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DEVELOPMENT OF AN AUTOMATED INFORMATION SYSTEM FOR ACCOUNTING AND MOVEMENT OF WIND TURBINE EQUIPMENT

The number of operating wind farms in the world is growing year by year. Kazakhstan annually increases the number of wind turbines, which currently stands at more than 200.

In this regard, today there is a problem related to the need to develop programs that allow solving problems related to the accounting and movement of wind farm equipment.

This task must be solved primarily due to the large number of equipment requiring replacement, repair and maintenance.

The presented article describes the developed program «Automated information system for accounting and movement of wind farm equipment in wind farms of the Republic of Kazakhstan».

The program database contains all the basic equipment and automation used in the operation of wind turbines.

The program stores data about the equipment of each wind turbine with the coordinates of the location of the latter, which can be provided online from any access point.

The program is developed in the MS SQL management studio, C# software environment. The program menu is quite informative and ergonomic.

The developed program can be used for practical purposes in companies engaged in the operation of wind farms.

The difficulty in creating a common database on wind turbine equipment in Kazakhstan lies in the heterogeneity of wind turbine equipment, since suppliers are different manufacturers, and both public and private companies are engaged in operation.

Nevertheless, an algorithm of the program is currently being developed using machine learning methodology, which allows updating the database on wind turbines based on information from any open sources.

Keywords: automated information system, management, accounting, program, data, efficiency, wind turbine.

Introduction

To date, according to [1], 341,000 wind turbines have been installed on our entire planet.

Wind turbines operate on the principle of maximizing the use of wind power, which in this case acts as a source of primary energy. By rotating the blades, they generate kinetic energy, and the generator then converts this kinetic energy into electrical energy.

The amount of energy a wind farm can produce depends on the location, size of the turbines and the length of their blades.

According to WindEurope, in 2021, European wind farms generated 437 terawatt-hours (TWh) of electricity, covering an average of 15 % of demand, although in several countries this exceeded 20 % of electricity coverage, for example, in Portugal (26 %), Spain (24 %) and Germany (23 %) [2].

Currently, there are the following types of wind turbines [3]:

- terrestrial, they are the most common, located on land at least 3 kilometers from the coast and are fed by ground air currents. The advantage of this location is its easy accessibility and proximity to the power grid;
- coastal, located on land, but less than 3 kilometers from the coast, can use both onshore and offshore winds to produce energy;
- structures are being built in the open sea a few miles from the coast, while the wind force is greater, at a lower altitude and more uniform than on land.

Table 1 shows the data on wind farms operating in Kazakhstan for the period 2020 [4; 5; 6; 7; 8].

The first wind farm in Kazakhstan, launched in Yerementau, Akmola region, 2013. Currently, 22 wind turbines are in operation, each with a capacity of 2 MW. Capacity expansion is expected to double.

In the city of Kokchetav, the installation of wind turbines is carried out by a private investor, and installation continues today.

The increase in the number of wind farms increases the requirements associated with high-quality operation of equipment, monitoring and timely replacement of failed sets of equipment.

Work related to the accounting and movement of wind farm equipment should be carried out on an ongoing basis.

To date, the 1C program is used for accounting and movement of equipment, which does not provide the functionality necessary for high-quality and reliable control of complex equipment installed on wind turbines. In this regard, the relevance of the study lies in the need to develop an automated information system for accounting and movement of wind turbine equipment.

Table 1 – Locations of wind farms

№	Place	Name	Company	Power Mvt	Year	Location
1	1	СЭС Нура	Hevel Kaz	100	2020	Акм. reg
2	1	СЭС Nurgisa	Eneverse Kunkuat	100	2019	Alm.reg
3	1	VES Zhanatas	ZhES	100	2020	Zham, reg
4	1	Ses SH-100	M-Kat green	100	2019	Zham, reg
5	1	Ses Saran	SES Saran	100	2019	Kar.reg
6	1	VES tecnology	VET	100	2019	Atyr.reg
7	2	Astana Expo	Green energy	50	2017	Astana
8	1	VES Kaskelen	Mistral energy	50	2020	Alm.reg
9	1	VES Uk-50	UK SES-50	50	2020	Uk.reg
10	1	SES Kentay	Hevel Kaz	50	2020	Turk.reg
11	2	SES Burnoe	Burnoe	50	2017	Zham, reg
12	1	SES Agadyr	Kaz Sapar	50	2019	Kar.reg
13	2	SES Baykonyr	Boykonyr solar	50	2019	Kyzyl.reg
14	1	SES KZT	KZT Solar	50	2021	Turk.reg
15	1	SES Ybrai	Zhol electric	50	2021	Kost.reg
16	1	SES Badamsha	Arm Wind	48	2021	Akt.reg
17	2	SES Erementay	1 WES	45	2015	Akm. reg

