EDUCATION AND SCIENCE MINISTRY OF UKRAINE
NATIONAL AVIATION UNIVERSITY
DEPARTMENT OF COMPUTER INTEGRATED COMPLEXES

ADMIT TO DEFENSE
Head of department
Viktor M. Sineglazov
“____” ______________ 2020

QUALIFICATION PAPER

(EXPLANATORY NOTE)

GRADUATE OF EDUCATION AND QUALIFICATION LEVEL “MASTER”

THEME: AUTONOMOUS HYBRID POWER PLANT FOR STOCKROOM

Executor: **Krasnikova K.S.**

Supervisor **Ph.D., Associate Professor Vasylenko M.P.**

Advisor on environmental protection: **D.Sc, professor Frolov V.F.**

Advisor on labor protection: **Ph.D., Associate Professor Konovalova O. V**.

Norms inspector: **Ph.D., Associate Professor Tupitsyn M. F..**

Kyiv 2020

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ
КАФЕДРА КОМП’ЮТЕРНО-ІНТЕГРОВАНИХ КОМПЛЕКСІВ

ДОПУСТИТИ ДО ЗАХИСТУ
Завідувач кафедри
В.М. Синєглазов
“_____”____________2020 р.

КВАЛІФІКАЦІЙНА РОБОТА

(ПОЯСНЮВАЛЬНА ЗАПИСКА)

ВИПУСКНИКА ОСВІТНЬО-КВАЛІФІКАЦІЙНОГО РІВНЯ “МАГІСТР”

Тема: АВТОНОМНА ГІБРИДНА ЕНЕРГЕТИЧНА СИСТЕМА ДЛЯ СКЛАДСЬКОГО ПРИМІЩЕННЯ

Виконавець: **Краснікова К.С.**

Керівник: **к.т.н., доцент Василенко М. П.**

Консультант з екологічної безпеки: **д.т.н., професор Фролов. В.Ф.**

Консультант з охорони праці: **к.б.н., доцент Коновалова О.В.**

Нормоконтролер: **к.т.н., доцент Тупіцин М.Ф.**

Київ 2020

НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ

Факультет аеронавігації, електроніки та телекомунікацій

Кафедра авіаційних комп'ютерно - інтегрованих комплексів

Освітній ступінь магістр

Напрям 15 – Автоматизація та приладобудування

ЗАТВЕРДЖУЮ

Завідувач кафедри

Синєглазов В.М.

“ ____ ” __________2020 р.

ЗАВДАННЯ
на виконання дипломної роботи студента
Краснікової Катерини Сергіївни

1. Тема роботи: «Автономна гібридна енергетична система для складського приміщення»

2. Термін виконання роботи: з 01.09.2020р. до 10.12.2020р.

3. Вихідні дані до проекту (роботи): склад запасних деталей аеродрому «Ніжин», особливості регіону Чернігівської області.

4. Зміст пояснювальної записки (перелік питань, що підлягають розробці):

1. Аналіз проблематики та актуальності. 2. Аналіз існуючих джерел альтернативної енергії їх переваги та недоліки. 3. Дослідження заданого складу запасних деталей аеродрому «Ніжин» та його енерговитрат. 4. Розбір наявних в регіоні джерел альтернативної енергетики. 5. Розрахунок необхідної кількості сонячних панелей. 6. Розрахунок необхідної кількості ресурсів для біогазової установки. 7. Розрахунок необхідної кількості та ємності акумуляторів. 9. Розрахунок газосховища 10. Моделювання поведінки сонячної системи.

5. Перелік обов'язкового графічного матеріалу: 1. Актуальність задачі. 2. Аналіз існуючих джерел альтернативної енергії. 3. Розбір наявних в регіоні джерел альтернативної енергії. 4. Структура системи. 5. Моделювання поведінки сонячної системи.

6. Календарний план-графік

№ п/п	Завдання	Термін виконання	Відмітка про виконання
1	Аналіз актуальності проблеми	01.09.2020-11.09.2020	
2	Дослідження існуючих альтернативних джерел енергії їх переваги та недоліки	11.09.2020-22.09.2020	
3	Дослідження заданого складу запасних деталей аеродрому «Ніжин» та його енерговитрат	22.09.2020-03.10.2020	
4	Розбір наявних в регіоні джерел альтернативної енергетики	03.10.2020-14.10.2020	
5	Розрахунок необхідної кількості сонячних панелей	14.10.2020-25.10.2020	
6	Розрахунок необхідної кількості ресурсів для біогазової установки	25.10.2020-05.11.2020	
7	Розрахунок необхідної кількості та ємності акумуляторів	05.11.2020-16.11.2020	
8	Розрахунок газосховища	16.11.2020-27.11.2020	
9	Моделювання поведінки сонячної системи	27.11.2020-10.12.2020	

7. Консультанти зі спеціальних розділів

Розділ	Консультант (посада, П. І. Б.)	Дата, підпис	
		Завдання видав	Завдання прийняв
Охорона праці	к.т.н., доцент, Коновалова О.В,		
Охорона навколишнього середовища	к.т.н., доцент, Фролов В.Ф.		

8. Дата видачі завдання ______________________________

Керівник: доцент ______________________ Василенко М.П.

(підпис)

Завдання прийняв до виконання ______________ Краснікова К. С.

(підпис)

NATIONAL AVIATION UNIVERSITY

Faculty of aeronavigation, electronics and telecommunications

Department of Aviation Computer Integrated Complexes

Educational level master

Field of study: 15 “Automation and Instrumentation"

APPROVED BY

Head of department

Victor M. Sineglazov

“______” _______________ 2020

Graduate Student’s Diploma Thesis Assignment

Krasnikova Katerina Sergiyivna

1. The thesis title: Control system of hybrid power plant.

2.The thesis to be completed between: from 01.09.2020 to 10.12.2020

3. **Output data for the thesis:** structure of hybrid powerplant, mathematical models of powerplant componrnts, amount of power gnerated by the powerplant, type and power consumption of load.

4. **The content of the explanatory note (the list of problems to be considered):** 1. Analysis of issues and relevance. 2. Analysis of existing alternative energy sources, their advantages and disadvantages. 3. Investigation of the specified composition of spare parts of the Nizhyn airfield and its energy consumption. 4. Analysis of alternative energy sources available in the region. 5. Calculation of the required number of solar panels. 6. Calculation of the required amount of resources for a biogas plant. 7. Calculation of the required number and capacity of batteries. 9. Calculation of the gas storage facility 10. Modeling the behavior of the solar system.

5. List of compulsory graphic material: 1. Relevance of the task. 2. Analysis of existing alternative energy sources. 3.Analysis of alternative energy sources available in the region. 4. System structure. 5.modeling the behavior of the solar system.

6. Planned schedule:

№	Task	Execution term	Execution mark
1	Analysis of the urgency of the problem	01.09.2020-11.09.2020	
2	Research of already existing automatic systems	11.09.2020-22.09.2020	
3	Consideration of the advantages and disadvantages of existing systems	22.09.2020-03.10.2020	
4	Development of the control system of a hybrid power plant	03.10.2020-14.10.2020	
5	Formation of a mathematical model of the system	14.10.2020-25.10.2020	
6	Implementation of the choice of software for the implementation of the developed system	25.10.2020-05.11.2020	
7	Implementation of the developed control system	05.11.2020-16.11.2020	
8	Development of system algorithm	16.11.2020-27.11.2020	
9	Analysis of the system, detection of shortcomings and their elimination	27.11.2020-10.12.2020	

7. Special chapters' advisors

Chapter	Advisor (position, name)	Date, signature	
		Assignment issue date	Assignment accepted
Labor protection	Ph.D, Associate Professor, Konovalova O. V.		
Environmental protection	Ph.D, Associate Professor, Frolov V.F.		

8. Date of task receiving: ____

Diploma thesis supervisor _______________ Mykola P. Vasylenko
(signature)

Issued task accepted _________________ Katerina S. Krasnikova
(signature)

РЕФЕРАТ

Пояснювальна записка до дипломної роботи «Автономна гібридна енергетична система для складського приміщення»: 116 с., 44 рис., 2 табл., 22 літературних джерела.

Об'єкт дослідження: Автономна гібридна енергетична система для складського приміщення.

Мета роботи: розробка автономної гібридної енергетичної системи для складського приміщення.

Методи дослідження: порівняльний аналіз, обробка літературних джерел, математичне моделювання.

АЛЬТЕРНАТИВНА ЕНЕРГІЯ, СОНЯЧНІ ПАНЕЛІ, БІОГАЗОВА УСТАНОВКА, СКЛАД ЗАПАСНИХ ДЕТАЛЕЙ АЕРОДРОМУ «НІЖИН», РОЗРАХУНОК ЕНЕРГОВИТРАТ, РОЗРАХУНОК ЕМНОСТІ АКУМУЛЯТОРА, PVSYST.

ABSTRACT

Explanatory note to the thesis " Autonomous hybrid power plant for stockroom ": 116 p., 44 figures, 2 tables, 22 literary resources.

The object of research: Autonomous hybrid power plant for stockroom.

The purpose of the work: development automatic hybrid power plant for stockroom.

Methods of research: comparative analysis, processing of literary resources, mathematical modeling.

ALTERNATIVE ENERGY, SOLAR PANELS, BIOGAS PLANT, SPARE PARTS WAREHOUSE «NIZHYN» AIRFIELD, ENERGY CONSUMPTION CALCULATION, BATTERY CAPACITY CALCULATION, PVSYST.

Content

GLOSSARY

HPS – Hydroelectric power stations

MGL – Metal halide lamps

LED – Light-emitting diode

MCO – Materials consists of organic

M_W - mass (volume) of water required for mixing raw materials

M_{dm}- the total mass of dry matter in the raw material

H_s - the required moisture content of the substrate

T_{mrm} - Total mass of raw materials

NGT – Natural Gas

LPG – Liquefied Petroleum Gas

GPPG – Gas piston power generators

GPEU – gas piston electric units

GPPP – gas piston power plants

PV – Photovoltaics

INTRODUCTION

Alternative energy is a set of promising methods of obtaining, transmitting and using energy that are not as widespread as traditional ones, but are of interest because of the profitability of their use with, as a rule, a low risk of causing harm to the environment.

In order for humanity to exist and develop rapidly, it is necessary to constantly improve the ways of obtaining energy. The search for new sources of energy and the development of alternative ways of obtaining energy is the main priority task of mankind in the new Millennium.

Energy is the basis of all processes in all sectors of the national economy, the main condition for creating material benefits and improving people's living standards. Today, energy is the most important driving force of global economic progress, and the well-being of billions of people on the planet directly depends on its state. The steady increase in the number of people leads to an increase in energy consumption. And if we don't develop alternative energy, it can lead to an energy crisis.

Traditional energy sources — oil, gas, coal, firewood — will eventually run out. According to some estimates, this will happen in the coming decades. The problem of switching from traditional hydrocarbon energy sources — wood, coal, oil, and gas — is becoming more urgent every year. And it's not just that traditional sources are being depleted, although this aspect of the problem is also important. In addition to the prospect of depletion of traditional sources, there is also an environmental problem, since the burning of hydrocarbon fuels leads to harmful emissions into the atmosphere, worsening the human habitat, creating environmental problems.

CHAPTER 1. RELEVANCE AND RENEWABLE ENERGY SOURCES

As an entirely renewable resource or phenomenon, an alternative energy source completely replaces the traditional one that runs on coal, natural gas, or oil. Humanity has been using various energy sources for a long time, but the increased scale of their use causes irreparable damage to the environment. It leads to the release of a large amount of carbon dioxide into the atmosphere. It provokes the greenhouse effect and contributes to global temperature rise and global warming. Dreaming of an almost inexhaustible or completely renewable energy resource, people are looking for promising ways to obtain, use and then transfer energy. Of course, taking into account the environmental aspect and the cost-effectiveness of new, non-traditional sources.

1.1 Solar energy:

Solar energy is one of the alternative energy sources that people use the most. Methods of converting solar energy to produce various types of energy used by humans can be divided into types of energy received and methods of obtaining it, these are:

❖ *Conversion to electrical energy:*

- By using photovoltaic cells (fig.1.1). Photovoltaic cells are used to make solar panels that serve as solar energy receivers in solar power plant systems. The principle of operation is based on obtaining the potential difference inside the solar cell when sunlight hits it. Panels differ in structure (polycrystalline, monocrystalline, with silicon deposition), overall dimensions and power.

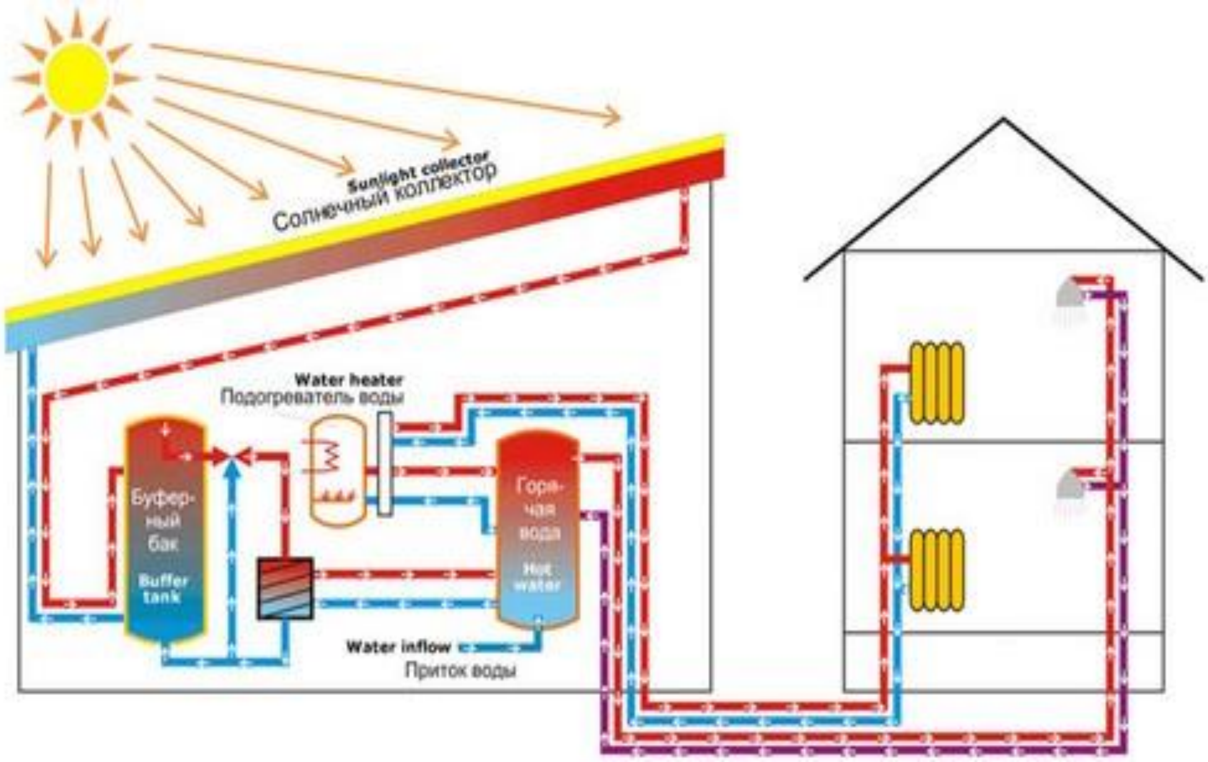

Fig.1.1. The principle of operation photovoltaic cells

▪ By using thermoelectric generators. A thermoelectric generator is a technical device that allows you to obtain electrical energy from thermal energy. The principle of operation is based on the conversion of energy obtained due to the temperature difference on different parts of the structural elements (thermo-electromotive force).

❖ *Conversion to thermal energy:*

• By using collectors of various types and designs. Vacuum collectors — tubular type and in the form of flat collectors. The principle of operation — under the influence of sunlight, a special liquid is heated, which, when certain parameters are reached, begins to evaporate, after which the steam transfers its energy to the heat carrier. After giving off heat energy, the steam condenses and the process repeats.

Flat collectors (Fig.1.2) – are a frame with thermal insulation and an absorber covered with glass, with pipes for the inlet and outlet of the coolant. The principle of operation — streams of sunlight fall on the absorber and heat it, the heat from the absorber passes to the heat carrier.

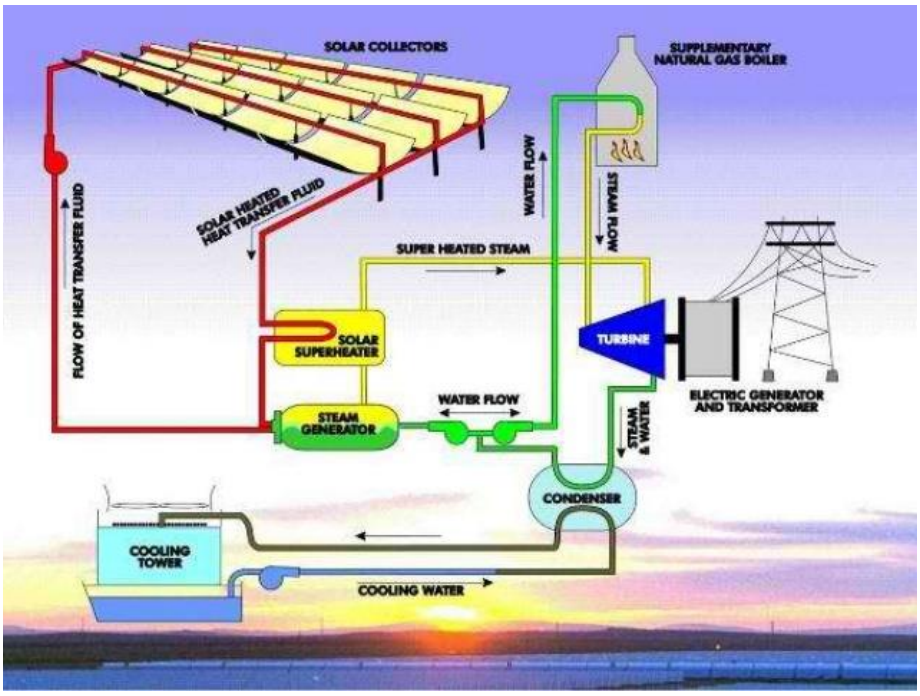

Fig. 1.2. The principle of operation flat collectors

- Through the use of geothermal plants (Fig.1.3.). The principle of operation is based on heating the surface that can absorb the sun's rays. The sun's rays focus through the lens focusing device, and then forwarded to a receiver where the solar energy is transferred for storage or transmission to the consumer by the carrier.

Fig. 1.3. Scheme of geothermal plants

Solar energy has both advantages and disadvantages. The advantages include environmental safety of installations, inexhaustibility of the energy source, low cost of energy received.

The disadvantage is that the installation directly depends on weather conditions (Sunny weather is a necessary condition), time of day, and time of year. In addition, these installations have low efficiency. And to top it all off, the very high cost of these installations, which most likely do not pay off.

1.2. Wind energy

Wind is a clean, free and easily accessible renewable energy source. Every day around the world, wind turbines capture wind energy and convert it into electricity. Wind power plays an increasingly important role in how we power our world – in a clean, sustainable way.

Wind turbines allow us to use wind energy and convert it into energy. When the wind blows, the turbine blades rotate clockwise, capturing energy. This drives the main shaft of the wind turbine, connected to the gearbox inside the nacelle, to rotate. The gearbox sends this wind energy to the generator, converting it into electricity. The electricity is then fed to a Transformer, where the voltage levels are adjusted according to the grid.

Further, the rotational force is converted into electricity, which is accumulated in the battery. The stronger the air flow, the faster the blades spin, producing more energy. Since the operation of the wind generator is based on the maximum use of an alternative energy source, one side of the blades has a rounded shape, the second is relatively flat. When the air flow passes over the rounded side, a vacuum section is created. This sucks in the blade, leading it to the side. This creates energy, which causes the blades to spin (Fig.1.4).

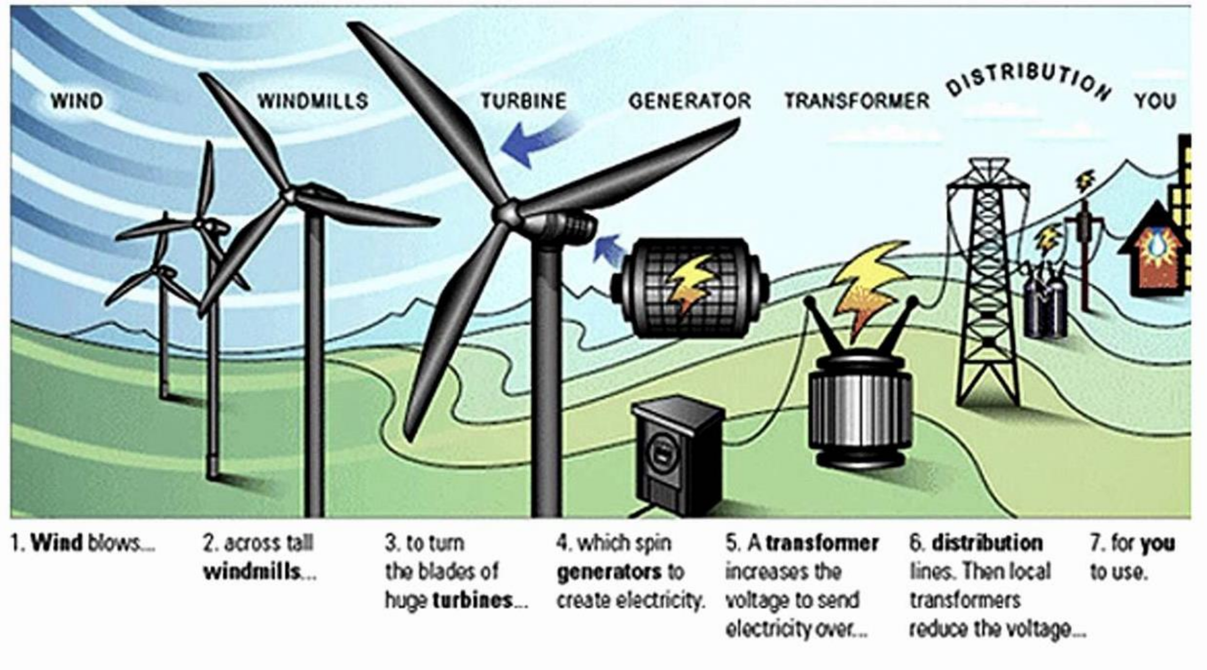

Fig.1.4. The principle of operation wind power plant

During their turns, the screws also rotate the axis connected to the generator rotor. When the twelve magnets attached to the rotor rotate in the stator, an alternating electric current is created, having the same frequency as in ordinary room sockets. This is the basic principle of how a wind generator works. Alternating current is easy to generate and transmit over long distances, but it is impossible to accumulate.

To do this, it must be converted to direct current. This work is performed by an electronic circuit inside the turbine. To get a large amount of electricity, industrial installations are manufactured. A wind farm usually consists of several dozen installations. By using such a device at home, you can get a significant reduction in energy costs. The principle of operation of wind turbines allows them to be used in such variants:

- in parallel with the backup battery;
- together with the solar panels;
- in parallel with a diesel or petrol generator.

If the air flow is moving at a speed of 45 km/h, the turbine generates 400 watts of electricity. This is enough to illuminate the suburban area. This power can be accumulated by collecting it in the battery.

A special device controls the charging of the battery. As the charge decreases, the rotation of the blades slows down. When the battery is fully discharged, the blades start to rotate again. In this way, charging is maintained at a certain level. The stronger the air flow, the more electricity the turbine can produce.

The unit is equipped with a special braking system so that it does not fail when there is a strong air pressure. If earlier moving magnets induced current in the windings, now this force is used to stop rotating magnets. To do this, a short circuit is created, which slows down the movement of the rotor. The resulting counteraction slows down the rotation of the magnets.

The advantage of this method of generating energy is that it does not produce emissions into the atmosphere. Moreover, no fuel is required to twist the wind turbine blades. Thus, to convert energy, it is enough to build wind turbines in places where the wind often blows throughout the year. To produce current, the air mass velocity of 3 m/s is sufficient. In case of strong gusts, more than 25 m/s, a special braking system stops the wind generator.

The construction of such an installation takes only a week, which allows you to quickly deploy a network of generators. Although such complexes cover large areas, the same territories can be safely used for agricultural purposes. Land can be located directly at the base of the mast, and residential buildings – no closer than 300 meters, the noise from windmills at this distance does not exceed the background. Failure of one installation does not affect the operation of the entire station, so if accidents occur, they do not significantly affect the overall capacity.

