The Baltic Beach Wrack Thermal Recovery And Relevant Analytical Performances - Case study overview No. 5

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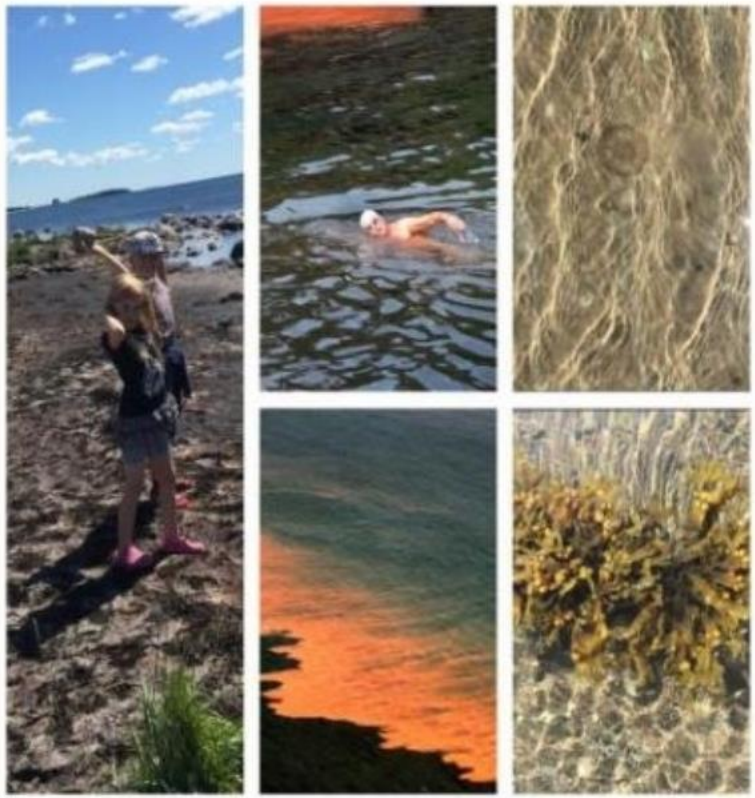
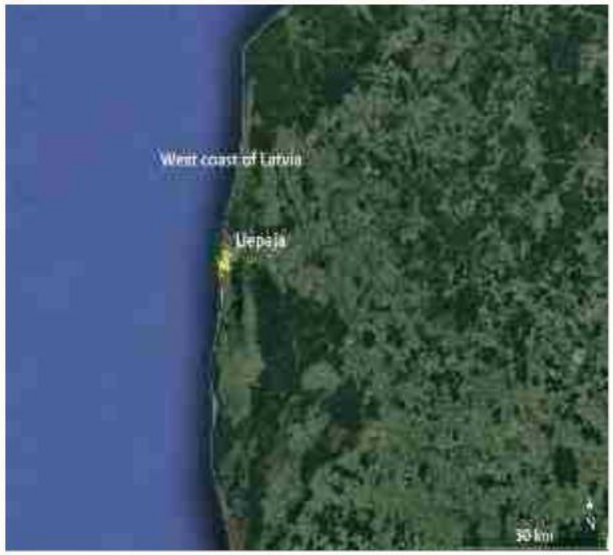
How vary beach wrack in time?



- Beach wrack is the accumulation of organic material that is washed up onto the beach by the **tides, wind** and **waves** that eventually breaks down and is recycled back into the system (Macredie et al. 2017)

Sampling locations

- Stenåsa, South-Eastern Öland and
- Vikegård: North-Eastern Öland, in June 2019
- Riga bay: Jaunkemeri, Bigauņciems, Ragaciems
- West coast of Latvia: Liepaja



Location of sampling sites: Öland, Latvia Bay and (b) west coast of Latvia (June 2019)

