

RESCUE – Renewable Energy Sources for Smart sustainable health Centers, University Education and other public buildings

Prof Damir Šljivac, PhD

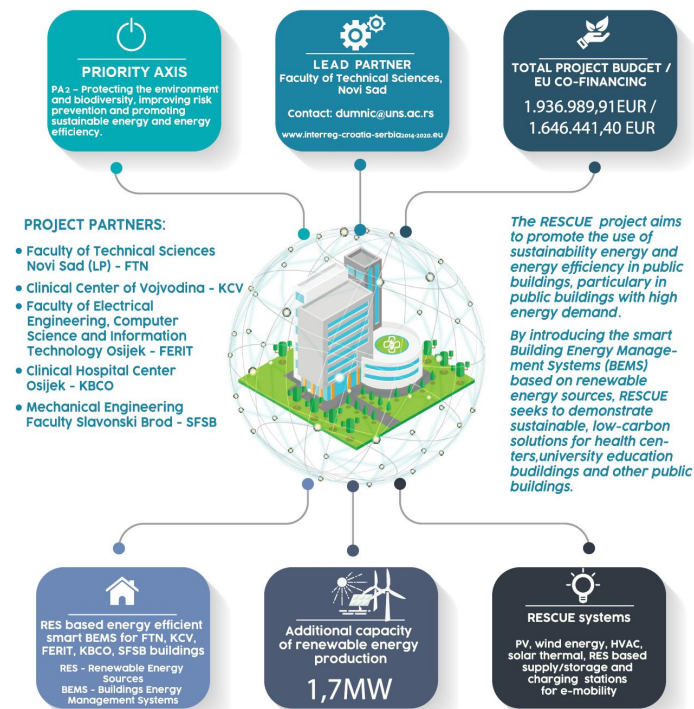
Head of Department for Power Engineering

Head of Laboratory for RES
<http://reslab.ferit.hr/>

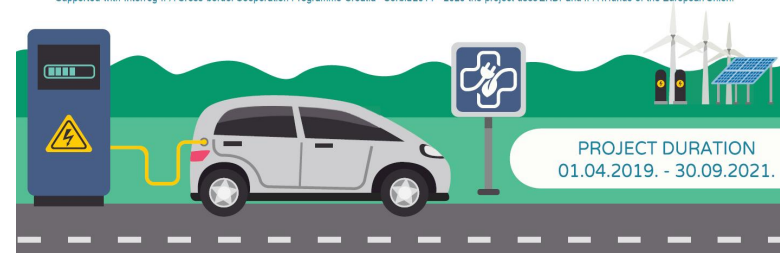


Interreg - IPA CBC   Rescue
Croatia - Serbia

Renewable Energy Sources for smart sustainable health Centers,
University Education and other public buildings



Supported with Interreg IPA Cross-border Cooperation Programme Croatia - Serbia 2014 - 2020 the project uses ERDF and IPA II funds of the European Union.





PRIORITY AXIS

PA2 – Protecting the environment and biodiversity, improving risk prevention and promoting sustainable energy and energy efficiency.



LEAD PARTNER

Faculty of Technical Sciences,
Novi Sad

Contact: dumnic@uns.ac.rs

www.interreg-croatia-serbia2014-2020.eu



TOTAL PROJECT BUDGET / EU CO-FINANCING

1.936.989,91EUR /
1.646.441,40 EUR

PROJECT PARTNERS:

- Faculty of Technical Sciences Novi Sad (LP) - FTN
- Clinical Center of Vojvodina - KCV
- Faculty of Electrical Engineering, Computer Science and Information Technology Osijek - FERIT
- Clinical Hospital Center Osijek - KBCO
- Mechanical Engineering Faculty Slavonski Brod - SFSB




The RESCUE project aims to promote the use of sustainability energy and energy efficiency in public buildings, particularly in public buildings with high energy demand.

By introducing the smart Building Energy Management Systems (BEMS) based on renewable energy sources, RESCUE seeks to demonstrate sustainable, low-carbon solutions for health centers, university education buildings and other public buildings.




RES based energy efficient
smart BEMS for FTN, KCV,
FERIT, KBCO, SFSB buildings

RES - Renewable Energy
Sources
BEMS - Buildings Energy
Management Systems



Additional capacity
of renewable energy
production

1,7MW



RESCUE systems

PV, wind energy, HVAC,
solar thermal, RES based
supply/storage and
charging stations
for e-mobility

Supported with Interreg IPA Cross-border Cooperation Programme Croatia - Serbia 2014 - 2020 the project uses ERDF and IPA II funds of the European Union.

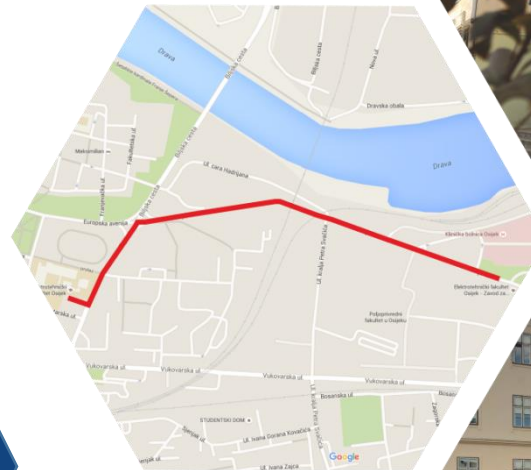


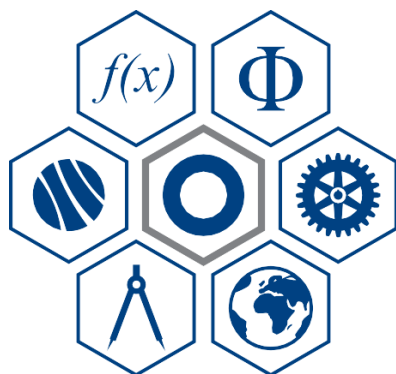
About FERIT – in RESCUE

- established 1978
- today:
 - 2 buildings (about 9000 sqm.)
 - 6 departments
 - 27 laboratories
 - about 2,000 students
 - about 150 employees
 - about 90 researchers

Dr. DRAGO ŽAGAR

Full Professor with Tenure
Dean, **RESCUE** team member





DEPARTMENT OF CORE COURSES

- Chair of Mathematics and Physics
- Chair of Mechanical Engineering and Foreign Languages