The disadvantage of such a system is the high cost of the system, which most likely will not pay off, direct dependence on weather conditions, and low productivity. In addition, the magnetic field created by wind turbines can lead to cancer.

1.3. Hydroelectric power

Hydroelectric power stations or hydroelectric power stations use the potential energy of river water and are currently a common means of generating electricity from renewable sources

A hydroelectric power station is a complex consisting of various structures and special equipment. Hydroelectric power stations are being built on rivers where there is a constant flow of water to fill dams and reservoirs. Such structures (dams) created during the construction of a hydroelectric power station are necessary for the concentration of a constant flow of water, which is converted into electrical energy using special equipment for hydroelectric power stations.

Note that an important role in terms of the efficiency of the HPS is played by the choice of location for construction.

The operation of a hydroelectric power station is quite simple. The constructed hydraulic structures provide a stable water pressure that flows to the turbine blades. The pressure sets the turbine in motion, causing it to rotate the generators. The latter generate electricity, which is then delivered to the consumer via high-voltage transmission lines (Fig. 1.5).

The main difficulty of such a structure is to ensure a constant water pressure, which is achieved by building a dam. Thanks to it, a large volume of water is concentrated in one place. In some cases, the natural flow of water is used, and sometimes the dam and the derivation (natural flow) are used together.

In the building itself there is equipment for hydroelectric power plants, the main task of which is to convert the mechanical energy of water movement into electrical energy. This task is assigned to the generator. It also uses additional equipment for monitoring the operation of the station, distribution devices and transformer stations.

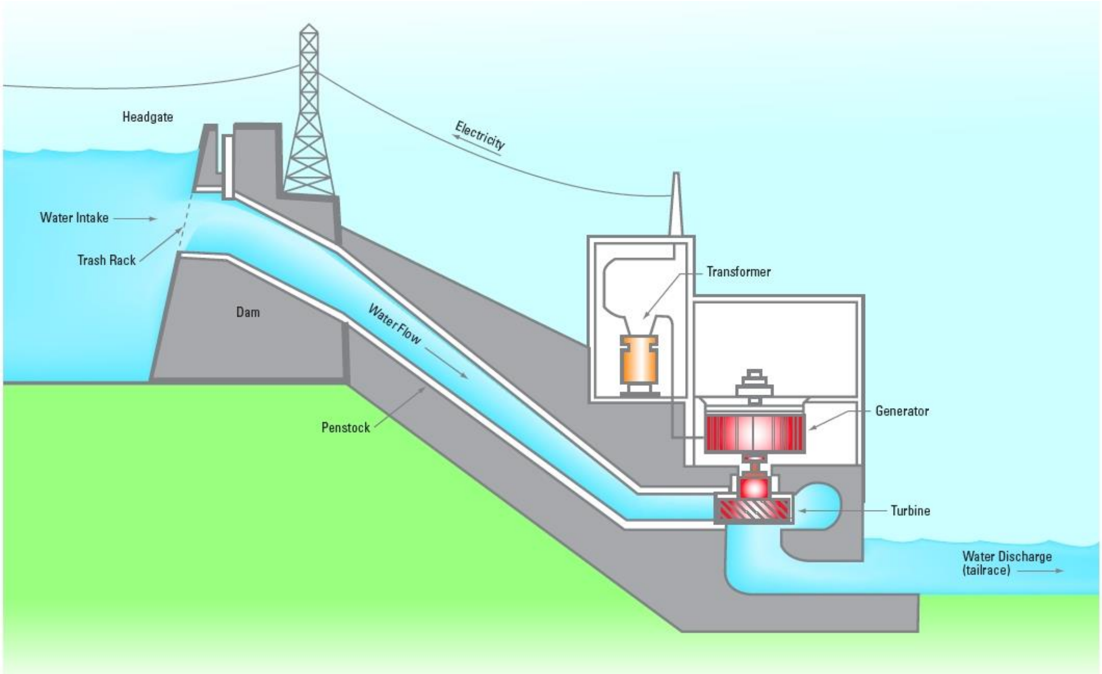

Fig.1.5. The principle of operation hydroelectric power station

As you can see, the water flow rotates the generator turbine, which generates energy, feeds it to the transformer for conversion, and then it is transported via a power line to the supplier.

There are different hydroelectric power stations that can be divided according to the power generated:

- Very powerful – with a power output of more than 25 MW.
- Medium – sized-with output up to 25 MW.
- Small – with output up to 5 MW.

The power of a hydroelectric power station depends primarily on the water flow and the efficiency of the generator itself, which is used on it. However, even the most efficient installation will not be able to produce large amounts of electricity with low water pressure. It is also worth considering that the capacity of a hydroelectric power station is not constant. Due to natural causes, the water level in the dam may increase or decrease. All this has an impact on the volume of electricity produced.

The most complex, large and in General the main element of any hydroelectric power station is a dam. It is impossible to understand what a hydroelectric power station is without understanding the essence of the dam's operation. They are huge bridges that hold the water flow. Depending on the design, they may differ: there are gravity, arched and other structures, but their goal is always the same – to hold a large volume of water. It is thanks to the dam that it is possible to concentrate a stable and powerful flow of water, directing it to the turbine blades that rotate the generator. It, in turn, produces electrical energy.

It was already written above that the principle of operation of the hydroelectric power station is based on the use of mechanical energy of falling water, which is later converted into electrical energy by means of a turbine and generator. The turbines themselves can be installed either in or near the dam. In some cases, a pipeline is used through which water that is below the level of the dam passes under high pressure.

There are several indicators of the power of any HPS: water flow and hydrostatic pressure. The latter indicator is determined by the height difference between the starting and ending points of free fall of water. When creating a station project, the entire design is based on one of these indicators.

Advantages and disadvantages of hydroelectric power plants:

- HPS operation is not accompanied by the release of carbon monoxide and carbon dioxide, nitrogen and sulfur oxides, dust pollutants and other harmful waste, and does not pollute the soil. Some of the heat generated by the friction of the moving parts of the turbine is transferred to the flowing water, but this amount is rarely large.
- Water is a renewable energy source. At least until the streams and rivers run dry. The hydrological cycle (the water cycle in nature) adds to the sources of potential energy due to the rain, snow and drainage.
- HPS performance can be easily controlled by changing the water flow rate (the volume of water supplied to the turbines).

- Reservoirs that are built for hydroelectric power stations can be used as recreation areas, sometimes around them there is a truly spectacular landscape.
- Water in artificial reservoirs is usually clean, as impurities are deposited at the bottom. This water can be used for drinking, washing, bathing, and irrigation.

Disadvantages of hydroelectric power plants:

- Large reservoirs flood large areas of land that could be used for other purposes. Entire cities fell victim to reservoirs, causing mass relocations, discontent, and economic difficulties.
- Destruction or accident of the dam is a large hydroelectric power station almost certainly cause catastrophic flooding downstream of the river.
- Construction of hydroelectric power plants is inefficient in lowland areas.
- Prolonged drought reduces and may even interrupt power generation.
- The dam reduces the level of oxygen dissolved in the water, as the normal flow of the river almost stops. This can lead to the death of fish in the artificial reservoir and endanger plant life in and around the reservoir.
- The dam may disrupt the spawning cycle of fish. This problem can be dealt with by constructing fish passages and fish lifts in the dam, or by moving fish to spawning areas using traps and nets. However, this leads to an increase in the cost of construction and operation of hydroelectric power plants.

1.4. Bioenergy

Bioenergy is the production of energy from biological fuels. Such fuel can be various: wood derivatives (wood chips, sawdust, etc.), briquettes made of straw, husk, peat, paper, as well as biogas and liquid biological fuel.

Bioenergy is not an innovative invention of today. Such types of fuel have been used by mankind since ancient times. But over time, biofuels were replaced by fossil fuels: gas, coal, and oil. However, fossil reserves are coming to an end, and the history of energy is making another round, returning to biological options that have a significant plus: they are renewable energy sources.

Bioenergy uses three main types of biofuels (Fig. 1.6): liquid, solid and gaseous. Liquid biofuels are used in internal combustion engines in the same way as traditional types of fuel for internal combustion engines (diesel fuel, etc.), the only difference is in the origin.

Solid biofuels are used in various heating boilers, including those that generate electrical energy along with thermal energy. Until recently, we knew a few options for solid biofuels – firewood, peat, manure briquettes.

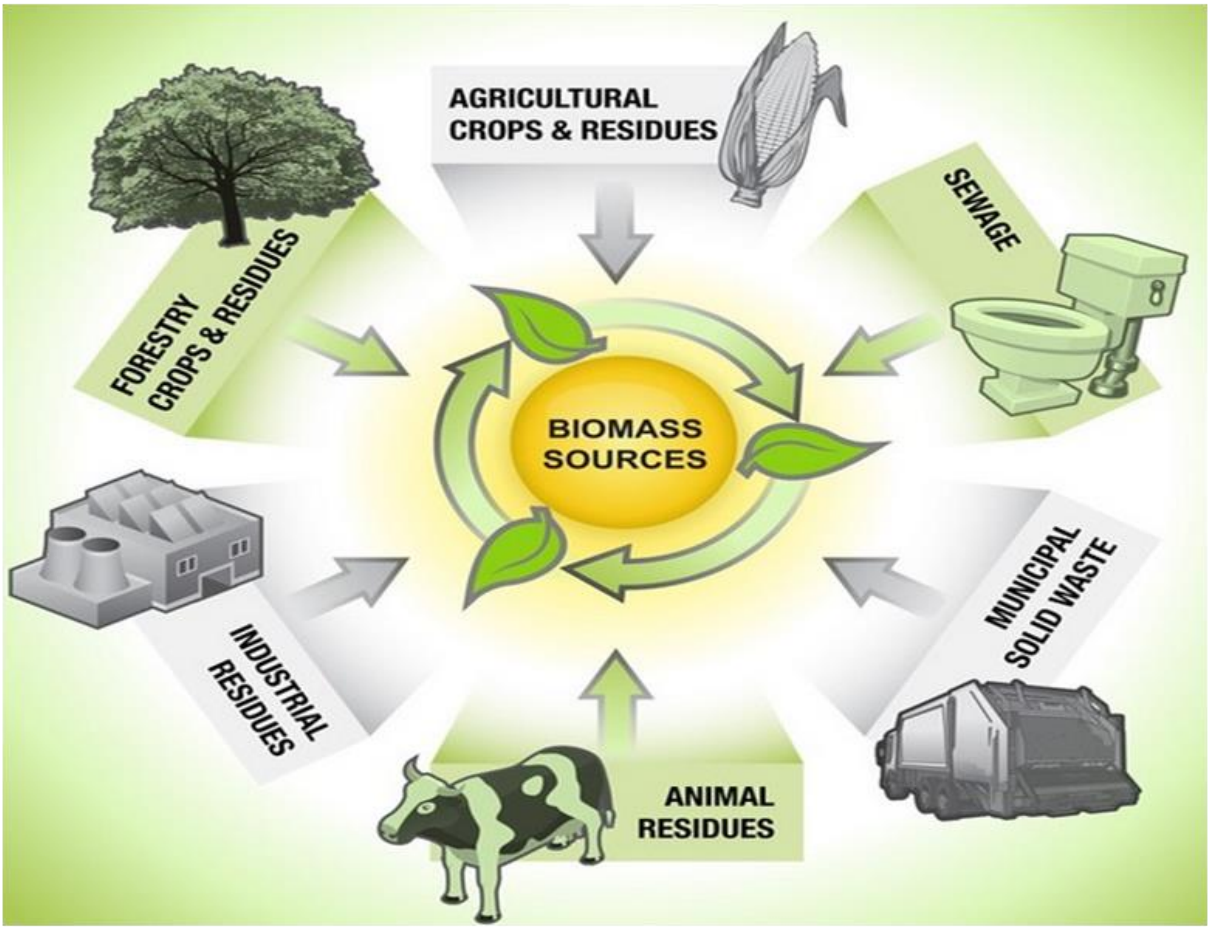

Fig. 1.6. Resources for biomass production

Gaseous biofuels are used for both heat and electricity generation. It is especially relevant where combustible gases are required (for example, for gas stoves, gas boilers, and so on). Recently, the production of gaseous biofuels has become important in individual country farms – to provide homes with heat and gas for stoves, in rare cases – to generate electricity.

Currently, bioenergy is actively developing, as this industry uses renewable resources to produce various types of energy (thermal and electric). Special attention is paid to the production of various types of biofuels from waste of biological origin: sawdust, straw, husks, bark, husks, manure, and so on. In addition, the world is actively producing liquid biofuels (for example, bioethanol and others), which are designed to replace traditional gasoline and diesel fuel in internal combustion engines.

For owners of country houses, it is especially interesting to produce biogas from various household waste by anaerobic digestion in special containers with bacteria. An ordinary household that uses only its own waste to produce biogas can get enough product to supply the kitchen with gas. If a country farm has livestock or crop production, the resulting biogas is enough for heating during the heating season. This ensures a certain degree of autonomy from external energy suppliers, and significantly reduces the cost of maintaining a country house and farm.

Advantages of energy resources:

- Economic availability of the material. Many countries spend a lot of money to buy oil or natural gas. The state's economy is suffering losses. You can get biological fuel in almost any country. Local fuel production reduces the cost of importing foreign energy resources.
- Mobility. Wind or solar installations are intended exclusively for stationary use. Cannot be transported. Biological materials can be transported from one region to another if necessary.
- Biological fuel is a renewable resource. The plant and animal waste will never disappear.
- A natural resource reduces the amount of greenhouse gas emissions into the atmosphere. Prevents the possibility of global warming.
- The use of biofuels for car engines reduces the cost of its maintenance.

Disadvantages and choice of place for growing the product:

- Climate. Some climate zones are not suitable for growing vegetable fuels. A natural spring does not grow in the depths of the tundra or in the desert.
- Cultivation of biomass disturbs the ecosystem. Clearing the territory for planting plants destroys the Microsystem of forests and other areas.
- A natural resource consumes a lot of water. Therefore, it is not possible to cultivate agricultural biomass in arid areas.
- Plant crops that are used as fuel in a time of growing need that extra nourishment. Some fertilizers for such plants harm the ecosystem.
- Aggressive behavior of plants for fuel adversely affects the authentic flora and the well-being of the entire ecosystem of a particular region.

1.5. Geothermal energy

Geothermal energy comes from the earth itself. Heat from the earth's core, which has an average temperature of 3,600 degrees Celsius, radiates toward the planet's surface.

Heating of springs and geysers underground at a depth of several kilometers can be carried out using special wells that supply hot water (or steam from it) to the surface, where it can be used directly as heat or indirectly for generating electricity by turning on rotating turbines.

Since the water below the earth's surface is constantly replenished, and the Earth's core will continue to generate heat relative to human life indefinitely, geothermal energy is ultimately clean and renewable.

Today, there are three main methods for collecting geothermal energy: dry steam, hot water, and the binary cycle. The dry steam process directly rotates the turbine drives of the power generators. Hot water is supplied from the bottom up, then sprayed into the tank to create steam to drive the turbines.

With binary cycle technology, warm water is extracted to the surface and combined with butane or pentane, which has a low boiling point. This liquid is pumped through a heat exchanger, where it evaporates and is sent through a turbine before being recirculated back into the system.

Almost everywhere, in shallow places below 3 meters from the surface, the earth has an almost constant temperature from 10° to 16°C. Geothermal heat pumps can use this resource to heat or cool buildings.

A geothermal heat pump system (Fig.1.7) consists of a heat pump, an air delivery system (air ducts), and a heat exchanger is a system of pipes located in shallow places near a building. In winter, the heat pump extracts heat from the heat exchanger and feeds it to the indoor air supply system. In summer, the reverse process occurs, and the heat pump transfers heat from the internal air to the heat exchanger. The heat removed from indoor air during the summer can also be used to provide a free source of hot water.

Some geothermal power plants use steam from the reservoir to spin the generator turbine, while others use hot water to boil the working fluid, which evaporates and then turns the turbine. Hot water at the surface of the Earth can be used directly for heat.

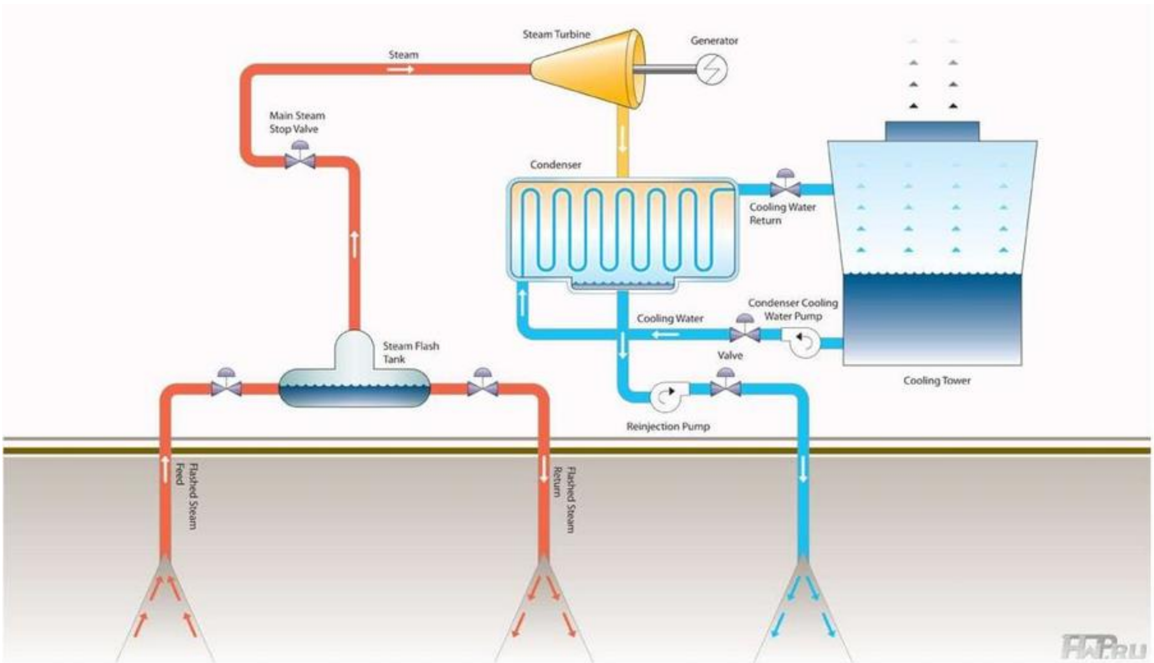

Fig.1.7. The principle of operation geothermal heat pump system

Advantages:

- Impressive reserves of geothermal energy. One of the main advantages of geothermal energy is that with proper operation, this source can be called renewable.
- Ecological compatibility. Geothermal sources and stations that operate them do not emit harmful substances. And those harmful substances that may occur during energy production are collected and processed (for example, oil or natural gas).
- Cost-effective operation. The station does not require large expenditures for its operation — only for scheduled maintenance, repairs and prevention.
- Added value. If the power plant is located on the seashore, it can be used for desalination. Water is distilled by heating and cooling the steam during the operation of the Geothermal power plant. In the future, this water can be used for drinking or artificial irrigation of land.

Disadvantages:

- Difficulties in approving the project. Problems arise at all stages of design: finding a suitable location, testing, obtaining permission from the authorities and the local population.
- Stop working at any time. It is difficult to predict a volcanic eruption or earthquake. The station may stop working even due to natural changes in the earth's crust. An unsuccessful choice of location for the construction of a Geothermal power plant also does not contribute to long-term stable operation. Another reason for the stoppage is the excess rate of water injection into the rock.
- If you do not use filters for emissions from the source, harmful substances may enter the environment.

In this section, various energy sources and converters were discussed. Each of them has its own advantages and disadvantages. Some depend on the time of day, time of year, etc. That's why people came up with the idea of combining several alternative energy converters into a system at once.

CHAPTER 2. ANALYSIS OF THE PARAMETERS OF AN EXISTING WAREHOUSE

2.1 Airfield Nizhyn

Nizhyn - the airfield of the Ministry of Emergency Situations of Ukraine, previously a military airfield, located in the northern part of the city of the same name Nizhyn, Chernihiv region of Ukraine, the administrative center of the Nizhyn region.

At present, the airfield is used by the Special Aviation Detachment OSS GZ GSChS of Ukraine. It is designed, independently or in cooperation with other civil protection units, to carry out the assigned tasks of protecting the population and territories, material and cultural values and the environment during the elimination of the consequences of emergencies, and carrying out special work in difficult conditions. Coordination and control of the activities of the Special Aviation Detachment of the OSS GZ GSChS of Ukraine is carried out in the manner determined by the GSChS of Ukraine The 1st class airfield has a concrete runway with a length of 3000x80 meters and is suitable for receiving aircraft of various types with a carrying capacity of up to 190 tons, in simple and difficult meteorological conditions, both during the day and at night.

The squad includes: control, manual.

Headquarters: Special Communications and Secret Regime Group, Meteorological Service; Mission Control Group; Financial and economic group.

Subdivisions: Special-purpose aviation squadron on airplanes, Special Forces Aviation Squadron in helicopters; Aviation Engineering Service; Search and rescue and paratrooper service; Recognition tools group; Department of information processing and objective control.

Security: Part of aviation technical and material support; Communication center (automated control systems and radio technical support); Medical service; Fire post; Security department.

At the moment, the airport has:

- An-30 (NATO codification: Clank - "Lazg") - aircraft for aerial observation and aerial photography. It is capable of carrying up to 18 passengers or up to 3000 kg of cargo.
- An-26 (according to NATO codification: Curly - "Curly") - military transport aircraft, for the characteristic sound of working engines received the nickname "The Ugly Duckling". Accommodates up to 40 passengers or 24 injured on stretchers accompanied by medical personnel. In the shortest possible time, it can be converted into a transport option for the carriage of goods with a total weight of up to 5500 kg.
- An-32P - flights to extinguish forest fires by draining the fire extinguishing liquid from the hinged drain units to the fires (the maximum mass of the fire extinguishing liquid is 8000 kg), parachutists - firefighters up to 28 people and firefighting equipment up to 10 packs of 100 kg each for extinguishing a forest fire; flights to patrol the territorial bases of aviation protection of forests, delivery to the airfield based in the area of forest fires of mobile filling stations. The aircraft can be converted into a cargo version for the transportation of goods (passengers), or their parachute landing, as well as a sanitary version for the transportation of injured places of emergency.
- Mi-8MTV (NATO codification: Hip) is a multipurpose helicopter, a modification with TV3-117 engines, at a time it can carry 2.5 tons of water using the VSU-5 spillway device, which is used to extinguish fires using helicopters
- Mi-8 -Multipurpose helicopter. Used likea firefighter or a transport vehicle for transporting goods in the cargo compartment and on an external sling

with a total weight of up to 3000 kg, as an ambulance, transports 3-6 wounded on a stretcher or 15 seated at a distance of up to 725 km.

- Eurocopter EC 145 is a Franco-German helicopter. Entered the Hermitage in 2009. Carries up to 8 passengers. The possibility of different use cases is provided - medical, rescue, patrol. The basic version allows you to perform the duties assigned to it day and night in simple and difficult meteorological conditions, from airfields and unprepared sites. The medical version provides for the installation of resuscitation equipment.

Naturally, all this requires a warehouse of spare parts for aviation equipment. Warehouse area 40 * 100 m2. It is necessary to calculate the energy consumption for lighting and the provision of a spare parts warehouse. Taking into account climatic conditions, what alternative energy sources are most suitable for the given premises. How much energy will solar panels on the roof give and what is the lack of energy.

2.2. Warehouse lighting

The warehouse is a room with special requirements, since it is a fairly large structure with high ceilings. Therefore, in order for it to be convenient and safe to work on, the level of illumination must be sufficient.

To find out how much light is required for a particular warehouse, the necessary calculations should be made. Any calculation of the required illumination level is based on several parameters:

- the purpose of the premises (the calculation is carried out based on the purpose of the warehouse). In our case, this is a warehouse of spare parts for aircraft;
- dimensions of the structure (4000 m2);
- the number of lamps that are available in the room (620 lamps);
- location of lighting devices throughout the warehouse (10 rows of 1 for every 1.5 meters of lamps);

ceiling height (9 meters);

- light sources that will be used to illuminate the warehouse.

2.2.1. Metal halide lamps.

These bulbs are gas-discharge lamps, so their work is due to an electric discharge in metal vapors.

