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An Assessment of the Modern Wind-Power Engineering Possibilities on Territory of the Taimyr, Dolgano-Nenets and Evenk Autonomous Districts of the Krasnoyarsk Kray

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In the given article we present the results of our research of the power energetic component of Taimyr and Evenkiya populated localities of the Krasnoyarsk Kray. On the basis of theoretical analysis of the obtained research results we suggest to construct untraditional and renewable sources of power in remote communities (URESOP). Besides, we have made a calculation of capital expenditures and economical efficiency of the wind-electric power stations.

Keywords: Taimyr, Evenkiya, the Siberian Federal University, URESOP, wind energetics, wind-electric power stations.

The northern territory of the Krasnoyarsk kray is a region rich in natural resources and minerals. The development of the local infrastructure will give possibilities to improve the living standards of the population including natives and increase volume of output from traditional activities.

Increasing the living standards of the population is possible at the cost of their involvement into the innovation activities and realization of modern innovative technologies in various fields. Uniting specialists of different professions allows realizing a skilful science and industry integration. The Siberian Federal University (SFU) is dealing with the task solution. A cooperation of SFU with the local territory administrations and financial and industrial groups will give an opportunity to carry on the innovation activities on the northern territory of the Krasnoyarsk kray with the maximum efficiency [1, 2].

A comprehensive analysis of population centers of Taimyr and Evenk autonomous districts of the Krasnoyarsk kray was carried out by employees and students of SFU. And there were identified basic problems and lines of their development [3].

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Table 1. Social and economic description of Essey, Nosok and Karaul

Settlement	Nosok, Karaul	Essey
Population	700	500
Fuel consumption, t/y	650	179,2
Diesel fuel price, Rubles/l	42,5	30,74
Electric power consumption volume, MW-hour	2 096,8	578,1
Winter on-peak demand, kW-hour	550	400
Sale price, Rub/kW-hour	20	20

There has been shown that the energetics is a basis for developing social and industrial structures of the northern settlements and involvement of the native people into the innovation activities.

There are plenty of population centers having decentralized power supply from local diesel engine power plants on the territory of Taimyr, Dolgano-nenets and Evenk autonomous districts of the Krasnoyarsk kray. The first cost of the power generation comprises 12 to 20 roubles per kilowatt-hour depending on settlement remoteness.

Information on the electric power consumption volume in 3 northern settlements of Evenk (Essey) and Taimyr (Nosok and Karaul) autonomous districts is presented in Table 1.

Using Unconventional and Renewable Energy Sources (URES) is a power efficient solution of the electric power supply to the remote settlements. It is the most perspective solution under the existing energy policy of the Russian Federation especially in settlements and industrial plants with the decentralized electric power supply. The URES usage is a power efficient solution utilizing local energy resources without periodical fuel delivery. On the northern territory of the Krasnoyarsk kray wind energy is the most perspective URES to be used.

The settlements in Table 1 are looked at as the most perspective to be in the first place equipped with wind-driven powerplants (WDPs) being implemented in the local decentralized power systems. There has been carried out analysis of different manufactures' WDPs. The preference has been given to those manufactured by Nordwind Energieanlagen GmbH Company [5].

Firstly, there was revealed that Nordwind's WDPs are realised with hydraulic rotational energy converter. This innovation technology allows reaching a higher output power compared to other manufacturers' WDPs of the same class. Secondly, the Nordwind Company develops WDPs suitable for the arctic climatic conditions with the temperature to –40ºC according to the manufacturer's data. The Nordwind's technology will give an opportunity to avoid the equipment being put out of action by low temperatures as it has happened to the WDP in the settlement Levinskie peski and arctic WDP in Vorkuta. Thirdly, the technology allows mounting and dismounting WDPs without using extra crane equipment. And finally, Nordwind is a relatively young and developing company and its pricing policy is rather liberal.

There has been calculated the capital expenditure and assessed economic implementation efficiency of the WDPs in Karaul, Nosok and Essey. From WDPs offered by Nordwind one suggests to use 3 WDPs NW 28-150 HY-D for settlements Nosok and Karaul and 3 WDPs NW 24-120 HY-D for Essey. Their specifications are presented in Table 2.

Table 2. Specifications of Nordwind's WDPs

WDP type	Nominal wind speed, m/s	Nominal power, kW	Tower height, m	Rotor diameter, m	Running voltage, kV	Line frequency, Hz
NW 24-120 HY-D	10,6	120	35	24	0,4	50
NW 28-150 HY-D	10,9	150	42	28	0,4	50

Table 3. Capital expenditures for building WDPs

Settlement	Essey	Karaul (Nosok)
Investments, rub.	68 251 894	79 245 022
Cost of equipment unit, rub. Cost of 3 WDPs, rub.	15 600 800 46 802 400	18 356 000 55 068 000
Custom clearance (5%), rub.	2 340 120	2 753 400,00
18% VAT, rub.	8 424 432	9 912 240,00
Cost of delivery to the area, rub.	3 600 000	3 600 000,00
Basement construction cost, rub.	2 340 120	2 753 340,00
Cost of erection works, rub.	2 340 120	2 753 340,00
Insurance, rub.	1 404 070	1 404 702,00
Designing, rub.	1 000 000	1 000 000,00

Table 4. Engineering-and-economical efficiency data of the WDP implementation

Settlement	Annual generation of electrical energy by WDPs, MW-hour	First cost of the electric power, Rub./kW-hour	Consumed diesel fuel equivalent, t
Essey	756,72	3,71	234,58
Karaul, Nosok	1 440	3,27	446,40

Technically the WDPs above are suitable for inland regions of low wind-energetic potential. Nosok and Karaul are situated close to each other, have similar characteristics of the wind-energetic potential and electric load. The WDPs for Essey were chosen taking into account a kindergarten and school being planned for putting into operation. Capital expenditures for building the wind-driven powerplants are presented in Table 3.

