Carbon Neutral is our Business

Case Study 2: Beach Wrack Conversion (BWC)

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a presentation by

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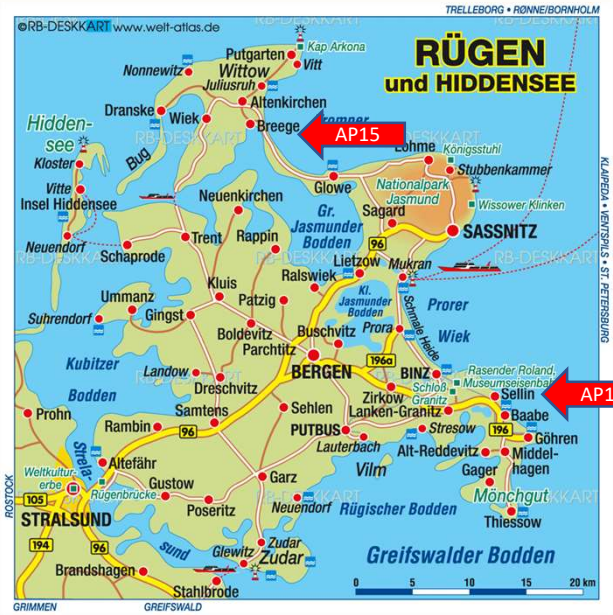
Case Study 2: Beach Wrack Conversion (BWC)

Case Study Area

Island of Rügen, MV, Germany



AP 15: Municipality of Breege / Juliusruh

AP 14: Municipality of Sellin

Main focus of CS2

Conversion of Beach Wrack to Biochar*

*: carbon neutral solid fuel or material resource made by carbonization of (fresh) biomass, in our case vapo-thermal carbonization

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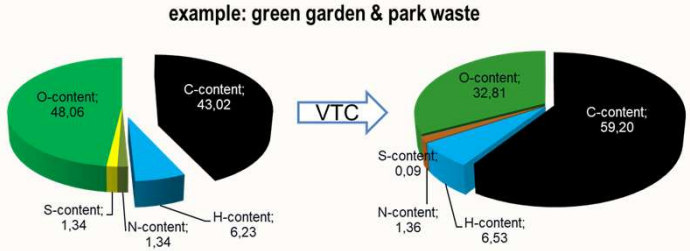
What is VTC and why?

VTC is a thermo-chemical process, it…

- increases carbon concentration in biomass
- works in saturated steam at 220°C and 23 bar
- imitates the natural formation of fossil coal (lignite, hard coal, etc.)
- needs around 3 - 4 h of reaction time
- works with every biomass tested so far



Biochar can be used…

- **to substitute fossil coal in energy production**
- to improve soil (better moisture holding capacity, more micro-organisms, longer storage of nutrients)
- as a raw material source for carbon products (pharmaceuticals, cosmetics, activated carbon, etc.)
- to prevent CO_2 and CH_4 leakage from decaying biomass (pyCCS – negative emissions)

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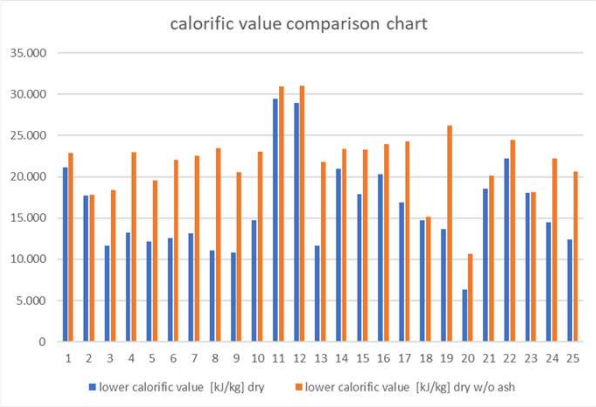
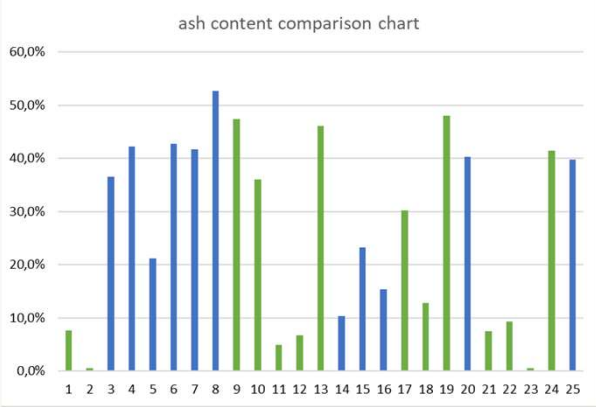
Bullet points done in CS2: BWC