Fig.2.1. Metal halide lamps

The main feature of MGL is the use of additional substances, for example, mercury vapors and halides, which in turn are in a gaseous environment.

When the luminaire is not working, vapors are deposited on the walls of the burner. When cracked, this "precipitate" forms vapors, and thus decomposes into ions. Thus, the glow of the MGL is obtained.

They are distinguished by a long service life, as well as good light output and color rendering. But their purchase will cost much more than other light sources. Unfortunately, such products are very harmful to health due to the content of hazardous substances inside.

2.2.2. Incandescent lamps.

Incandescent lamps (Fig.2.2) are sources of light, heat. Outwardly, it is a glass vessel with a tungsten spiral inside. The cavity itself in incandescent lamps is filled with an inert gas. It prevents metal elements from oxidizing. When switched on, an electric current is passed through the coil, resulting in heating and emission of visible light.

Fig.2.2. Incandescent lamps

Before the advent of energy-saving lamps, incandescent light bulbs were used in industrial areas, household use, etc. This application led to ease of installation and operation. But even now, these lamps can be seen often: Internal, external lighting of rooms, streets, offices. Workplace lighting. Car incandescent bulbs. A small lamp of this type is also screwed into the lanterns. On public transport, trains, etc. They are often used for emergency lighting, but recently their popularity has declined dramatically compared to other light sources.

2.2.3. Fluorescent lamps

Lighting a warehouse with fluorescent lamps is one of the most common solutions. Warehouses can also be lit using T5 fluorescent lights instead of LED lights. These luminaires contain multiple T5 tubes and a reflector that will divert the light towards the work area for optimal visibility. In addition, the installation costs for these luminaires are modest and the lighting quality is adequate.

2.2.4. LED warehouse lighting

LED luminaires have become the best solution in the lighting industry; they are very well suited for warehouse lighting. LED highbay luminaires (luminaires for high ceilings) offer maximum performance as well as exceptional quality and versatility. They use 60% less energy than traditional fluorescent and HID lighting systems. In addition, they are designed to reduce energy costs while still providing more lighting in the warehouse than conventional lighting systems.

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The advantages of LED warehouse lighting include, in particular, a longer service life. The height of the ceiling and the significant number of fixtures in this type of space result in significant maintenance costs. Replacing a simple light bulb often involves a complex process such as requiring the use of a forklift truck, which can be quite costly, hence the cost of labor to replace the bulbs.

LED maintenance and energy consumption are modest, two factors that represent the main benefits in large spaces with high ceilings.

Finally, the LED lighting system significantly reduces heat output. Therefore, there is no need for air conditioning in the warehouse to counteract the heat generated by the lighting fixtures, as LED lighting minimizes the cost of air conditioning. We call this “cross-light conversion effect,” and it is an important consideration when calculating cost savings.

Warehouses with high ceilings require a special lighting system to ensure that the space is bright enough to work with. High ceiling LED luminaires are designed for installation heights from 6 to 20 meters and provide the required illumination level for at least 60,000 hours. They are well suited for high ceilings and provide excellent quality, high quality lighting. They provide constant brightness with both direct and indirect illumination. Many ceiling lighting solutions offer additional features that are ideal for warehouse installations, such as preventing light loss due to dust build-up, protecting luminaires from damage and making them easier to maintain.

These are the lamps that are used in the spare parts warehouse for aircraft. Industrial LED lamp with a power of 100 W is used to illuminate high industrial premises, warehouses, hangars (Fig.2.3).

Fig.2.3. Industrial LED lamp with a power of 100 W

Luminaire advantage:

- high-quality light, no flicker, with a low loss of brightness during operation, no more than 3% in 10,000 hours.
- high color rendering index, reproduces colors without distortion (CRI> 85).
- energy efficient diodes with light output from 162 lm / watt.
- long service life of LEDs 100,000 hours.
- environmentally friendly - during production, operation and disposal there are no harmful emissions, UV radiation, and the fire hazard is also reduced.

Power (W) - 100

Luminous flux (lm) - 16200

2.3. Energy consumption calculation

It is necessary to calculate the minimum energy consumption depending on the season using average values.

2.3.1. Calculation of consumption by light sources

So, to calculate electricity consumption must be multiplied by the number of hours. The power of 1 lamp is 100 W. There are 620 lamps in stock. Work 12 hours a day. One lamp per day consumes:

100 W * 12h = 1200W = 1.2kW

This means the minimum power consumption:

1.2kW * 620 = 744kW / day

2.3.2. Calculation of consumption for room ventilation

High-quality warehouse ventilation is necessary to ensure labor safety and optimal storage conditions for products. When equipping the ventilation system, it is necessary to adhere to the norms of the frequency of air exchange.

The microclimate parameters in warehouses and the frequency of air exchange are prescribed in **DSN 3.3.6.042-99.**

The air exchange of the warehouse is necessary to achieve two goals:

- creation of a special microclimate of the room, optimal for storing this type of product.
- Removal of harmful, explosive and other impurities and aerosols from the premises.

To ensure normal sanitary and fire safety conditions in the workshop, it is necessary to remove from each machine: sawdust, shavings, dust, harmful gases. This is done using pneumatic conveying, aspiration and ventilation systems. To eliminate the air imbalance in the workshop, an intake ventilation system is designed to supply air to the workshop.

With all the variety of ventilation systems due to the purpose of the premises, they can be classified according to the following main features:

- purpose (exhaust and supply);
- scope (local and general);
- a way to create pressure drops to move air (with natural and mechanical impulse);
- design features (channel and channelless).

Exhaust systems are designed to remove polluted air from rooms. Supply systems serve to supply clean air to ventilated rooms instead of remote air. The supplied air, if necessary, is subjected to special treatment - cleaning, heating, humidification. In the general case, both supply systems and exhaust systems are provided in the room, and their performance should be approximately the same.

Local ventilation systems serve limited areas of the premises. With their help, polluted air is removed from the places where harmful emissions are formed and clean air is supplied here. General exchange systems, both supply and exhaust, are designed to ventilate the room as a whole or a significant part of it. They are arranged to localize excess heat and moisture, dilute harmful concentrations of vapors and gases not removed by local and general exhaust ventilation, as well as to ensure the calculated sanitary and hygienic standards. With a negative heat balance, that is, with a lack of heat, general exchange supply ventilation is arranged with mechanical stimulation and heating of the entire volume of supply air. Usually, the air is cleaned of dust before supply.

The movement of air in natural ventilation (aeration) systems occurs under the influence of pressure arising from the temperature difference between the outside air and the air in the room, as a result of the effect of wind on the building, as well as the combined action of these factors. Aeration is not used if the technology requires preliminary treatment of the supply air or if the influx of outside air causes the formation of fog or condensation.

Ventilation systems, depending on different characteristics, are classified into the following types:

- by the method of ventilation: supply (provide air supply from the street to the room), exhaust (remove exhaust air from the premises), supply and exhaust (simultaneously provide forced air supply and exhaust);
- according to the main function: basic (provide ventilation of premises in operating mode), emergency (designed to work in case of failure of the main system or in emergency situations);

- by design features: channelless (operate without a duct network), ducted (air is distributed in rooms through a duct network);
- by the covered area: general (provide service to the entire building), local (intended to serve individual areas or rooms of the building).

The most important classification feature is the way the flow is induced to move. On this basis, natural and forced ventilation systems are distinguished. In the first case, air movement is provided without the use of special equipment, and fans are used in forced systems.

Natural ventilation systems are used in warehouses of relatively small dimensions, provided that they accommodate goods that are not demanding on storage conditions. Large warehouses require large volumes of air to be pumped. Only forced ventilation systems can cope with this task. They are also used in cases when products placed in a warehouse require special storage conditions.

Room ventilation is calculated for each type of air pollution.

The calculation is based on the amount of supply air required for normal operating conditions. The calculation of the exhaust ventilation is performed after the calculation of the supply ventilation and is based on ensuring the balance of the supply and exhaust air at the facility. Depending on the characteristics of the warehouse facility, the calculation can be made:

- excess heat
- with increased moisture content
- calculation of personnel allocations

Most often, in warehouse facilities, ventilation is calculated to reduce indoor humidity. For the calculation, you need to know the temperature of the outside air, indoor air and their relative humidity: tн, tв, jн, jн. From these indicators, we can obtain the absolute humidity dн and dв.

The requirement for maximum energy savings is officially enshrined in the Ordinance on Thermal Protection of Buildings. With this requirement in mind, all engineering equipment systems for buildings and warehouses should be designed and created. Against the background of increased attention to the thermal insulation of buildings under construction, ventilation and air conditioning technology is becoming increasingly important, especially in newly constructed buildings. These systems must fully comply with the state of the art.

While conventional heating systems only determine the thermal behavior of a building, air conditioning systems are capable of performing broader special tasks for indoor air quality, influencing not only its temperature, but also humidity and cleanliness. Thus, of course, a significant contribution is made to the preservation of human health and working capacity, and at the same time another positive effect is achieved, namely, the problem of protecting buildings from moisture accumulations in the walls of structures and on the walls themselves is solved and the sound insulation of buildings is noticeably increased. For reasons of hygiene and taking into account a number of physical aspects, it is imperative that air saturated with moisture and containing harmful substances and odors be removed from the premises from the construction industry.

As a rule, a recuperator is installed in such an installation, this is done to reduce the cost of electricity. A reasonable solution to install a recuperator in a warehouse of 1000 m2. There are rotary and plate recuperators. As a rule, most of them use plate recuperators, because of its simple design, low cost, and high efficiency. The disadvantage is freezing of the plastic at low temperatures, in which case it is better to install a rotary recuperator.

- In cases where it is necessary to reduce the humidity in the room, it is allowed to ventilate it only if the absolute humidity of the outside is lower than the absolute humidity in the room.
- If it is necessary to lower the humidity and temperature in the room, then ventilation is allowed in cases where the temperature and humidity outside the room are lower than the temperature and relative humidity inside.

The calculation of electricity consumption for supply and exhaust ventilation is done by the amount of air to be removed from the workshop for an hour. For this, it is necessary to have data on the amount of exhaust air from each piece of equipment.

Summing up the amount of exhaust air from all equipment in the enclosure, the amount of exhaust air is obtained.

$V = S * H$= 4000 * 12 = 48000 m3 / h

H-height of the warehouse

S - warehouse area

There are 400 hoods, each of which consumes a minimum of 18 W / h in the cold season, a maximum of 25 W / h in the warm season.

So, the cost of electricity in winter per day will be equal:

$$400 * 18 * 24 = 172800 \frac{W}{day} = 172.8 \frac{W}{day}$$

In the summer:

400 * 25 * 24 = 240000 = 240 $\frac{kW}{day}$

2.3.3. Calculation of consumption for space heating

Heating of warehouses is an important part of the design of a warehouse; the heating system should be located in an easily accessible place for direct service. Heating systems are air and water. Hot water heating is usually installed along the walls where the heating runs, which allows it to be installed quickly and conveniently. The downside is the slowness of the temperature drop. Air heating is used everywhere and is connected to the supply ventilation system, which allows us to provide the warehouse with heat and fresh air in a short period of time. It is also beneficial to use such a system in rooms with high ceilings, which cannot be said about a system with water heating. High efficiency up to 95%. The disadvantage is its size due to the large air transport.

With the initial data:

- Room length - 100 (m.)
- Room width - 40 (m.)
- Ceiling height - 12 (m.)

- Outdoor temperature in cold seasons from -29.98 to 13.2 (° C)
- Required room temperature from 13 to 18 (° C)

Minimum energy consumption at an ambient temperature of 10° C, required room temperature 15 ° C, will be equal to 209 kW / h, which means that 2508 kW / day will be spent on the shift.

Average energy consumption at an ambient temperature of -7° C required room temperature 14 ° C, will be equal to 879 kW / h. At this temperature, it is already necessary to heat the room around the clock, and this is already 21096 kW per day.

And at minimum temperatures (-20° C) to a temperature of 12-13 ° C in the room, it is necessary at all 1339 kW / hour, and it goes out per day, and this is already 32136 kW / day.

Therefore, heating will be an unprofitable solution.

2.3.4. Minimum energy consumption depending on the season

Even taking into account our own boiler house, energy costs are simply colossal.

In winter, the minimum electricity consumption is 69.2 kW / hour or 916.8 kW / day.

In summer, the same costs are 72 kW / hour or 984 kW / day.

CHAPTER 3 JUSTIFICATION OF THE STRUCTURE OF THE POWER PLANT

Before proceeding further, it is necessary to choose which alternative energy sources are most suitable for a given region.

3.1. Wind power plants

The choice of locations for wind turbines should be made in areas with favorable wind conditions, ensuring the economic feasibility of using wind energy (Fig.3.1).

In areas with average annual wind speeds of 6 m / s and above, the use of wind turbines becomes profitable for wind turbines of any purpose in a wide range of capacities. The design of wind power systems for areas with average annual wind speeds below 6 m / s requires additional justification with the calculation of the expected energy production and its comparison with the demand data and an assessment of the acceptability of the results obtained in terms of economic indicators for specific consumers.

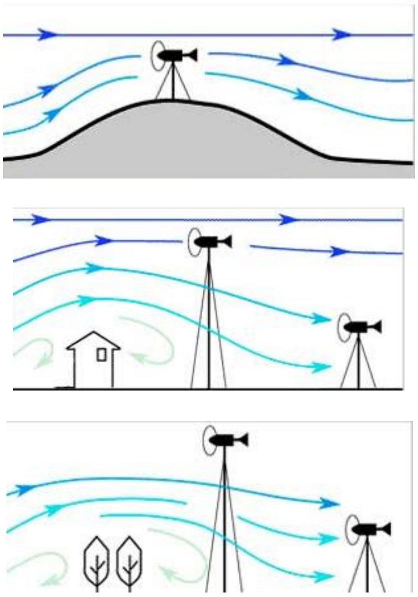
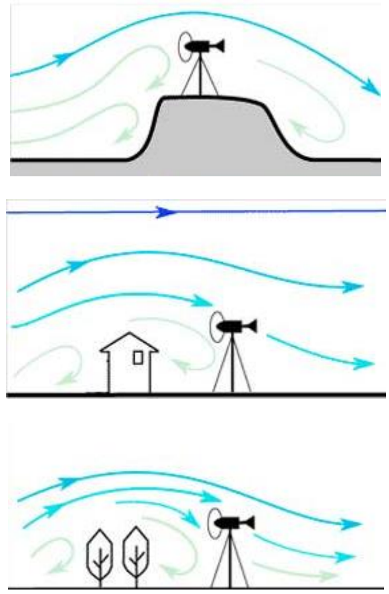
Right	Wrong
	

Fig.3.1. Correct and incorrect location of wind farms

Avoid places with a concave relief, as well as places near forests, residential buildings and industrial facilities, which can interfere with the unhindered access of air masses to the wind turbine. In this case, it is necessary to pay special attention to the elimination of interference on the path of the wind in the directions carrying the predominant part of the energy.

The project of a wind power station should provide for the placement of wind turbines in a fenced area inaccessible to unauthorized persons. Otherwise, the construction of a fence around the wind turbine should be provided. Safety warning posters must be installed.

The wind turbine should be removed from residential premises, hospitals, schools and holiday homes at a distance that reduces the noise level generated by the operating wind turbine to a level of 45 db.

The site for the construction of wind turbines should be located outside the designated area of the location of railways and highways, power lines, gas mains, cable and water lines.

Wind turbines should not be installed on the paths of the main routes of migratory birds, as well as located near their mass nesting sites.

If a wind turbine has a noise, visual or other impact, then the selected site for the construction of wind turbines must be agreed with the local administration of the area where the wind turbine is located.

The most favorable places are considered to be elevated and flat areas, places close to sea coasts, valleys of large rivers and reservoirs.

Unfortunately, there are not many regions in our country where the wind speed is at least 5-7 meters per second. The data is taken on average for the year. In the overwhelming majority of latitudes suitable for habitation, this very speed is equal to a maximum of 2-4 m / s (Fig 3.2).

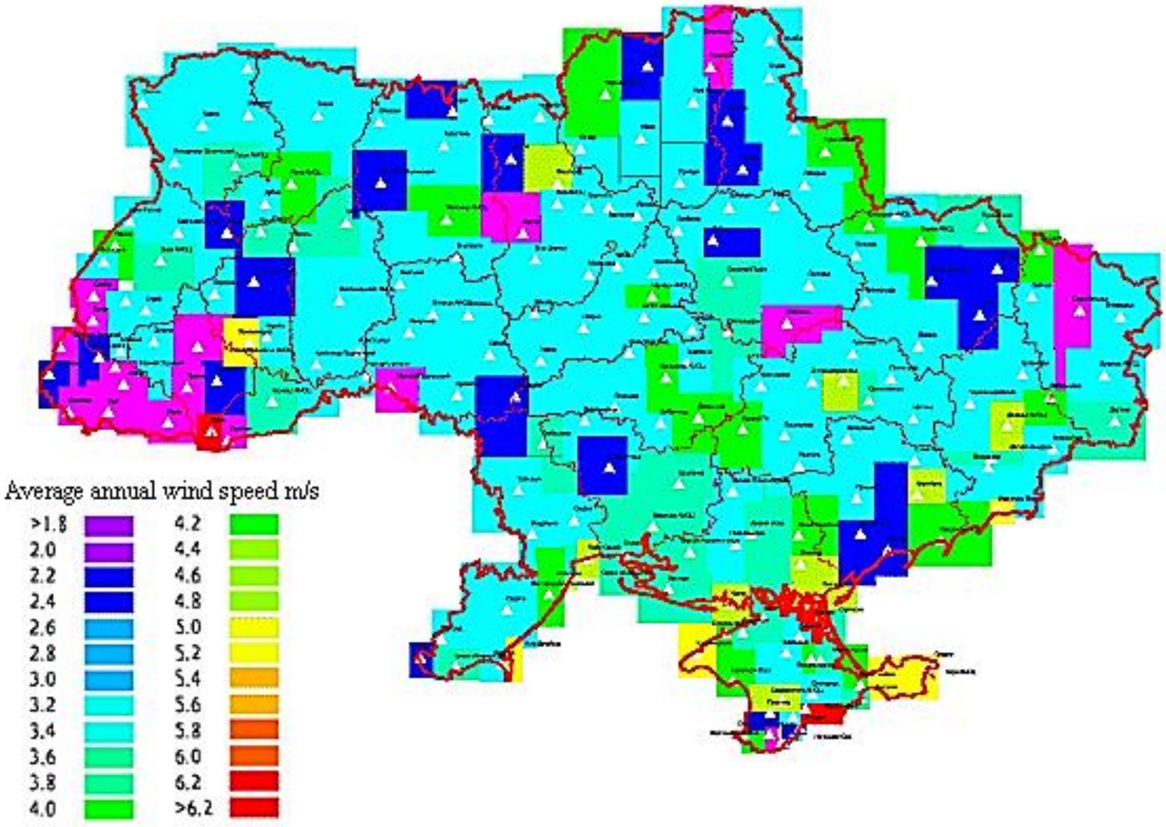


Fig.3.2. Average annual wind speed m/s in Ukraine

This suggests that your wind turbine will not work most of the time. For a stable generation of electricity, it needs a wind of about 10 m / s.

If the wind is 7m / s in the region, then the generator will operate at a maximum of 50% of its nominal value. And if only 2m / s, then by 5%.

The tilt of the earth's axis and the variety of landscape forms lead to differences in wind speed in different regions. And for a wind generator, it is this parameter that is the most important operational characteristic, which determines the possibility of its use for generating electricity. Therefore, the choice of wind turbines begins with finding the value of the average annual wind speed for a given area.

A wind map or wind energy inventory is used for this. The numbers given in them are indicated for a distance from the surface of 10 meters. To get into the zone of stronger winds and avoid the influence of turbulence, wind turbines are often installed at a different height (Fig.3.3).

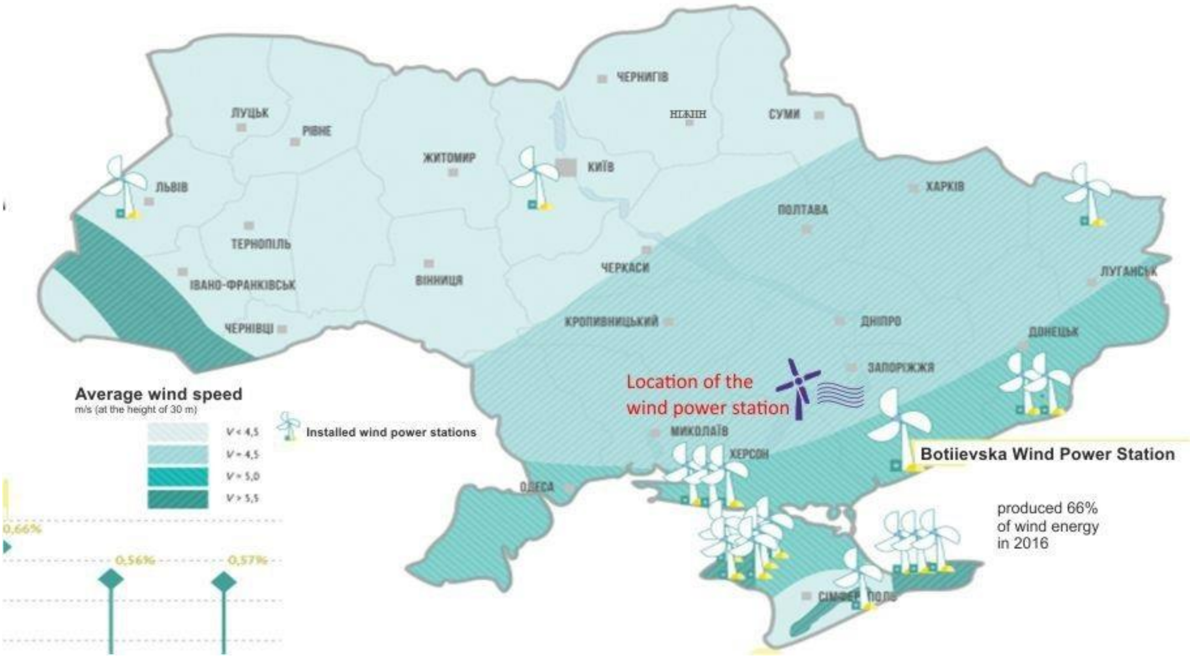


Fig.3.3. Average wind speed m/s in Ukraine

After analyzing the data for the October-November 2020 (Fig 3.4), we came to the conclusion that the wind speed in the city is not high enough.

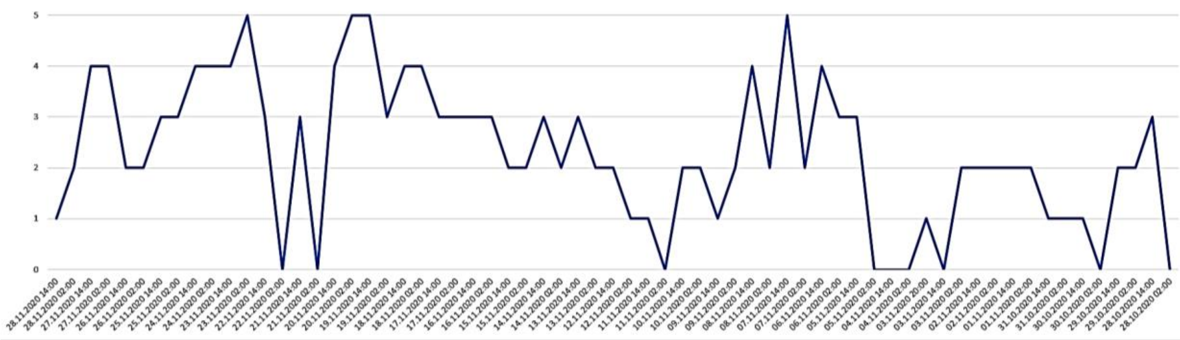


Fig. 3.4. Wind speed in Nizhyn for October-November

In addition, the city of Nizhyn is located in a lowland, which does not contribute to the operation of wind farms.

3.2. Solar panels

How efficiently solar power plants work depends on the amount of solar radiation they receive. This amount of solar radiation is usually called the level of insolation.

Insolation is the amount of solar energy that falls per unit area in a given area during the year. It should be understood that the presented insolation maps of the territory of Ukraine are averaged data for a certain number of years, usually 10 years of observations are taken for analysis and averaging. Therefore, data and metrics may fluctuate depending on the freshness of the data. Usually, the most recent and relevant data from the meteorological service and NASA are offered to buy, and the publicly available insolation maps of Ukraine, although somewhat outdated, are quite suitable for calculating solar power plants and collectors.

