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**the way we live**  
Development • Innovation • Partnerships

# PROPOSAL FOR ARTISAN TRAINING OF COLLEGE TEACHERS STAFF

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- Researching:
  - Solar panels,
  - Photovoltaic converter
  - Wind power plant.

The guarantee of its quality is the International Certificate of Conformity of the quality management system ISO 9001.

## TRAINING PROGRAMMES:

### 20.03 Photoelectric converters

- ✓ Experimental test of single solar panel characteristics.
- ✓ Experimental test of series connected solar panels characteristics.
- ✓ Experimental test of parallel connected solar panels characteristics.
- ✓ Experimental test of series-parallel (combined) connected solar panels characteristics.
- ✓ Experimental demonstration of bypass diode operation.
- ✓ Experimental demonstration of the conversion of solar energy into electricity for electric power supply.
- ✓ Experimental test of solar panels characteristics while changing radiation intensity.
- ✓ Experimental test of solar panels characteristics while changing sunrays incidence angle.
- ✓ Experimental demonstration of solar system operation modes with accumulator battery.

### 20.80 Energy-saving technologies. Wind turbine studies

- ✓ Experimental test of wind turbine speed characteristics dependence on wind speed.
- ✓ Experimental test wind turbine speed characteristics dependence on the type of impeller.
- ✓ Experimental test wind turbine power dependence on wind speed.
- ✓ Experimental test of wind turbine characteristics at a constant wind speed and changeable load.
- ✓ Experimental test of the electrical characteristics of synchronous generator.

### 20.81 Energy saving technologies. Study of photoelectric energy converter – solar panel

- ✓ Experimental test of single monocrystalline and polycrystalline solar panel characteristics.
- ✓ Experimental test of series-connected solar panels characteristics.
- ✓ Experimental demonstration of bypass diode operation.
- ✓ Experimental test of solar panels characteristics while changing radiation intensity.
- ✓ Experimental test of solar panels characteristics while changing sunrays incidence angle.

### 20.82 Energy saving technologies. Solar power generator with tube collector

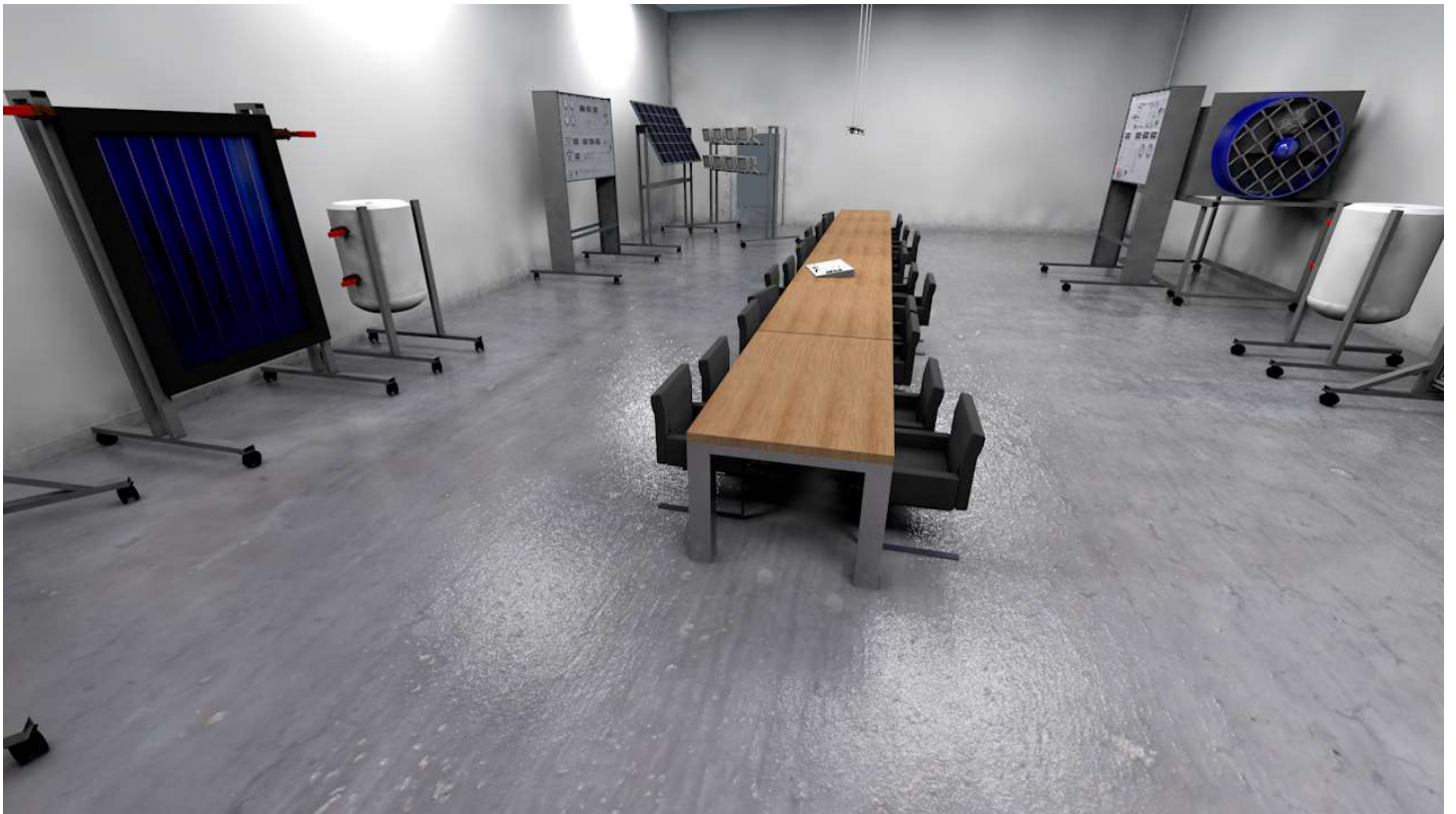
- ✓ Practical work on operating solar power generator with collector.
- ✓ Experimental test of tube collector characteristics.
- ✓ Practical work for the study of electronic controller of operating solar power generator with collector.

