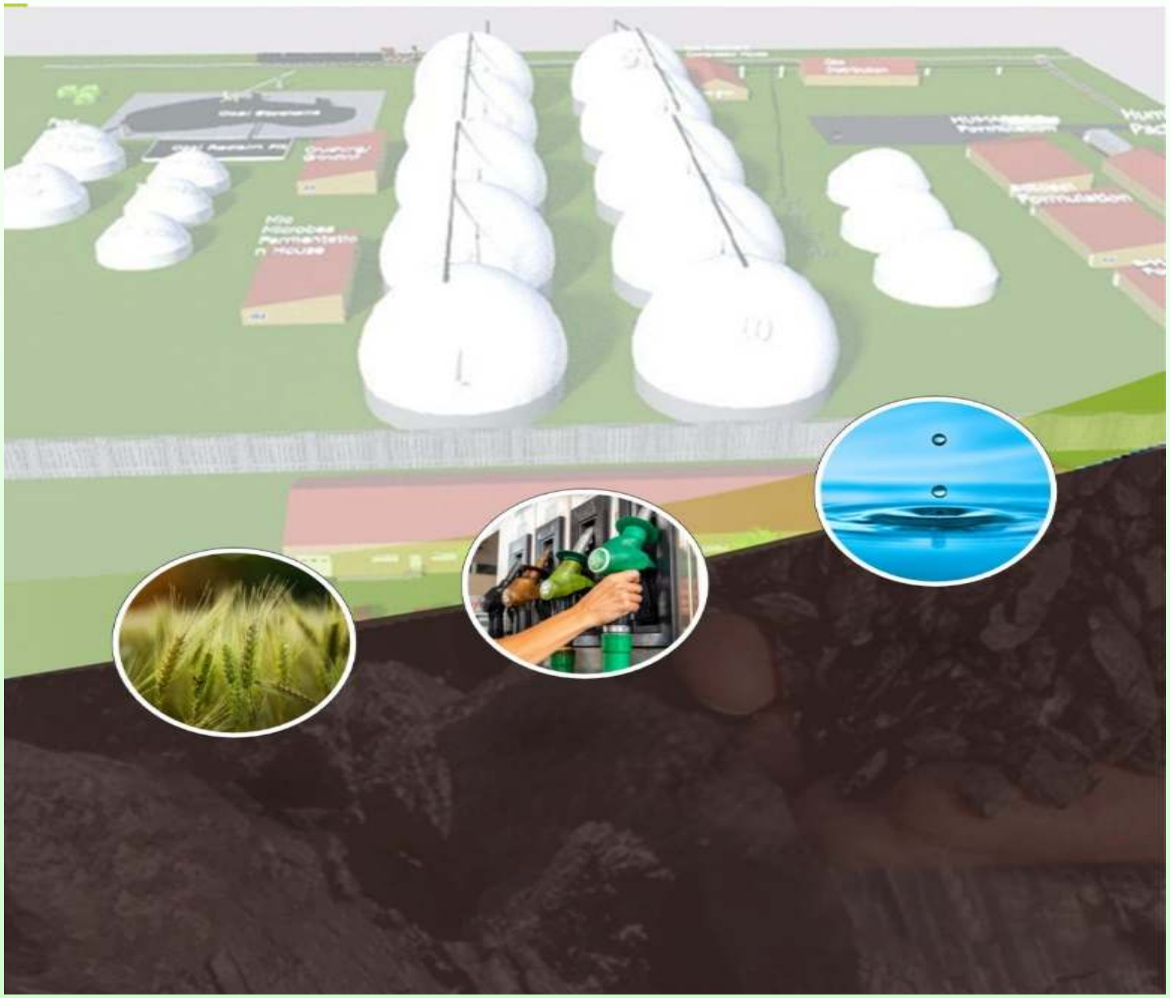
MicGAS™ Coal Biotechnology Lowers Environmental Footprint from Coal Use and Creative and Value Generation Approach for Mitigation of Carbon Emissions



Technology Presentation

By

ARCTECH, Inc.

Centreville, Virginia USA

POC: Dr. Daman S. Walia

571 3338-5005

dwalia@arctech.com

www.arctech.com

January 2023

Balanced Sustainability

ARCTECH

Preserving tomorrow's world... today

ARCTECH Corporate Profile

- Established in 1988 as Spin-Off Company
    - From a Major US Aerospace Company
- Corporate Headquarters & Technical Research Center
    - Virginia—Washington DC Metro
- Manufacturing Plant
    - South Boston, Virginia
- Market Profile: Develop Innovative Solutions from Concept to Implementation for the Energy, Environmental, and Agricultural markets
- Commercial Products Applications in the US, Egypt, Gulf Countries, & South Korea
- Creating Biotechnology Solutions since Mid 70's
- Selected as One of the Top Six Bio-Processing Firms in the United States
    - By Ernst & Young in 1989
- Founding Member of *Humic Products Trade Association (HPTA)* in 2011

Chronology of Biotechnology Development at ARCTECH

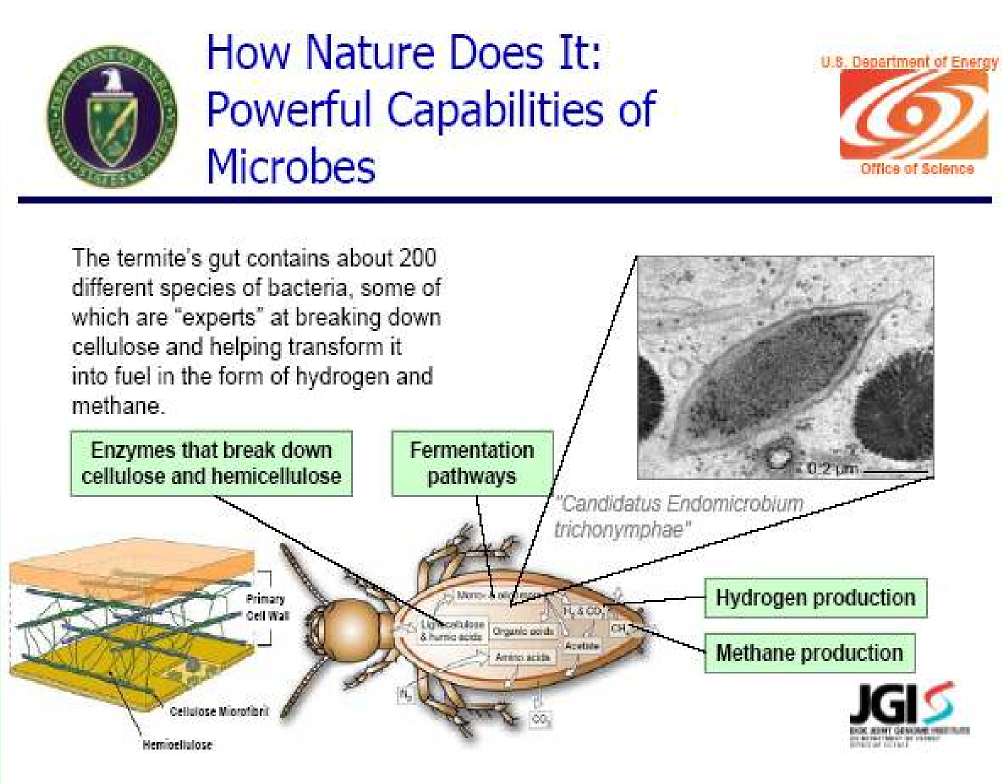
1970-1980	Bioremediation of Explosives in Composting Reactors for U.S. Army
Mid 1980s	Biodesulfurization of Coals
1987	Bioconversion of Lignite Coal to Methane Development of coal-derived humic acid products
1990	Established Feasibility of *in situ* Coal to Methane Application in Packed Columns
1990 -1995	Enhancement of technology for lignite and higher ranks of coals under sponsorship of DOE, GRI, EPRI, and Houston Lighting and Power. Establish the feasibility of biogas from residue oil, tar sands, crop residues (rice and wheat husk), and animal manure Introduced commercial actosol® humic acid organic fertilizer, HUMASORB® multipurpose water filter and Actodemil® for military munitions recycling
1997 - 1998	BIOREACTOR DEVELOPMENT U.S. Patents Received
1999-2000	Feasibility tests at high pressure for in situ biogas from coal
2000-	Genetic Enhancement and Development of Applications-Continuing
2012-	Advancement of HUMAXX Coal Biorefinery & Commercial Applications of Products Worldwide

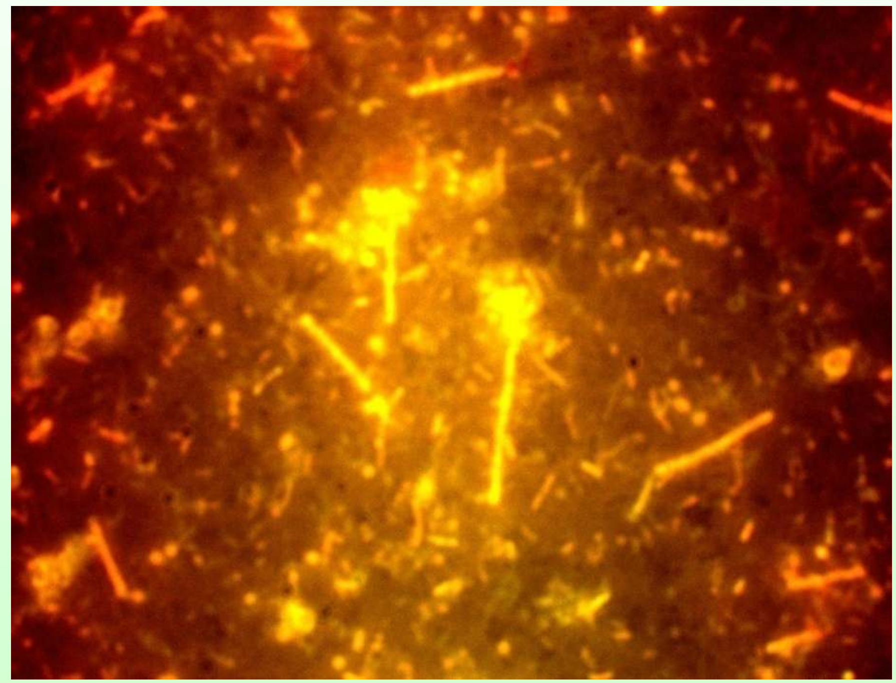
Balanced Sustainability

Preserving tomorrow's world... today

MicGAS™ Coal Biotechnology Among U.S. Department of Energy 14 Transformation Technologies

US Department of Energy *2007*





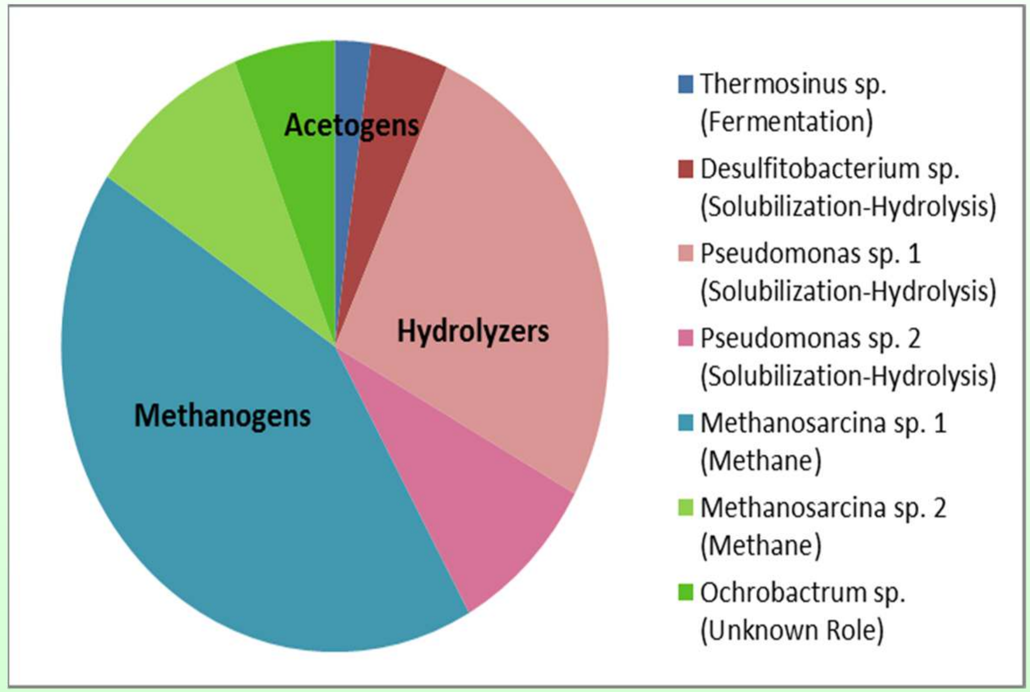
Mic1 Biotechnology Microbes from Termite Guts

Dr. Steven Chu sees an America free from foreign oil, powered by home-grown genetically engineered and eco-friendly fuel.
The Nobel laureate gets his inspiration from the guts of termites.
The processes that allow insects to turn the hard fabric of plant material - cellulose - into an ethanol-like fuel is the key to cheap, clean-burning and virtually limitless fuel.

Multiple Groups of Microbes Bioconvert Coals in MicGAS Biotechnology (Metagenomics Analysis)

Degradation Steps	Example KEGG Metabolic Pathways	Representative Microbes[1]
1. **Coal Solubilization and Degradation**:	Biofilm Adhesin Biosynthesis	*Bacillus* sp.
	Exopolysaccharide Biosynthesis	*Cupriavidus* sp.
	Rhamnolipids in Pseudomonas	*Desulfitobacterium* sp.
Coal-components released and converted to intermediate compounds	Anaerobic Benzoate Degradation	*Pseudomonas* sp.
	Biphenyl Degradation	*Ralstonia* sp.
	Central Meta-Cleavage of Aromatics	*Rhodococcus* sp.
	Homogentisate Degradation Pathway	
	n-Phenylalkanoic Acid Degradation	
2. **Fermentation and Hydrogen Formation**:	Acetyl-CoA to Butyrate	*Alkaliphilus* sp.
	Acetone Butanol Ethanol Synthesis	*Clostridium* sp.
	Alcohol Dehydrogenases	*Pelotomaculum* sp.
Intermediates converted to smaller, easily-metabolized compounds	CO Induced Hydrogenases	*Treponema* sp.
	Fermentation: Mixed Acids	*Veillonella* sp.
3. **Methane Generation**:	Coenzyme F420	*Methanobacterium* sp.
	Methanogenesis	*Methanoculleus* sp.
Simple compounds converted to methane-rich biogas	Pyrrolysine	*Methanosarcina* sp.
	Serine-Glyoxylate Cycle	

[1]Genus-level annotations based on >70% metagenome sequence similarity with best hits in databases.