The higher the insolation, the more energy the modular structural elements will give at the output, they can be smaller in size. If the sun exposure is low, more larger elements will be required.

It is possible to calculate insolation manually using a certain algorithm; there is also a computer program.

The level of insolation in Ukraine is unevenly distributed, while it cannot be said that it depends only on latitude - the farther south, the higher it is. The Carpathian Mountains exert their influence - in the western regions the level of insolation is lower than at the same latitude in the east. Another example - the level of insolation in the Dnieper is lower than in the north of Kiev. In general, the level of insolation in Ukraine ranges from 1150 kW * h / m2. per year (western region) up to 1550 (Black Sea region, in particular - Izmail and the southern part of the Odessa region).

It should be understood that the performance of a solar power plant is mainly influenced by the amount of solar radiation, and not by the air temperature. In winter, when the sky is clear, the production of electricity is higher than in the gloomy spring days. An additional increase in generation in winter can be provided by snow cover due to re-reflection of solar radiation. This increase is especially noticeable if double-sided solar panels are installed.

Another advantage of Ukraine is the fact that with a sufficiently high level of insolation, the temperature regime is quite moderate. After all, at too high temperatures, the volume of electricity generation decreases due to the heating of the solar panel. On average, power losses are about 5% when the panel is heated by 10 degrees (starting from 20 - 25 degrees).

The city of Nizhyn is located in the orange zone, which means that the potential is over 1200 kW / m2 (Fig.3.4.).

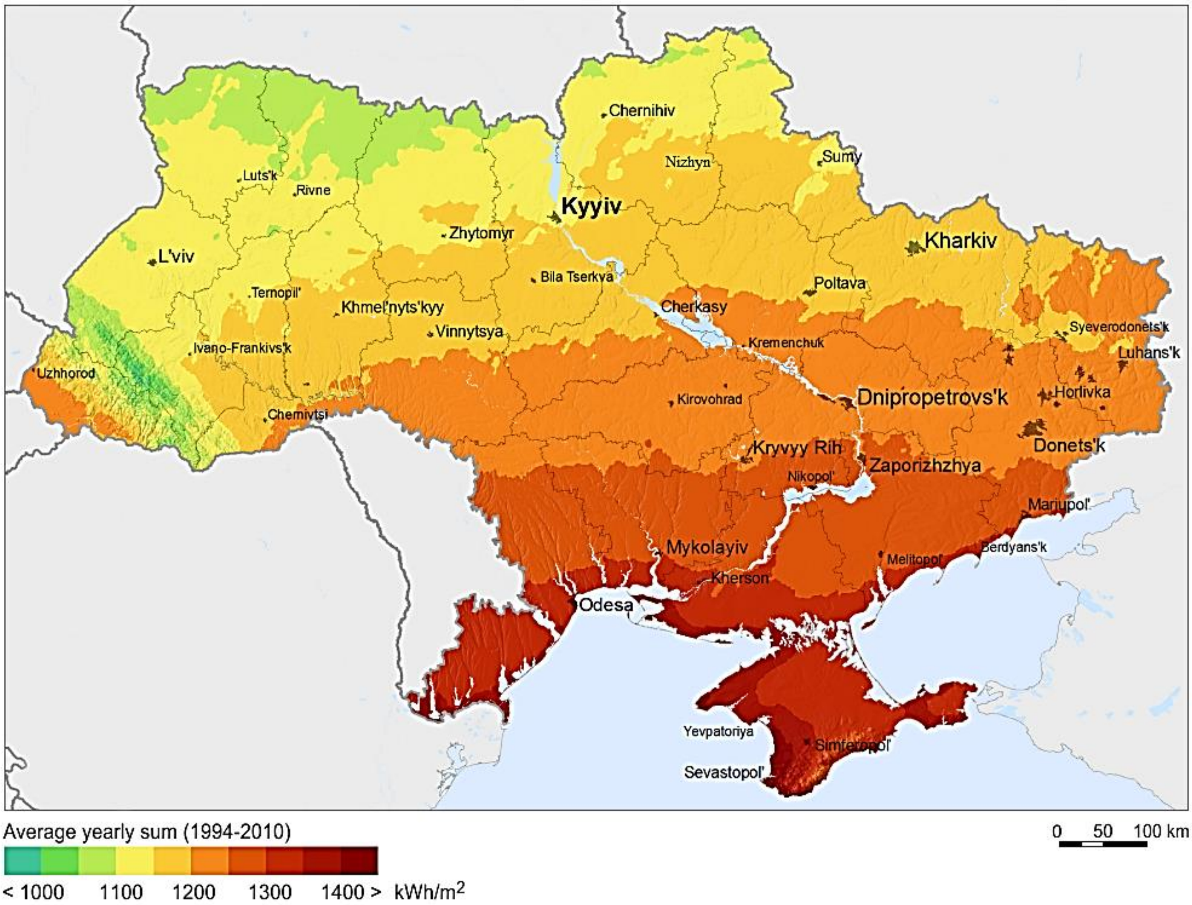


Fig.3.4. Average level of insolation in Ukraine

Before you purchase equipment for a power plant and install it yourself or with the help of specialists, you need to take into account many nuances. They relate to position, system environment, and costs. Correct installation of solar panels will allow the system to operate smoothly and recoup the costs a hundredfold.

Pay attention to the environment and shade. The energy source for a private power plant is radiation from the sun. It makes sense that it should be enough. A building located in the shade of trees or other private buildings will receive less electricity than a building located in direct sunlight.

Pay attention to the type of panels you are purchasing:

- polycrystalline in the shade only reduces energy output;
- monocrystalline in the shade will completely stop energy production.

Before installing solar panels, check if the surface where they will be placed is shaded, especially between 10:00 and 14:00.

Electricity will be generated more efficiently the longer the panels are exposed to direct sunlight.

If one part of the roof is darkened and the other is not, it is recommended to connect them to different trackers. The most common solar panel mount is on the roof. The work of modular elements of the system here does not often depend on the shadow, but it also has some peculiarities.

The structure should not be at an angle less than 40 degrees. Too sharp an angle for receiving solar energy has low efficiency: the owners with their own hands can ruin the operation of the system (Fig.3.5).

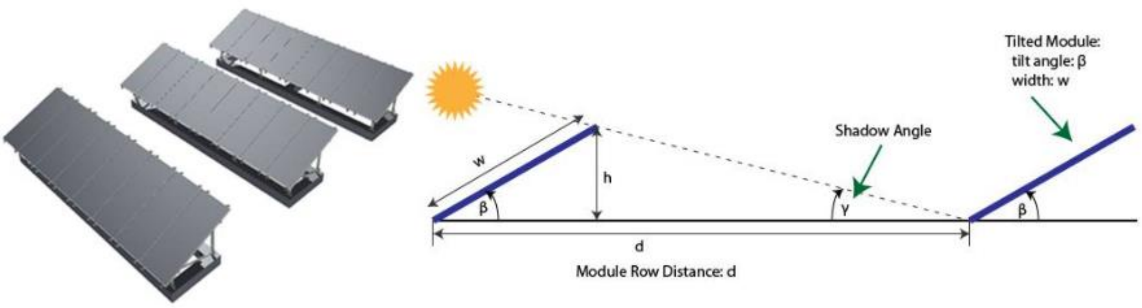


Fig.3.5. The position angle of the solar panel

To compensate for the angle of inclination, if necessary, the structure is installed on the frame or part of the roof is dismantled.

We use fixed panels, which means that the most suitable angle for the panel is 60 °

The photocells of the system must receive the maximum flow of sunlight. That is why it is necessary to place the structure in the sun. In the northern hemisphere, the faceplate should face south, and in the southern hemisphere it should face north.

The size of the structure of a private solar power plant does not depend on the size of the building itself. The main thing here is to take into account insolation and the amount of energy you need (see Fig.3.6).

Fig.3.6. Location of solar panels on the roof

3.3. Bioenergy plant

In non-traditional energy, a special place is occupied by the processing of biomass (fig.3.7) (organic agricultural and household waste) by methane fermentation to obtain biogas containing about 70% methane and disinfected organic fertilizers. The utilization of biomass in agriculture is extremely important, where a large amount of fuel is consumed for various technological needs and the demand for high-quality fertilizers is constantly growing. In total, about 60 varieties of biogas technologies are currently used or developed in the world.

Fig.3.7. Biogas plant

Biogas is a mixture of methane and carbon dioxide formed during anaerobic digestion in special reactors - digesters, arranged and controlled in such a way as to ensure maximum methane release. The energy obtained from the combustion of biogas can reach 60 to 90% of that of the starting material. Another - and very important - advantage of the biomass processing process is that its waste contains significantly fewer pathogens than in the original material.

Biogas production is economically justified and is preferable when processing a constant stream of waste (effluent from livestock farms, slaughterhouses, plant waste, etc.). Cost-effectiveness lies in the fact that there is no need for preliminary waste collection, organization and management of their supply; it is known how much and when the waste will be received. Biogas production, which is possible in installations of various sizes, is especially effective in agro-industrial complexes, where there is a possibility of a full ecological cycle. Biogas is used for lighting, heating, cooking, for driving mechanisms, transport, and power generators.

Due to these initial biological properties of the technical process of a biogas plant, it is impossible to absolutely accurately calculate in advance such output parameters as a specific set of chemical reactions, the depth of decomposition of biomass, specific yield of biogas and its composition. The number of "external" factors influencing the technical process (control actions) is very limited. Typically, these are the temperature, temperature gradient and rate of change of temperature inside the reactor, the degree of tightness of the reactor, the frequency of feeding into the reactor and the size of the portion of the fresh feed, the frequency of sludge removal, the frequency and duration of the substrate stirring cycles inside the reactor. Natural "internal" factors are described by thousands of possible parameters. There may be more than a thousand types of bacteria involved in the process alone,

It is almost impossible to calculate all this. Therefore, when designing biogas plants, experimental results are used, obtained in laboratory plants, simulating the required technical process in miniature. Also, statistics of operating large biogas plants are collected. Statistical data are processed, grouped, and as a result, tables of recommended process parameters and approximate output parameters are obtained when using various types of raw materials. But the spread of values in such tables is up to 50%.

Therefore, it is possible to predict, for example, the daily yield and composition of biogas for a projected biogas plant with just such an accuracy. To increase the accuracy of calculations to several percent, it is necessary to conduct a laboratory experiment and the corresponding measurements. Nevertheless, the simplest calculations will allow at least to estimate the boundaries of the biogas outlet, especially the upper one.

There are three methods of obtaining gas. The modes differ in temperature, which directly affects the quality and quantity of the final product.

Psychrophilic. Psychrophiles or cryophiles are bacteria that can only multiply at relatively low temperatures. In this case, it is minimal in a biogas plant - from 5 to 25°. These conditions are unfavorable: decomposition occurs at a slow pace, little gas is formed, and it itself is of rather low quality.

Mesophilic. In this mode, the temperature in the chamber is much higher: it ranges from 25 to 45°. These conditions are ideal for the multiplication of mesophilic bacteria that prefer moderate temperatures: neither hot nor cold. The processing process takes much less time (10-20 days), and the amount of gas increases.

Thermophilic. Heat-loving bacteria proliferate at 45-50° C or higher. In this case, production takes only 3-5 days, and the gas yield is maximum. If you create ideal conditions for microorganisms, then 1 kg of manure can turn into 4.5 liters of biogas.

The process of active gas formation with the thermophilic method begins after 12 days. But even minor temperature differences (2° C decrease) lead to reduced gas output. With the psychrophilic method, the processing speed is low: the formation of a large amount of biogas begins after 30-80 days.

To create such a biogas plant, high-quality thermal insulation of the complex, constant heating and temperature control devices are required. The equipment will provide the largest yield of a gaseous product, but the thermophilic method has a small drawback: it is the impossibility to add waste if processing has already begun.

Designing biogas plants is impossible without acquaintance with their scheme. Its main element is a reactor, or bunker, in which the fermentation process and gas production take place. In addition to it, there should be separate bunkers (hatches) for loading / unloading products - raw materials and finished fertilizers. A pipe is inserted into the upper part of the bioreactor, designed to remove the formed gas.

After it, a system is placed for gas refinement - its purification, increasing the pressure in the gas pipeline to a working condition. Mesophilic and thermophilic modes require a bioreactor heating system. This role is usually played by gas boilers that run on the produced fuel. The device is connected to the bioreactor by a pipeline system. For them, polymer pipes are used that better tolerate the effects of aggressive media (see figure 3.8).

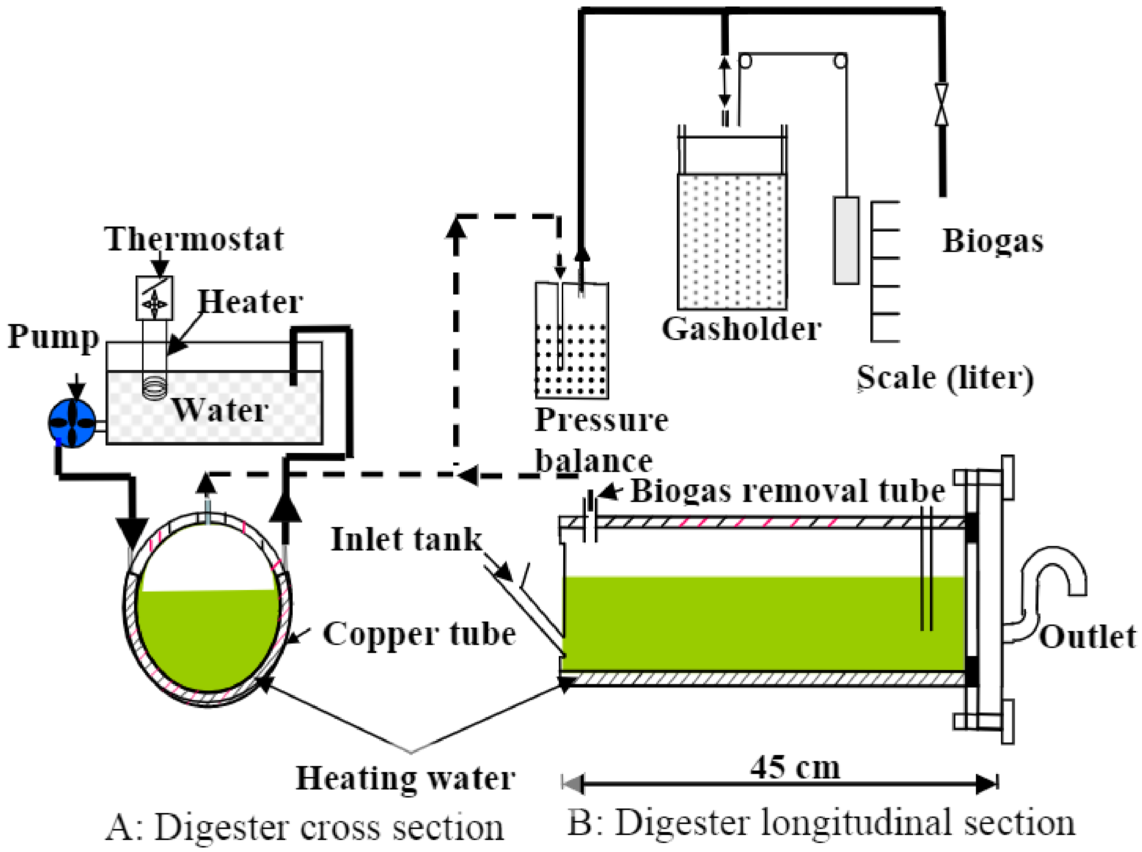


Fig.3.8. Schematic diagram of a horizontal bench biogas boiler.

A system for mixing decomposing raw materials is the next essential element. The gassing process is hindered by a crust that forms on the surface and solid particles that invariably accumulate in the bottom of the container. To ensure the homogeneity of the biomass, mixers are used, either mechanical or automatic. The former require manual labor, the latter are started with a timer. Automated systems will cost significantly more, but the process will require a minimum of attention.

These systems are classified according to the type of installation. They are elevated, semi-buried, or buried. The latter promise a decrease in heating costs, a simpler arrangement of the thermal insulation of the system, therefore, when planning the design of biogas plants, it is better to take into account that this more costly method is still optimal for Russian realities. He has one minus: it is the need for earthworks.

Before starting this stage, you need to find the perfect location for the system. To ensure convenience and minimize costs, it is recommended to locate the biogas plant near the source of raw materials - from buildings where animals are kept. The best option is gravity loading. In practice, this is done with a pipeline sloping towards the reactor (see Fig.3.9).

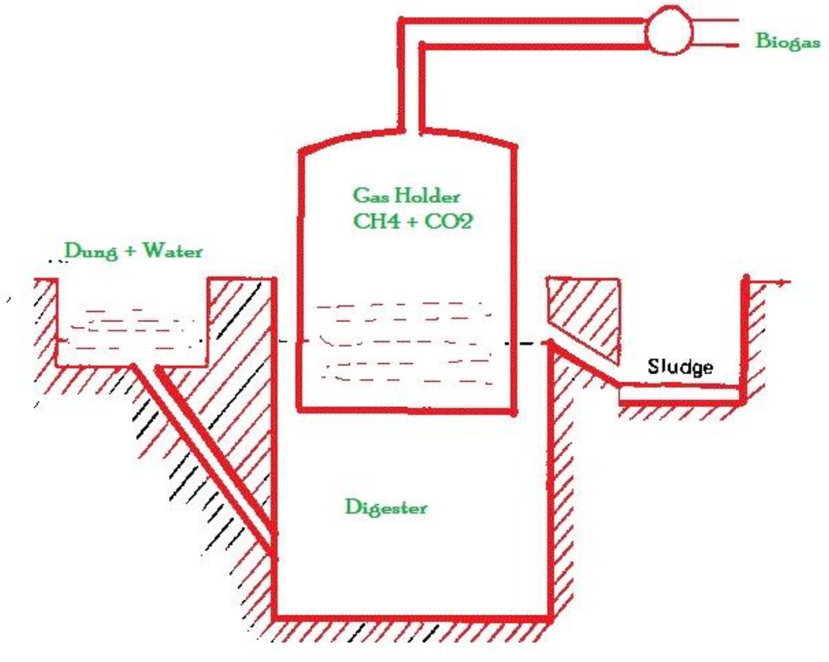


Fig.3.9. Biogas plant design

This method will give a chance to minimize manual labor - manure removal and system maintenance. The only drawback can be considered the remoteness of housing for animals from home. However, it is easier to stretch a pipeline to it than to create a line designed to transport and load raw materials - dung and manure.

Bioreactor (Fig.3.10) and materials for it. There are quite serious requirements for the main capacity.

Fig.3.10. Bioreactor

Tightness and maximum strength. The raw materials should not have any contact with the external environment, even a microscopic gas hole will make the whole process meaningless. In addition, the liquid must not pollute the surrounding space. Only a strong container will allow the vessel to withstand the mass of the loaded raw materials, as well as the pressure created by biogas and soil.

Convenience for equipment maintenance. In our case, the optimal vessel is a cylindrical container that will facilitate mixing and avoid the appearance of stagnant areas. It can be either vertical or horizontal. Rectangular bioreactors are more convenient if the biogas plant is made independently, but their weak points are the corners where cracks form, and the substrate cannot be mixed well.

If the container is available and meets these requirements, then there are no problems. When it is not there, you will have to look for a suitable option. The main condition for materials is the absence of fear of aggressive environments, since biomass can have an alkaline or, conversely, acidic reaction.

- Metal

The first strong candidate is metal (see Fig.3.11), which allows the reactor to be shaped in any shape as long as the owner knows how to handle the welding machine. If the farm has an old but strong cistern, then the problem can be considered almost solved. To minimize the risk of its destruction due to constant contact with chemically active substances, the metal container must be protected with an anti-corrosion coating.

Fig.3.11. Metal bioreactor

- Polymer

Plastic is the second worthy contender. It does not rust, does not rot, it is chemically correct, as it "observes neutrality." However, there are several stringent requirements for the polymer material. The walls of the container should be thick, ideally if they are also reinforced with fiberglass. Such a bioreactor can easily withstand pressure and heating to a relatively high temperature. The disadvantage of this container is the high price, plus the durability.

- Concrete blocks, stone, brick

This is the last option that can be considered by those who are used to working with masonry, or have familiar craftsmen. In this case, it must withstand heavy loads, therefore, it must be reinforced every 3-5 rows. To ensure the impermeability of the walls, it is recommended to make a multi-layer treatment of the walls, internal and external. They are plastered with a cement-sand mortar with special additives that guarantee gas and water protection.

- Main hopper dimensions

The volume of the future reactor depends on the selected temperature regime of production. For the independent construction of a biosystem "from manure to gas", the mesophilic method is often preferred, since such an installation is much easier to maintain. Another advantage is the ability to recharge the reactor. If the conditions are ideal, then the formation of biogas is quite stable. To calculate the volume of the reactor, the starting point is the amount of manure and droppings that appear on the farm per day. It is necessary to provide average statistical data:

chickens - 0.17 kg, humidity - 75%;

pigs - 4.5 kg, humidity 86%;

Cattle - 40 kg, humidity - 86%.

For the decomposition of manure in a mesophilic regime, it takes 10-20 days. To calculate the volume, the mass is multiplied by the number of days. When calculating, do not forget about water, which may have to be added: the ideal moisture content of the prepared (crushed) biomass is 85-90%. The result obtained is increased by 50%, since the biomass should not occupy more than 2/3 of the tank volume, it is necessary to leave room for gas.

- Loading, unloading

Bins and hatches for the entry and evacuation of products are made in opposite sides of the container, this foresight will make it possible to evenly distribute the substrate. If buried equipment is planned, then pipes, both loading and unloading, are mounted at an acute angle.

Their lower end should be located below the biomass level so that air does not enter the tank. Pipes are equipped with valves: rotary or shut-off. They are only opened during loading / unloading. The recommended diameter is 200-300 mm, a smaller size will lead to permanent clogging of them with large undigested fragments. The pipes are connected after the installation of the tank, but before it is insulated.

The optimal mode of operation is production with regular loading of new raw materials and disposal of waste. This operation is carried out every 1-2 days. The mass is collected in a storage tank, there it is crushed, if necessary, add water, stir. A stirrer, even a mechanical one, will minimize manual labor. If this receptacle is placed in a sunny place, then the heating costs will decrease.

The installation depth of the reactor must be such that manure can move without human intervention. The damper should be closed during the accumulation of raw materials in it. To ensure the tightness of the installation, rubber seals are provided for the intake and discharge area. The minimum amount of air in the main tank is the chance of a clean gas escape.

- Biogas collection and disposal system

The gas discharge pipe is mounted on the upper surface of the tank. Its other end is released into a sealed container filled with water. It is called a water seal. The second pipe, located above the liquid surface, receives the cleaned gas. A shut-off valve is installed at the outlet, a ball device is usually recommended.

Different methods are used to get rid of biogas from impurities. Carbon dioxide can be eliminated by pouring slaked lime into the water seal, but it will have to be changed periodically. Hydrogen sulfide is removed using filter containers filled with metal shavings, its replacement is old metal scouring pads.

Gas, passing through the metal, loses hydrogen sulfide, accumulates in the upper part of the tank, then follows on through another pipe.

Gas is dried by installing additional hydraulic locks in the pipeline to eliminate condensate. The disadvantage of this method is the need to drain water from time to time, otherwise the gas pipeline may be blocked. Another option is a container with silica gel. In this case, it will also require periodic drying: for example, heating with a microwave oven.

For gas transmission, either PPR or HDPE gas pipes or metal galvanized ones are used. Whenever working with gas equipment, checking the joints with soap foam is mandatory. The pipeline is assembled from pipes and fittings of the same diameter.

Gas holder

The cleaned gas, which is not used immediately, enters the gas tank for storage. A strong and reliable (gas-tight) plastic container, a sealed polyethylene bag, etc. can become a reservoir. Gas is supplied to the consumer - a boiler or stove - by means of a compressor. To ensure a stable pressure, a receiver is installed downstream of the compressor, excluding its surges.

The easiest way to mix biomass is to make a mechanical stirrer. If the muscle strength for a large capacity is not enough, then the device is supplied with an electric motor, which is turned on by a timer.

Another option is to use the produced gas. To arrange such a stirrer, a tee is mounted at the outlet of the tank. Thanks to the new branch, part of the gas is sent back and exits through small holes made in the pipe dipped into the biomass. Gas that "has done its job" is not wasted: then it goes to the gas tank.