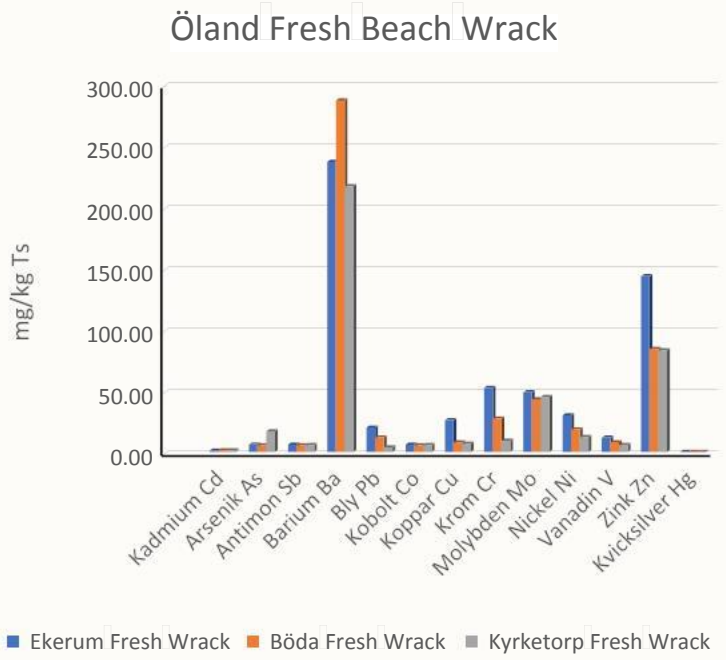
Beach Wrack harvesting - Emissions??

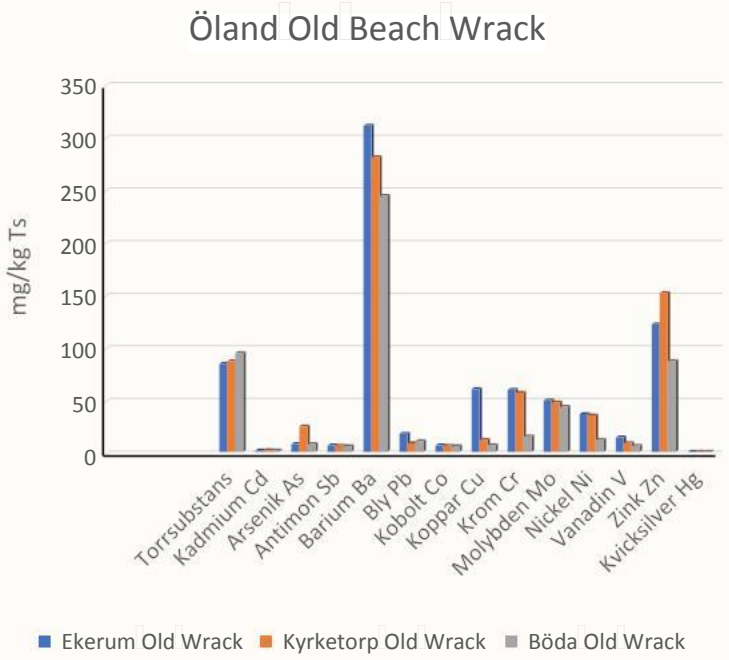
Managed beach: Böda beach - March 29th, 2020

