IPZE CPES Lab

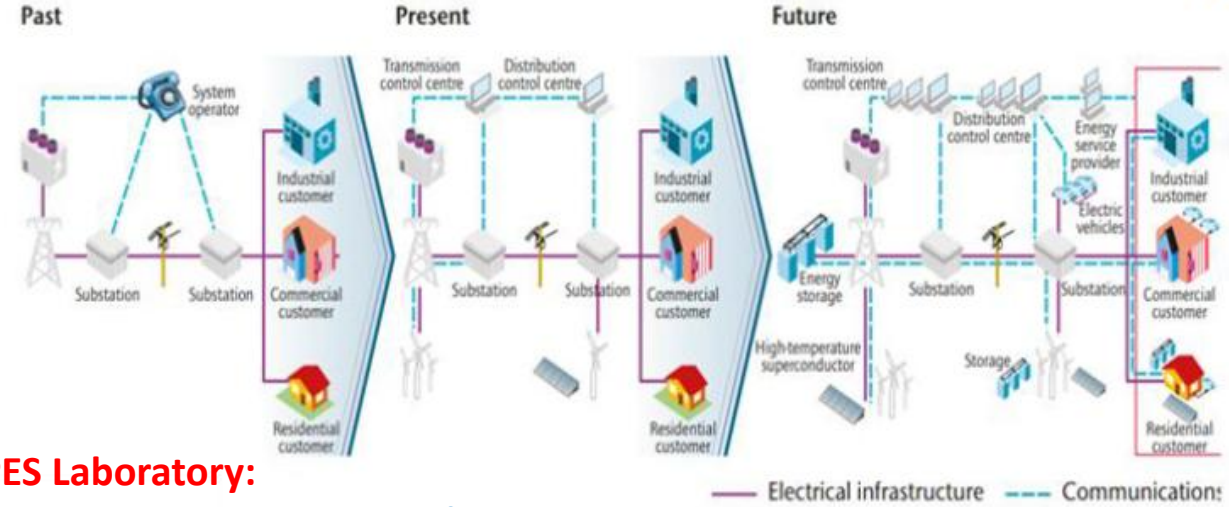
Cyber Energy Systems Laboratory

Future Energy Center

Concept development

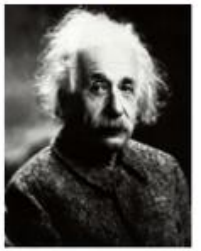
DEPARTMENT OF SOFTWARE ENGINEERING FOR POWER INDUSTRY

https://ipze.kpi.ua/en/



Today's problems cannot be solved if we still think the way we thought when we created them."

Albert Einstein



CPES Laboratory:

- tangible testbed is critical for validating virtual models with real hardware and generating authentic operational data,

- a core facility for hardware-in-the-loop testing, real-time data acquisition, and pilot demonstrations that bridge virtual simulations with physical energy system

Targeting:

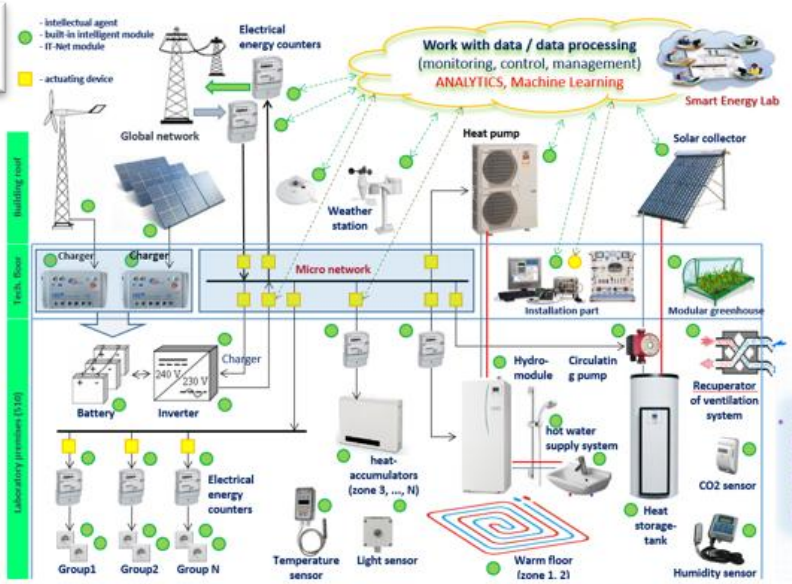
Efficient, sustainable and inclusive energy use

