

**KEZO Research Centre**



**Centrum Badawcze PAN**  
Konwersja Energii i Źródła Odnawialne  
**KEZO**

# Work of the KEZO Research Center on energy systems including biomass



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Projekt współfinansowany przez Unię Europejską oraz ze środków Europejskiego Funduszu Rozwoju Regionalnego w ramach Regionalnego Programu Operacyjnego Województwa Mazowieckiego 2007-2013

# Who we are and where are we going



- established in 1965 - over 60 years of experience
- over 220 employees, including 30 professors
- research in the fields of: fluid mechanics, multiphase flows, thermodynamics and heat transfer, machine mechanics, tribology and diagnostics of energy machines, modern energy systems, RES, energy storages

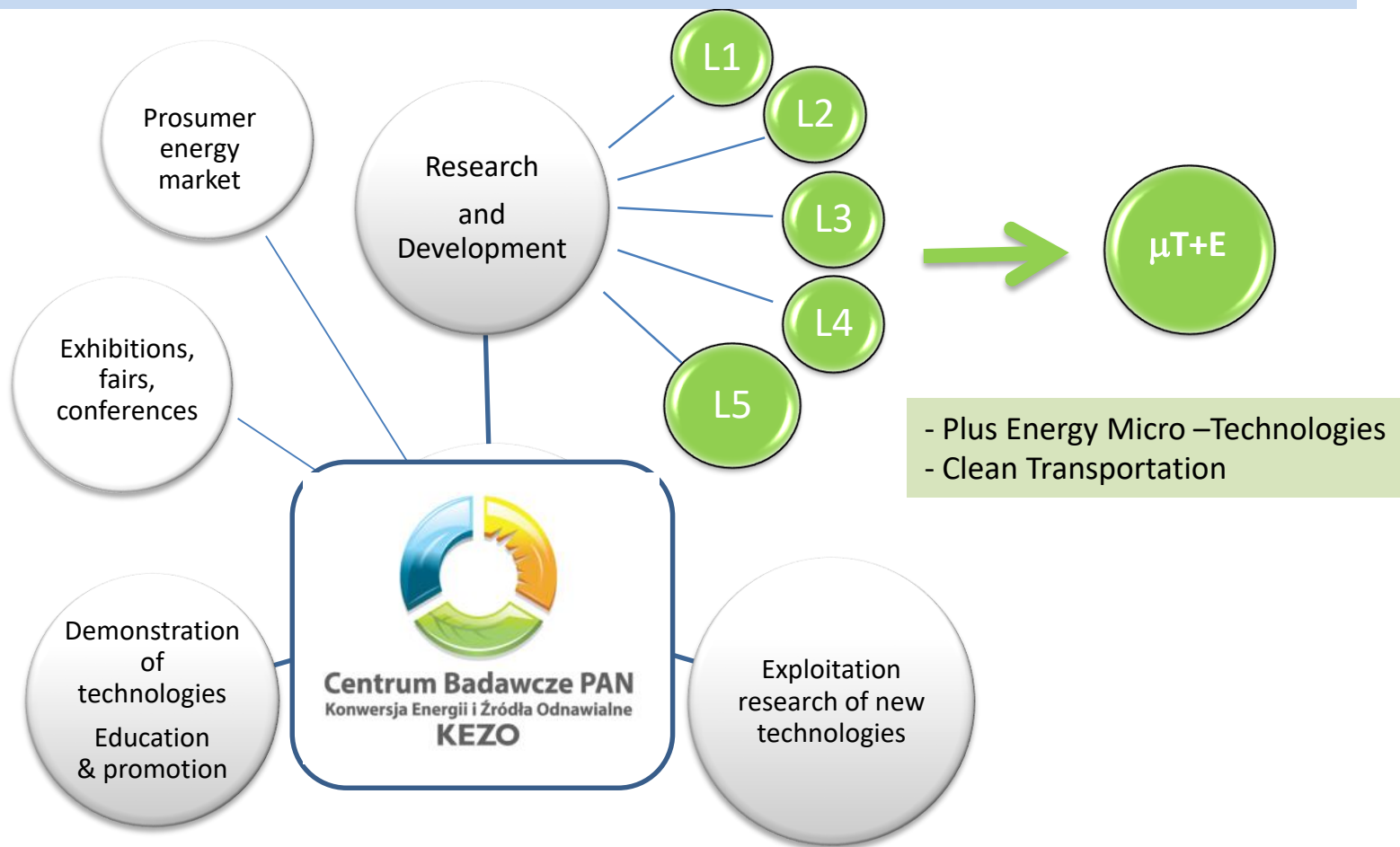


External laboratory of the IMP PAN

**ultimately a Center of Excellence in  
the field of clean energy technologies**



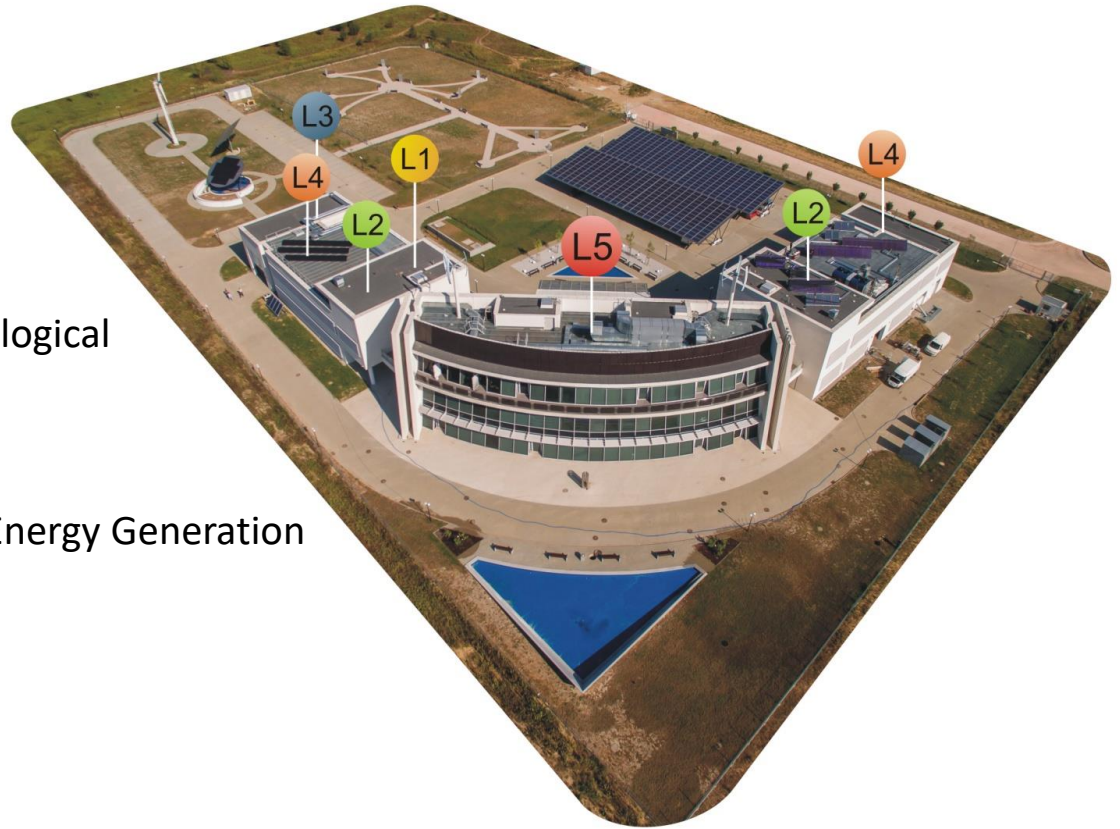
# KEZO Research Centre



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## • KEZO – laboratories

- L1** Solar Technology Laboratory
- L2** Micro-Cogeneration Plants and Ecological Boilers Laboratory
- L3** Wind Energy Laboratory
- L4** Safety Engineering Laboratory for Energy Generation
- L5** Integrated Plus-Energy Laboratory





# Building of a Centre is the space for work, but also the living laboratory.

## We utilize all the locally available sources of RES:

- Sun
- Wind
- Geothermal energy
- **Biomass**

## We store heat, cold and electricity:

- BTES
- TTES
- LHTES (with PCM)
- Hybrid energy storage (*VRFB, Li-Ion, gel batteries*)

## We utilize waste heat:

- production of electric power
- production of cold

## We support development of ecological transport:

- EV charging station (V2G)
- e-vehicle

## We monitor and manage production and consumption of energy in Centre

- Expanded BMS : a local micro „smart grid” in the future





**KEZO Centre- Test-side for devices** producing and storing heat, cold and electricity from RES as well as test side of software for management of generation and consumption of energy

