



**SCIENCE & TECHNOLOGY PARK ZEMUN Corp.**

---

# **HYBRID SOLAR BIOGAS PILOT PLANT**

**ANALYSIS OF INCREASING OF OPERATIONAL AND TECHNOLOGICAL  
PERFORMANCE OF ANAEROBIC MANURE TREATMENT**

Innovation project partially funded by the Ministry of Education, Science and  
Technological Development of the Republic of Serbia

---

Belgrade, Serbia, June 2013



**SCIENCE & TECHNOLOGY PARK ZEMUN Corp.**

---

## **Project coordination:**

**IHIS Science and Technology Park Zemun Corp.**

**Batajnički drum 23**

**11080 Belgrade SERBIA**

**[www.ihis.co.rs](http://www.ihis.co.rs)**

---





## SCIENCE & TECHNOLOGY PARK ZEMUN Corp.

Main reasons for use of animal and agricultural waste:



If we do not process and use the animal and agricultural waste we automatically generate the pollution of the environment and green house gases as well!





## SCIENCE & TECHNOLOGY PARK ZEMUN Corp.

Current manure handling practice in Serbia:





## One of the possible solutions:

One of the possible solutions is the development of coupled modular anaerobic – solar bioreactor or ASB systems which maximise the use of agricultural and animal waste for the purpose of biogas production as a form of an alternative energy source, and for the purpose of high quality natural fertilizer production.

---





## Project idea:

The idea of the project is to apply anaerobic treatment of agricultural waste in general (both animal and crop residues), in conjunction with the thermal energy or heat gained from the Sun thanks to solar collectors.