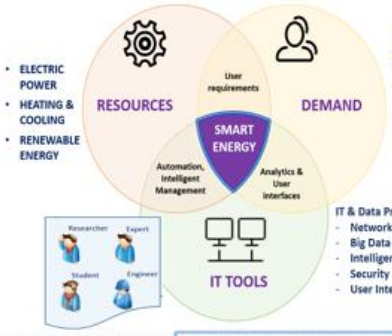
NTNU

DEPARTMENT OF SOFTWARE ENGINEERING FOR POWER INDUSTRY

Future Energy Center – Educational and RnD Smart Energy Lab IVB

- *Cyber-physical Energy Systems*
- *Intelligent management of integrated energy infrastructures*





- ELECTRIC POWER
- HEATING & COOLING
- RENEWABLE ENERGY

USER ENERGY NEEDS for:
- Business
- Comfort
- Security
- Entertainment

IT & Data Processing:
- Networks
- Big Data Processing
- Intelligent Control
- Security
- User Interfaces

The core element of the Center is a **cyber-physical energy system research site:**

- ***(DT) - digital models - simulators:***
  - Thermal power unit of steam-gas installation;
  - Wind power plant;
  - Solar power plant;
  - Hydrogen generation ;
  - Nuclear power unit.
- ***Real generation:***
  - Wind power plant;
  - Heat pump;
  - Solar power plant;
  - Hydrogen fuel cells;
  - Energy storage devices (electricity and heat)
  - Bio-energy unit.
- **Smart Grid**

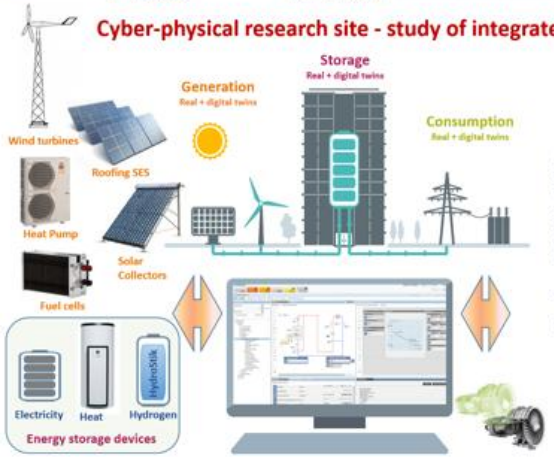
The SEL technical resources provides base for research experiments of energy modes in:

- heat pumps - heat, cold, hot water generation
- supply and exhaust systems
- heating, ventilation, and air conditioning (HVAC)
- Lighting
- thermo-active building systems (TABS)
- passive cold and heat supply systems
- automatic storage heater
- electricity generation systems:
  - wind power
  - solar PV
  - bioenergy generation

Joint activity in research and education

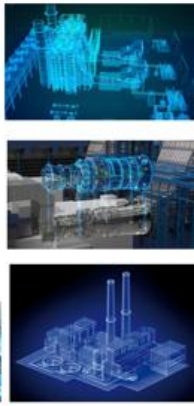
CREATION AND EXPERIMENTAL STUDIES of cyber-physical systems	MATHEMATICAL MODELING of energy processes and systems
• Research of energy processes and systems • Creation advanced equipment of samples of by the technologies: - Smart grid; - Micro Grid; - Smart Building; - virtual power stations. • Creation of equipment prototypes using IIoT technology (Industrial Internet of Things)	• Development of mathematical models of cyber-physical systems • Intelligent agents and multi-agent energy infrastructures • Implementation of an optimization approach in the synthesis of the structure and management of the operating modes of the energy infrastructure elements
LABORATORY OF CYBER-PHYSICAL ENERGY INFRASTRUCTURES	JOINT VIRTUAL LABORATORY - interactive cloud training complex