The last method is the use of fecal pumps, which take the substrate from the bottom and then pour it out from the top. This idea has one drawback - dependence on electricity.

Heating the container is necessary, since only psychrophilic bacteria like comparative cold, and the process itself will drag on for at least 30 days, but often even longer is required. In warmer months, preheating the substance, good thermal insulation and hot weather can provide almost ideal conditions, but they are not achievable in winter.

There is one, the most rational, way to get a favorable temperature. These are the use of a boiler: electric, working on liquid, solid fuel, or on the obtained gas. The maximum water temperature is 60 °. Higher values will cause the substrate particles to stick to the pipes.

To heat the mass, ordinary radiators, pipes bent into a coil, welded elements can be used. The best material for them is polypropylene or metal-plastic. It is possible to use corrugated stainless-steel pipes: they are convenient for laying, but particles of biomaterial readily adhere to them.

To deal with the potential attraction of particles, it is recommended to place them in the area of the mixer, but so that the device does not touch them. It is irrational to arrange a heating system in the lower part of the tank because of its insufficient effect, therefore it is better to place the batteries on the walls.

Water heating of the bioreactor can be both external and internal. The first method requires more heat consumption, but the stirrers will not become an obstacle. The second method does not allow regular maintenance and repair, therefore, when arranging it, maximum attention should be paid to all connections.

Insulation begins with a pit: a layer of sand is poured into it, then a layer of thermal insulation is laid - clay, which is mixed with expanded clay, straw, slag. Each material can be stacked separately. The prepared surface is leveled, then the tank is installed (see Fig. 3.12).

The walls of the bioreactor are insulated in different ways. The most elementary option is to cover it with clay mixed with straw in several layers. Suitable modern thermal insulation materials are low density aerated blocks, extruded polystyrene foam, polyurethane foam, foamed glass (broken, crumb).

The main constituent of biogas is methane, its share is about 60% of the total volume. About a third (35%) is carbon dioxide. The remaining 5% is shared by other substances (for example, hydrogen, hydrogen sulfide, nitrogen). Biogas obtained in this way is practically no different from its natural "counterpart", which is widely used for domestic and industrial needs.

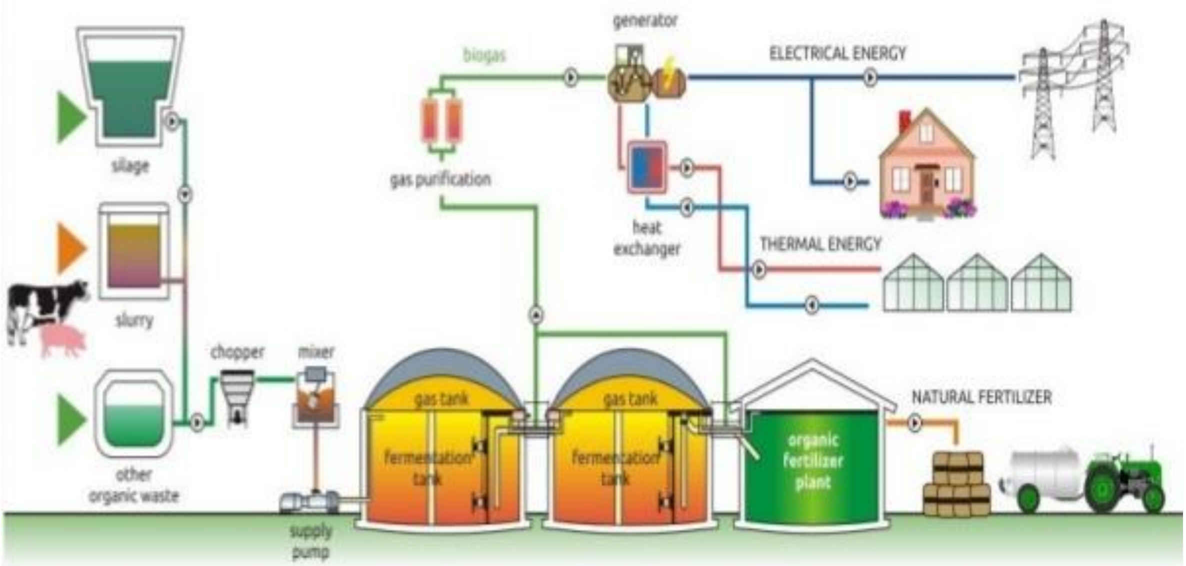


Fig.3.12. Principle of operation of the biogas plant

A biogas plant works thanks to bacteria: hydrolytic, acid-forming and methane-forming - methanogens. Each type of microorganism consistently performs its stage of work. Combustible gases are formed from any residues of plant, animal origin. But the main supplier of wonderful bacteria is cattle, in the intestines of which this natural microflora lives. Microorganisms are excreted in the manure. It is he who is the main raw material for biogas (gas generating) plants.

First, manure is placed in the container, but any organic waste can be added to it. For example, excrement of other animals or poultry, plants, cleaning from vegetables, sawdust, food waste are suitable for processing. Plant residues are first crushed, diluted with water, and then mixed. To get not only gas, but also the most valuable fertilizer, one must ensure one prerequisite - the lack of access for air.

There are substances that can not only reduce, but also stop the activity of bacteria. For example, any chemical impurities are not allowed. Even small proportions of antibiotics, solvents, and synthetic detergents are prohibited. You cannot lay moldy products and resins; therefore, it is also not recommended to use sawdust from coniferous trees.

The dry matter of raw materials consists of organic (MCO) and inorganic substances. The ratio of inorganic and organic substances is characterized by such a parameter as ash content.

To obtain these parameters, it is necessary to take samples of raw materials and carry out appropriate analyzes in the laboratory.

Knowing the type of raw material, and its moisture and ash content, it is possible to calculate how much organic matter is contained in a unit of raw material mass. Knowing the daily amount of feedstock, it is possible to calculate how much MCO will enter the reactor of the biogas plant on a daily basis

Statistical tables usually indicate how much biogas will be released from a unit mass of MCO during the optimal duration of the fermentation cycle of this type of raw material. Typically, this value ranges from 0.2 to 0.8 m3 / kg MCO. The density of biogas is approximately 1.13 kg / m3. Therefore, if all organic matter were converted into biogas, then the biogas yield would be 0.885 m3 / kg MCO. However, in the process of anaerobic fermentation, not only biogas is obtained, but also water, and the mass of the released water can be equal to the mass of the released biogas. The ratio of released water and biogas depends on the predominance of certain chemical reactions in the process, and it, in turn, depends on the bacterial composition and the initial composition of the raw material. In addition to water and biogas, a certain amount of mineral salts is also formed.

In addition, the optimal cycle time is usually selected according to the criterion of the maximum biogas output rate. After decomposition of about half of the MCO in the composition of the feedstock, the rate of biogas evolution usually decreases markedly.

This is due to the fact that the organic composition of the MCO in the feedstock is rather heterogeneous. Therefore, the rapidly decomposable substances decompose first, and the “long-playing” components, such as lignin, remain almost intact during this period. Thus, the depth of decomposition of biomass in biomass reactors is usually 40-60%. This value can be higher only when using a homogeneous artificially created organic raw material, such as glycerin, or when applying preliminary deep homogenization of raw materials, such as cavitation grinding, which destroys even molecular bonds.

There are several farms (chicken farms, an ostrich farm, a pig farm), a hippodrome and many fields near the airfield. Single holdings are not counted due to insufficient resources (see Fig. 3.13).

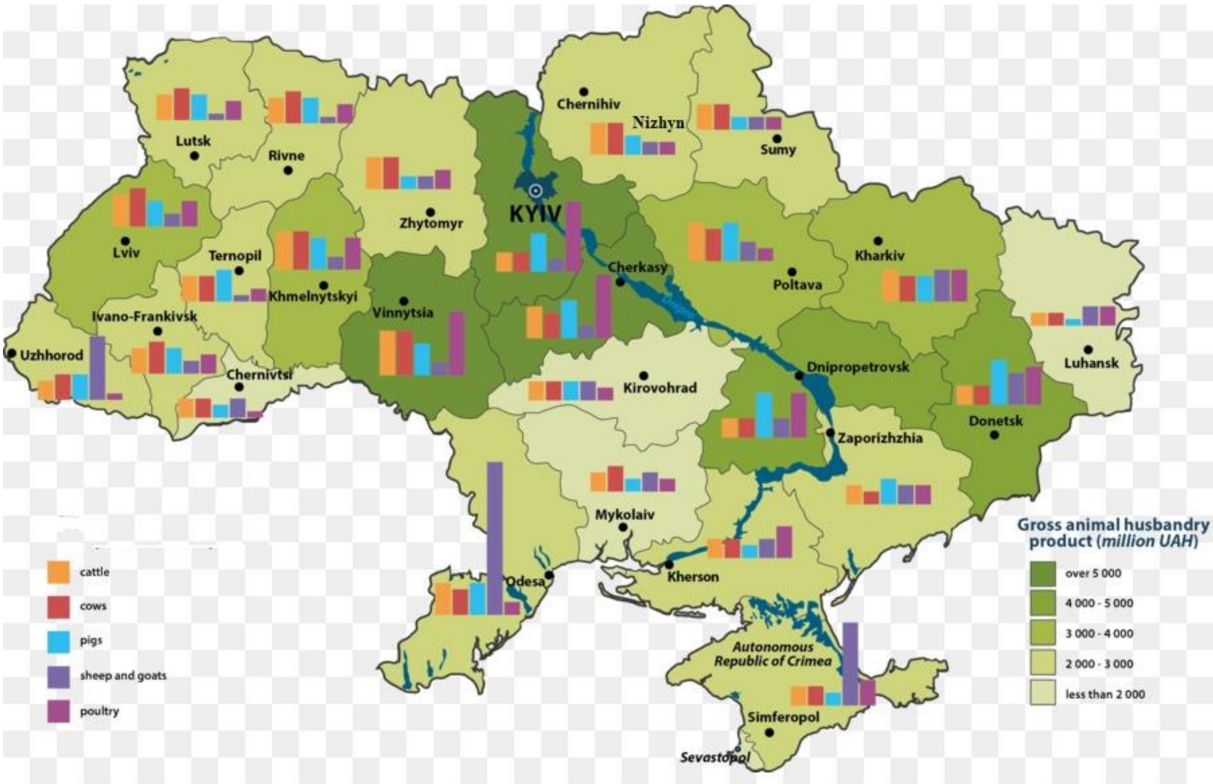


Fig.3.13. Animal husbandry in Ukraine

CHAPTER 4. CALCULATION OF A HYBRID ALTERNATIVE ENERGY SYSTEM

4.1. Calculation of panel power

Depending on the calculated amount of energy consumed, the number of solar panels can be different. You should also consider what tasks are assigned to the battery - full productivity or using it as an additional source of power if your building is often interrupted. If you want to cover all the electricity costs in a building, then you have to spend well and purchase devices with high power and productivity.

The power of the panel will directly depend on the amount of energy consumed by both electrical appliances in the building and technical devices that are mandatory for the operation of the solar station. Here one cannot but take into account the number of sunny days in a month, the level of insolation, the frequency of the change in the angle of inclination. The maximum performance of the panel is observed no more than 7 hours a day, and then provided that the sky is clear, and at night there will be no generation at all, respectively, when correlating the consumed energy with the battery power, these two indicators cannot be equated. The power should be 30-40% more.

For example, you can take a battery with a specified power of 1 kW. This value must be multiplied by the number of hours the panel has been operating at maximum performance, plus additional costs for supplying the inverter and battery, as well as the time in the day when there is no sunlight. As a result, you can get the performance of one battery. If the indicator is too small, then you need to look at batteries with a higher capacity. We use Solar panel Neosun NS-400M-72H (see fig.4.1)

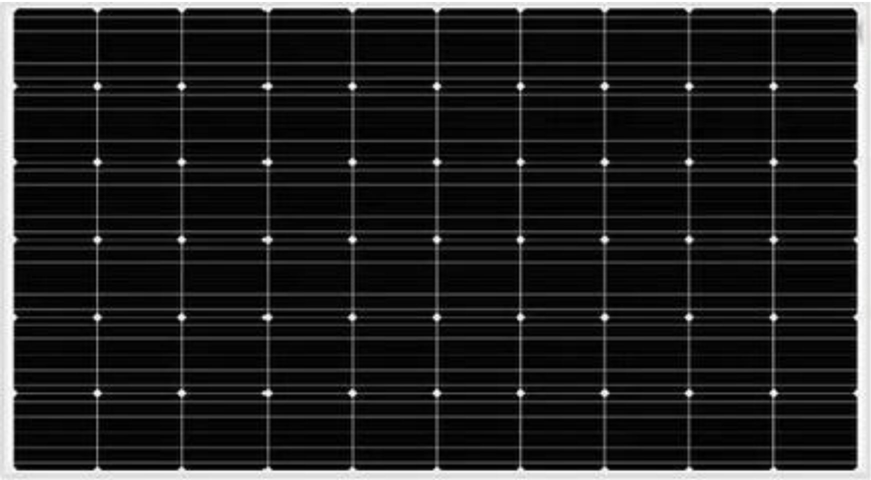


Fig 4.1 Solar panel Neosun NS-400M-72H

Panel type - Monocrystalline

Module material - Pure silicon

Frame material - Aluminum

Voltage - 24 V

Rated power - 400 W

Current at maximum power - 9.9 A

Voltage at maximum power - 40.45 V

Short circuit current - 10.5 A

No-load voltage - 48.6 V

Number of elements - 144

Minimum operating temperature - -40 ° C

Maximum operating temperature - 85 ° C

Protection degree IP - 68

Efficiency, not less - 19.9%

Weight - 23 kg

Length - 2015 mm

Width - 996 mm

Thickness - 40 mm

Such panels will fit on the roof 20 rows of 40 pcs (fig.4.2).

Figure: 4.2. Probable location of roof panels

To calculate the required power of solar panels, you need to know how much energy you consume. For example, if your energy consumption is 100 kW * h per month (readings can be viewed on the electricity meter), then accordingly you need the solar panels to generate that amount of energy.

The solar panels themselves generate solar energy only during daylight hours. And they give out their passport power only when there is a clear sky and the sun's rays fall at a right angle. When the sun falls at angles, the power and power generation decrease noticeably, and the sharper the angle of incidence of the sun's rays, the greater the drop in power. In cloudy weather, the power of solar batteries drops 15-20 times, even with light clouds and haze, the power of solar batteries drops 2-3 times, and all this must be taken into account.

When calculating, it is better to take the working time, in which the solar panels work at almost their full capacity, equal to 7 hours, this is from 9 am to 4 pm. The panels, of course, will work in the summer from dawn to dusk, but in the morning and in the evening, the output will be very small, in terms of volume, only 20-30% of the total daily output, and 70% of the energy will be generated in the interval from 9 to 16 hours.

The capacity of such a system is 320kW / hour.

Opening hours in summer from 9:00 to 17:00 on clear days, which means that in summer the system will generate 2560 kW / day, which fully ensures the work of the warehouse in summer.

In winter, the situation is not so good. The working hours of the deputy are at best from 9:00 to 15:00, which means that the maximum system will generate 1920 kW / day. In addition, there are not many sunny days in cold seasons (see fig. 4.3).

So, there is a need for an additional source of energy.

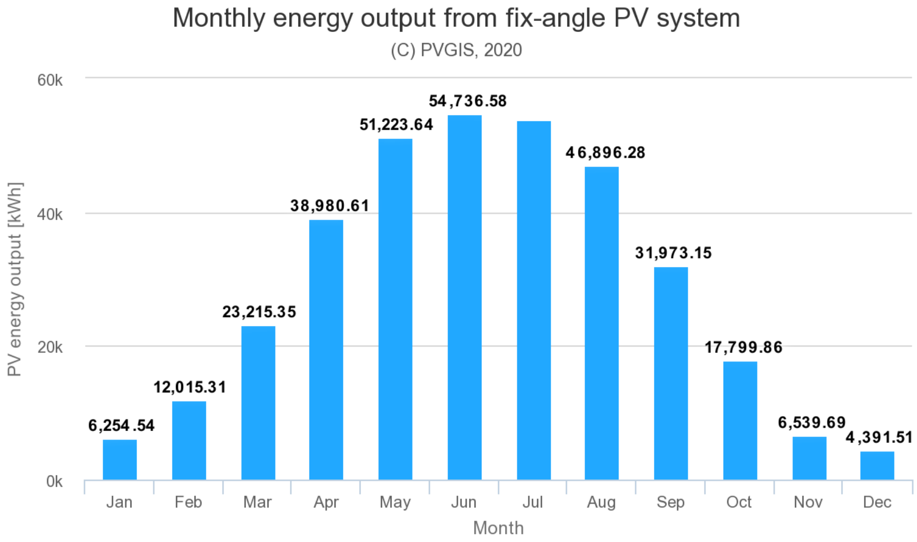


Figure: 4.3 Power generation by one panel

4.2. Biogas plant

From 1 kg of WWS, you can get 0.3-0.5 cubic meters. m of biogas.

In terms of quality indicators, the product produced by the installation has a density of 1.16 - 1.27 kg / m3; its energy reserve of 1 m3 is about 5 - 9 kW / h, and the calorific value (calorific value) is 4500 - 7300 kcal / m3; ignition temperature: 600 - 750 ° C. For ease of perception, you can make the following comparison: when burning 1 m3 of biogas to heat a room, the same amount of heat is released as when burning 1.5 kg of coal or 3-4 kg of firewood, or using 7-9 kW / h of electricity.

After purification from impurities, biogas obtained in the installation will not differ in any way from natural gas extracted from the bowels of the earth. As for the amount of its production, it largely depends on the production capacity of the reactor, the volume of raw materials, its moisture content and the nature of its origin, since various organic products release different amounts of biogas during decomposition.

For example, from a ton of cow dung with a moisture content of 95%, 22 m3 of biogas can be obtained; from the same manure, but with a moisture content of 88%, up to 43 m3 will be released. Processing of pig manure with a moisture content of 95% will give 25 m3 of biogas; the same product with a humidity of 85% will emit no more than 62 m3 of fuel. From poultry droppings with residues of bedding material with a moisture content of 60%, up to 90 m3 of gas is formed over the entire decomposition period, and at a humidity of 75% and without litter admixtures, about 105 m3 of product can be obtained.

Grain straw and crop residues have a high potential for productive decomposition. Up to 425 m3 of fuel can be synthesized in a reactor from 1 ton of such raw material! About 187 m3 of gas is obtained from corn silage spoiled or for some reason not suitable for feeding to animals (see Table 4.1).

Table. 4.1. Biogas production m3 per 1 ton of raw materials

Raw materials (1 t)	The amount of gas released m3
Greens	290 - 490
Beet tops	75 - 150
molasses	up to 630
fruit or vegetable pulp	108
Beer grains at 75% moisture	138

Barda	40 - 50
Food waste	about 100
Fat	1300
Pig manure	340-580
Bird manure	310-620
Horse dung	200-300
Cow dung	300-450
Sheep dung	300-620

If we talk about raw materials that can serve as feed for livestock farms, then from one ton of greenery, 290 - 490 m3 of gas will be obtained. The most productive in this category are legumes: clover, alfalfa, vetch, peas. The biogas plant will be able to produce about 75 - 150 m3 of methane from beet tops, up to 630 m3 from molasses, 108 m3 from fruit or vegetable pulp, and 160 m3 from beet pulp with a moisture content of 75%. Maize pulp emits up to 85 m3 of combustible gas.

To obtain biogas, you can also use the products of processing of the brewing industry. Beer grains with a moisture content of 75% can give 138 m3 of combustible mixture, and stillage - 40-50 m3. A good source of biogas can be household food waste (about 100 m3 of gas) and waste from a slaughterhouse, fish processing and meat processing workshops. Blood, intestines, skin scraps, scales, fish heads, tails, bones and soft tissues when decomposed in a reactor give 100 - 300 m3 of biogas. Fat has a very large potential energy reserve: from one ton of it, 1300 m3 of gas can be obtained, and from 1 ton of fat slurry - 250 m3.

As you can see, any organic waste can not only be safely disposed of in a biogas plant, but also receive additional benefits from this in the form of cheap fuel and valuable organic fertilizer that can be used in the fields for any crops. The spent biomass after methane production contains almost the same amount of components valuable for plants as the starting material, but all nutrients are in a more accessible form for the plant organism. The mining also contains macronutrients and humic acids. The use of this organic matter as fertilizer increases the yield of agricultural crops by 30 - 50%.

It is best, of course, to generate the largest amount of gas in the period from March to October, since at this time planting is carried out and it will be possible to sell the resulting fertilizer to farmers and ordinary people, thereby adding payback to the system.

Next, you need to select the capacity of the biogas plant. A small biogas plant is sufficient to provide a warehouse. There is a manufacturer in Ukraine (together with Russia). LLC "AgroBioGas" (Russia, Ukraine) is a joint Russian-Ukrainian production and research center that performs design, assembly, equipment supply, construction and installation of biogas plants that provide cost-effective disposal of all types of agricultural waste.

Since in the warm season the main focus will be on solar panels, it is possible at this time to start accumulating biogas for the cold season and the time when solar panels cannot provide enough energy.

So, in the neighboring pig farm there are about 200 individuals of different ages.

Approximate output per individual per day:

- Boar producer - 11.1 kg.
- Sows without litter - 8.8 kg
- Sows with litter - 15.3 kg.
- Weaners - 2.4 kg.
- Fattening young stock up to 40 kg - 3.5 kg
- 40-80 kg - 5.1 kg
- Over 80 kg - about 6.6 kg.
- If fattening uses food waste, multi-component feed, then the weight of waste increases by 20-25%.

In addition, the manure is mixed with the litter during collection.

In general, this whole economy gives about a ton of substance with a moisture content of about 65%, on the basis of which the installation can work. The required moisture content of the substance is about 90%.

First, you need to find out the required daily intake of water. To do this, we will use the formula:

$$M_W = \frac{M_{dm} * 100\%}{(100\% - H_s)} - T_{mrm}$$

M_W - mass (volume) of water required for mixing raw materials;

M_{dm}- the total mass of dry matter in the raw material;

H_s - the required moisture content of the substrate;

T_{mrm} - Total mass of raw materials.

If you know the moisture percentage of the manure Hm, then you can determine the amount of water by weight. Subtract this water to obtain the dry mass Mdm.

$$M_{dm} = \frac{T_{mrm} * (100\% - \mathrm{H}_m)}{100\%}$$

$$M_{dm} = \frac{300 * (100\% - 65\%)}{100\%} = 105kg$$

$$M_W = \frac{105kg * 100\%}{(100\% - 90\%)} - 300kg = 750kg = 750l$$

We need 300 kg of fertilizer and about 750 liters of hot water per day to prepare the substrate. 300 kg of manure is 330 liters of substance. The resulting substrate will have a volume of 1080 liters.

The fermentation cycle (optimal duration) will be about 15 days. The biogas plant reactor must be 80% full. Therefore, the required reactor volume is 20 cubic meters. The volume of the preparation container should be one third larger than the daily volume of the substrate, so that the substrate can be mixed without the danger of splashing, i.e. about 1410hp

Such a biogas plant will produce about 70-80 m3 of biogas per day. It will also produce about 860 liters of liquid biofertilizers per day. The standard for the use of biofertilizers is 400-2000 l / ha for the growing season. This means that this installation will provide fertilizers for a year from 160 to 800 hectares of sown areas.

4.3. Battery capacity calculation

When calculating an autonomous power supply system, it is very important to choose the right battery capacity (accumulator battery).

For a preliminary calculation, you can be guided by the following simple rules:

- **the capacity that the battery should give out**, is calculated based on the amount of electricity in W / h consumed from the battery in the discharge mode.
- **If there are several batteries** - then the amount of energy in them is summed up.
- **Permissible depth of discharge** should not exceed 30-40% for sealed maintenance-free batteries, and not more than 50% for starter batteries. In cyclic operating modes of the battery, gel batteries or special batteries with liquid electrolyte must be used. In the buffer mode of operation (that is, if the batteries are in a charged state for most of the time and sometimes, in the event of a power failure, they give up their energy), AGM batteries can be used. It should be borne in mind that the state of charge of the battery does not depend rigidly on its voltage. With a fast discharge with high currents, a lower final voltage of the batteries (up to 9.8 V) is allowed, and if the battery is discharged with a low current for a long time, then it can be discharged by 100% even at a voltage of more than 11.5 V.