To achieve this goal, it is necessary:

- to develop an information logical model of an «automated information system for accounting and movement of wind turbine equipment»;

-create a database of the «automated information system for accounting and movement of wind turbine equipment», which includes equipment, components, electrical appliances, automation, control equipment, including transmission.

Materials and methods

When developing the program «Automated information system for accounting and movement of wind turbine equipment», the following methods were used:

- methods of logical and physical design.
- IDEF1X notation.

Programs:

- Visualstudio,
- With#;
- Windows Form;
- MS SQL management studio.

The program is written in Russian.

Results and discussion

This publication does not consider the creation of an information-logical model, as it is described in another publication. Fig.1 shows the ILM (information and logical model) of the «Automated information system for accounting and moving a wind turbine».

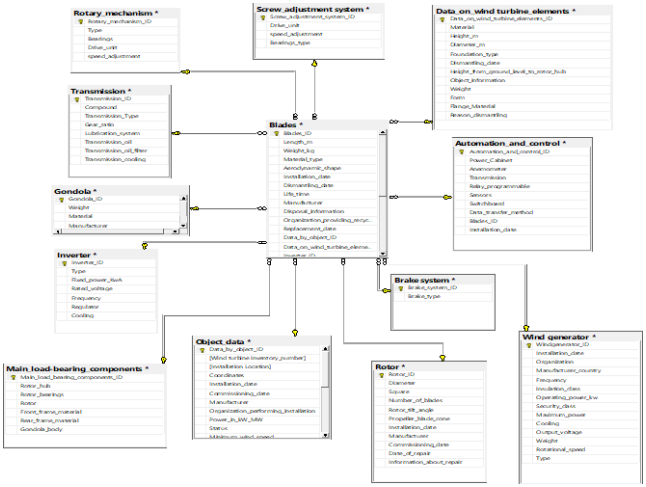

Figure 1– ILM "Automated information system for accounting and movement of wind turbine equipment

Presented, ILM, provides, definition of entities, attributes for each entity, relationships between entities. Fig. 2 shows the main components of the wind farm.

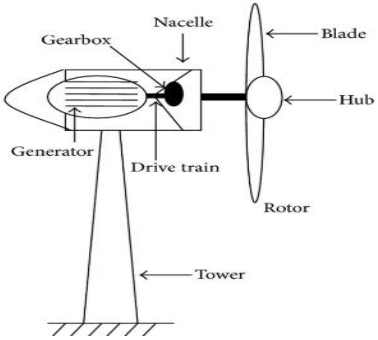

Figure 2– The main components of the wind turbine

The main nodes of the wind turbine include:

-a gondola in which a wind generator, brakes, sensors and other auxiliary equipment are installed;

- the tower in which all automation and control transmission are located, cable – growth with cables, control cables;

- rotor blades of a wind turbine;

- the foundation.

Let's consider the functionality of the program. The program is started using a batch file WindPowerApp.exe Fig. 3.

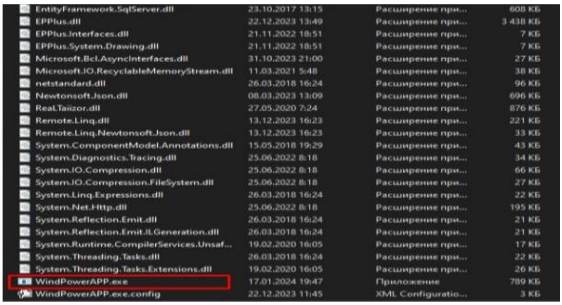

Figure 3 – The command file of the program

Fig.4, shows the main menu of the program.

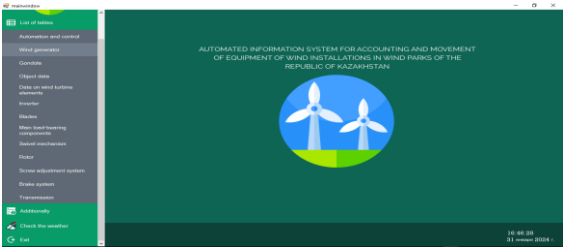

Figure 4– The main menu of the program

The following operations are located on the left side of the menu:

- list of tables;
- optional;
- the weather.