Cyber-physical research site - study of integrated cyberphysical dynamical systems



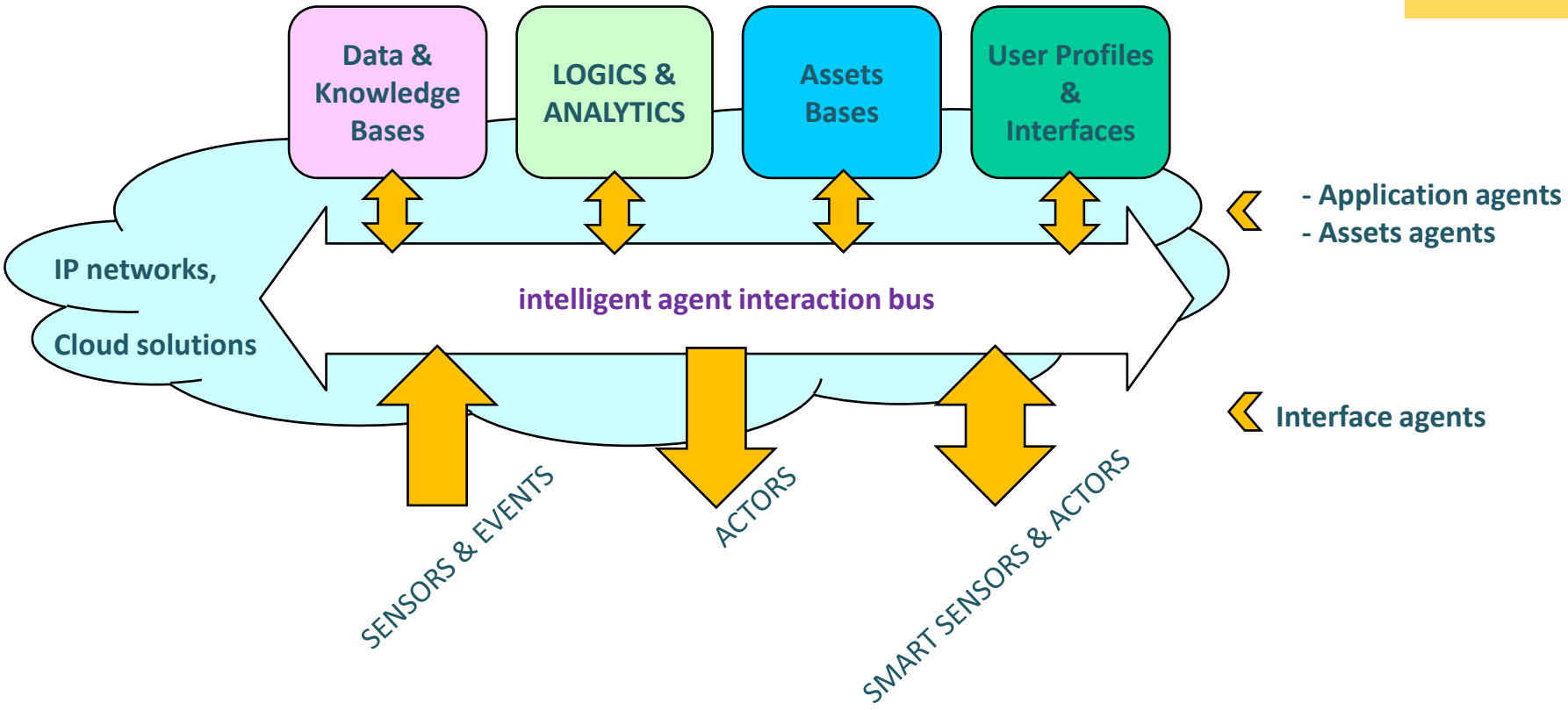
Digital twins / simulators

- Virtual NPP power unit
- Steam-gas station
- Wind turbines and SES
- Heat pump
- Energy storage devices
- Predictive analytics
- Digital simulator for staff training
- Use of IoT technologies to control objects
- AR / VR technology

