

REIMAGINED COALS With MicGAS Coal Biotechnology for, a Practical, Economic Value Generation Path for Pollution Free and Net Zero Carbon Emissions, while Producing Clean Fuels, Increasing Food Production, Clean Waters, and Wastes Recycling.

A High-Level Technology Brief—March 2022

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Developed over 30+years based on realizing scientifically coals are biomass not fossil fuel, a misnomer even for oil, shale, and gas. A fossil in scientific terms is the remains of plant and living forms, whose tissues have been replaced by mineral matter without much carbon and are rendered noncombustible. So, coals are ancient plant biomass. Gas is always associated with coal, oil, and shale, produced by microbes. Even microbes produce gas in humans and animals. We used wood-eating termites to feed on coals. From their guts, we isolated the unique microbes, which have now been adapted to digest coals to produce gas without having to burn the coal. Gas is converted with proven technologies to aviation fuel or other products. Residue from digester is bioprocessed and converted into organic humic products. No wastes are produced. **So, our coal biotechnology emulates nature.** The humic matter being plant originated in coals is same as we know humus or soil organic matter. It makes soils fertile and so far, we know is unique to our planet and contributes to its viability. Soils are the fourth largest storehouse of carbon as humic substances. First are sedimentary rocks, second coal, oil, gas, and third oceans. Fifth is air. We are not only increasing carbon in the air but stripping our soils of organic humic matter. Today, depleting organic humic carbon in soils is equally at peril as increasing carbon in our air. Thus, our approach of use of humic products derived from coals offers a path forward to replenish the humic matter in soils while mitigating carbon emissions, producing economic value, and maintaining the viability of our planet.

We have also established the feasibility of injecting the microbes in deep unmineable coal seams to produce gas for converting to aviation fuel. USGS states 9.5 trillion tons are in US Coalfields. DOE EIA reports make up 90.7 % of all fossil fuels worldwide. Presently, we are making at our prototype coal biorefinery in Virginia multiple organic humic products for agriculture use to increase soil fertility and crop yields, reclaim lands, water clean-up, wastes treatment, and recycling.

Even for capturing CO₂ and safe destruction of military obsolete munitions and nuclear wastes disposal. Approved for use by USDA, USEPA, and several States in the USA and in China, India Egypt, etc. Proven in meeting real-world needs.

Our integrated approach of making energy and non-energy products allows producing 20-40X profitable revenues from a ton of coal than the current approaches of its use. It follows Rockefeller's business model he fostered for higher sulfur oil discovered in Ohio to make kerosene and asphalt. Oil companies continue to capitalize on this model with the use of technologies to make myriad of energy and non-energy products even during wide fluctuating oil prices. Even today 70% of oil costs less than \$10 per barrel. Saudi oil is only \$2-3 per barrel. Since 1973 we have experienced almost six times wide price fluctuations. A year ago, almost dropped to zero price. A myriad of coal technologies developed since the 1973 oil embargo has been unable to compete with when oil prices came down with OPEC set production manipulations. Our technology approach offers to overcome this barrier. Oil and gas continue to be geopolitical challenges as some have it some do not. Whereas coal is available on all the continents and harnessing it with our technology can become an equalizer and geopolitical stability.

MicGAS Coal Biotechnology offers to mitigate emissions of the most prevalent greenhouse CO₂ gas both directly and indirectly from both coal use and from other sources as follows: 1. Directly by capturing CO₂ and other pollutants with the use of coal-derived humic reagent. The spent humic reagent with bound CO₂ and pollutants is recycled in a water filter product. Thus, enabling permanent sequestration of carbon while deriving economic value by controlling toxic leachates from coal wastes and ash ponds. 2. Indirectly, the use of coal-derived humic acid in soils for re-carbonizing, improving their fertility for increasing crop yields as well as planting trees even in impaired lands while capturing 10 Tons of CO₂ and releasing 6 Tons of oxygen per acre per year. Note: www.ihccs.org

IHS Markit Crop Science Forum 2021 Award Winner for improving efficiency, delivery of fertilizers while enabling farmers to increase crop yields, quality, soil health-fertility, sequester carbon and mitigate increasing ecological concerns

The Director of Air Pollution Control at EPA has stated that **“this approach lowers the environmental footprint from coal use and a creative value generation approach for mitigation of carbon emissions”**. Some time ago Senator Vance