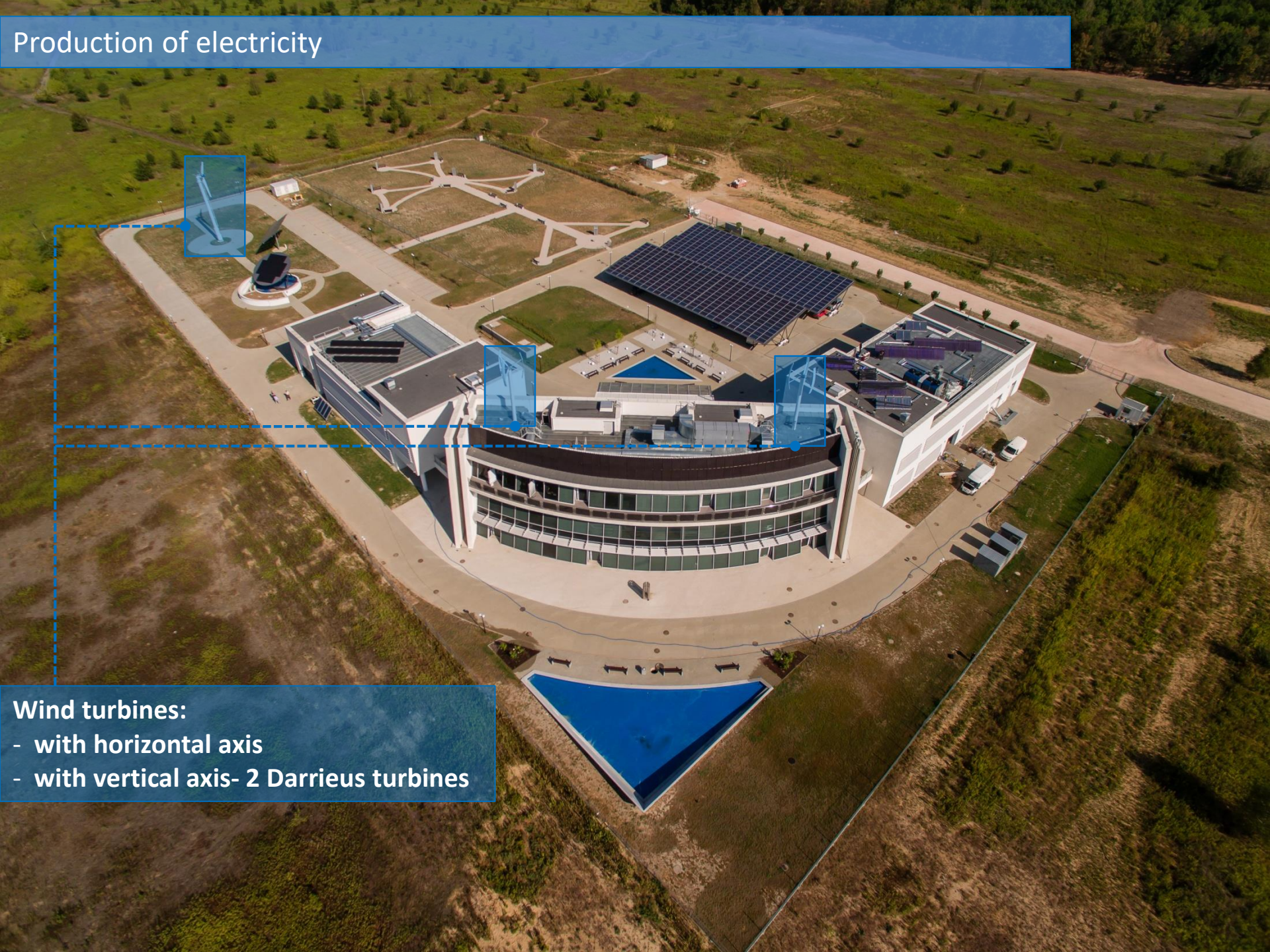


**Depicted installations play roles of:**

- **Demonstrators** of modern technologies (majority of them is not yet available at the Polish market)
- **research object** (metering, data acquisition and analysis, control)
- **functional systems** supplying building of the Center in heat, cold and electricity



# Production of electricity



- Wind turbines:
- with horizontal axis
  - with vertical axis- 2 Darrieus turbines



# Production of electricity



- Photovoltaics:**
- monocrystalline cells
  - polycrystalline cells
  - PVT panels
  - thin-film cells
  - transparent panels
- Tracker, sheds, BIPV



