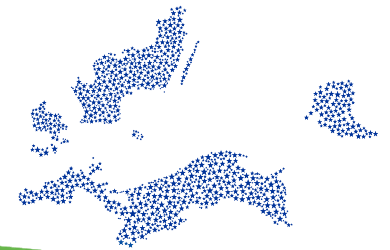




Cluster On Anaerobic digestion environmental Services and nuTrients removal

5th Project Conference

Pre-treatment Laboratory Results



Robert Aranowski

17th Jun 2021

Partners



Universität Rostock



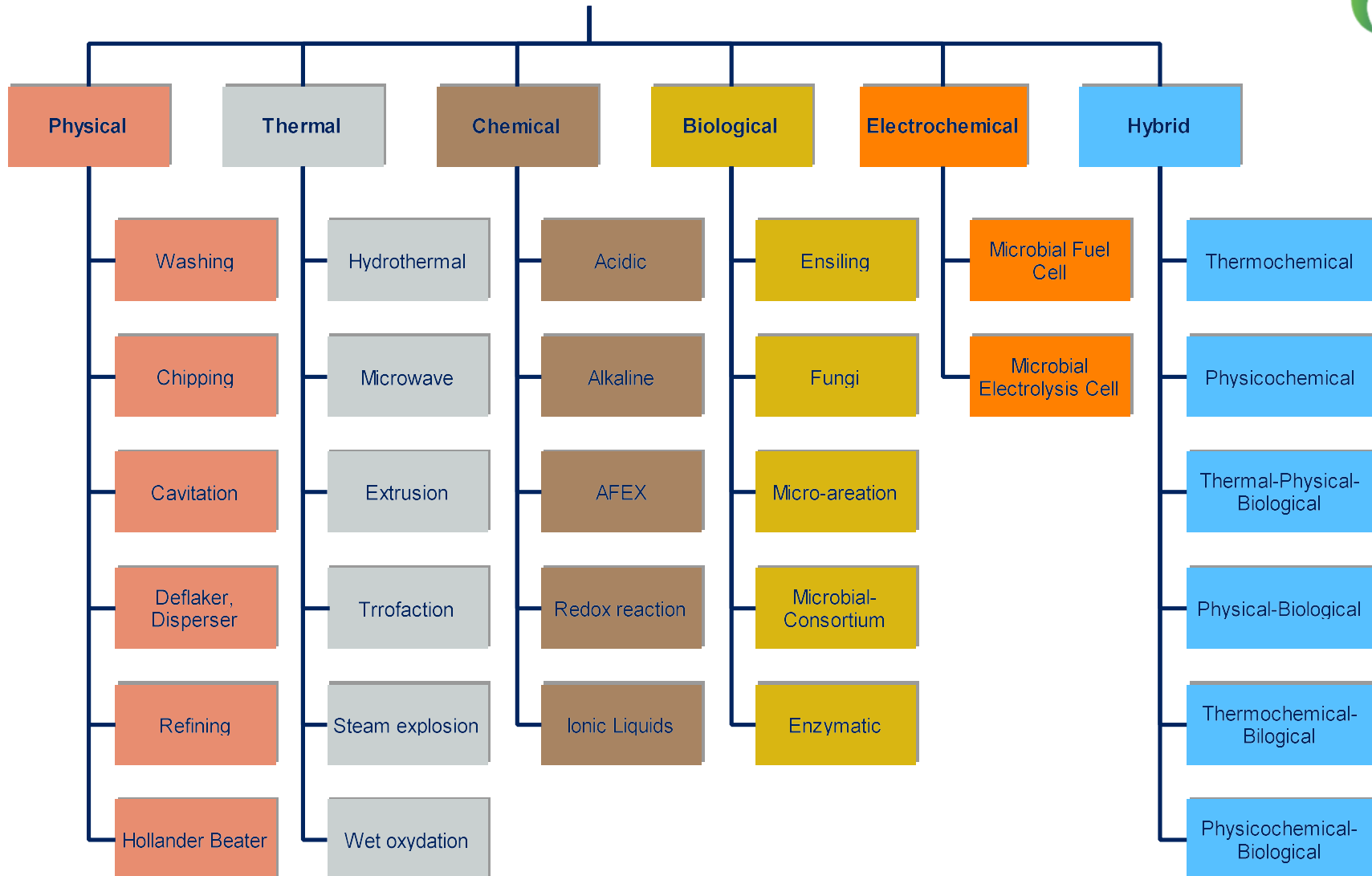
Funded by



European Regional Development Fund



Pre-treatment



Partners



Funded by

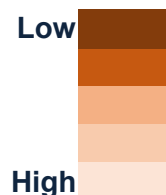


European Regional Development Fund

Comparison of pre-treatment methods



Parameters	Pre-treatment methods										
	Milling	Chopping	Washing	Microwave	Hydrothermal	Extrusion	Steam explosion	Acidic	Alkaline	Enzymatic	Ensiling
Size reduction	Low	Low	High	High	High	Low	High	High	High	Low	Low
Surface to volume increase	Low	Low	High	Low	Low	Low	High	High	Low	Low	Low
Energy consumption	Low	Low	High	Low	Low	Low	Low	Low	Low	High	High
Salt removal	High	High	Low	Low	Low	High	High	High	Low	High	High
Loss of readily digested substrates	High	High	Low	High	High	High	Low	Low	Low	High	High
Sand removal	High	High	Low	High	High	High	High	Low	Low	Low	High
Hazard risk	High	High	High	High	High	High	High	Low	Low	Low	Low
Not suitable for some seaweeds	High	High	Low	High	High	High	High	High	High	Low	Low



