



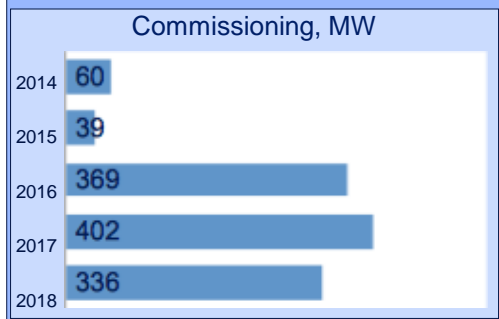
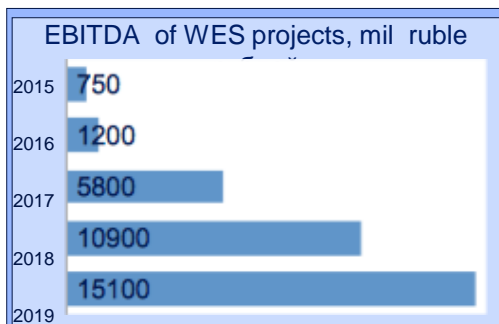
Wind Energy Systems®

Construction of wind power plant  
«Mirny» 60MW in Yeisk municipality of  
Krasnodar region

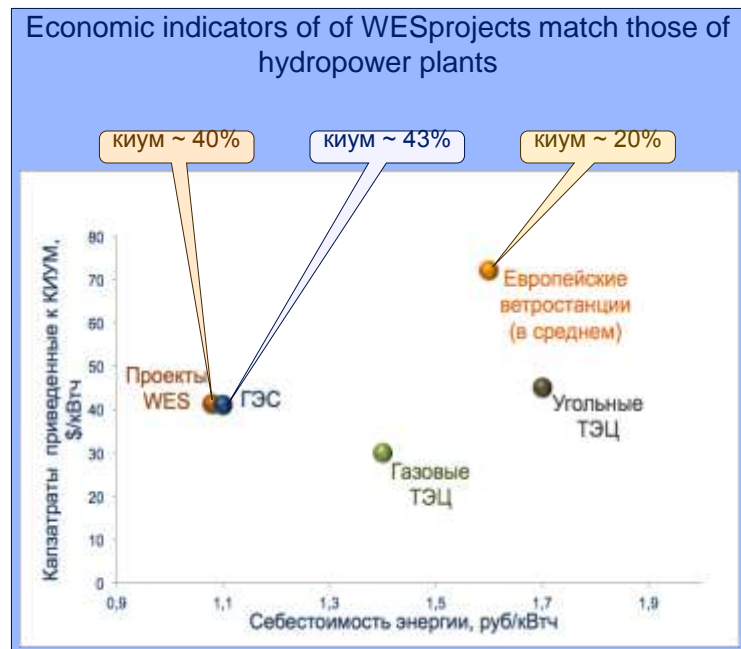
The company "Wind Energy Systems» (WES) was established in 2009

The company's strategy is to achieve by 2019 the following indicators: to become the leading operating company in the Russian Federation in the field of wind energy with a market share of at least 40%: operating wind farms ~ 1200 MW of installed capacity; turnover from the sale of electricity and participation in the CSA ~ 19 bln ruble/year, the presence of key competencies for the wind monitoring, wind farm design, organization of financing, construction and operation of wind farms;

WES projects meet the following criteria: the construction of wind farms in the deficit energy systems, the average annual wind speed of at least 7 m / s, the capacity factor of at least 35% (the European average capacity factor of ~ 20%), proximity to transmission lines and consumers - to reduce the cost of consolidation; interest in the cooperation of local authorities and utilities.



