3R – Recycle – Recover – Reuse

Resouce effient conversion of agro and food industrial un-exploited biomass resource streams into high market added value natural products and circular economical results.

3R technology and product development milestones 1989 - 2022

Background:

1972-1979	Edward Someus: University of Lund, Sweden (Natural and Earth sciences, graduated in 1978, M.Sc., (Natural & Environmental Science).
1980 - 2022	Edward Someus carrier: upcycling & environmental engineering, biochar science & technology senior engineering, soil remediation, waste management.
1986	The 3R technology invention: horizontally arranged indirectly heated systems (new generation of indirectly heated rotary kiln for high temperature carbonization of organics, carbon activation and bone char processing.

The 3R development milestones:

1986-1989 

TRL3

Technology validated in lab. First generation lab unit of the 3R. Pre evaluation: scientifically research, laboratory bench tests. Evaluation of the concept and the competitor state-of-the-art, evaluation of patents, initial market research for future full scale application feasibility.

1989 

TRL4

TRL4 small-scale prototype, integrated with complementing subsystems of the 3R. Pilot Plant engineering concept design (LangCarbon Ltd. – est. 1989 - a joint venture with Lang Machine Works (established in 1875, Alstom Power Corp. subsidy). RTD and innovative development concept: develop, design, build & operate economically attractive and ecological sustainable organic waste high added value zero emission processing industrial system, but use no exotic design/materials**.** Industrial application feasibility study and concept pre design.

1990-2001

TRL5

TRL5 large scale prototype: confirmed proof of evidence for main components for the technical and economical efficiency of the construction, focused on test of 3R technology specific design elements: (1)indirect heat transfer, (2)achieved very high material core temperature 850 °C in carbonization phase, (3)separation of carbon – gas-vapour phase, (4)sealing and air tight construction, (5)continuous input and output, (6)flexible operation mode, (7)high operational safety (8)high carbonization efficiency and high end product quality.

2002-2005 

EU FP5 NNE5/363/2001 Clean Coal project is EU contracted for specific energy application of combined brown coal and biomass “towards zero emission” programme. The industrial development meet the requirements of the US EPA U.S. RCRA Miscellaneous Units 40 CFR 264 Subpart X as well. Development of pre design concept for conversion of raw pyrolysis gas-vapor to syngas and conversion of raw pyrolysis oil to transport quality fuel oil. Development of process method and industrialized full scale technology engineering design development of

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https://www.biophosphate.net biochar@3ragrocarbon.com edward.someus@gmail.com
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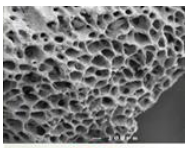
ABC animal bone biochar integrated solid state fermentation and formulation biotechnology.

2005-2009



The business and application oriented scientific RTD project EU FP6 514082 PROTECTOR is EU contracted (12 partners from 8 countries). The low input farming RTD and demonstration project is aiming to develop biocontrol agents against soil borne plant pathogens in the vegetable cultivations and provide natural plant nutrition with recovered Phosphorus. Other parameters concerning scale-up, environmental, regulatory, and socio-economic issues are defined and qualitatively assessed. Duration: 42 months, total cost € 2,63 million.

2008-2009

Intelligent Energy Europe BIOPROFARM EIE-05-086: Promotion of Biomethanisation in Agricultural Environment as a Decentralised Renewable Energy Resource for Europe EU contracted.

2008-2012

EU FP7 EUPHOROS 211457: Reducing the need for external inputs in high value protected horticultural and ornamental crops is EU contracted.

2009-2012

GOP-1.1.1-08/1-2008-0010: development of method and catalyst materials for conversion of pyroylsis gas to syngas.

2009-2012

EU-CIP-ECOINNOVATION: large scale industrial application and market replication of Agrocarbon bio-technology is EU contracted. (2009-2012).

2011-2016

TRL6

REFERTIL

TRL 6 pilot demonstrated in relevant environment. EUFP7 REFERTIL 289785: Reducing mineral fertilizers and chemicals use in agriculture by treated compost and biochar. Improvement of comprehensive bio-waste transformation and nutrient recovery treatment processes for production of combined natural products and recovered Phosphorus. EU policy support to the Commission for the law harmonization of the biochar and compost cases. Manufacturing approach is defined. Environmental, regulatory, and socio-economic issues are addressed.Development of new compost and biochar standards in the EU27 for EU law harmonization. (project value €4.2 M).