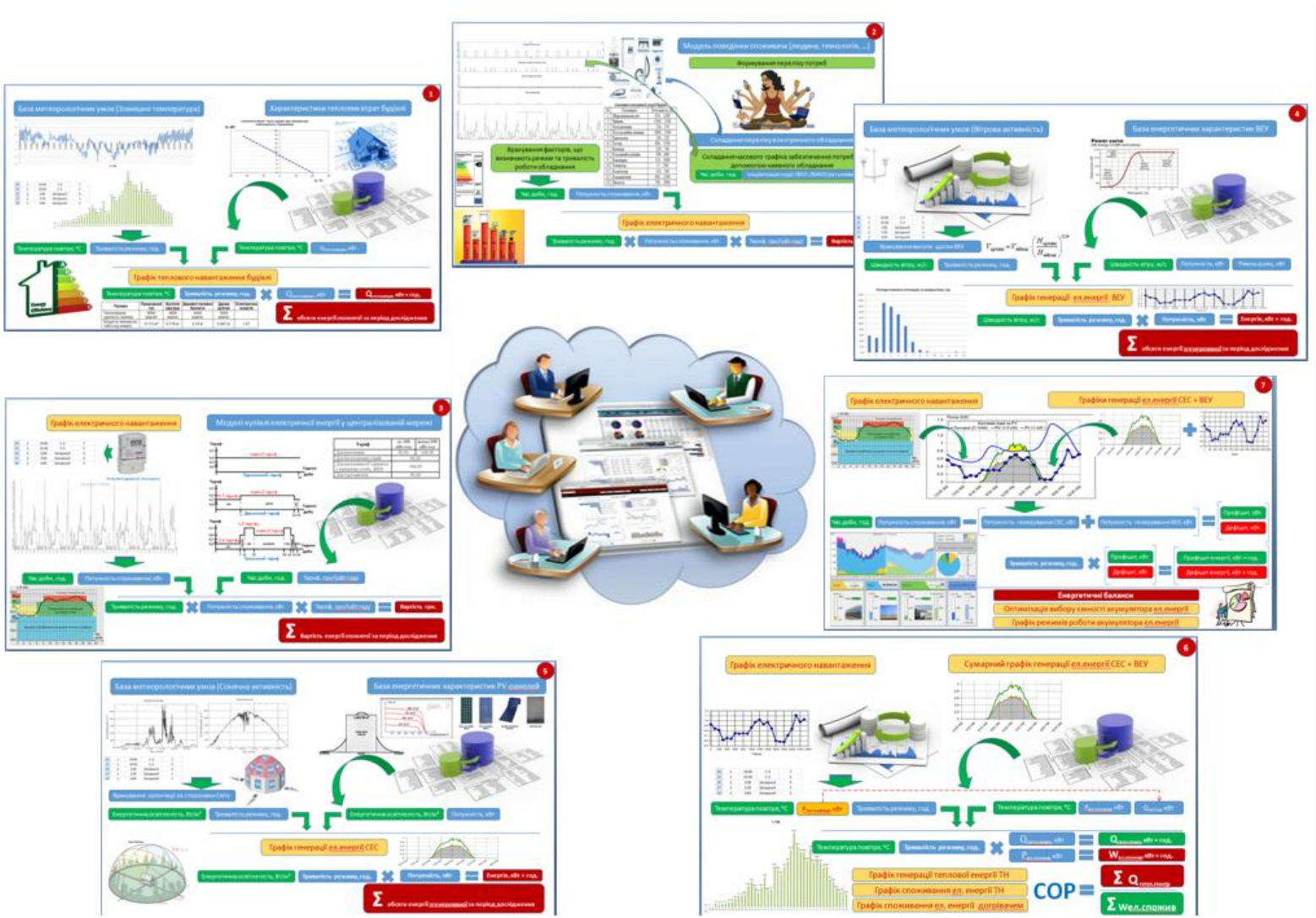


SMART ENERGY LAB KPI – NTNU

MULTIAGENT APPROACH



