

8-20-2017

# BiocharFX: Production with carbonFX technology, characterization and applications in potting soil related to plant production

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## Recommended Citation

Sébastien Lange and Sylvain Bertrand, "BiocharFX: Production with carbonFX technology, characterization and applications in potting soil related to plant production" in "Biochar: Production, Characterization and Applications", Franco Berruti, Western University, London, Ontario, Canada Raffaella Ocone, Heriot-Watt University, Edinburgh, UK Ondrej Masek, University of Edinburgh, Edinburgh, UK Eds, ECI Symposium Series, (2017). <http://dc.engconfintl.org/biochar/69>

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**BiocharFX** production with CarbonFX  
technology: characterization and applications in  
potting soil related to plant production



Sébastien Lange, Ph.D. Researcher, Biopterre

Sylvain Bertrand, CEO, Airex Energy



Biochar: Production, Characterization  
and Applications

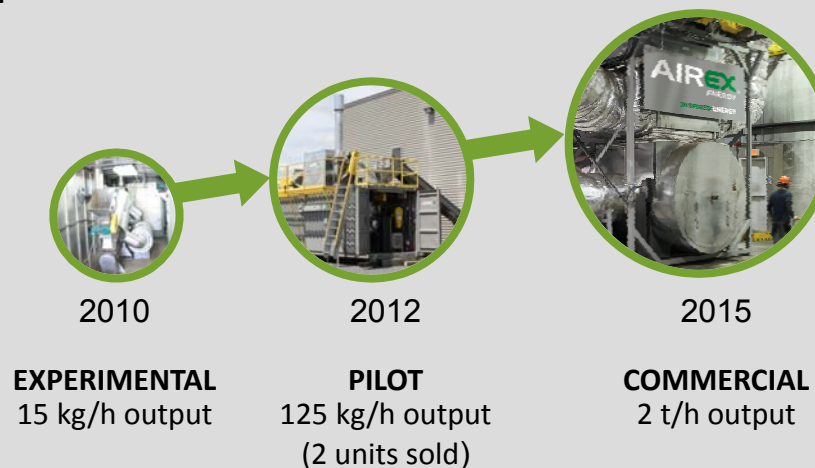
Alba, Italy, Monday, August 21, 2017



# Airex Energy

<http://www.airex-energy.com/en/>

- Airex Energy **develops, manufactures** and **markets torrefaction** systems for Biocoal and Biochar production
- Started R&D activities on torrefaction technology in 2010
- Airex Energy has successfully developed a proprietary CarbonFX process for biomass torrefaction
- Since 2015, Airex Energy has **operated the first and only commercial-scale** biocoal plant in Canada. Registration of the CarbonFX trademark in Canada, US and Europe.



# CarbonFX technology



## **SMALLEST FOOTPRINT OF THE INDUSTRY:**

Biomass particle residence time inside the reactors is 3 seconds compared to 30 minutes for competing torrefaction technologies.



## **HIGH ENERGY EFFICIENCY:**

Residual heat from the process is used to pre-dry the biomass in an integrated system



## **SCALABLE SYSTEM :**

Proven multi-cyclonic reactor design



## **EASY TRANSPORTATION AND ASSEMBLY:**

Modular design allows components to be shipped to site by either rail or train in standard containers with final assembly on site.