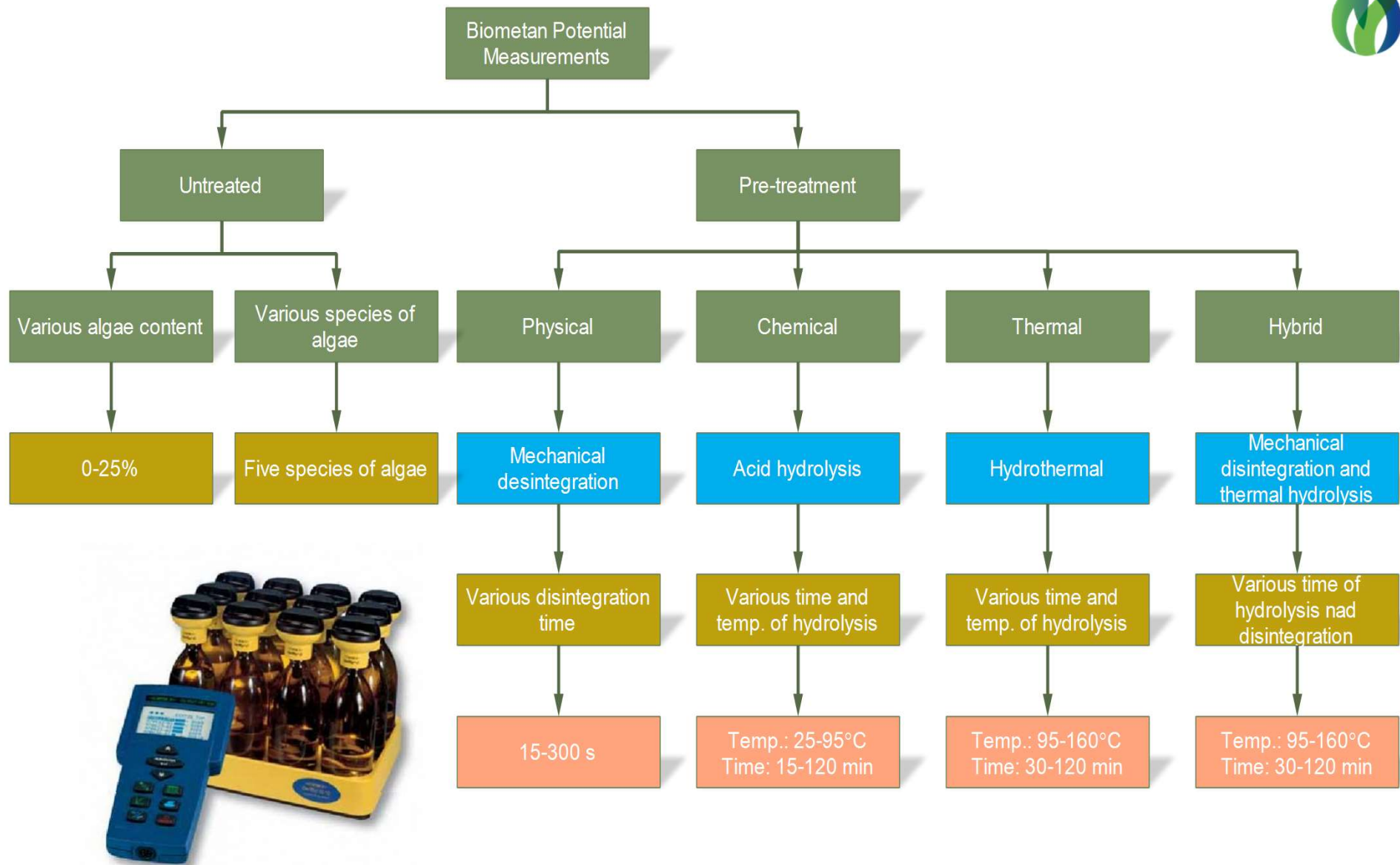
Partners



Funded by



European Regional Development Fund



Partners



Universität Rostock

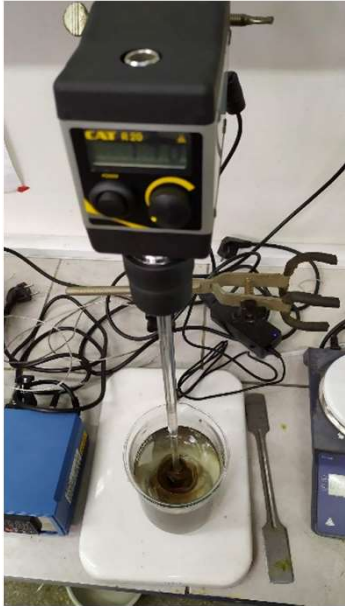
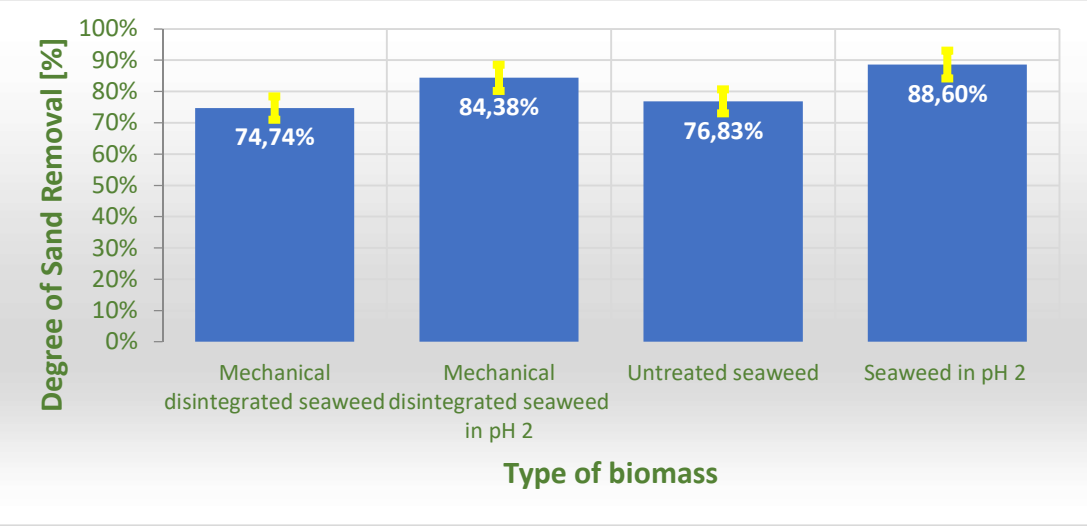
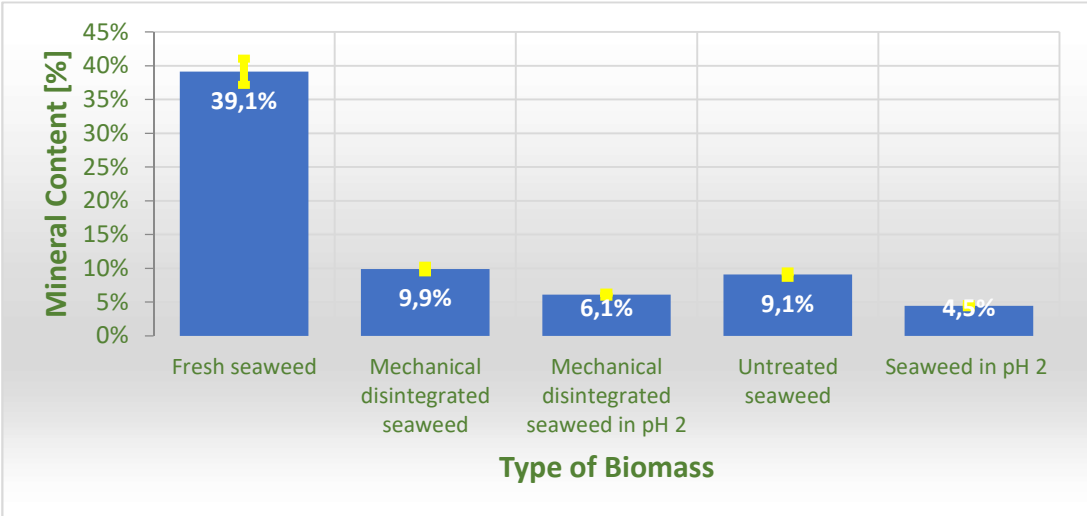


Funded by



European Regional Development Fund

Sand removal



Sand removal was carried out with a laboratory agitator, which was rotated at a speed of 180 rpm (photo on the left) as well as in a 600 L tank equipped with a mechanical agitator (photo on the right).