- ### Advantages of WES projects
- Location selection:**
    - ✓ power deficit regions;
    - ✓ high wind energy potential (capacity factor no less than 35%);
    - ✓ low connection cost;
    - ✓ cheap land leasing.
  - Wind monitoring:**
    - ✓ is carried by leading european companies;
    - ✓ Data of NASA, EWEA, HMCs are used.
  - Structure of financing:**
    - ✓ higher return on capital due to high long-term debt
  - ✓ Design carried out by the world's leading companies Infra (Austria), Rambol (Belgium);
    - ✓ equipment suppliers - the world's leading manufacturers Vestas (Denmark), Siemens (Germany);

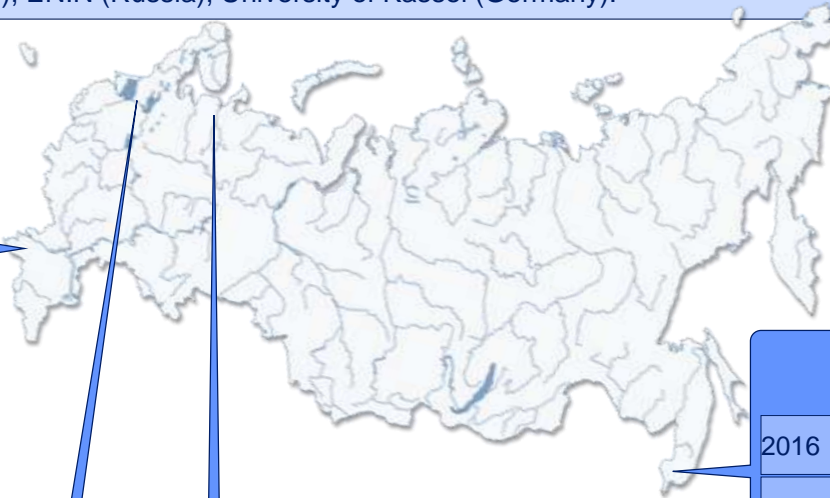


# Projects of WES

## Wind Energy Systems

### The company WES:

- Participant of the program "Modernization of Russian power sector by 2020";
- Owner of the projects for the construction of wind power installed capacity of 1,200 MW in four regions of the Russian Federation;
- projects of construction of wind power projects in Yeisk district of Krasnodar region WF "Mirny" and the wind farm "Ochyabryskyr":
- ✓ included in the "general scheme of the generating capacities on the basis of renewable energy sources in the Russian Federation";
- ✓ included in the "General scheme of electric power facilities of the Krasnodar Territory";
- ✓ included in the draft program of modernization of the power sector of the Russian Federation until 2020;
- ✓ wind monitoring is carried out in collaboration with the companies: CUBE and Garrad @ Hassan;
- ✓ design work carried out by companies: Infra (Austria), Rambol (Belgium), Royal Haskoning (Holland);
- ✓ partners - manufacturers of wind turbines: Vestas (Denmark), Siemens (Germany), Gamesa (Spain);
- ✓ Partners of WES holding: CUBE (Germany), ENIN (Russia), University of Kassel (Germany).



### Krasnodarsky region Projects portfolio 468 MW

2014	WF «Mirny» 60 MW
2015	WF «Jktyarsky» 39 MW
2016	WF «Achtarsky» 150 MW
2016	WF «Schtrbinovskaya» 99 MW
2017	WF «Chervonnaya» 120 MW

### Republic Karelia Project portfolio 192 MW

2017	WF «Kem» 96 MW
2018	WF «Belomorie» 96 MW

### Archangelsk region Project portfolio 120 MW

2017	WF «Pinega» 60 MW
2018	WF «Onega» 60 MW

### Primorsky region Project portfolio 426 MW

2016	WF «Vrangel» 120 MW
2017	WF «Krylova» 48 MW
2017	WF «Povorotny» 78 MW
2018	WF «Plastun» 60 MW
2018	WF «Olga» 60 MW
2018	WF «Chasan» 60 MW

# Improving of economic efficiency of wind power projects with the introduction of CSA

**Till 05.2013, According to the Federal Law № 35-FZ on electric power industry**

***Federal Law № 35-FZ provides: grid companies obligation to purchase electricity generated on the basis of renewable energy sources to compensate losses***

Conditions of realization:

