Biochar Quality Management

Biochar: Production, Characterization and Applications
ECI Conference

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Ataullah Khan[1], Don Harfield[2], Bruce Hillen[3], Fabian Stenzel[4], Andreas Hornung[4]

[1]InnoTech Alberta & Alberta Biochar Initiative, CANADA

[2]Community Advocate (ex InnoTech Alberta/ABI), CANADA

[3]Susteen Technologies Ltd., CANADA

[4]Fraunhofer UMSICHT, Sulzbach-Rosenberg, GERMANY

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Motivation
Sustainable Feedstocks

Limits of sustainable utilization

Biogenic residues

Organic waste[1]
4 Mio. Mg/a

Garden and park waste[2]
4.5 Mio. Mg/a

Straw[3]
8 - 13 Mio. Mg/a

Hay[4]
0.6 – 0.9 Mio. Mg/a

Sewage sludge[5]
1.9 Mio. Mg/a (TS)

■ ■ ■ ■ ■ ■

Sources: [1] UBA, 2011 [2]Destatis 2010 [3]Zeller et al., 2011; [4]Simon et al., 2008; [5]UBA, 2012

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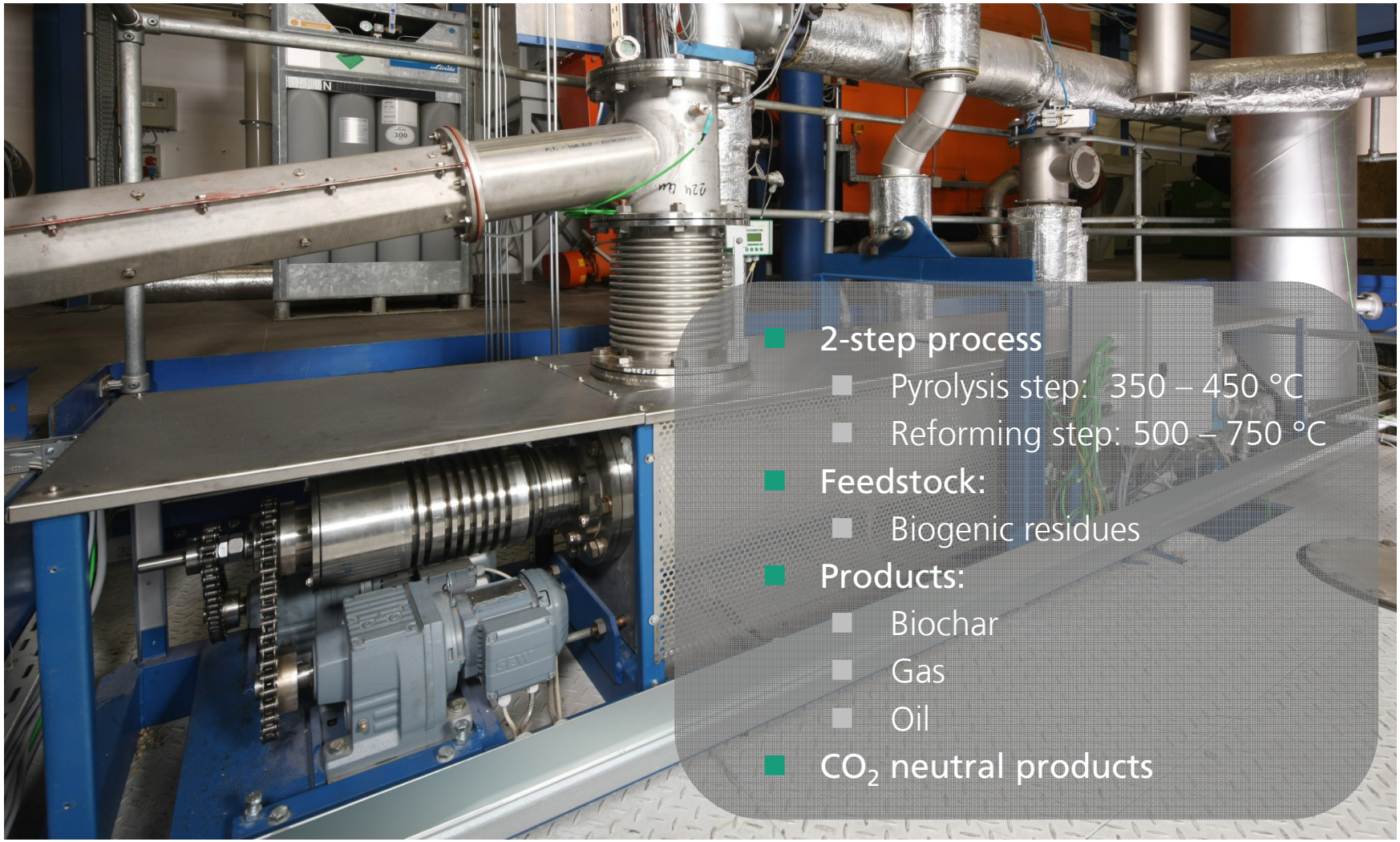
Production of Biochar

