Added value through carbon sequestration in agriculture

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Introduction

What if we could sequestrate carbon and at the same time:

- **empower renewable energy,**
- **increase agriculture efficiency and**
- **rise local value creation?**

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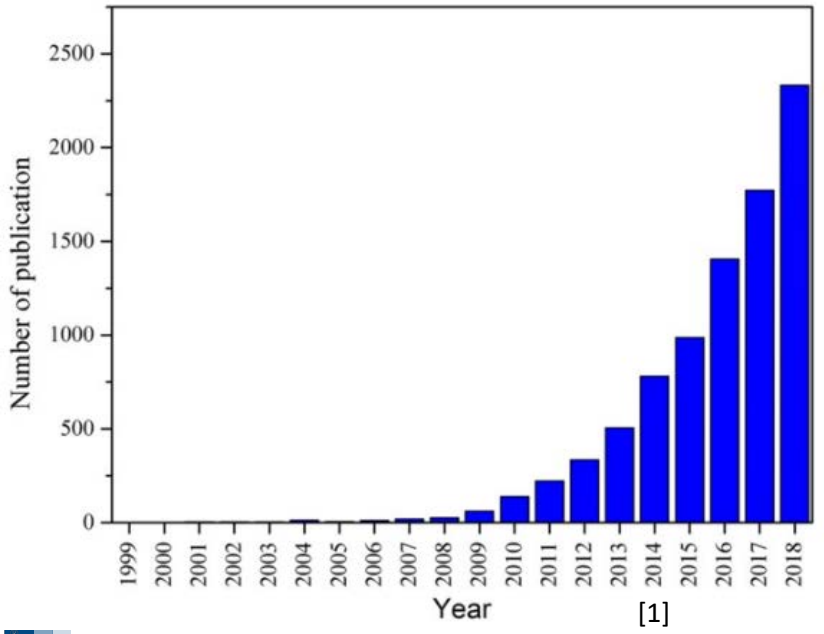
Introduction

- Currently, the production and use of biochar is experiencing a renaissance.
- The science is working hard in this field. In 2018 more than 2000 biochar-related papers were published. *[1]*
- A great value is placed on regional and regenerative products, using biochar.



[1]

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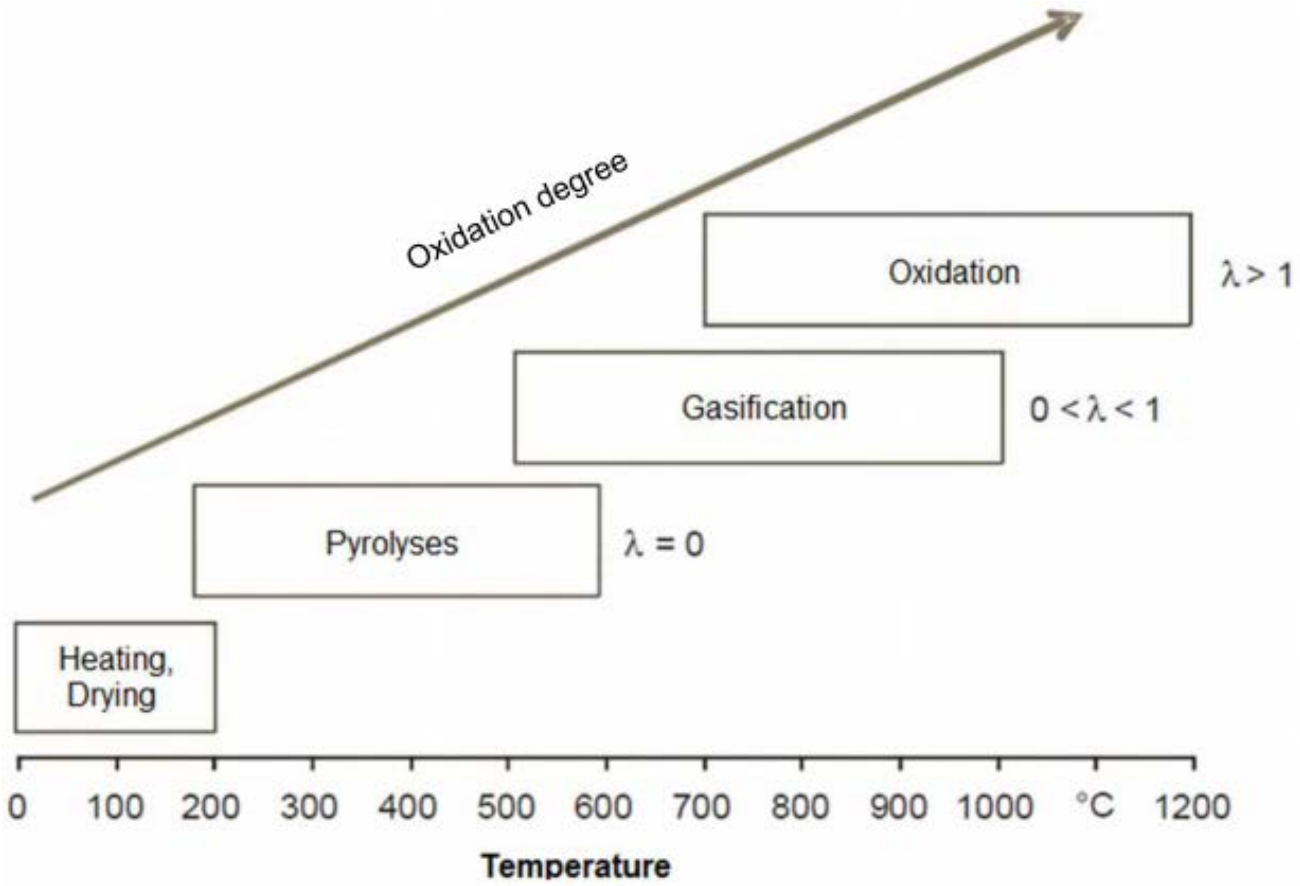
Production Processes of Biochar