- **battery capacity decreases with decreasing temperature**... Gel batteries lose their capacity less when the temperature drops, AGM and starter batteries usually have a capacity 2 times lower than the nominal already at 0 ° C and with a further decrease in temperature, their useful capacity drops sharply.
- **battery life** decreases when the ambient temperature rises above 25 ° C.

Sometimes, information about the voltage to which the battery sags when discharged by various currents is indicated by the manufacturer in the battery passport. We need to ensure the operation of the warehouse (72 kW / h) or 984 kW / day, that is, consumption will be 984 kW * hour, and for this we want to use batteries for an operating voltage of 12V and a capacity of 200 A / h.

Let's calculate how many of these batteries we need.

The amount of stored energy in a charged battery will be equal to:

$P = R_x * V = 200A / h * 12V = 2400 W / h$

R_x - battery capacity

V is voltage.

This amount of energy can be obtained by fully discharging a fully charged battery. However, the batteries may not be fully charged. In addition, a deep full discharge after a small number of charge-discharge cycles will quickly destroy the batteries. We can use Challenger A12-200 Battery (see figure 4.4)

For example, an ordinary good battery, when discharged to 30% of its capacity and then charged immediately after discharge, can withstand 1000 such cycles. If 70% of the capacity is taken during the discharge, then the number of cycles will decrease to about 200. Therefore, in the calculations it is necessary to enter a coefficient that takes into account the depth of discharge.

It follows from this that the amount of stored energy in the battery is equal to:

$$P = R_x * V_x * k$$

$$P = 200Ah * 12V * 0.7 = 1680 W / h.$$

Figure: 4.4. Challenger A12-200 Battery

Accordingly, to determine the capacity, you need to divide the amount of energy consumed by the battery voltage multiplied by the capacity factor.

Then the formula for determining the required capacity will look like this:

$$E = Q / (V * k)$$

Where E is the required total capacity of the batteries in A / h;

Q is the amount of energy to be obtained from the batteries in W / h;

V-voltage of each battery;

k-capacity utilization factor, taking into account what part of the energy of all used batteries can actually be used by consumers.

In order to determine how much capacity is needed for the batteries to obtain electrical energy in the amount of 984,000 Wh. Taking into account the losses in the inverter (we take 10% for the calculation), an energy reserve is required 984000 + 10% = 1082400 W / h., We divide this amount of energy by the operating voltage of each battery equal to 12V. As a result, we get that 90200 A / h battery capacity is required. If we apply a capacity factor equal to 0.7, taking into account the fact that it is unacceptable to often completely discharge the batteries, then we obtain the value of the required installed battery capacity equal to 117143 A / h.

E = 1082400 W / h / (12Vx07) = 128858 A / h.

Since we wanted to use a 200 A / h battery, in this case 644 batteries of this capacity will be needed.

This calculation is given for the case when there is no energy from solar panels and biogas. On sunny days they give out2560 kW / day, and cloudy only 20% of the declared capacity. It's somewhere around 512kW / day. From the last meaning it is necessary to make an appropriate amendment to the calculation, namely:

With a voltage of 12 V, the required rating will be (1082400-512000) /12/0.7 = 67904.7 A / h, i.e. in this case 340 batteries with a capacity of 200 A / h will be enough.

4.4. Gas turbine power calculation

Gas piston power generators are units designed to generate electricity using gas as fuel. To power the units, gases with different calorific value are used - propane-butane and methane, therefore their consumption for generating 1 kW of electricity is different. In the passports of models capable of operating on both types of gas fuel, 2 consumption values are indicated at a certain load. Gas consumption per hour for a gas generator depends not only on its chemical composition, but also on the load - the higher it is, the more fuel will be needed. Other factors also affect this parameter.

Mainline methane (NGT) and propane-butane (LPG) are supplied to the consumer in various aggregate states. Methane coming from the main pipeline is in the vapor phase, measured in cubic meters. Propane-butane in the liquefied phase is supplied in cylinders, measured in liters or kilograms. It is possible to use methane as a fuel for an electric generator at a pressure in the main pipeline of

1.3-2.5 kPa. Therefore, it is necessary to clarify the information on the actual pressure value with the employees of the gas company.

The average consumption of methane gas per hour by a gas generator to generate 1 kW of electricity is 0.3-0.45 m3, propane-butane - 0.3-0.45 kg.

A modern environmentally friendly option is the use of biogas, which is formed during the decomposition of organic matter of plant origin.

Practice shows that it is undesirable to constantly operate gas piston electric units with a load higher than 90% of the rated power. If this rule is observed, the reliability of the equipment is increased, mechanical wear is reduced and the risk of emergency stops is reduced, which together leads to a decrease in operating costs. This threshold is empirical. It is not indicated in any official documents of the manufacturers, but it is confirmed by the practice of operating the GPPG.

At the same time, different specialists have very seriously different opinions about the value of the maximum permissible load of gas piston plants. Someone lowers the load threshold to 85%, and even to 80%, but some engineers talk about the possibility of continuous work at 95%. In principle, the most correct approach is to individually set this border based on the results of the operation of the GPEU at a specific facility.

GPEU manufacturers, as a rule, do not define an upper limit for the load of their machines, but very often they set a lower limit for the load at the level of 40% - 50% of the rated power. In some cases, this limitation is solely due to the fact that at a lower load in the exhaust gases, the content of harmful emissions (primarily CO and NO_x) increases. If we neglect the environmental component, then the majority of gas piston generating sets can operate with a minimum load and up to 30% of the nominal value. However, running at lower power can already lead to certain problems with increased mechanical wear and a general decrease in engine reliability.

In addition, it is necessary to take into account that the operation of a GPEU with a low load is economically unprofitable, since the cost of electricity generated sharply increases. Therefore, in my calculations, I set the lower threshold value for the GPEU load at 40% of the nominal. However, the calculation tables allow you to set any other value for this indicator.

Part of the electricity generated by any power plant is consumed for their own needs. In the case of gas piston units, this is, first of all, the operation of fans as part of remote radiators, as well as various pumps.

The problem is that the intrinsic consumption of GPEU is not a constant, but constantly changes within certain limits. Of course, manufacturers usually indicate the power of all power-consuming devices in the GPPG (pumps, fans, heating elements, etc.). However, at any given time, these "internal" consumers can be included in a completely arbitrary order. In addition, in addition to the own needs of a particular GPEU, electricity is simultaneously consumed by the general systems of the entire power plant (for example, lighting and fire alarm), which also operate in a completely arbitrary mode. As a result, it is almost impossible to predict the exact value of electricity consumption for the auxiliary needs of the GPPP.

So, one of the factors influencing the selection of the generated electricity for the needs of the GPEU is the weather. For example, if in the summer there is no need to use recovered heat, then the remote radiator of a gas piston unit operates at almost full capacity in extreme heat. But at the same time, the circulation pump of the external (or intermediate) circuit does not work at all, since the heating at the facility is turned off. However, if it rains, the power requirement for the external radiator is immediately reduced slightly, as the fans become easier to cope with the cooling of the engine.

In winter, the power consumption of the external radiator decreases very significantly, since almost all of the recovered heat goes to consumers. But at the same time, the pump of the external circuit is switched on "to the fullest", which ensures circulation of the coolant and the transfer of "free" thermal energy to these very consumers.

Thus, the own needs of any gas piston installation change in a completely unpredictable way, as a result of which it is almost impossible to establish their exact value. Despite this, “internal” electricity consumption must be taken into account when selecting equipment for a gas turbine power plant. Therefore, in calculating the technical and economic parameters of a power plant, as a rule, a certain conditional average annual value of its own needs is set for one GPEU. For example, for large machines with a capacity of 4 - 4.5 MW, this may be 200 - 250 kW per unit. If the power plant consists of 5 - 6 of the same, then the selection of electricity for its own consumption is quite decent - 1.0 - 1.5 MW. When choosing a GPU, one cannot ignore such a significant dropout power.

Cos φ is the ratio of active power to apparent power.

Cos φ = P / S

The rated power of the generator is taken to be greater than or equal to the maximum value of the estimated total load power, multiplied by a factor of 1.1.

Since the entire calculation is of a probabilistic nature, adding a 10% surcharge to the maximum value of the estimated total load power is intended to cover all unaccounted electrical energy costs.

For economical gas consumption, it is required: to operate the generator set at 75% of the rated power and to allow operation "at the limit" only for a short period. Therefore, you should purchase models whose power is 30-40% higher than required. Such a reserve not only allows you to optimize fuel consumption, but also provides other benefits:

- minimizes the risk of premature wear of the generator machine;
- without harm to the unit, compensates for the high starting currents inherent in some electrical appliances and tools;
- prolongs the engine life.

Frequent operation in starting and braking modes has little effect on the engine resource, and compliance with permissible temperatures is an essential factor. When starting up in the cold season, it is necessary to provide heating, and when operating in summer - efficient heat dissipation.

As already mentioned, fuel consumption is mainly determined by the amount of load. However, this does not mean that gas consumption is zero during idle operation without load. Fuel is needed to turn the engine.

Generac SG 130 gas power plant (Fig. 4.5 and Fig. 4.6). The parameters of this power plant are described in Table 4.2.

Figure: 4.5. Generac SG 130 gas power plant

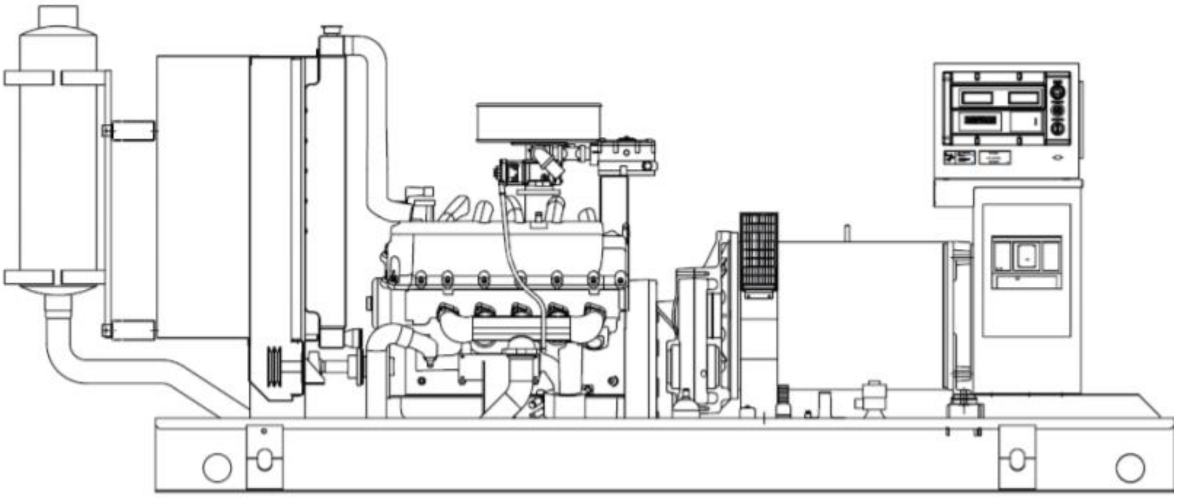


Figure: 4.6. Scheme dbase power plant Generac SG 130

Rated capacity in standby mode

130 kVA, 50 Hz, 3 phases

104 kVA, 50 Hz, 1 phase

Ratings in main power supply mode

105 kVA, 50 Hz, 3 phases

84 kVA, 50 Hz, 1 phase

Table 4.2. Options base power plant Generac SG 130

	Nominal performance standby power <200 h/year				Nominal production characteristics electricity**			
	Nature gas		Propane		Nature gas		Propane	
Rated current and full load	kVA	A	kVA	A	kVA	A	kVA	A
220 IN, one phase	104	473	104	473	84	382	84	382
220 IN, 3 phase	130	341	130	341	105	276	105	276
380 IN, 3 phase	130	198	130	198	105	160	105	160

400 IN, 3 phase	130	188	130	188	105	152	105	152
Electric motor starting power (kVA)								

Instantaneous voltage drop %	ten%	15%	twenty %	25%	thirty %	35 %
High voltage 380 - 400	93	139	186	232	278	325
Low voltage 220	70	104	139	174	209	244
One phase	59	89	118	148	177	207

Fuel consumption	
(Nature... gas in m^3/h)	(Propane vapor in l/h)

Applied load in % from the rated standby power	25%		fifty%		75%		one hundred %	
Fuel	When genus... gas	About pan	When genus... gas	About pan	When genus... gas	About pan	When genus... gas	About pan
Consumption	15.34	22.59	28.20	41.54	38.59	56.84	49.48	72.87
58 Engine cooling system								

Cooling system capacity (l)	25.0
Heat transfer to coolant (BTU /h)	519967
Radiator air supply (m^3/min)	141.6
Maximum operating air temperature on the radiator	60 0FROM
Maximum ambient temperature	50 0FROM
Maximum external pressure drop across the radiator	12.7 mm of water...pillar
Combustion air requirements	
Consumption at rated power fifty Hz (m^3/min)	7.79
Exhaust system	
Exhaust consumption	21.18
Maximum back pressure	7.5 kPa, 56 mm hg...st... (0.074atmosphere)
Exhaust gas temperature, ^{0}FROM	588
Engine parameters	
Rated synchronous vol../min	2500
Power in l...from... at rated power in kVA	164
Power adjustment for ambient conditions	

5% for every one hundredFrom above - 25 0FROM	25
1.1% for every one hundred m above ... m	183

4.5. Biogas storage and prospects

The biogas consumption per hour is approximately 24.22 m3. This means that the daily flow rate will be about 24.22 m3 / hour * 8 hours = 193.8 m3.

So for 3 months of winter you need to stock up:

193.8 m3 * (30 + 31 + 28) = 17244.6 m3

If the biogas plant is operated from the beginning of March to the middle of November, then during this time about:

75 m3 * 260 = 19500 m3

So it makes no sense to operate the unit in winter.

But it is necessary to store biogas somewhere.

Biogas leaves the reactors unevenly and with low pressure (no more than 5 kPa). This pressure, taking into account the hydraulic losses of the gas transmission network, is not enough for the normal operation of gas-using equipment. The simplest solution to eliminate excess biogas is to burn it in a flare unit, but energy is irretrievably lost. A more expensive, but ultimately economically justified way of leveling the unevenness of gas production and consumption is the use of gas tanks of various types. All gas tanks are divided into "direct" and "indirect". In the "straight" gas tanks, there is always a certain volume of gas injected during periods of decline in consumption and withdrawn at peak load. "Indirect" gas tanks provide for the accumulation of not the gas itself, but the energy of an intermediate heat carrier (water or air), combustion gas heated by combustion products, i.e. thermal energy is accumulated in the form of a heated coolant.Biogas, depending on its amount and direction of subsequent use, can be stored under different pressures, respectively, gas storage facilities are called low (not higher than 5 kPa), medium (from 5 kPa to 0.3 MPa) gas tanks and high (from 0.3 to 1.8 MPa) pressure. Low pressure gas tanks are designed to store gas at low fluctuating gas pressure and significantly changing volume, therefore they are sometimes called gas storage facilities of constant pressure and variable volume. Medium and high pressure gas tanks are arranged according to the principle of constant volume, but changing pressure. In the practice of using biogas plants, low pressure gas tanks are most often used. The capacity of high-pressure gas tanks can be different - from several liters (cylinders) to tens of thousands of cubic meters. Storage of biogas in cylinders is used when gas is used as fuel for vehicles. The main advantages of high and medium pressure gas tanks are small dimensions with significant volumes of stored gas and the absence of moving parts, and the disadvantage is the need for additional equipment: a compressor unit for creating medium or high pressure and a pressure regulator to reduce the gas pressure in front of the burners of gas-using units.

The principle of operation of all types of gasholder systems is similar. They differ in installation method and shape.

For use in agriculture and in medium and small enterprises, a two-membrane gas tank with top fastening is used. It mounts directly onto the bioreactor reservoir and is supported by brackets.

- Rectangular gasholder (Fig. 4.7) is installed on a fermenter of appropriate shape. Usually the membrane on it is additionally protected by a system of staples.
- Top-mounted gas tank with service platforms provides unhindered access to all engineering systems of the bioreactor. Maintenance times and downtime are reduced accordingly.

- Ring gas tanks are placed on steel or concrete tanks. They also have a central platform with equipment installed on it for the operation of the bioreactor. They generally do not require mounting brackets.

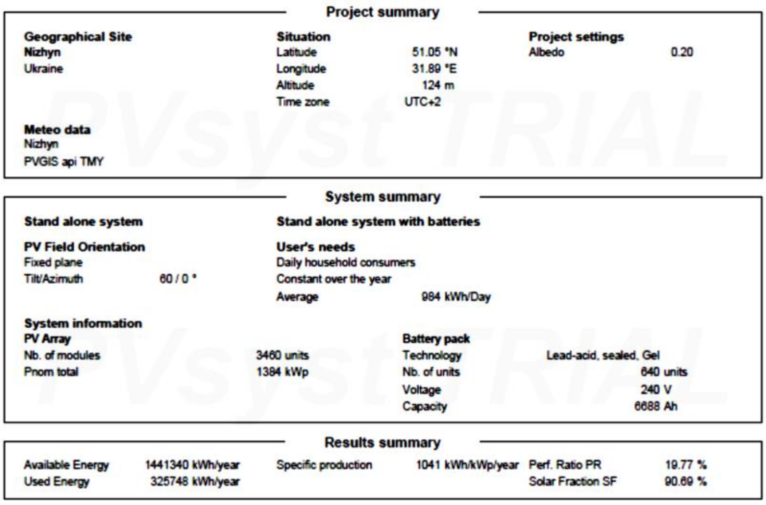
Figure 4.7. Rectangular gas tank

- The soft storage system (Fig. 4.8) with bridges is similar to an annular gas tank. Only the equipment is installed on special bridges. Storage systems with service platforms are the preferred choice as they reduce maintenance downtime.

Figure: 4.8. Soft storage system with bridges

4.6. PV system simulation

The PVsyst program was chosen to simulate the solar panel system. Using the capabilities of PVsyst, based on the energy characteristics of solar radiation during a typical day, an analysis of the generated electricity volumes of an array of photovoltaic panels with a given installed power, placed in a certain way on the ground with fixed geographic coordinates, was carried out (Fig. 4.9).



Project summary

Geographical Site
Nizhyn
Ukraine

Situation
Latitude 51.05 °N
Longitude 31.89 °E
Altitude 124 m
Time zone UTC+2

Project settings
Albedo 0.20

Meteo data
Nizhyn
PVGIS api TMY

System summary

Stand alone system — **Stand alone system with batteries**

PV Field Orientation
Fixed plane
Tilt/Azimuth 60 / 0 °

User's needs
Daily household consumers
Constant over the year
Average 984 kWh/Day

System information

PV Array
Nb. of modules 3460 units
Pnom total 1384 kWp

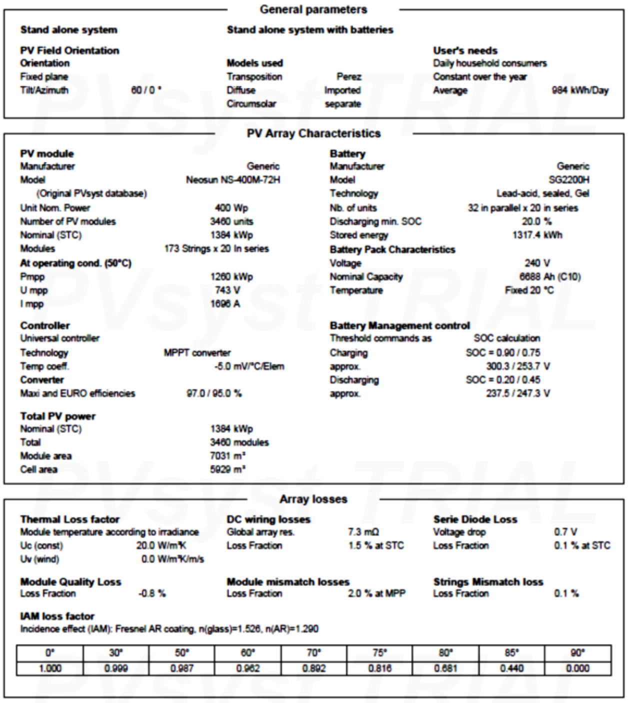
Battery pack
Technology Lead-acid, sealed, Gel
Nb. of units 640 units
Voltage 240 V
Capacity 6688 Ah

Results summary

Available Energy	1441340 kWh/year	Specific production	1041 kWh/kWp/year	Perf. Ratio PR	19.77 %
Used Energy	325748 kWh/year			Solar Fraction SF	90.69 %

Fig 4.9 General summary of system

First, it was necessary to set the system parameters (Figure 4.10).



General parameters

Stand alone system — **Stand alone system with batteries**

PV Field Orientation
Orientation
Fixed plane
Tilt/Azimuth 60 / 0 °

Models used
Transposition Perez
Diffuse Imported
Circumsolar separate

User's needs
Daily household consumers
Constant over the year
Average 984 kWh/Day

PV Array Characteristics

PV module
Manufacturer Generic
Model Neosun NS-400M-72H
(Original PVsyst database)
Unit Nom. Power 400 Wp
Number of PV modules 3460 units
Nominal (STC) 1384 kWp
Modules 173 Strings x 20 In series
At operating cond. (50°C)
Pmpp 1260 kWp
U mpp 743 V
I mpp 1696 A

Controller
Universal controller
Technology MPPT converter
Temp coeff. -5.0 mV/°C/Elem
Converter
Maxi and EURO efficiencies 97.0 / 95.0 %

Total PV power
Nominal (STC) 1384 kWp
Total 3460 modules
Module area 7031 m²
Cell area 5929 m²

Battery
Manufacturer Generic
Model SG2200H
Technology Lead-acid, sealed, Gel
Nb. of units 32 in parallel x 20 in series
Discharging min. SOC 20.0 %
Stored energy 1317.4 kWh
Battery Pack Characteristics
Voltage 240 V
Nominal Capacity 6688 Ah (C10)
Temperature Fixed 20 °C

Battery Management control
Threshold commands as SOC calculation
Charging SOC = 0.90 / 0.75
approx. 300.3 / 253.7 V
Discharging SOC = 0.20 / 0.45
approx. 237.5 / 247.3 V

Array losses

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 20.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

DC wiring losses
Global array res. 7.3 mΩ
Loss Fraction 1.5 % at STC

Serie Diode Loss
Voltage drop 0.7 V
Loss Fraction 0.1 % at STC

Module Quality Loss
Loss Fraction -0.8 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

IAM loss factor
Incidence effect (IAM): Fresnel AR coating, n(glass)=1.526, n(AR)=1.290

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	0.999	0.987	0.962	0.892	0.816	0.681	0.440	0.000

Figure 4.10 General parameters and characteristics of system

Based on these data, various graphs were obtained, which are necessary for modeling the system:

1. Detailed User`s needs (Figure 4.11)

Daily household consumers, Constant over the year, average = 984 kWh/day

Annual values

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	620	100W/lamp	12.0	744000
Vents	400	50W/app	12.0	240000
Stand-by consumers			24.0	24
Total daily energy				984024Wh/da

Hourly distribution

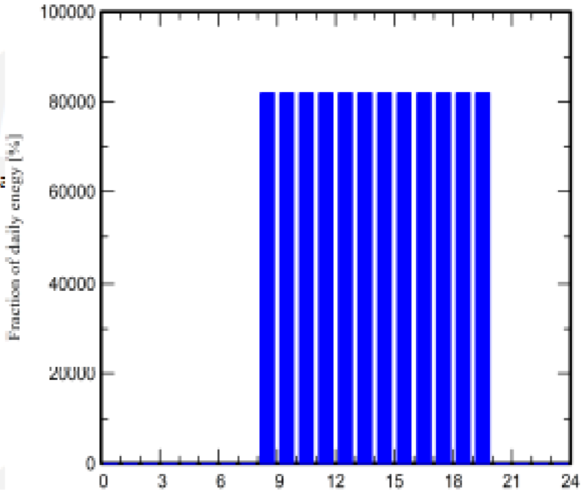


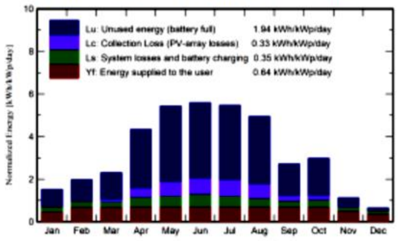
Fig.4.11 Detailed User`s needs

2. Main results, such as Normalized productions and Performance ratio PR (Fig. 4.12)

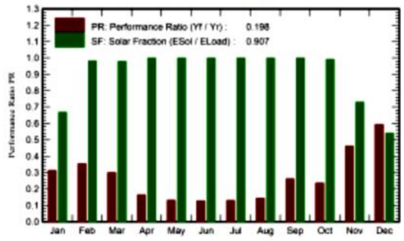
System Production

Available Energy	1441340 kWh/year	Specific production	1041 kWh/kWp/year
Used Energy	325748 kWh/year	Performance Ratio PR	19.77 %
Excess (unused)	982502 kWh/year	Solar Fraction SF	90.69 %
Loss of Load		**Battery aging (State of Wear)**	
Time Fraction	10.6 %	Cycles SOW	75.7 %
Missing Energy	33421 kWh/year	Static SOW	93.3 %