Thermo-Catalytic Reforming (TCR®)



- 2-step process
  - Pyrolysis step: 350 – 450 °C
  - Reforming step: 500 – 750 °C
- Feedstock:
  - Biogenic residues
- Products:
  - Biochar
  - Gas
  - Oil
- CO_2 neutral products

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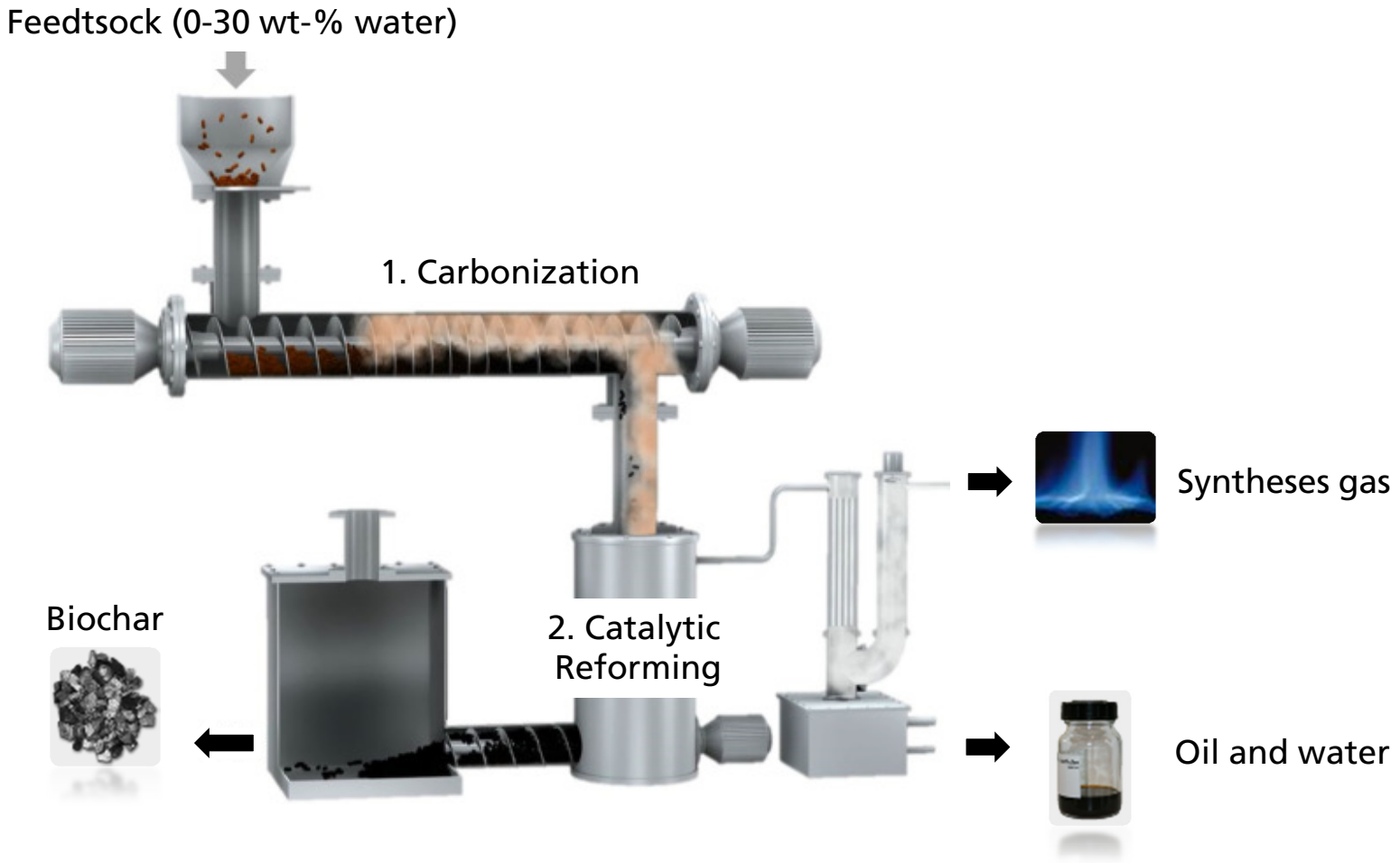
Production of Biochar
TCR® process scheme