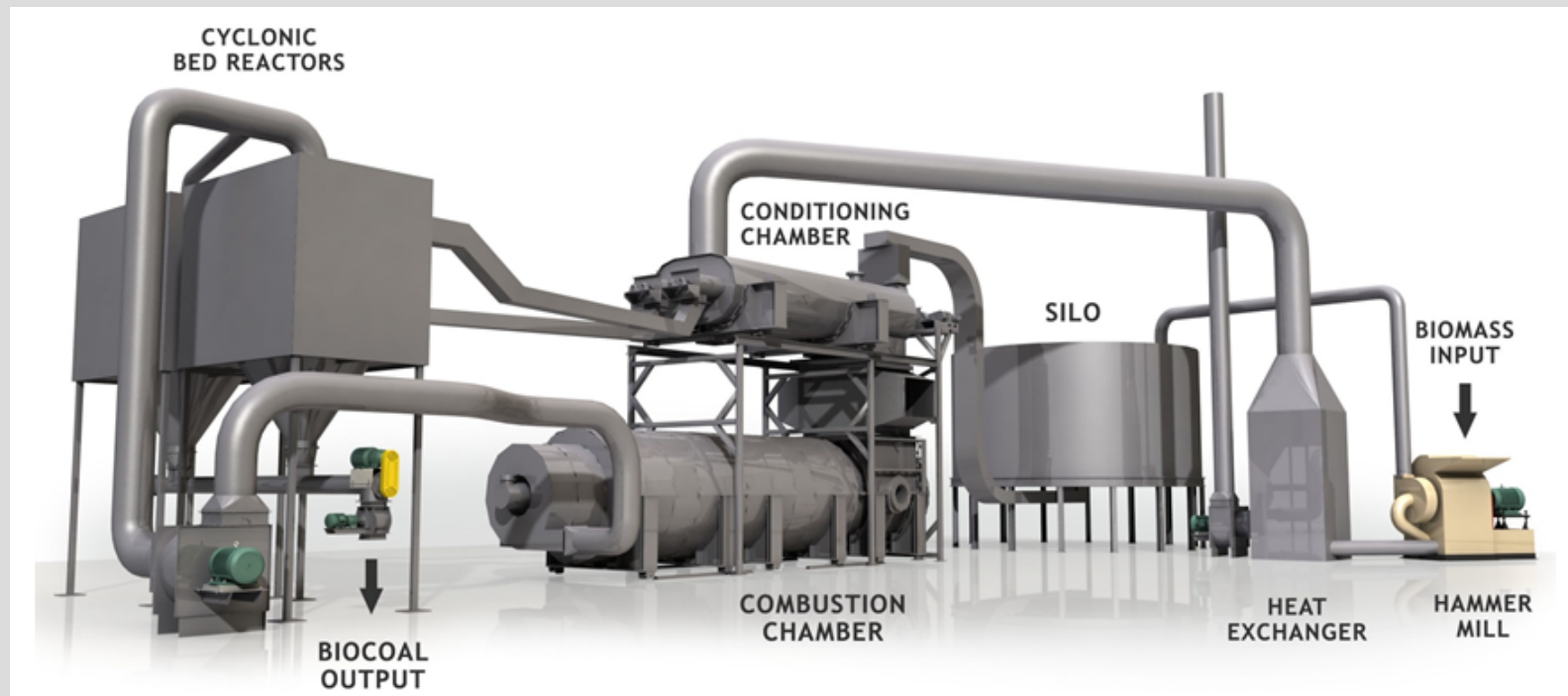
## **COST COMPETITIVE:**

CarbonFX system doesn't require pressure vessel, biomass boiler, drum dryer or thermal oil heat exchanger. No technology/royalty fees on equipment or biocoal produced. Use very low cost sawdust as feedstock (vs. woodchips).



# CarbonFX technology

The CarbonFX torrefaction process consist of the pre-drying system, the conditioning chamber, the combustion chamber and the cyclonic bed reactors





# CarbonFX technology


Video of the commercial plant available on YouTube with key words: airex energy and vert et net

<https://www.youtube.com/watch?v=bhPoH6WZ4hc>



# CarbonFX technology


CarbonFX: large-scale production of a wide range of clean and renewable valued-added carbonized products

CARBONIZATION LEVEL	INDUSTRY	TRADITIONAL MATERIAL	APPLICATION	AIREX ENERGY'S SOLUTIONS
	Materials	Wood flour	Wood-plastic composite	Torrefied wood flour
	Energy	Coal	Coal-fired power plants and cement/lime kilns	Biocoal pellets
	Agriculture	Chemical fertilizer	Soil amendment	Biochar
	Chemicals	Carbon black	Color pigment	Biochar
	Metallurgy	Coke	Silicon metal manufacturing and blast furnace (extraction of iron)	Biochar
	Water	Activated carbon	Waste water treatment	Biochar



# CarbonFX technology

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BiocharFX



- Soil amendment: Certification process in progress with the Canadian Food Inspection Agency
- Required analysis for certification: Metals content, dioxins and furans
- Additional information:
  - General content: CHONS, ash, humidity, PAH,
  - Basic analysis: particles size distribution, electrical conductivity, pH
  - Biological parameters: germination effect and earthworm appreciation



# BiocharFX properties

Label market

## BIOCHAR

100% NATURAL ORGANIC PRODUCT

# LOT: \_\_\_\_\_

WEIGHT: \_\_\_\_\_ kg

**BIOCHARFX SOIL AMENDMENT PROMOTES PLANT GROWTH AND YIELDS BY IMPROVING:**

SOIL AERATION AND DRAINAGE

MICRO-ORGANISMS ACTIVITY

NUTRIENT RETENTION

SOIL MOISTURE AVAILABILITY

**APPLICATION**

**BIOCHARFX SHOULD BE MIXED TO POROUS MEDIA.** It is recommended to blend BiocharFX at a maximum ratio of 25% by volume with compost, peat or soil to promote plant growth and/or to improve soil properties.