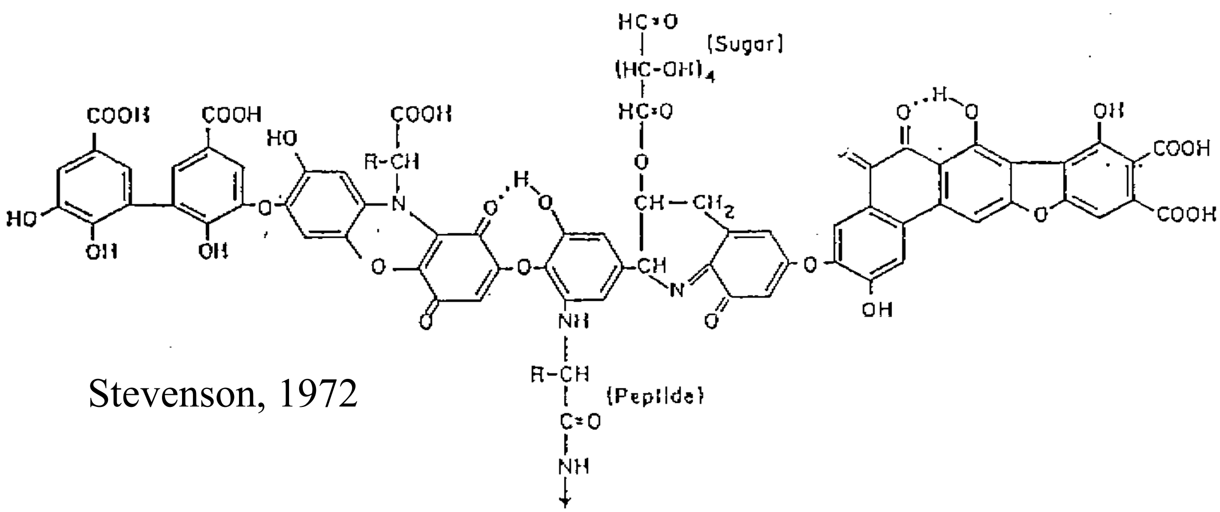


Balanced Sustainability

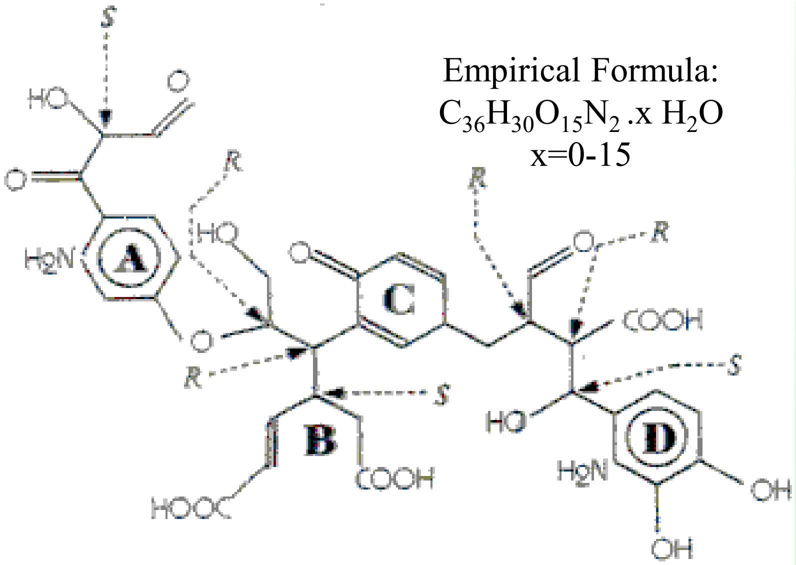
ARCTECH

Preserving tomorrow's world... today

Coal and Humic Substance Similarities



Stevenson, 1972



Empirical Formula:
$C_{36}H_{30}O_{15}N_2 .x\ H_2O$
x=0-15

TNB, 1998 (Temple, Northeastern and Birmingham)

Element	Humic Acid %	Coal
Carbon	53.8-58.7	60–75
Hydrogen	3.2-6.2	6.0–5.8
Oxygen	32.8	34
Nitrogen	0.8-4.3	1.5
Sulfur	0.1-1.5	0.2-10

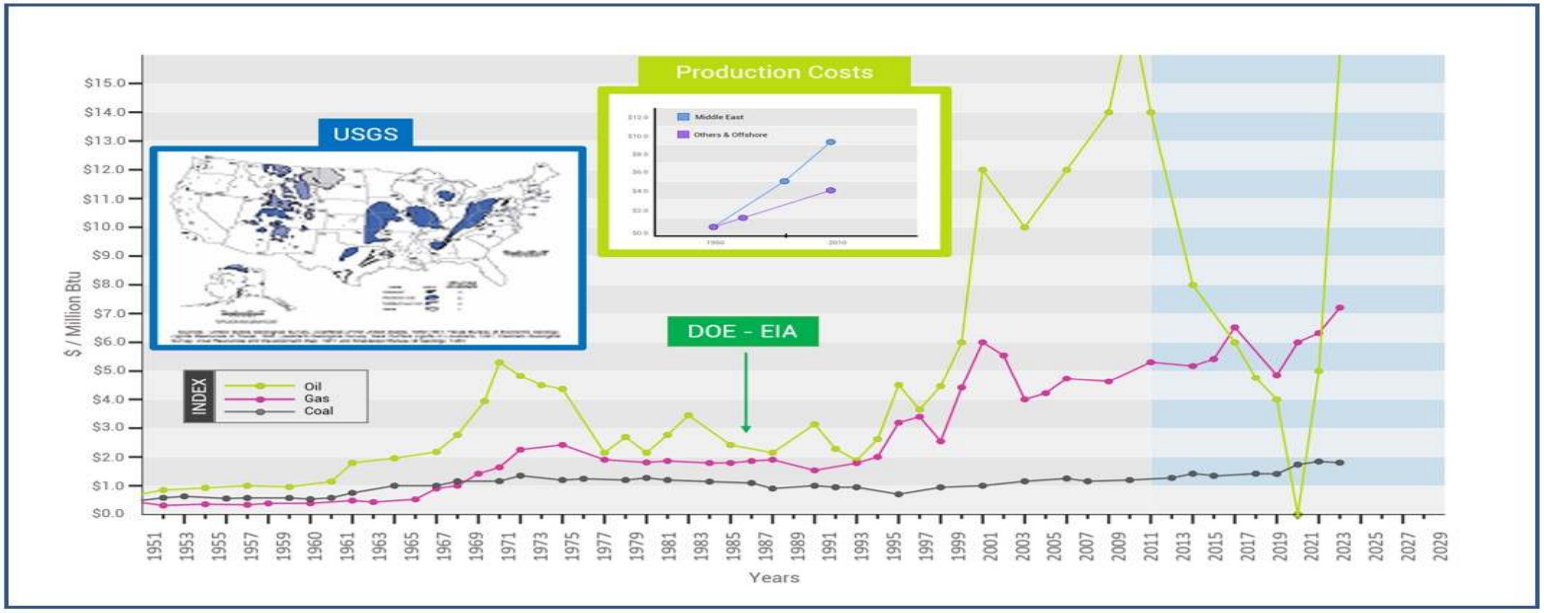
Financial Times 2014

Major Exploration Country	Exploration Type	Marginal Production Cost	Transport Costs to major Distribution Channel
Saudi Arabia	Onshore	3	4
Middle East ex Saudi	Onshore	14	4
Russia	Onshore	18	12
Other former USSR	Onshore	21	12
Venezuela/Mexico	Standard	32	4
Norway/UK	Northsea	50	2
United States	Deep-water	57	2
Brazil	Ethanol	66	5
Brazil	Offshore	80	2
United States	Shale	73	12
Canada	Sand	90	15
Europe	Ethanol	103	2
Europe	Biodiesel	110	2
Russia	Arctic	120	5

Coal is the Most Abundant and Lowest Cost Source of Carbon for Fuels and Chemicals

Source	**$/Ton**	**% Carbon**	**$/Ton Carbon**
Waste Biomass	-5 + 40	25	-20 + 160
Cultivated Biomass	60	25	240
Corn Grain	120	30	400
Coal	**5-40**	**60**	**12.5-100**
Oil	**$60/BBL**	**85**	**530**
Gas	**$3/Mbtu**	**60**	**180**

Artificial Pricing of Oil Since First Oil Embargo of 1973 is at the Crux of Dilemma in Commercializing Energy Technologies



Dec. 07, 2008. Saudi Oil Minister Ali Al-Naimi made following three points to Leslie Stahl on 60 minutes:

1. We are not drug dealers who are making you addictive. You need it, we have it and we will sell it to you.
2. You do not have alternates.
3. It costs me less than $2 per barrel to produce oil.

May 31, 2011. Saudi Prince Talal in an interview with Fareed Zakaria, on CNN, stated "*The kingdom could use low oil prices to stave off alternate energy development. We do not want the west to find alternatives.*"

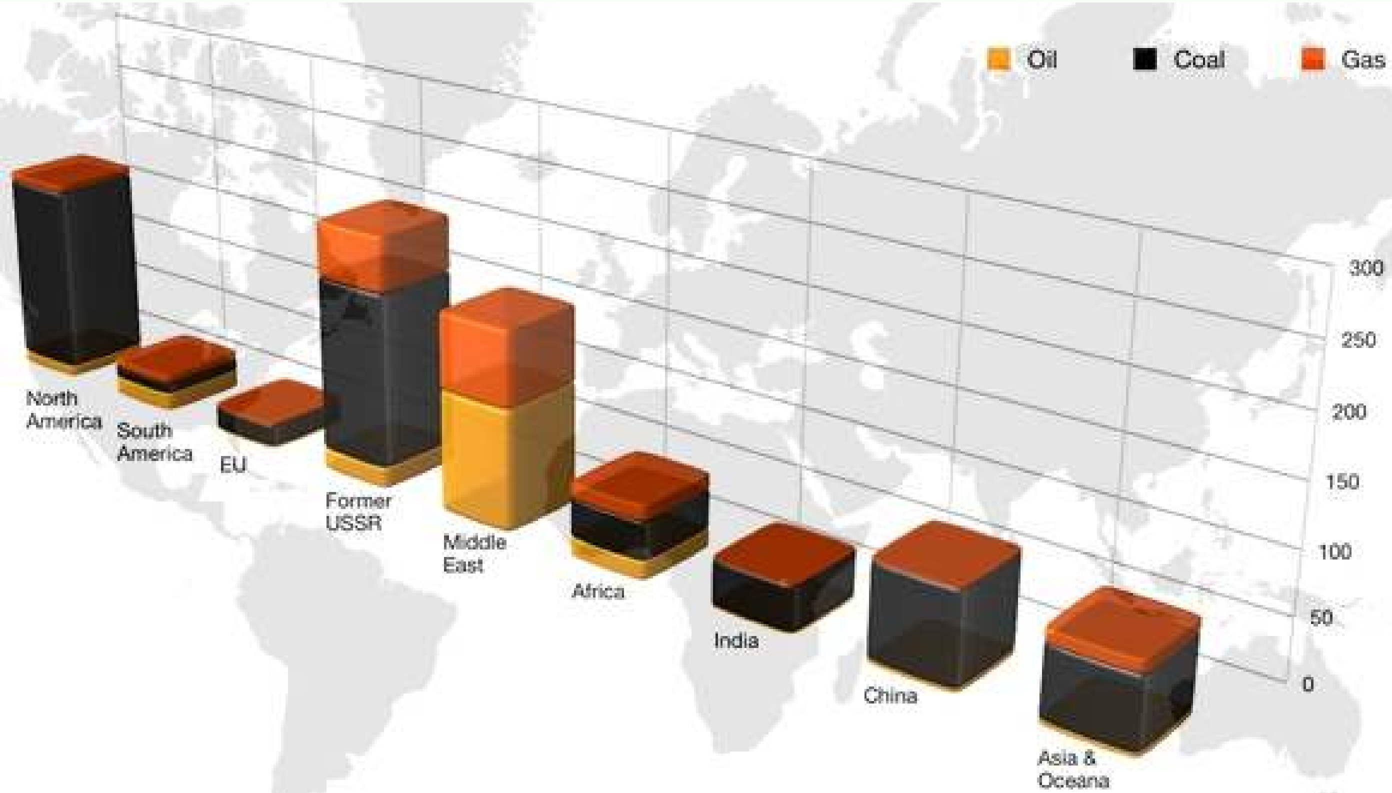
Feb. 24, 2022. Russia-Ukraine war begins.

NOW Countries Controlling Large Oil &Gas Reserves and Production At Limited Places Have Weaponized These. Coals Available On All Continents Used with MicGAS Coal Biotechnology Offer Path for Overcoming this Challenge

Balanced Sustainability

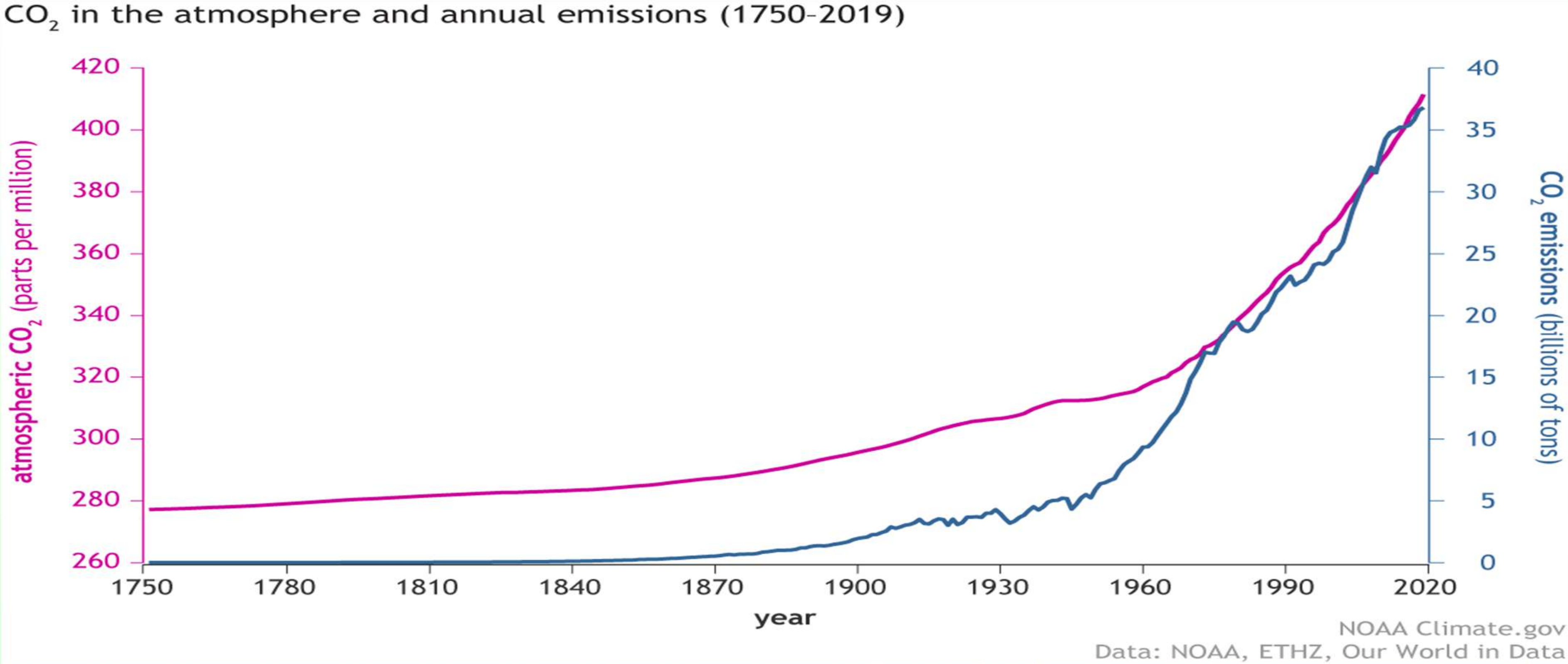
ARCTECH *Preserving tomorrow's world... today*

Almost One Trillion Tons of Coal Reserves Available In Almost Every Country Worldwide Sufficient for Next 200+ Years at Current Rate Consumption



In Million Short Tons	Total reserves	Percent of world reserves
Total World	948,000	100%
United States	260,551	28%
Russia	173,074	18%
China	126,215	13%
Australia	84,217	9%
India	66,800	7%
Germany	44,863	5%
Rest of World	192,281	20%

URGENT Need for Mitigating Huge Carbon & Other GHG.s Emissions from Past and Future-Globally To Protect Our Planet & Provide for its Inhabitants



with human emissions (Blue Line)

