Feasibility Assessment of Distributed Energy Resources in Enshi Prefecture of Hubei Province

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Abstract. As distributed energy focused attention on energy security and saving policy in the world, its exploitation and utilization is appreciated much more than ever before in Hubei Province of China. This feasibility study addressed a special place—Enshi Prefecture of Hubei Province, which is the important base of Western Development Policy. We pay attention on the benefits of constructing small scale generation & distribution to lower carbon emissions and protect our environment. Combined with the region’s energy situation and structure, some ideas and guidance for the exploitation of distributed energy are proposed, which made an important reference to the development of this district.

Introduction

Energy resources are the basic materials for national economic development and human civilization. While investigating Jiangxi Province in February 2016, Jinping Xi, Chinese President emphasized on the importance of energy, he said “It is necessary to reform the structure of supply slide, make the dominant industry stronger, change the traditional industry faster, foster the new industries bigger, and upgrade industry structure pro-actively and initiatively”; The Committee of National Development and Reform released the document of No.392[2016], which pointed out that one of the basic principles of the current energy development is to deepen the reform of the energy system and construct the system of energy market for promoting supply-demand structure of energy and technology revolution. The “Twelfth-Five-Year Plan” of our country proposed that conservation priorities, diversified development and environmental protection are the essential factors of building a safer, stable economical, clean energy industry system. Distributed Energy Systems (DES) is the exact answer to meet the policy and consumers’ demand for a diversity of energy requirement[1-4]. Accordance with the principle of “counterparts of temperature, graded use of energy”, DES has a higher energy efficiency, less pollution of environment, better economic benefits and more security than traditional energy[5-6]. It is also in line with regional characteristics and energy supply and demand structure of Enshi Prefecture.

Tu'jia and Mao Autonomous Prefecture of Enshi is located in the southwest of Hubei Province. Its Longitude is from 108° 23’ to 110° 38’, and its latitude is from 29° 07’ to 31° 24’. It covers 24,061 square kilometers. It is the core area of ecological and cultural circle and attractive tourism of west Hubei Province. The climate has the character of subtropical
monsoon. Because of the complex terrain and height disparity, the geographical differences brings less coldness in winter and less hotness in summer than other place in Hubei Province, it is a bountiful place, which covered by forest up to nearly 70 percent. Enshi Prefecture enjoys many titles, such as "E Xi Linhai", "Drug Storehouse of Central China", "the kingdom of Tobacco", etc.

The Status Quo of Energy in Enshi State

Currently, abundant water resources are contained in this Prefecture. There are more than 60 rivers and streams, with a total drainage area of 21,801 square kilometers. The sum of water resources is up to 29.98 billion cubic meters, and the quantities of capacity is up to 3.491 million kilowatts, accounting for 10.6 percent of Hubei province. At present, it has 3.2 million for total installed capacity of hydro-power production, the amount of annual power generation reaches 9 billion degrees, and the annual output is about 3.0 billion RMB. Besides its abundant water resources, the mineral species are very rich. It has 150 billion cubic meters of natural gas to be proven and reserved. It also has the largest independent selenium deposits in the world, so Enshi Prefecture enjoys the reputation of “Capital of selenium.” There are more than 60 kinds of proven minerals, such as iron, coal, coal, natural gas, phosphorus and pyrite. The storage capacities of these minerals are very rich, for example, 1 billion tons of iron ore, 51.52 million tons pyrite, 1.178 billion tons of phosphate rock, etc. The locations of these kinds of minerals are closed to the cradle of coal and hydro-power resources, which provides a great convenience to these minerals for the exploitation and utilization.

Until the end of 2013, 5 projects about wind power generation in Enshi Prefecture have been completed and put into operation. A total investment of 2.4 billion RMB and 244,400 kilowatts of installed capacity make the online power output reaching 427 million degrees per year. At the same time, there are 33 wind turbines of Lichuanqiyue Hill to be lifted, which meant this district will earned the reputation of "The First Wind Farm of Central District of China.” In 2017, the total installed capacity of wind power will exceed 800,000 kilowatts. At the end of 2015, the wind industry has achieved the output value of 67.94 million RMB, and the total amount of natural gas earned No.1 in whole province of Hubei, the forefront development of hydro-power and solar power is in the ascendant which invested more than ten billion RMB in recent five years. This clean energy will inspire the new pillar industries, which brings to great benefit to industrial development mode for the district.

The development and utilization of new energy sources are on the pot in Enshi Prefecture. In recent years, Enshi Prefecture explores with bio-gas as a link to eco - cycle agricultural mode of "Pig – Marsh - industry". Until September of 2015, there are 33 stations about this subject have put into use, and 20 stations are under construction. The Clean Development Mechanism (CDM) has been approved by the United Nations, which named "Eco-village household of bio-gas station in Enshi." The method is to change the energy consumption mode of household use to improve energy efficiency constantly, which could reduce emissions intensity and promote economic development.

