National Technical University
“Kharkiv Polytechnic Institute”
Power Stations Department

PROPOSALS
for cooperation

of Power Stations Department of

National Technical University “Kharkiv Polytechnic Institute”

National Technical University
“Kharkiv Polytechnic Institute”
Power Stations Department

Acting Head of the Department
Ph.D, Senior research scientist, Professor K. V. Makhotilo

Specialties
- Power Stations
- Energy Management and Energy Efficient Technologies

Our recent projects:
-**TEMPUS TACIS Project The Region Center of Energy Managers Training (2000-2004)**
-**The Training center of Schneider Electric (since 2009)**
-**GTZ - Project Energy Efficiency in Ukraine (2010)**
-**Project KEEA. UniKasselTransfer, Ost-West-Wissenschaftszentrun (2011)**
-**GIZ Project. Energy efficiency in buildings (BMZ) (2014)**
-**Poland Erasmus for Ukraine (2014-2015)**
-**Membership in SIGRE (2015)**

Department research results:

1. V. B. Klepikov, S. A. Sergeev, K. V. Mahotilo, Modification of Holland's Reproductive Plan for Diploid Populations // Proc. Int. Conf. Artificial Neural Nets and Genetic Algorithms ICNNGA'95, Ales, France, 1995, p. 337–339
2. S. A. Sergeev, K. V. Mahotilo, Evolutionary Synthesis of Dynamical Object Emulator Based on RBF Neural Network // Proc. First Online Workshop on Soft Computing WSC1, On the Internet, Served by Nagoya University, 1996, p. 31–36.
3. V. B. Klepikov, K. V. Mahotilo, S. A. Sergeev, Amplitude-Frequency Characteristic of a Neural Control Based DC Drive // Tagungsband Leistungselektronische Aktoren und intelligente Bewegungssteuerungen Fachtagung, Magdeburg, Deutschland, 1996, S. 47–53.
4. S. A. Sergeev, K. V. Mahotilo, G. K. Voronovsky, S. N. Petrashev, Genetic Algorithm for Training Dynamical Object Emulator Based on RBF Neural Network // Int. J. of Applied Electromagnetics and Mechanics, vol. 9, p. 65–74, 1998.

Department research results:

5. L.I. Lysenko, V.I. Omelyanenko, S.A. Sergeev, Parallel genetic algorithm and its application to linear synchronous motor optimization // International Journal of Applied Electromagnetics and Mechanics 9 (3), 303-314, 1998.
6. S. F. Artyukh, V. V. Galat, V. V. Kuz'min, I. I. Chervonenko, Yu. G. Shakaryan, P. V. Sokur, Improving the energy efficiency of Pumped-storage power plants // Power Technology and Engineering. – 2015. – № 5. – P. 396-399.
7. G. K. Voronovsky, L. M. Lyubchyk, S. O. Sergeev, K. V. Makhotilo, District Heating Control System Based On Indirect Estimation Of Indoor Temperature Deviations // IFAC ESC'06: Energy Saving Control in Plants and Buildings. Bansko, Bulgaria : IFAC, 2006
8. K. V. Makhotilo, Diploid Genetic Algorithm with Mortality // Journal of Automation and Information Sciences, – 2011, Vol. 43, No 6, p. 60–73

Proposals for the cooperation

Project #1

Theme of the project: “**Development of a complex generation-regulation node based on renewable energy sources**”

1. The Project is devoted to developing a complex generation-regulation node of a power system based on renewable energy sources. It includes a photovoltaic plant (PVP), a wind power plant (WPP), and a hydroelectric or hydroelectric pumped storage power plant (HPP-HSP). Such power node will be able to function as:

- a cycling power plant for peak-load operation;
- a consumer-regulator for off-peak night load regulation;
- a renewable energy plant providing specified power output regardless of weather conditions.

The Project aims at developing power node designing techniques taking into account geological and climatological conditions and power system operation conditions. The Project results expected are new designing techniques for renewable energy plant assemblies. New scientific knowledge concerning renewable power plant operation and joint operation of photovoltaic, wind and hydro plants in a single generating node will be gained.

2. The Project objective is to develop methods of designing a generation-regulation power complex comprising PVP, WPP, and HPP-HSP with allowance for power system operation modes and local geological and climatic conditions. Stability, reliability, and efficiency problems for renewable generation plants functioning in a single power node are also to be solved,

Proposals for the cooperation

Project #1

3. The Project tasks

The Project will research into operation of a complex generating-regulating node comprising a PVP, WPP and an HPP-HSP. In the complex, an HPP-HSP serves as

- an energy storage to compensate unfavorable condition caused energy generation dips of other renewable energy plants in the power node;
- a consumer-regulator for night-time steam-electric power plant energy generation;
- fast-acting reserve capacity in case of power system operation disturbances.