- Experiments & observations in beach cleaning technology
- Evaluation of common equipment
- Carbonization of 25 samples (BW, BW components, other biomass)
- Laboratory analysis of samples (both biomass and Biochar)
- Assessment of available biomass for co-treatment
- Design of a VTC treatment plant for BW
- Development of business case (economical feasibility study)





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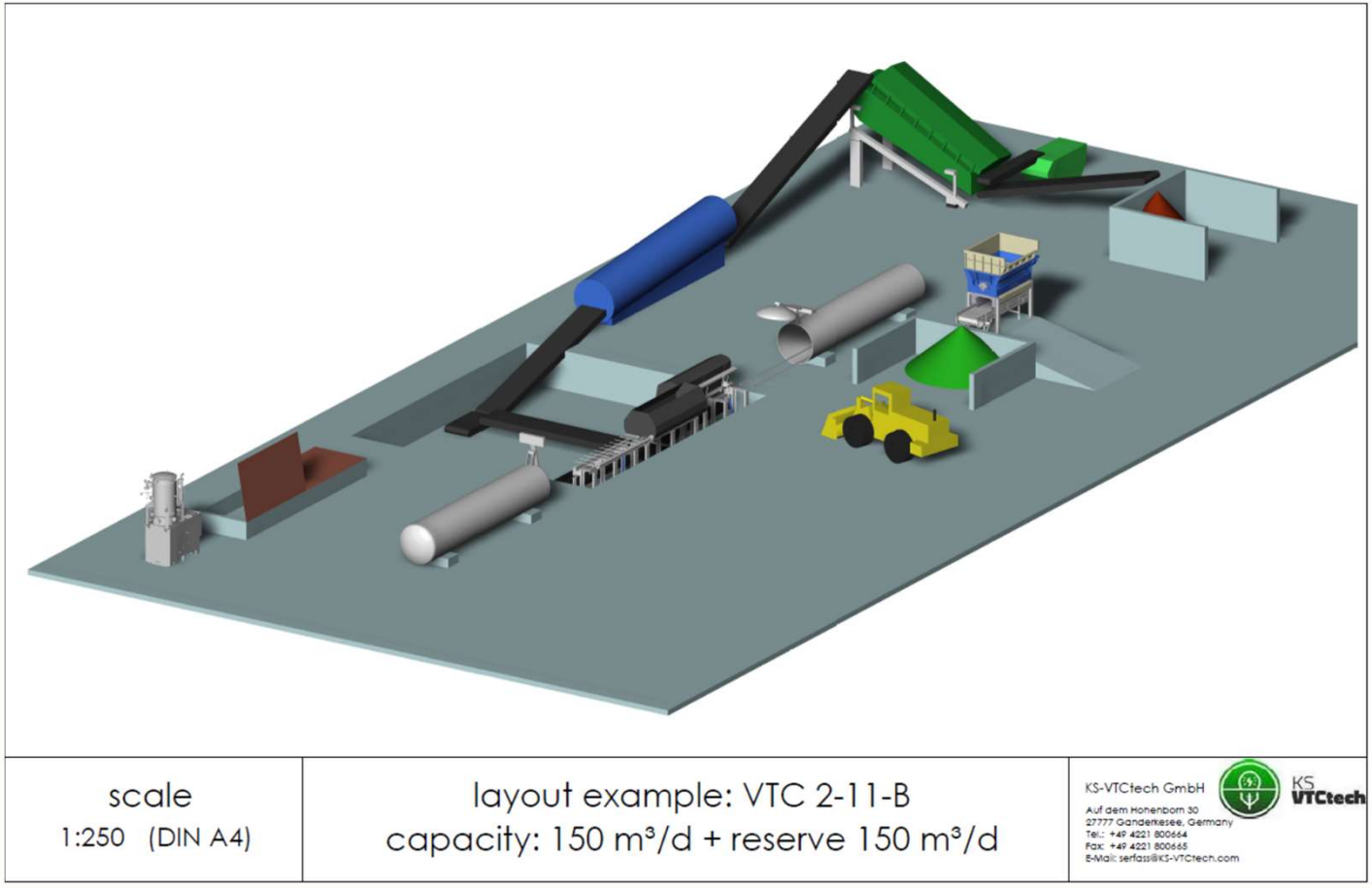