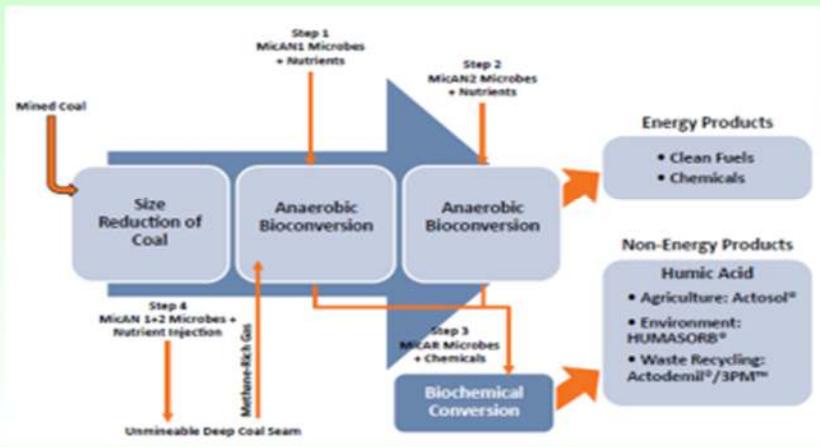
Hartke, from the coalfields in Indiana had characterized Dr. Walia's coal biotechnology business model akin to the genius of John D. Rockefeller and Thomas Edison's approach of fostering new ideas into practically applied and cost-competitive innovation of possibilities. ARCTECH has utilized the Iroquois Indians 7th Generation impacts analysis to ascertain if any future collateral damages and concluded none were expected. Rather this approach of coal use would give our future generations a legacy of facing challenges with creative value-generating solutions.

Widespread deployment of this game-changer multi solutions technology requires another "Moon Shot" and harnessing the strengths of institutions of government, industry, and academia to address this common global goal, which otherwise is stove-piped. *Propel the second industrial revolution ... just as steam production from coal combustion helped propel the first industrial revolution in the mid-1800s*

The patented MicGAS™ technology is based upon applying natural microorganisms adapted to digest coal under anaerobic conditions in equipment similar to wastewater treatment systems. This results in the production of biogas, which is a mixture of methane and CO₂. If desired; the methane gas can be separated from the CO₂ to produce a gas equivalent to natural gas. The unconverted coal from the anaerobic digester is further subjected to a biochemical process for extraction of the humic acid products.

ARCTECH has developed this technology by adapting microorganisms (derived from wood-eating and humus-eating termites) to coal in presence of appropriate nutrients. The process conditions have been optimized to achieve high rates of gas production and humic acid products.

