



3R = Recycle – Reduce – Reuse = Circular economical incentive for combined applied science & industrial engineering for low grade organic by-products added value conversion into high grade resources

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What is biochar/pyrolysis material?

Biochar/pyrolysis material is plant and/or animal bone biomass origin stable carbon carboniferous and legally labelled product with functionality of solid organic fertilizer and/or solid organo-mineral fertilizer and/or organic soil improver.

Biochar/pyrolysis material is a chemically modified substance, which – depending on the highly variable feed materials - may have either variable composition and complex reaction products (REACH) or well defined mono and multiconstituent character.

All biochar/pyrolysis products in the EU are characterized by:

- 1) mandatory EU and MS Government Authority permitted for import, manufacturing, placing on the market and application above 1 t/year capacity,
- 2) REACH certified above 1 t/year capacity import, manufacturing, placing on the market and application,
- 3) labeled and full value chain safe product,
- 4) having Extended Producer Responsibility product guarantees,
- 5) the input material made from is sustainable sourced, e.g. not competing with human food, animal feed and plant nutrition supply, not from primarily and secondarily land use and having environmentally sustainable logistics, while meets the EU Circular Economy incentive relevant sections.

In this context the safe biochar/pyrolysis product equally importantly meets all the four elemental criteria and it is:

- a) commonly used for specific purposes with functionality of natural solid organic fertilizer and/or solid organo-mineral fertilizer and/or organic soil improver; and
- b) there is an existing market and demand for safe biochar; and
- c) the use is lawful, fulfils the technical requirements for the specific purposes and meets all the existing legislation and standards applicable to biochar product; and
- d) the use will not lead to overall adverse environmental and/or human health impacts.



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What is NOT biochar?

- a) biochar is not fine ground charcoal, not a labile carbon, not hydrochar, not activated carbon, not torrefraction processed energetic char and/or
- b) having no biochar specific and mandatory EU and MS Authority permits for import, manufacturing, placing on the market and application above 1 t/year capacity, and/or
- c) having no biochar specific and mandatory REACH certification above 1 t/year capacity import, manufacturing, placing on the market and application, and/or
- d) having no labelled Extended Producer Responsibility certificate, and/or
- e) the output biochar product economical value and free market valorisation is not based on common market demands and commercialization process, e.g. biochar product valorization may not be based on grants and subsidies, and/or
- f) does not meet quality to be irrevocably put into open ecological soil environment, and/or
- g) made from input feed material, that is not sustainable, and/or
- h) made for renewable biofuel for energy (gasification, torrefraction, hydrothermal carbonization chars), whereas biochar/energetic carbons are
 - a. two very different products with
 - b. two very different product functionalities/product criteria,
 - c. two very different production scenarios and processing conditions,
 - d. two very different product safety aspects,
 - e. two very different accredited product quality laboratory assessments,
 - f. two very different EU/MS Authority permits, permit procedures and legal environments that are to be applied at two different cases.
 - g. two very different application areas, and
 - h. two very different markets and users with very different product functionality demands.

Remarks on waste derived carbon products: There are several basic research projects to process waste materials into different carbon type products. However, many of them are challenging issues, not even viable when full industrialization targeted. Based on my +30 years of biochar S&T experience and biochar specialization with long term core competence, focused on biochar technology and product development, I have rather difficult to believe that most waste-to-biochar projects, could meet legal, technical, economical and market demand user criteria for biochar products under market competitive conditions.



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Is biochar/pyrolysis material a new product? No biochar/pyrolysis material is not a new product.

In modern age since 1870, the time of the technology revolution, many carbon processing technologies and many different types of carbon products developed, produced and applied in large industrial scale, especially related to the WWI., WWII. and past decades of activated carbon operations. **The carbon processing technologies and carbon products are the most extensively scientific/technical researched and technological developed past 130 years.** Majority of the carbon processing technologies and carbon products developed for energetic and activated carbon adsorbent applications. Some of them have been successful, others are not.

During the 1980's Siemens, Babcock, Toshiba and many other large corporations in the EU, USA, Japan and elsewhere worldwide tried to develop large industrial scale energetic carbon processing systems for pyrolysis, gasification and by other means, but many of them, failed. Chemviron Carbon, Cabot Norit and several others are successfully producing activated carbons in large scale, for which the global market presently is approx. 1.5 million t/year (approx. \$2 billion/year), which is increasing by 8-12%/year and estimated to reach \$3.7 billion, by 2020. ABC Animal Bone Char have been large scale industrially produced in the EU since 1870 and up until 2002, whereas the old technology phased out and new ABC specific technology and new improved quality product development stated up in a 20 years EU programme 2002-2022 (3R technology). The soil improver functional plant based biochar is also one of the carbon materials known since long time.

However, the knowledge based environmental norms and standards have been significantly upgraded past 20 years that have been impacting the performance and safety requirements of the carbon processing technologies and its products as well. Therefore, new generation safe and efficient pyrolysis technology and product system need to be developed in modern age.

Since 2002 Edward Someus is specialized for developing new generation zero emission pyrolysis and carbon refinery technology – that is specific and unique for the ABC Animal Bone Char processing and meet the new EU, US and Australian industrial, environmental and climate protection norms and standards for the 21st century.