Clicking on the «List of tables» menu opens access to all tables, both for filling in and receiving reports.

The blades of the wind turbine are not subject to repair and must be disposed of after a service life of 15–20 years, Fig. 5 shows a table with data on the blades.

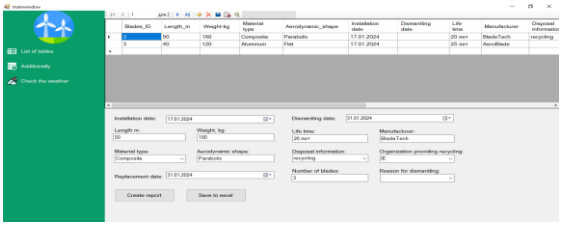

Figure 5– Table with data on wind turbine blades

One of the most important information is object data, which contains information such as installation location, coordinates, inventory number, installation date, etc., Fig.6.

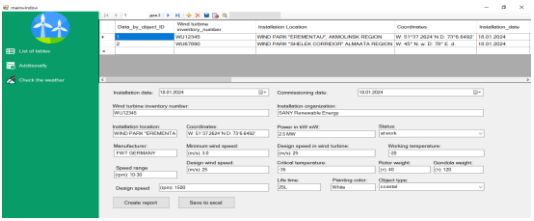

Figure 6 – Object data.

In this table, the data on the time of installation of the blade and its service life are important. The program has the ability to send an alarm when the control dates expire.

In real time, we can find out information about wind and air temperature anywhere in the world Fig.7.

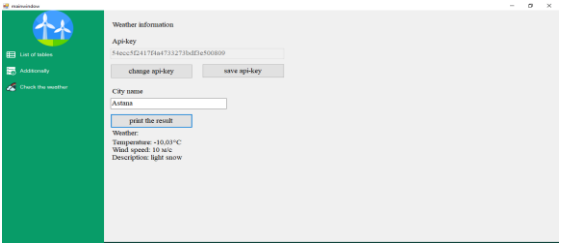

Figure 7– Weather Information

The program allows you to receive reports in Excel, save, forward and print Fig. 8.

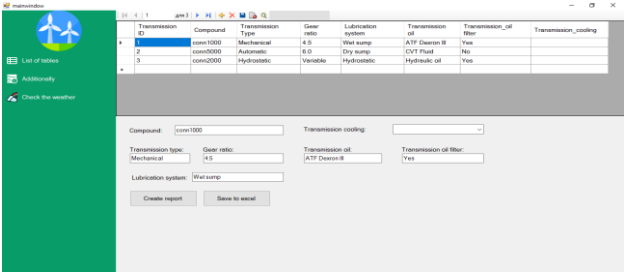

Figure 8– Generating reports

It is possible to convert reports to excel.

Conclusions

The developed program "Automated information system for accounting and movement of wind turbine equipment" is designed to:

- automate the process of accounting and moving equipment;
- exclusion of the influence of the human factor in making managerial decisions;
- storing and receiving data on the nomenclature and serial numbers of equipment online;
- provision of data on the location of the facility and equipment;
- timely informing the staff about the need to dispose of equipment with expired service life.

To date, software is installed as part of wind turbines during installation, the functionality of which is limited by monitoring the physical condition of a node, which does not ensure the effectiveness of managing wind farms [9-14], in particular at a significant distance from the control point.

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%B0%D1%81%D1%82%D0%BE%D1%8F%D1%89%D0%B5%D0%B5,%D1%83%D0%B2%D0%B5%D0%BB%D0%B8%D1%87%D0%B5%D0%BD%D0%B8%D0%B5%20%D0%BC%D0%BE%D1%89%D0%BD%D0%BE%D1%81%D1%82%D0%B8%20%D0%B4%D0%BE%201655%20%D0%9C%D0%92%D1%82.