Partners



Funded by



European Regional Development Fund

Methodology of laboratory measurements of algae biogas potential



The procedure of determining the biogas potential

- Amount of biomass mixture used for test was approximately 100 g
- The volume of OxiTop reactors was 1.1 dm³
- The temperature of incubation was 37°C.
- The reactors were mixed with magnetic stirrers at a rotation speed of about 180 min⁻¹.
- The total solids of the biomass mixture at the start of experiment was approximately 8%
- The experiments duration no less than 30-45 day



Partners



Universität
Rostock



Funded by



European
Regional
Development
Fund

Methodology of laboratory measurements of algae biogas potential



The biogas cumulative volume production was calculated using following equation:

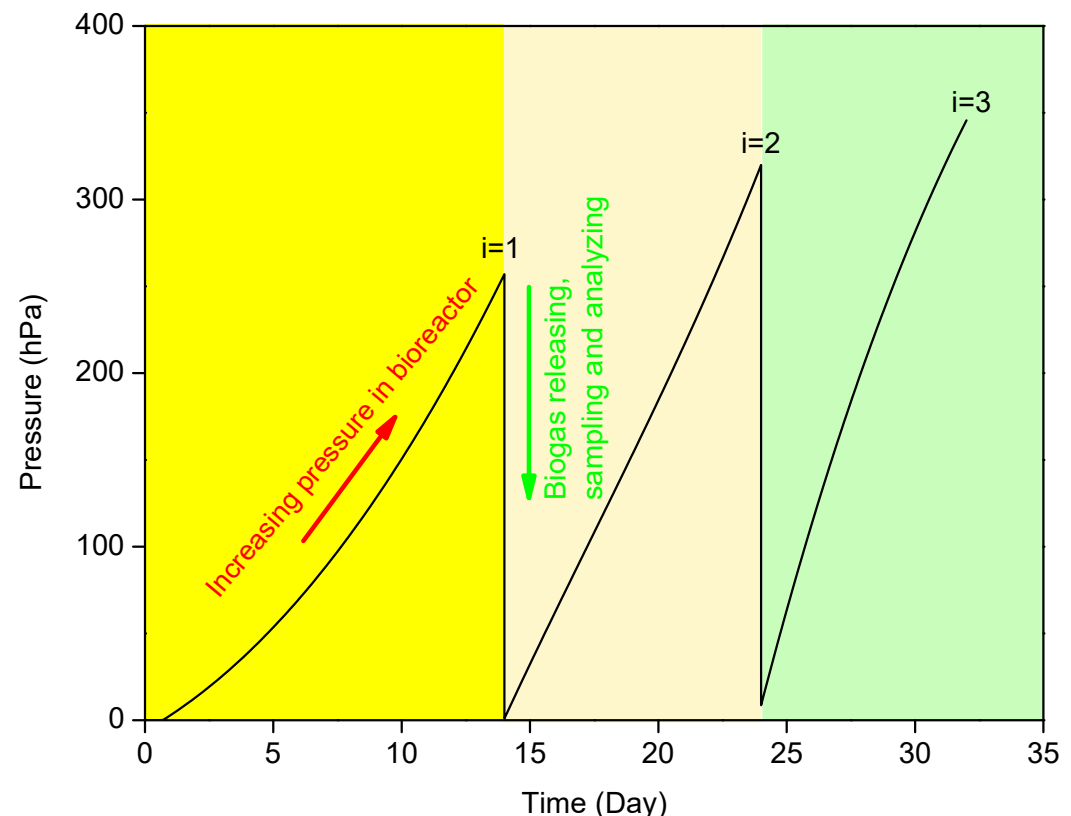
$$V_t = \sum_{i=1}^N \frac{P_i \cdot V}{R \cdot T}, [\text{Nm}^3]$$

The compound x volume production was calculated using below equation:

$$V_{tx} = c_{xi} \sum_{i=1}^N \frac{P_i \cdot V}{R \cdot T}, [\text{Nm}^3]$$

Where:

V_t – Total biogas volume,
 P - Pressure in the OxiTop bioreactor,
 V - The volume of space above the liquid phase in the OxiTop bioreactor,
 R - Gas constant,



T - Measurement temperature
 N – number of biogas release cycles
 c_{xi} – concentration of x compound in i cycle