Synthesis of Intelligent Agents of Energy Infrastructure



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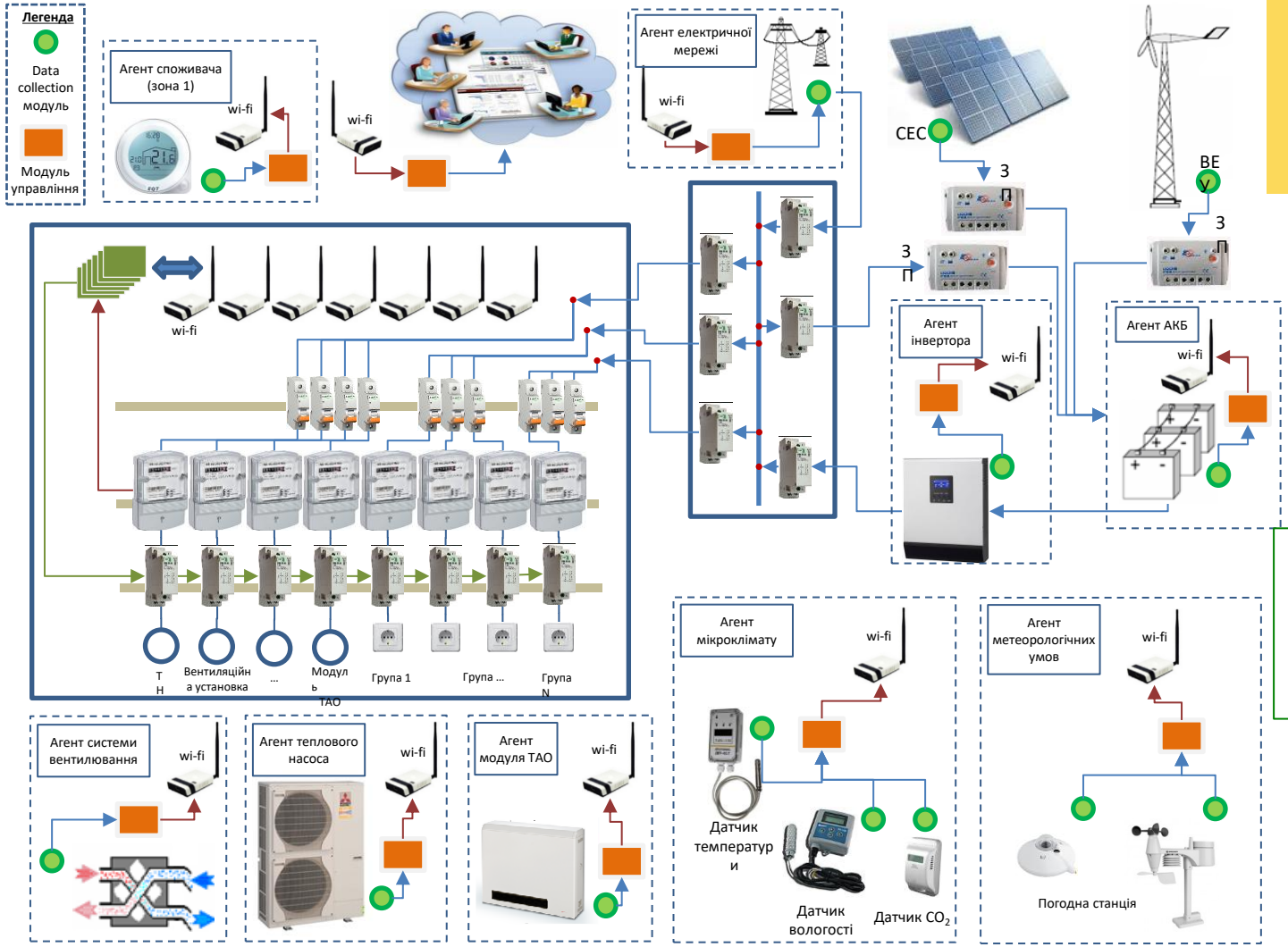
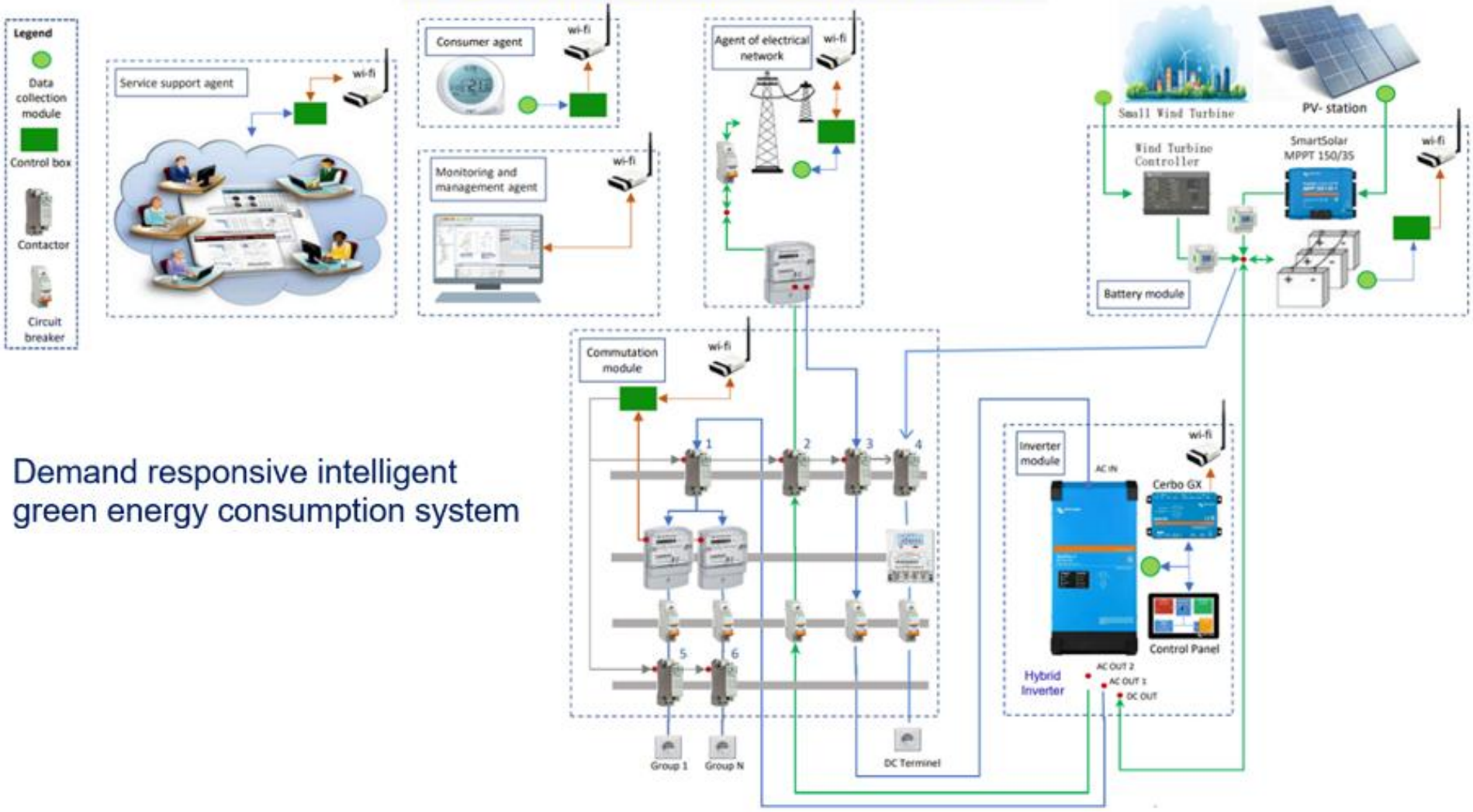
Implementing multi-agent approach