FAST,SUSTAINABLE,COST EFFECTIVELY AND EVEN ECONOMIC VALUE GENERATION

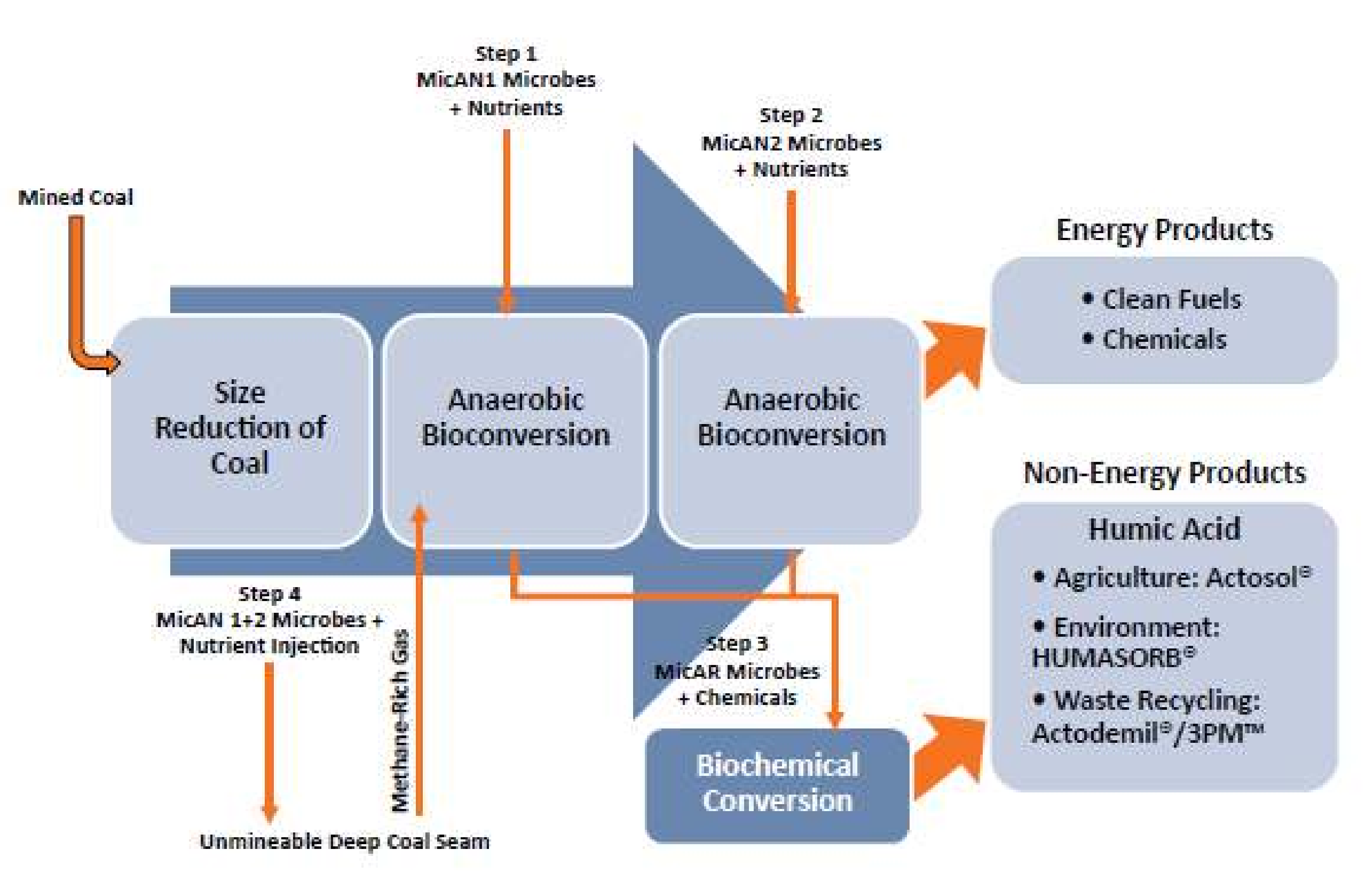
www.climate.gov

Balanced Sustainability

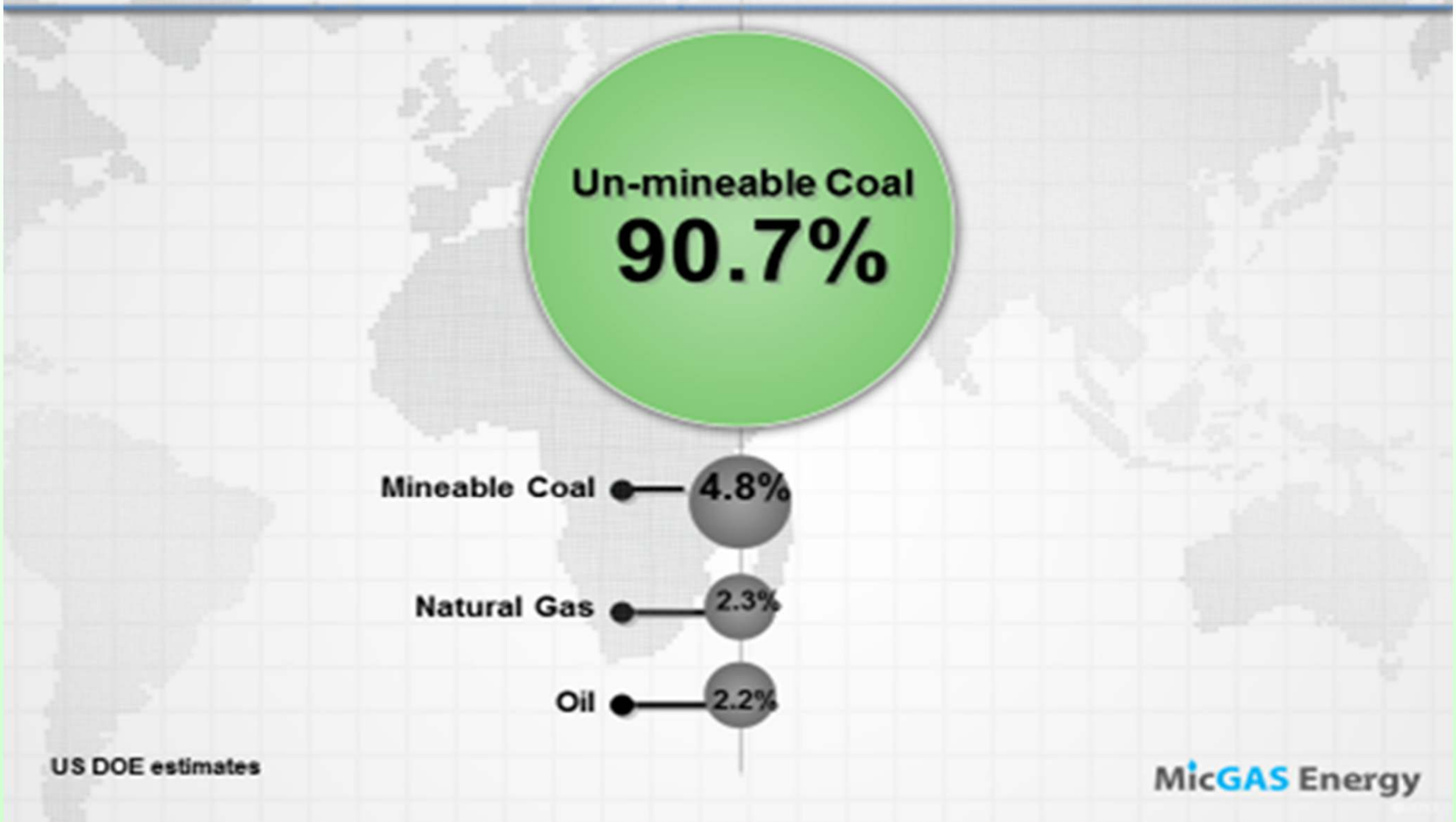
ARCTECH

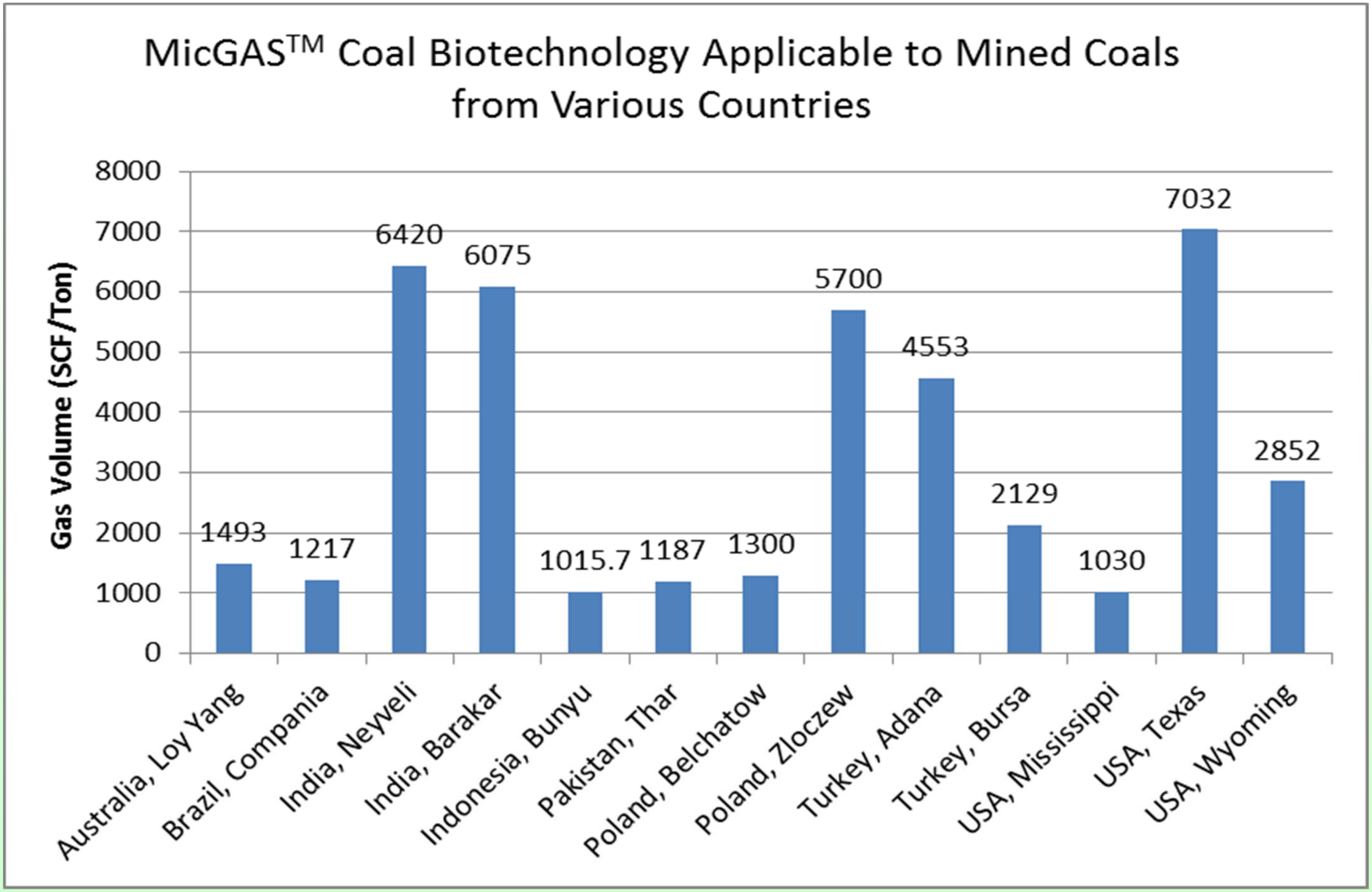
Preserving tomorrow's world... today

Integrated MicGAS™ biotechnology process flow scheme



Global Fossil Energy Resource Distribution



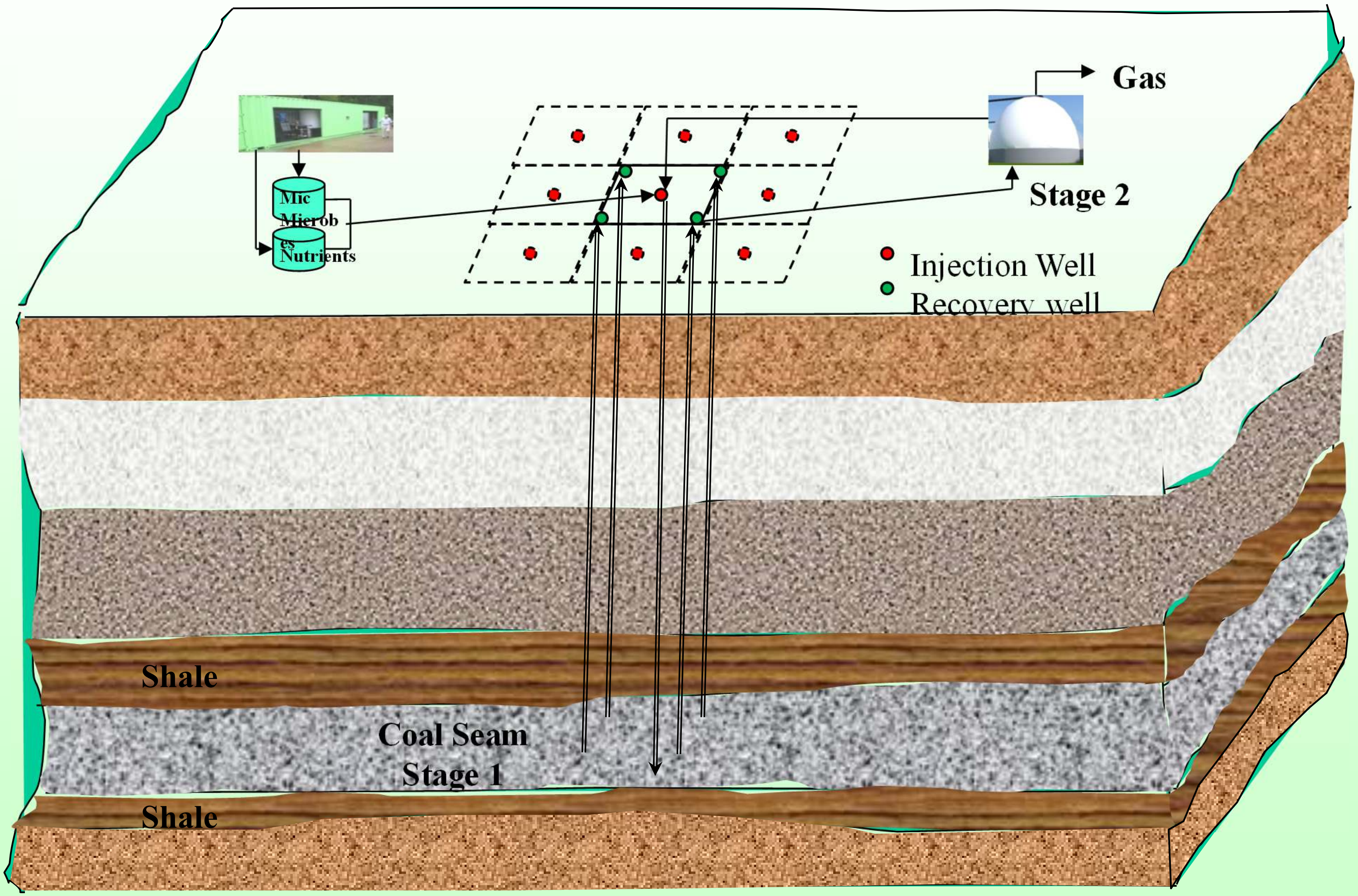


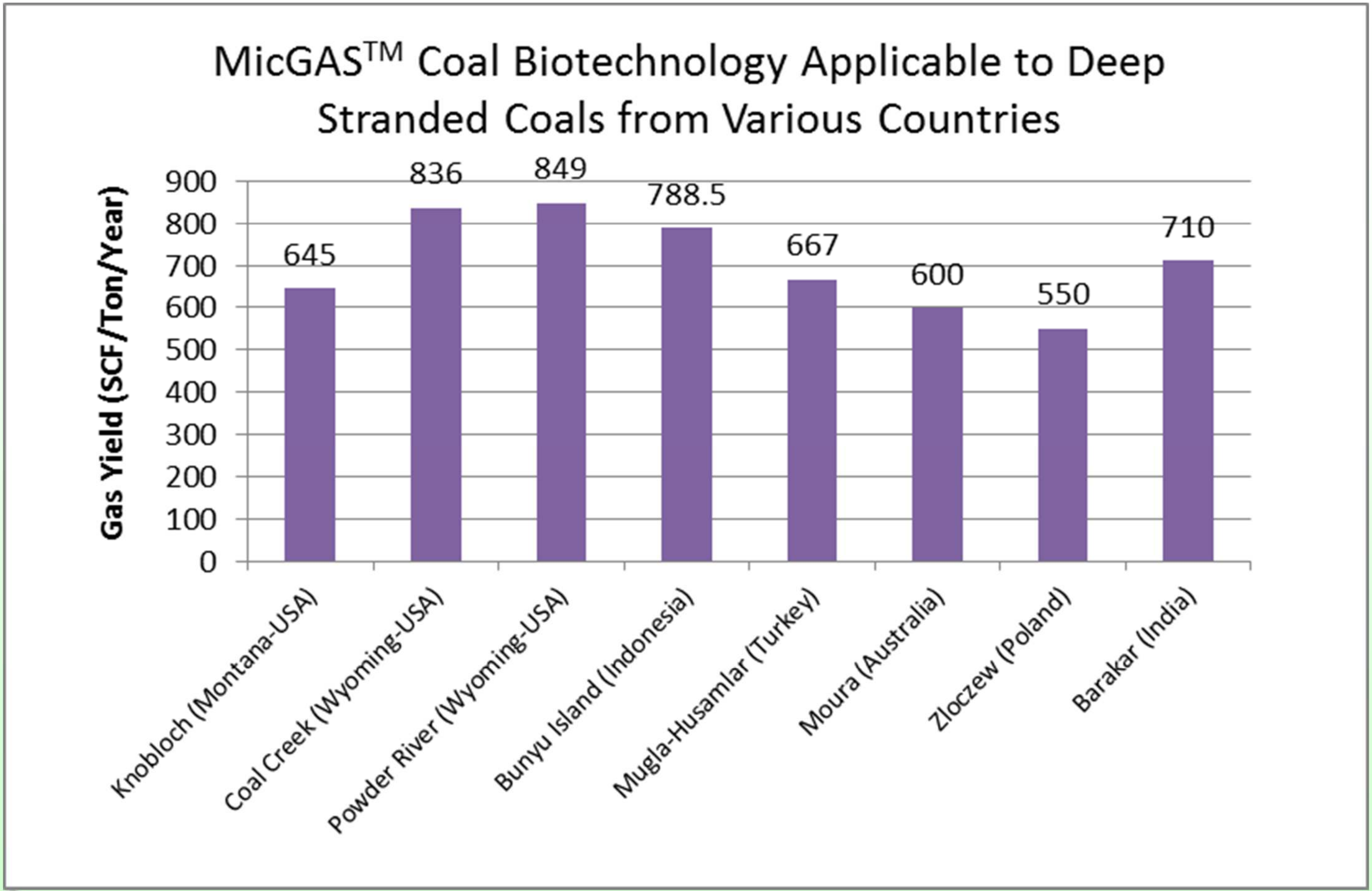
Balanced Sustainability

ARCTECH

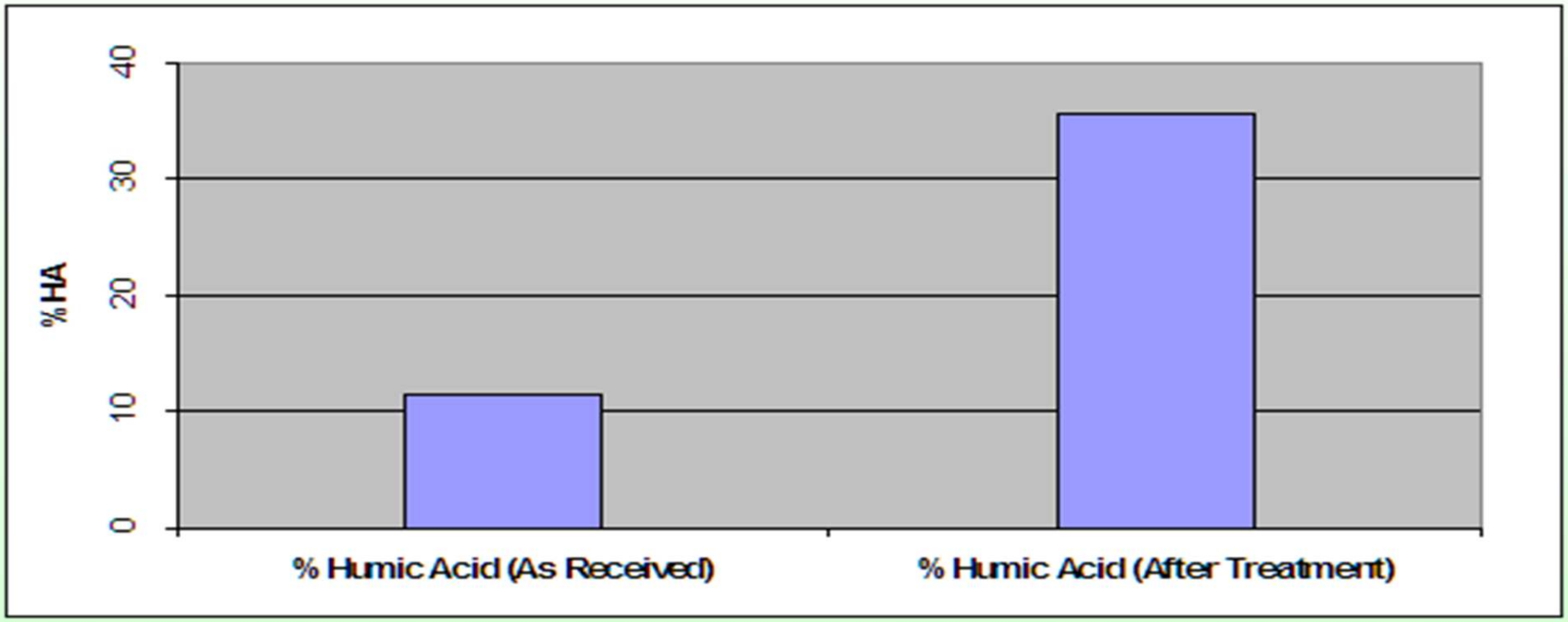
Preserving tomorrow's world... today

MicGAS™ In Situ Facility Layout




MicGAS™ Coal Biotechnology Applicable to Deep Stranded Coals from Various Countries
Gas Yield (SCF/Ton/Year)
900
800
700
600
500
400
300
200
100
0
645
836
849
788.5
667
600
550
710
Knobloch (Montana-USA)
Coal Creek (Wyoming-USA)
Powder River (Wyoming-USA)
Bunyu Island (Indonesia)
Mugla-Husamlar (Turkey)
Moura (Australia)
Zloczew (Poland)
Barakar (India)

Increased Extractable Humic Acid After MicGAS Coal Bioconversion



No Toxic Metals in Actosol Humic Acid Fertilizer Produced From Wyoming Sub Bituminous Coals

Toxic Metals, ppm	Humic Acid		RCRA Regulatory Level, ppm
	Black Thunder	Coal Creek	
Ag	0.12	N.D	5.0
As	0.499	0.365	5.0
Ba	14.7	17.64	100.0
Cd	N.D	N.D	1.0
Cr	0.656	0.548	5.0
Hg	0.017	0.013	0.2
Pb	N.D	N.D	5.0
Se	N.D	N.D	1.0

MicGAS™ Coal Biorefinery Plant Products
Carbon and Mass Balance

1 Tons of Wyoming Sub-bituminous Coal

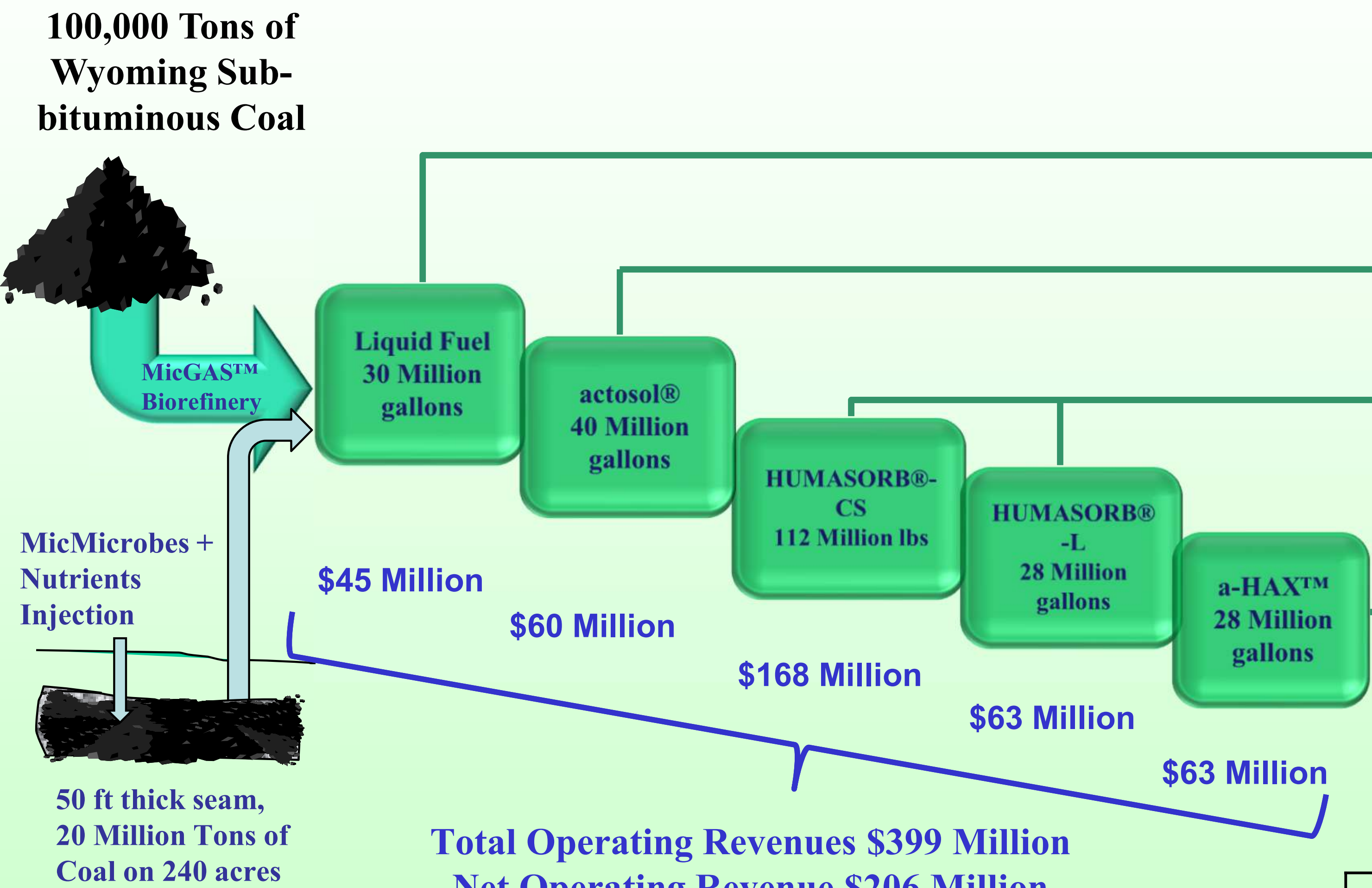
