider net power injection at each node or node.

If net injection in the node (K) Show with P_{IK} So, we have:

$$P_{IK} = P_{GK} - P_{DK} \quad (12)$$

In the above relationship:

P_{GK} - Generating capacity of generators.

P_{DK} - The power required by consumers is in node K.

If both generators and consumers are connected to a specific node, this net injection is positive if the field output exceeds the demand, and it will be negative when the opposite is true. In each node, a function $W_K(P_{IK})$ We define that if it is negative, equal to the contents of the consumers in the node Node K is the net injection P_{IK} and if it is positive, it is negatively equal to the cost of producing this net

injection. By adding this function to all nodes of a network we have:

$$W = \sum_{k=1}^n W_k(P_{IK}) \quad (13)$$

According to the above definition, you can select function (13) to get the maximum net injection power.

$$Max_{P_{IK}}(w) = Max_{P_{IK}} \left[\sum_{K=1}^n W_K(P_{IK}) \right] \quad (14)$$

By solving the above function, we bring that:

$$\frac{\partial C_K}{\partial P_{IK}} = \frac{\partial C_n}{\partial P_{IK}} \left(1 - \frac{\partial f}{\partial P_{IK}} \right) = \pi \left(1 - \frac{\partial f}{\partial P_{IK}} \right) \quad (15)$$

7. The Effects of Privatization of the Electricity Sector on Energy Prices

Consider a situation where two companies, A and B, are competing for electricity supply. Assume that based on empirical research, the picture of the demand function at a given hour is as follows:

$$\pi = 100 - D \quad \$/MWh \quad (16)$$

D is the power consumption at this time. Suppose that Company A produces energy cheaper than Company B:

$$\begin{aligned} C_A &= 35P_A \quad \$ / h \\ C_B &= 45P_A \quad \$ / h \end{aligned} \quad (17)$$

We can describe and solve this problem mathematically. Because each company uses its output as a decision variable, the profit of each company is represented by the following relationships:

$$\begin{aligned} \Omega_A(P_A, P_B) &= \pi(D) \cdot P_A - C_A(P_A) \\ \Omega_B(P_A, P_B) &= \pi(D) \cdot P_B - C_B(P_B) \end{aligned} \quad (18)$$

By placing the values obtained from the equations (4-24) (4-25 in the equation) (4-30), (4-29), (28-28) we reach the reaction curves:

$$\begin{aligned} P_A &= \frac{1}{2}(65 - P_B) \\ P_B &= \frac{1}{2}(55 - P_A) \end{aligned} \quad (19)$$

By solving these two equations at the same time, we reach the same equilibrium that we obtained by forming Table 1.

Table 1. Description of Cournot (bipolar) competition in the above example market with two companies. The numbers inside each cell represent the following quantities.

		A Company production													
		5	10	15	20	25	30	35							
B Company production	5	10	275	15	500	20	675	25	800	30	875	35	900	40	875
		225	90	200	85	175	80	150	75	125	70	100	65	75	60
	10	15	250	20	450	25	600	30	700	35	750	40	750	45	700
		400	85	350	80	300	75	250	70	200	65	150	60	100	55
	15	20	225	25	400	30	525	35	600	40	625	45	600	50	525
		525	80	450	75	375	70	300	65	225	60	150	55	75	50
	20	25	200	30	350	35	450	40	500	45	500	50	450	55	350
		600	75	500	70	400	65	300	60	200	55	100	50	0	45
	25	30	175	35	300	40	375	45	400	50	375	55	300	60	175
		625	70	500	65	375	60	250	55	125	50	0	45	-125	40
	30	35	150	40	250	45	300	50	300	55	250	60	150	65	0
		600	65	450	60	300	55	150	50	0	45	-150	40	-300	35
	35	40	125	45	200	50	225	55	200	60	125	65	0	70	-175
		525	60	350	55	175	50	0	45	175	40	-350	35	-535	30

Table 2. The descriptive for Table 1 and the numbers in each cell represent the following quantities.