DEPARTMENT OF COMMUNICATIONS

- Chair of Radiocommunications and Telecommunications
Prof Žagar, Dr Vranješ
RESCUE FERIT IT&A, BEMS
- Chair of Electronics and Microelectronics
- Laboratory for High Frequency Measurements



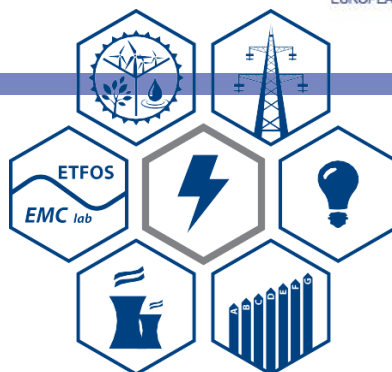
DEPARTMENT OF SOFTWARE ENGINEERING

- Chair of Visual Computing
- Chair of Programming Languages and Systems
Dario Došen, Mcomp
RESCUE FERIT IT&A, BEMS



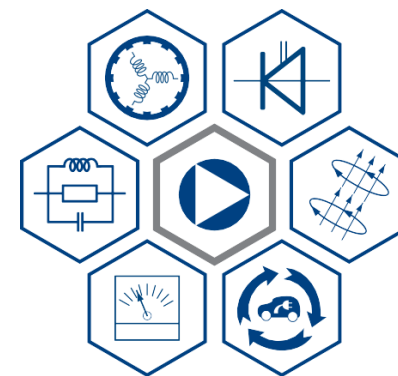
DEPARTMENT OF COMPUTER ENGINEERING AND AUTOMATION

- Chair of Automation and Robotics
- Chair of Computer Engineering
Prof Keser
FERIT RESCUE IT&A, BEMS



DEPARTMENT OF POWER ENGINEERING

- Chair of Power Systems and Substations
Prof Marić, Prof Knežević,
Prof Fekete, Kljajić MEng
- Chair of Power Plants and Energy Processes
Prof Šljivac (head), Prof Topić,
Žnidarec MEng
- Electromagnetic Compatibility Laboratory
Prof Klaić (vice), Primorac MEng
FERIT RESCUE RESe, BEMS



DEPARTMENT OF ELECTROMECHANICAL ENGINEERING

- Chair of Fundamentals of Electrical Engineering and Measurements
- Chair of Electric Machines and Power Electronics
Prof Pelin, Brandis MEng
FERIT RESCUE PE, BEMS

**RESEARCH GROUP FOR
INTELLIGENT SYSTEMS AND
ROBOTICS**

**RESEARCH GROUP FOR ADVANCED
(SMART) ENERGY TECHNOLOGIES AND
SYSTEMS**

Šljivac, Klaić, Marić, Topić, Knežević,
Fekete, Kljajić, Žnidarec, Primorac

**RESEARCH GROUP FOR
ADVANCED INDUSTRIAL
SYSTEMS**

Pelin, Brandis

**RESEARCH GROUP FOR
INFORMATION AND
COMMUNICATION TECHNOLOGIES**

Žagar, Vranješ

**RESEARCH GROUP
FOR INTELLIGENT VEHICLES**

**RESEARCH GROUP FOR COMPUTER
SCIENCE AND HUMAN-COMPUTER
INTERACTION**

**RESEARCH GROUP FOR HIGH-
PERFORMANCE COMPUTING AND
DATA ANALYSIS**

Došen

**RESEARCH GROUP FOR
COMPUTER ENGINEERING**

Keser

**RESEARCH GROUP FOR
BIOMEDICAL ENGINEERING**

**RESEARCH GROUP FOR ADVANCED
TEACHING METHODS IN TECHNICAL
SCIENCES**

FERIT Office for International Cooperation, Scientific and Research Projects



- Mirela Glavaš, head, mirela.glavas@ferit.hr
[Tihana Vajnand \(RESCUE\) administrative staff, tihana.vajnand@ferit.hr](mailto:tihana.vajnand@ferit.hr)
- establishes and supports international cooperation of the Faculty at the institutional level;
- informs and educates staff and students about the possibilities of participation in international initiatives, research and educational programmes/projects and mobility programmes;
- prepares, monitors and provides support in implementation of international, scientific and research projects;
- manages outgoing and incoming mobility procedures for students, academic and non-academic staff.
- Active Cooperation with about 60 institutions:
Albania, Austria, Bulgaria, Bosnia and Herzegovina, France, Germany, Hungary, Italy, Latvia, Macedonia, Montenegro, Poland, Portugal, Romania, **Serbia (incl. FTN Novi Sad)**, Slovakia, Slovenia, Spain, Sweden, Switzerland, The Netherlands, Turkey, USA

FERIT Laboratory for Renewable Energy Sources

<http://reslab.ferit.hr/>

- **RESEARCH GROUP FOR ADVANCED (SMART) ENERGY TECHNOLOGIES AND SYSTEMS and DEPARTMENT FOR POWER ENGINEERING**

Development and past projects:

- Established in 2014 within IPA CBC Croatia Hungary **REGPHOSYS** project, head **Pelin** (2013-2014), partners: FERIT, Hungarian Academy of Sciences, Kaposvar University - 10 kW power plant ETFOS1 (FERIT1) and 5 different PV technologies testing (REGPHOSYS)
- **On-line research measurements data-base** (FERIT internal research project)
- Interreg CBC Croatia Hungary **RuRES** project, head **Topić** (2017-2018) partners: FERIT, Hungarian Academy of Sciences, Kaposvar University, off-line rural PV system

FERIT Laboratory for Renewable Energy Sources

<http://reslab.ferit.hr/>

Active projects 2018 – 2022 (coordinator: Prof. Damir Šljivac)

- **Interreg IPA CBC Croatia Serbia RESCUE (2019-2021)**, partners: FERIT, SFSB, KBCO, FTN, KCV: **smart FERIT buildings microgrid development!**
- J.J. Strossmayer University of Osijek **Establishment of RES interdisciplinary research group**, partners: FERIT, SFSB (partners of RESCUE team) 2019 - 2020
- **FERIT IZIP Internal Scientific projects – Data acquisition system development and achieving zero energy buildings standards 2019.-2020.**
- **COST WECANet project (2018-2022)**, a pan-European network on **wave energy converters** and **integration** with over 30 countries and 50 partners 2018 - 2022