- ✓low tariff
- ✓inability to establish the tariff for the whole payback period of the project
- ✓the tariff shall be approved only after the completing the procedure of plant commissioning and qualification
- ✓Inability to enter into an agreement of power purchase and sale on the whole payback period
- ✓The lack of economic incentives for grid companies to purchase electricity generated on the basis of renewable energy sources

**After 05.2013, according to the Order of the Government of the Russian Federation № 861-r of May 28, 2013 and the Resolution of the Government of the Russian Federation № 449 of May 28, 2013**

***Order of the Government of the Russian Federation № 861-p and Government Decree number 449 determining: targets for renewable energy implementation up to 2020;***  
***✓targets for the degree of localization in Russia of the main and / or auxiliary wind generation equipment up to 2020;***  
***✓list of indicators determining the contribution of individual elements of wind generating equipment in the degree of localization***

Conditions of realization:

- ✓Guaranteed cash flow for the whole payback period;
- ✓Cost-effectiveness (payback period is significantly lower than under the terms of the Federal Law № 35-FZ)
- ✓The need for commissioned equipment to comply localization conditions in the territory of the Russian Federation for the developers of wind farms to meet requirements of the CSA program

## **Comparison of revenue when implementing CSA and sale of electricity to cover losses (at the example project WF-Mirny in the Krasnodar region)**

Years of the project	2015	2016	2017	2018	2019	2020	2021	2022	Project payback period
Revenue from the CSA, EUR million	23,95	23,86	23,88	23,56	23,46	23,60	23,78	24,16	10 лет
Revenue from the sale to cover the losses, EUR million	13,98	16,77	17,78	18,85	19,98	21,18	22,45	23,80	12 лет

# Targets for wind power market in the Russian Federation

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Wind Energy Systems

**Commissioning targets volumes of installed capacity generating units, operating on the basis of wind power and the degree of generating equipment production localization in the RF , using wind energy**  
(RF Government Order of 28 May 2013 № 861-p)

Year of commissioning	2014	2015	2016	2017	2018	2019	2020	BCEFO
Target, MW	100	250	250	500	750	750	1000	3600
The volume of equipment market, EUR million	120	300	300	600	900	900	1200	4320
Target degree of localization, %	35	55	65	65	65	65	65	
The market volume of localized equipment, EUR million	20,4	129	165	330	495	495	660	2294,4

## Change in revenue from CSA (in the case of any breach of the localization) by the example of WF-Mirny

Years of the project	2015	2016	2017	2018	2019	2020	2021	2022	Срок окупаемости и проекта
Revenue from the CSA under the conditions of the localization, EUR million	23,95	23,86	23,88	23,56	23,46	23,60	23,78	24,16	10 лет
Revenue from the CSA at default of localization conditions, EUR million	14,63	14,62	14,79	14,53	14,73	14,95	15,58	16,04	26 лет

In case of default conditions of localization cash flow from the project in the CSA will be lower by 55%, which leads to inefficiency of investment in the project

Yeisk municipality is supplied with power from Rostovenergo generating capacities through Kubanenergo dead-end high-voltage power line from 100 MW substations Yasenevskaya and Morevskaya that does not provide municipality with necessary reliability and quality of power supply. The only source of power generation in this power node at the moment is Yeisk 18 MW gas-piston TPP. According to the winter 2010 reference measurements, the Yeisk power node is currently at 78% deficit. The WF projects that are realized by WES Company in Krasnodar Region can cover only about 8% of total electricity losses in the networks of JSC "Kubanenergo". By 2018, the electricity consumption of Yeisk power node could reach 575 million KWh, with the maximum load of 127 MW. Introduction of the planned WF to the system will reduce the deficit in this region, thus meeting the goal of the project.

The relationship with Krasnodar Region are fixed by agreements with the Administration of Krasnodar Region, the System Operator of Kubanenergo and the Yeisk district Administration signed at the International Investment Forum "Sochi-2009". The project is included in the program of modernization of the power sector of Russia until 2020, as a pilot, in energy conservation program and general scheme of the generating capacities of the Russian Federation and Krasnodar Region.