Benefit A =40	Demand =625
Price =225	Benefit B=60

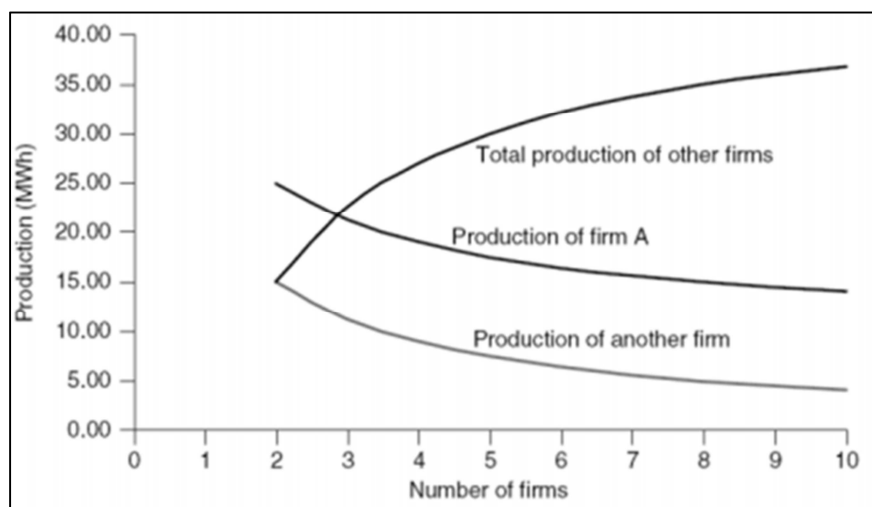
The above example provides an opportunity to examine the effects of increasing the number of competing companies in a market. For simplicity, consider a situation in which Company A competes against a growing number of competitors, all of whom are similar to Company B. An adaptation condition such as Equation (16) can be written for each of these companies, and this set of equations can be combined with the inverse relationship of demand (15) and an equation that represents the competition of all these companies in a market (18) Solved together:

$$D = P_A + P_B + \dots + P_N \quad (20)$$

N is the number of companies competing in this market. In this particular case, solving these equations is simple for any number of companies; Because companies B to N are the same and therefore have the same amount of production. Because the cost of generating electricity for Company A is lower than for other companies, it has a competitive advantage in this

market. Figure 1 shows that the production of company A is always higher than the production of other companies. Although its market share decreases as the number of companies increases, it does not tend to zero, unlike the individual share of other companies. Figure 2 shows that as the number of companies competing in the market increases, the market price decreases, even if the cost of new companies is the same as the cost of existing companies.

Of course, in this case, the price tends to \$40/MWh, which is equal to the production cost of companies B to N. This expanded competition has increased demand and thus benefited consumers. Also, this expanded competition, as shown in Figure 3, causes the profit of each company to decrease. Company A's profit is higher than the total profit of other companies due to its lower cost, and unlike the profit of companies that are at the bottom edge of competition, it does not tend to zero with the increase in the number of commercial competitors.

**Figure 1.** Changes in the production of a company, with increasing number of competitors.

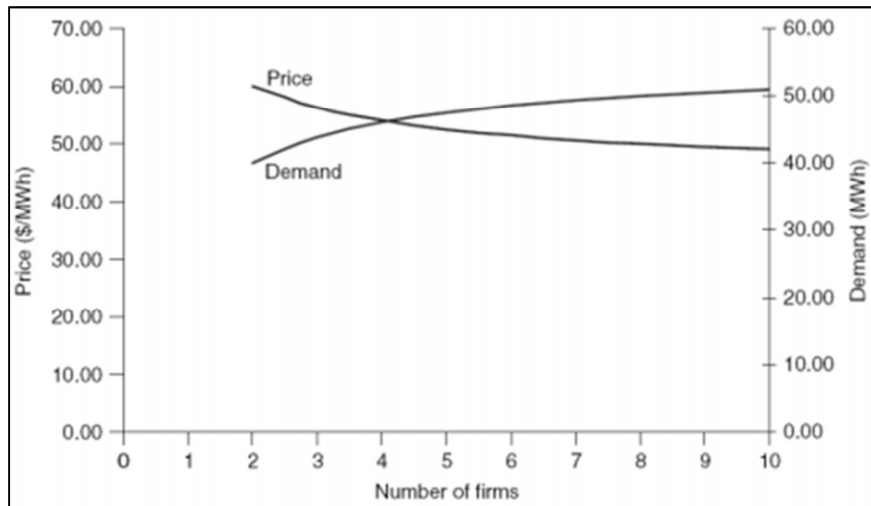


Figure 2. Price and demand changes as the number of competitors increases.