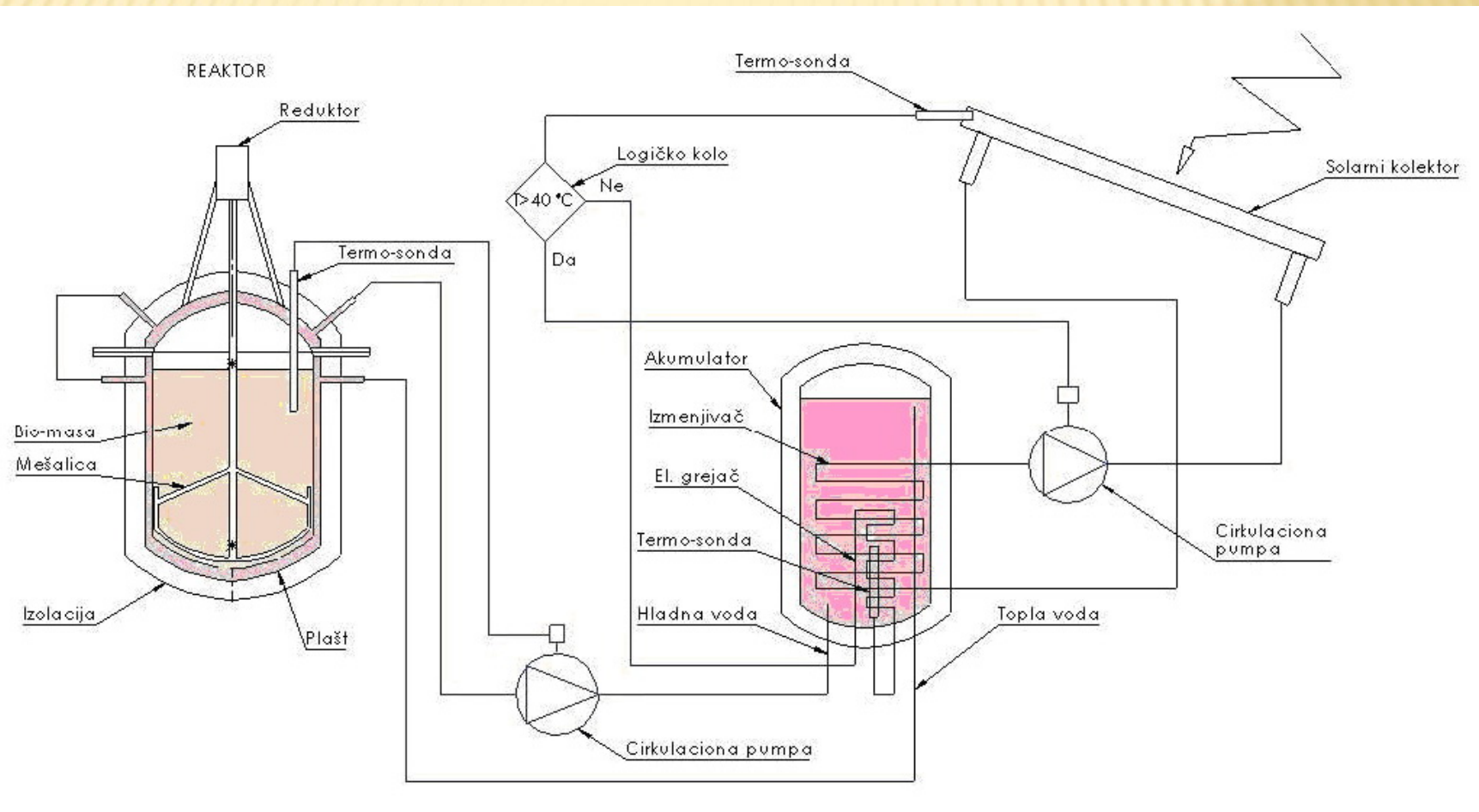
---



## Project activities / goals:

1. Development and design of the modular anaerobic – solar bioreactor (ASB) along with the production of entire project documentation,
2. Production and installation of the solar collector,
3. Definition of the coupled solar – anaerobic process operational parameters,
4. Investigation of the influence of the temperature at which the anaerobic fermentation is taking place and on the biogas production rate in real conditions.

## Anaerobic – solar bioreactor (ASB) system schematic layout:







## Anaerobic – solar bioreactor (ASB) system components:

1. Anaerobic reactor in the form of a vessel with a double wall and an electric mixer,
2. Water thermal energy storage with an electric heater (3kW),
3. Heat exchanger,
4. Solar collector (aprox. 3kW),
5. Circulation water pump (2 EA),
6. Control and regulation module.



# SCIENCE & TECHNOLOGY PARK ZEMUN Corp.

## Components of an experimental anaerobic – solar bioreactor (ASB) system:



Anaerobic reactor with a thermal energy storage unit



Solar collector with the expansion vessel



Water circulation pump placed next to the thermal energy storage unit





## ASB system experimental testing results:

Characteristic/performance:	Pilot plant:	Real / full scale plant:
Average process temperature	15 °C	15 °C
Hydraulic retention time (HRT)	100 days	100 days
Anaerobic reactor volume	300 liters	10,000 liters
Reactor type	Semi-continuous reactor with the piston flow	Semi-continuous reactor with the piston flow
Ratio of manure water dilution	2 : 1	2 : 1
Substrate quantity	15kg/day + 2kg/day of crop residues (agricultural biomass)	67kg/day + 26kg/day of crop residues (agricultural biomass)
Biogas production per 1kg of animal (pig) manure	up to 50 liters	up to 50 liters
Estimated daily biogas production	Aprox. 1m <sup>3</sup>	4 – 5 m <sup>3</sup>
Fresh manure adding frequency	1 – 2 times a day	1 – 2 times a day



## Project main results:

1. The technical and technological solution for the biogas production plant that is coupled with the solar collector has been adopted,
2. Thanks to the numerical, mechanical and thermodynamic calculations done on the computer using Solidworks and CHEMCAD software, all the components of the system were modeled, dimensioned, designed and optimized. All of their operational parameters were calculated,
3. Experimental investigation of the influence of temperature on the biogas production rate in real conditions has been performed within the project closing stage,
4. The technical and technological solution for biogas production using solar energy was presented at the Belgrade Fair of Technique in May 2013,
5. An article titled "Solar biogas production plant for the agricultural and animal farms" was published in the Serbian magazine "Industry", no. 44 / June 2013, pages 16 – 17.





Example of the real / full scale anaerobic digester underground installation:



(1)



(2)



(3)



(4)



(5)



(6)



(7)



## Benefits of the proposed technology:



- 1.Improvement of the facilities hygiene,
- 2.User's own production of organic fertilizer,
- 3.Energy independence,
- 4.Sustainable development.





# SCIENCE & TECHNOLOGY PARK ZEMUN Corp.

---

This project was realized in association with professors from the University of Belgrade

Project leader:

Prof. Dr. Mirko Komatina

Project coordinators:

Prof. Dr. Branko Bugarski

Prof. Dr. Marko Rakin

Contact person:

Marijana Stamenkovic Djokovic, B.E.

Tel: +381 11 6195 700

Fax: +381 11 6194 991

E-mail: [ihis@eunet.rs](mailto:ihis@eunet.rs)

Presentation prepared by Srdjan Uzelac, B.E.