MicGAS™ Biorefinery

	Liquid Fuel 21 gallons	actosol® 400 gallons	HUMASORB® -CS 1,120 lbs	HUMASORB® -L 280 gallons	a-HAX™ 280 gallons
Carbon, lbs 1,000	200	100	550	75	75
Mass of Coal, lbs 2,000	400	200	1100	150	75

MicGAS™ Coal biotechnology Product Yields Potential from Different Ranks of Coals

Lower Rank	Gas, SCF/Ton	Humic Acid Products/Ton
Lignite	5-10,000	1000 gallons actosol® Liquid Fertilizer
Sub-bituminous		1000 lbs. HUMASORB® Water Filter
Higher Rank		
Bituminous	2-10,000	2000 lbs of HUMASORB Water Filter
Anthracite		

Total Value Chain of MicGAS™ Coal Biorefinery Plant



APPLICATION USE

Transportation	30 Million gallons of gasoline and/or jet fuels

Agricultures	4 Million Hectares
Non-Agricultures	2 Million Hectares

Industrial Wastewater	28 Billion gallons
Soil Remediation	Site Specific
Gas Treatment	Site Specific

Waste Recycling	56,000 Tons
Municipal Sewage Water Recycling	20 Billion gallons

Assumption: actosol® and a-HAX™ go 50/50 to the each application.

Total Operating Revenues $399 Million
Net Operating Revenue $206 Million

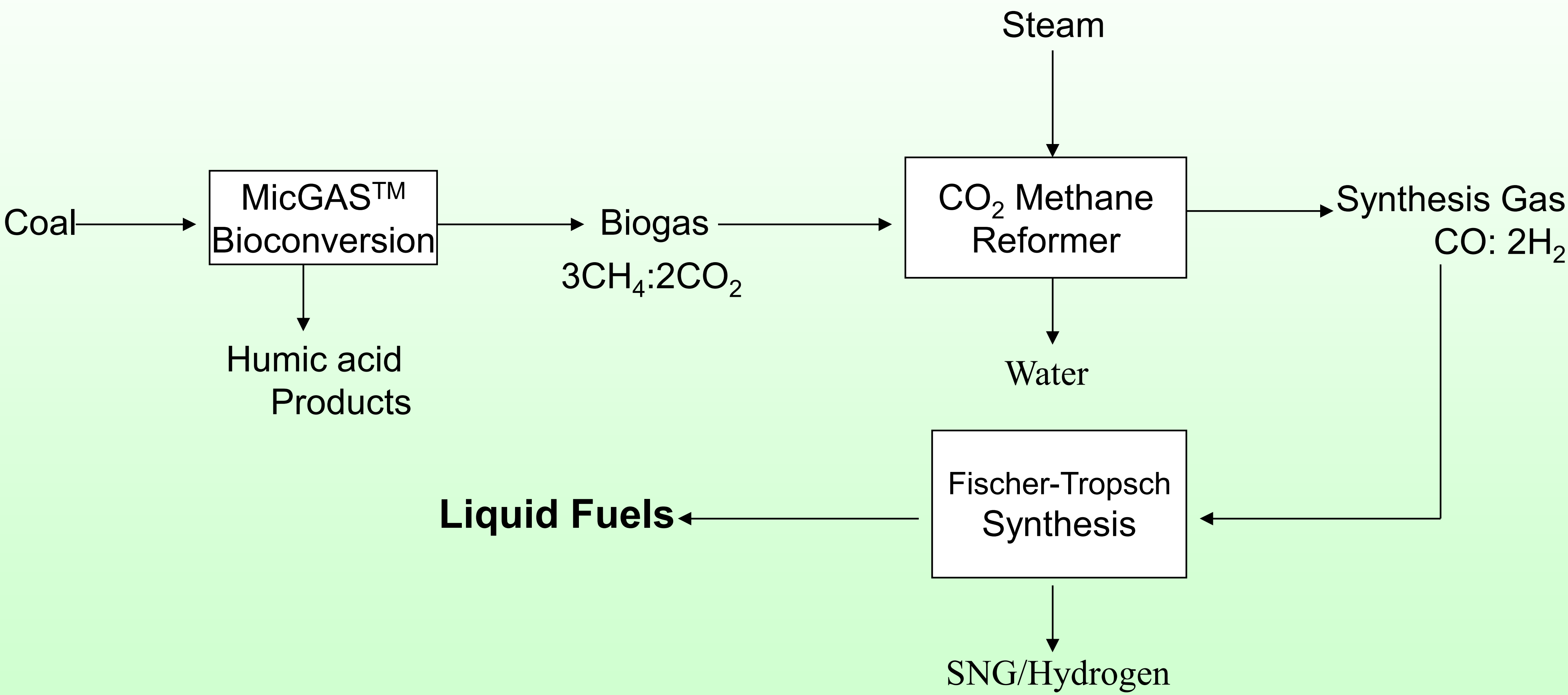
On 150 Million Capital Investment
NPV=$658 million
Rate of Return=42.5 percent

Note:

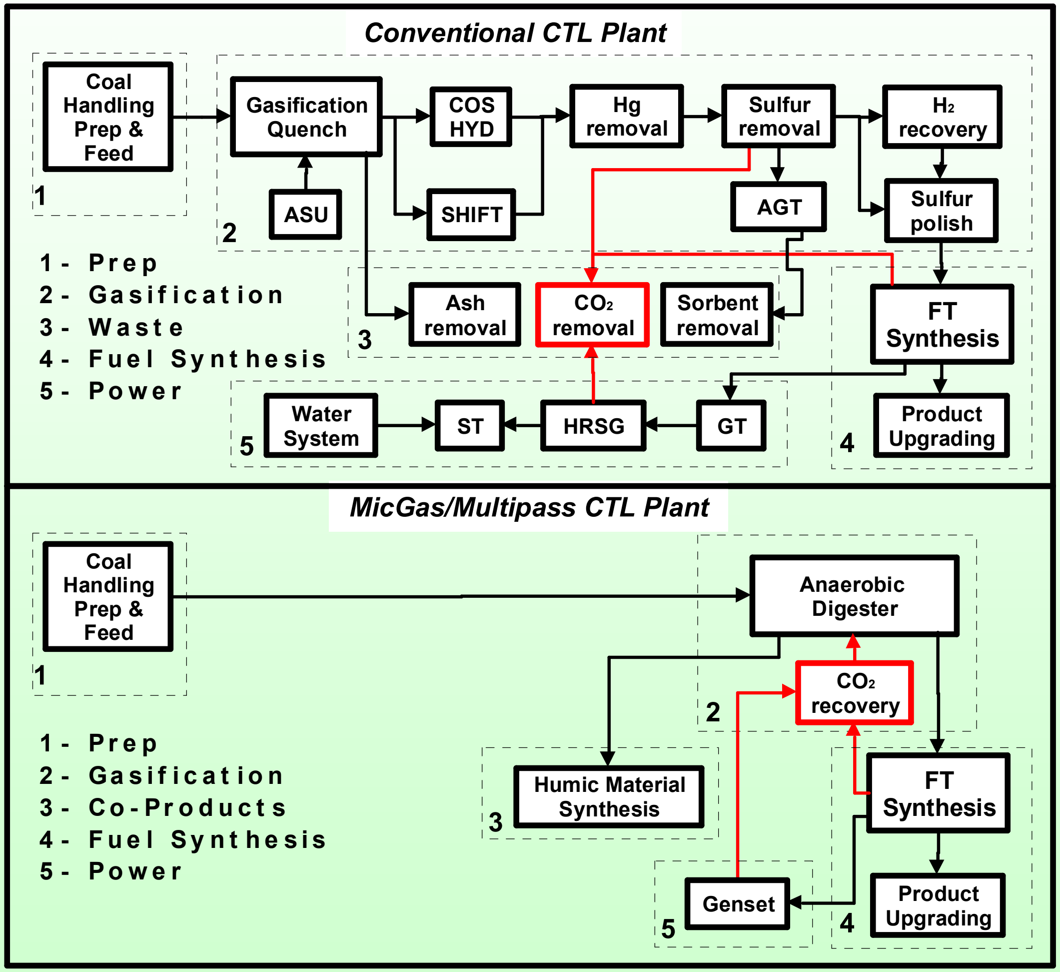
Agriculture: 5 gallons of actosol®/ acre
Non-Agriculture: 10 gallons of actosol®/acre
Wastewater: 5 lbs of HUMASORB®-CS/1000 gallon
Wastewater: 5 gallons of HUMASORB®-L/1000 gallon
Wastes Recycling: 250 gallons of a-HAX™ / 1 Ton
Municipal Sewage: 0.67 gallons of a-HAX™ /1000 gallon