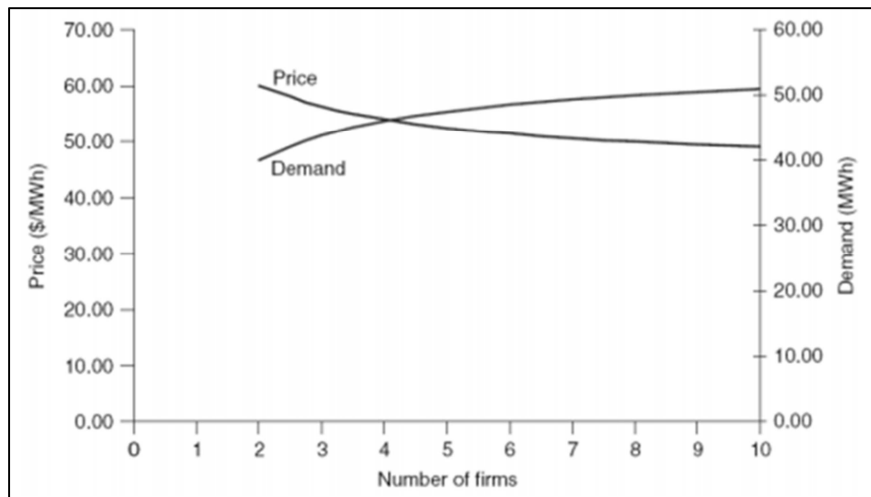


Figure 3. Changes in the profit of each company with increasing number of competitors.

In some cases, a manufacturing company with market power may decide to limit or even lower the market price. Such a solution may be adopted for the following reasons:

- 1) Willingness to increase or maintain market share.
- 2) Trying to discourage new players from entering the market.

Therefore, in addition to solving the above problems, the Department of Regulation of Energy Services and Regulations in the Electricity Market can create comprehensive programs for reforms in the country's electricity sector.

8. Conclusion and Recommendations

Today, Breshna Company, the largest monopolist in Afghanistan's electricity industry, has grown to a size that the private sector cannot compete with. The company has taken over all market segments. In such a way that the subscribers have no choice but this company and their electricity consumption is provided by Breshna (government) company and that company produces and

imports the electricity consumption of the subscribers to distribute it to the consumers through the transmission and distribution network. Rates and tariffs are set by Breshna itself. In a competitive system, in addition to the fact that consumers supply the company, the determinant, rates and sales tariffs, although essentially subject to certain rules, are ultimately determined by the market. This means that the rate of demand and supply of energy determines the final price. Cost rates for transmission and distribution network services will remain under government oversight and legislation. The results show that the electricity market affects energy prices.

With the privatization of the electricity sector, we can manage the critical situation of the country's energy sector and pay attention to the following:

- 1) Breshna Company cannot be the only risk for Afghanistan Electricity, but it can have the opportunity to provide services to the individual and by dividing the types of services and different markets, the company will deal with different parts of the company. Liquidity, productivity and productivity in the Afghan electricity industry.

- 2) One of the problems in developing a particular activity is the impossibility of operating jointly with foreign companies. Many Western and regional companies are willing to partner with Afghan companies in similar countries in Afghanistan, and with more government support, local companies could be involved.
- 3) The issue of new restructuring in Breshna Company by dividing it into three specialized parent companies and focusing on forming a specialized parent company for the production of thermal power plants and a specialized parent company for power distribution should be seriously on the agenda and legal obstacles to its realization should be removed.
- 4) We can reduce production costs and increase labor productivity by increasing the number of skilled and highly educated staff, and given that one of the goals of privatization is to reduce costs and improve performance, we can say that one of the benefits of privatization Improving human capital and consequently significantly improving the per capita production of employees.

It is expected that the solution of structural, legal and administrative problems such as customs, insurance and bank credits by the government will facilitate the competitive environment for our country's private companies in the country.

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