The site of WF “Mirny” is located at a distance of about 6 km from the SS-110 kV "Morevskaya."

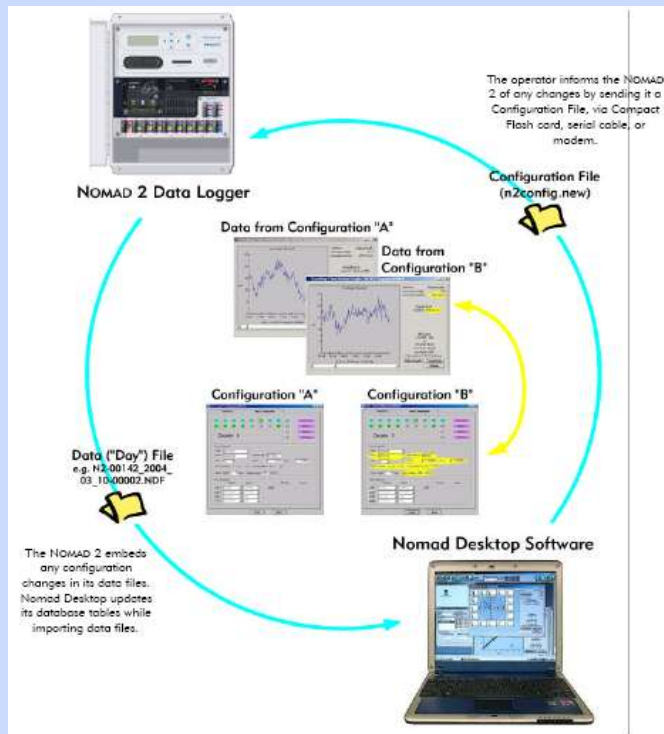


# Wind Monitoring and measuring equipment

## WIND MONITORING MAST AT YEISK SITE



- ✓- Height of mast – 70 m
- Measurement of speeds and wind directions at heights 40, 50, 60 и 70 m
- Measurement of air temperature
- The independent power supply from solar modules
- GSM data transmission



## WIND DATA PROCESING WAS CONDUCTED BY:

- The Institute «ROSTOVTEPLOENERGOPROJECT»,
- The United High Temperature Institute of Russian Academy of Science,
- Lomonosov Moscow State University,
- «GARRAD HASSAN», Bristol, United Kingdom - «CUBE Engineering», Kassel, Germany



## The dependence of the mean wind speed on the height above ground level

### the results of wind monitoring data processing ("CUBE Engineering GmbH")

average wind speed at a height of 40 m - 5.8 m / s, 50 m - 6.2 m / s, 60 m - 6.3 m / s, 70 m - 6.8 m / s.

More significantly than 30% than wind speed previously known from reference books and databases

Extrapolation using the software package WindPRO gives average wind speed at a height of 100 m up to 7.2 m / s and 120 m - 7.8 m / s.

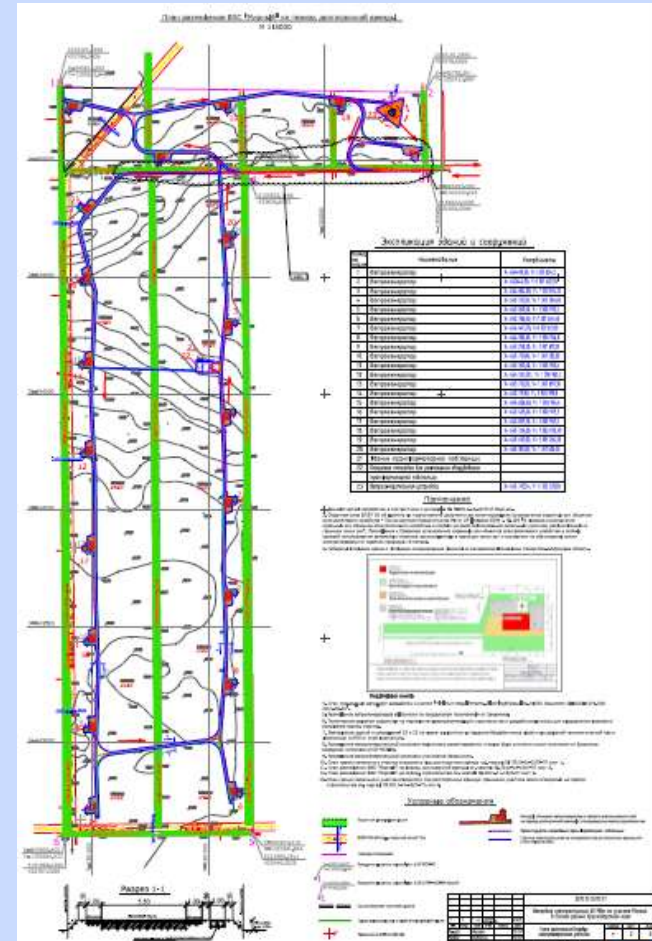
In accordance with classification of the International Electrotechnical Commission for efficient conversion of wind energy potential, for average values of wind speed which obtained at altitudes of 100-120 m, IEC III and IEC IIIA classes of wind turbines are recommended .