Integrated MicGAS™ biotechnology process flow scheme

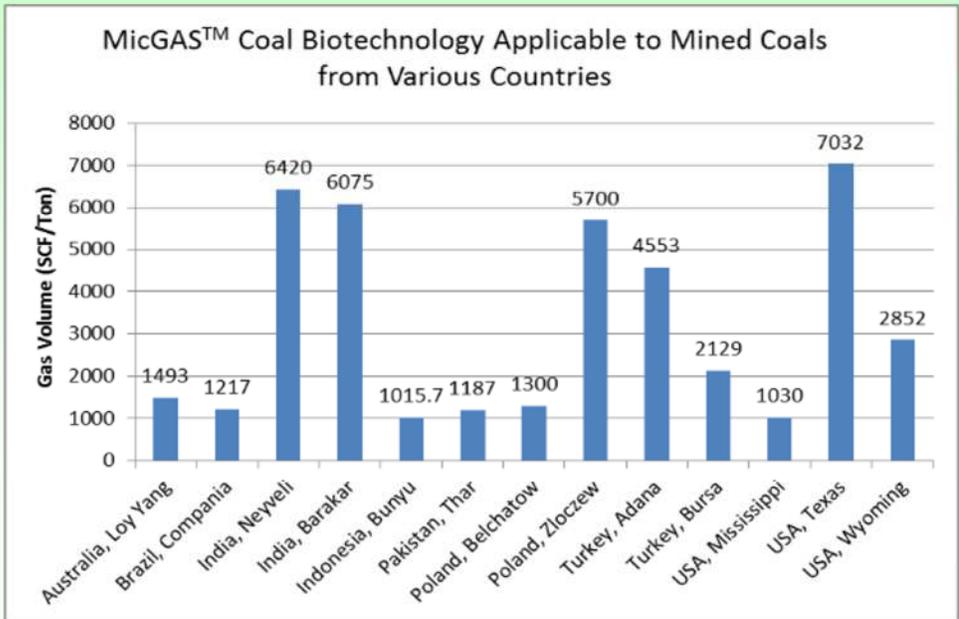


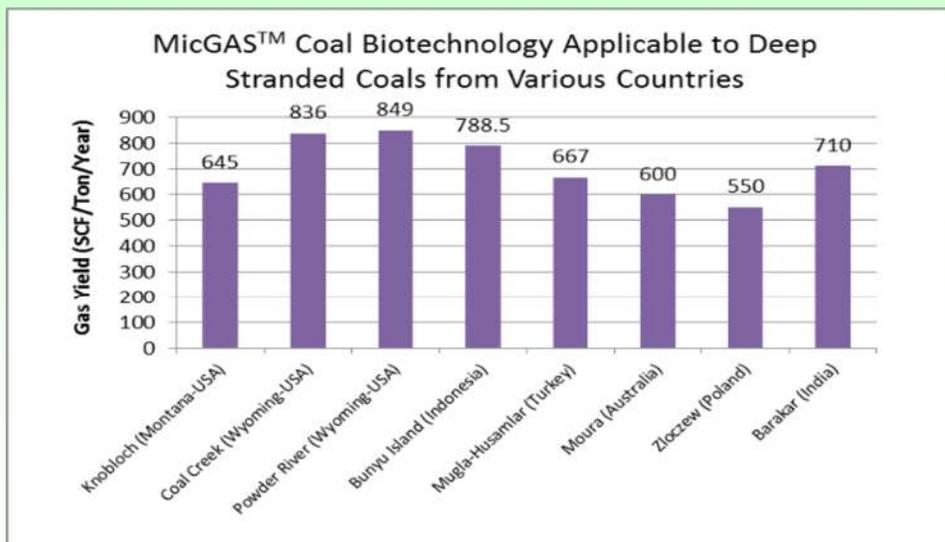
MicGAS™ COAL BIOTECHNOLOGY PROCESS SCHEMATIC

The bioconversion is accomplished in four major steps as shown in the simplified flow scheme in Figure 1. In the first step, the hydrolytic and fermentation process, the proprietary microbes convert the coal into volatile organic liquids (primarily acetate and CO₂). In the second step, the organic liquids are fermented with methanogenic (methane-producing) microbes to produce biogas. In the third step, the residue coal is subjected to biochemical conversion under aerobic conditions to produce humic acid. The humic acid is further formulated in salable products.

The fourth step entails the injection of microbes and nutrients into the deep otherwise unmineable coal seams. This results in gradually converting the coal into gas, which is then pumped to the surface. This approach has been validated in collaboration with a major gas company for in situ coal bed gas enhancement of many depleted wells and from un-mineable deep coal seams. Highly economical gas at about <\$2 per million Btu is projected to be produced; however, no humic

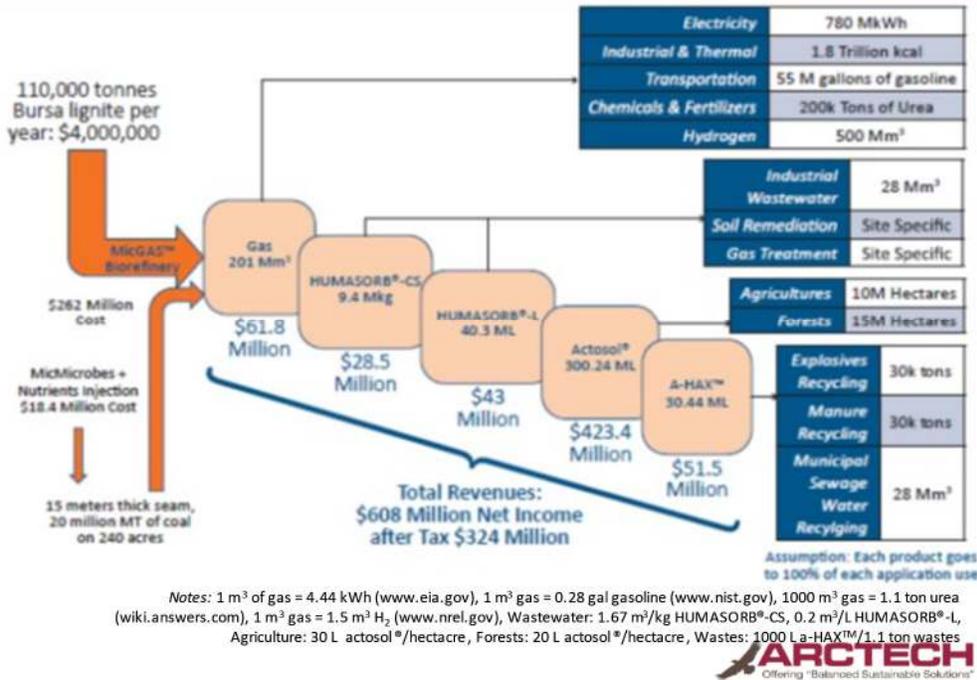
acid co-products are produced unless the residue coal can be extracted for surface processing.