Current Energy Consumption of Enshi

Relying on the farmer-friendly policy of national power, Enshi Prefecture has made a breakthrough in the grid construction. It has completed a lot of projects, such as the construction
of rural power grids, the transmission of 500-kilo-volt power from village to village, the supply to electrics to railway traction power, etc. It has achieved some breakout gaps that the ability of generating power from the 220 kV to 500 kV, the structure from the decentralization to separation, the forms of contact from single to multiple, which made a big progress in this area. In accordance with unified arrangement by the commission and state government of Enshi Prefecture, Enshi Prefecture accelerated the construction of hydro-power, wind power, shale gas industry and other energy construction. At the end of 2014, the total power generating capacity is up to 4 million kilowatts. The main index and cities of energy consumption are as shown in table 1.

### Table 1. Energy consumption on main cities in Enshi Prefecture.

<table>
<thead>
<tr>
<th>counties</th>
<th>Energy exhausting of per GDP (ton/10 thousand RMB)</th>
<th>Reducing rate (%)</th>
<th>Electronic consuming of per GDP (KWH/10 thousand RMB)</th>
<th>Reducing rate (%)</th>
<th>Raw coal (ton)</th>
<th>Natural gas (ten thousand cubic meter)</th>
<th>Diesel fuel (ton)</th>
<th>Gasoline (ton)</th>
<th>Ten thousand (KWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enshi</td>
<td>1.1567</td>
<td>3.66</td>
<td>866.59</td>
<td>4.56</td>
<td>262197</td>
<td>405.32</td>
<td>4305</td>
<td>241</td>
<td>23411.81</td>
</tr>
<tr>
<td>Lichuan</td>
<td>0.9254</td>
<td>2.8</td>
<td>618.56</td>
<td>2.93</td>
<td>4171</td>
<td>214.6</td>
<td>0</td>
<td>0</td>
<td>5946.46</td>
</tr>
<tr>
<td>Jianshi</td>
<td>1.0111</td>
<td>2.53</td>
<td>725.45</td>
<td>3.87</td>
<td>520775</td>
<td>0</td>
<td>410</td>
<td>40</td>
<td>14256.33</td>
</tr>
<tr>
<td>Badong</td>
<td>0.9989</td>
<td>3</td>
<td>670.47</td>
<td>5.36</td>
<td>26025</td>
<td>0</td>
<td>258</td>
<td>281</td>
<td>7082.64</td>
</tr>
<tr>
<td>Xuanen</td>
<td>0.7009</td>
<td>2.52</td>
<td>458.9</td>
<td>-3.78</td>
<td>10662</td>
<td>4.85</td>
<td>706</td>
<td>31</td>
<td>4350.81</td>
</tr>
<tr>
<td>Xianfeng</td>
<td>1.0692</td>
<td>3.36</td>
<td>524.31</td>
<td>1.44</td>
<td>67257</td>
<td>0</td>
<td>5513</td>
<td>4151</td>
<td>16403.69</td>
</tr>
<tr>
<td>Laifeng</td>
<td>0.8633</td>
<td>2.8</td>
<td>557.71</td>
<td>1.74</td>
<td>82671</td>
<td>0</td>
<td>528</td>
<td>63</td>
<td>10455.44</td>
</tr>
<tr>
<td>Hefeng</td>
<td>0.7474</td>
<td>2.64</td>
<td>624.88</td>
<td>3.9</td>
<td>86168</td>
<td>0</td>
<td>357</td>
<td>129</td>
<td>19296.5</td>
</tr>
</tbody>
</table>

In recent years, the reduced rate of energy consumption in Enshi Prefecture is lower than the whole province of Hubei. In 2014, it reduced 3.66%(Table 1), which is faster than 3.33% over the year of 2013 and lower than the 5.24% of the whole province. It indicated that the energy structure and the efficiency of energy utility improved gradually.

### The Necessity and Feasibility of The Development of Distributed Energy

#### Environmental Protection and Energy Conservation, Essential Guarantee

Enshi Prefecture possesses plenty of clean energy, such as water, wind, solar, bio-energy, etc. Especially, the highlight is the clean air which makes the pollution is lower than other districts of Hubei Province. It is also an ideal place to develop folk custom and ecological tourism. But it changed in recent years. With the rapid development of economy and vigorous promotion of urbanization construction, environmental issues have become a heavy problem.

Although it has abundant natural resources, due to geographical factors, currently, the flux density of renewable energy in this state is very low and dispersed in different areas, which is inconvenient to supply energy centrally. DES is a benefit ways to solve the problems[7-8]. It concentrates each kind of energy sources and units together. When the common grid fails to generate power, it can take the initiative to disconnect from the utility grid, what could reduce the impact on other users. The security and reliability is higher than traditional energy resources.
On the other hand, the clean energy resources in DES could bring less polluted air and reduce the pressure of environment[9]. In the system of DES, natural gas, solar energy, geothermal energy, wind energy and other items are combined together, which provide some chances to use renewable resources and improve the environmental condition.