Balanced Sustainability

Integrated Flow Scheme of MicGAS^{TM} Coal Biotechnology With Fischer-Tropsch Liquids/Synthetic Natural Gas/Hydrogen Production

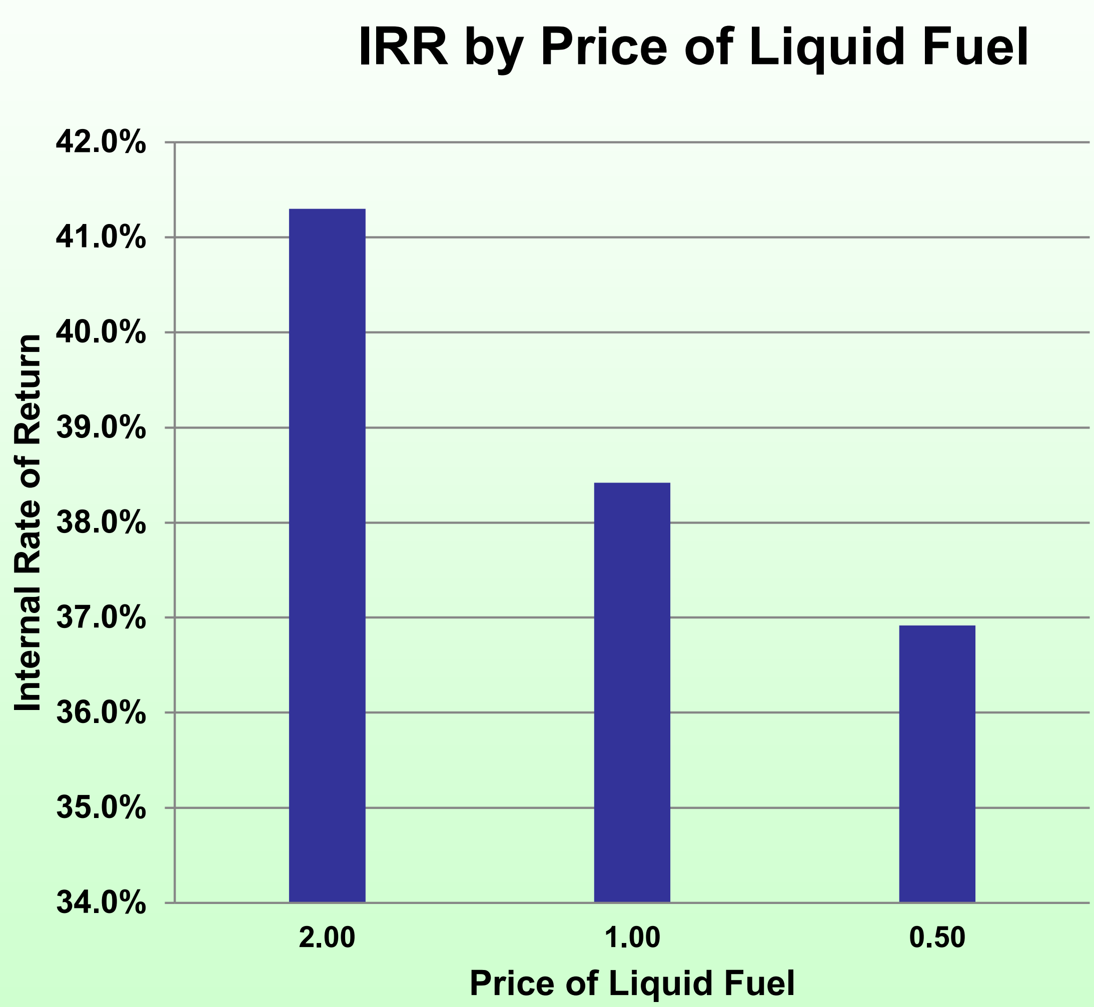


HUMAXX Biorefinery Offers Lower Cost Coal to Liquid Production Plants



1. Eliminates eight major steps in the gasification subsystem,
2. Utilizes water in the coal for process water
3. Near ambient temperature and pressure gasification
4. Eliminates ALL gas, liquid and solid wastes.
5. Converts residuals into valuable humic acid co-products
6. All CO2 produced in the power generation and MultiPass fuel synthesis subsystems into MicGAS module

HUMAXX MicGAS™ Coal Biorefinery Produced Aviation Fuel Prices Even at $0.50/gallon Will Produce 37% IRR – Remains Competitive During Falling Oil and Gas Prices



Balanced Sustainability

ARCTECH

Preserving tomorrow's world... today

Huge Market Potential Exist for HUMAXX Biorefinery Products Produced in Wyoming

Market Potential for HUMAXX-MicGAS™ Biorefinery Products for Different Geographies

Market Sectors	Wyoming	United States	Foreign
ENERGY SECTOR			
Liquid Fuel	1.0 Billion Gallons	12 Billion gallons	29 Billion gallons
AGRICULTURE SECTOR			
actosol®	270.9 Million gallons	8,271 Million gallons	9,108 Million gallons
ENVIRONMENTAL SECTOR			
HUMASORB®-CS	296 Million lbs	362,040 Million lbs	171,961 Million lbs
HUMASORB®-L	74 Million gallons	90,510 Million gallons	42,990 Million gallons

Market and Output Potential for HUMAXX-MicGAS™ Biorefinery Products

	Market Need/Year Today	HUMAXX Biorefinery		
		100,000 TPY	1,000,000 TPY	10,000,000 TPY
ENERGY SECTOR				
Liquid Fuel	40 Billion gallons	30 Million gallons	300 Million gallons	3,000 Million gallons
Market Need Met		0.07%	0.74%	7.43%
AGRICULTURE SECTOR				
actosol®	17,650 Million gallons	40 Million gallons	400 Million gallons	4,000 Million gallons
Market Need Met		0.23%	2.27%	22.66%
ENVIRONMENTAL SECTOR				
HUMASORB®-CS	534,300 Million lbs	112 Million lbs	1,120 Million lbs	11,200 Million lbs
Market Need Met		0.02%	0.21%	2.10%
HUMASORB®-L	133,575 Million gallons	28 Million gallons	280 Million gallons	2,800 Million gallons
Market Need Met		0.02%	0.21%	2.10%

Royalty Fee Potential to US Government of $2.5 Billion/Year with MicGAS Insitu from Deep Un Mineable Coals in US Coal Fields

.

In 2016 DOE-EIA reported that about 15.8 trillion cubic feet (Tcf) of dry natural **gas** was **produced** directly from **shale** and tight oil resources in the **United States** in 2016. This was about 60% of **total U.S.** dry natural **gas production** in 2016.

MicGAS offers potential of 21 Tcf of coal gas every year from only 1% of 7 Trillion Tons of deep un mineable coals which will complement shale gas and offers our country to change the dynamics of worldwide energy supply and economics.

US DOI -BLM (IM WY-85-14-- Royalty Calculations for Gas from Underground Coal

Royalty ($/mo) = cents/MMBTU (coal) X dollars/cent X MMCFGPD X BTU/scf X day /mo X 0.125 (royalty rate).

= 100 X 1/100 X 21 ,000,000,000,000/365X1/1,000,000X 1,000 X 30 X 0.125
= $2.58 Billion/Year

Today US Government Royalty Fees from Mineable Coal Leases =$0.5 Billion per year and decreasing
GEO June 2017 Report http://www.gao.gov/assets/690/685335.pdf

Creates Three Million Green Jobs

Conversion of 10% of total coal use today or 100 million tons of coal will generate almost $0.5 trillion in yearly revenues

This will result in creating almost three million direct jobs at an average yearly wage of over $150,000 per job (salary plus taxes, overhead etc.) in the growing large energy, agriculture and environmental market sectors seeking today's green solutions.

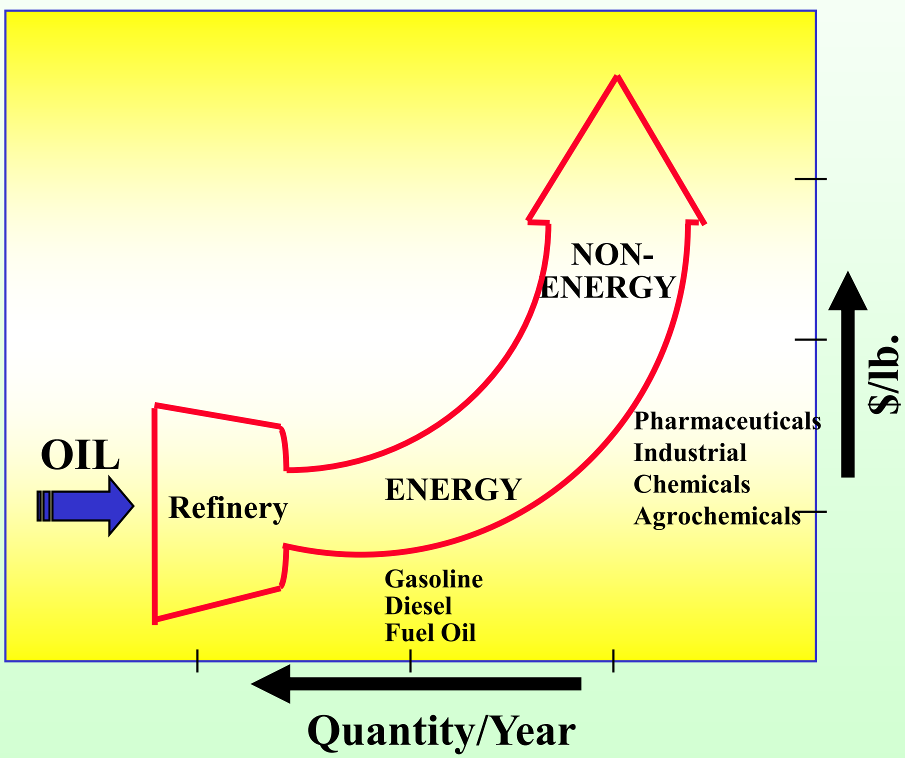
Commercial Prototype Approach:

- Provide technology to coal companies license fee basis. Build technology expertise and capacity in coal mining regions.
- Recipient coal companies to provide products to meet commercial and federal government project needs.

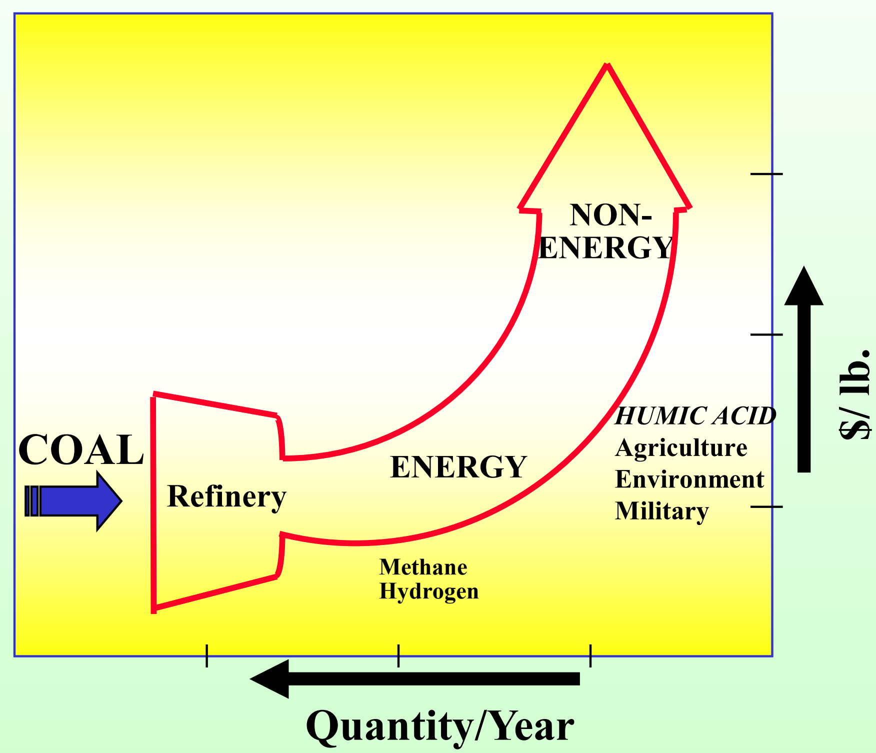
Broad Scale Commercialization in the USA and worldwide per HUMAXX Business Plan –Bell Labs &AT&T Business Model

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

OIL REFINERY



COAL BIOTECHNOLOGY



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

Balanced Sustainability

ARCTECH
Preserving tomorrow's world... today

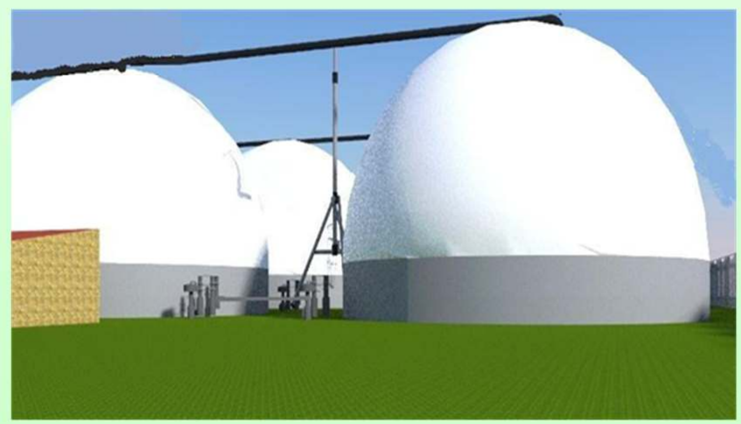
MicGAS™ Coal Biotechnology Demo Units

Balanced Sustainability

ARCTECH

Preserving tomorrow's world... today

ARCTECH, Inc. USA Envisioned Commercial MicGAS™ Clean Coal Biotechnology Plant



Balanced Sustainability

ARCTECH

Preserving tomorrow's world... today

Counterintuitively, the footprint of a bioconversion plant is comparable or even lower than that of a conventional thermal plant- Acres/Million TPY

Great Plains Synfuels Plant: 6 million TPY lignite; >480 acres → >80 acres
Polk Power IGCC: 800,000 TPY coal & petcoke; >75 acres → >90 acres
Kemper County IGCC: 4.4 million TPY lignite; >250 acres → >57 acres
Nakoso IGCC: 600,000 TPY coal; >40 acres → >67 acres

HUMAXX MicGAS Coal Biorefinery: 50 acres

https://www.netl.doe.gov/research/Coal/energy-systems/gasification/gasifipedia/biological-coal-gasification

MicGAS Coal Biotechnology Offers a New Path To Cost Competitive Lower Carbon Footprint Plentiful Biofuels and Bioenergy

-- Clean natural gas and liquid fuels remain competitive even in the face of lower prices and the use of humic products creates a negative carbon footprint

-- The technology costs and carbon utilization are distributed across both energy and non-energy products.