scale	layout example: VTC 2-11-B	KS-VTCtech GmbH
1:250 (DIN A4)	capacity: 150 m³/d + reserve 150 m³/d	Auf dem Hohenborn 30 27777 Ganderkesee, Germany Tel.: +49 4221 800664 Fax: +49 4221 800665 E-Mail: serfass@KS-VTCtech.com

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Year of operation	unit	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Carbon emmission fee	[€/t CO2]	0 €	35 €	45 €	55 €	60 €	60 €	60 €	60 €	60 €	60 €	60 €	60 €	60 €
Annual price increase lignite	[%/a]	0%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Price for lignite	[€/t lignite]	75 €	77 €	78 €	80 €	81 €	83 €	84 €	86 €	88 €	90 €	91 €	93 €	95 €
Price for lignite incl. Emissions	[€/t lignite]	75 €	171 €	200 €	228 €	243 €	245 €	246 €	248 €	250 €	252 €	253 €	255 €	257 €
Discount on competing prices	[%]	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
Sales price for biochar	[€/t biochar]	53 €	120 €	140 €	160 €	170 €	171 €	173 €	174 €	175 €	176 €	177 €	179 €	180 €
Revenues from biochar	**[€/a]**		**836.967 €**	**976.608 €**	**1.116.400 €**	**1.190.267 €**	**1.198.214 €**	**1.206.320 €**	**1.214.588 €**	**1.223.022 €**	**1.231.624 €**	**1.240.398 €**	**1.249.347 €**	**1.258.476 €**
Annual gate-fee increase (biomass)	[€/a]		2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Gate-fee green & garden waste	[€/t biomass]	40 €	41 €	42 €	42 €	43 €	44 €	45 €	46 €	47 €	48 €	49 €	50 €	51 €
Gate-fee leftover food waste	[€/t biomass]	50 €	51 €	52 €	53 €	54 €	55 €	56 €	57 €	59 €	60 €	61 €	62 €	63 €
Gate-fee beach wrack	[€/t biomass]	50 €	51 €	52 €	53 €	54 €	55 €	56 €	57 €	59 €	60 €	61 €	62 €	63 €
Revenues from gate-fees	**[€/a]**		**816.000 €**	**832.320 €**	**848.966 €**	**865.946 €**	**883.265 €**	**900.930 €**	**918.949 €**	**937.328 €**	**956.074 €**	**975.196 €**	**994.699 €**	**1.014.593 €**
Total revenues	**[€/a]**		**1.652.967 €**	**1.808.928 €**	**1.965.366 €**	**2.056.213 €**	**2.081.479 €**	**2.107.250 €**	**2.133.537 €**	**2.160.349 €**	**2.187.698 €**	**2.215.593 €**	**2.244.047 €**	**2.273.069 €**
Annual increase (all costs)	[%/a]	0%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Financing of investment costs	[€/a]	-838.769 €	-294.988 €	-294.988 €	-294.988 €	-294.988 €	-294.988 €	-294.988 €	-294.988 €	-294.988 €	-294.988 €	-294.988 €	0 €	0 €
Heat energy	[€/a]	-222.891	-227.348 €	-231.895 €	-236.533 €	-241.264 €	-246.089 €	-251.011 €	-256.031 €	-261.152 €	-266.375 €	-271.702 €	-277.136 €	-282.679 €
Electrical energy	[€/a]	-97.200	-99.144 €	-101.127 €	-103.149 €	-105.212 €	-107.317 €	-109.463 €	-111.652 €	-113.885 €	-116.163 €	-118.486 €	-120.856 €	-123.273 €
Feed water for steam generator	[€/a]	-16.722	-17.057 €	-17.398 €	-17.746 €	-18.101 €	-18.463 €	-18.832 €	-19.209 €	-19.593 €	-19.985 €	-20.384 €	-20.792 €	-21.208 €