Partners



Universität
Rostock

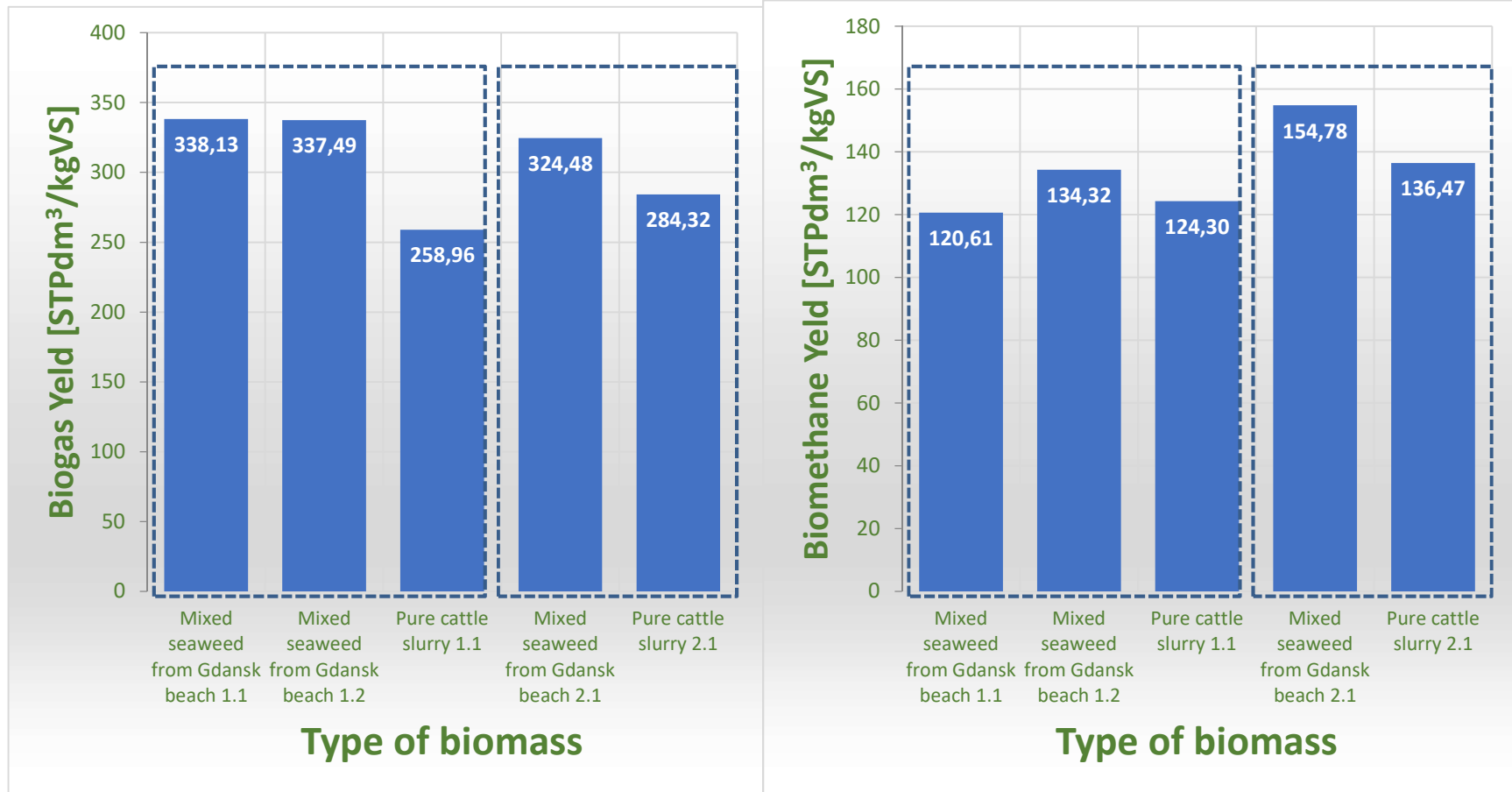


Funded by



European
Regional
Development
Fund

Co-digestion of seaweed and cattle slurry



Marine biomass content in mixture – 25%
Time of digestion – 30 days

Partners



Funded by



European Regional Development Fund

Mechanical pre-treatment



Biomass: mixture of algae from Gdansk beach

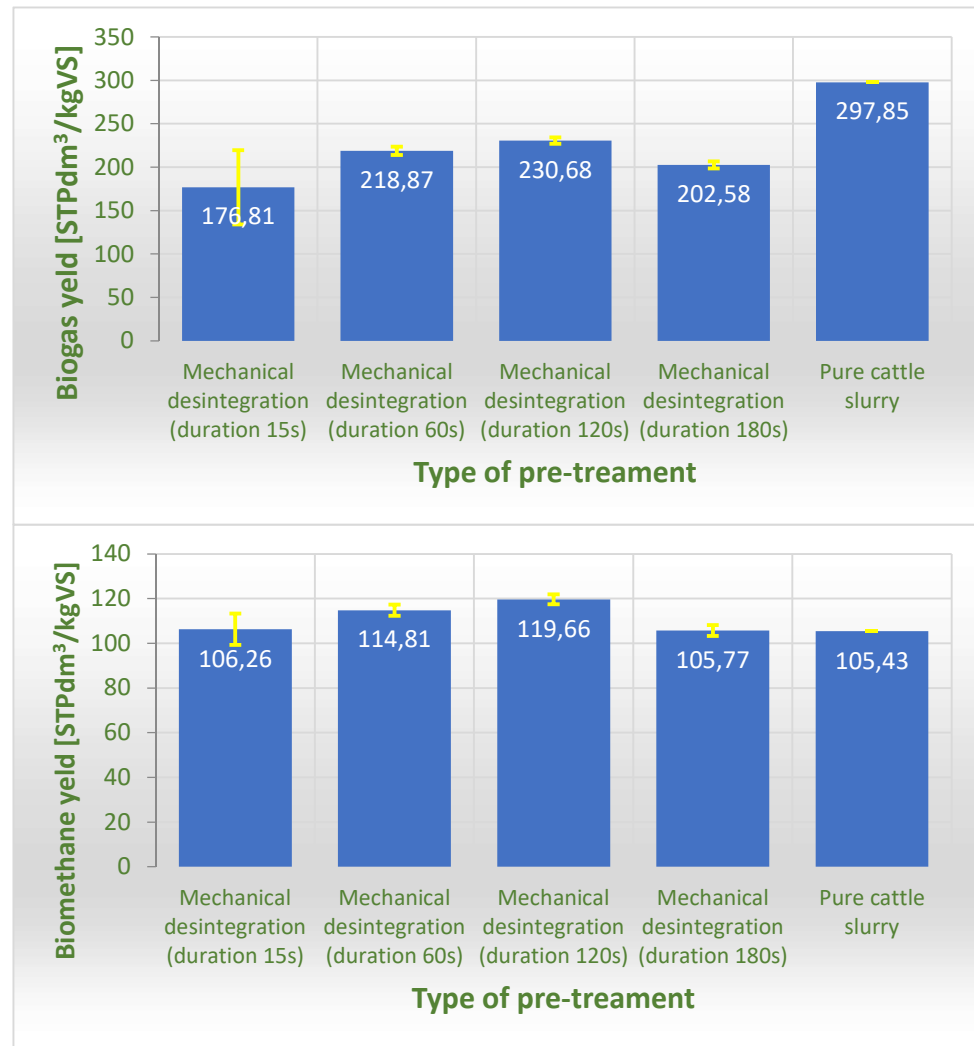
Equipment: laboratory grinder

Power: 1200 W

Rotary speed: 24 000 min⁻¹,

Screen: 200 mesh

Time of disintegration: 15-180 s.



Partners

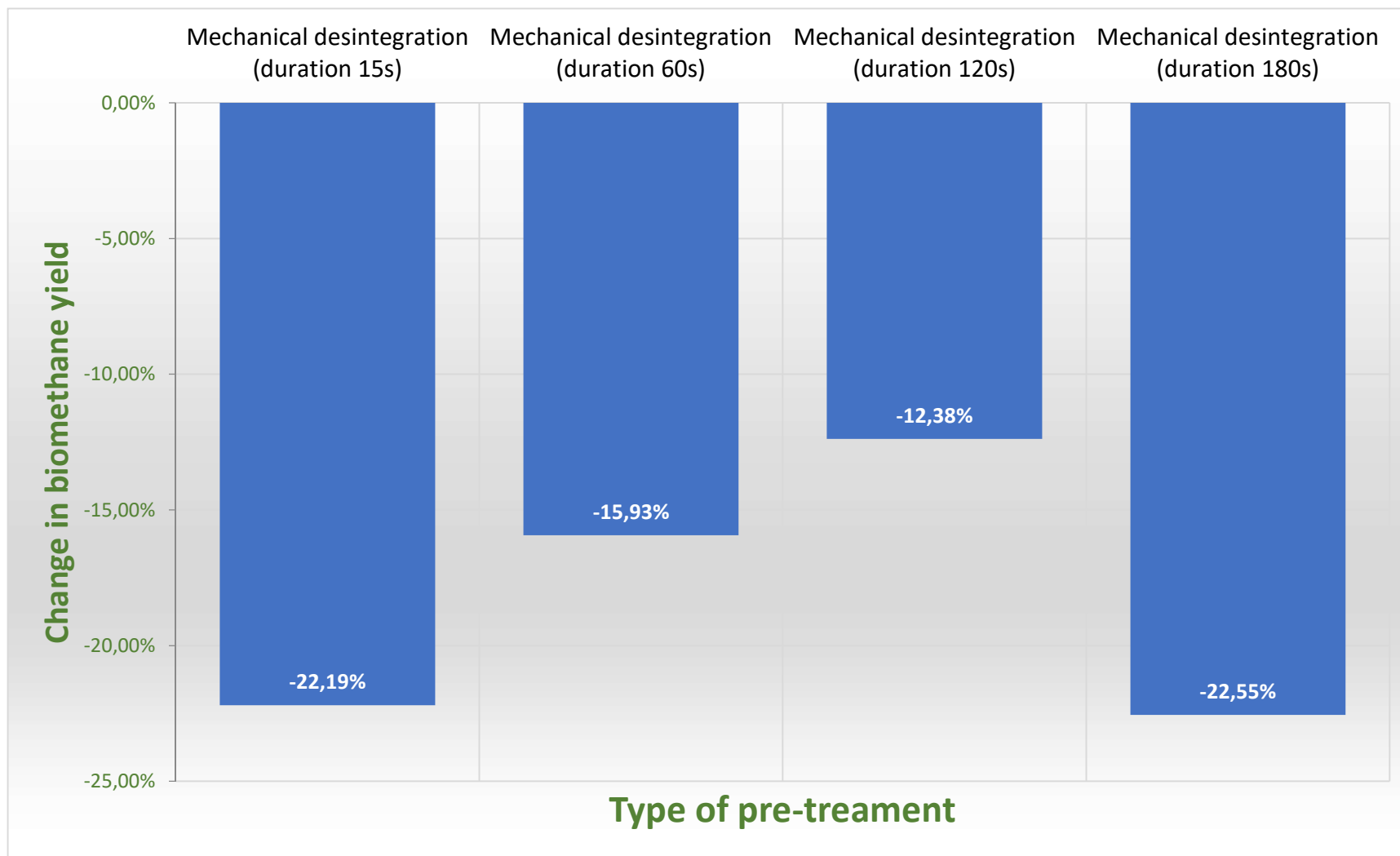


Funded by



European Regional Development Fund

Change in biomethane yield for mechanical pre-treatment in comparison to untreated seaweed