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Biochar characterization
Analysis

Sewage Sludge		Digestate		Brewer Spent Grain		Wood	
C	**22.2 wt.-%**	**C**	**64.0 wt.-%**	**C**	**72.6 wt.-%**	**C**	**89.8 wt.-%**
H	0.9 wt.-%	H	1.0 wt.-%	H	0.1 wt.-%	H	2,2 wt.-%
N	2.0 wt.-%	N	1.4 wt.-%	N	4.6 wt.-%	N	0.3 wt.-%
S	1.0 wt.-%	S	0.5 wt.-%	S	0.4 wt.-%	S	0.1 wt.-%
O	0.0 wt.-%	O	0.7 wt.-%	O	4.9 wt.-%	O	4.5 wt.-%
Ash	**74.4 wt.-%**	**Ash**	**32.0 wt.-%**	**Ash**	**17.5 wt.-%**	**Ash**	**3.1 wt.-%**
LHV 8.2 MJ/kg		LHV 23.0 MJ/kg		LHV 26.0 MJ/kg		LHV 34.4 MJ/kg	

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Biochar characterization

Nutrients – char from digestate

Requirements for nutrients in accordance to the German Fertilizer Ordinance (DüMV) and analysis results for char from digestate

NP Fertilizer	**solid**	**Biochar**
Components	[%]	[%]
N	3	1.34
P_2O_5	5	7.34*
NK Fertilizer	**solid**	**Biochar**
Components	[%]	[%]
N	3	1.35
K_2O	5	6.27*
PK Fertilizer	**solid/ from ashes**	**Biochar**
Components	[%]	[%]
P_2O_5	5 / 2	7.34*
K_2O	5 / 3	6.27*
NPK Fertilizer	**solid / from ashes**	**Biochar**
Components	[%]	[%]
N	3	1.34
P_2O_5	5 / 2	7.34*
K_2O	5 / 3	6.27*
NPK fertilizer on substrate		**Biochar**
Components	[%]	[%]
N	1	1.34
P_2O_5	1	7.34*
K_2O	1	6.27*

*Calculation in accordance to DüMV

- Requirements regarding phosphate and potassium contents are met
- Nitrogen contents for NP and NPK fertilizers must be adjusted
- Nutrients requirements for PK fertilizer are met

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Canadian Food Inspection Agency (CFIA)

Vision:

- To excel as a science-based regulator, trusted and respected by Canadians and the international community.

Mission:

- Dedicated to safeguarding food, animals, and plants, which enhances the health and well-being of Canada's people, environment and economy.

Canadian Food Inspection Agency

Agence canadienne d'inspection des aliments

http://www.inspection.gc.ca/

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CFIA – Biochar Regulation

- CFIA considers 'Biochar' as a supplement under the Federal Fertilizer Act and requires its registration prior to sale or import into Canada.
- CFIA non-compliance could result in product detention and prosecution.
- For registration of Biochar, applicants must demonstrate that the product is safe with respect to human, animal, plant health and the environment.
- **InnoTech Alberta's** pioneering on Biochar Quality Management / Safety Assessment had led to the debut (1st) approval of Biochar for sale/use in Canada.
- **InnoTech Alberta** has assisted/assisting Air-Terra, Prasino Group, Titan Clean Energy, Fraunhofer-UMSICHT, Susteen Technologies and several other clients with biochar product safety Assessments for CFIA registration.
- For further information/guidance please contact:

Ataullah Khan, PhD
Technical Lead
for Thermochemical Processing Technologies
& Alberta Biochar Initiative
InnoTechAlberta.ca
TEL: 780.632.8206 **CELL:** 587.280.3264
ataullah.mohammed@InnoTechAlberta.ca

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Safety Concerns Associated with Biochar

Variability in carbon source material and manufacturing processes warrant regulatory oversight, given resultant variability in composition and potential for hazardous by-products and contaminants

- **Metals**
- **Dioxins and Furans**
  Higher level of concern associated with sea-transported wood, biosolids
- **Polycyclic Aromatic Hydrocarbons (PAHs)**
- **Polychlorinated Biphenyls (PCBs), Hexachlorobenzene (HCB) and Emerging Substances of Concern (ESOCs) (e.g. pharmaceuticals) in biosolids**
- **Treated and/or Contaminated Carbon Sources**
  e.g. treated railway ties
- **Undeclared NPK Content of Manure and Biosolids**
  environmental concerns with over-application

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Biochar Safety Assessment – CFIA

Toxicant Compliance Testing

Maximum permissible heavy metal concentration in bio-solids for land application in Canada and USA