In pot cultures, BiocharFX is effective when mixed with other components during potting, while surface application is much less effective. BiocharFX is dry and light and its application to soil should be followed by tillage to avoid wind transportation and runoffs.

We recommend only one application per year, preferably at the beginning of the growth period.

**SAFETY PRECAUTIONS**

- > Wear individual safety protections (glasses, gloves, wear dust respirator and overalls)

- > Avoid eye and skin contact
- > Do not ingest
- > Do not apply directly in water

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INFO@AIREX-ENERGY.COM

**100 % PURE BIOCHAR**  
**MADE BY PYROLYSIS OF CLEAN WOOD**

**PROPERTIES (DRY BASIS)**

**BIOCHAR 100%**  
**MOISTURE < 15%**  
**CARBON > 60%**  
**ASH < 15%**  
**pH 8 ± 1**

**AVERAGE PARTICLES SIZE**

**> 2 mm 6%**  
**0.5 to 2mm 54 %**  
**< 0.5 mm 40 %**

**ELECTRICAL CONDUCTIVITY 850 µS/cm ± 150**

**METAL CONTENT RESPECT NORMS FROM CFIA, BNQ, US-EPA, IBI**

Germination rate: 10% v/v similar to control (85%); 50% v/v upper than 65% and no time delay for the germination

Earthworms appreciation: not contraindicated for earthworms

Salmonella: not detected and Fecal coliforms < detection limit

Dioxins and furans: most are < detection limit and all are ≤ quantification limit

PAH: all are < detection limit and respect norms from the Quebec and Canada ministry of environment



# Experiments with BiocharFX

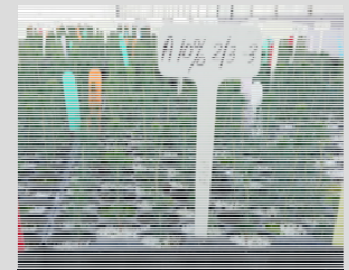
- White spruce production in multicavity containers:

- Growth
- Economic aspect
- C sequestration



- Black spruce production in multicavity containers:

- Growth
- Reduction of fertilization



- Wheat production in large containers (in progress):

- Reduction of fertilization
- Reduction of N<sub>2</sub>O emissions





# White spruce production in multicavity containers

Treatment	Treatments composition with BiocharFX % (V/V)			
	Euro HP BM4 peat with adjusted pH	Coarse sphagnum peat BPC	Perlite	Biochar
<b>Control</b>	46.9	46.9	6.2	0
<b>1</b>	46.9	46.9	0	6.2
<b>2</b>	40.7	46.9	6.2	6.2
<b>3</b>	34.9	46.9	6.2	12
<b>4</b>	28.1	46.9	0	25

- **SUBSTRATES** Compaction, dryness and deterioration, Initial and final pH (optimum pH for white spruce: 4.5 to 5.5)
- **PLANTS** Germination rate, Height, Collar diameter, and ratio, Dry root and foliar masses, and ratio, Quality based on the ministry guide (2011), N contents in needles
- **ECONOMIC** Profitability to use biochar in substrates for white spruce production in Quebec nursery
- **C SEQUESTRATION** Potential quantity of C sequestered by the use of BiocharFX in the substrates by our partner only



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# White spruce production in multicavity containers

Treatment	BiocharFX Volume (%)	Height (cm)	Collar diameter (mm)	Ratio	Dry air mass (g)	Dry root Mass (g)	Ratio
<b>Control</b>	0	14,58 (7)	3,33 (8)	4,39 (7)	7,14 (11)	1,38 (16)	5,21 (7)
<b>BiocharFX</b>	6.2	13,67 (15)	3,10 (8)	4,41 (15)	6,66 (14)	1,25 (18)	5,31 (16)
	6.2	15,47 (8)	3,24 (6)	4,78 (8)	7,32 (14)	1,36 (15)	5,42 (10)
	12	13,64 (7)	3,28 (4)	4,16 (6)	7,13 (10)	1,41 (8)	5,07 (11)
	25	13,71 (7)	3,22 (5)	4,27 (8)	6,86 (11)	1,40 (13)	4,97 (17)