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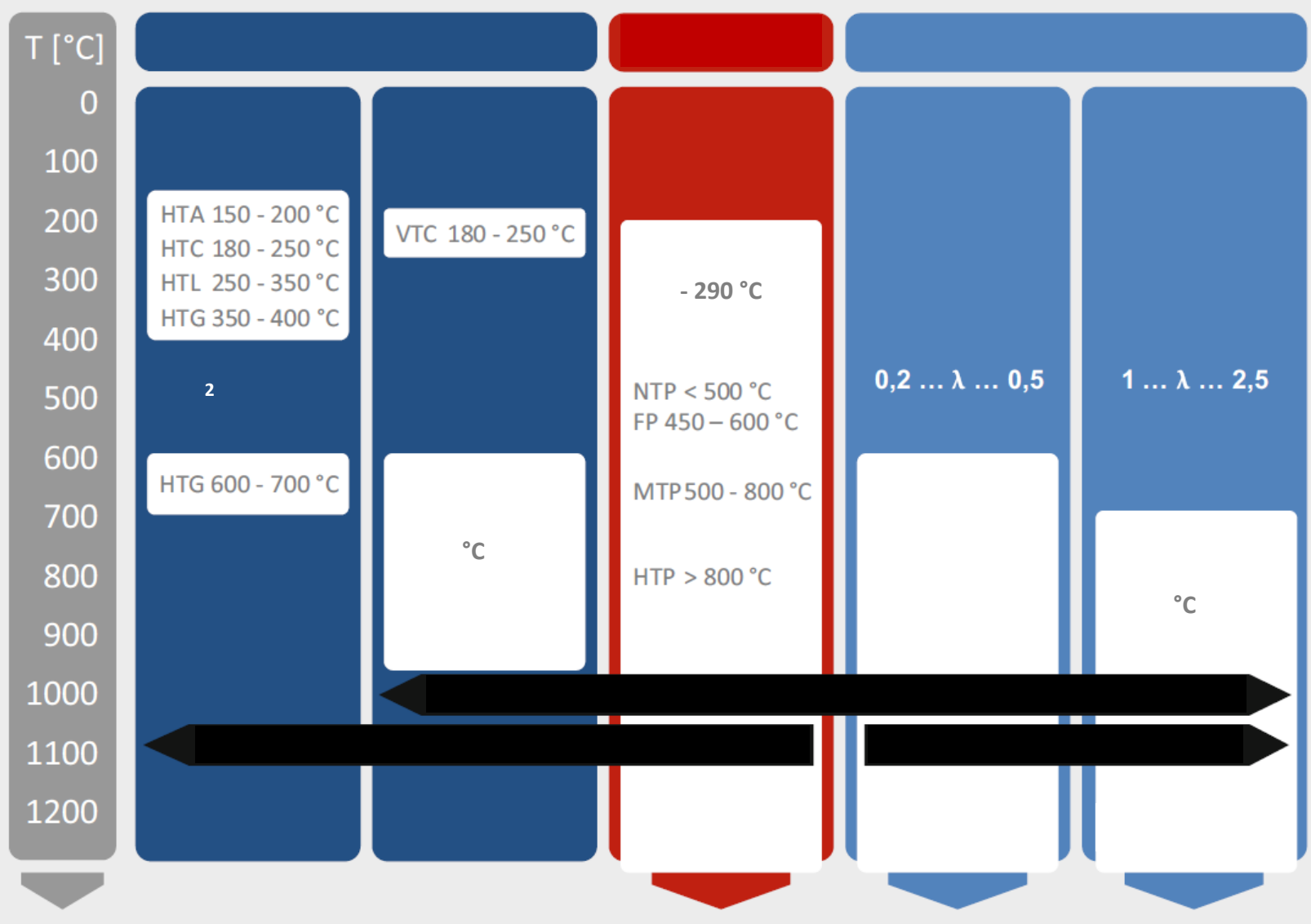