Partly managed beach: Ekerum, type of bays, April 2020

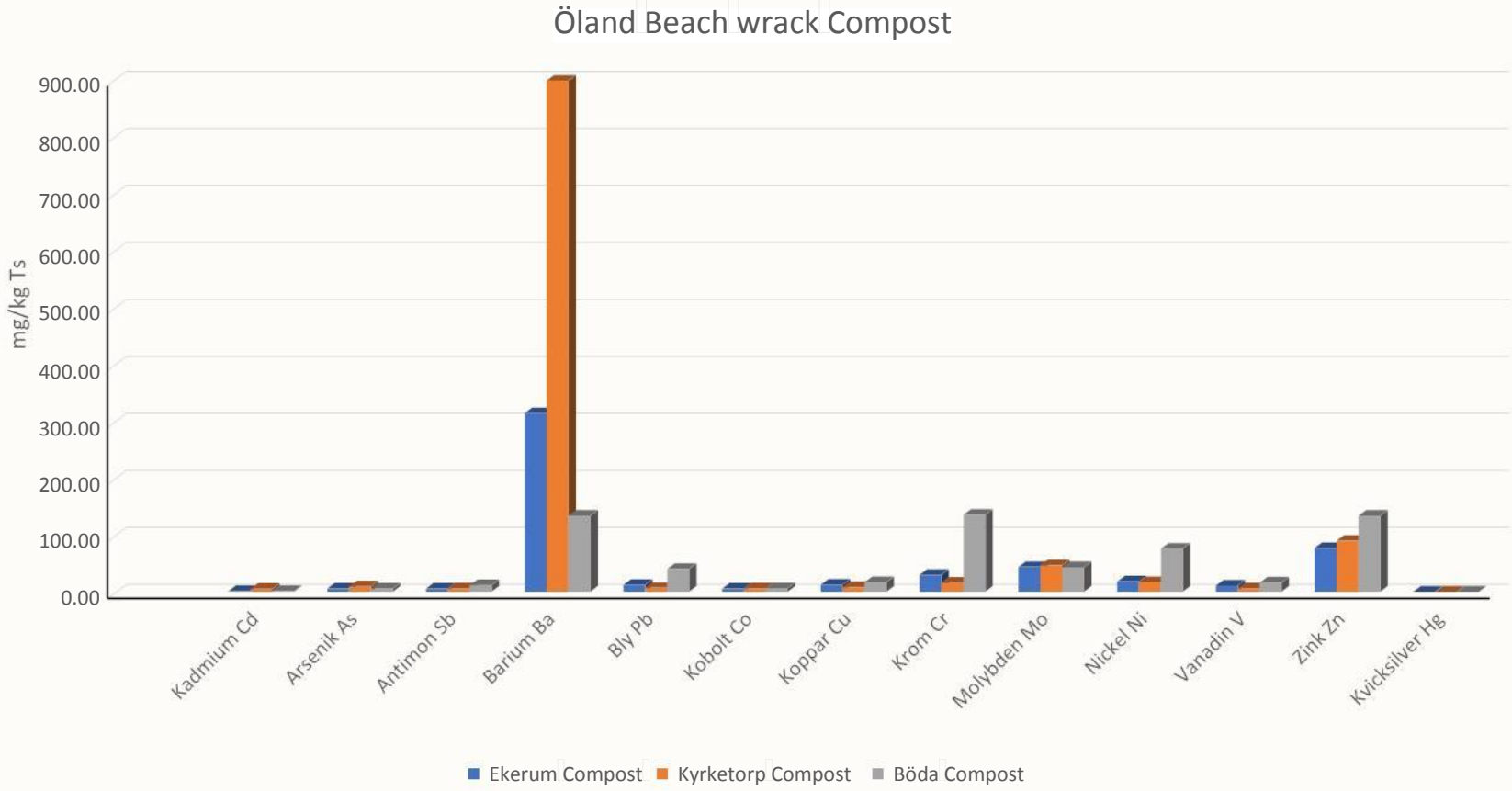
Metal analysis

Algae metal analysis: Fresh wrack Vs Old wrack

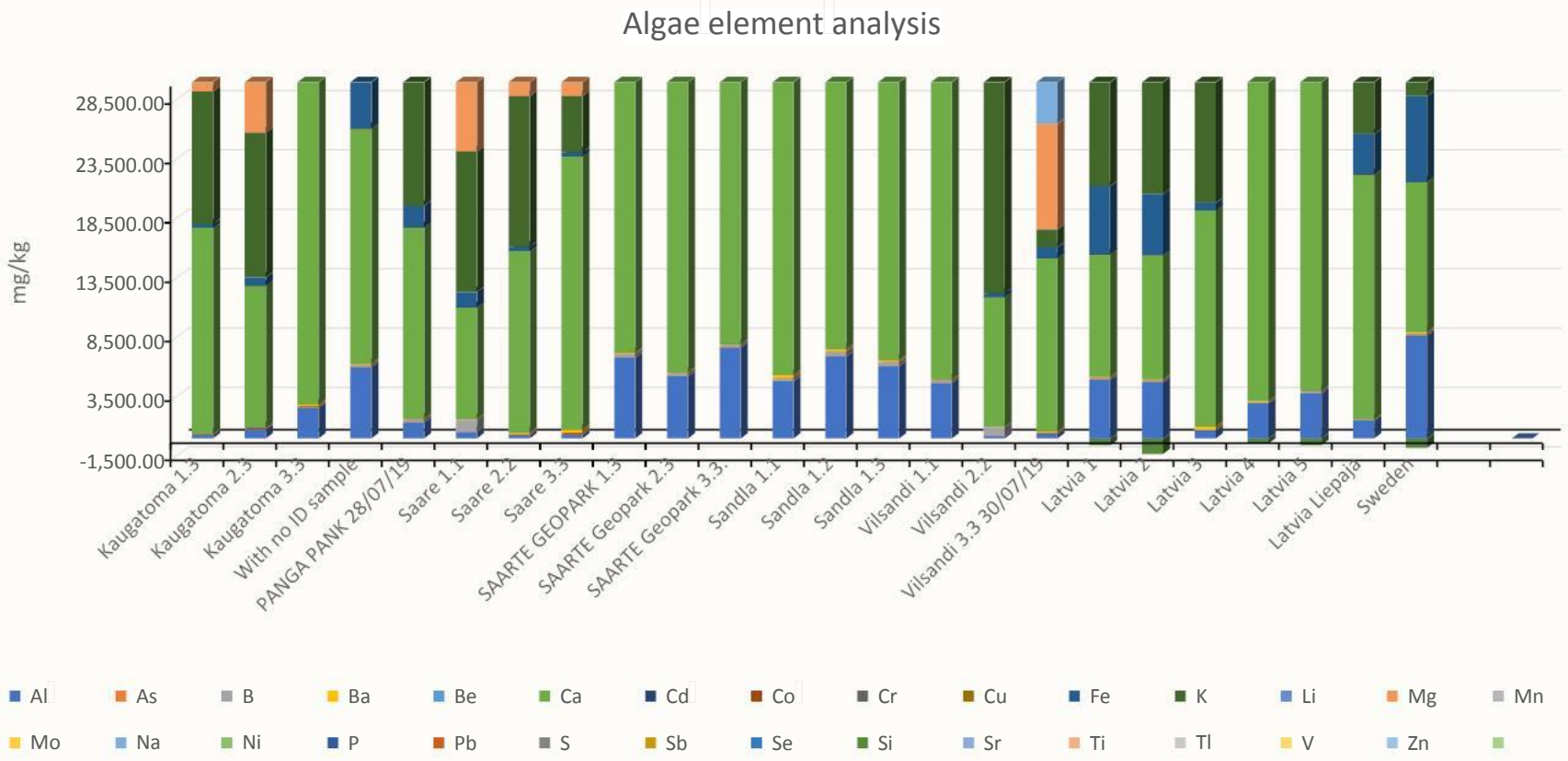




Compost-storage hills on the beaches



Algae element analysis from multiple regions



Gathering beach wrack to compost and soil amendment

A washed up computer monitor lies on the shore!

The main assumption of the study

- Energy recovery of the beach wrack accumulations along shore. (Much is lost)