## Heat Production

### Heat pumps:

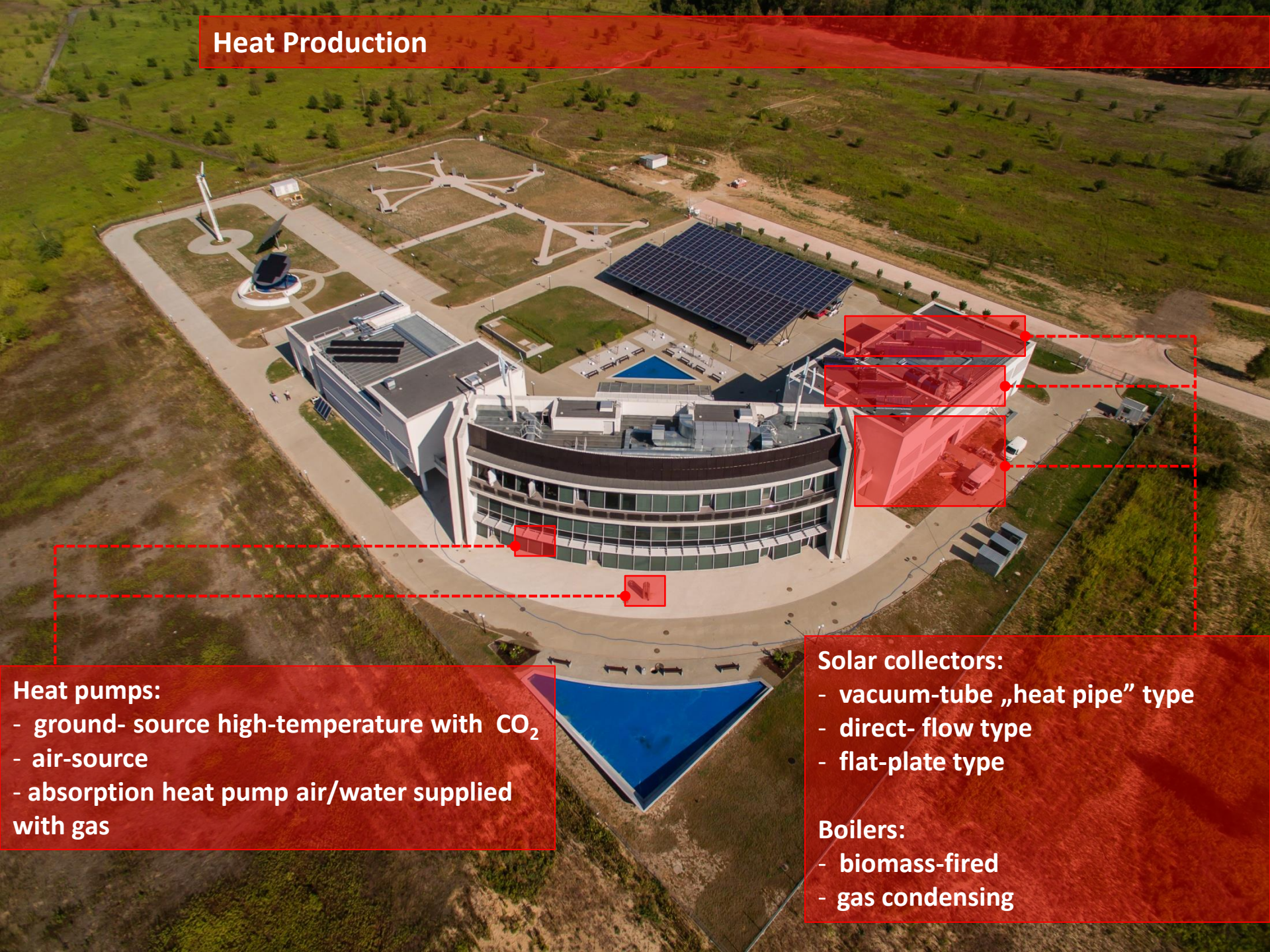
- ground- source high-temperature with  $\text{CO}_2$
- air-source
- absorption heat pump air/water supplied with gas

### Solar collectors:

- vacuum-tube „heat pipe” type
- direct- flow type
- flat-plate type

### Boilers:

- biomass-fired
- gas condensing





# Production of heat and power in cogeneration



## Gas systems:

- fuel cell
- Stirling engines
- ignition engines
- gas microturbine 100kWe/165kWt

PVT type photovoltaic panels

## Biomass systems:

- biomass gasifier with CHP unit coupled with ignition engine 30kWe/80kt
- CHP unit coupled with pellet-fired Stirling engine



## Cold Production



### Heat pumps:

- ground- source high-temperature with  $\text{CO}_2$
- absorption heat pump air/water supplied with gas

### Waste heat utilizing systems:

- Absorption chillers utilising heat from solar collectors and waste heat from testing rigs



# Heat, cold and electricity storages

## Electricity storage system:

- accumulator
- lithium ion energy storage
- vanadium redox flow battery
- electric vehicle by V2G charging stations

## Heat storages:

- high and low temperature accumulation tank  $2 \times 5 \text{ m}^3$
- TTES (Tank Thermal Energy Storage  $50 \text{ m}^3$ )
- BTES (Borehole Thermal Energy Storage )
- LHTES (Latent Heat Thermal Energy Storage utilising PCM  $2 \times 1 \text{ m}^3$ )