To achieve this, the following tasks are to solved:

- designing of a photovoltaic plant to study photovoltaic operation conditions;
- designing of a wind mill to study wind plant operation conditions;
- accumulation and analysis of experimental data on PVP and WPP capacity dependence on seasonal, weather and time conditions ;
- creation of a power generation-regulation node model comprising various renewable energy plants;
- research on peculiarities of HPP-HSP operation as part of the power generation-regulation node under consideration.
- development of an HPP-HSP parameters determination technique for the HPP-HSP optimal operation in the power generation-regulation node.
- development of an HPP-HSP optimal regulation system;
- development of a power generation-regulation node parameters choice technique and specification of the node operation optimal conditions subject to power system requirements.

Proposals for the cooperation

Project #1

4. Expected results:

The Project research is expected to result in:

- new scientific knowledge in renewable energy plants operation in a single power node;
- new compensation methods for power output dips by separate power stations;
- new approaches to designing renewable energy plants and selecting their output parameters;
- the technology of co-utilization of a solar, a wind and a hydropower plants in a single power generation-regulation node.

The power node designed will be able to function as a cycling power plant for load factoring; a consumer-regulator for night-hours low-load regulation; a renewable generation station with given power output irrespective of weather conditions.

Proposals for the cooperation

Project #2

Theme of the project: “**Neural networks and genetic algorithms application to CHPP district heating control**”

1. Abstract

The research is concerned with designing a control method for CHPP-based district heating (DH) and hot water supply, the method employing neural networks and genetic algorithms.

Neural network based models and algorithms are to be developed to control hourly average temperature of the output heat carrier at a large suburban CHPP. The heat carrier temperature control is to compensate negative impact of hot water demand variation on CHPP energy efficient operation in district heating systems with centralized quality regulation available in post-soviet countries.

The proposed method implementation effect consists in heat loss saving in main pipelines, heat supply improvement, and cogeneration plant performance enhancement. The models and control laws are built on Kharkiv CHPP #5 (Ukraine) operational mode data.

2. Description

CHPP operation simulation and optimal heat supply control is a complicated engineering problem of large practical importance. Its solution requires developing novel methods based on state-of-the-art information and computational technologies.

Proposals for the cooperation

Project #2

In Ukraine, like in other post-soviet states, large gas and oil burning CHPPs form the basis of urban DH systems. Their heat supply zones are characterized by large extent of pipes and nonuniformity of the load that comprises heating and hot water supply. Such systems are controlled at CHPPs over average daily parameters of the output heat carrier in pursuant to ambient temperature forecast. This method was developed, and is efficient, only for systems with stable heat load. However, cycling up and down hot water consumption causes large-amplitude oscillations in the daily return temperature curve at the CHPP. They negatively act on combined cycle power generation efficiency, result in additional heat distribution losses, and decrease heating quality. The problem of intra-day DH load variations is quite old; proposed and implemented technologies for its compensation by consumers, however, have insignificant effect in practice and are actually not applied in Ukraine.

The objective of the research is designing a novel method for hourly average flow temperature control at a CHPP which allows compensating impact of intra-day heat load nonuniformity in the DH system. To fulfil the task, an hourly CHPP return temperature model versus the plant operational modes and meteorological conditions is to be built with allowance for the historical data. After that, the model will be used to develop heat-carrier temperature control laws that will maintain specified daily heat output and daily return temperature stabilization at the CHPP.

Genetic algorithm trained neural networks are the proper base for such models and controllers synthesis. However, taking into account such features of the control object as multivariable external influence, extension in space and availability of long transport delay, the complexity of neural network models and controllers synthesis is quite high. Solving this problem requires improving genetic algorithm and employing techniques of multistage synthesis of growing networks.

Proposals for the cooperation

Project #2

Main advantages

The project will result in developing new genetic algorithm based neural network synthesis methods and advancing available ones that will be adapted for solving multidimensional problems of complex facility and process simulation and control.

The developed tool for hourly average carrier temperature control at a CHPP will provide return temperature disturbance compensation, daily heat distribution loss saving, and CO2 emission reduction at the CHPP.

Proposals for the cooperation

Project #3

Theme of the project: **“Energy efficiency improvement of thermal power plant under variable load”**

The project is devoted to increasing energy efficiency of thermal power plant auxiliary mechanisms under variable load. In these conditions, energy-efficient auxiliary control is essential. The project involves application of variable-frequency drive based group control of auxiliary mechanisms operation.
The objective is development of advanced energy efficient control methods for thermal power plant auxiliaries under variable load.

The task to solve are:
- analysis of thermal power plant auxiliary modes and auxiliary electricity consumption;
- analysis of available auxiliary power supply circuits;
- development of state-of-the-art methods and circuits for auxiliary power supply and consumption and designing auxiliary control systems with applications of variable-frequency drive;
- development of mathematical models for thermal power plant auxiliary mechanisms and their power supply circuits;
- development Matlab models for behavior simulation of thermal power plant auxiliaries under variable load;
- justification and implementation of proposed group capacity control of thermal power plant auxiliaries and new auxiliary power supply circuits.

Proposals for the cooperation

Project #3

Expected results:

- new approach to thermal power plant auxiliary power supply circuit designing;
- state-of-the-art group capacity control of auxiliary operation based on variable-frequency drive application;
- improved efficiency of thermal power plant auxiliary operation under variable load;
- reduced auxiliary electricity consumption and extended auxiliary mechanisms life.