Partners



Universität Rostock

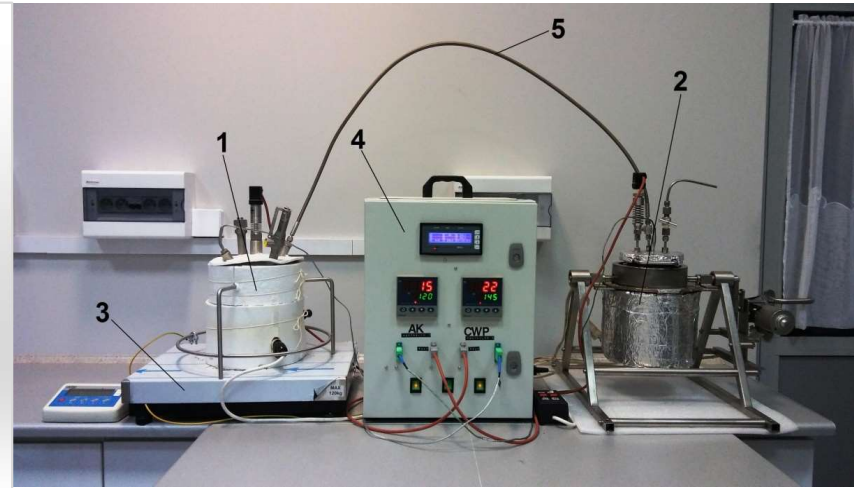
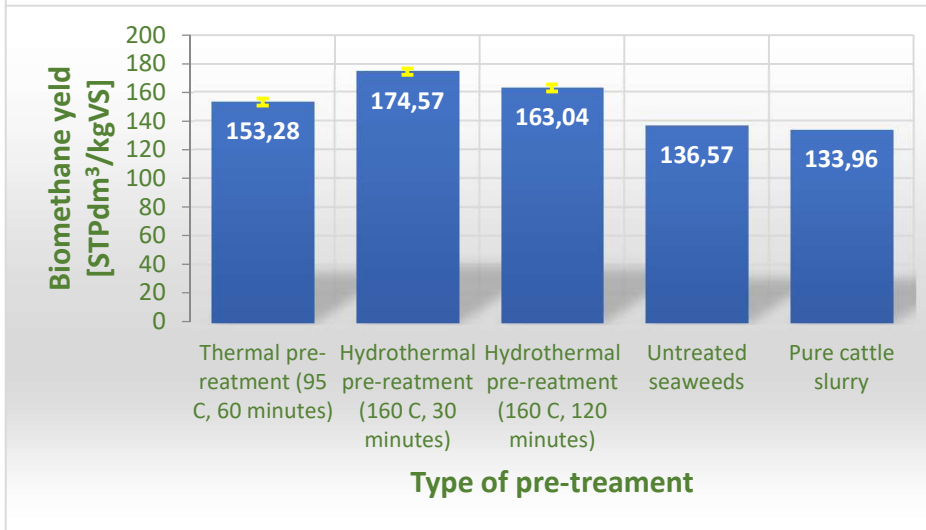
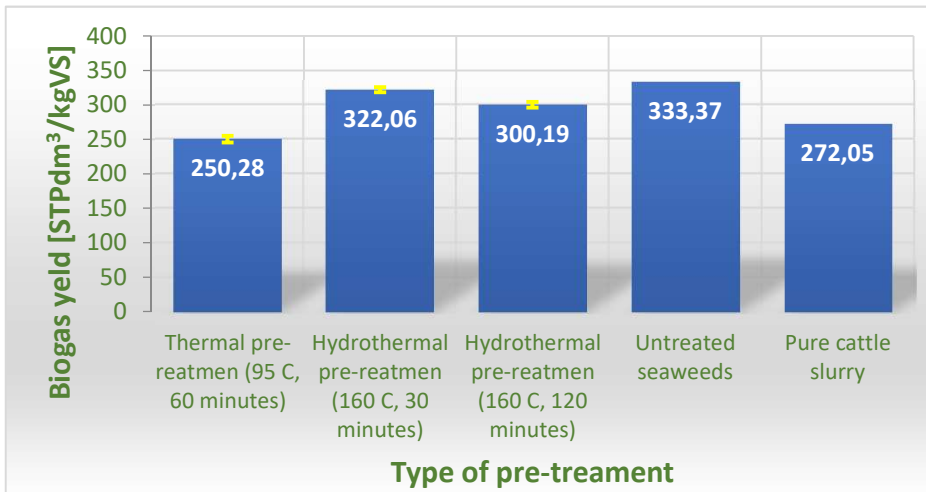


Funded by



European Regional Development Fund

Hydrothermal pre-treatment



System for thermal treatment of biomass (1) steam generator, (2) autoclave for hydrothermal lysis, (3) balance for measuring steam consumption, (4) control system; (5) steam connection.