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Since 1980's Edward Someus is specialized for pyrolysis and carbon processing technologies ("3R" zero emission pyrolysis) and different types of biochar products, while since 2002 primarily focused on a new generation ABC Animal Bone bioChar S&T and industrial engineering under the European Commission RTD programmes, that development has successfully reached large industrial scale-up capacity by the end of 2018.

Past decades **biochar has been re-researched** to adopt carbon science results to soil functionalities and upgraded environmental knowledge and market application aspects for the 21st century. In this context over 3500 scientific publication made, most of them as up to <TRL5 basic research and study results. Past years several laboratory and small scale pilot plants build related to grant financed new carbon research projects. According to the IBI approx. 350 biochar vendors known globally, but the aggregated biochar production is still low.

However, most carbonization vendors have been following the traditional and the already well known technical concepts of the energetic carbon processing (such as gasification, torrefaction, hydrothermal carbonization, a.s.o. with primarily objective driven processing to produce gas and liquids), that at the end not truly suitable to produce the specific quality of the biochar with different product functionalities. Past three decades several pyrolysis (reductive thermal processing or carbonization processing in absence of air) projects also developed in different scale, few of them successfully, others not.

In biochar carbon processing the key parameter is the material core temperature with primarily objective driven processing to produce solid carbon that can be achieved by true value reductive thermal treatment conditions. Gasification and fast pyrolysis energetic carbon processes generating fly ash as well, that might negatively impact the available porosity of the carbon products, which is so much important for functional biochar.

It is important to highlight, that the results from laboratory and small scale pilot scientific research plants below <TRL7 low research maturity may be significantly different versus results from high research maturity >TRL8 plants, which is the master key to enter TRL9 industrial replication model under true value market competitive real conditions.

TRL9 (that is a combination of the science-technology-engineering-economy-market demands) **is the only and ultimate evidence and demonstration of the true value viability of the research results** for biochar technology and product developments.



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Primarily the biochar/pyrolysis processing technology design and engineering performance quality is the prime definition factor to determine the output biochar product quality, safety and application value.

Obsolete biochar processing technologies resulting low end carbon products, that are qualified for energetic carbons, but not for safe biochar. Secondly the selected feed material characteristics are the important factors that are reflected in the output biochar product character.

Biochar nutrient content:

- a) **Plant based biochar/pyrolysis material** does not have economically interesting nutrient value under market competitive industrial conditions. The plant availability of the nutrients in the ash is also low. The benefits and application of the plant biochar is **organic soil improver**, water/nutrient retention in soil and other long list of beneficial effects to be used in 5,000 kg/ha to 20,000 kg/ha doses, in average 10,000 kg/ha.
- b) **The ABC Animal Bone Char** is a full value natural **solid organic fertilizer** with high P/Ca nutrient density and full macro-porosity to be used in 100 kg/ha to 600 kg/ha doses, in average 300 kg/ha.
 - a. The food grade category 3 ABC bone grist feed material is from the rendering industry, that is one of the most controlled and regulated industrial sector.
 - b. The ABC product safety and supply security is proven demonstrated exceptional high.
 - c. The ABC full **industrial scale production** is already MS permitted according to the valid EU regulations (Authority permit number FES/01/0851-33/2015).
 - d. The ABC full **industrial scale application** is already MS permitted according to the valid EU regulations (Authority permit number 04.2/102-2/2015).
 - e. ABC P recovery having over 20% EU27 substitution potential for the Cadmium/Uranium contaminated mineral rock phosphate fertilizers already in short/medium term already before 2030 with specific application in the organic and low input farming sectors.



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7 reasons why we need to transform phosphorus use in the global food system:

- 1) Phosphorus equals food and life. NO P = NO LIFE.
- 2) Growing food demand, growing phosphorus demand.
- 3) Non renewable and finite phosphate: the low Cadmium and Uranium content mineral fertilizer resources already used up and in the future only contaminated resources are available.
- 4) Geopolitical risks: imported Phosphate is an critically important issue for the national security already now. All farmers need phosphorus, yet just 5 countries control 88% of the worlds remaining phosphate rock reserves.
- 5) An inefficient food system: large amount of P to waste streams, no recovery.
- 6) Cheap fertilizer: a thing of the past for farmers.
- 7) In the near future very drastic P price increase to come (In 2008 it was >700%).

The key concept for the "3R" zero emission pyrolysis process and product development; +30 years of biochar S&T experience:

Whatever technical, environmental and/or climate challenge the applied scientific research and technical development faces, it is considered that most probably one or more of the world's millions of creatures and natural processes has not only already faced the same challenge during the past millions of years, but has also evolved effective strategies to solve it as well.

Due to the new environmental improvements and strict regulations, new technologies and methods need to be developed. *"The significant problems we face cannot be solved at the same level of thinking we were at when we created them"* Albert Einstein. In this context the "Stone Age" did not ended because there were no more stones, but rather because of new technologies come up in practice, that rapidly open wide range of new technical, economical and environmental opportunities. This is what the "3R" do.

The "3R" Recycling-Reduce-Reuse zero emission carbon refinery technology is a typical case example for advanced technology revolution in modern age, specifically developed for the temperate climatic zone countries and advanced markets. The "3R" is safer, better, less costly and more environmental friendly best available technology than any known solutions. The new "3R" technology and its high added value refined carbon products opening new technical, economical, market, legal and environmental opportunities with special focus on the EU, Australian, Japanese and US/Canadian markets.