## Cold storage:

- Ice water accumulation tank  $5 \text{ m}^3$



# Integration of sources, storage and energy receivers in KEZO Centre



SYSTEM BMS WIDOK PARTERU BUDYNEK B2



SYSTEM BMS WIDOK PARTERU BUDYNEK L5



Expanded BMS system



# Expanded BMS system

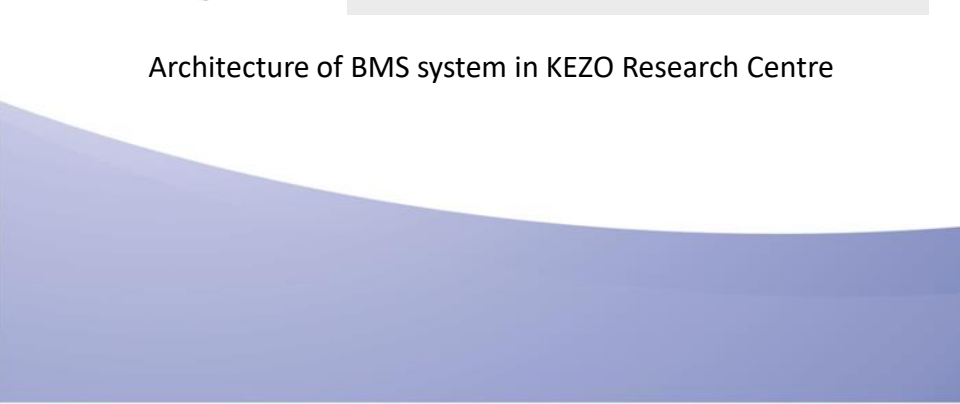
The diagram illustrates an Expanded BMS (Building Management System) architecture. At the center is a blue circle labeled "BMS". It is connected to 18 green ovals, each representing a different system or function, with an icon next to it. The functions are: KONTROLA DOSTĘPU (Access Control), NADZÓR WIZYJNY (OUT) (Visual Monitoring (Out)), NADZÓR WIZYJNY (IN) (Visual Monitoring (In)), NADZÓR P. POZ. (Fire Alarm Monitoring), NADZÓR ZASILANIA ELEKTR. (Electrical Power Monitoring), NADZÓR SIECI CO (Heating Network Monitoring), NADZÓR OŚWIETLENIA (Lighting Monitoring), NADZÓR WEN-KLIMA (HVAC Monitoring), NADZÓR WODA SCIEKI (Water/Wastewater Monitoring), SYSTEM ODMRAŻANIA PODŁOŻA (Floor Defrosting System), NADZÓR TELEINFORM. (Telecommunication Monitoring), PREZENTACJA DANYCH Z LAB. (Lab Data Presentation), ZARZĄDZANIE DANYMI Z OBIEKTU (Object Data Management), DETEKCJA GAZÓW NIEBEZPIE. (Gas Detection), and KONTROLA DOSTĘPU (Access Control). To the right, a red line connects the BMS to a "Server danych" (Data Server). Below the server, a blue line connects to a "CRIO" (CRIO) module, and a red line connects to a "PXI" module. Both modules are labeled "Moduł SVE". A green line connects the BMS to a "WAGO" module, which is also labeled "Moduł SVE". The photo at the bottom shows a modern, multi-story building with a glass facade and a courtyard with benches and a fountain.

Expanded BMS system

Diagram illustrating the components and connections of an Expanded BMS system:

- Central BMS (Building Management System) hub.
- Connected systems (Surrounding the BMS hub):
  - KONTROLA DOSTĘPU (Access Control)
  - NADZÓR WIZYJNY (OUT) (Visual Monitoring (Out))
  - NADZÓR WIZYJNY (IN) (Visual Monitoring (In))
  - NADZÓR P. POZ. (Fire Alarm Monitoring)
  - NADZÓR ZASILANIA ELEKTR. (Electrical Power Monitoring)
  - NADZÓR SIECI CO (Heating Network Monitoring)
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  - PREZENTACJA DANYCH Z LAB. (Lab Data Presentation)
  - ZARZĄDZANIE DANYMI Z OBIEKTU (Object Data Management)
  - DETEKCJA GAZÓW NIEBEZPIE. (Gas Detection)
- External components and connections:
  - Server danych (Data Server)
  - CRIO (Control and Instrumentation)
  - PXI (Process Control)
  - WAGO (Electronics)

Photograph of a modern building (B2) with a glass facade and a courtyard area.