-- Plentiful Large Resources of Coals available on all continents to produce large volumes of Biofuels and Bioenergy

HOW DOES ---MicGAS COAL PRODUCTS LOWER CRBON INTENSITY THEN FROM CONVENTIONAL

- **HUMASORB - Direct Capture of CO2 & Pollutants and Recycling Spent HUMASORB Into Water Filter for Pollution Prevention from Ash Ponds Etc.**

- **actosol – Indirect Capture by increasing vegetation, crops, trees and humification of crop residues in soils for improving soil fertility and sequestration of carbon in soils.**

  PROVEN 10 Tons Per Acre Per Year, 20% +Crops

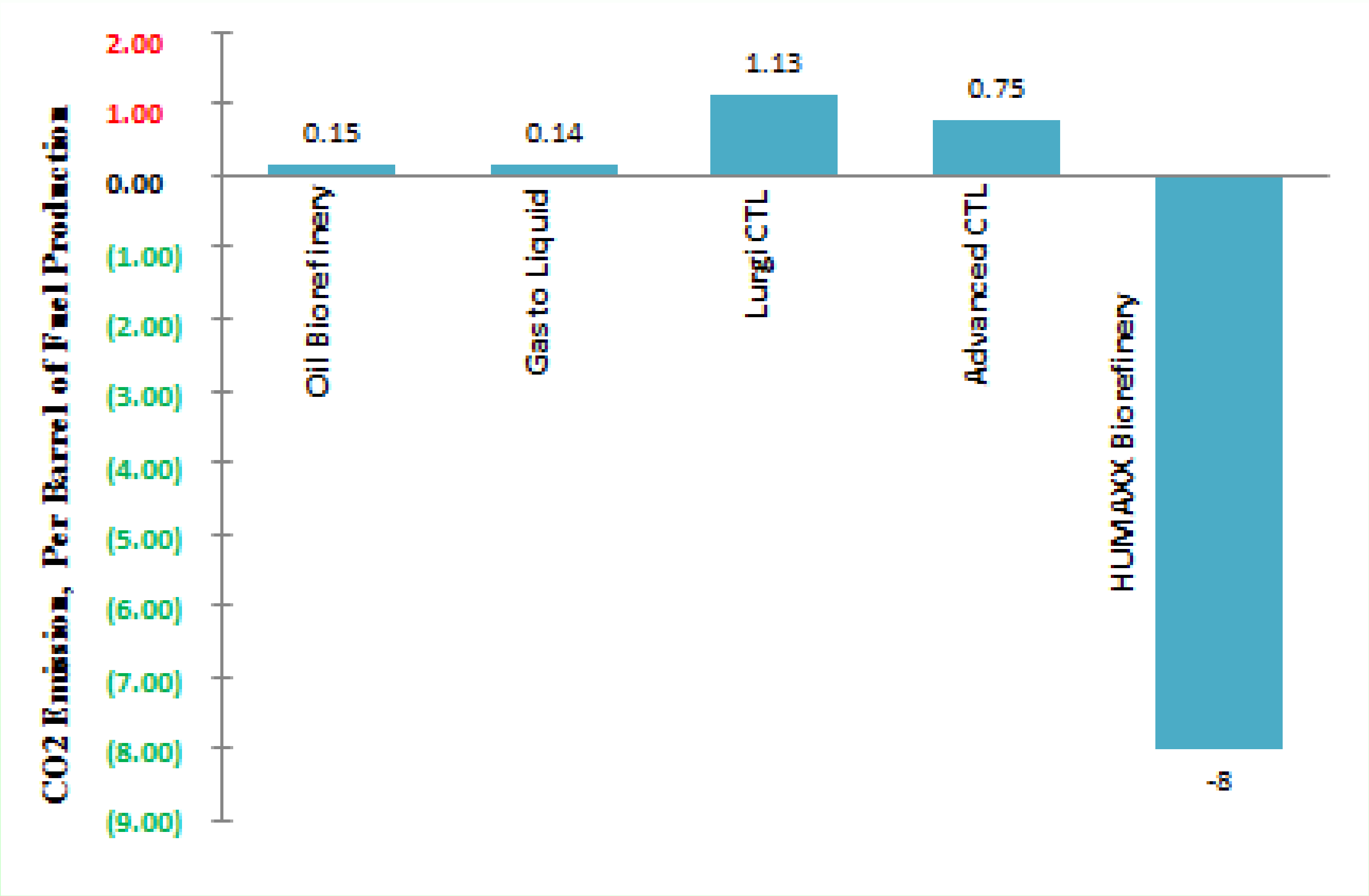
Loss of carbon in soils, the fourth largest storehouse of carbon is equally at peril as increasing in air. actosol addresses to rebalance both storehouses

Environmental Benefits of Humaxx-MicGas Biorefinery – CO_2 Reductions

- **Use of HUMAXX-MicGAS™ Coal Biorefinery** Products would create a negative carbon footprint

HUMAXX Biorefinery per Ton of Coal Processed	Retained in Products and Soils (tons of CO2 Captured)	CO2 Captured Through Increased Biomass	CO2 Emitted When Combusted in Jets
All Products	1.45		
Actosol		15.00	
Liquid Fuels			0.55 tons
Totals	16.45 tons of CO2 Captured or Retained in Soils		0.55 tons of CO_2 Emitted

MicGAS™-FTL Eliminates Carbon Foot Print for Coal to Liquids Productions



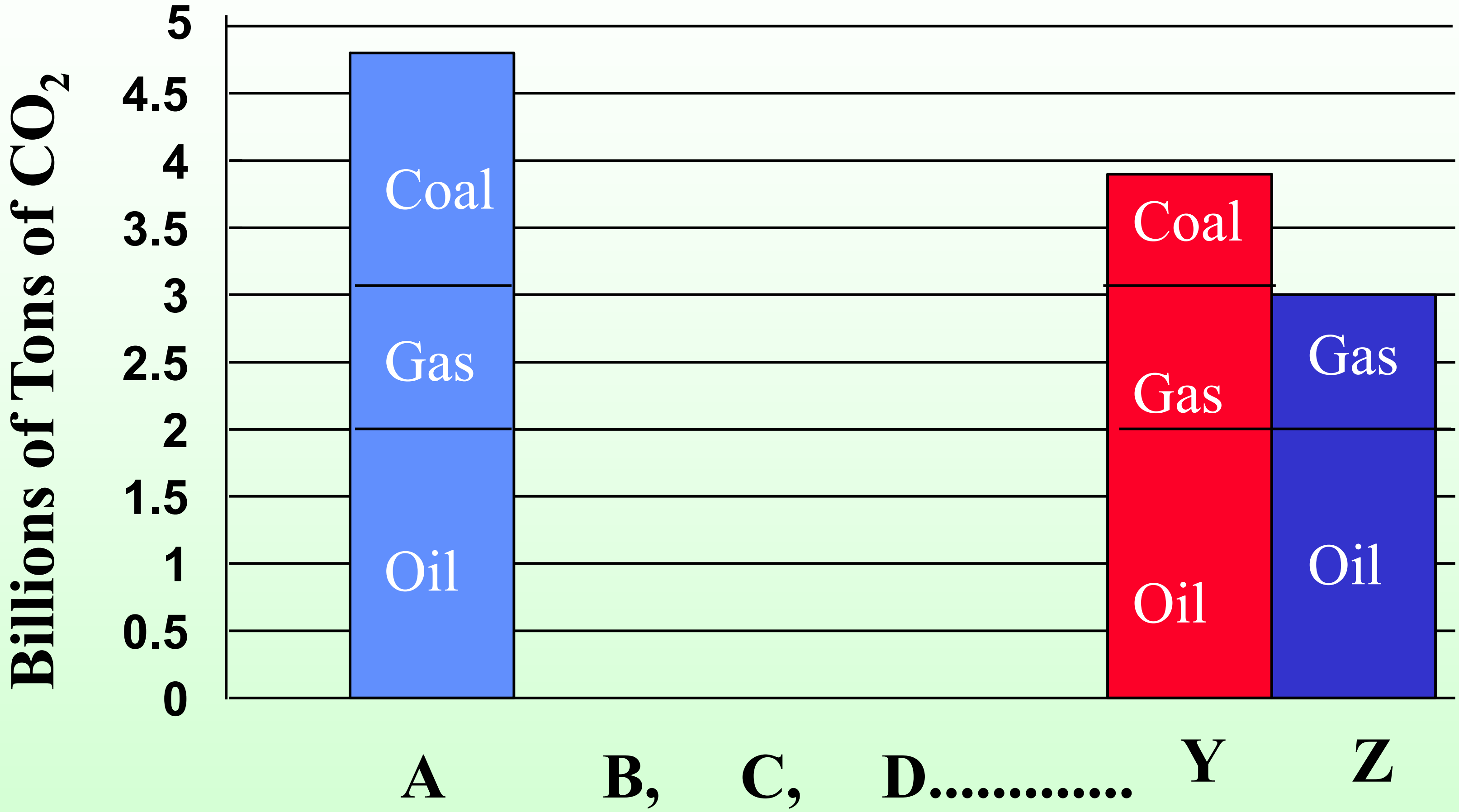
US Government mandate to purchase aviation fuel from alternate sources with equal or lower GHG emissions by petroleum sources (EISA 2007 §526).

Balanced Sustainability

ARCTECH

Preserving tomorrow's world... today

Significant Potential Exists For Mitigating Green House CO_2 With The MicGAS™ Coal Technology



A: Current yearly rate of emissions of CO_2

Y: Reduction with maximum potential of MicGAS™

Z: Reduction with additional biomass sink (assuming 30% increase in biomass with actosol® humic acid)

Balanced Sustainability

ARCTECH

Preserving tomorrow's world... today

Soils are Fourth Largest Storehouse for Carbon

Table 1. Estimated Size of Major Pools of Carbon in the World Carbon Budget

	Trillion kilograms of carbon
Atmosphere (as CO_2)	700
Land	
Biomass	480
Humic substances (expressed as 50% of soil organic matter)	1500-2500
Waters	
Freshwater	250
Marine dissolved and suspended	4150
Sediments	2,000,000
Fossil fuels	10,000

Sources: B. Bolin Science, **196**, 613 (1977); B. Bolin and R. B. Cook, Eds. *The Major Biogeochemical Cycles and Their Interactions*, Wiley, New York, 1983.

Land Degradation and Water Shortages Threaten Global Food Production – UN FAO, November 28, 2011

- Global food production is being undermined by land degradation and shortages of farmland and water resources, making feeding the world's rising population – projected to reach nine billion by 2050 – a daunting challenge.

- A quarter of the land is highly degraded, while another eight per cent has moderate degradation, 36 per cent is classed as stable or slightly degraded and 10 per cent ranked as "improving."

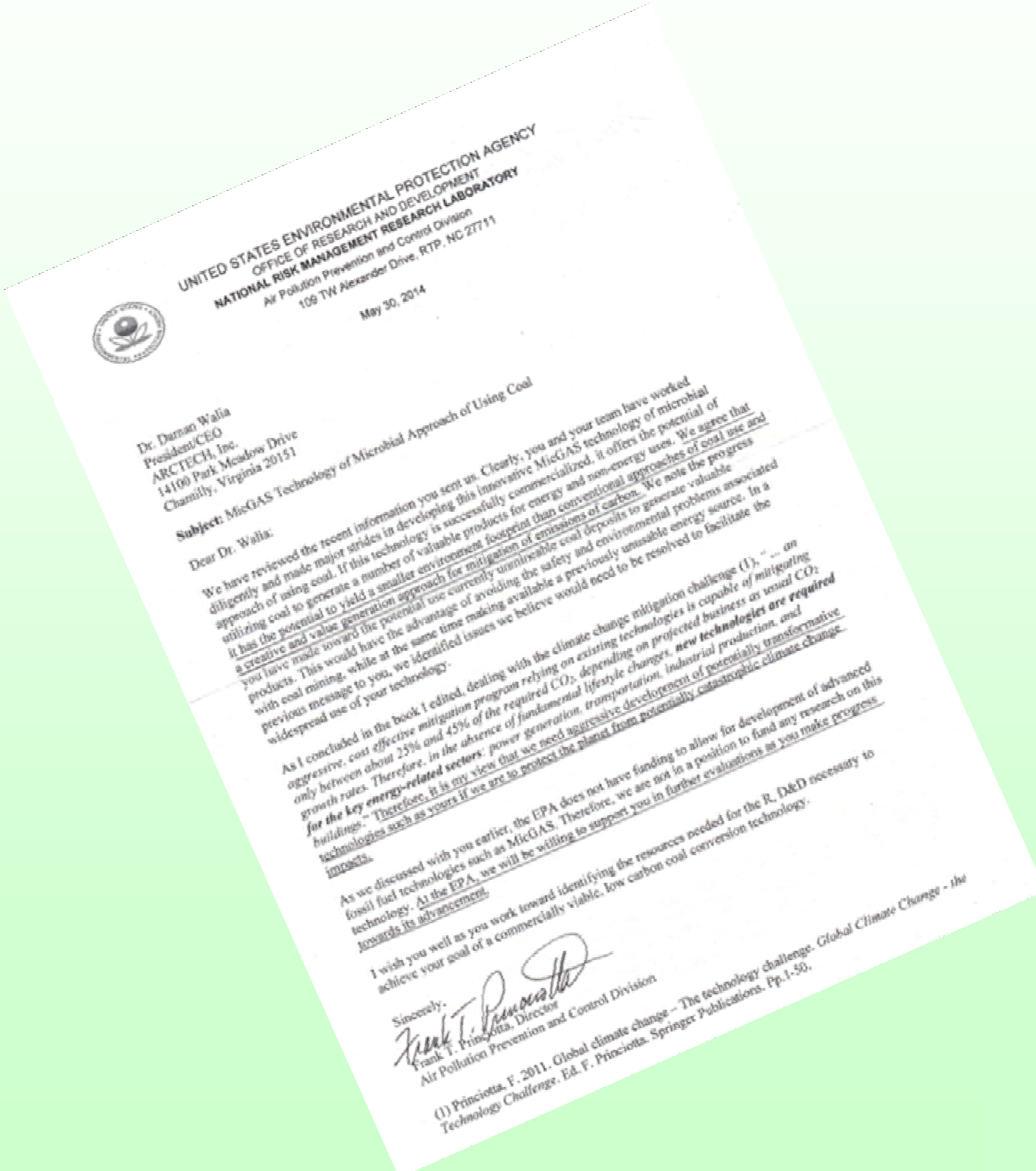
United Nations has declared 2015 International Year of Soil.

MicGAS Coal Biotechnology Offers a New Path To Cost Competitive Lower Carbon Footprint Plentiful Biofuels and Hydrogen While Replenishing Soils with Carbon – Rich Organic Humic Matter

Soils are the 4th largest storehouse of carbon after Sedimentary rocks, fossil fuels, and oceans. Fifth is our atmosphere. Since the mid-18th century industrial age, increasing loss of carbon in form of humus due to excessive use of soils and erosion is as much at peril as is increasing CO_2 in the air. Reconfiguring these two storehouses is the lowest hanging fruit for speeding up the capturing from the air and becoming a major contributor to achieving net-zero CO_2 emissions by 2050

Loss of carbon in soils, the fourth largest storehouse of carbon is equally at peril as increasing in air. actosol addresses to rebalance both storehouses - Daman Walia, President/CEO ARCTECH Inc.

USEPA recognized "the potential to yield a smaller environment footprint than conventional approaches of coal use and a creative and value generation approach for mitigation of emissions of carbon"



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
NATIONAL RISK MANAGEMENT RESEARCH LABORATORY
Air Pollution Prevention and Control Division
109 TW Alexander Drive, RTP, NC 27711

May 30, 2014

Dr. Daman Walia
President/CEO
ARCTECH, Inc.
14100 Park Meadow Drive
Chantilly, Virginia 20151

Subject: MicGAS Technology of Microbial Approach of Using Coal

Dear Dr. Walia:

We have reviewed the recent information you sent us. Clearly, you and your team have worked diligently and made major strides in developing this innovative MicGAS technology of microbial approach of using coal. If this technology is successfully commercialized, it offers the potential of utilizing coal to generate a number of valuable products for energy and non-energy uses. We agree that it has the potential to yield a smaller environment footprint than conventional approaches of coal use and a creative and value generation approach for mitigation of emissions of carbon. We note the progress you have made toward the potential use of currently unminable coal deposits to generate valuable products. This would have the advantage of avoiding the safety and environmental problems associated with coal mining, while at the same time making available a previously unusable energy source. In a previous message to you, we identified issues we believe would need to be resolved to facilitate the widespread use of your technology.

As I concluded in the book I edited, dealing with the climate change mitigation challenge (1), "... *an aggressive, cost effective mitigation program relying on existing technologies is capable of mitigating only between about 25% and 45% of the required CO_2 depending on projected business as usual CO_2 growth rates. Therefore, in the absence of fundamental lifestyle changes,* ***new technologies are required for the key energy-related sectors****: power generation, transportation, industrial production, and buildings*." Therefore, it is my view that we need aggressive development of potentially transformative technologies such as yours if we are to protect the planet from potentially catastrophic climate change impacts.

As we discussed with you earlier, the EPA does not have funding to allow for development of advanced fossil fuel technologies such as MicGAS. Therefore, we are not in a position to fund any research on this technology. At the EPA, we will be willing to support you in further evaluations as you make progress towards its advancement.

I wish you well as you work toward identifying the resources needed for the R, D&D necessary to achieve your goal of a commercially viable, low carbon coal conversion technology.