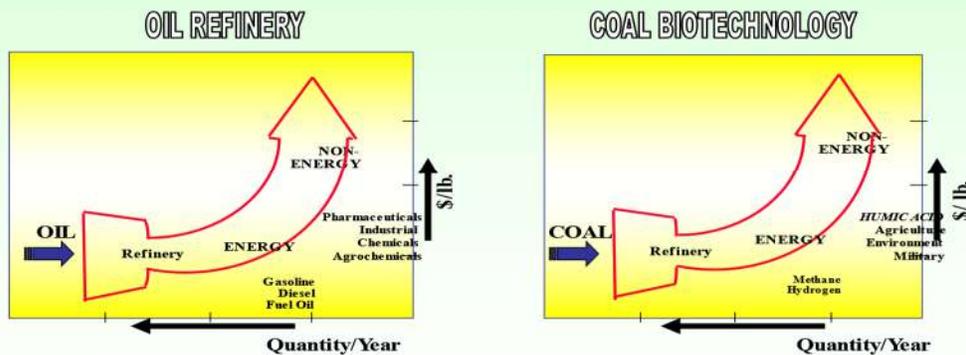


The coal utilization concept of MicGAS™ technology is similar to that used in oil refineries. A barrel of crude oil as a result of cracking and refining provides a multitude of products that are valued at several times higher than the price of crude itself. The higher value obtained from the sale of these by-products (petrochemicals) enables the oil industry to sell #6 oil to the power companies at almost the same or below the crude price coming into the refinery. Even though the strategy of MicGAS™ follows the oil refinery's multiple product scenarios, it evolves around products based on unique humic acids developed from coal and will serve large agriculture and environmental market sectors, and thus, will not compete for traditional petrochemical markets.

Total value chain of HUMAXX MicGAS™ coal biorefinery for Turkish lignite



Coal Biotechnology Follows Rockefeller Oil Refinery Strategy of Producing Low Cost Energy Fuels By Creating High Value Non-Energy Co-Products



Humic Acids Co-Products are unique to coal because of its plant origin--- can not be made from oil.



ARCTECH has already established the market viability of the following humic acid products being made at its Coal Biorefinery in South Boston, Virginia from humic-rich lignite:

- **actosol®**, humic acid fertilizer for agriculture for increasing crop yields, sequestering carbon in soils while enhancing soil health and fertility.
- **HUMASORB®**, a humic acid absorber for removal of contaminants from waters, gas and combustion gases including carbon dioxide, and recycling into a water filter.
- **ActoHAX™**, for safe treatment and recycling of wastes. **Actodemil®**, explosive munitions into fertilizer; **3 PM™** (Pollution Prevention and Profits from Manures) for recycling of animal manures to organic fertilizer
- **ActoCLENSE™**, a multipurpose industrial cleaner for poultry farms for mitigation of ammonia and pathogens.
- **ActoNUTRITION™**, a Water Soluble, Chelated Nutrients, Carbs, Protein for Efficient Healthy Feed for Poultry and Cattle

The strategy underlying MicGAS™ technology is to capitalize on the inherent plant-based nature of coals to create high-value, carbon-rich humic acid products for large agricultural and environmental market sectors while making available low-cost methane gas to produce “clean” power. The scientific feasibility of this approach has been established by utilizing naturally occurring microorganisms to convert coals, under anaerobic conditions, into methane gas, and by biochemically converting coal residue under aerobic conditions into humic acid. The low-rank lignite and sub-bituminous coals have been shown to be amenable for producing methane gas, liquid humic acid for agriculture, and solid absorbers for water treatment. Whereas the higher rank bituminous and anthracite coals are amenable to producing methane and only solid adsorber. This difference is attributed to the high polymerized nature of higher rank coals. However, the high sulfur bituminous coals, which are highly undesirable as fuel, produce highly effective absorbers for capturing highly toxic contaminants. This approach results in the complete utilization of coal **without any** waste by-products.