Microgrid development at FERIT Laboratory for RES

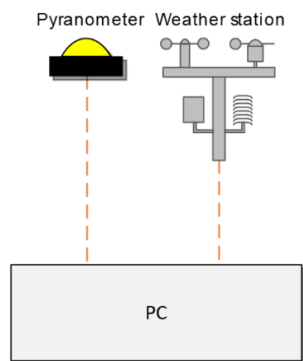
► Existing parts (REGPHOSYS project):



Source: reslab.ferit.hr

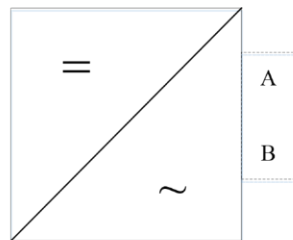
Microgrid development at FERIT Laboratory for RES

- Existing parts (REGPHOSYS project):
 - Microgrid system for 5 different technology PV modules + 2 batteries + 5 grid-tie inverters
 - 10 kW PV power plant
- Weather station and data acquisition system (FERIT internal project) - Došen, Žnidarec

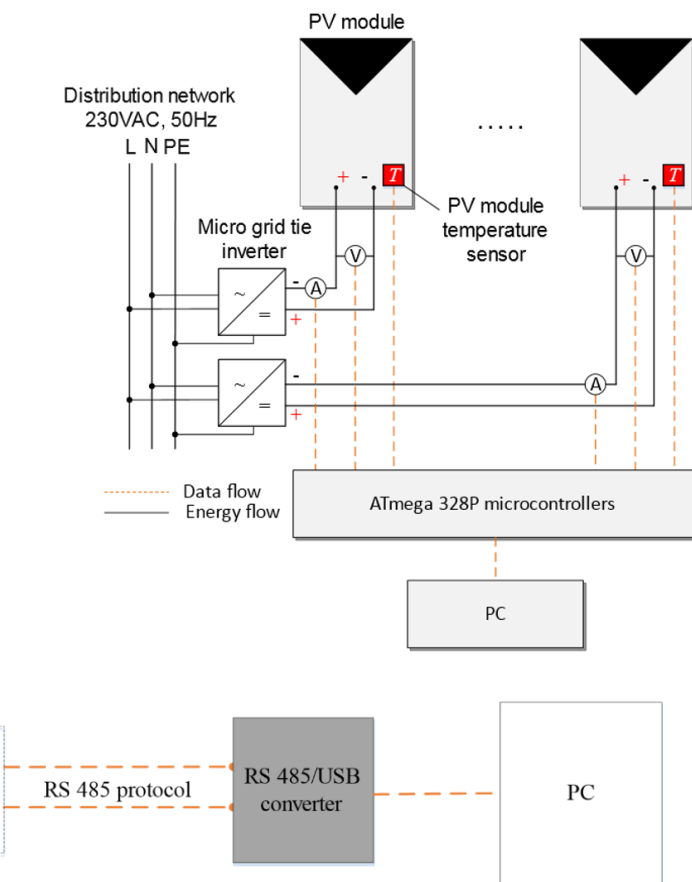


--- Data flow

PV power plant inverter
KACO Powador 12.0 TL3

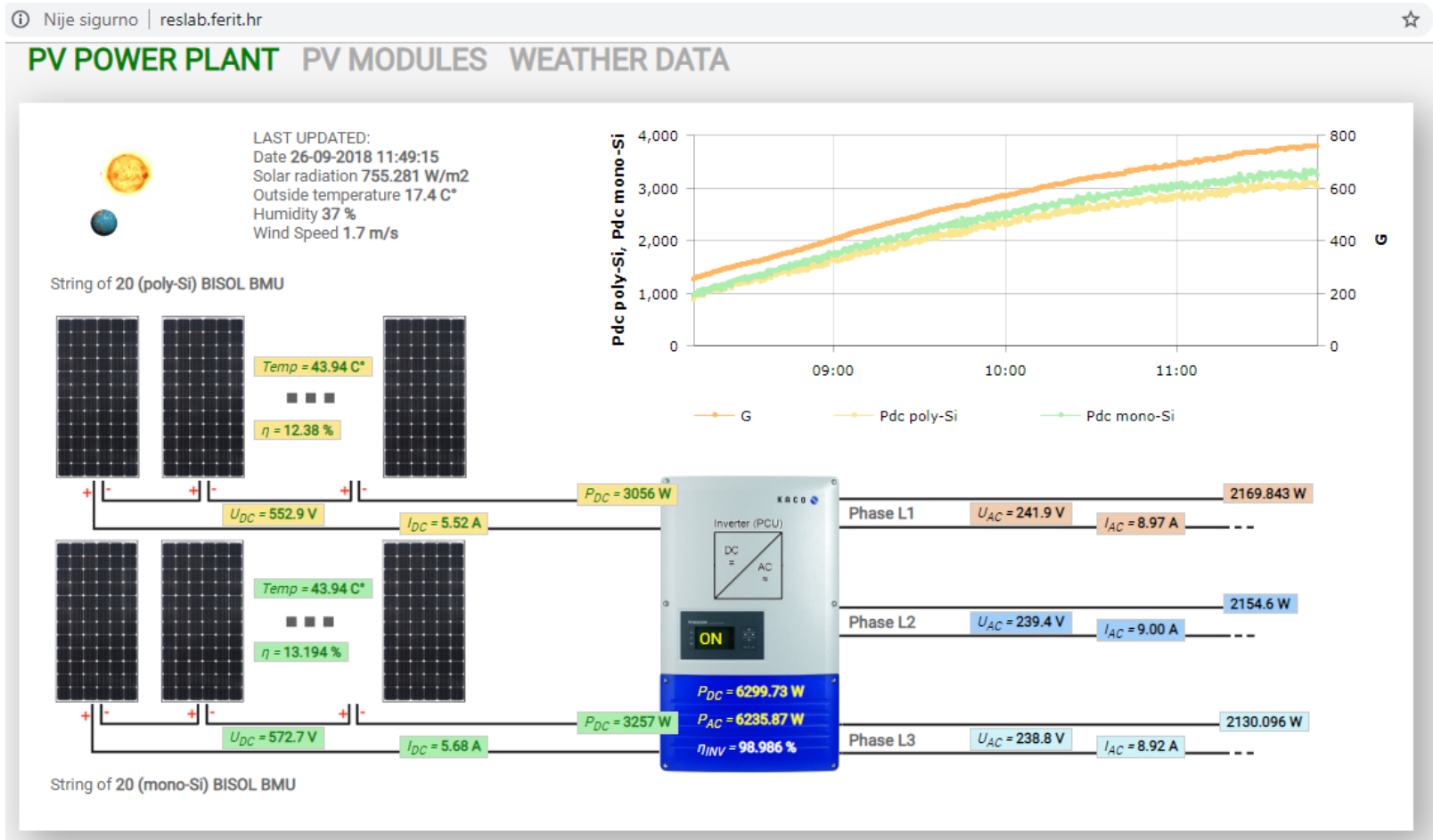


--- Data flow



Source: reslab.ferit.hr

10 kW Power Plant with data acquisition system: real-time monitoring



5 PV modules technologies data acquisition system: real-time monitoring

Source: reslab.ferit.hr

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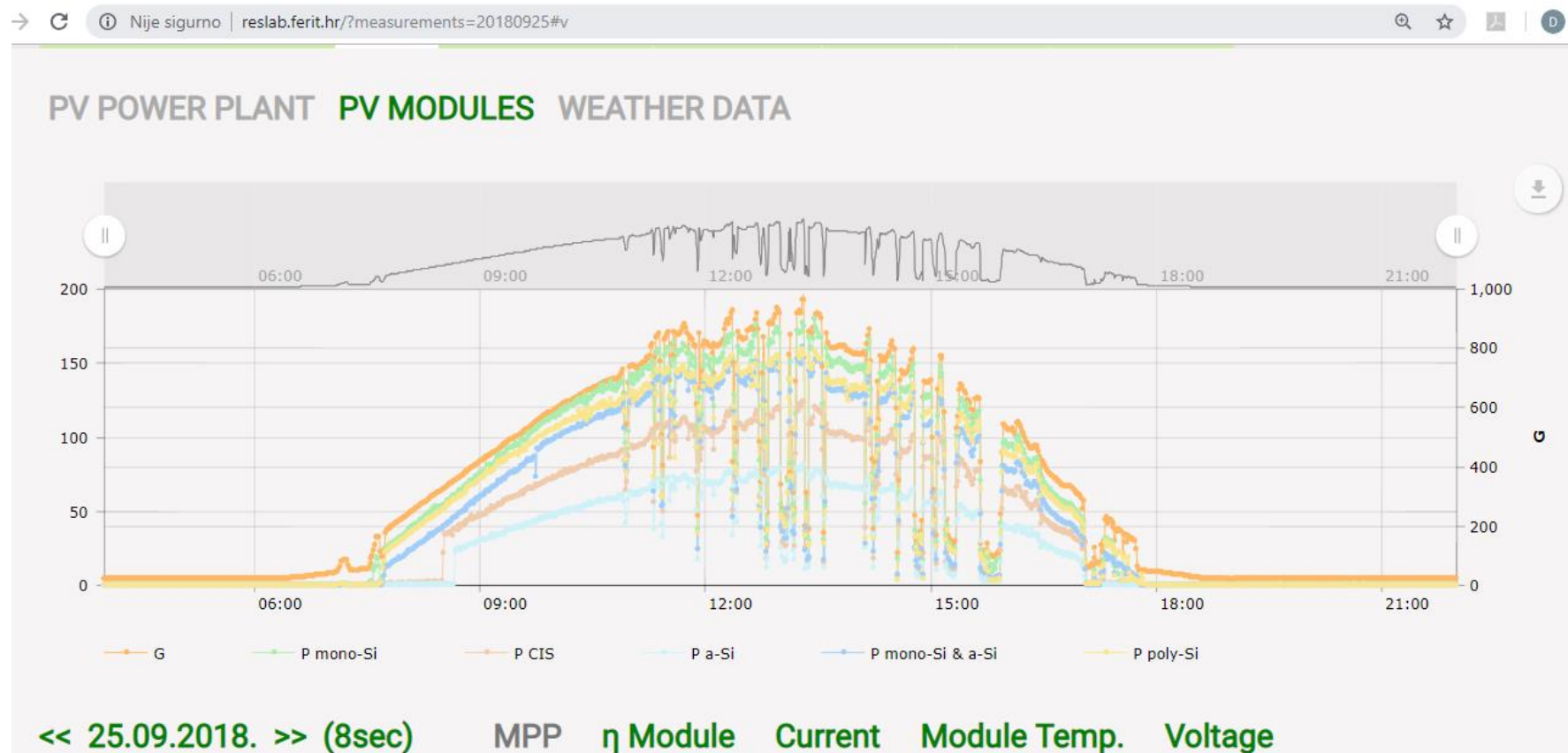