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РАЗРАБОТКА АВТОМАТИЗИРОВАННОЙ ИНФОРМАЦИОННОЙ СИСТЕМЫ УЧЕТА И ДВИЖЕНИЯ ОБОРУДОВАНИЯ ВЕТРОВЫХ УСТАНОВОК

Количество работающих ветровых станций растет в мире год от года. Казахстан ежегодно наращивает количество ветровых установок, которое в настоящее время составляет более 200. Ветровые установки объединенные в ветровые парки, требуют постоянного контроля в части управления параметрами оборудования, передачи выработанной электрической энергии в сеть, обеспечения передачи корректных данных с датчиков, измерительной аппаратур. Если программами, участвующими в контроле за показаниями автоматики и приборов, ветровые установки обеспечены на высоком уровне, то программная часть обеспечивающая учет, движение оборудования, для замены, ремонта и т. д, практически отсутствует.

В этой связи на сегодняшний день, существует проблема, связанная с необходимостью разработки программ, позволяющих решить задачи, по учету и движению оборудования ветровых установок. Данная задача, требует решения прежде всего в связи о с большим количеством оборудования, которое требует замены, ремонта и обслуживания.

В представленной статье, представлена разработанная программа «Автоматизированная информационная система учета и движения оборудования ветровых установок». В базе данных программы размещены все основное оборудование, автоматика используемая в работе ветровой установки.

Программа, хранит данные по оборудованию, каждой ветроустановки, с координатами размещения последней, которые могут быть предоставлены в режиме онлайн, из любой точки доступа.

Программа разработана в программной среде MS SQL management studio, C#. Меню программы достаточно информативно и эргономично. Разработанная программа может

быть использована для практических целей в компаниях занимающих эксплуатацией ветровых станций.

Ключевые слова: автоматизированная информационная система, управление, учет, программа, данные, эффективность, ветровая установка.

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ЖЕЛ ҚОНДЫРҒЫЛАРЫ ЖАБДЫҚТАРЫНЫҢ ҚОЗҒАЛЫСЫ МЕН ЕСЕПКЕ АЛУДЫҢ АВТОМАТТАНДЫРЫЛҒАН АҚПАРАТТЫҚ ЖҮЙЕСІН ӘЗІРЛЕУ

Әлемде жұмыс істейтін жел станцияларының саны жылдан жылға артып келеді. Қазақстан жыл сайын жел қондырғыларының санын көбейтіп келеді, ол қазіргі уақытта 200-ден асады. Жел парктеріне біріктірілген жел қондырғылары жабдықтың параметрлерін басқару, өндірілген электр энергиясын желіге беру, датчиктерден, өлшеу аппаратураларынан дұрыс деректерді беруді қамтамасыз ету бөлігінде тұрақты бақылауды талап етеді. Егер автоматика мен аспаптардың көрсеткіштерін бақылауға қатысатын бағдарламалармен жел қондырғылары жоғары деңгейде қамтамасыз етілсе, онда есепке алуды, жабдықтың қозғалысын, ауыстыру, жөндеу және т.б. қамтамасыз ететін бағдарламалық бөлім іс жүзінде жоқ.

Осыған байланысты, бүгінгі таңда жел қондырғылары жабдықтарының есебі мен қозғалысы бойынша міндеттерді шешуге мүмкіндік беретін бағдарламаларды әзірлеу қажеттілігіне байланысты проблема бар. Бұл міндет, ең алдымен, ауыстыруды,

жөндеуді және техникалық қызмет көрсетуді қажет ететін көптеген жабдықтарға байланысты шешуді талап етеді.

Ұсынылған мақалада «жел қондырғылары жабдықтарының қозғалысы мен есепке алудың автоматтандырылған ақпараттық жүйесі» әзірленген бағдарламасы ұсынылған. Бағдарламаның мәліметтер базасында барлық негізгі жабдықтар, жел қондырғысының жұмысында қолданылатын автоматика бар.

Бағдарлама кез-келген кіру нүктесінен онлайн режимінде ұсынылуы мүмкін соңғы орналастыру координаттарымен жабдық, әрбір жел қондырғысы бойынша деректерді сақтайды.

Бағдарлама бағдарламалық ортада әзірленген MS SQL management studio, бірге#. Бағдарлама мәзірі жеткілікті ақпараттық және эргономикалық. Әзірленген бағдарлама жел станцияларын пайдаланатын компанияларда практикалық мақсаттар үшін пайдаланылуы мүмкін.

Кілтті сөздер: автоматтандырылған ақпараттық жүйе, басқару, есепке алу, Бағдарлама, деректер, тиімділік, жел қондырғысы.

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