The expected generation of electrical energy by WDPs in the settlements above was determined according to the technique in paper [6]. The calculation was done taking into account the tower height for the surface roughness type "0" that corresponds to the local relief of the arctic desert [7]. The WDPs are suggested to be situated on an elevation at the distance of 150 to 200 m from a settlement. The WDPs are directly connected to the local power supply system. An extra substation is not planned to be built. The calculation results of the expected electrical energy generation are presented in Table 4.

There has been carried out the investment analysis of the WDP implementation taking into account all possible economic risks. The calculation was done on assumption that all electric power is

sold to the customer at the price of 20 rub./kW-hour. The profit tax rate is 20%. The real rate of return is 18.24 %.

The calculation of the real rate required was done at the following indicators:

– the refinancing interest rate of CB – 8 %;
– the annual inflation prediction – 8 %;
– the real risk-free rate, calculated on the Fisher formula – 0 %;
– the real risk-adjusted rate – 15 %

The real rate of return is figured out as a sum of the real risk-adjusted rate and the real risk-free rate and equals 15 %. The start-up moment of the WDPs in the local power-supply system is taken as a point of departure for the net present value (NPV) calculation. On the assumption of the results one can make a conclusion that the payback period of the WDPs in Nosok and Karaul will be 7 to 8 years and in Essey 12 to 13 years taking into account all possible financial risks. The project is profitable for the Krasnoyarsk kray administration since the WDPs implementation will allow reducing grants from the territorial budget for the diesel fuel purchase. Moreover the reduced rates will lead to the development of the local industry, that is, to the emergence of new tax bearers.

The project can be of interest to a private investor, too, especially if there will be support from the authorities. The payback period can be decreased to 5-6 years in Nosok and Karaul and 8-10 years in Essey. This is possible if there will be tax remissions or grants as well as the VAT recurrence for companies supporting the life level of the northern territory native population and implementing ecologically pure energetic URES-based industry. And it will be attractive for private investors upon the government support.

The project is innovative and has no analogues in the modern world power industry. This is caused by the region remoteness, severe climate, social and legislative aspects. The technological solutions of the industry have to be obtained by the cooperation of scientists, manufacturers, financiers, lawyers and social workers. Their joint effort will allow reaching the greatest power efficiency saving the culturological constituent of the ethnic population.

Conclusions

1. A comprehensive analysis of population centers of Taimyr and Evenk autonomous districts revealed 3 settlements as the most perspective for the modern wind-driven powerplants implementation. This will make it possible to improve the social and economical level of the population and contribute to the local industry development.

2. The project has low payback periods of 5 to 13 years. It becomes investment attractive in case of its support by the local and territorial administrations.

3. For the projects to be realised effectively and proffessionally and complex technological support to be organized one can recommend to create an association of enterprises and institutions based on the specialized technological platform of Siberian Federal University.

References

[1] *Верховец С. В., Кирко В. И., Кеуш А. В.* // Инновации. 2010. № 10. С. 1–5.

[2] *Кирко В. И., Копцева Н. П., Кеуш А. В.* // Journal of Siberian Federal University. Humanities & Social Sciences (2011 4). 8. 1127-1131.

[3] *Захарута В. В., Кирко В. И., Фаткулина Л. М.* // Journal of Siberian Federal University, Humanities & Social Sciences (2011 4). 8. 1127-1131.

[4] *Бобров А. В., Тремясов В.А., Чернышев Д. А.* // Инновации. 2009. № 3. С. 74–77.

[5] Information resource: http://www.nordwind-energieanlagen.de

[6] *Бобров А. В., Тремясов В.А.* // Пролемы энергетики. 2008. № 9-10/1. С. 36–42.

[7] Старков Н., Ландсберг Л. Атлас ветров России. М.: «Mojaisk-Terra», 2000. 560 с.

Оценка возможностей современной ветроэнергетики на территории Таймырского (Долгано-Ненецкого) и Эвенкийского муниципальных районов Красноярского края

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В статье изложены результаты исследования энергетической составляющей населенных пунктов Таймыра и Эвенкии Красноярского края. На основе теоретического анализа полученных исследований предложена установка в удаленных населенных пунктах нетрадиционных и возобновляемых источников энергии (НВИЭ). Проведен расчет капитальных затрат и экономической эффективности ветроэнергетических установок.

Ключевые слова: Таймыр, Эвенкия, Сибирский федеральный университет, НВИЭ, ветроэнергетика, ветроэнергетические установки.