### Architecture of BMS system in KEZO Research Centre



# Laboratory of Thermal Processing of Biomass and Biofuels

- Research on biomass gasification,
- Design of high-tech biomass boilers,
- Chemical analysis of syngas and derivatives



Experimental stands for research of combustion processes and self-made test bench.



# Laboratory of Micro ORC Technologies

- analysis of heat transfer processes and their dynamics for different types of heat exchangers for power ratings from several kW to 300 kWt,
- research on microturbines working in ORC systems with power up to 50 kW,
- research on cogeneration and trigeneration systems with simultaneous production of electricity, heat and cold,
- analysis of the possibilities of using waste heat from technological processes to develop the ORC cycle using low temperature heat for electricity production,





## Laboratory of CHP Systems

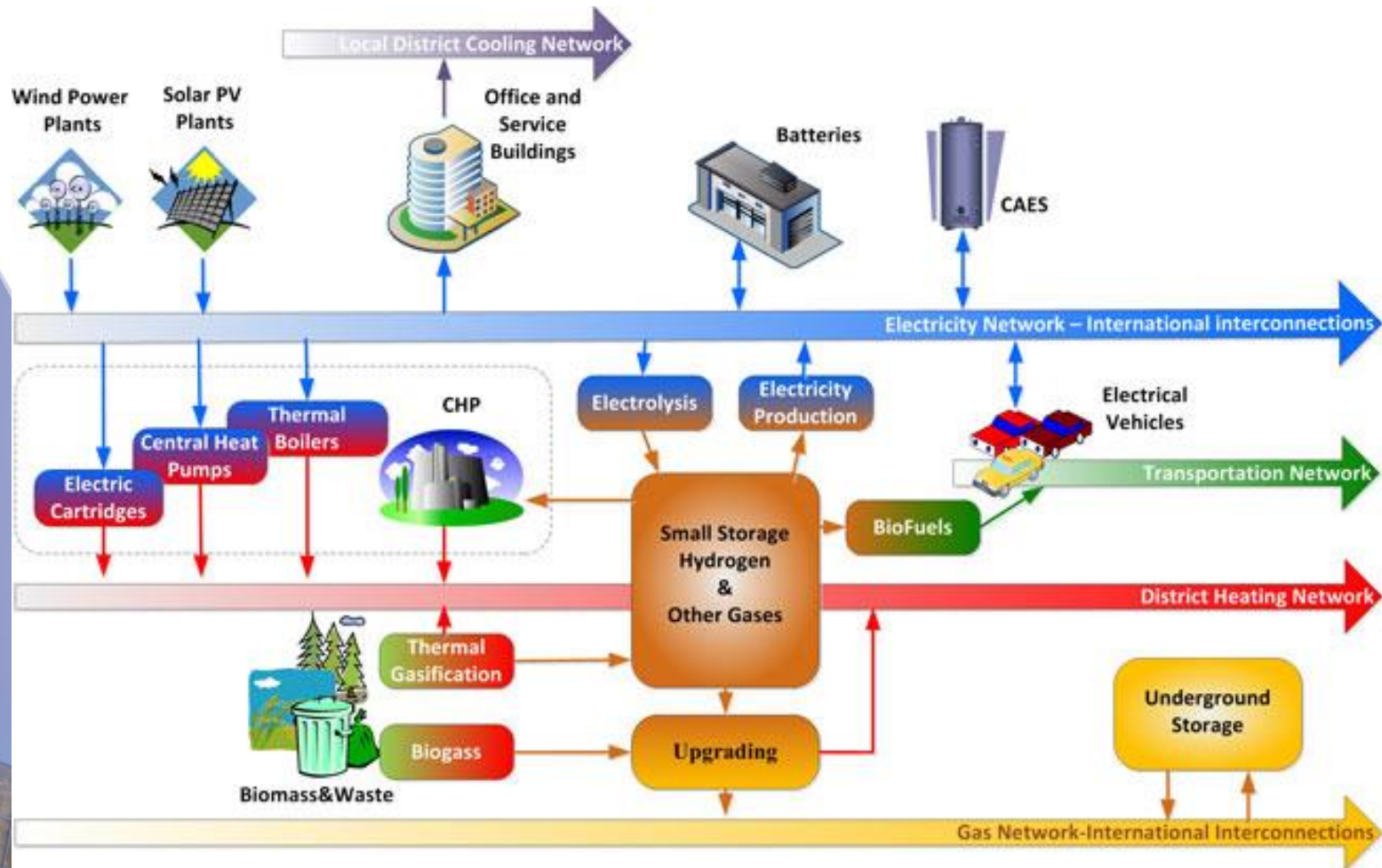
The laboratory is equipped with gas turbine, ORC system using waste heat, absorption cooling systems, set of micro CHP systems (fuel cell, stirling, gas engine), a gasifier with a syngas engine, heat pumps, gas boiler, biomass boiler with smart biomass storage – all this interconnected in one system that is managed remotely.