PV POWER PLANT PV MODULES WEATHER DATA

Measured data is sampled and averaged of approx. 60 values per minute. Date: 2018-09-26 Last record: 11:48 Difference: 300 sec			Monocrystalline silicon (mono-Si) BISOL BMO Read specifications $A = 1.40454 \text{ m}^2$ (angle 7°) $P_{MPP} (STC) = 250 \text{ W}$ $\eta_{MODULE} (STC) = 15.3 \%$					<i>NOT CONNECTED YET!</i> Copper indium selenide (CIS) SOLAR FRONTIER SF-150 Read specifications $A = 1.16375 \text{ m}^2$ (angle 7°) $P_{MPP} (STC) = 150 \text{ W}$ $\eta_{MODULE} (STC) = 12.2 \%$					Amorphous silicon (a-Si) MASDAR MPV100-S Read specifications $A = 1.4301 \text{ m}^2$ (angle 7°) $P_{MPP} (STC) = 100 \text{ W}$ $\eta_{MODULE} (STC) = 7.0 \%$					Monocrystalline silicon (mono-Si) + Amorphous silicon (a-Si) Panasonic HIT N240 Read specifications $A = 1.107072 \text{ m}^2$ (angle 7°) $P_{MPP} (STC) = 240 \text{ W}$ $\eta_{MODULE} (STC) = 19.0 \%$					Polycrystalline silicon (poly-Si) BISOL BMU Read specifications $A = 1.40454 \text{ m}^2$ (angle 7°) $P_{MPP} (STC) = 250 \text{ W}$ $\eta_{MODULE} (STC) = 15.3 \%$				
Time	Temp	Solar	T1	IMPP	UMPP	PMPP	η_1	T2	IMPP	UMPP	PMPP	η_2	T3	IMPP	UMPP	PMPP	η_3	T4	IMPP	UMPP	PMPP	η_4	T5	IMPP	UMPP	PMPP	η_5
11:48	14,38	755,366	43,654	4,922	28,28	139,208	13,121%	43,964	1,136	84,069	95,494	10,863%	39,649	0,872	73,672	64,238	5,947%	38,162	3,437	37,281	128,144	15,324%	43,778	4,665	27,574	128,599	12,121%
11:47	14,31	757,395	43,482	4,797	28,742	137,832	12,957%	43,801	1,136	84,152	95,573	10,843%	39,523	0,856	73,792	63,196	5,835%	38,1	3,448	37,406	128,978	15,382%	43,623	4,533	27,919	126,505	11,892%
11:46	14,13	757,073	43,215	4,742	28,813	136,637	12,85%	43,532	1,135	84,191	95,58	10,849%	39,404	0,861	74,036	63,725	5,886%	38,04	3,433	37,278	127,983	15,27%	43,366	4,453	27,824	123,884	11,651%
11:45	14,25	754,425	43,081	4,683	29,127	136,442	12,877%	43,3	1,148	83,962	96,37	10,976%	39,173	0,869	73,894	64,254	5,956%	37,907	3,403	37,582	127,884	15,312%	43,213	4,391	28,006	123,032	11,611%
11:44	14,13	752,881	43,155	4,75	28,768	136,738	12,931%	43,236	1,123	84,038	94,4	10,774%	38,962	0,854	73,511	62,752	5,828%	37,752	3,424	37,437	128,197	15,381%	43,101	4,512	27,749	125,306	11,85%
11:43	14,25	748,609	43,177	4,753	28,941	137,674	13,093%	43,172	1,12	84,038	94,091	10,8%	38,861	0,852	73,999	63,054	5,89%	37,703	3,39	37,629	127,566	15,392%	42,982	4,504	27,825	125,464	11,932%
11:42	14,19	751,93	43,019	4,703	28,744	135,313	12,812%	43,142	1,13	83,71	94,623	10,813%	38,75	0,841	73,875	62,12	5,777%	37,543	3,402	37,441	127,403	15,305%	42,815	4,488	27,74	124,64	11,802%
11:41	14,19	750,751	42,798	4,766	28,844	137,606	13,05%	43,039	1,128	84,034	94,787	10,849%	38,569	0,852	74,102	63,132	5,88%	37,391	3,417	37,28	127,391	15,328%	42,677	4,514	27,817	125,682	11,919%
11:40	14,25	752,832	42,439	4,785	28,877	138,286	13,079%	42,742	1,142	83,907	95,821	10,937%	38,348	0,86	73,752	63,414	5,89%	37,095	3,398	37,402	127,086	15,248%	42,379	4,526	27,794	125,894	11,906%
11:39	14,31	750,322	42,109	4,898	28,745	140,838	13,364%	42,409	1,128	83,88	94,586	10,832%	38,011	0,852	73,752	62,823	5,855%	36,722	3,412	37,364	127,485	15,347%	42,068	4,577	27,875	127,612	12,109%
11:38	14,19	744,869	41,869	4,848	28,882	140,023	13,384%	42,119	1,13	83,937	94,838	10,941%	37,666	0,844	74,263	62,669	5,883%	36,438	3,397	37,802	128,406	15,571%	41,825	4,533	28,155	127,631	12,199%
11:37	13,94	744,18	41,732	4,72	28,519	134,585	12,876%	41,831	1,13	83,536	94,413	10,902%	37,488	0,843	74,042	62,417	5,865%	36,31	3,378	37,773	127,583	15,486%	41,663	4,342	28,07	121,917	11,664%
11:36	14,13	745,448	41,677	4,814	28,89	139,001	13,276%	41,792	1,125	84,1	94,567	10,901%	37,603	0,837	74,053	61,974	5,813%	36,4	3,393	37,595	127,557	15,457%	41,632	4,465	28,158	125,645	12%
11:35	14,31	745,983	41,589	4,665	29,296	136,629	13,04%	41,732	1,126	84,199	94,824	10,923%	37,688	0,845	74,327	62,79	5,886%	36,384	3,381	37,969	128,359	15,543%	41,631	4,399	28,385	124,819	11,913%
11:34	14,19	744,227	41,473	4,897	28,454	139,293	13,326%	41,544	1,109	83,821	92,951	10,732%	37,668	0,847	73,859	62,553	5,877%	36,288	3,376	37,665	127,159	15,434%	41,483	4,559	27,769	126,509	12,103%