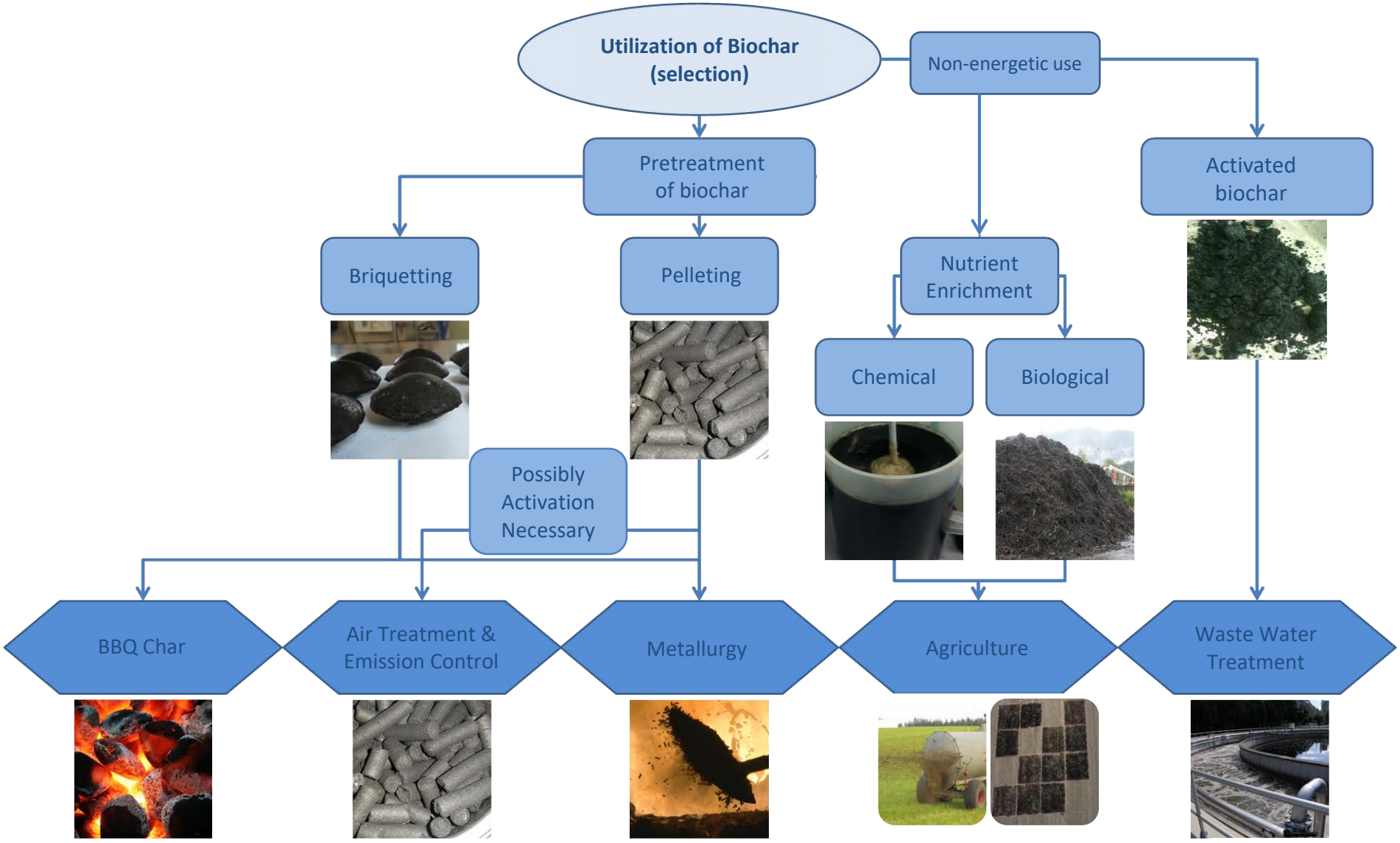
Production Processes of Biochar