Sincerely,

Frank T. Princiotta, Director
Air Pollution Prevention and Control Division

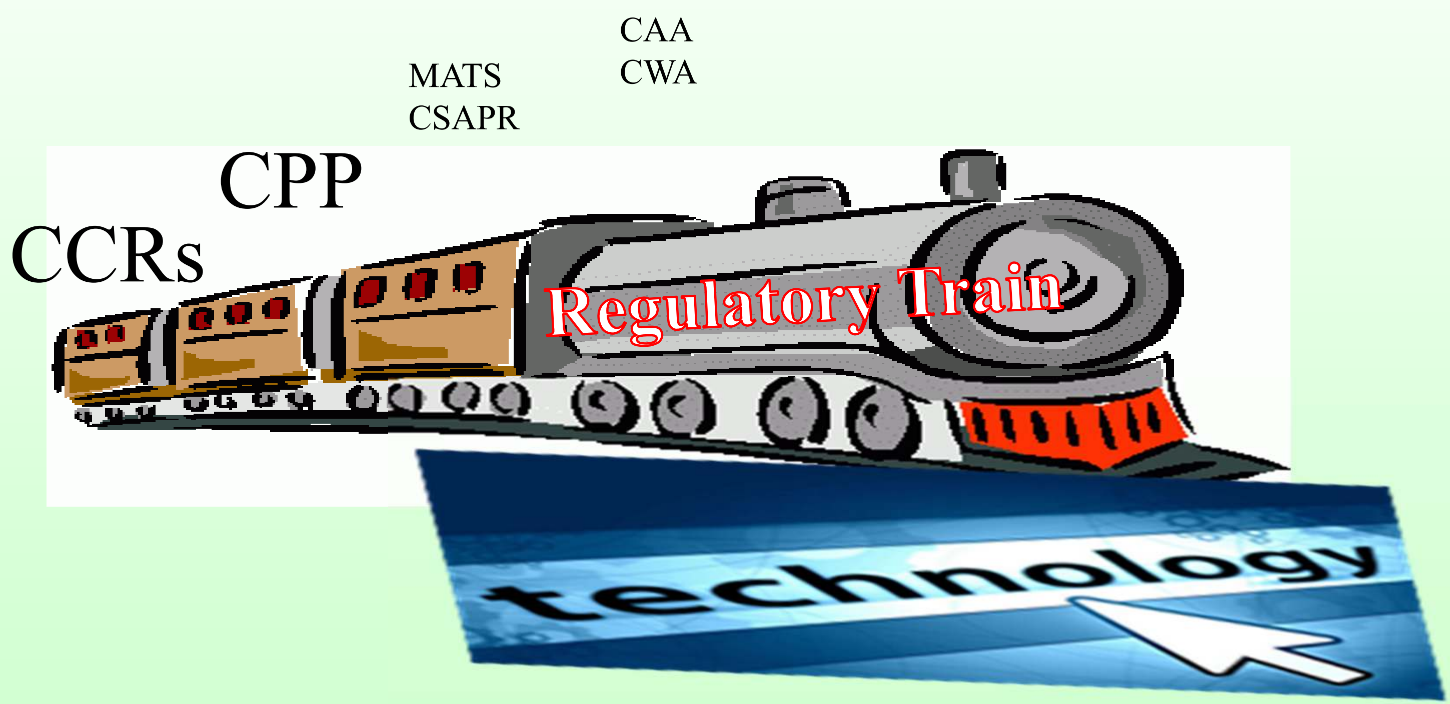
(1) Princiotta, F. 2011. Global climate change – The technology challenge. *Global Climate Change - the Technology Challenge*. Ed. F. Princiotta. Springer Publications. Pp.1-50.

Balanced Sustainability

ARCTECH

Preserving tomorrow's world... today

MicGAS Coal Biotechnology Offers Approaches to Catch Up Regulatory Train and Even Get Ahead of It



Prototype HUMAXX Coal Biorefinery

South Boston, Virginia

PRODUCTS PROVING OUT FOR MEETING REAL-WORLD NEEDS

- AGRICULTURE:
  - **actosol®,** humic acid fertilizer for agriculture for increasing crop yields, sequestering carbon in soils while enhancing soil health and fertility.
  - **NutrientENHANCER, a one step coating/impregnating granular fertilizers and seeds to improve their efficiency and delivery.**
  - **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

- **ENVIRONMENT:**
  - **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

HOW DOES ---MicGAS COAL PRODUCTS LOWER CRBON INTENSITY THEN FROM CONVENTIONAL

- **HUMASORB - Direct Capture of CO2 & Pollutants and Recycling Spent HUMASORB Into Water Filter for Pollution Prevention from Ash Ponds Etc.**

- **actosol – Indirect Capture by increasing vegetation, crops, trees and humification of crop residues in soils for improving soil fertility and sequestration of carbon in soils.**

  PROVEN 10 Tons Per Acre Per Year, 20% +Crops

Loss of carbon in soils, the fourth largest storehouse of carbon is equally at peril as increasing in air. actosol addresses to rebalance both storehouses actosol®

Humate Fertilizer

- Increases yields of crops, vegetables and fruits
- Produces superior turf and deep roots
- Enhances uptake of fertilizers
- Replenishes depleted soils
- Promotes ecological balance

OMRI LISTED

USDA Approved

actosol® Organic Humic Fertilizer Products Proven in Commercial Applications-Now Ready for Retail Market

Commercial

Retail

Proven by Pros! Now Available to Homeowners!

actosol®

humaxx USA
offering balanced sustainable solutions

Approvals of *Actosol* HUMIC ACID

USDA National Organic Food Production Program
October 21, 2002

Allows use of HUMIC ACID for Growing Organic Foods

www.ams.usda.gov/nop

US Environmental Protection Agency
June 13, 2003

Approves HUMIC ACID as Environmentally Safe & exempts from Tolerance Requirement when used as an Ingredient (adjuvant, UV protectant) in Pesticide Formulations

www.epa.gov/fedregstr

OMRI Listed (Organic Materials Review Institute)
February 18, 2005

www.omri.org

South Carolina, Dept. Of Transportation
March, 2012

Approved HUMIC ACID as a Biological Stimulant

www.scdot.org

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

IHS Markit

FerteconFertilizer Awards 2021

Winner

Best Supporting Role

ARCTECH INC

On behalf of IHS Markit Agribusiness, I would like to congratulate you on your achievement

SarahMarlow AllanPickett

Sarah Marlow Head of Current Information Fertecon/IHS Markit	Allan Pickett Head of Analysis Fertecon/IHS Markit

in collaboration with

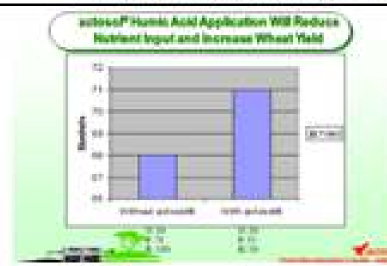
Chemical Week

Balanced Sustainability

ARCTECH

Preserving tomorrow's world... today

Examples of the Use of actosol® Organic Humic Acid on Agriculture Crops

Agriculture	Description	Results on agricultural crops
Wheat Experiment conducted by Paul Bodenstein, Crop agronomist, Ag. Systems, Virginia Crop Consulting firm	Plot 1: 3 gal actosol® + 30 N: 70 P: 100 K Plot 2: 3 gal actosol® + 30 N: 35 P: 50 K	 Addition of actosol® humic acid reduced phosphorous & potassium application by 50% and increased yield by 4%
Wheat (Southern States 8308 variety), Woodlief Farms in Rolesville, North Carolina	Application rate @ 1.5 gal/40 gal water/ acre were applied overhead. Plot size: 1 acre/ treatment. Both treatments received the identical amount of fertilizer and same growing conditions. Data collected consisted of 10 replication for each treatment.	 actosol® control actosol® control *actosol®* Improved root development, Plant Height. Results showed that the use of *actosol* averaged 44 seeds per head vs. 21 for the control and weight of seeds per head averaged three times as great 2.2 grams vs. 0.8 grams for the control.
Wheat North Delta, Egypt	applied at 2 gal/acre before seeding	 Increased germinations, yield of grain & straw by 12%

Balanced Sustainability

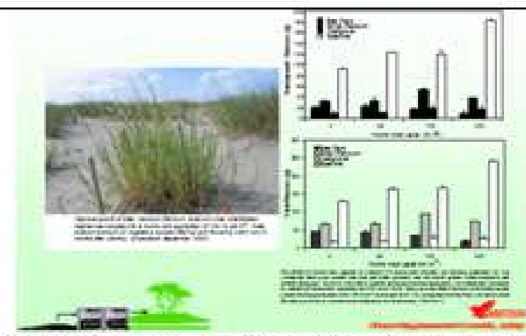
ARGTECH

Preserving tomorrow's world... today

Examples of the Use of actosol® Organic Humic Acid on Agriculture Crops

Agriculture	Description	Results on agricultural crops continue
Soybean At a 44,000 acre farm located in Beaufort, North Carolina. Experiment conducted by Paul Bodenstein, Crop agronomist, Ag. Systems, Virginia Crop Consulting firm	Foliar application at 550 mg actosol®/liter water (or 1.1 lb./acre) with a post-emergence application of blazer herbicide, surfactant and manganese. Applications on soybeans were during the fourth trifoliate.	 actosol® + Blazer Blazer Fourteen days after treatment, test plots treated with actosol® and Blazer had progressed to the eighth trifoliate while soybeans treated with Blazer alone were just beginning their fifth trifoliate. Addition of actosol® to the Blazer significantly reduced phytoxicity and enhanced growth resulting in an increase of 6.8 bushels /acre.
Clover North Delta, Egypt	applied at 2 gal/acre before seeding	 Increased chlorophyll, # harvest & yield by ~13%
Tobacco Plants Hope Farm, Clinton, North Carolina	Green house: Seedlings: 288cells/tray applied *actosol®* @12.5 gal /500 gal. water Field: Seedlings transferred to field & received 2 gal actosol®/ 80 gal. water /acre	 Increased root mass, nutrient uptake, plant height by 10% & improved chlorophyll content

Examples of the Use of actosol® Organic Humic Acid on Turf

Turf	Description	Results on turf
Grass in Sand dunes, Ocean City, Maryland	Application rate @5 gal/ acre. actosol® was applied as part of the hydro-seed mix (recycled wood fiber mulch, biodegradable tack, seed mix of 1/3 perennial rye,1/3 grain rye and 1/3 K-31 fescue at 10 lbs/1000 square feet)	 Increased root mass, chlorophyll, established robust cover
On produced water resulted from J.M. HUBER Inc. , a coal bed methane producer in Wyoming. Work was conducted by Robert Downey of Energy Ingenuity of Colorado	A field unit consisting of a chemical pulse pump and a turbine flow meter mounted on a small skid for automated metering in actosol® into the high salinity produced water prior to irrigation of the adjoining land area. actosol® was metered in to add only 50 ppm into the water during the 30 days of the 45 days of test period. The control area received only produced water without any addition of actosol®.	 The test area showed lush green vegetative growth without any bare spots compare to the control
On 4 varieties of sea grasses in Marsh Land, Louisiana, Prof. Mark Hester at Univ. Louisiana	actosol® was applied at four dosage rates.	 Application of actosol® resulted in enhanced growth of both root biomass and top growth.

Balanced Sustainability

ARCTECH

Preserving tomorrow's world... today

Examples of the Use of actosol® Organic Humic Acid on Turf

Turf	Description	Results on turf continued
On tall fescue in central sod farm in Maryland (Billarpinski)	2.5 gal/acre +100% STD fertilizer, 2.5 gal/acre + 80% STD fertilizer, Grower STD fertilizer.	 Reduction in fertilizer, improved root development & turf growth
On Turf in Virginia Beach Area (Symsi Manuel)	Application rate @ 3 gal. per 60 gallons of water was used to cover the turf area. The first application was made with a hand held power sprayer and then the second application was applied with a bloom sprayer.	Control actosol®  *Calcium actosol®* on Root and Turf Growth Under High Salinity Conditions

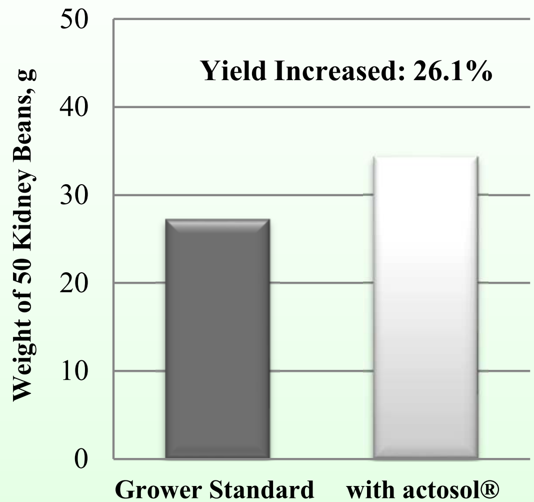
Examples of the Use of actosol® Organic Humic Acid on Horticulture

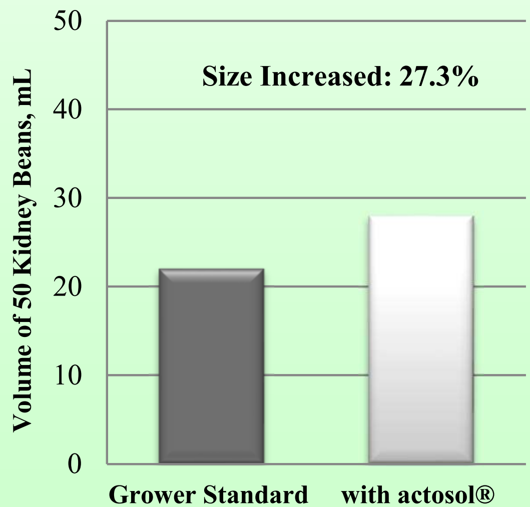
Horticulture	Description	Results in horticulture/ornamentals
On Ornamentals at Country Joe's Nursery, at Boynton, Beach, FL (David Englert)	Application rate @ 4 oz/ 2 gallon water (1:30 ratio) or 4oz/4 gallon water (1:60 ratio)	(Begonia) (Montera)   Control actosol® Control actosol® Improved Roots and Foliage Growth on Variety of Ornamentals & Reduced the Production Time for Marketability of Container Ornamentals