When comparing models of wind turbines from different manufacturers the main selection criterion was wind turbines production in MW · h / a, attributed to capital expenditures for 1 MW of installed capacity, taking into account specific requirements of System Operator to electrical parameters of the wind turbine .

The following models of wind turbines were under consideration: "Gamesa G90/2.0 MW" (100 m tower height), "GE Wind Energy 2.5 MW" (100 m tower height), "Nordex N100/2.5 MW" (100 m tower height), "Siemens SWT 2.3/93 "(103 m tower height)," Vestas V90/2.0 MW "(105 m tower height)," Vestas V112/3.0 MW "(120 m tower height)," Wikov Wind W2000/92.5 "(100 m tower height).

**The choice was made in favor of the wind turbine V112-3.0 MW (Vestas) with high performance, and hmaximum production per unit of investment and capacity factor = 0.43 (according to Vestas and CUBE).**

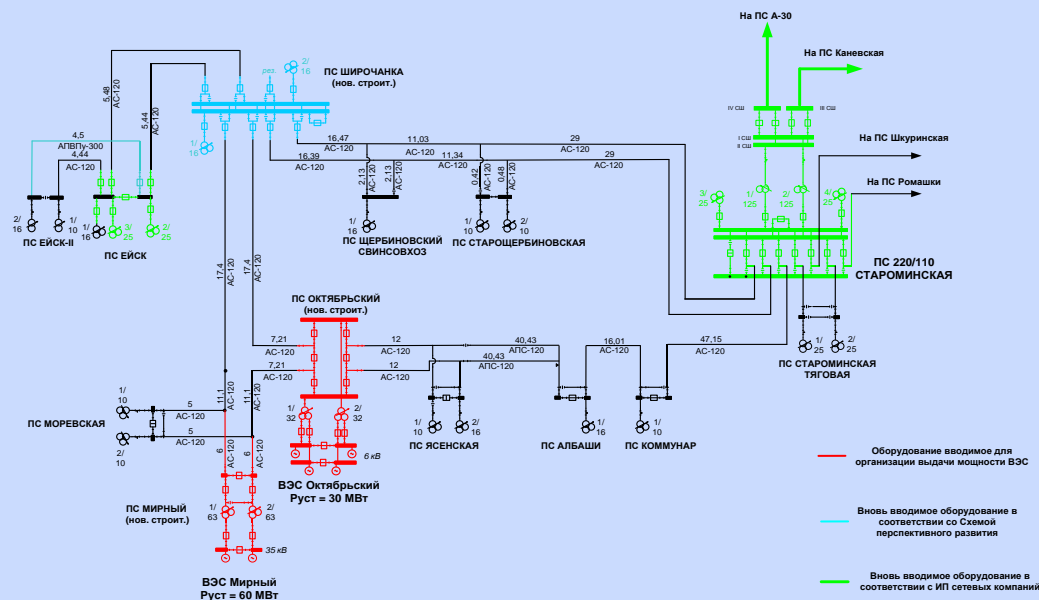




The lease agreement are registered in the land cadastre of the Krasnodar Region