modified from [6]

Utilization of Biochar at MCI



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Utilization of Biochar – Agriculture

Agriculture

Motivation:

Emissions

- Odor:
  - Quality of life
  - Potential conflicts
  - Brand Tirol
- NH_4^+
  - Treatment of causes instead of symptoms
  - NEC-directive

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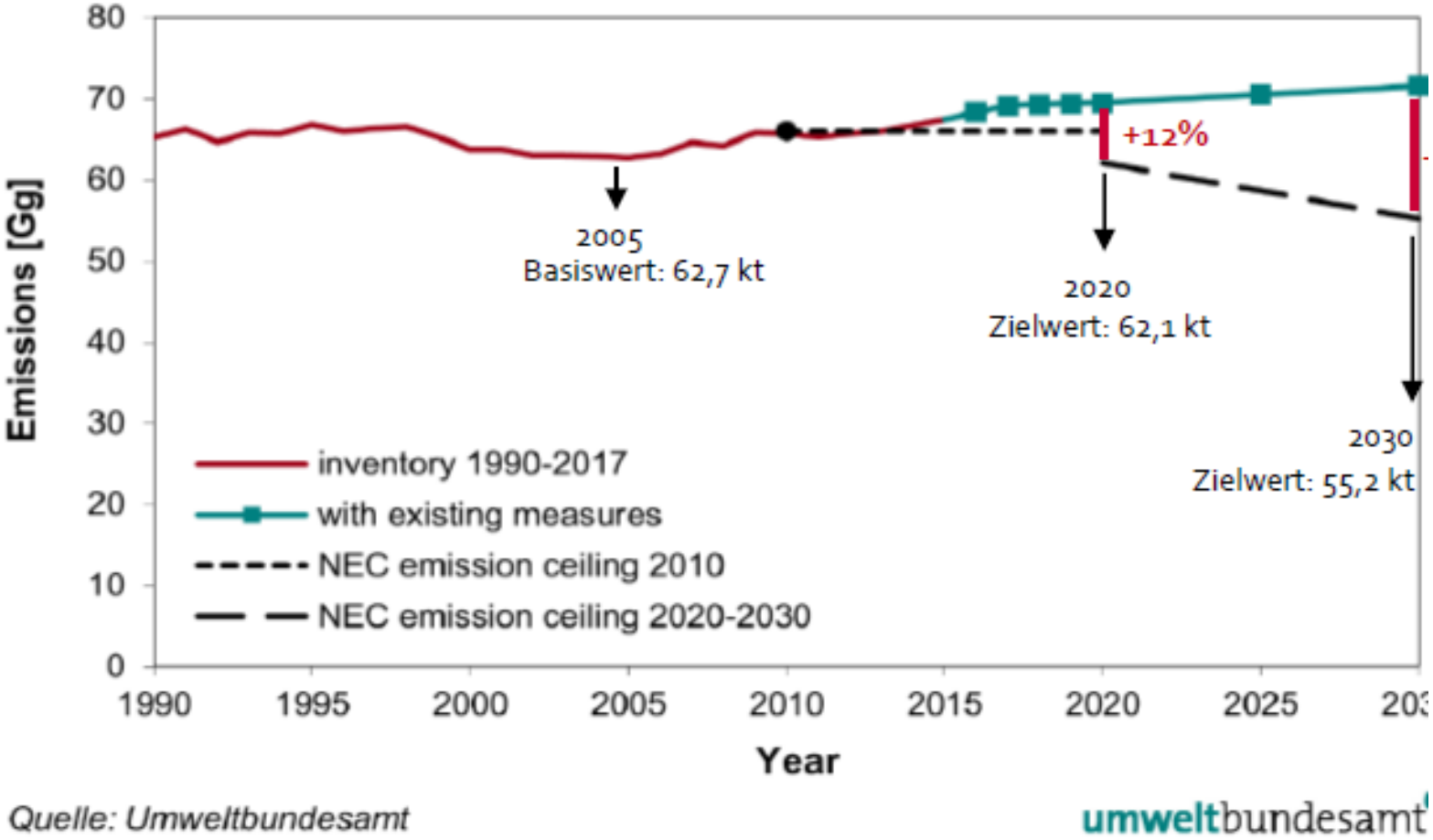
Utilization of Biochar – Agriculture