Partners

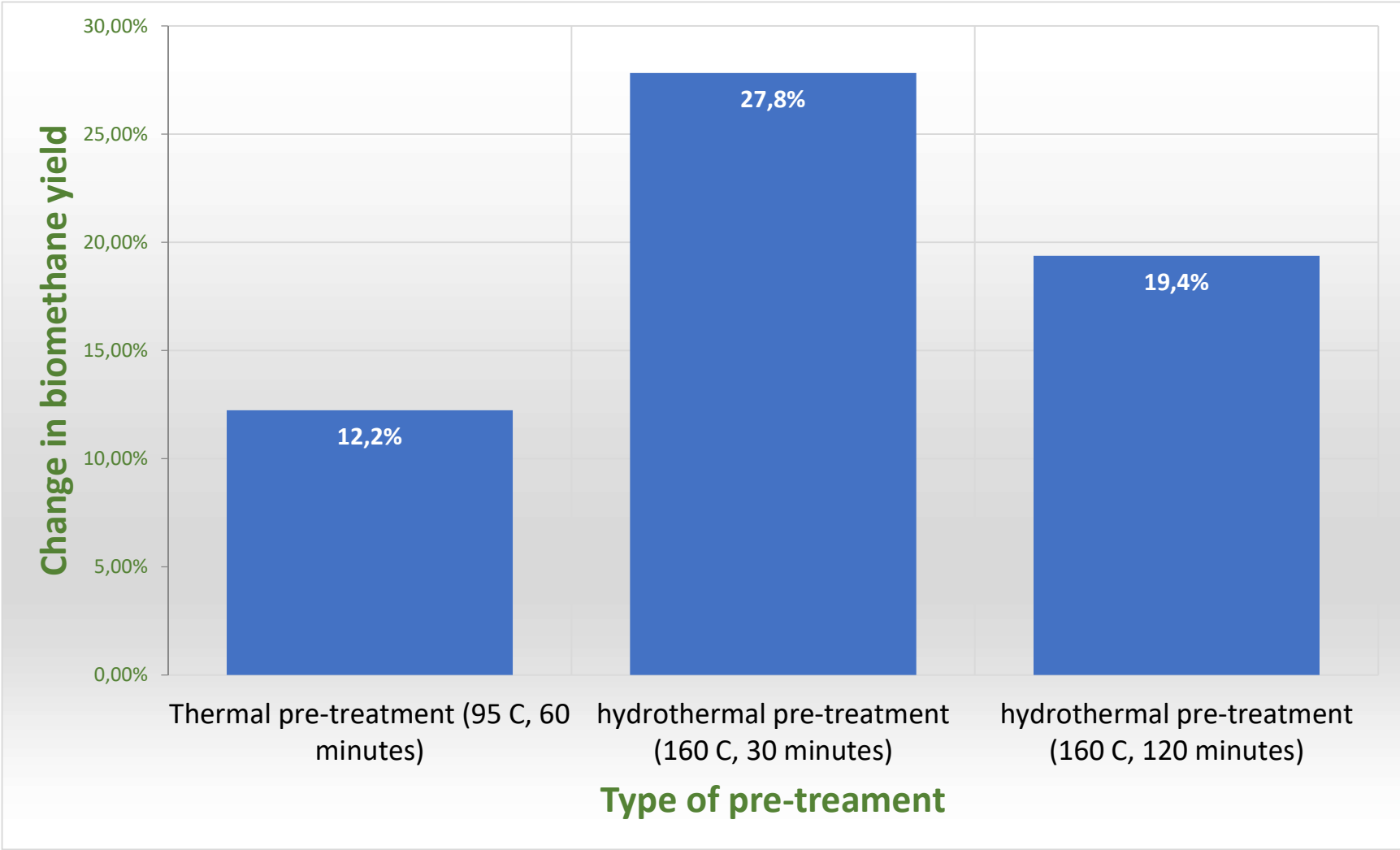


Funded by



European Regional Development Fund

Change in biomethane yield for hydrothermal pre-treatment in comparison to untreated seaweed



Partners



Universität Rostock



Funded by

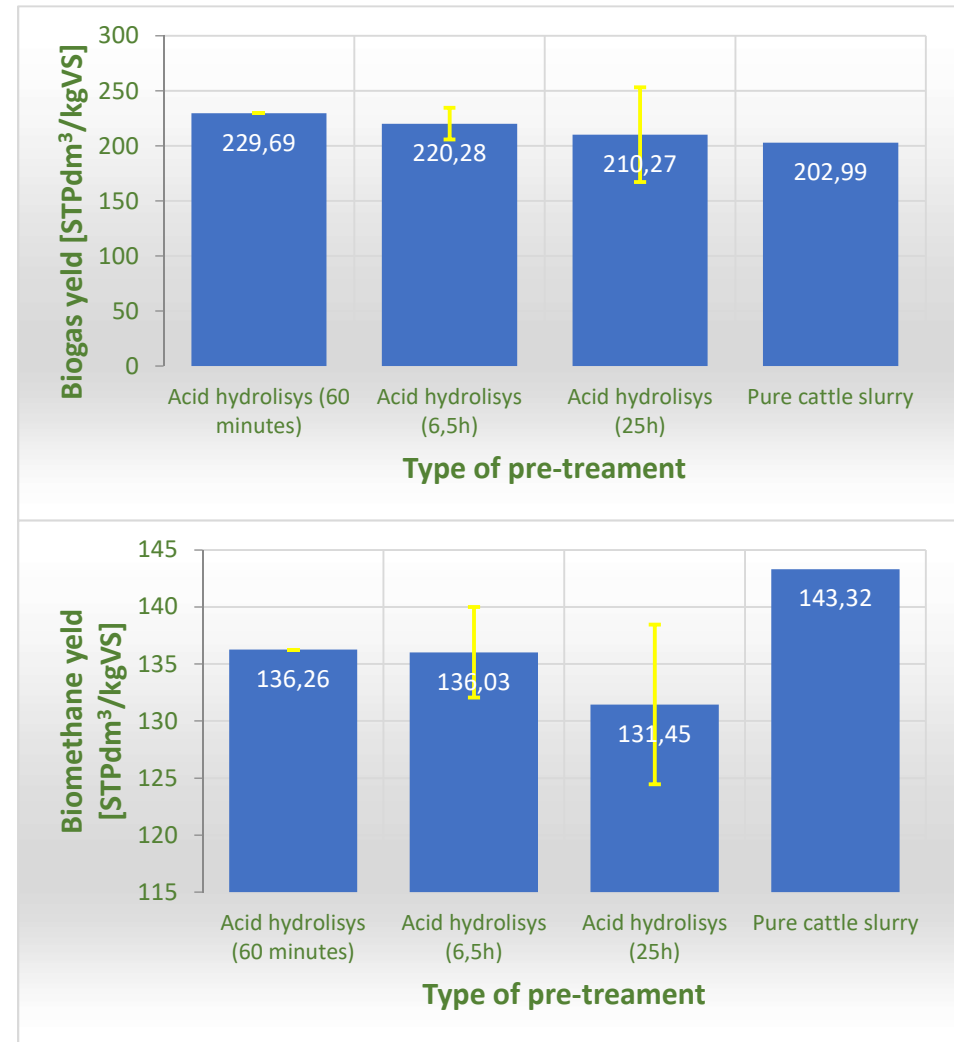


European Regional Development Fund

Acid pre-treatment



- In the acidic pre-treatment the marine biomass was treated by sulphuric acid solution of pH 2 for 1, 6, 5 and 25 hours respectively
- After certain time the solution was neutralised by adding sodium carbonate to the neutral pH level