### 20.83 Energy saving technologies. Solar power generator with flat-plate collector

- ✓ Practical work on operating solar power generator with collector.
- ✓ Experimental test of flat-plate collector characteristics.
- ✓ Practical work for the study of electronic controller of operating solar power generator with collector.

## **3D MODELS AND EXAMPLES**







## SKILLS ACQUIRED

### 20.03 Photoelectric converters

- ✓ Measuring characteristics of a single solar cell.
- ✓ Measuring characteristics of solar cells connected in series.
- ✓ Measuring characteristics of solar cells connected in parallel.
- ✓ Measuring characteristics of solar cells connected in series-parallel configurations.
- ✓ Demonstrating the operation of bypass diodes visually.
- ✓ Visually demonstrating the conversion of solar energy into electrical energy to power consumers.
- ✓ Measuring solar cell characteristics under varying irradiance levels.
- ✓ Measuring solar cell characteristics with changes in the angle of incidence of rays.
- ✓ Demonstrating operating modes of a solar system with a battery.

### 20.81 Energy saving technologies. Study of photoelectric energy converter – solar panel

- ✓ Measuring characteristics of individual monocrystalline and polycrystalline solar cells.
- ✓ Measuring characteristics of solar cells connected in series.
- ✓ Measuring characteristics of solar cells connected in parallel.
- ✓ Demonstrating the operation of bypass diodes visually.
- ✓ Measuring solar cell characteristics under varying irradiance levels.
- ✓ Measuring solar cell characteristics with changes in the angle of incidence of rays.

### 20.82 Energy saving technologies. Solar power generator with tube collector

- ✓ Practical work on a functioning solar collector installation
- ✓ Measuring characteristics of a tubular solar collector.
- ✓ Studying the electronic regulator in a functioning solar collector installation.

### 20.83 Energy saving technologies. Solar power generator with flat-plate collector

- ✓ Practical work on a functioning solar collector installation
- ✓ Measuring characteristics of a flat solar collector.
- ✓ Studying the electronic regulator in a functioning solar collector installation.

### 20.80 Energy-saving technologies. Wind turbine studies

- ✓ Determination of air stream speed and blower rotation speed.
- ✓ Studying wind turbine speed properties depending on impeller type and blade slope angle.
- ✓ Studying wind turbine power dependence on wind speed.
- ✓ Studying wind turbine performance at a constant wind speed.
- ✓ Studying synchronous generator performance.

## **EQUIPMENT INCLUDES:**

- ✓ Training laboratory equipment NTC 20.03.C «Photoelectric converters » - 50 pcs (10 pcs per laboratory);
- ✓ Training laboratory equipment NTC 20.81.C «Energy saving technologies. Study of photoelectric energy converter – solar panel» - 5 pcs (1 pcs per laboratory);
- ✓ Training laboratory equipment NTC 20.82.C «Energy saving technologies. Solar power generator with tube collector» - 5 pcs (1 pcs per laboratory);
- ✓ Training laboratory equipment NTC 20.83.C «Energy saving technologies. Solar power generator with flat-plate collector» - 5 pcs (1 pcs per laboratory);
- ✓ Training laboratory equipment NTC 20.80.C «Energy saving technologies. Wind turbine studies» - 5 pcs (1 pcs per laboratory);
- ✓ Projector sheet – 5 pcs (1 pcs per laboratory);
- ✓ Projector – 5 pcs (1 pcs per laboratory);
- ✓ Software and methodological support with a detailed description of the sequence of experiments included.