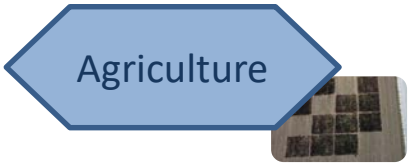
Agriculture



Quelle: Umweltbundesamt

umweltbundesamt

Utilization of Biochar – Agriculture



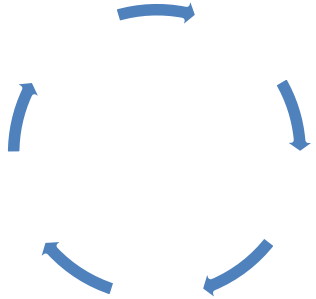
Motivation:

Emissions

- Odor:
  - Quality of life
  - Potential conflicts
  - Brand Tirol
- NH_4^+
  - Treatment of causes instead of symptoms
  - NEC-directive

Added Value

- Nutrient retention
- Byproduct of Renewable energy production
- Forest management
- Employment
- Carbon sequestration
- Circularity



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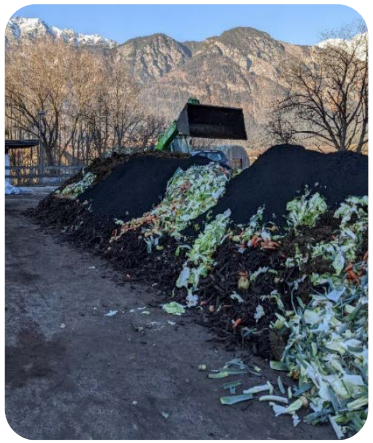
Utilization of Biochar in Agriculture (Composting)

Agriculture

Results of practical application

- Easy production of compost (no dust emission; no extra handling)
- Can be easily applied on fields with existing machinery
- No loss of yield detected once applied during compostsing[1]
- A+ (Bio) Certification possible (according national guidelines)
- Carbon sequestration of 2,6 t CO_2 per ha/a possible[2] [10]



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[1] Other studies clame an increase in yield of in average 13%. [15]

[2] Qualitative calculation: 15 m% TS of biochar with 20 m% ash content in compost. Application of 8 t/ha and a. This calculation includes a yearly decrease of 0,3% C for 100 years. [10] Transport and other side-emissions not included.

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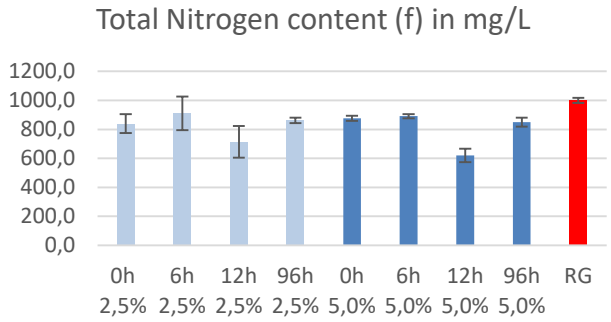
Utilization of Biochar