	Unit	EPA	Ontario	TCR char from digestate
Arsenic	mg/kg DM	75	170	< 0.3
Cadmium	mg/kg DM	85	34	< 0.005
Chromium (total)	mg/kg DM	3000	2800	18
Copper	mg/kg DM	4300	1700	101
Lead	mg/kg DM	840	1100	2.74
Mercury	mg/kg DM	57	11	0.017
Molybdenium	mg/kg DM	75	20	6.44
Nickel	mg/kg DM	420	420	12.1

< below the detection limit

Limit values for organic pollutants in biochar in accordance to the IBI guidelines

	Unit	**IBI**	**TCR char from digestate**
PAH	mg/kg DM	20	0.41
Dioxins	ng/kg DM	9	< 1.8
Furans	ng/kg DM	9	8.1
PCB	mg/kg DM	0.5	0.001

< below the detection limit

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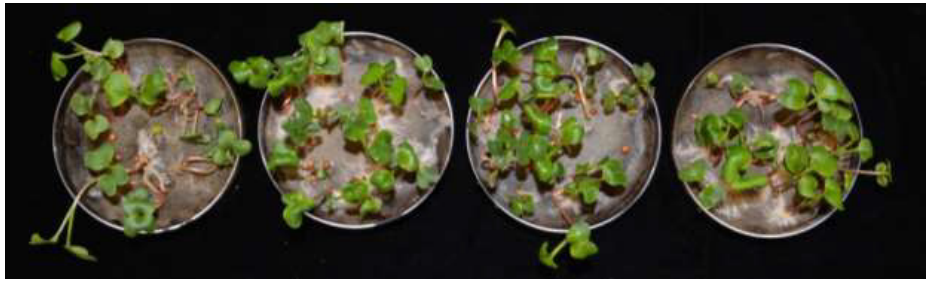
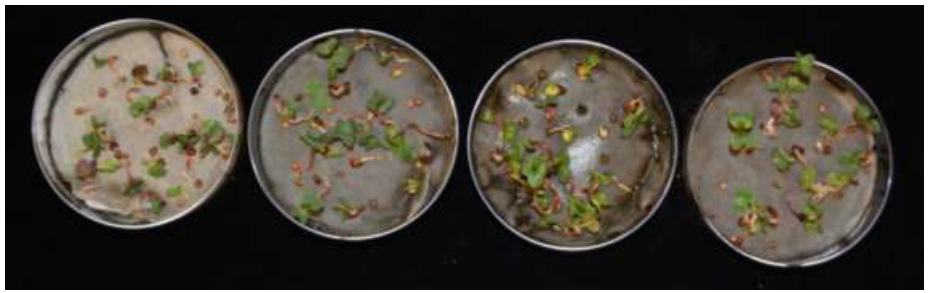
Biochar Safety Assessment – CFIA

Toxicity Bioassay - Radish Seed Germination Compliance Tests



- Mixture of peat and biochar (25 wt-%)

- Mixture of compost and biochar (25 wt-%)



- Mixture of soil and biochar (25 wt-%)

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Alberta Biochar Initiative (ABI)