# Connection scheme

Based on the results of calculations the conclusion is made that there is no need for additional sources of reactive power. Putting WF into operation will improve the regulation of voltage levels in Yeisk power node and will provide a better balance of reactive power. In the regimes of maximum load output / input of the reactive load is about 27MVA. Yeisky power load is characterized by relatively low levels of short-circuit currents. The excess of the breaking capacity of the existing switchgears from the perspective of the development of power grid, as well as implementation of the connection scheme WF does not occur. Utilization of wind turbines Vestas, connected to the external network via inverters (consisting of a rectifier, DC link and an inverter) makes the occurrence of asynchronous generators impossible



Connection scheme is agreed on with utilities and System Operator

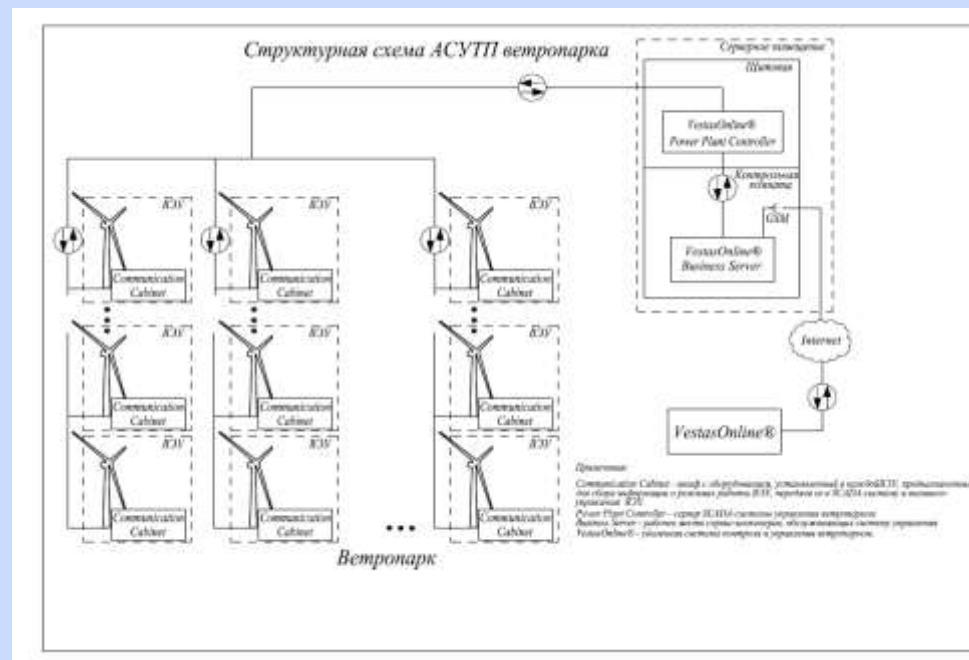
# Control system of WF "Mirny"