2020 MS permit

BioPhosphate commercial application MS permit: **6300/2407-2/2020**

2016-2022

TRL6 long term tested and pilot demonstrated in relevant environment with 2,000 t/y capacity to confirm process and performance reliability. Output BioPhosphate products sucessfully field tested under production conditions at user farmers.

>2018- 2022

Establishment of 3R industrial replication franchise model BAT/BREF concept (REPLICATOR) and market uptake network (https://www.nutriman.net). for utilization and exploitation of the results; key enabling technological achievements and actual system proven in operational environment.

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Coming up…

2023 – 2024 **TRL7-TRL8**	TRL7 large scale demonstrations and **TRL8 validations targeted, incl. REACH and (EU) 2019/1009 conformity assessments.**
2024 – 2025 **MARKET CAPITALIZATION and replications** **TRL9**	Implementation of the TRL9 full industrial REPLICATOR with 20,800 t/y throughput capacity and sales plan over €15 million/year targeted. Extensive market valorization and market capitalization of the 3R Zero Emission Pyrolysis technology and Bio-Phosphate products to reach immense market and economic values in the EU, USA, Australia and Japan. **5-10 replicated full industrial projects** targeted in several EU countries, USA and Australia with business objective to exceed >€100million scale.

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SCIENCE to ACHIVE DEMONSTRATED RESULTS IN PRACTICE

Acknowledgement: I am using this opportunity to express my gratitude to the European Commission and all Partners who supported throughout the course of the 3R pyrolysis technology and biochar product development project since 2002. The 3R development has been built up step by step, whereas these key important projects have been the coherent and integrated building stones of the past decade, which systematic efforts resulted a fully matured and comprehensive solution for „science to achieve results" by 2022.

1) The **NUTRIMAN** project is co-funded by the European Union, Seventh Framework Programme under Grant Agreement number 818470, 2018-2022.
2) The **REFERTIL** project is co-funded by the European Union, Seventh Framework Programme under Grant Agreement number 289785, 2011-2016.
3) The **PROTECTOR** project is co-funded by the European Union, CIP Eco-innovation under Grant Agreement number ECO/08/238984/SI2.532247, 2009-2012.
4) The EU FP7 **EUPHOROS** project is co-funded by the European Union, Seventh Framework Programme, under Grant Agreement number 211457, 2009-2012.
5) The EU FP6 **PROTECTOR** project is co-funded by the European Union, Sixth Framework Programme under Grant Agreement number 514082, 2005-2009.
6) The EU FP5 **MULTI FUEL** project is co-funded by the European Union, Fifth Framework Programme under Grant Agreement number NNE5/363/2001, 2002-2005.

3R CARBON RELATED WORK FIELDS:

- **Carbon Recycling and Refining**, thermal processing by zero emission carbonization for recycling of carbon for wide range of natural and carbon negative product applications.
- **Phoshorus recovery.**
- **Carbon Bio-formulation**, biotech formulation of carbon for efficient bio and plant availability of nutrient uptake process support. SSFF solid state fertmentation/formulation.
- **Carbon Bio-energy**, chemical processing of pyrolysis gas-vapors and bio-oils for syngas and bio-energy production and other added value products.

3R TECHNOLOGY MAIN ELEMENTS:

- **CARBONIFEOUS MATERIALS-to-REFINED CARBONS:** carbonization process (main technology), indirectly heated horizontally arranged rotary kiln vacuum pyrolysis.
- **CARBON BIO-CARRIERS:** solid state fermentation and formulation, biotech process, where specific and biotech adaptable carbon is used as solid carrier for soil microorganism for purpose of accelerated and plant available mineral dissolution, develop controlled microbiological environment in soils with effects of plant growth promotion and biocontrol by effects. Objective: safer food production for less cost.
- **CARBON-to-LIQUID FUEL (biomass-to-liquid fuel):** catalytic conversion of raw pyrolysis gases/oil liquids to high grade liquid bio-fuels and other added value products/organic chemicals.