Alberta Biochar Initiative

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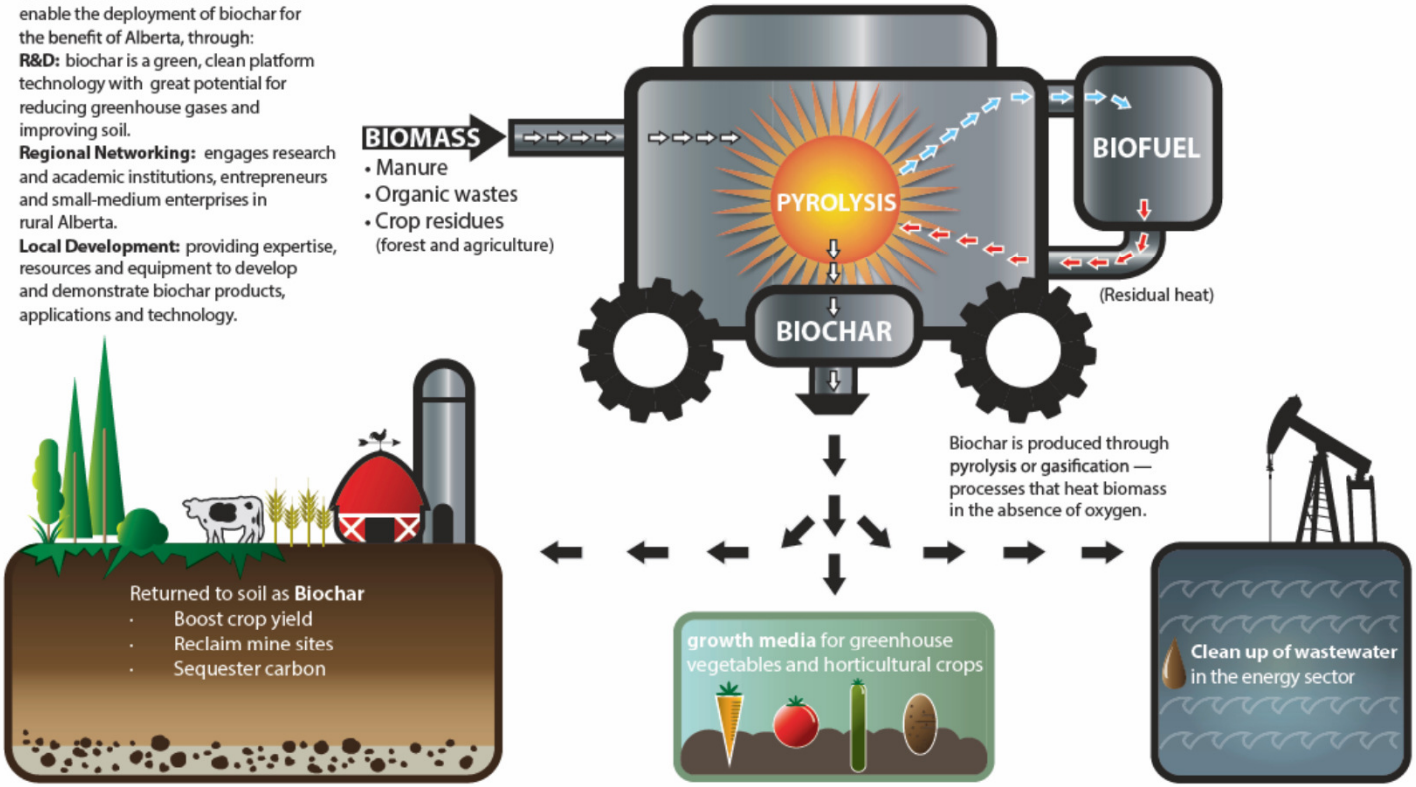
The Alberta Biochar Initiative works to enable the deployment of biochar for the benefit of Alberta, through:

R&D: biochar is a green, clean platform technology with great potential for reducing greenhouse gases and improving soil.

Regional Networking: engages research and academic institutions, entrepreneurs and small-medium enterprises in rural Alberta.

Local Development: providing expertise, resources and equipment to develop and demonstrate biochar products, applications and technology.

How biochar is made, and its potential applications



Ataullah Khan Mohammed, PhD.
Team Leader, Thermochemical Processing
Alberta Innovates Technology Futures
Email: attaullahkhan.mohammed@innotechalberta.ca
Tel: 780 632 8206
Website: www.albertatechfutures.ca

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www.biochar-international.org/regional/ABI

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Biochar application
Energetical use

Co-incineration in power plants

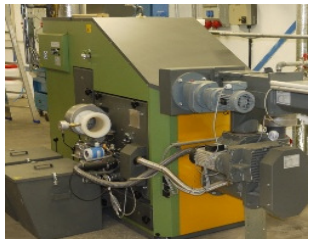
- Coal-fired power plant
- Biomass heated power plant
- Waste-to-energy plant

Lime and cement production

- Green secondary fuel

Small scale combustion plants

- Production of tailor made fuels



Home area

- Substitute for conventional wood made barbeque coal

Hans-Peter Schmidt 2013

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Biochar application
Material use

Livestock farming

- Additive for fodder
- Livestock bedding
- Manure treatment

Filter material / Water treatment

- Treatment of drinking water and water for aquacultures
- Exhaust air treatment

Soil ammendement

- Multi-nutrients carrier
- Additive for compost
- Adsorption of heavy metals or organic pollutants
- CO_2-Sequestration

Metallurgical processes

- Reducing agent
- Slag forming material
- Elektrode material

Hans-Peter Schmidt 2013

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BIOCHAR QUALITY MANAGEMENT

Thank you very much!

Contact:
Fraunhofer UMSICHT
Institutsteil Sulzbach-Rosenberg
An der Maxhütte 1
92237 Sulzbach-Rosenberg
E-Mail: info-suro[at]umsicht.fraunhofer.de
Internet: http://www.umsicht-suro.fraunhofer.de

Dipl.-Wi.-Ing. Fabian Stenzel
Telefon: +49 9661 908-432
E-Mail: fabian.stenzel[at]umsicht.fraunhofer.de

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