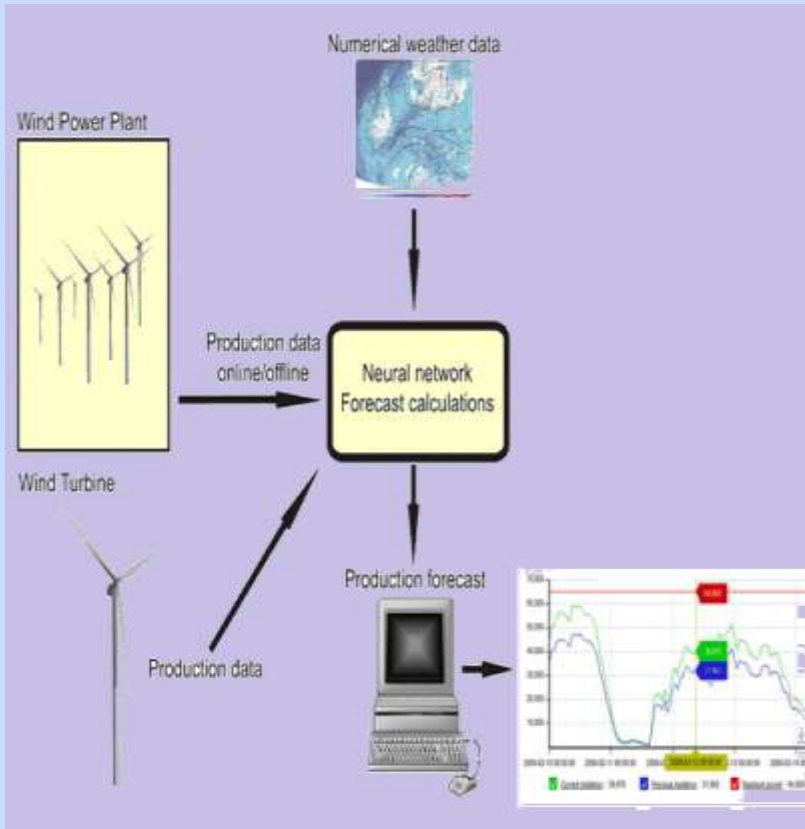
The main control and monitoring system for WF is **APCS**.

APCS is created as a multi-level hierarchical system, consisting of three levels: lower, middle and upper level.

APCS made in accordance with the structural diagram of APCS based on SCADA-system «VestasOnline® Power Plant Controller, Mk II».

Through the communication channels of the Substation "Mirny" necessary information on the equipment operation modes is transferred from WF to System Operator and interested divisions of utilities. Using the GSM-modem the information on the modes equipment operation is passed from WF system «VestasOnline®» to the control room of the company «Vestas».

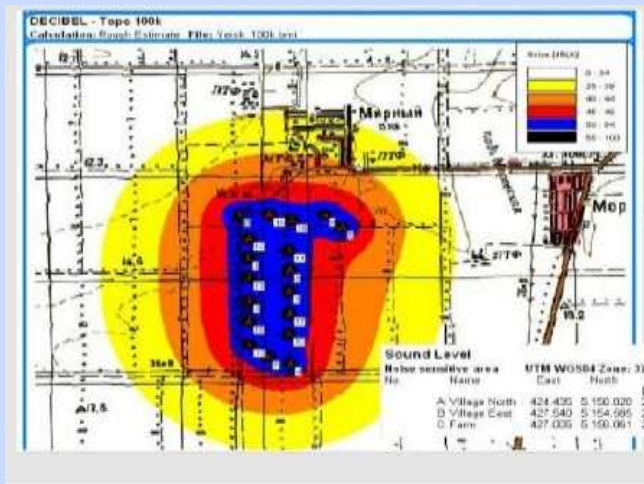




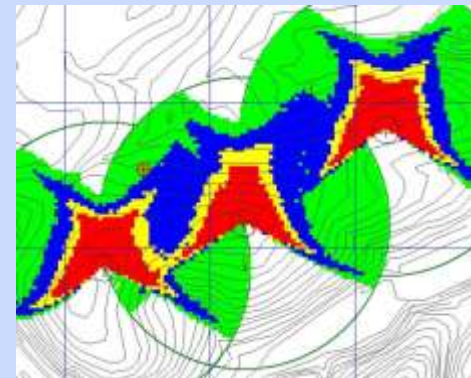
The communication system connecting WF with the Regional Dispatch Office provides technical measures and software for the formation of dispatch schedule for the operating day, weekly and long-term planning of WF regimes in the power balance of the system. Stationary wind measuring complex located on 4 levels of 100m mast every 10min will transmit over fiber-optic lines to the control room of WF the package information (wind speed and direction, temperature, humidity, air density) on the basis of which and the long-term data meteorological observations taking into account parameters of the generating equipment will be calculated and sent to the control room of system operator.