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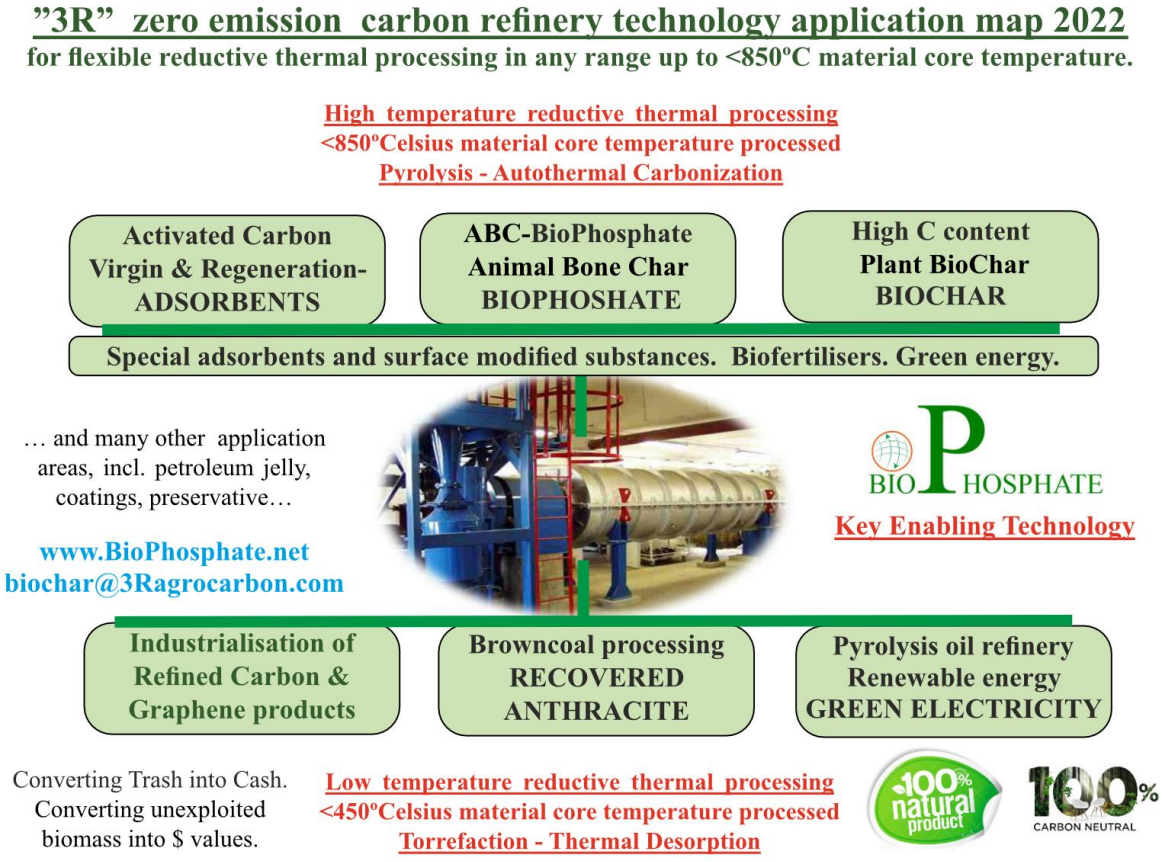
3R APPLICATIONS:

- **Agriculture - horticulture:** plant and/or food grade animal bone (category 3, 2) based biomass refinery conversion, biochar, bone char; fully natural bio-NPK-C fertilization organic P fertilizer (**ABC Animal Bone bioChar**) for food crop productions with biocontrol and plant growth promotion effects, and strong support of drought and salt tolerance food crop/forest cultivations.
- **Energy Biomass:** plant and/or animal MBM/PAP organic waste to solid (bio-carbon) and liquid (steam reformed producer gas, bone oil (Dippel's Oil), bio oil, thermal energy.
- **Energy Clean Coal:** large industrial scale conversion and valorisation of brown coal into clean coal and liquid fuel kerosene. Conversion and valorisation of scrap tire rubber crumb into liquid fuel and secondary carbon black.
- **Adsorbent**: ABC bone char adsorbents for very high efficient treatment of macromolecular organic contaminations, heavy metal and radionuclide contaminations.
- Other applications are for cases by case considerations.
- **IPR Intellectural property rights**

  Sole inventor and sole owner is Edward Someus.

  The 3R is developed and industrial designed by Edward Someus.

  The 3R original solution is protected by confidential industrial designs and know-how.



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