### **IMPORTANT NOTES!**

- ✓ Regarding the assembly of equipment, there is no assembly needed, machines just need to be plugged in electrical outlets and that is it, "plug & play" principle.
- ✓ Regarding the guarantee for equipment, it is 2 years for most components. Factory bears expenses for replacing faulty parts under guarantee. Parts would be sent to you, and your technical person would replace the part with live video guidance and supervision from the factory.
- ✓ Online support and assistance for any questions or problems is available 24/7.
- ✓ Training of staff takes approximately up to 10 days. Certificate of completion is issued upon training is completed.

## DESCRIPTION OF EQUIPMENT AND EXPERIMENTS PROVIDED

### Training laboratory "Solar, photovoltaic and wind power sources"

TRAINING LABORATORY EQUIPMENT NTC 20.03.C «PHOTOELECTRIC CONVERTERS »



#### Experiments provided

1. Familiarization with solar cells operation principle.
2. The study of solar cell characteristics.
3. The method of solar cells termination in groups
4. Solar battery operation while shading separate modules.
5. Electrical specifications of solar batteries.
6. The characteristics of solar batteries depending on radiation intensity, beam incidence angle and temperature.
7. Solar accumulator battery.

#### Description

The training laboratory system allows to carry out practical works on studying the processes of photoelectric energy conversion.

It is designed to be used as a teaching facility for practical and laboratory classes on studying the processes of solar radiation to electricity conversion, determining KPI and characteristics of converters in higher and secondary technical institutions.

On the front panel of the bench the following equipment is located:

- 4 solar cells 6W/40mA;

- **accumulator battery;**
- **fan DC 12V;**
- **LED point-light 12V;**
- **active variable load;**
- **independent voltage source 12V.**

The electrical connections between separate nodes in performed by flexible jumpers with plug connectors. The bench is completed with a light source with adjustable intensity, elevation and angle of slope. For current measurement the bench is completed with conducting bridges in the form of jumpers.

The training system is supplied with a set of methodical and technical documentation of teaching staff.

NTC-20.81 "THE STUDY OF THE PHOTOELECTRIC ENERGY CONVERTER – SOLAR PANEL"



### **Experiments provided**

1. **The study of the laboratory bench.**
2. **The study of the construction and operation principle of photoelectric converters.**
3. **The study of the characteristics of the solar panels of different types.**
4. **Parallel connection of solar panels.**
5. **Series connection of solar panels, bypass diodes.**
6. **The characteristics of solar panels depending on radiation intensity, incidence angle and temperature.**

### **Description**

The training laboratory system is designed as an educational equipment for studying photoelectric energy conversion.

The construction of the bench consists of a control unit, two solar modules (with single-crystal and multi-crystal solar panels) and a lighthouse.



The control unit consists of a housing with the following equipment installed: power supply units, electronic circuit boards, load resistors, front panel and an integrated desktop tabletop.

The schemes of the solar panel, load connection and measurement means are depicted on the control unit front panel.

The following equipment is also located on the front panel:

- **mains switch;**
- **functional switches;**
- **lighters with halogen lamps (4 pcs.);**
- **digital indicators;**

The solar modules are movable frames made of steel section. Each unit has two solar panels mounted on it. The angulation of the panels could be adjusted from 0 to 90 degrees at fixed 5 degree intervals. The temperature of each panel is controlled by a digital thermometer.

The lighthouse is a movable frame made of steel section with 8 (2 groups of 4 pieces) halogen lamps, each 0.5 W power. Each group has its own power switch.

The laboratory system set includes software and methodical guidelines.

NTC-20.83 "ENERGY SAVING TECHNOLOGIES. SOLAR POWER UNIT WITH FLAT-PLATE COLLECTOR"



### **Experiments provided**

1. **The study of the solar power unit;**
2. **Solar collectors. General characteristics;**
3. **Mounting and working with the equipment;**
4. **The study of the solar collector operation;**
5. **Solar power unit controller.**

## Description

The training laboratory system is designed as an educational equipment for practical laboratory tests in universities and specialized schools.