Agriculture

Examples of Results at MCI and Literature:

- **N-Storage** out of liquid manure with gasifier-biochar
  Mean: 18 %
- Adsorption of NH_4^+- N is possible *[7]*
  Up to 45 mg/g-Biochar
- Odor reduction is determined with olfactometry but no reduction of ammonia detected *[9]*
- Biochar with high pH (<9) increase ammonia volatilization (AV) greater surface area initially reduce AV *[8 – meta analysis]*



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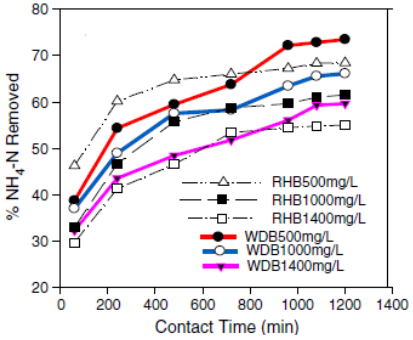

[7]

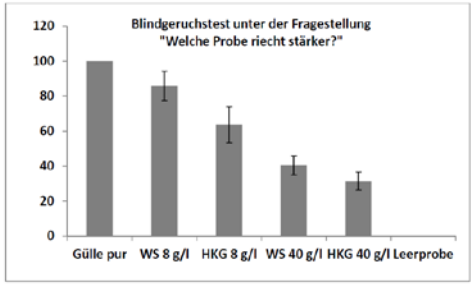

Abbildung 4. Blindgeruchstest mit Gülleansätzen mit und ohne Kohle (n =25)

[9]

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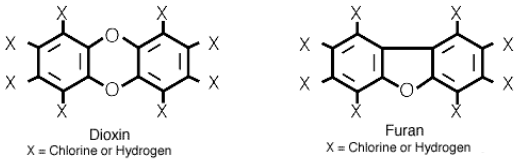
Utilization of Biochar

Agriculture

Parameters which make the difference

- Input material, process conditions
- pH, Water Content, Fixed Carbon Content c_{Fix}, Organic Carbon Content $c_{org.}$
- Nutrients and Distribution, Particle Size, Particle Distribution
  - BET: Brunauer-Emmett-Teller surface area analysis &
  - BJH: Barrett-Joyner-Halenda pore size and volume analysis
- Contaminations:
  - Organic: PAH, PCDDs, PCDFs
  - Inorganic: Heavy metals (Pb, Cd, Hg,…)



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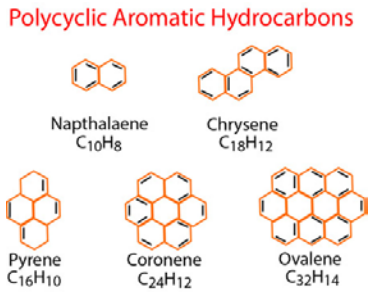

[11]

[12]

PAH: Polycyclic aromatic hydrocabons
PCDD: Polychlorinated dibenzodioxins
PCDF: Polychlorinated dibenzofurans