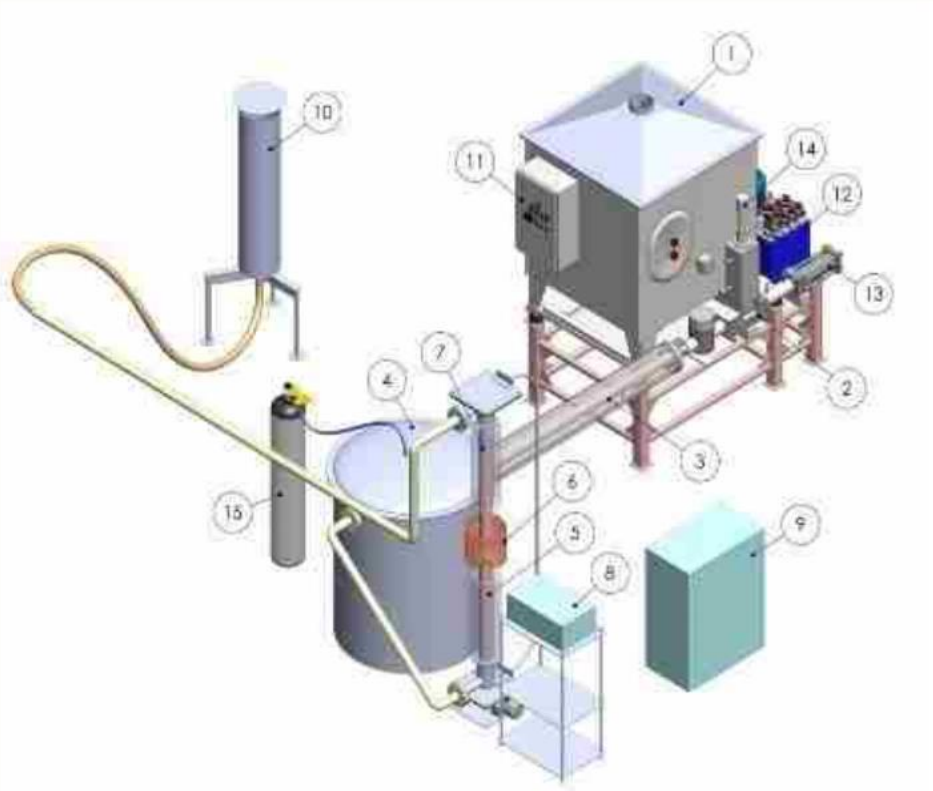
- To perform preliminary analysis to use beach wrack collected from the Baltic Sea region, as a feedstock for the production of bio covers, soil amendments or biogas/biochar.

- This study contribute to circular economy and bio-waste reduction through recycling /processing of the blue biomass waste.

Left: Gasification unit with feeding system, pyrolysis chamber, gas cracking and gas measurement equipment. Right: Beach wrack drying and loading for gasification.

1 – Case study progress (2/2)

Experimental gasification plant



- 1. Feedstock bunker
- 2. Hydrolic press feeder
- 3. Heated extruder
- 4. Gas and char accumulation tank
- 5. Secondary gas cracking
- 6. External inductive heater
- 7. Gas cooler
- 8. Inductive heater resonator
- 9. Inductive heater power box
- 10. Flare
- 11. Control cabinet
- 12. Hydrostation
- 13. Hydrocilinder
- 14. Prior hydropresser box
- 15. Nitrogen balloon

The Gasification reactor is located at University of Latvia https://www.beachwrack-contra.eu/alrea/

Heating values of the beach wrack

HHV MJ/Kg **8.96**,
LHV MJ/Kg **7.55**

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Proximate composition (%) of the beach wrack sample from Stenåsa (N_2, 20C°/min)

- Moisture (w%) **7.4**

Volatile matter (w%) **20.4**
Ash (w%) **33.9**

Samples were dried from the initial 80% moisture to 20% moisture content by weight of the wet substance

Results of the studies

- The coast washed beach wrack, small amount of methane can be generated per dry rganic matter in absence of pretreatment and conditioning of the samples.

- Washing of brown algae as pretreatment for anaerobic fermentation avoid salts inhibition and thus can make good use of biomethane production.
- Proximate composition has a low content of volatile mater, significant content of fixed carbon and very high content of ash.
- Beach wrack is suitable as a feedstock for the production of biochar and gasification application.