The training system consists of:

- laboratory unit mounted on a platform;
- solar collector mounted on a platform;
- storage water heater mounted on a platform.

The solar collector devices are mounted on the laboratory unit. The elements of the system are fixed on an aluminium profile frame (mobile mounting platform).

The following equipment is installed on the mobile platform:

- **pumping unit;**
- **pipeline accessories;**
- **expansion tank;**
- **water meters;**
- **pulse flow meters;**
- **temperature-sensing points (Pt500).**

The panels of: thermal energy flow meters (heat meters), thermometers with remote sensors, solar energy unit digital controller are mounted at the front of the frame.

The measuring system includes digital thermometers with 4 remote sensors, digital and analog flow meters and water meters (4), 2 heat meters, 4 mounted water temperature-sensing points (Pt500), 3 multifunction meters of electric power parameters.

The laboratory bench is completely ready for operation, it's possible to connect external heating devices and additional modules.

The laboratory bench set includes the following software and methodological support: a set of methodological and technical documentation for teaching staff.

## NTC-20.82 “ENERGY SAVING TECHNOLOGIES. SOLAR POWER PLANT WITH TUBE COLLECTOR”



### Experiments provided

1. The study of the solar power unit;
2. Solar collectors. General characteristics;
3. Mounting and working with the equipment;
4. The study of the solar collector operation;
5. Solar power unit controller.

### Description

The laboratory training system is designed to be used as a teaching facility for practical laboratory tests in universities and specialized schools.

The training system consists of:

- laboratory unit mounted on a platform;
- solar collector mounted on a platform;
- storage water heated mounted on a platform.

The solar collector devices are mounted on the laboratory unit. The elements of the system are fixed on an aluminium profile frame (mobile mounting platform).

The following equipment is installed on the mobile platform:

- pumping unit;
- pipeline accessories;
- expansion tank;
- water meters;
- pulse flow meters;
- temperature-sensing points (Pt500).

The panels of: thermal energy flow meters (heat meters), thermometers with remote sensors, solar energy unit digital controller are mounted at the front of the frame.

The measuring system includes digital thermometers with 4 remote sensors, digital and analog flow meters and water meters (4), 2 heat meters, 4 mounted water temperature-sensing points (Pt500), 3 multifunction meters of electric power parameters.

The laboratory system is completely ready for operation, it's possible to connect external heating devices and additional modules.

The laboratory system set includes the following software and methodological support: a set of methodological and technical documentation for teaching staff.

## NTC-20.80 “Energy saving technologies. Wind turbine studies”



### Experiments provided

1. Studying the laboratory bench;
2. Determination of air stream speed and blower rotation speed;
3. Studying wind turbine speed properties depending on impeller type and blade slope angle;
4. Wind turbine power dependence on wind speed.
5. Wind turbine performance at a constant wind speed.
6. Synchronous generator performance.

### Description

The training laboratory system is designed to study different types of wind turbines and their operating modes in higher and secondary educational institutions.

Structurally, the training system consists of:

- testing facility;
- control and measurement unit.

The control unit consists of a housing with the following equipment installed: power source, electronic boards, load resistors, front panel and tabletop of integrated desktop.

On the front panel there's an electric scheme of the wind turbine, load connection and measurement devices.

**The following equipment is also located on the front panel:**

- **power switch;**
- **functional switches;**
- **load lights unit (2 lamps);**
- **digital indicators;**
- **power cord for testing facility connection.**