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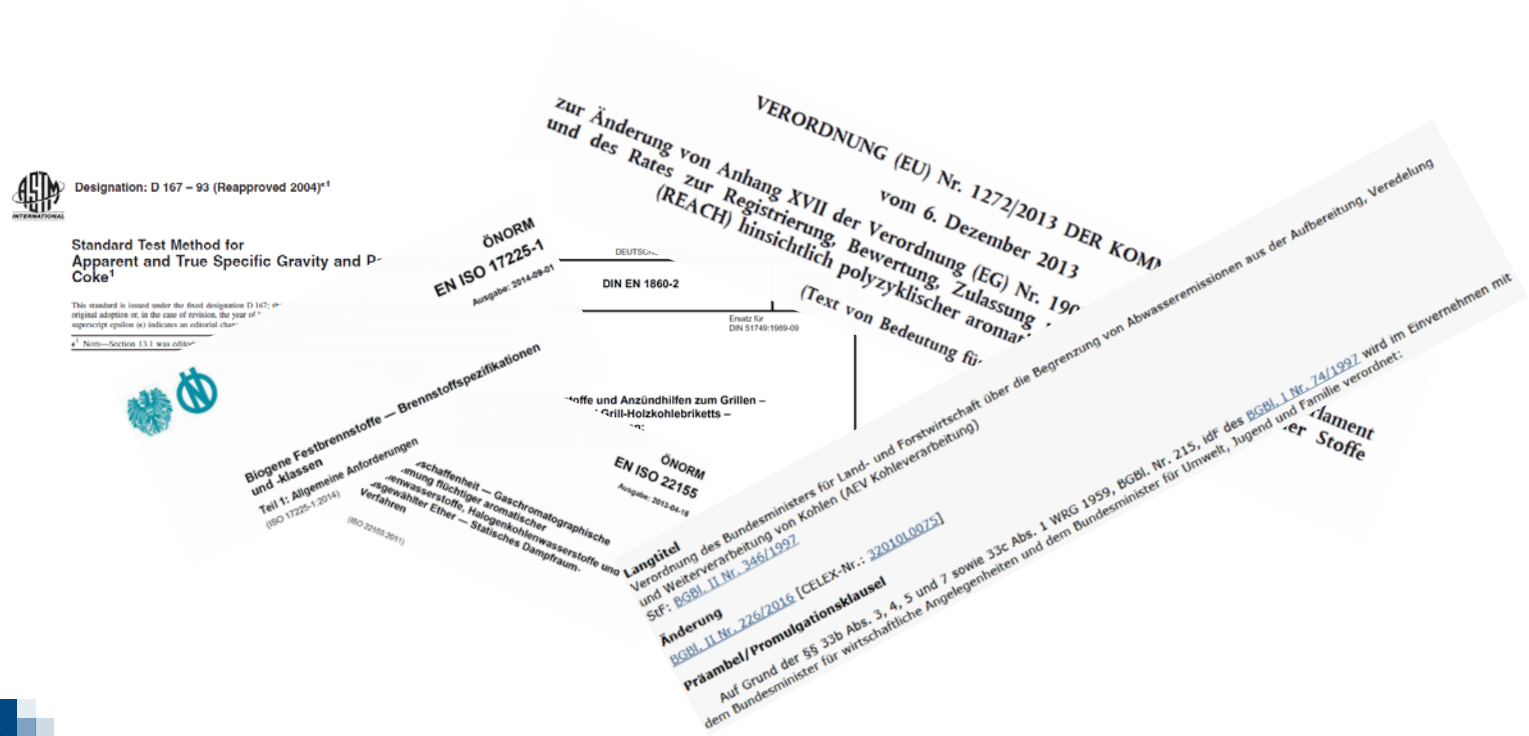
Quality of Biochar

- Depending on the use of biochar different parameters have to be determined.
  - These parameters are usually prescribed by authorities or specialist circles to the respective user for documentation and control.
  - Furthermore, the different measuring methods which are to be used for the various parameters are described in the different regulations or standards.



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Quality of Biochar

- Extract of the determined parameters ("full analysis") to show the complexity according to an accredited laboratory