**Abundant Energy Sources, Safe Supply**

In this district, there has a ridge named Qiyueshan, which has 120 km length, and 3.5 km width. Hundreds of wind turbines were installed in the ridge, and the capacity amount to 195,100 kilowatts. Because of its big power generation, it earned a good reputation, named "The NO.1 wind farm in central district of China." Some other clean energy, such as solar energy, Shale gas is other kind of clean resources in Enshi Prefecture. It reserves about 5 trillion cubic meters of power, what provides a huge energy bonanza. Currently, the quantities of bio-gas and the total gas are also very rich, solar power is in the ascendant, it invested more than ten billion RMB to develop the new energy within five years, and these clean energy will constitute the new pillar industries of Enshi, and can benefit greatly for industrial development mode.

There are many energy projects were completed within these years. Some villages dig lots of digesters to accumulate the gas, which is also a good way to use trash reproducing some useful energy sources. In the villages of Dragon-phoenix and Baiguo, some farmers use farm litter to produce bio-gas, which is a wonderful way to solve living energy shortage and provide an implementation of “home-supply, free installation, metered payment.” The residue of bio-gas provides organic fertilizer to the fruits and vegetables. Pumping stations, irrigation pipe network and equipment of automated bio-gas fertilizer irrigation established a good base of circle for the purposes of low input, high output, low energy consumption, low emission, high energy demonstration[10]. Development of new energy also provided a strong upholder and a reliable guarantee for the local natural resources and environmental protection.

**Requirement of Market, Reliability of Economy**

Since different grade utilization of energy can be reached, different type of users combine electronics, heat, air-condition together according to their own needs, which make the energy efficiency reached more than 80 percent. Because of its benefit of low investment, high output, closing to the users’ equipment and convenient to energy delivery, the DES reduces one-time investment and costs dramatically.

According to a report, which is given by Prospect Industrial Research Institute, named 2013-2017 distributed energy industry of Chinese Market Outlook and Investment Strategy Planning Analysis. It pointed out that domestic natural gas distributed energy projects took capacity of about 5.4 million kilowatts, which have been completed and put into operation. The influence of the larger projects among them are: Beijing Olympic Media Village, Zhongguancun Science and Technology Park, Shanghai Pudong International Airport, the global international financial center, Beijing Gas Group Building, Shanghai Polytechnic University, Guangzhou University City, Hopes Group of blue green energy center in Sichuan of China, Changsha airport, etc. These success stories for exploiting distributed energy provide a valuable wealth of practical experience to Enshi Prefecture to develop distributed energy resources. Combining with the development and use of local clean energy, The DES is a good
solution to solve the problems about the instability of traditional energy supply to achieve security and reliability for energy utilization.

**Guidance by Government, Management Orderly**

Energy management policies and measures formulated by the government is an important guarantee to guide a healthy, ordered and rapid development of distributed energy stations. The government plays an irreplaceable role in the aspects of changing the traditional concept of energy, the adjustment of energy structure, etc. As the primary agent of energy management, the government would like to develop some series mechanisms to make energy management more efficiently, which stimulates other relevant departments to supervise and assist in the establishment of security, stability and sustainable development of energy management and monitoring systems. The specific structure is shown in Fig. 1.

![Figure 1. The Energy System of management and monitor.](image)

Enshi Prefecture is known as the "Golden place of plants and animals" and "Drug Storehouse of China." There are more than 80 percent of households use electricity and natural gas in urban, and more than 60 percent of rural households use bio-gas. In 2012, Comrade Li Keqiang did field research in this district. He required establish a low-carbon industrial park, which is included five sub-parks, so as to make the balance of economic development and low-carbon construction, and make a good example among Midwestern cities of China. According to the requirement of Central Government, Enshi Prefecture proposed "the development of low-carbon economy, establishing Enshi like paradise "as the objective of construction, and formulated the rule of *Implementation Opinions to create a low-carbon city*. The government of Enshi called the citizen for setting up “a beautiful, clean, ordered, quiet and peaceful state, which make life happier and more comfortable.”

In September of 2015, the Transportation Bureau of Enshi released a series of initiatives for "to promote ecological civilization, to build a beautiful prefecture", which aimed to build a strong green chassis. The government put forward some programs for the plan of "to save energy resources and protect the ecological environment is the necessary duty to every family member. In order to enhance the further awareness of residents to low-carbon environment, we propose to act now act from us act from trifles."

**Conclusion**

In this paper, we analyzed the characteristics and advantages of developing distributed energy in Enshi Prefecture. Combining with the local energy needs, we analyzed the necessity and feasibility of distributed energy exploitation from social, economic and environmental goals. It is essential not only to implement the western development strategy, but also to promote the
inherent requirements of the West Region and coordinated economic development. Currently, there are still a lot of problems on the development of distributed energy in this district. Government's guidance should like to be strengthened; economic development is still lagging industrial restructuring; the efficiency of utilization of energy needs lots of human capitals, rapid economic development also brings the pressure on ecological environment, etc. There still have a long distance to exploit and develop new energy resources. Therefore, it is necessary to define scientific concept of energy development actively, so as to encourage the development and use of new energy sources, to develop a low-carbon economy, to combine with local characteristics, to optimize the industrial structure, and to attract more talents, what are the better way to realize the construction of “paradise of Enshi.”

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