Partners



Universität Rostock

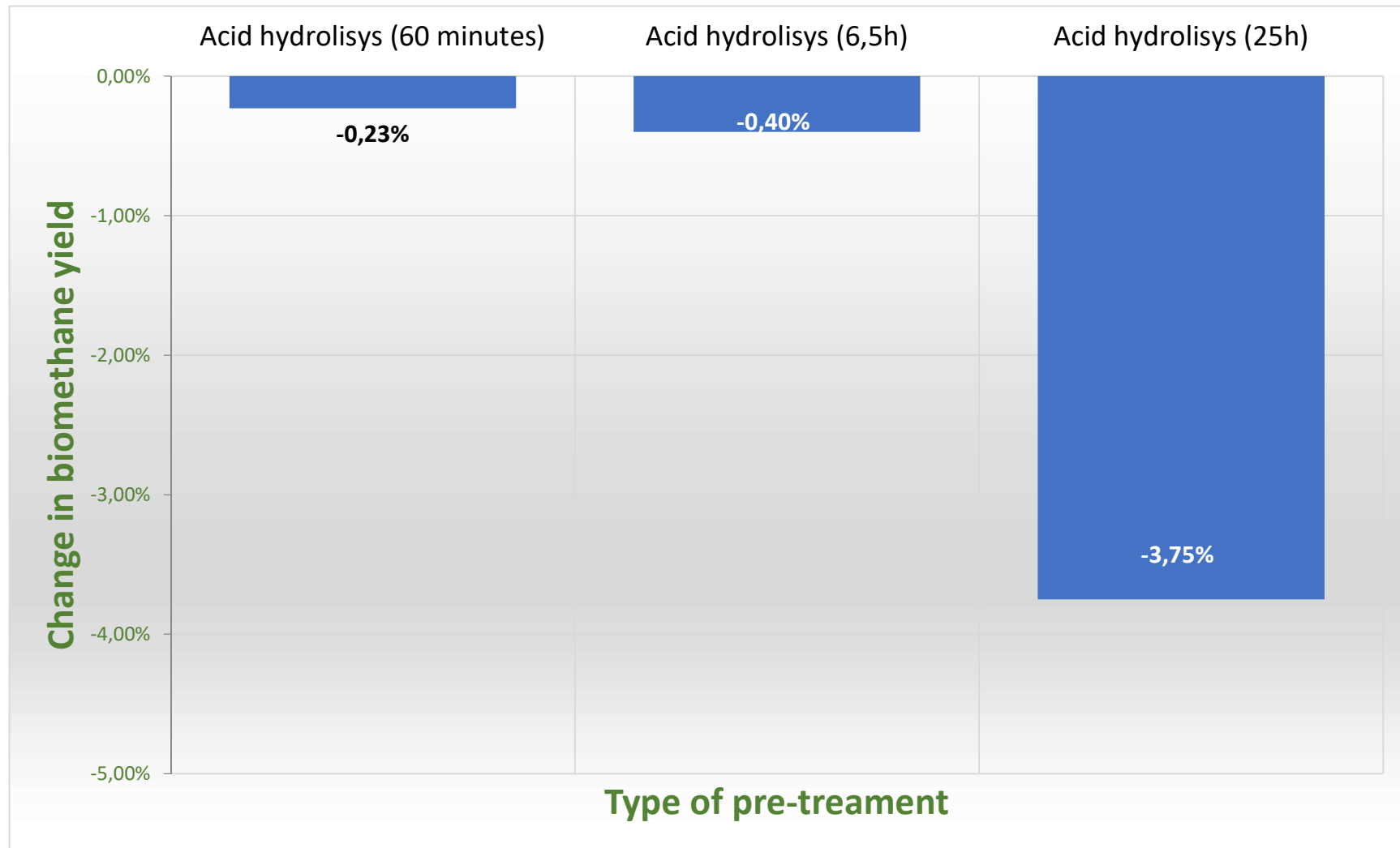


Funded by



European Regional Development Fund

Change in biomethane yield for acid pre-treatment in comparison to untreated seaweed