VIRTUAL LABORATORY - interactive cloud training complex

INTEGRATED micro-POWER PLANT



Demand responsive intelligent green energy consumption system

National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”
Department of Software Engineering for Power Industry

Intelligent Methods for Power Engineering – IPZE Projects Overview

Intelligent Energy Management System software

Andriy Verlan, DSc, IPZE NTUU KPI

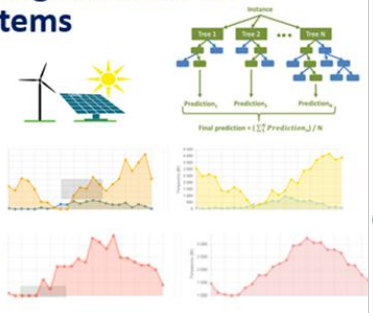
National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Department of Software Engineering for Power Industry

Intelligent Adaptive Power Balancing Platform for Alternative Energy Systems

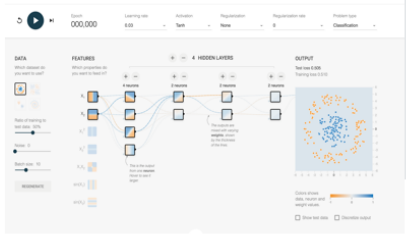
Project Results and Novelty:

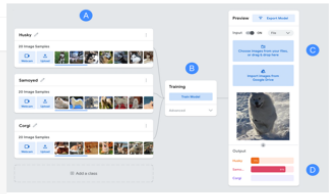
- Implemented generation, balancing, forecasting, and other functional modules
- Developed the server-side architecture and deployed a user interface
- Conducted system functionality tests with successful validation results
- Successfully deployed and launched the operational system



Head: Anna Saryboga Specialty 121 Software Engineering

Visual neural network builder for machine learning





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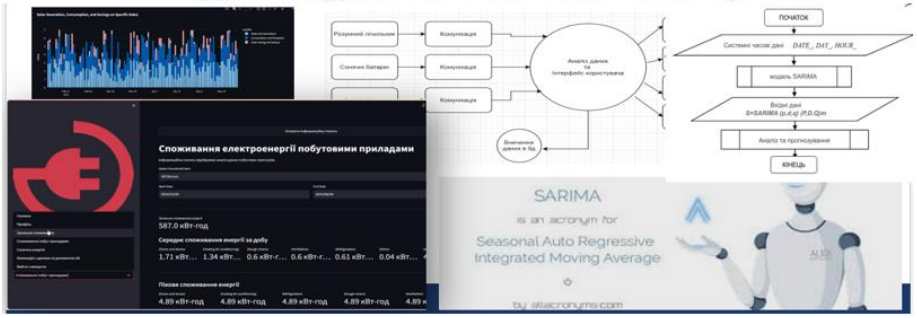
Analytical processing of energy monitoring data for efficient energy management in the Smart Grid system

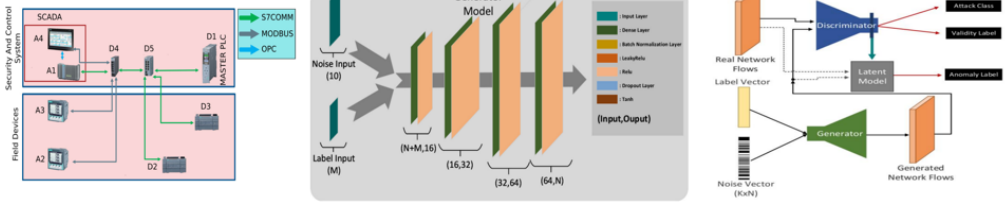


Intelligent monitoring of the building's energy consumption in the Smart Grid system

Edge Computing for Smart Grid Intelligent Energy Management

Anomaly Detection in Smart Grid Systems Using Artificial Intelligence

***Autoencoder-GAN** combines both the anomaly detection process and the anomaly classification into a single DNN (deep neural network)*



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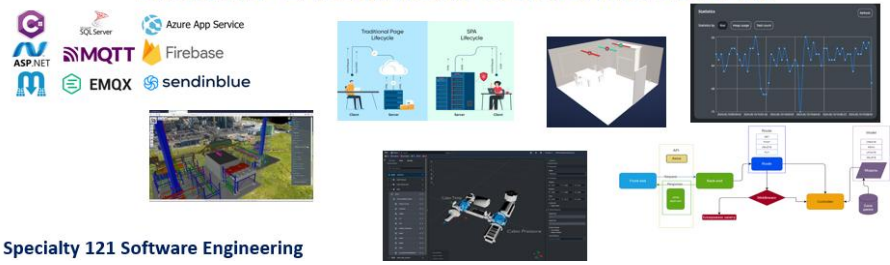
Microclimate Agent of Cyber Physics Systems Laboratories