- **All plants respect the norms of the ministry** after 1 year of growing and **all plant plants can be sold**
- Replacement of peat and perlite without effect on plant up to 25% of **BiocharFX**
- With **BiocharFX** potential financial savings of 9% without affecting plant quality
- C sequestration may reach more than 24 tons of C /year compare to the control
- Perlite is not essential and may be totally replace by **BiocharFX**

S.F LANGE, S.E. ALLAIRE, D. PAQUET. Substrates containing biochar for white spruce production (*Picea Glauca* sp.) in nursery: growth, economic aspect and carbon sequestration. Accepted by New Forest Journal



# Black spruce production in multicavity containers

**OBJECTIVE:** Study if the **BiocharFX** in black spruce substrates reduces fertilizer input while maintaining high quality

- **TREATMENTS:** Control without **BiocharFX** and treatments with **BiocharFX** at a rate of 10% V/V with 3 levels of fertilization (std, 2/3 std and 1/3 std); 145 days of growth
- **SUBSTRATES, PLANTS, ECONOMIC** : same as previous experiment

**HIGHLIGHT:**

**BiocharFX** addition associated to a fertilization reduction shows that:

- no effect on substrate pH
- no effect the plant quality (foliar and root masses, height, collar diameter) dependently of the ministry norms
- N content of the leaves decrease with the fertilization level
- an economic gain evaluated to 5.4% if 10% V/V of the **BiocharFX** was added to the substrates associated to a fertilization of 2/3 std



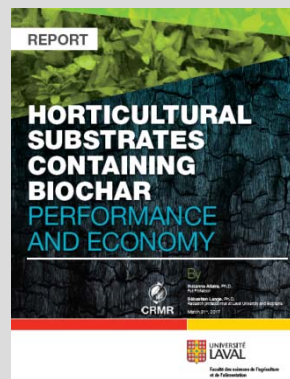
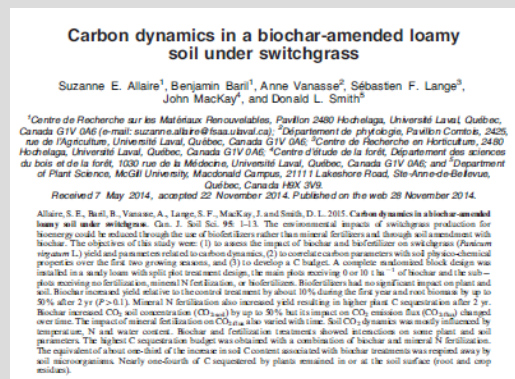


# Scientific contact information

## Sébastien Lange

Ph.D., Biopterre and ULaval

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- (1) 418-932-4272
- [https://www.researchgate.net/profile/Sf\\_Lange](https://www.researchgate.net/profile/Sf_Lange) :
  - Few available reports and scientific papers about the use of biochar in horticulture and agriculture



# Commercial contact information

## Sylvain Bertrand

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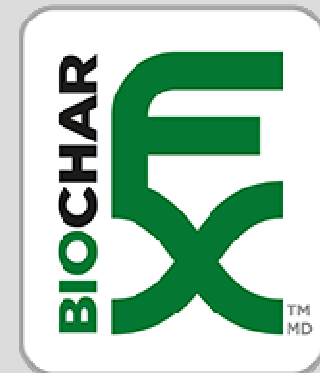
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# Acknowledgements

All student and employees that performed the experiments



# Wheat production in large containers (in progress)

## OBJECTIVE:

Study if the **BiocharFX** added at a rate of 15 or 30% v/v in a mineral soil increase fertilizer efficiency (reduces fertilizer leaching) and reduces N<sub>2</sub>O emission at two soil moisture level (30 and 70% saturation)

## TREATMENTS:

Control without **BiocharFX** and treatments with **BiocharFX** at a rate of 15 or 30% V/V with 2 levels of soil moisture



## OBSERVATIONS:

**BiocharFX** seems to raised to the soil surface by irrigation

## RESULTS:

No differences between treatment until the first fertilization event

After, ??? experiment is in progress