**The testing facility is a movable frame with the following equipment installed on it:**

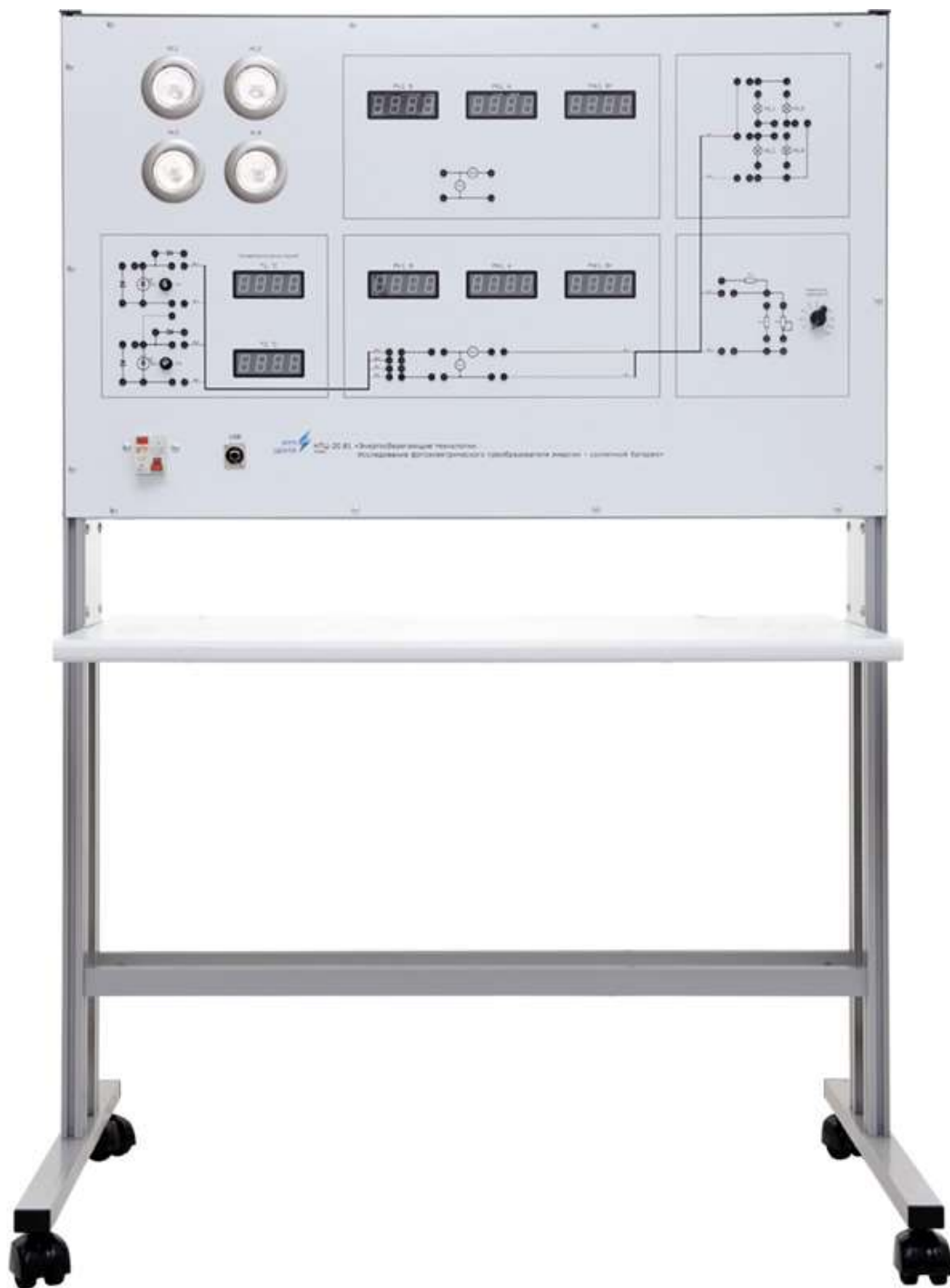
- **centrifugal blower;**
- **air channel (aerodynamic tunnel) for creating and routing air flow from the blower;**
- **rack with synchronous generator mounted;**
- **inverter for blower speed regulation;**
- **electrical commutation unit.**

The air stream from the blower passes through the air case to the impeller of the wind turbine, thus rotates it. The impeller is changeable, the kit includes at least 4 types of impellers. Impeller blades type 1...3 are adjustable by slope angle. Maximum air flow speed at the blades is 20 m/s. Maximum generator power is 5 W. The commutation of the electrical schemes at the panel is performed using unified jumpers.

The laboratory system set includes software and methodical guidelines.



NTC-20.03 "Photoelectric converters"



NTC-20.81 “Energy saving technologies. The study of the photoelectric energy converter – solar panel”



**NTC-20.82 “Energy saving technologies. Solar power plant with tube collector”**





**NTC-20.80 "Energy saving technologies. Wind turbine studies"**



## Our advantages

- ✓ Complete technical support
- ✓ The quality meets the price
- ✓ Reliability
- ✓ Ergonomic design
- ✓ Visual teaching method
- ✓ Teaching and learning materials
- ✓ Video-materials on how to operate with equipment
- ✓ Interactive software
- ✓ Using universal jumpers when conducting experiments to eliminate false commutation and improve readability of circuits
- ✓ Interconnection of laboratory work (the results of previous work can be used as the basis for subsequent ones)
- ✓ Implementation the orders according to the any weatherization needed
- ✓ Flexibility
- ✓ Development of stands in accordance with the technical specifications of the customer
- ✓ "Turnkey" laboratories

Our educational equipment has already been chosen by more than 1000 higher and secondary special educational institutions of the countries of near and far abroad