DIGITAL TWIN INTERFACE OF THE CYBER-PHYSICAL SYSTEMS' LABORATORY'S LIGHTING SYSTEM



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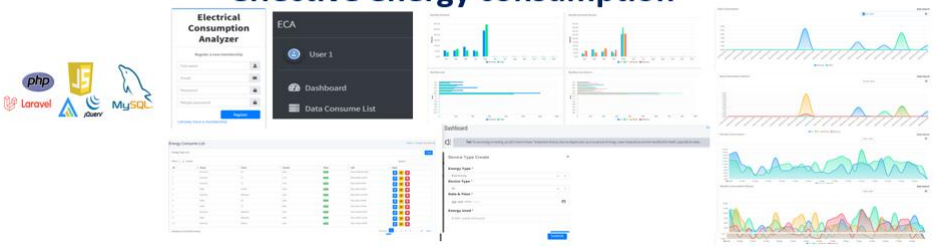
Intelligent software application for analyzing the user's effective energy consumption



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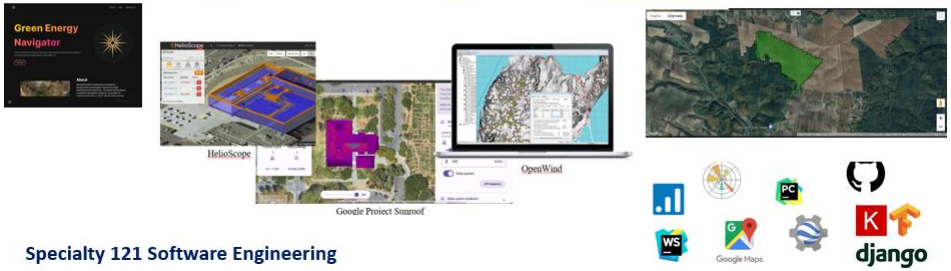
Smart software application for assessing conditions for installing alternative energy sources in a given location



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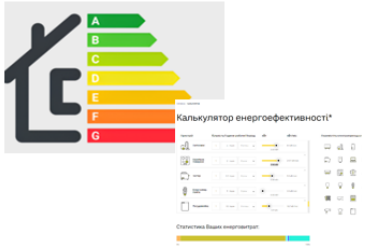
Smart Energy Efficiency Diagnostics System for Buildings

Project results:
- a smart automatic system has been developed that calculates the energy efficiency class of the building and provides authorized users with access to recommendations for improving energy efficiency by building type



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Development of algorithms and software tools for managing and monitoring the battery storage system with the integration of IoT

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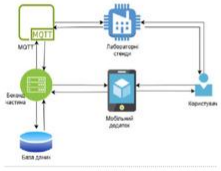
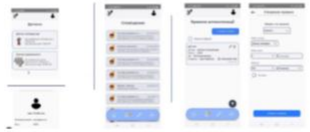
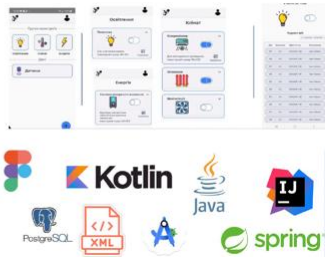
Mobile application for managing the Smart Laboratory of cyber energy systems







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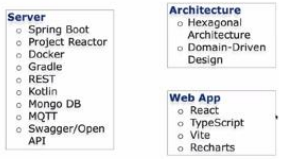
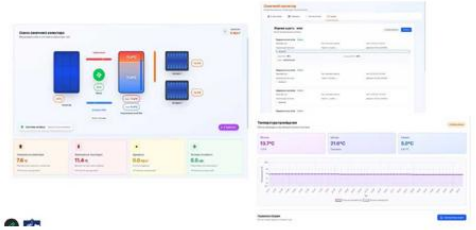
Software for controlling the operating modes of the solar collecto based on the environmental parameters' analysis





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Virtual learning platform for effective management of energy resources of renewable sources based on the "Digital Twin" technology

Specialty 121 Software Engineering

Intelligent agent for managing renewable energy resources and demand in a home energy network

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