# Environmental Impact

The nature and sources of impact on the environment during the construction of WF are not much different from those in other capital construction. The project does not affect lands of wildlife sanctuaries, national parks, plantations, orchards, ponds. During operation the WF, in principle, can have an impact on the human, flora and fauna, air, waters and land as noise, vibration, electromagnetic radiation, optics and operation of waste. The calculated noise levels in residential areas within the settlement Mirny will be in the range of 35-44 dBA, which meets the requirements of Construction Norms 2.2.4/2.1.8.562-96 "Noise in the workplace, in residential and public buildings and in residential areas"



The analysis was done and the impact of moving optical blades for residential buildings was eliminated.



When designing a WF careful consideration of all possible and to minimize the negative impact of factors on the WF and the environment at all stages of its life cycle is made .

**Public hearings and sociological survey showed support for the project 87% of the population.**

# Wind Farm “Mirny”, Krasnodar Region

## Wind Energy Systems

### Project parameters:

- ✓WF total installed capacity - 60 MW;
- ✓Annual electricity sales volume - 192 million kWh;
- ✓Terms of construction - 2014 - 2015;
- ✓Equipment lifespan - 25 years;
- ✓Total project investments - 4,300 million rubles;
- ✓Equity - 958 million rubles;
- ✓Loan - 3,342 million rubles;
- ✓Revenue from CPA and energy sales in 2015 – 1,037 billion rubles;
- ✓Rate of Return (IRR) -> 17,5%;
- ✓ Loan Rate - ~ 11.5%

### Project Status

Agreements with municipality administrations, wind monitoring, business plan.	+
Consultation with equipment manufacturers, site selection, detailed design, land allocation.	+
Projects submission to the general scheme draft of electric power facilities of municipality, equipment supply tender	+
Financing scheme. Design, grid connection contract,	✓
Participation in the tender for the right to enter into CSA	30.05.2014
Obtaining construction permit.	20.05.2014
Supply of equipment, construction, installation, commissioning, start-up.	20.12.2015

### Features of the project:

- ✓Load factor of the wind farm is about 40% taking into account the losses:
- ✓Average annual wind speed at the site “WF- Mirny” at the height of 119 meters is 7.6 m / s;
- ✓equipment used in the project generates electricity with a quality that does not require additional expensive technical measures for the grid company;
- ✓Considering 70% of electricity shortage in the Krasnodar region, as well as the features of Yeisk energy node:
  - connection of 60 MW capacity will allow to sell all the generated energy.
  - Vestas - wind turbine supplier takes up duties of EPC contractor and solves all the issues related to the transportation, construction, installation, operation, training.

\* CSA mechanism allows you to get payback period of 10-11 years

## Conclusions

1. The project is included in the program of modernization of electric power industry of RF until 2020 into the program of energy conservation and the general layout of the power generation facilities of Krasnodar Territory and RF;
2. The project is implemented under the trilateral agreement between the administrations of the Krasnodar region, Yeisk district and WES;
3. The WF construction project in the Yeisk municipality is supported by the local population. This is confirmed by the results of public hearings and public opinion poll conducted in April 2009 in Yeisk, which showed 87% of the surveyed spoke in favour of WF construction.
4. The capacity factor is 40% - taking into account losses of the station, which is close to that of conventional energy sources;
5. The equipment used in the project generates electricity with the quality that does not require additional expensive technical measures for the network company;
6. Considering the fact that 70% of its own electricity deficit in the Krasnodar region, as well as features of energy Yeisk node– the connectable capacity of 60 MW will allow to realize almost all of produced energy.
7. When electricity produced by wind farm is sold under the CSA mechanism the payback period of 10-11 years is considered typical for the industry and could be substantially reduced by optimizing capital costs. .
8. The design works are at a final stage. "INFRA Project Development Russland" - a subsidiary of «INFRA Project Development GmbH» (Austria), evolved in 2007 from a group of companies «ILF», a well-known company in international field of engineering and consulting, was chosen as a chief designer from the list of six Russian and foreign design companies.
9. "All-Russian Research Institute of relay protection design", is conducting the design works for substations and 110 kV overhead transmission lines.
10. The connection scheme is developed and agreed with grid company and system operator.



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