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

	GlobHor kWh/m²	GlobEff kWh/m²	E_Avail kWh	EUnused kWh	E_Miss kWh	E_User kWh	E_Load kWh	SolFrac ratio
January	21.3	46.6	61710	34311	10091	20414	30505	0.669
February	36.0	54.5	72999	38463	495	27058	27553	0.982
March	62.9	70.4	90776	53877	645	29859	30505	0.979
April	122.7	127.0	158550	113780	0	29521	29521	1.000
May	180.1	163.8	200491	152091	0	30505	30505	1.000
June	199.7	162.4	197177	146791	0	29521	29521	1.000
July	189.6	164.9	197983	149742	0	30505	30505	1.000
August	152.5	149.6	180396	136035	0	30505	30505	1.000
September	73.1	79.6	98720	61439	0	29521	29521	1.000
October	58.5	91.3	116069	74789	259	30245	30505	0.991
November	21.6	33.2	41967	15915	7961	21559	29521	0.730
December	12.6	19.8	24502	5269	13970	16535	30505	0.542
Year	1130.5	1163.1	1441340	982502	33421	325748	359169	0.907

Fig. 4.12. Main results

3. Reference Incident Energy in Collector Plane (Fig. 4.13)

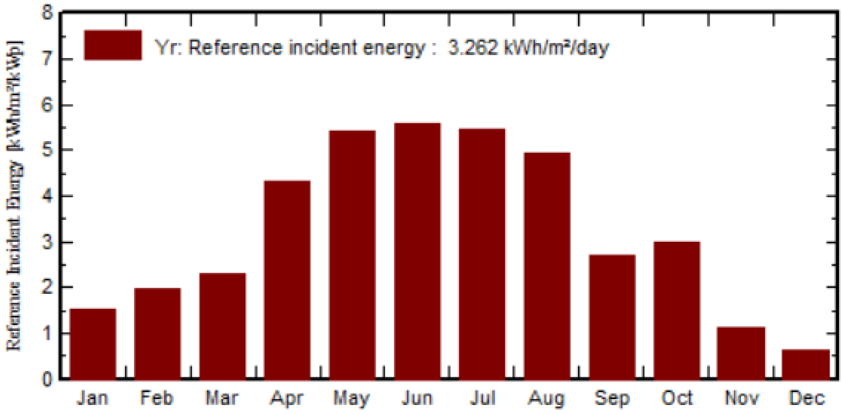


Fig. 4.13 Reference Incident Energy in Collector Plane

4. Normalized Production and Loss Factors (Fig. 4.14).

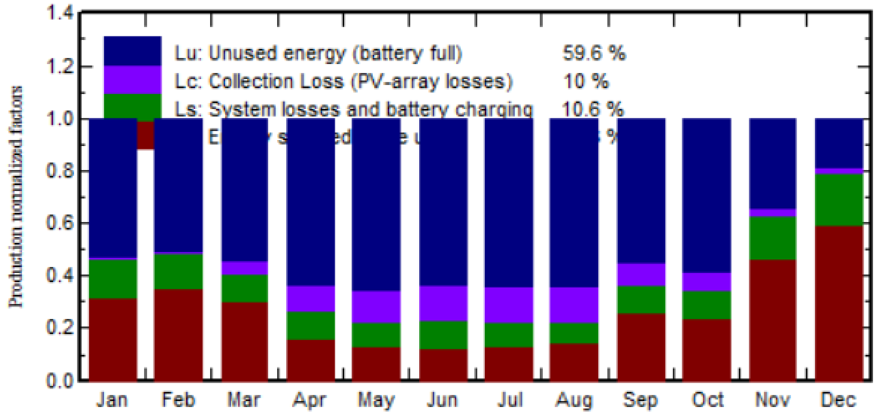


Fig. 4.14. Normalized Production and Loss Factors: Nominal power 1384kWp

5. Incident Irradiation Distribution (Fig. 4.15)

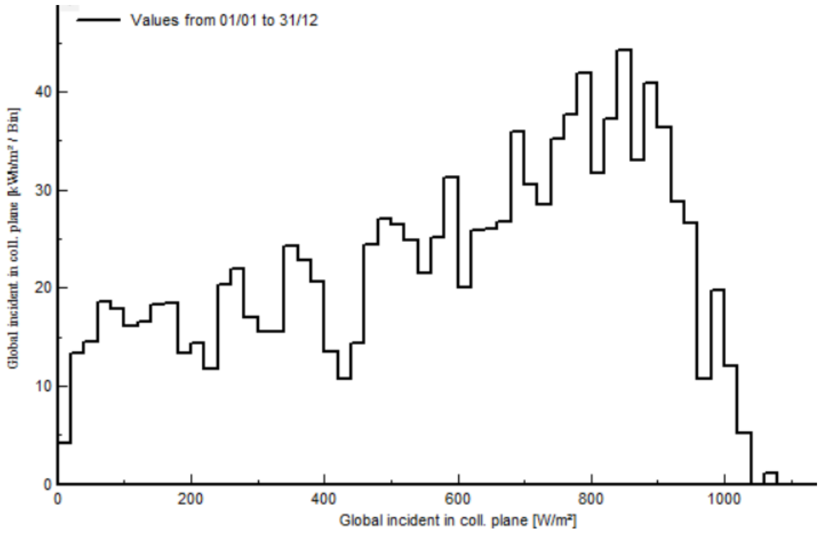


Fig. 4.15 Incident Irradiation Distribution

6. Incident Irradiation Tail Distribution (Fig. 4.16)

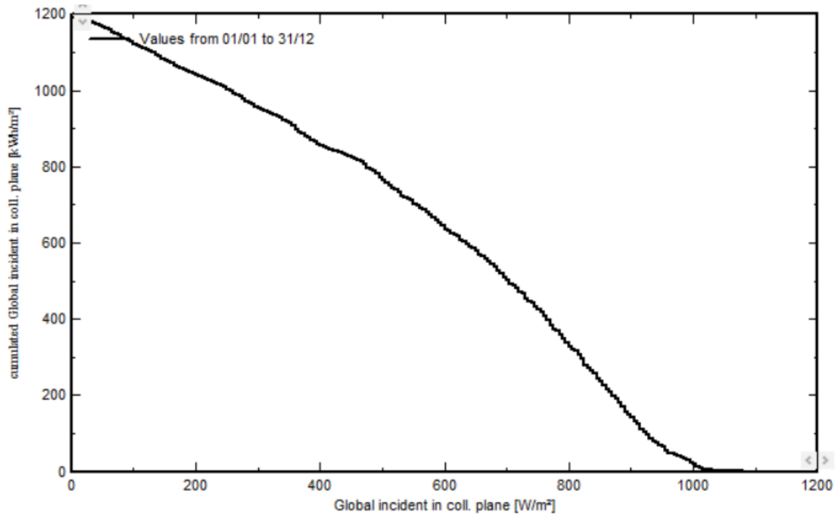


Fig. 4.16 Incident Irradiation Tail Distribution

7. Daily Input / Output diagram (Fig.4.17)

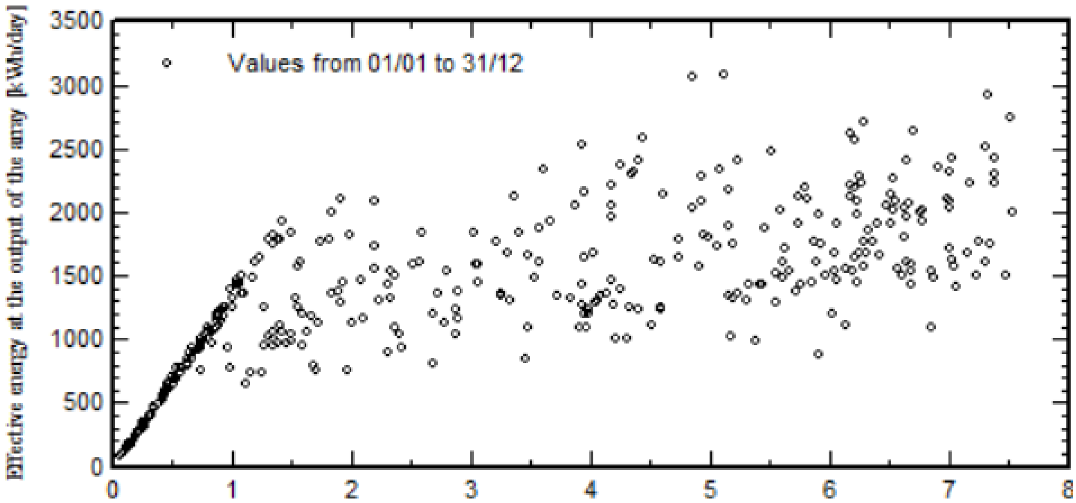


Fig. 4.17. Daily Input / Output diagram

8. Daily Array Output Energy (Fig. 4.18)

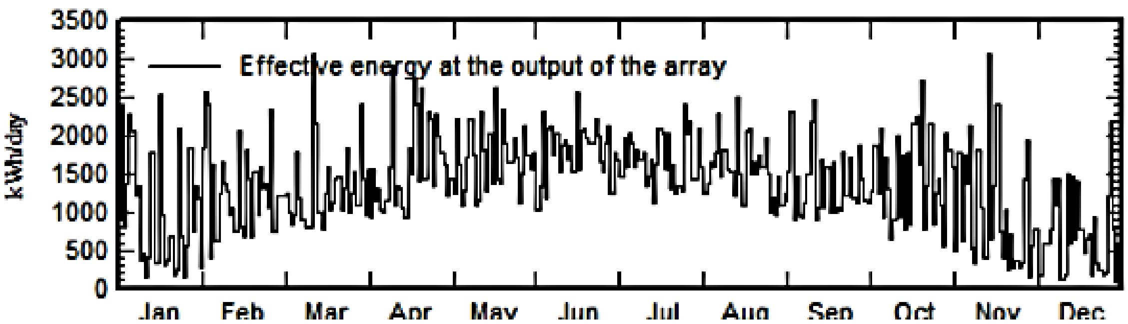


Fig.4.18. Daily Array Output Energy

9. Array Power Distribution (Fig. 4.19)

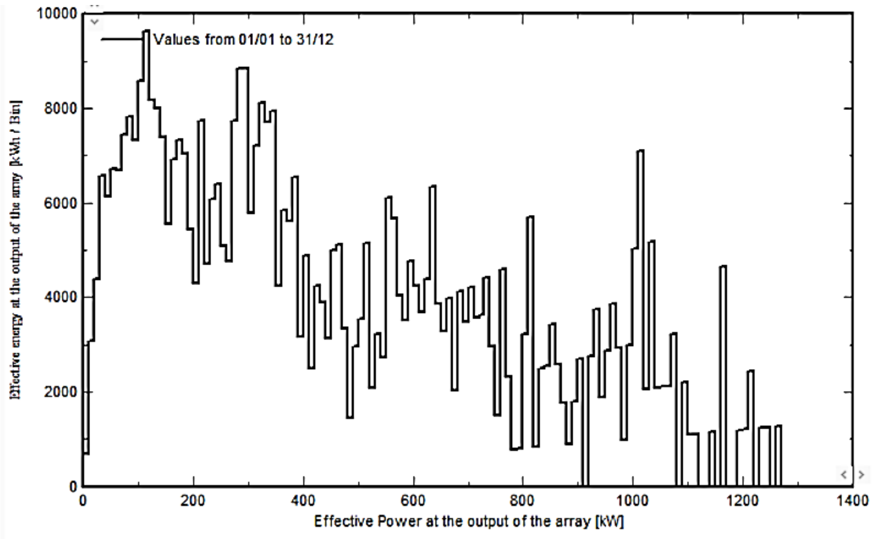


Fig.4.19. Array Power Distribution

10.Losses of system (Fig.4.20.)

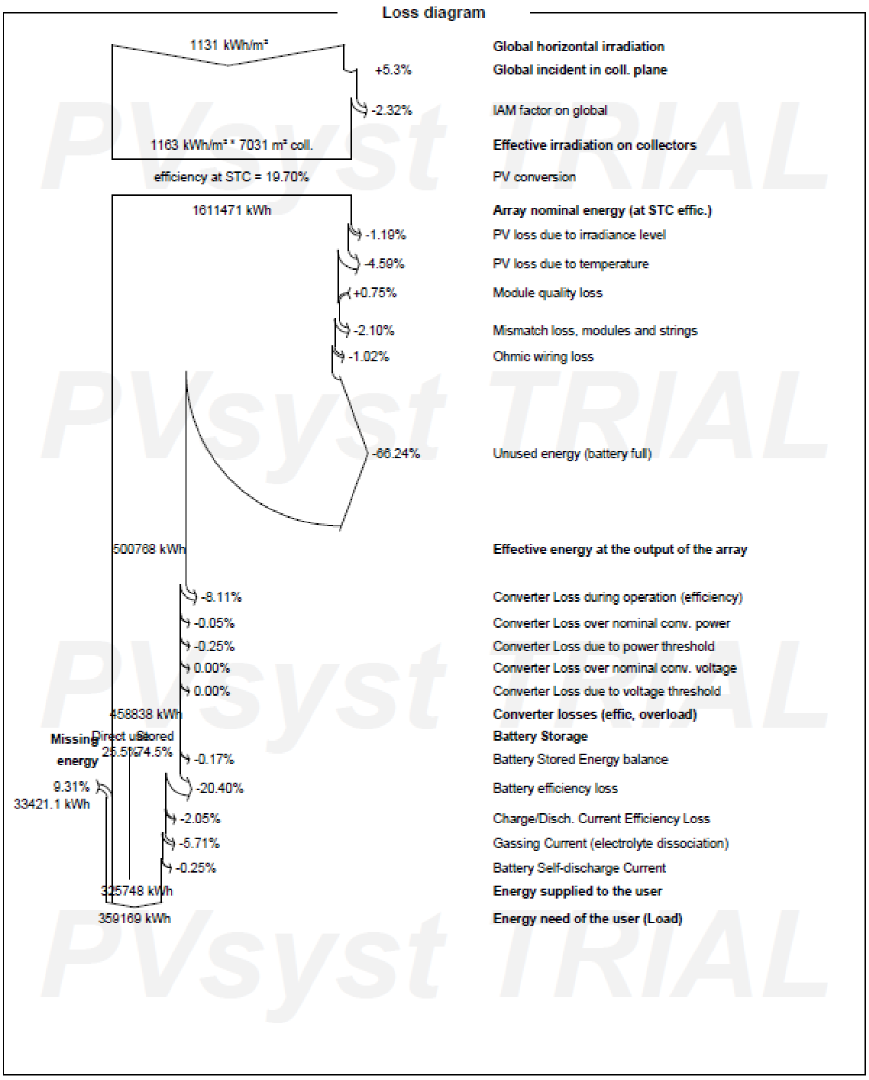


Fig. 4.20. Losses of system

As can be seen from the graphs, the system fully covers the energy needs of the warehouse during the warm season (Fig. 4.21), while in the colder months it is necessary to use a biogas plant.

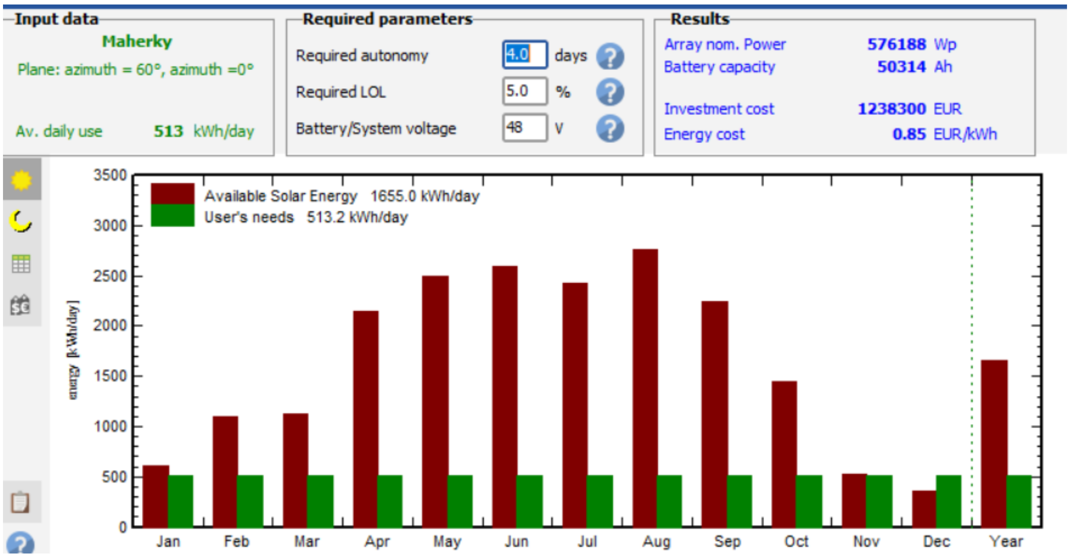


Figure: 4.21. Energy production versus consumption

CHAPTER 5 OCCUPATINAL SAFETY

This chapter describes the main issues that need to be considered to ensure the safety of people when installing, connecting and providing a hybrid alternative energy system with, in particular, solar panels and a small biogas plant. Solar panels are mainly associated with RRG in the low and medium voltage range and are mainly installed on the roof.

While hybrid alternative energy systems provide many benefits, there are also various hazards associated with them. For example, when installing and providing solar panels on the roofs of warehouses. Installing solar panel systems on rooftops can create electrical, fire, structural and weather hazards that must be properly addressed by appropriate codes, standards and guidelines. Significant progress has been made in recent years in many countries with a long tradition of using photovoltaic technology; however, there are still gaps to be pointed out.

The purpose of this chapter is to gather information on a wide range of safety hazards for people working in installing solar panel systems on roof structures and providing biogas plants.

This chapter summarizes the main performance categories associated with the installation and provision of a hybrid alternative energy system based on solar panel and biogas plant systems, and identifies the specific hazards that need to be considered. These include the safety of workers both during the construction phase and during the operational phase (as well as during decommissioning). Safety concerns in a hybrid alternative energy system are usually associated with electrical hazards, and installing solar panel systems on rooftops further introduces the hazards associated with elevated construction.

Finally, a hybrid alternative energy system presents different types of hazards that arise at different stages.

Human safety issues relate to all phases of a hybrid alternative energy system, from the permitting and design stage, where potential safety hazards associated with construction and operation need to be identified and analyzed.

Based on the risk assessment, recommendations are made for operators of the hybrid alternative energy system.

5.1. Analysis of harmful and hazardous production factors

The labor process is carried out in certain conditions of the warehouse, which is characterized by a set of elements and factors of the material and production environment. Consider the working conditions of a hybrid alternative power plant operator who controls rooftop solar panels and a biogas plant in a separate room.

The operator of a hybrid alternative power plant needs to install and monitor the operation of photovoltaic (PV) solar panels, which convert the sun's rays into electricity, or solar thermal panels, which trap the sun's rays to generate useful heat, and a biogas plant that converts organic agricultural residues into gas, and after into energy. The solar panel installer can install panels on the ground, on rooftops, on building walls, or on poles. Because solar panels work best with the maximum amount of sunlight, they are usually placed in an elevated position, which is why solar panel installers spend a lot of time working in high places such as roofs and poles. Needless to say, solar panel installers cannot be afraid of heights.

Workers in the energy industry are potentially exposed to a variety of serious hazards such as arc flash (which includes arc flash and explosion hazard), electric shock, falls and thermal burns, chemical burns, and gas poisoning, which can lead to injury or death.

5.2. Hazardous and harmful production factors according to GOST 12.0.003-74:

1. Physical:

I. Increased temperature of the surfaces of equipment, materials (in no case should you carry out repair work when the solar panels are heated);

II. Increased explosion hazard. Biogas mixed with air in a ratio of 5% to 15% can lead to an explosion if an ignition source of 600 ° C or more is present. Open fire is dangerous when the concentration of biogas in the air is more than 12%. Thus, smoking and fires around the installation are prohibited. When carrying out welding work, the distance to the gas equipment must be at least 10 meters. After draining raw materials from biogas plants for repair, the reactor must be ventilated, since there is a danger of explosion of the mixture of biogas and air.

III. Increased level of static electricity. The work environment must be controlled in accordance with safety requirements and all other relevant legal requirements.

IV. Increased voltage in the electrical circuit, the short circuit of which can occur through the human body.

There are many sources of electrical shock when working with photovoltaic systems, but only those aspects related to direct current from photovoltaic components are considered here, as they are specific to photovoltaic systems and are significantly different from those associated with the use of alternating current.

Whether they work in a household or an industrial facility, people who work with live electrical components must be aware of the hazards involved, and it is important that they take all safety measures to prevent and minimize these risks.

A common mistake associated with the risk of electric shock is to underestimate the risks associated with electric shock, especially if the subject is a healthy adult. On the contrary, it should always be remembered that electric shock, in addition to death, can cause serious physiological consequences for the human body. Hazardous situations, such as the consequences of a startle reaction, can cause muscle contraction, which in turn can lead to falls and other injuries. Thus, depending on the working conditions and environment, the consequences of a fall can be much worse than an initial electric shock (severe injury or death).

Electric shock is common in power systems with a grounded pole. In this case, it is required that the worker touches only one of the live parts in order to close the fault circuit. Photovoltaic installations with a grounded positive pole are more dangerous than a grounded negative pole due to the upward current (positive on the legs and negative on the shoulders).

While prevention is paramount, adequate knowledge of electricity and wiring is critical. The more a worker knows about the dangers, the more he can avoid risks. It is imperative that the potential hazards are well understood and each subject is informed and trained to take all necessary precautions and measures.

V. Increased fire hazard. This type or hazard is mainly concerned with the fire brigade and therefore the safety of the people whose task in this case is to extinguish a fire associated with a hybrid alternative energy system or, more generally, in a structure. Different scenarios are possible:

- A fire breaks out in a building whose roof is covered with PV modules, so eventually the fire spreads to the roof and the PV modules ignite
- The ignition is from photovoltaic modules, usually located on the roof, with the risk of fire spreading to the underlying structure.
- A fire occurs in equipment other than PV modules (inverter, totalizer unit, switchboard, etc.) and this can only slightly affect the PV array.

Scenarios 1 and 2 present a number of additional hazards for firefighters. In both cases, the presence of voltage in the photovoltaic system must always be taken into account and the hazards associated with specific actions to reduce the hazard must be considered. For example, cut-off string cables can be useful for limiting the elongation of live parts (for example, by isolating adders and inverters), but for this, firefighters must have sufficient knowledge of the PV system. Firefighters should also be aware that these operations do not completely eliminate the presence of hazardous voltages in the PV installation.

In principle, extinguishing a prolonged fire in a building often requires the use of water, and therefore having a photovoltaic system with parts still energized can be a problem if proper safety measures are not taken. The photovoltaic module, although damaged, can still generate electricity and create hazardous conditions, ranging from the perception of electric current above the threshold of perception to electric shock, therefore the regulations for the manipulation of arrays and photovoltaic modules must also be followed by firefighters. It is important that the protective equipment used by firefighters, such as shoes and gloves, is designed and tested for electrical shock, as required for fire fighting on a photovoltaic installation.

In addition, firefighters should be aware of the potential hazards of tripping, slipping, and falling when working on a roof, as PV modules and arrays can be slippery or fragile. Special care should be taken near the roof line, as modules or solid sections may slide off the roof.

Scenario 3 is sometimes easier to manage a fire brigade because it can be viewed as a fire caused by an electrical circuit requiring special non-conductive fire extinguishers (eg water is not allowed). However, additional complications can arise if all connections to the PV array are not disconnected. In these cases, the photovoltaic array continues to fuel the fire and thus extinguishing can be time consuming and laborious.