Biomass gasifier 30kWe/80kwt



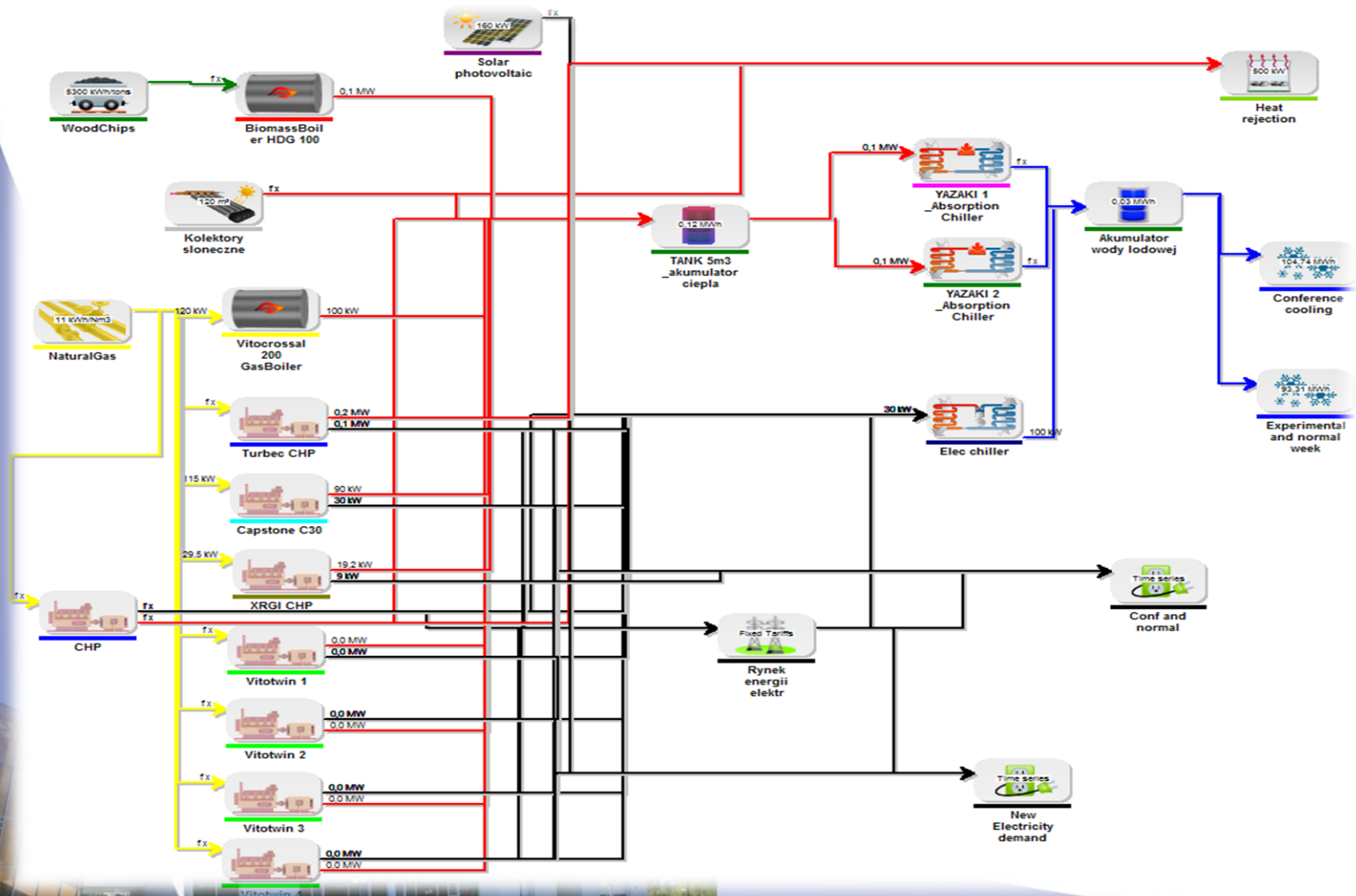
ORC 20kWe

# Smart Energy System





# KEZO - Smart Energy System (selected units)

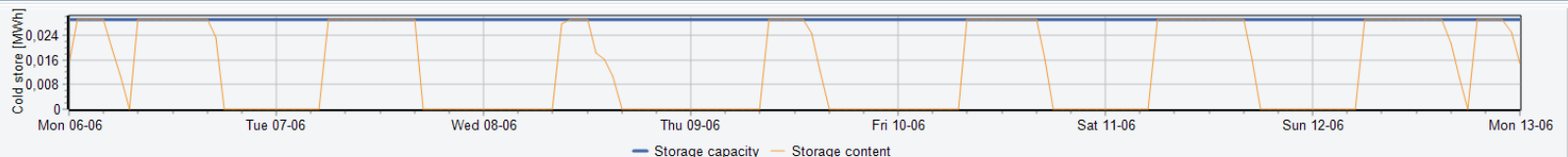
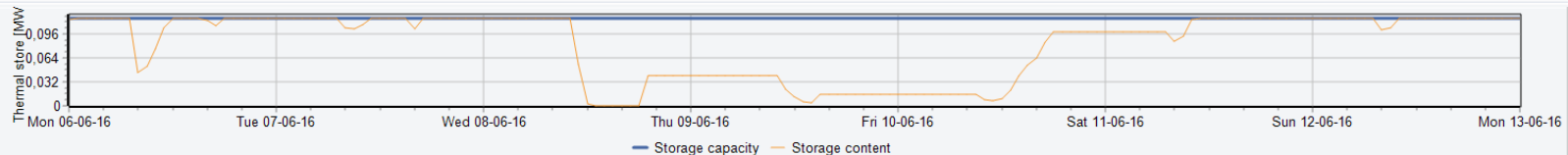
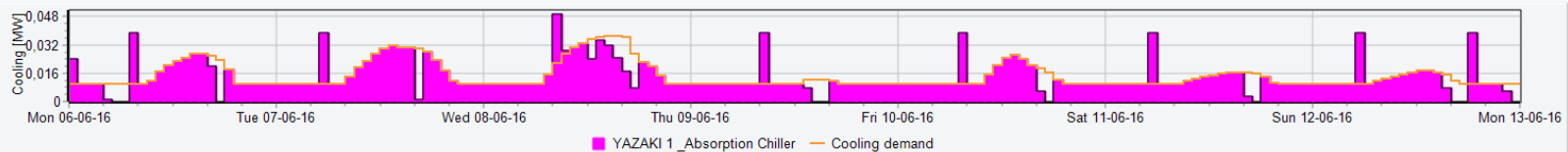
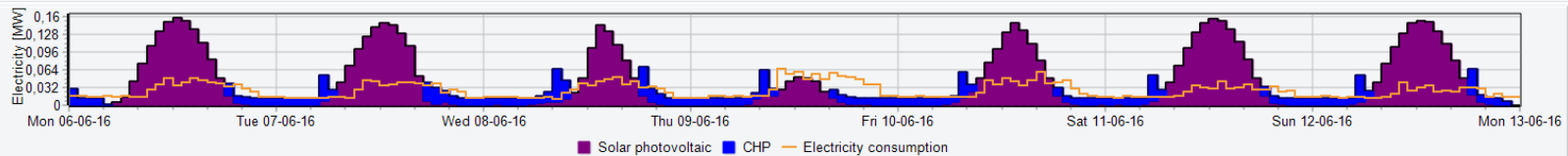
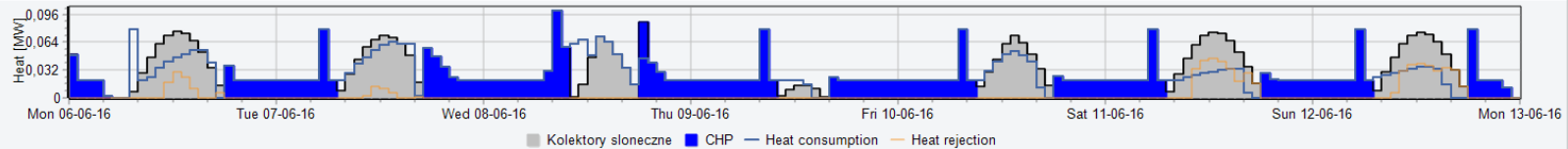


Example of KEZO Energy System



# KEZO „usual summer week”

## Mix Solar Collectors+CHP+PV

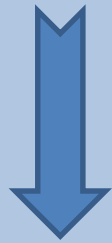




# Intelligent management of Energy flows in the Centre – local Smart Energy System

Planned evolution:

BMS



Smart Energy  
System

**Micro scale:**  
office building,  
home

**Macro scale:**  
municipality, city



- Monitoring of local heat and power network
- Development of different types of work scenarios for particular real or virtual approaches/solution
- Development of management algorithms
- Regulation of demand and supply of energy
- EV infrastructure integration



**Thank you for your attention**

**Questions?**



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