Partners

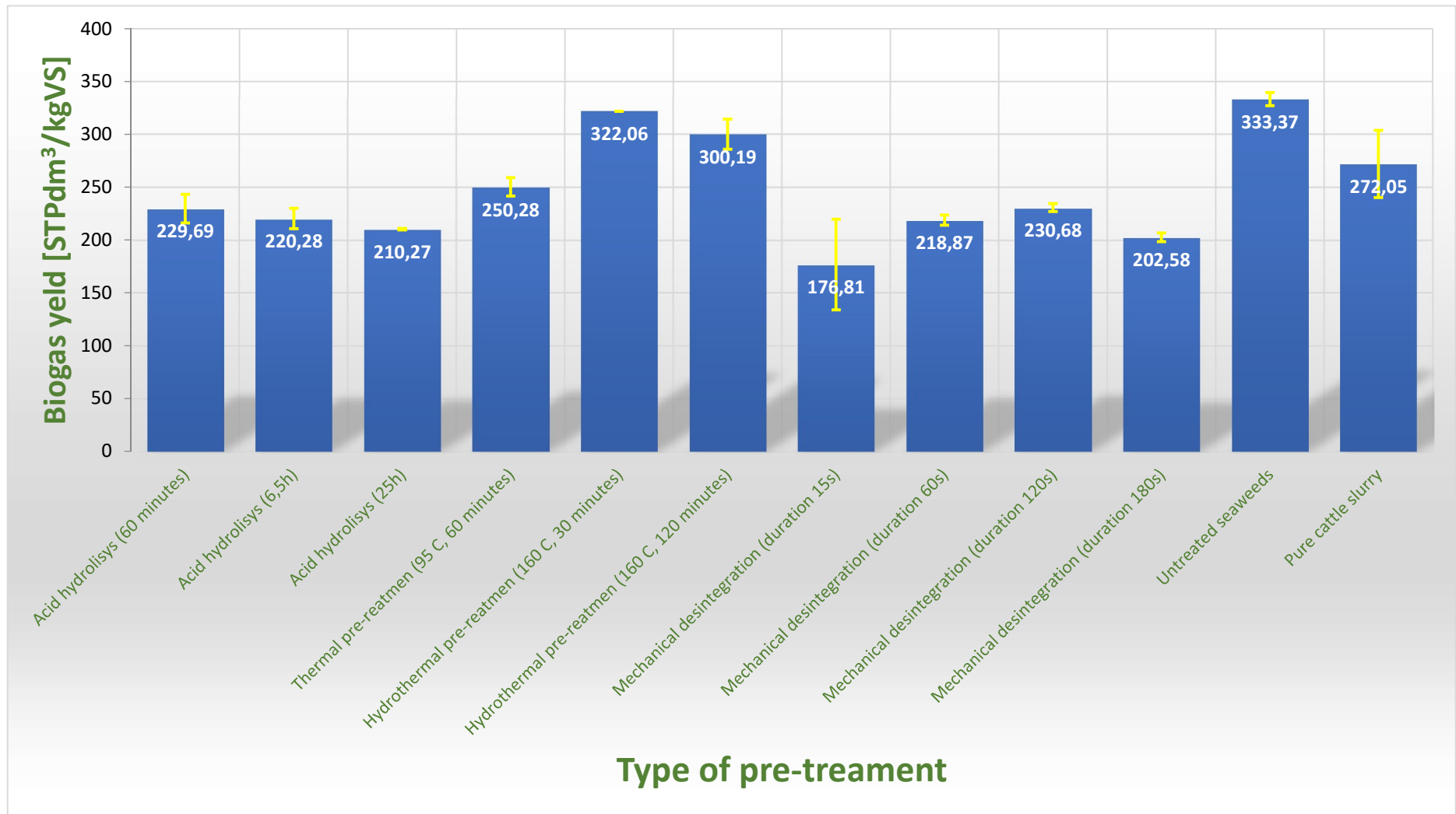


Funded by



European Regional Development Fund

Biogas yield for different types of pre-treatment



Partners

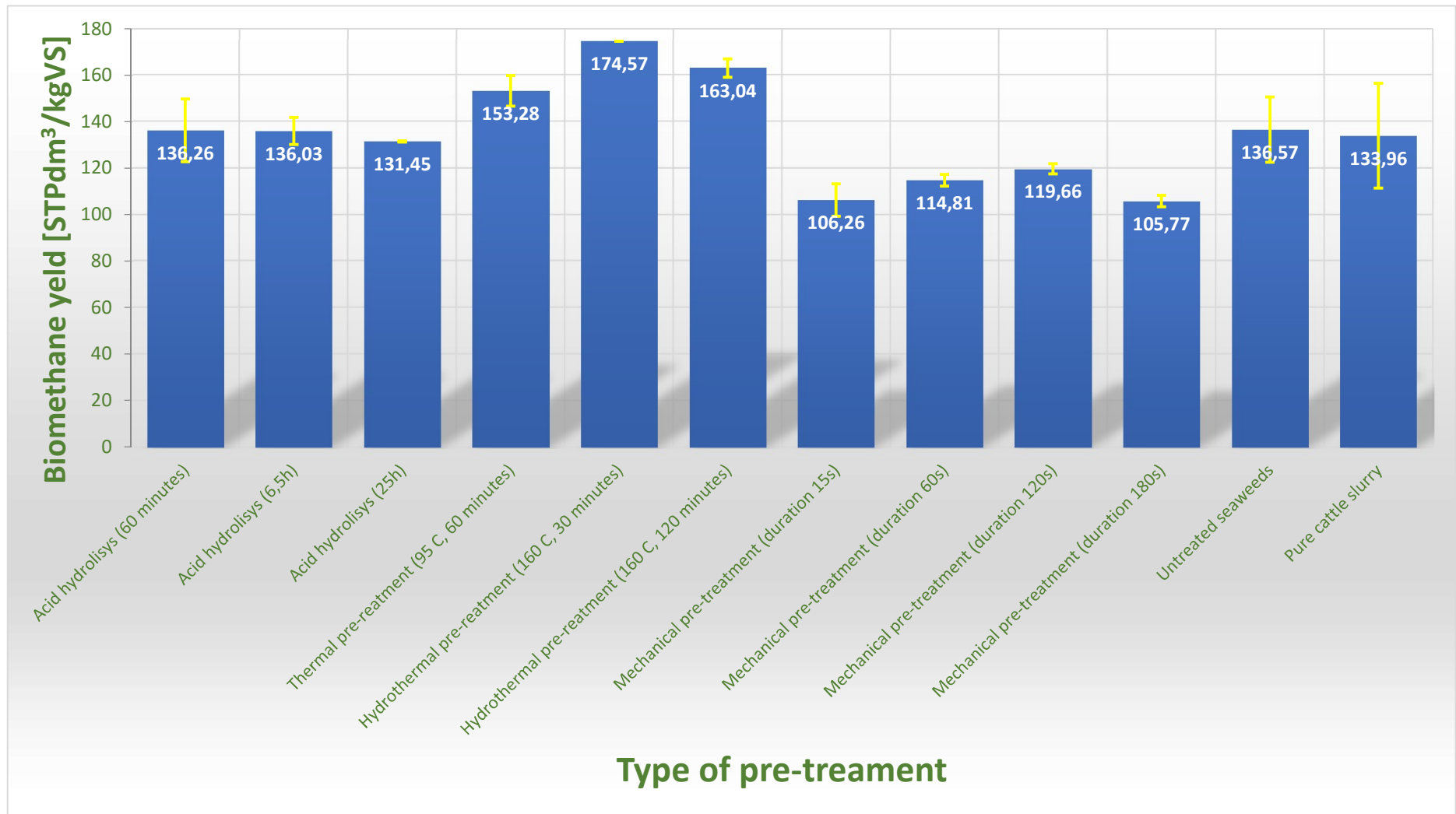


Funded by



European Regional Development Fund

Biomethane yield for different types of pre-treatment



Partners

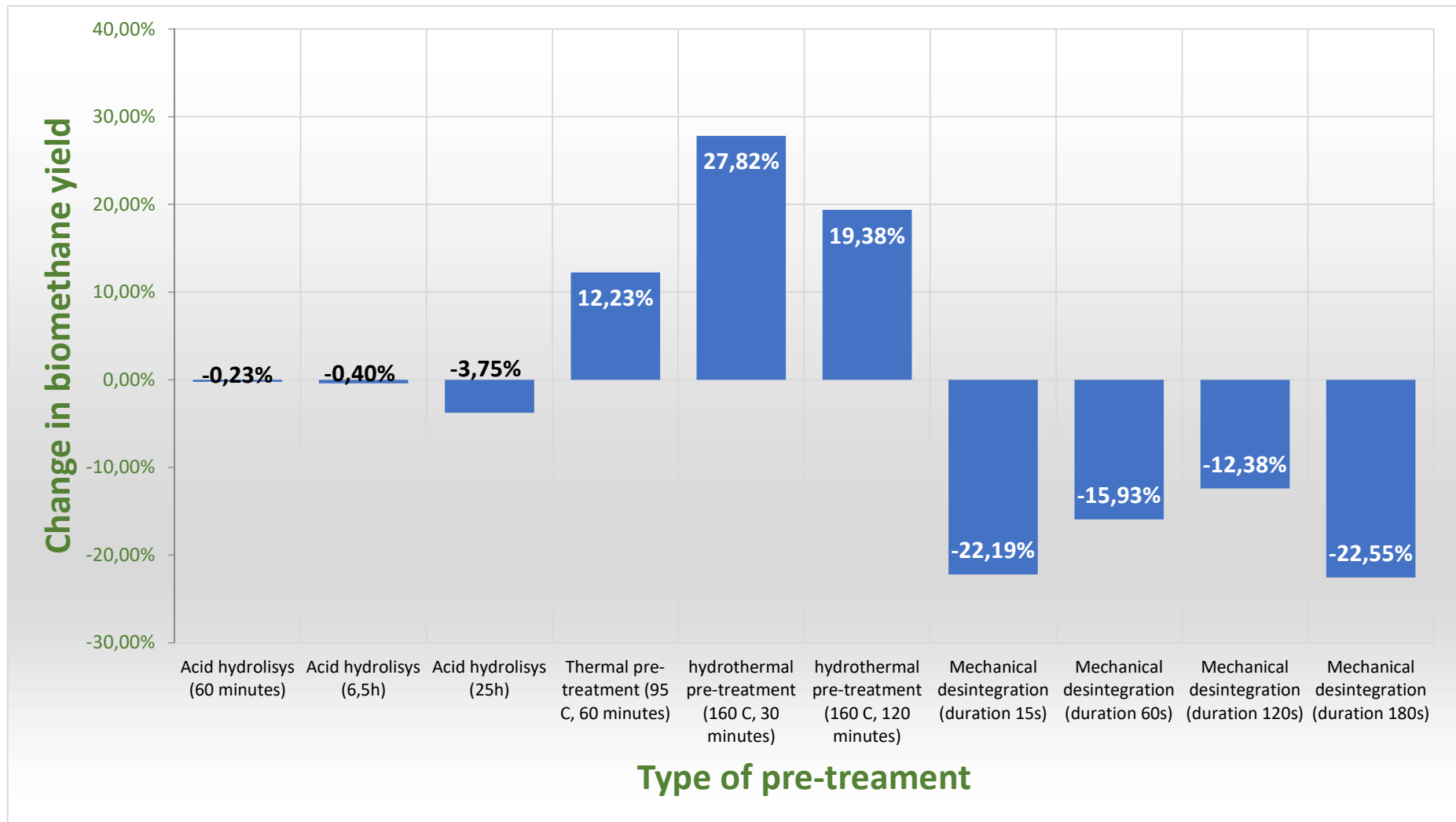


Funded by



European Regional Development Fund

Change in biomethane yield compered to untreated seaweed



Partners



Universität Rostock



Funded by



European Regional Development Fund

Summary



- Sand separation is more effective in an acidic solution (pH 2)
- Mechanical grinding of marine biomass reduces the efficiency of sand separation in both acidic and neutral solutions
- Hydrothermal pre-treatment shows the highest biomethane yield increase compared to untreated seaweed and pure cattle slurry (12-27%).
- Mechanical pre-treatment results in decrease biogas and biomethane yield in the range from -22% to -12%.
- Biomethane yield achieved for acid pre-treatment did not change significantly in comparison to untreated seaweed. The change is in the range from -3.7% to -0.2%.

Partners



Universität
Rostock



Funded by



European
Regional
Development
Fund

Thank you!

The Coastal Biogas project was co-financed by the European Regional Development Fund under the Interreg South Baltic 2014/2020 programme (contract no. STHB.02.02.00-DE-0129/17-00), the Ministry of Education and Science Republic of Poland (contract no. 5013/SPB 2014-2020/2019/2) and Gdańsk University of Technology.



Ministry
of Education
and Science

Partners



Universität
Rostock



Funded by



European
Regional
Development
Fund