Labor Nr.:	agr13-0653.1 (Biokohle)		Labor Nr.:	agr13-0653.1 (Biokohle)	
Parameter	**Einheit**	**Messwert**	**Gesamtgehalte**	**Einheit**	**Messwert**
Wassergehalt	%	56,43			
Wasserhaltevermögen	ml/kg TS	3030	PCDD / PCDF**		
pH-Wert (1:5 - H_2O)		9,27	2378-TetraCDD**	ng/kg TS	<0,30
pH-Wert (1:5 - 1M KCl)		9,43	12378-PentaCDD**	ng/kg TS	<0,41
pH-Wert (1:5 - 0,01M $CaCl_2$)		8,05	123478-HexaCDD**	ng/kg TS	<0,81
BET Oberfläche (ISO 9277)**	m^2/g TS	240,1	123678-HexaCDD**	ng/kg TS	<0,81
Ges. Kohlenstoff (C_t)	% TS	88,4	123789-HexaCDD**	ng/kg TS	<0,81
H/C Verhältnis**	mol/mol	0,12	1234678-HeptaCDD**	ng/kg TS	<0,91
Gesamtgehalte			OctaCDD**	ng/kg TS	<3,72
Kalzium (Ca)	mg/kg TS	13240	2378-TetraCDF**	ng/kg TS	<0,54
Magnesium (Mg)	mg/kg TS	1420	12378-PentaCDF**	ng/kg TS	<0,74
Kalium (K)	mg/kg TS	3130	23478-PentaCDF**	ng/kg TS	<0,74
Natrium (Na)	mg/kg TS	159,5	123478-HexaCDF**	ng/kg TS	<0,68
Aluminium (Al)	mg/kg TS	457	123678-HexaCDF**	ng/kg TS	<0,68
Barium (Ba)	mg/kg TS	112,9	123789-HexaCDF**	ng/kg TS	<0,68
Phosphor (als PO_4)	mg/kg TS	1641	234678-HexaCDF**	ng/kg TS	<0,68
Phosphor (P)	mg/kg TS	535,2	1234678-HeptaCDF**	ng/kg TS	<3,38
Bor (als BO_3)	mg/kg TS	164,0	1234789-HeptaCDF**	ng/kg TS	<0,64
Bor (B)	mg/kg TS	30,16	OctaCDF**	ng/kg TS	<33,8
Silber (Ag)	mg/kg TS	<5	WHO (1998)-PCDD/F TEQ inkl. BG^2 **	ng/kg TS	1,57
Eisen (Fe)	mg/kg TS	1226	WHO (2005)-PCDD/F TEQ inkl. BG^2 **	ng/kg TS	1,58
Mangan (Mn)	mg/kg TS	716,2	I-TEQ (NATO-CCMS) inkl. BG^2 **	ng/kg TS	1,74
Kupfer (Cu)	mg/kg TS	6,13	PAK (16) Summe	mg/kg TS	<3,58
Zink (Zn)	mg/kg TS	137	Benzo(a)pyren	mg/kg TS	<0,22
Kobalt (Co)	mg/kg TS	0,82	PCB (7) Summe	mg/kg TS	<0,16
Molybdän (Mo)	mg/kg TS	0,30	PCB-28	mg/kg TS	<0,022
Zinn (Sn)	mg/kg TS	2,80	PCB-52	mg/kg TS	<0,022
Selen (Se)	mg/kg TS	<9	PCB-101	mg/kg TS	<0,022
Arsen (As)	mg/kg TS	<0,56	PCB-118	mg/kg TS	<0,022
Nickel (Ni)	mg/kg TS	9,21	PCB-138	mg/kg TS	<0,022
Chrom (Cr)	mg/kg TS	7,42	PCB-153	mg/kg TS	<0,022
Blei (Pb)	mg/kg TS	1,32	PCB-180	mg/kg TS	<0,022
Cadmium (Cd)	mg/kg TS	0,68			
Quecksilber (Hg)	mg/kg TS	<0,01			
Thallium (Tl)	mg/kg TS	<10			
Vanadium (V)	mg/kg TS	<83			
Ges. Stickstoff (N_t)	mg/kg TS	4090			
org. Kohlenstoff (C_{org})[1]	% TS	88,2			

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Technology & life science

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2378-TetraCDD**	ng/kg TS	<0,30
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PCB-153	mg/kg TS	<0,022
PCB-180	mg/kg TS	<0,022

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Quality of Biochar

- Some essential (for certain use cases) parameters are not mentioned in this analysis.
  - Fixed Carbon Content c_{Fix}
  - Particle Size, Particle Distribution
  - volatile Organic Components VOC
  - Pore Size Distribution BJH
  - …

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Quality of Biochar

- EBC (European Biochar Certification) *[16]*
  - Ensures sustainable production of biochar
  - Includes detailed rules on production and quality criteria
  - Transparent and measurable quality for biochar users
- Certificates with different thresholds for before mentioned parameters
  - EBC-Feed
  - EBC-AgroOrganic
  - EBC-Agro
  - EBC-Urban
  - EBC-ConsumerMaterials
  - EBC-BasicMaterials

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Conclusio

- But there are many factors to be considered:
  - Different quality and properties for specific applications
  - Local conditions (regulations, environmental conditions, …)
  - Choice of production methods can influence the application
  - Organic (PAH, PCDD, PCDF, …) and inorganic (heavy metals) contamination preclude some applications

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Wirtschaftsstandort

Christian Doppler
Forschungsgesellschaft

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Thank you for your attention

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