5 PV modules technologies data acquisition system: real-time monitoring

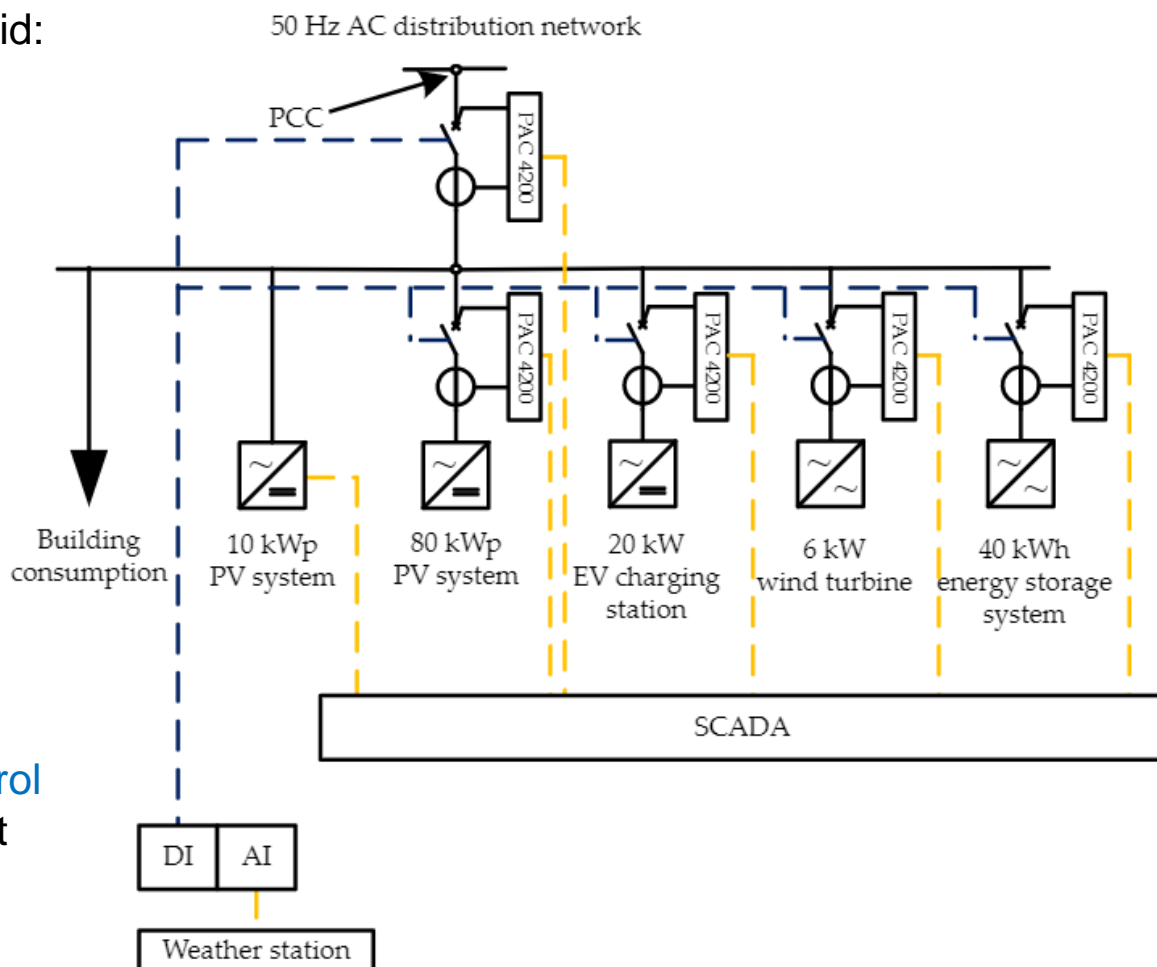
Source: reslab.ferit.hr



Microgrid development at FERIT Laboratory for RES

► Future FERIT main building microgrid:

- add. 80 kW PV power plant
(+ 40 kW PV plant Campus)
- 6 kW wind power plant
- 40 kWh (20 kW)
batteries+chargers
- Min 5 kW charging station
for (with) min 5 e-bikes
- 6,5 kW biodiesel aggregate
- **Microgrid control system –
Building energy management
system (BEMS)**
- Data acquisition monitoring **to control**
and planning system development
- Air-conditioning and overall **load
management**



FERIT PV BASED MICROGRID WITH BUILDING EMS

- Establishment of smart FERIT building energy management system (BEMS) or microgrid with 120 kW PV power plants on (two) location(s), 40 kWh (20 kW) battery storage system, 6 kW wind power plant.



PV power plant FERIT 1 (80 kW)
(Trpimirova street building)

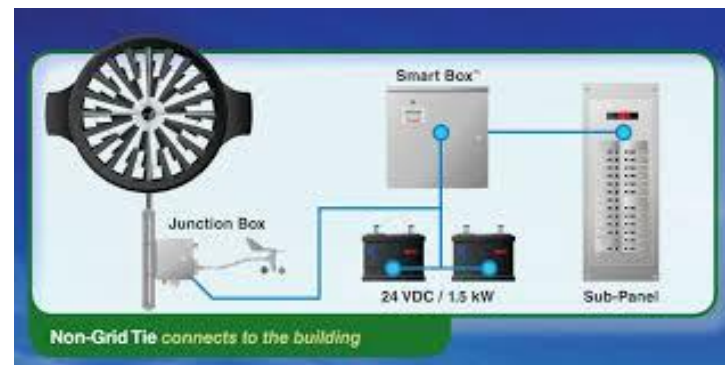


PV power plant FERIT 2 (40 kW)
(University Campus building)

- Management, scientific research, education/training/workshops (OS, SB, NS, SU), dissemination, etc.

FERIT ELECTRIC VEHICLES CHARGING MICROGRID

- ▶ Electrical bicycle (vehicles) charging station: 5 kW
- ▶ Tracker or fixed PV system: 5-10 kW
- ▶ Wind power plant(s): 6 kW
- ▶ Storage/supply with programmable characteristic: 10-20 kWh (5-10) kW

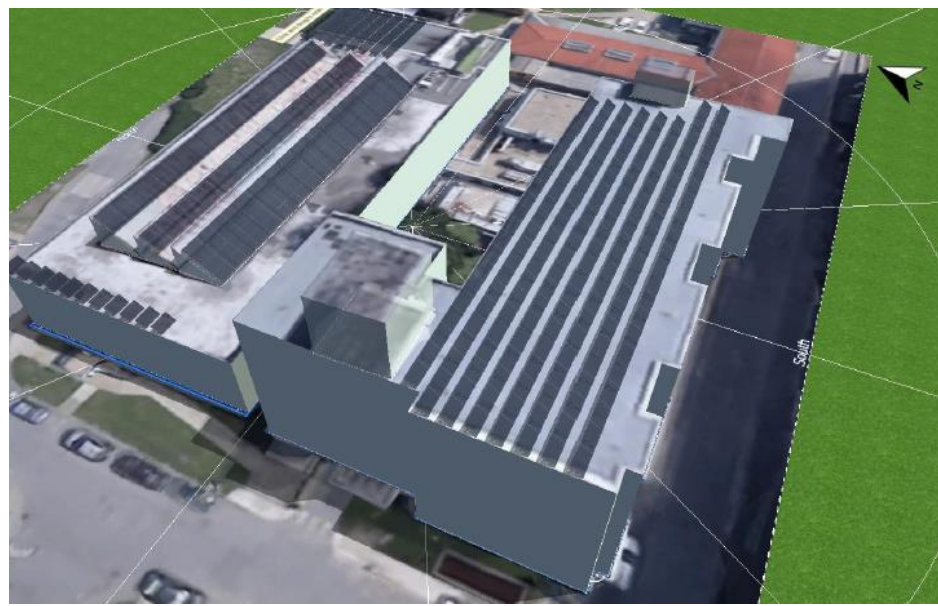


FERIT TEAM SUPPORT FOR KBCO ON RESCUE

- Technical support for smart KBCO building energy management system (microgrid) with 230 kW PV power plants on two locations, 2x125 kW biodiesel generators