Biogass production from beach wrack

Sample	TS% of wet	VS% of wet	Ash% of TS	C% of TS	H% of TS	N% of TS	O% of TS	C: N
A. nodosum	23.2	19.4	16.1	40.4	5.3	1.6	36.6	26.0
H. elongata	12.65	8:10	36.0	30.8	4.1	1.4	27.7	21.4
L. digitata	14:20	10:34	27.2	34.2	4.8	1.5	32.3	22.3
F. spiralis	19.72	13.92	29.4	36.1	4.7	2.1	27.7	17.3
S. latissimus	15:49	10:09	34.9	29.1	3.8	1.2	31.0	24.0
A. esculenta	18.72	11.91	36.4	29.3	4.2	1.9	28.2	15.5
U. lactuca	18:03	10.88	39.7	30.0	4.4	3.5	22.4	8.5

Specific methane yields

Algae	CH4 / kgVS	Country	Reference
Brown algae			
H. elongata	261	Ireland	Allen et al. 2015
H. elongata	202	United Kingdom, France	Jard et al., 2013
L. digitata	218	Ireland	Allen et al. 2015
L. digitata	246	Ireland	Vanegas and Bartlett, 2013
F. serratus	96	Ireland	Allen et al. 2015
S. latissimus	342	Ireland	Allen et al. 2015
S. latissimus	335	Ireland	Vanegas and Bartlett, 2013
S. latissimus	223	Norway	Vivekanand et al., 2011
S. latissimus	220	Norway	Østgaard et al., 1993
S. latissimus	209	United Kingdom, France	Jard et al., 2013
A. nodosum	166	Ireland	Allen et al. 2015
U. pinnatifida	242	United Kingdom, France	Jard et al., 2013
S. polyschides	255	Ireland	Vanegas and Bartlett, 2013
S. polyschides	216	United Kingdom, France	Jard et al., 2013
P. palmatum	279	United Kingdom, France	Jard et al., 2013
G. verrucosa	144	United Kingdom, France	Jard et al., 2013

Anaerobic fermentation results

The sample indicates quite substantial presence of coastal reed besides red and brown as well as minor presence of green algae. **Moisture content 63%** as received, **ash content 22.1%** and **volatile 58.2%.**

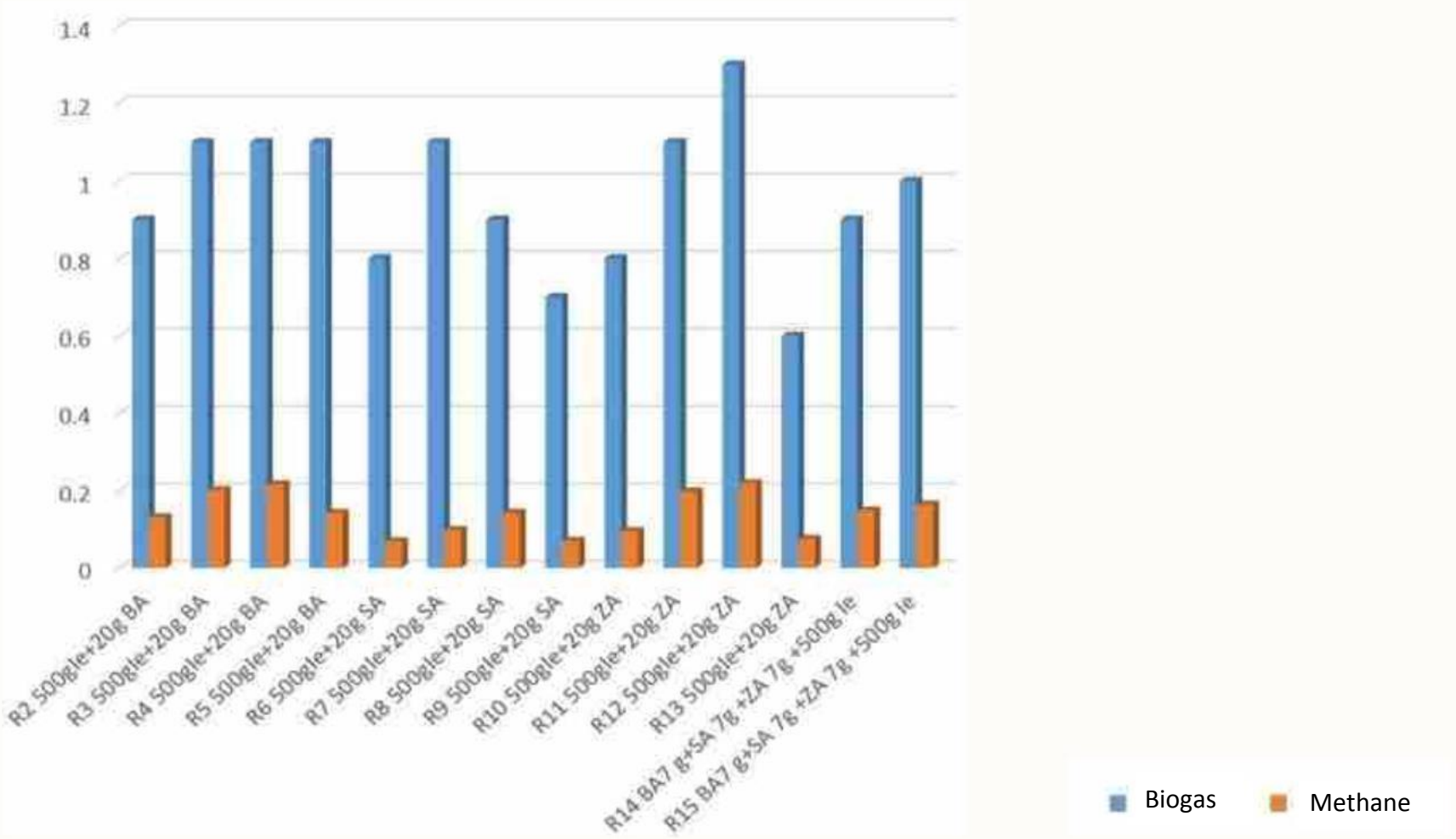
Equipment (1)