2. Chemical:

a) Inhalation of large quantities of biogas over a long period of time can cause poisoning, as the hydrogen sulfide contained in the biogas is very toxic. Untreated biogas smells like rotten eggs, but after cleaning it has no smell. Therefore, all rooms with household appliances using biogas must be regularly ventilated. Gas pipes must be regularly checked for leaks and protected from damage. Detection of gas leaks should be done using a soap emulsion or special devices. The use of open flames to detect gas leaks is prohibited.

Toxic effect of hydrogen sulfide:

Air Concentration (Ppm = 0.0001%) - Exposure

from 0.03 to 0.15 ppm - Perception wave, rotten egg smell

15 to 75 ppm - Eye irritation, nausea, vomiting, headache

150 to 300 ppm - Tactile nerve paralysis

more than 375 ppm - Death due to poisoning (after a few hours)

more than 750 ppm - Loss of consciousness and death from respiratory arrest within 30-60 minutes

over 1000 ppm - Instant death due to respiratory paralysis within minutes

Biologically hazardous and harmful production factors include:

b) The main sources of sanitary hazards are the presence of helminth eggs, E. coli bacteria and other pathogenic microflora in liquid manure and manure runoff. Therefore, precautions must be taken to prevent infection. For example, it is not recommended to eat in the premises of the farm and near biogas plants.

5.3. Measures to reduce exposure to harmful and hazardous production factors

A training program should be designed and conducted by appropriate training organizations to inform and educate the relevant personnel regarding the hazards and protective measures for the installation of a PV plant, which should cover the broader range of topics involved (e.g. design, installation, testing and commissioning, operation and maintenance).

The Applicant / Contractor shall ensure that all relevant personnel are well informed and trained regarding the health and safety risks and measures for any particular project.

The risk of arc damage in a photovoltaic system can be reduced or minimized during the design phase by adopting one of the following provisions:

- Installing a manual alarm that disconnects or shorts each module or group of modules separately.
- Install an arc fault breaker (AFCI) to protect the DC side from serial arcs. When the AFCI detects a failure, it cuts off the DC side of the photovoltaic system and beeps.

To minimize the possibility of an explosion in a biogas plant, it is necessary to inspect the system for gas leaks before starting work.

When working in production, various standards must be observed, and strict requirements are imposed on working conditions. A lot depends on the correct air exchange in enterprises. Natural ventilation will not help to provide it, so it is necessary to install supply and exhaust ventilation. This requires special equipment, which means that it is necessary to calculate the ventilation of the production room.

When designing a ventilation device, the air flow rate is calculated using the formula:

L=N*V

Where N – the multiplicity of air per hour

V – the amount of space

For a biogas plant, the multiplicity N is equal to 5.

$L = 5*20m^3=100m^3/hour$

It is with this power that the hood should be in the system.

5.3. Labor protection instructions

I. General requirements for labor protection

I. Persons who have reached the age of 18, who have passed a mandatory medical examination, induction instruction, initial instruction at the workplace, trained in safe working methods and having an electrical safety group of at least II, are allowed to work independently with a hybrid alternative energy system.

II. When working with a hybrid alternative energy system, the worker must:

I. Perform only that work, which is determined by the instructions for work (work) approved by the administration of the enterprise, and provided that the employee is well aware of the safe ways to perform it.

II. Observe the internal labor regulations.

III. Use personal and collective protective equipment correctly.

IV. Observe labor protection requirements.

V. Immediately notify your immediate or superior manager about any situation that threatens the life and health of people, about any accidents at work or about the deterioration of your health, including the manifestation of signs of an acute occupational disease (poisoning).

VI. Undergoing training in safe methods and techniques for performing work and providing first aid to victims in the workplace, instructing on labor protection, testing knowledge of labor protection requirements.

VII. Undergo mandatory periodic (upon hiring) medical examinations (examinations), as well as undergo extraordinary medical examinations (examinations) as directed by the employer in cases stipulated by the Labor Code and other federal laws.

VIII. The employee must be able to provide first aid to victims of electric shock and other accidents.

IX. Be able to use primary fire extinguishing equipment.

III. When working with a hybrid alternative energy system, workers should be provided with work clothing, safety footwear, and other personal protective equipment in accordance with the Industry Standard Rules for Free Distribution of Overalls, Safety Shoes and Other Personal Protective Equipment and the Collective Agreement.

IV. In the event of ice formation on the roof in winter, the worker should request that it be covered with sand or sawdust.

V. Keep tools and work area dry.

VI. When working with a hybrid alternative energy system, an employee is prohibited from:

. work without a partner;

I. insert electrically conductive objects into connectors;

II. Disassemble solar panels

III. Lean sharp parts against the back of the panel;

IV. Expose panels to artificially focused radiation.

V. Check biogas leaks with a fire.

VI. Smoking near the biogas plant.

VII. go behind the fences of technological equipment without permission

VIII. remove barriers to hazardous areas of operating equipment

VII. In case of injury or discomfort, you must stop work, notify the supervisor and contact a medical facility.

II. Labor protection requirements before starting work:

I. Wear coveralls to avoid drooping ends and constricting when moving, wear safety shoes and personal protective equipment

Check and verify that stationary equipment, tools, fixtures and protective equipment are in good working order. Position the tool for maximum ease of use, avoiding unnecessary items in the work area.

II. Check that the tools and work surface are dry.

III. Ventilate the biogas plant room

IV. Disconnect the inverter from the mains.

V. The employee is prohibited from:

I. use unsuitable and incorrectly sharpened tools and devices;

II. touch live parts of electrical equipment, open the doors of electrical cabinets. Contact your service personnel if necessary.

VI. All defects and malfunctions of the tool, devices and protective equipment found during the inspection should be reported to the work manager for taking measures to eliminate them.

- Labor protection requirements during work:
- Install and remove parts only when the power is off
- When working with a hybrid alternative energy system, an employee must:
- securely and correctly fasten the workpiece to be processed to exclude the possibility of its departure;
- Check the parameters of the level of mechanical stress.
- Check modules for grounding
- Follow the instructions for use and repair of equipment
- The employee is prohibited from:
- Dropping construction details.
- Lean sharp parts against the back panel cover
- Labor protection requirements in emergency situations
- Under the guidance of the person responsible for the performance of work, promptly take measures to eliminate the causes of accidents or situations that may lead to accidents or accidents.

. Immediately notify the fire brigade by phone "01", notify the workers, notify the head of the unit, report the fire to the guard post.

I. Open emergency exits from the building, de-energize, close windows and doors.

II. Start extinguishing the fire with primary fire extinguishing equipment, if it is not associated with a danger to life.

III. Exit the building and stay in the evacuation zone.

IV. Move to a safe distance from the biogas plant.

V. Immediately provide the victim with first aid and, if necessary, deliver him to a medical organization;

VI. Take urgent measures to prevent the development of an emergency or other emergency situation and the impact of traumatic factors on others;

VII. 3 Before starting the investigation of the accident, preserve the situation that was during the accident, if this does not threaten the life and health of others and does not lead to a catastrophe, accident or other emergency, and if it is impossible to save, correct the current situation (draw up diagrams, take other measures).

I. Labor protection requirements upon completion of work.

A. Make sure all items are connected correctly and secured.

B. Tidy up your workplace

C. Connect the inverters to the grid

D. Remove the jumpsuit and put it in the closet.

E. Wash your face and hands with warm water and soap

F. Inform the work supervisor about all the shortcomings noticed in the process of work and the measures taken to eliminate them.

CHAPTER 6. ENVIRONMENTAL PROTECTION

Man, today cannot do without the use of energy. Unfortunately, the reserves of natural fuels are limited. Energy consumption is increasing annually, so the practical significance of using other energy sources is gaining in popularity. Energy is one of the main air pollutants today. Power plants operating on traditional fuels contribute up to 3% of the volume of harmful air emissions, pollute the soil and water with combustion products and wastewater. The processing of fossil fuels has dangerous environmental consequences. Hence the problem - traditional energy sources are not endless and can cause irreversible processes in the environment.

As you know, any method of obtaining energy is accompanied by an impact on the environment. Thermal energy uses, as a rule, more coal in the production than other types of fuel. In turn, it is coal that has the main negative environmental effect. Thermal power plants emit combustion products into the atmosphere and dump waste into water bodies. Many experts believe that the use of traditional energy sources is limited precisely ecologically. The production limit is not only related to the pollution of the environment with particulate matter. Overheating of the Earth's surface and atmosphere as a result of heat release during the combustion of hydrocarbon fuels is an important limiting factor. This can cause global disturbances of natural thermal equilibrium, climate change

Therefore, today all over the world more and more resort to the use of alternative energy.

6.1. Green Energy as an environmentally friendly alternative

Our kind is actively working on the exhaustion of fossil fuels. So, we need to urgently find an alternative. Green technology aims the active use of renewable resources – sunlight, water and wind through solar panels, dams, geothermal wells wind turbines.

6.2. Solar panels

The sun in general is one of the most environmentally friendly forms of energy. However, it is known that the potential harm from solar energy on the environment can be observed during the production and disposal (or disposal) of waste. The source of environmental pollution is factories producing semiconductor materials for solar cells, not solar energy, which is "clean".

6.2.1. Benefits of solar panels

Already installed battery lines show that the free land required to produce each gigawatt-hour of solar energy is still less than the same amount of energy produced in conventional coal-fired power plants.

There is no need to touch areas sensitive to penetration by cars and people. Also, there is no need to somehow interfere in this regard with the lands of settlements or generally go deep into difficult territories. The beneficial nature of solar energy itself, its environmental friendliness, including reasonable water consumption, minimizes concerns about the environmental effects of batteries.

Small electrical substations do little to harm the environment, just like solar panels. Surprisingly, solar batteries do not pollute the environment, do not produce emissions and wastes that are risky for the fauna and flora by so easily producing the electrical energy that a person needs. This energy production does not require liquid or gaseous fuels and does not need to be transported or burned. When viewed from a wide field of view, the risks to the environment from solar panels are minimal. The approximate air emissions during production are 0.02 grams of cadmium telluride per GIGAWATT / hour of electricity generated over the life of the solar module, which is very low.

Large-scale use of solar panels does not pose any risk to human health and living beings. And the re-processing of modules that have already served their service life almost completely neutralizes the concern of the "green" about the harmfulness of this type of electricity production.

During their operation, solar modules do not produce environmental pollution, and moreover, gradually replacing traditional fuels (gas, oil, coal), they bring significant benefits to the environment. Cadmium telluride in solar cells actually turns out to be much more friendly to Nature than all other types of cadmium batteries currently in use, including the famous nickel-cadmium ones.

Since the solar panels are located on the roof of the building, they do not take up "extra space".

6.2.2. Environmental Impact of Solar Energy Development

While the use of solar energy does not pollute the environment, the manufacture of certain types of solar devices is quite possible. Environmentalists have no serious complaints about solar water heating and heating installations, and they are also small-scale. There may be problems when antifreeze flows out of 2, 3-circuit systems. Regarding solar power plants (SES), solar power plants (SEC) and solar photovoltaic plants (SPES), then conditionally environmentally friendly can only be called their operation. Silicon is a stable material and is essentially non-hazardous to the environment. In the production of silicon solar cells, harmful substances are emitted in the same way as in the electronics industry; in general, in these cases, monitoring and control, both in factories and in the environment, is carried out constantly [1]. In the production of solar cells based on copper and indium diselenide, as well as cadmium telluride, potential harm can occur due to the use of selenide and cadmium. Table 1 shows data on the emission of various harmful substances and compounds during production, solar cells and modules. The most promising direction for using solar energy is its use in solar heat supply systems.

The attribution of solar stations to environmentally friendly power plants cannot be called fully justified due to insufficient knowledge of this renewable source and the consequences of its use. In the best case, the final stage can be attributed to ecologically clean - the stage of operation of solar power plants (SPP), and that is relative.

Solar stations are quite earth-intensive. The specific land capacity of SPP varies from 0.001 to 0.006 ha / kW with the most probable values of 0.003-0.004 ha / kW. This is less than for hydroelectric power plants, but more than for thermal power plants and nuclear power plants. Also, solar stations are very material-intensive (metal, glass, concrete, etc.), moreover, in the given values of land capacity, land acquisition at the stages of extraction and processing of raw materials is not taken into account. In the case of a solar power plant with solar ponds, the specific land capacity will increase and the risk of groundwater pollution by brines will increase.

Solar concentrators cause large areas of land shading, which leads to dramatic changes in soil conditions, vegetation, etc. The production of 50 MEGAWATTS of electric power using gas combustion plants will require approximately 2 to 5 acres of land. To get the same amount of energy from solar modules, it will be necessary to cover about a thousand acres of land with solar panels (and this is even if we take into account the optimistic figures in obtaining energy of 10 watts per square meter or 5% efficiency at peak production).

An undesirable environmental action in the area of the station's location causes heating of the air when solar radiation, concentrated by mirror reflectors, passes through it. This leads to a change in heat balance, humidity, wind direction; in some cases, overheating and fire of systems using concentrators are possible, with all the ensuing consequences. The use of low-boiling liquids and their inevitable leakage in solar energy systems during long-term operation can lead to significant contamination of drinking water. Fluids containing chromates and nitrites, which are highly toxic substances, are especially dangerous.

Solar technology has an indirect effect on the environment. In the regions of its development, large complexes for the production of concrete, glass and steel should be built. During the manufacture of silicon, cadmium and arsenide-helium photovoltaic cells, silicon dust, cadmium and arsenide compounds, hazardous to human health, appear in the air of industrial premises.

Space SES, due to microwave radiation, can affect the climate, interfere with television and radio communications, affect unprotected living organisms that have fallen into the zone of its influence. In this regard, it is necessary to use an environmentally friendly wavelength range to transfer energy to the Earth.

6.3. Biogas plant

Growth in greenhouse gas emissions, increased water consumption, water pollution, depletion of land and natural energy resources are forcing the search for new sources of energy. One of them is biogas technologies. According to forecasts, the contribution of biomass as an additional source of energy by 2040 will reach 23.5% of total energy consumption.

6.3.1. Advantages of a biogas plant

The production of electricity from biomass is considered the most environmentally friendly sector of the energy sector, as it helps to reduce environmental pollution by all kinds of waste (livestock, household, forestry and woodworking industries, etc.).

The transition of the enterprise to biogas is associated with some aspects that have a positive effect on the environment:

- Converting biomass into biogas - an environmentally friendly way of processing organic waste;
- Getting biogas and using it instead of natural gas eliminates the need to use an expensive non-renewable resource;
- Raw materials for biofuel production. Unlike traditional oil or gas, biofuels are made from renewable biological material such as plants, manure or waste.
- The list of organic waste suitable for biogas production: manure, poultry manure, grain and molasses distillery stillage, brewer's grains, beet pulp, fecal sediments, fish and slaughterhouse waste (blood, fat, intestines, kanyga), grass,

household waste, waste dairies - salty and sweet milk whey, waste from biodiesel production - technical glycerin from the production of biodiesel from rapeseed, waste from the production of juices - fruit, berry, vegetable pulp, grape pomace, algae, waste from starch and molasses production - pulp and syrup, waste potato processing, chips production - peels, skins, rotten tubers, coffee pulp.

- In addition to waste, biogas can be produced from specially grown energy crops such as silage corn or silphium, as well as algae. The gas output can reach up to 300 m3 from 1 ton. The biogas output for various sources is given in table.
- The processing of organic waste provides (depending on the nature of the processed raw materials) feed additives or effective biofertilizers; From 1 cubic meter. m of biogas, you can get about 2 kW of electricity. Heat from gas combustion can be spent on heating premises, maintaining greenhouses and livestock in rural areas, for operating refrigerators at an enterprise. In the fermented mass, mineralization is 60%, in ordinary manure - 40%. Such balanced fertilizers increase yields by 30-50%. They, as well as surplus gas or electricity, can be sold. biogas is ecological anaerobic.
- The anthropogenic load on ecosystems is decreasing;
- The company uses renewable resources efficiently.

An additional biogas purification system is installed for refueling vehicles, after which it can be used as fuel. Purified biogas can be used to refuel equipment, which is very important at the present time, in the context of a constant rise in prices for diesel fuel. A byproduct of cleaning is carbon dioxide, from which you can also get some profit - used as dry ice, for soda or for technical purposes.

The advantages of obtaining fuel from organic waste include the following factors:

- Biofuels are a renewable resource and are therefore a long-term and reliable source of energy.

- Biogas production - for the production of electricity and heat, as well as as fuel for internal combustion engines. Biogas plants can partially or completely replace outdated regional boiler houses and provide electricity and heat to nearby villages, townships, small towns. Combustion of 1 m3 of biogas in a modern cogeneration plant makes it possible to obtain 2.4 kW * h. electricity and 2.8 kWh (at 60% methane in biogas) heat energy in the form of hot water. Bioenergy can be of great help in solving energy conservation problems.
- Production of high quality biofertilizers with a high content of nitrogen and phosphorus components. The fermented mass is ready-made environmentally friendly liquid and solid biofertilizers, devoid of nitrites, weed seeds, pathogenic microflora, helminth eggs, and specific odors. When using such balanced biofertilizers, the yield increases by 10-20%. Biofertilizers can be sold. These fertilizers are higher in quality than mineral fertilizers, and their cost is practically zero.
- Cost savings in wastewater treatment plants.
- Odor emission is reduced by up to 80%.
- Reducing the level of harmful emissions into the atmosphere.
- Biogas production can reduce greenhouse gas emissions.
- The average payback period of the project is 1.5-2 years, since there is no need to pay for gas, electricity, warm water, fertilizers. The high profitability of domestic biogas technologies is ensured by the simultaneous production of highly efficient organic fertilizers. According to specialists' calculations, in Russian conditions the most profitable units are of medium and high power.
- Wet fermentation involves pre-wetting the biomass to a liquid state. The liquid fraction is pumped into the reactor by special pumps. The continuity of the technological process of biogas formation is carried out due to the gradual supply of fresh biomass to the lower part of the bioreactor and the simultaneous pumping out of the old from the upper layers. The fermentation process

produces biogas and high-quality organic fertilizers enriched with the waste products of anaerobic bacteria. For heating the reactor in winter conditions, a small part of the produced gas is used - usually no more than 10% of the produced volume of biogas.

- The dry method consists in using a specially designed fermenter. Dry biomass with a moisture content of not more than 50% is loaded into a sealed fermenter. In the fermenter, the raw material is fermented without the access of oxygen due to the constant irrigation of the biomass with liquid filtrate from the reactor. The filtrate flowing into the drainage system with the help of pumps returns to the irrigation system again. This recirculation system avoids the need to constantly stir the substrate, thereby significantly reducing energy costs. A favorable temperature regime is provided by heating the side walls and the floor of the reactor. The whole process of fermentation takes place in one stage - the biomass ferments until complete decomposition without introducing new raw materials and selecting old ones.
- Complex use. The greatest efficiency of a biogas plant is achieved through the integrated use of all types of products obtained as a result of the station's operation. The diagram shows the items of revenue from the complex use of a biogas plant.

Integrated use implies the sale or use of electricity and heat, the sale of fertilizers, cost savings by reducing tax payments as a result of waste disposal. Part of the thermal energy produced by the biogas plant is used for own needs (heating the biogas reactor), and the rest can be supplied to the network.

Do not forget about organic fertilizer, which is obtained as a result of the work of a biogas plant. It is an environmentally friendly and extremely cheap source of complex organic fertilizers for agriculture, devoid of nitrites, weed seeds, pathogenic microflora, and specific odors. The consumption of such fertilizers is 3-5 tons instead of 60 tons of untreated manure for processing 1 hectare of land, and tests show an increase in yield by 2-4 times. There is no need to expect that the resulting fertilizer can be sold on the territory of the European Union. To do this, you need to go through a complex certification procedure.

6.3.2. Disadvantages of using a biogas plant

Biogas contains 40–80% methane, 60–20% carbon dioxide and minor amounts of other gases and vapors (H_2S, H_2O, N_2, O_2, etc.). Biogas formation mainly occurs during the anaerobic decomposition of organic matter and as a result of the vital activity of ruminants.

The problem of utilization of organic waste of plant and animal origin is very urgent. In the liquid phase, these are animal and poultry waste (manure and dung) and municipal wastewater. There is a significant amount of solid household and agricultural waste containing an organic component. In Ukraine, solid waste is disposed of at landfills, and municipal wastewater is sent to a biological treatment plant, where it is subjected to a special treatment with an anaerobic method. In small towns, as well as in livestock and poultry farms, the problem of waste management is practically not solved. Around large livestock and poultry complexes, water and soil 3-5 km away are poisoned by animal waste products, which may contain pathogenic microorganisms, including salmonella and others.

During anaerobic digestion, organic matter is decomposed without oxygen. At the first stage, under the action of anaerobic bacteria, complex organic compounds (fiber, proteins, fats, etc.) are decomposed to simpler compounds: volatile fatty acids, lower alcohols, hydrogen, carbon monoxide, acetic and formic acids, etc. At the second stage methane-forming bacteria convert organic acids into methane, carbon dioxide and water. The residue that forms during the biogas production process contains nutrients and can be used as fertilizer. The composition of the residue obtained during the anaerobic processing of waste from livestock farms and poultry farms depends on the chemical composition of the feedstock, which is loaded into the bioreactor.

Under favorable conditions and observance of optimal technological modes, about 70% of organic substances decompose, the remainder is 30%. The main advantage of anaerobic digestion is that virtually all of the nitrogen contained in the feedstock is retained in organic or ammonia form. From the point of view of hygiene and environmental protection, for the processing of animal and poultry waste, the method of anaerobic digestion is most acceptable, since it provides effective destruction of pathogenic microorganisms.

Agricultural production accumulates 75% of all generated organic waste (45% - in animal husbandry and poultry, 30% - in crop production). Currently, about half of the by-products of the agro-industrial complex is not used - straw and chaff of cereals, stalks and cobs of corn and sorghum, stems and husks of sunflower, tops of potatoes and vegetables, waste of the meat and dairy industry, livestock complexes and poultry farms. Calculations show that as a result of methane fermentation of manure from one cow, up to 2.5 m3 of biogas can be generated per day. In the municipal economy, the sources of biogas are municipal wastewater and solid waste. During anaerobic fermentation of urban wastewater, sewage (aeration) gas is formed, consisting of 60-65% methane, 30-35% carbon dioxide, 2-4% hydrogen. The outlet of sewage gases from a processing station fed by a sewer network and serving a population of 100 thousand people can exceed 2,500 m3 per day. Biogas is also released during the decomposition of sewage sludge. Depending on the chemical composition of the sludge, 1 m3 of biogas can form from 5 to 15 m3.

At the same time, during fermentation processes for the processing of biomass into ethanol, a significant amount of by-products (washing water and distillation residues) arises, which significantly pollute the environment. For example, the production of one liter of ethanol generates 13 liters of liquid waste. In addition, thermal pollution, depletion of soil organic matter, depletion and erosion of soils occur. The use of bioethanol as fuel for automobiles will entail an increase in the volume of carbon dioxide emitted into the atmosphere, and will also lead to an increase in the area of logging. As countries' demand for biofuels increases, so will the area of fields used for planting corn and reed, leading to deforestation. The shrinking woodlands, in turn, will convert less carbon dioxide into oxygen.

In addition, we can say that the benefits of alternative energy sources are many times greater than the harm, and with proper installation and maintenance, problems with these installations will occur very rarely.

CONCLUSIONS

Further development of energy in Ukraine and around the world will shift towards the development of alternative energy sources and so-called small energy. And this is primarily due to the lack of energy and limited fuel resources. alternative energy sources are environmentally friendly, renewable, and also relatively evenly distributed, so the leadership in their use will be won by regions with a skilled workforce, receptivity to innovation and strategic foresight.

The diploma presents the theoretical development of a hybrid alternative energy system for the warehouse of spare parts of the airfield "Nizhyn", consisting of solar panels and a biogas plant. The above data show that these alternative energy sources will be more productive than others.

Solar panels will be effective in the warm season and give even more than the norm of energy, which can then be used for the needs of the complex, such as lighting the perimeter or providing other buildings of the complex with electricity. In the warm season, it is best to accumulate biogas in a gas tank. In winter, there is a need to use biogas, which is used as fuel for a gas turbine.

The presented system is able to work for a day without recharging. The system was created specifically for the conditions of the region as a whole and this warehouse in particular.

In the diploma, the calculation of electricity costs was carried out depending on the time of year. The calculation of the necessary number of solar panels, power, biogas plants, gas turbine power, battery capacity and volume of gas tank is required for storage of biogas. We performed a simulation of the behavior of solar panels.

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