Waste water from VTC	[€/a]	-79.297	-80.883 €	-82.501 €	-84.151 €	-85.834 €	-87.551 €	-89.302 €	-91.088 €	-92.910 €	-94.768 €	-96.663 €	-98.596 €	-100.568 €
Maintenance costs	[€/a]	-134.000	-136.680 €	-139.414 €	-142.202 €	-145.046 €	-147.947 €	-150.906 €	-153.924 €	-157.002 €	-160.142 €	-163.345 €	-166.612 €	-169.944 €
Personnel costs	[€/a]	-105.000	-107.100 €	-109.242 €	-111.427 €	-113.655 €	-115.928 €	-118.247 €	-120.612 €	-123.024 €	-125.485 €	-127.994 €	-130.554 €	-133.165 €
Administration costs	[€/a]	-26.250	-26.775 €	-27.311 €	-27.857 €	-28.414 €	-28.982 €	-29.562 €	-30.153 €	-30.756 €	-31.371 €	-31.999 €	-32.639 €	-33.291 €
Other costs (insurance, etc.)	[€/a]	-48.795	-49.771 €	-50.766 €	-51.782 €	-52.817 €	-53.874 €	-54.951 €	-56.050 €	-57.171 €	-58.315 €	-59.481 €	-60.671 €	-61.884 €
Transport costs	[€/a]	0	0 €	0 €	0 €	0 €	0 €	0 €	0 €	0 €	0 €	0 €	0 €	0 €
Total costs	**[€/a]**	**-838.769 €**	**-1.039.747 €**	**-1.054.642 €**	**-1.069.835 €**	**-1.085.332 €**	**-1.101.139 €**	**-1.117.262 €**	**-1.133.707 €**	**-1.150.482 €**	**-1.167.591 €**	**-1.185.044 €**	**-907.857 €**	**-926.014 €**
Annual surplus	**[€/a]**		**613.220 €**	**754.287 €**	**895.531 €**	**970.881 €**	**980.340 €**	**989.988 €**	**999.829 €**	**1.009.867 €**	**1.020.106 €**	**1.030.550 €**	**1.336.190 €**	**1.347.056 €**
Cumulative surplus	**[€]**		**-225.549 €**	**528.738 €**	**1.424.269 €**	**2.395.150 €**	**3.375.490 €**	**4.365.478 €**	**5.365.307 €**	**6.375.175 €**	**7.395.281 €**	**8.425.831 €**	**9.762.021 €**	**11.109.077 €**
Treatment costs per t of biomass (without consideration of gate-fee and biochar sale)			**-55 €**	**-56 €**	**-56 €**	**-57 €**	**-58 €**	**-59 €**	**-60 €**	**-61 €**	**-61 €**	**-62 €**	**-48 €**	**-49 €**
Overall treatment costs per t of biomass with consideration of gate-fee and biochar sale			**32 €**	**40 €**	**47 €**	**51 €**	**52 €**	**52 €**	**53 €**	**53 €**	**54 €**	**54 €**	**70 €**	**71 €**

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Lessons learned

Beach cleaning

- needs to be improved
- available machines remove too much sand OR do not clean efficiently
- biggest problem: large variety of BW

BW as a raw material for VTC

- should contain only little sand
- should be stored dry to avoid decay
- can be co-treated with other biomass
- leads to good Biochar calorific value IF only little sand is included

Vapo-thermal Carbonization (VTC) of BW

- works like every other biomass
- can produce good quality Biochar
- can be an ecologically sound disposal solution
- is economically feasible IF
  - other biomass (green & garden waste, leftover food, organic waste, etc.) is available for co-treatment (seasonality, small amount of BW)
  - and combustion of fossil fuels becomes more expensive (carbon emission price!)

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Thank you very much for your attention!