Biogas production amount was investigated using laboratory equipment consisting of 16 x 0.75 liter bioreactors. For digesters standard vessels were used. Continuous operating temperature was provided by the oven fan Universal oven (SNOL) - 2 pieces (Temperature up to 300°C, volume 300 l, electronic controls, stainless steel).

Dry matter was determined by dry weight Shimazu at 120°C temperature.

Organic matter composition by drying oven Nabertherm assistance, drying of samples for special programs at 550°C.

Biogas and methane by separate bioreactor



Gasifiction of beach wrack

- Suitable for production of biochar and gasification. Based on the gas waste gasification tests beach wrack is suitable for use for gasification.

- The quality of the char and synthesis gas produced is consistent with the original concept of gasification biomass.

- Beach wrack have much higher ash content than other biomass

- Presence of high concentration of inorganics require proper gasification process conditions.

Elemental analysis of gasification char

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Sample	Moisture, %	Organics, %	Carbonates, %	Inorganics, %
GasificationChar	18.51	63.25	7.07	29.68

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As	B	Ba	Be	Ca	Cd	Co	Cr	Cu
8.10	102.78	264.24	<0.01	33597.90	<0.1	3.08	14.62	8.97

Fe	K	Li	Mg	Mn	Mo	Na	Ni	P
6156.03	21211.51	3.10	8059.73	2948.76	1.13	10168.85	171.13	3281.32

Pb	S	Sb	Se	Si	Sr	Ti	Tl	V	Zn
2.44	18615.16	7.81	<3	233.58	739.72	24.60	2.79	1.88	74.2

Metals expressed in mg/kg from ds

Energy potential

- High concentration of sand in beach collected feedstock and the economical and logistical arguments gain higher importance in choice of upscale methods.

- High level of methane has been quite specific and unique in the course of the tests.

It may be attributed to specific pressure and indirect heating conditions which deserves further analysis by applying repetitive test runs with larger amount of the feedstock to gain more continuous process.

It may have far reaching new opportunities for small scale distributed beach wrack utilization systems in the region

- Local Biocoal Reactor

Mixer for Bottom sediment, Biochar and Beach Wrack

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