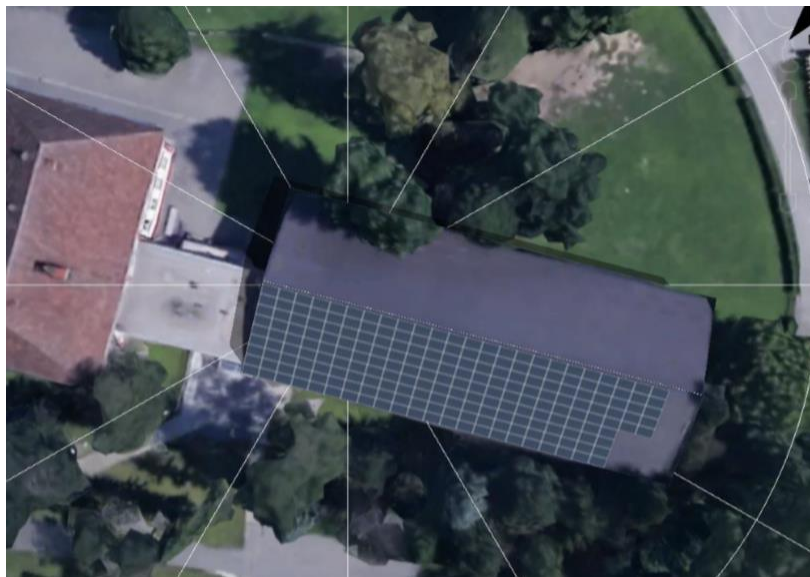
PV power plant KBCO 1 (110 kW)
(Nutrion building)



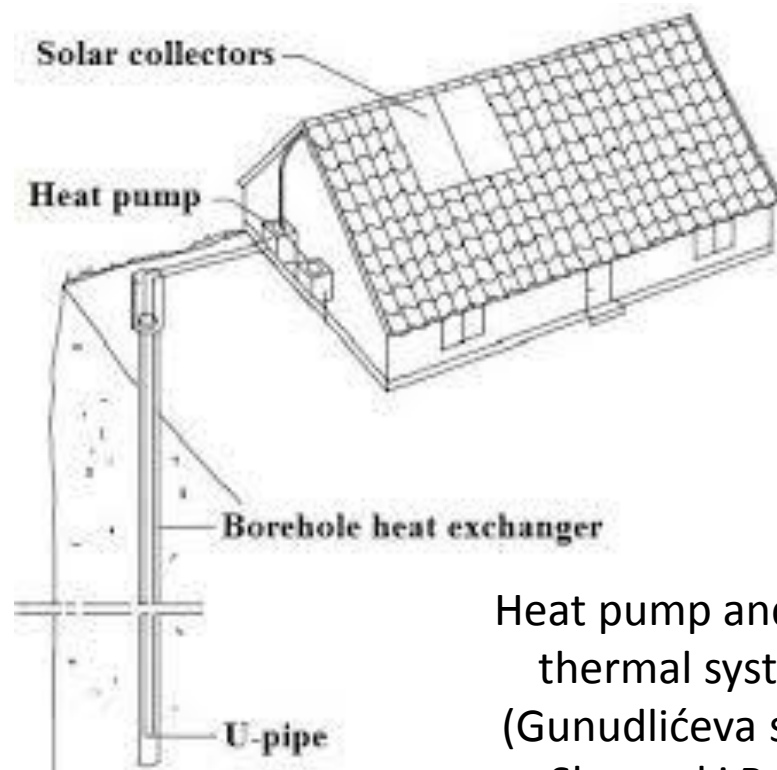
PV power plant KBCO 2 (120 kW)
(Oncology and Radiology buildings)

FERIT TEAM SUPPORT FOR SFSB ON RESCUE

- Technical support for smart SFSB building energy management system (microgrid) with 60 kW PV power plants on two locations, solar thermal and heat pump systems



PV power plant SFSB (60 kW)
(Gunudlićeva street, Slavonski Brod)



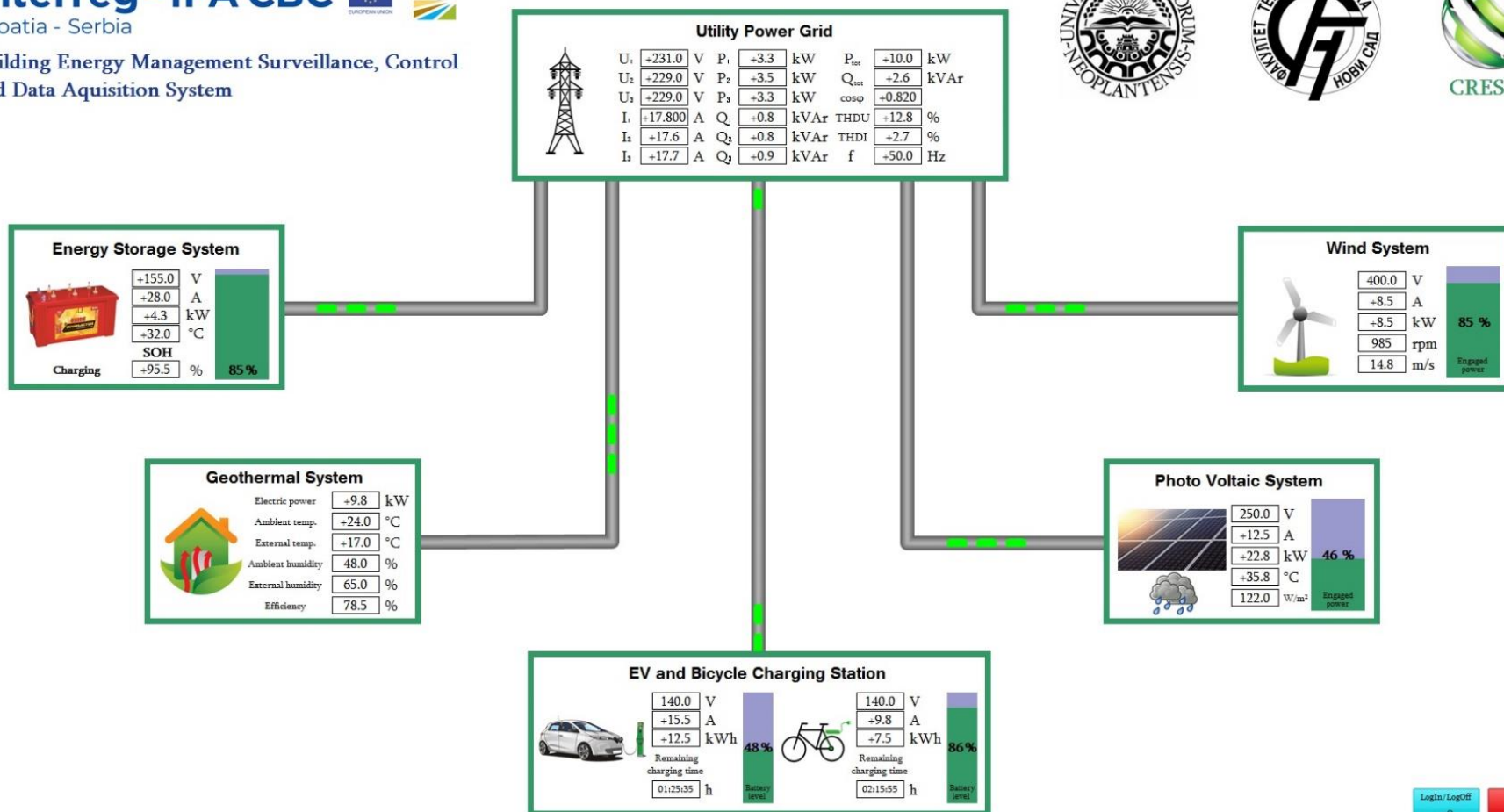
Heat pump and solar
thermal systems
(Gunudlićeva street,
Slavonski Brod)

Building EMS in RESCUE – Support by FTN Novi Sad

Interreg - IPA CBC

Croatia - Serbia

Building Energy Management Surveillance, Control
and Data Acquisition System



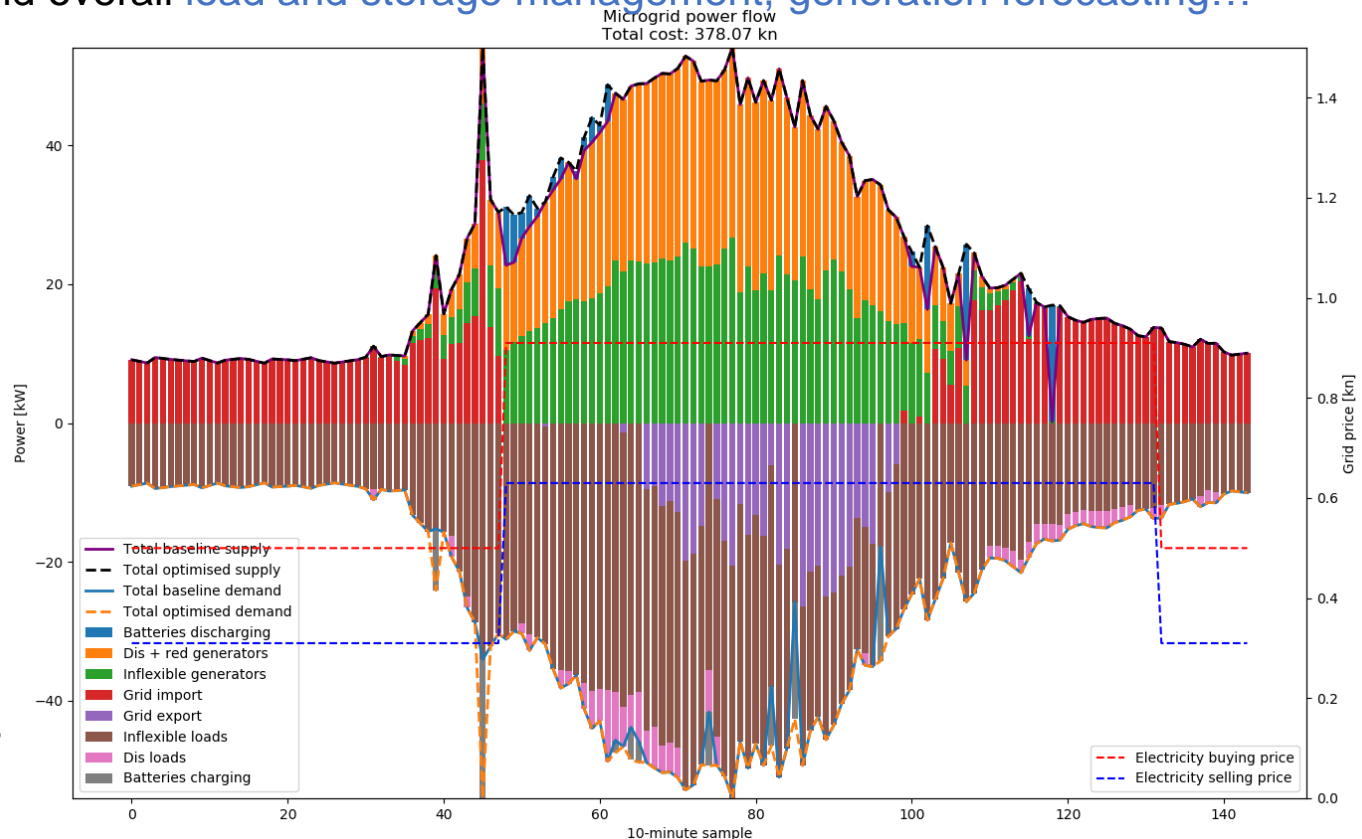
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Login/Logout

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Microgrid development at FERIT Laboratory for RES

- ▶ **Microgrid control system – Building energy management system (BEMS)Tran**
- ▶ From data acquisition monitoring to control and planning system model
- ▶ Air-conditioning and overall load and storage management, generation forecasting...



Source:

Matej Žnidarec, PhD thesis
(Prof Damir Šljivac, supervisor)