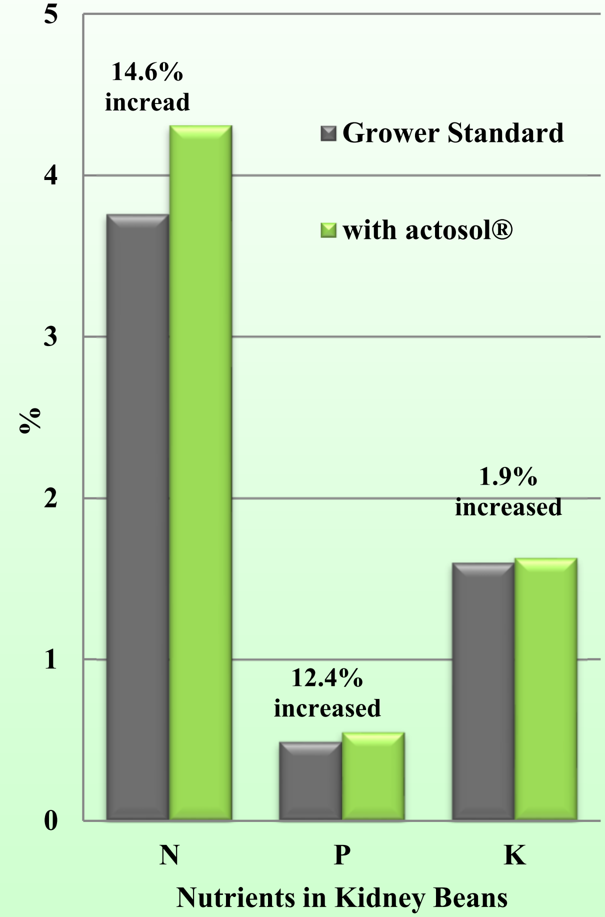
actosol® vs. Miracle-Gro

Did use our fertilizer

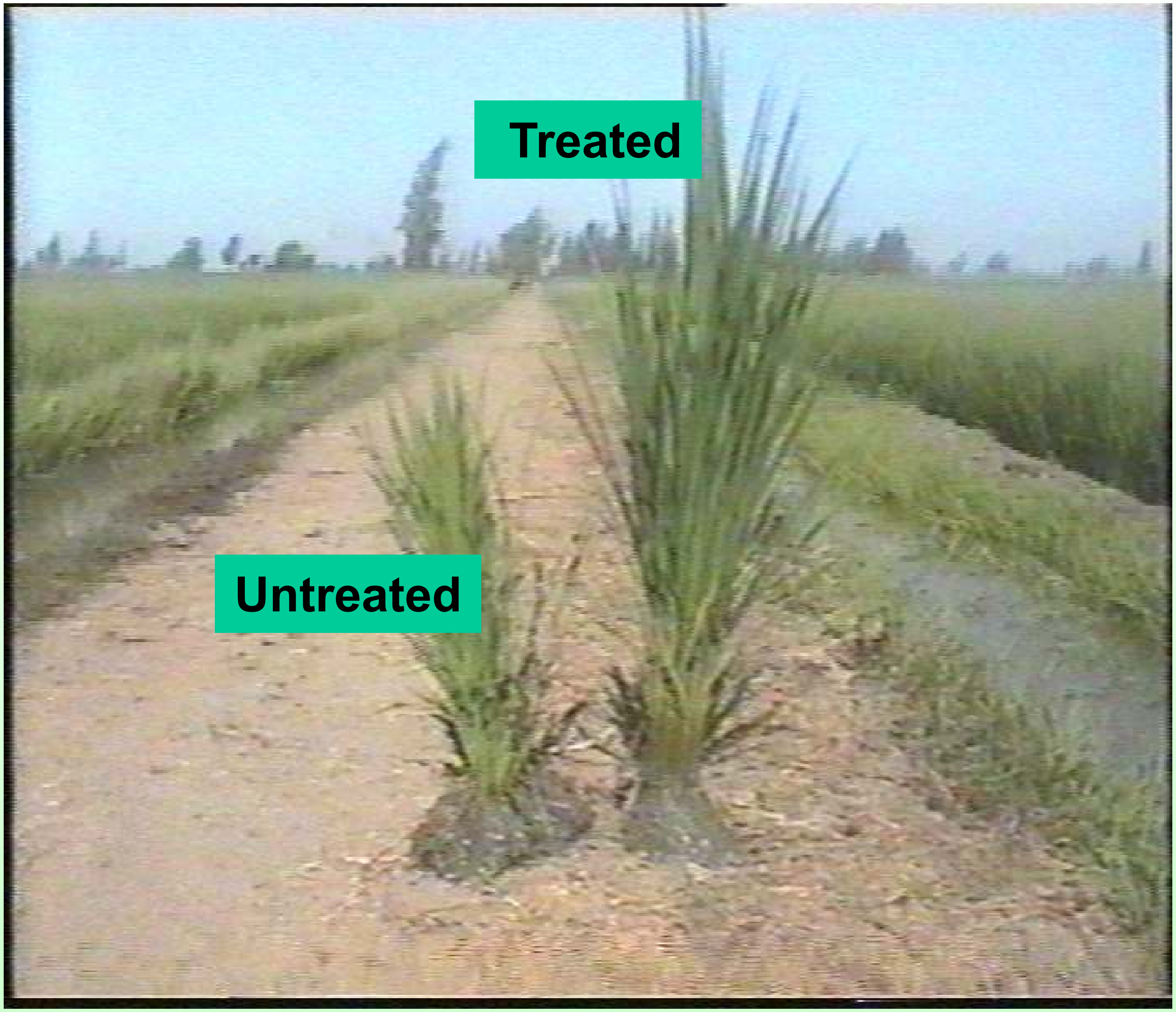
Kidney Beans Grown with actosol® by Carlson Farm, MN Showed Increased Yield and Size







Rice

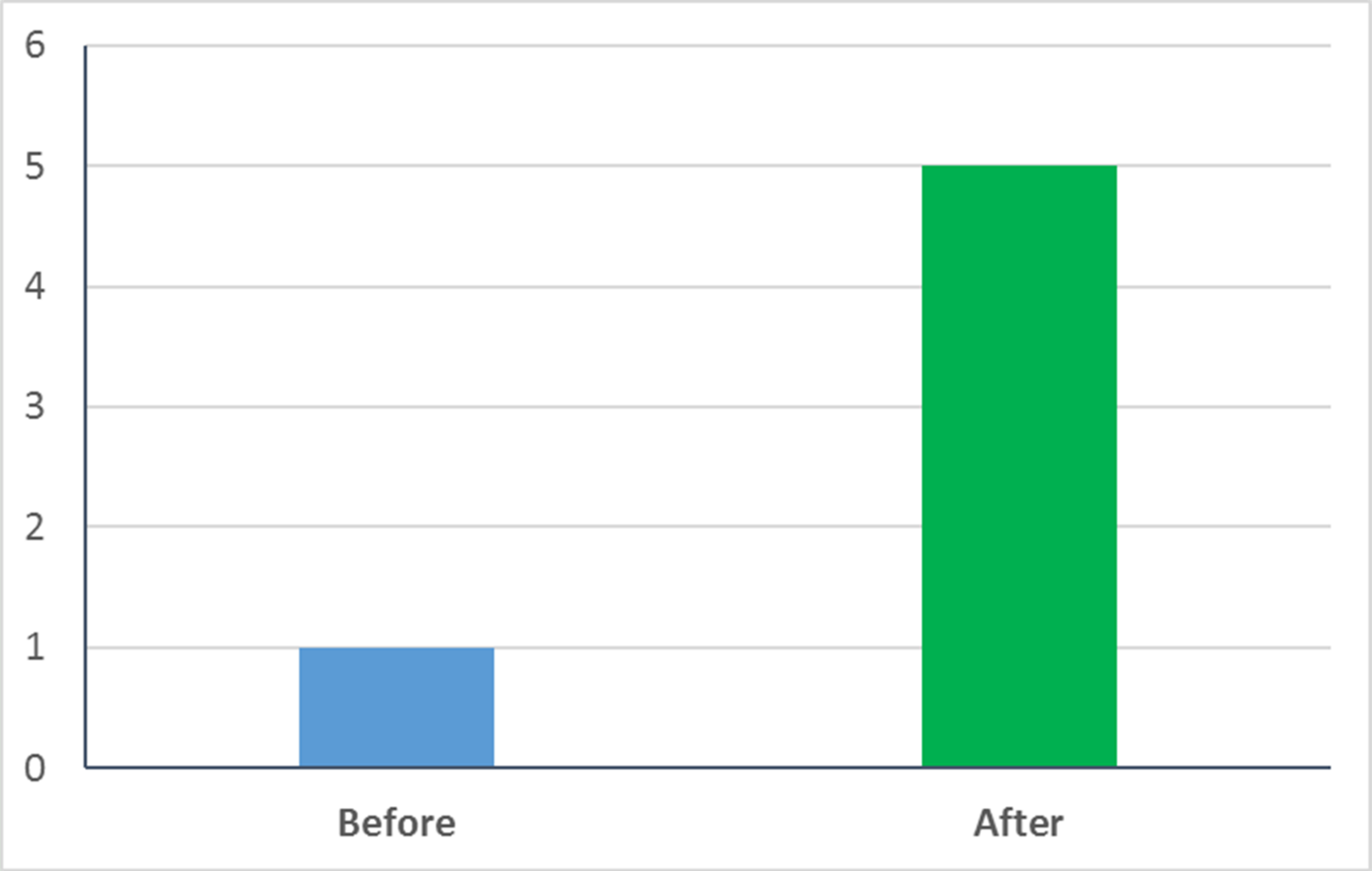


actosol® in Egypt

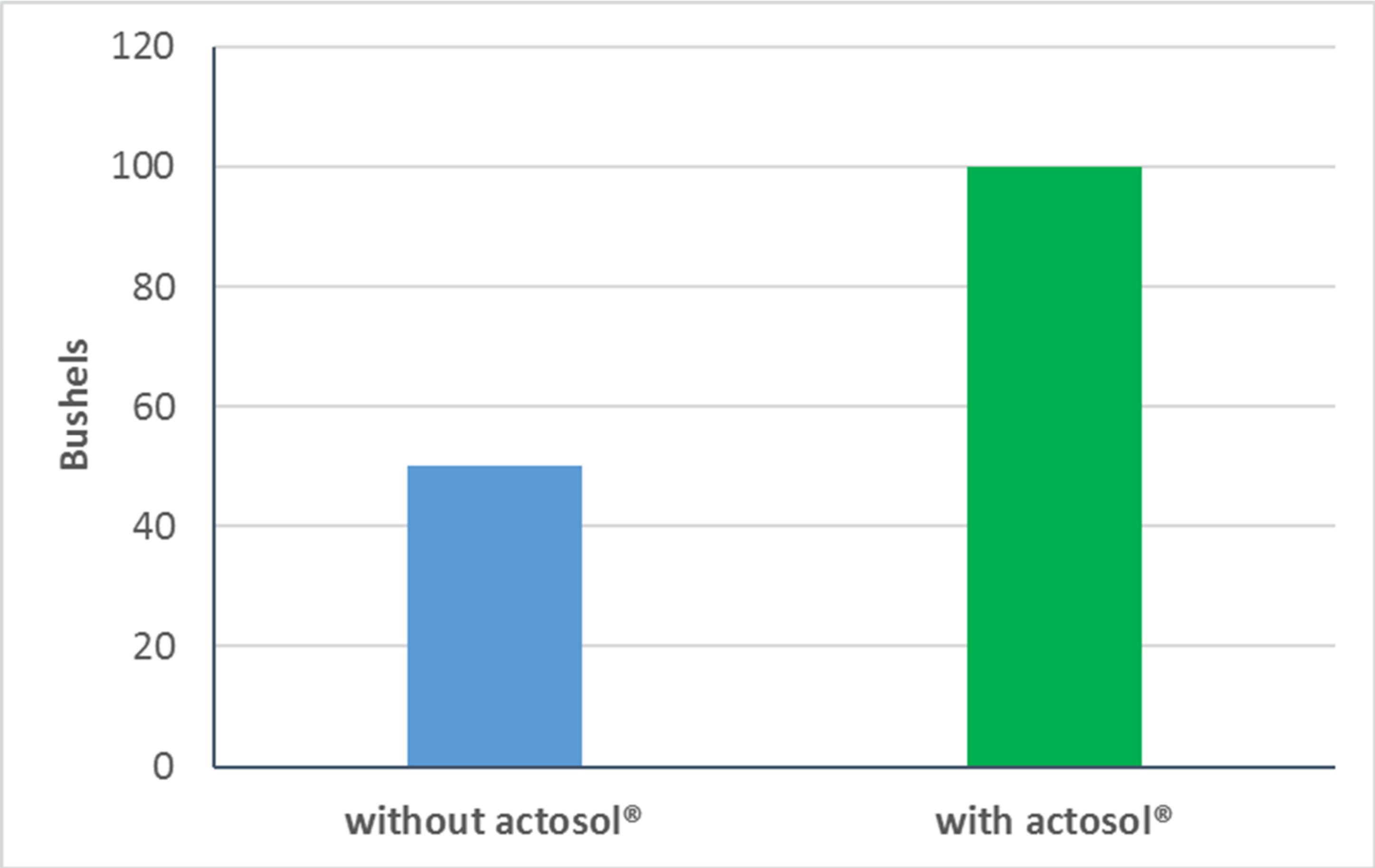
Crop	Location (Soil Type)	Crop Increase [ton/acre]	Crop Increase [%]	Extra Revenue from Crop Increase [LE/acre]	Chemical Fertilizers Reduction [%]	Chemical Fertilizers Savings [LE/acre]	Cost of Organic manure [LE/acre]	Cost of actosol [LE/acre]
Wheat & wheat hay	Valley	0.39	14.4	1500	30	150	400	240
Rice	Valley	0.75	18.5	1500	50	250	400	240
Sugarcane	Valley	5.7	11.8	2300	25	300	800	400
Potatoes	Desert	2.5	17.8	2500	25	300	1500	480
Cucumber	Desert	2	20	2400	25	300	1500	480
Pears	Desert	1.8	12	2700	25	150	1000	400
Orange	Desert	2	11.1	2000	20	150	1000	400
Grapes	Desert	2	20	2500	20	150	1000	400
Apple	Desert	3.3	52	3000	20	100	1000	400
Mango	Desert	0.65	16.25	3200	25	150	1000	400

US 1$ = 7.14 LE (Egyptian Pound)

actosol® Gradually Increasing Organic Matter Over 10 Years – Based on Soil Quality Assessment



Average Yield Increased from 50 Bushels per Acre to 100 Bushels per Acre



CALCULATIONS -Lawson Farm in Virginia USA

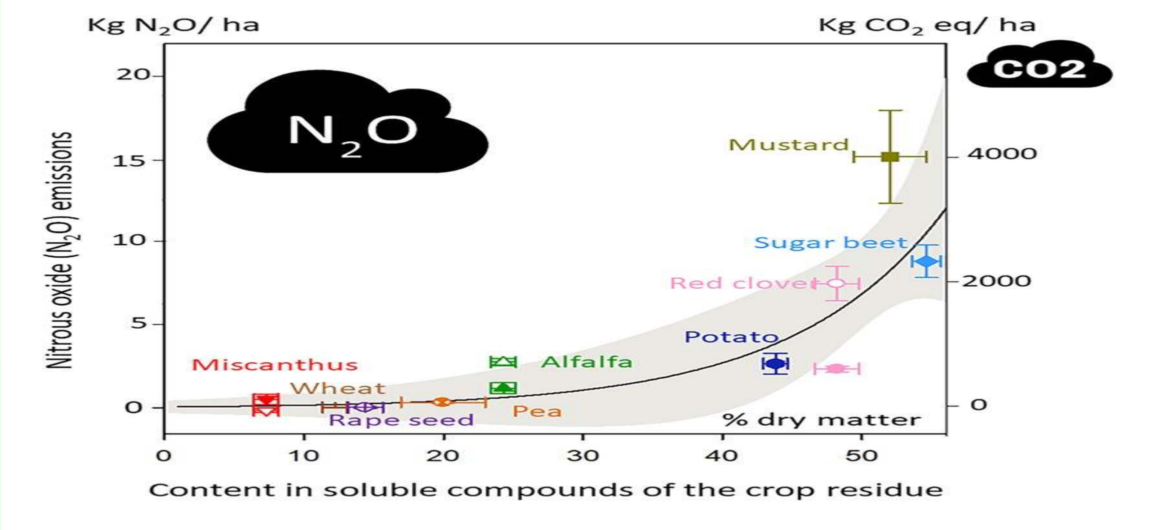
Based on Per Acre: 43,500 sq.ft per acreX 1 feet depth = 43,500 cubic Feet

@60 lbs soil per cu.ft =43,500 X60= 2,610,000 lbs or 1186 tonnes

Organic matter increase from 1 to 5% by 4% over 10 years Organic matter dry basis = 1186X0.04= 47.45 tonnes/Year 47.45/10= 4.75 tonnes/year

@ 60% C in organic matter = 2.85 tonnes/Year CO2e Equivalent 2.85X44/12 = 10.45 tonnes /Acre/Year

Average =10 tonnes/Acre /Year



Nutrient ENHANCER™

One Step Impregnation

Nutrient ENHANCER™ is a One Step Impregnator of Urea, DAP, Muriate of Potash, Ammonium Nitrate, & other granular plant nutrients for improved efficiency and proportional release during Germination & Growth Cycle.

Also useful for coating seeds, lime, & other products...

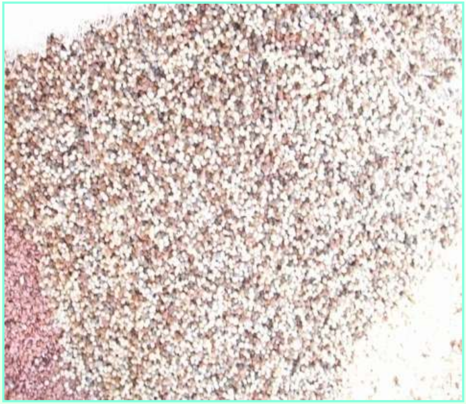
An Innovation By:

ARCTECH
Preserving Tomorrow's World...Today

Balanced Sustainability

ARCTECH
Preserving tomorrow's world... today

Nutrient ENHANCER™ Improves Efficiency of Granular Fertilizers



Southern Sates Commercial Facility, Nutrient-ENHANCER™ Impregnated NPK and Its Application on the Farm.

Nutrient-ENHANCER™ NPK Increased Height of the Rye Plant

ActoCLEANSE ™

EcoFriendly General Purpose Industrial Cleaner

For Use on Poultry Farms

- Reduces Caking of Litter
- Forms a Biological Barrier
- Controls Ammonia & Other Odors
- Reduces Shavings & Bedding Costs

An Innovation By

ARCTECH

Preserving Tomorrow's World...Today

Balanced Sustainability

ARCTECH

Preserving tomorrow's world... today

3PM™ PROCESS

Pollution Prevention and Profit from Manure Process

Produces humic rich fertilizer

Eliminates odor, pathogens and viruses from manures;

Modular design, applicable for small to large scale operations

Converts problem into economic opportunity

ARCTECH

Preserving tomorrow's world... today

ARCTECH
Preserving tomorrow's world... today

Soils are Fourth Largest Storehouse for Carbon

Table 1. Estimated Size of Major Pools of Carbon in the World Carbon Budget

	Trillion kilograms of carbon
Atmosphere (as CO_2)	700
Land	
Biomass	480
Humic substances (expressed as 50% of soil organic matter)	1500-2500
Waters	
Freshwater	250
Marine dissolved and suspended	4150
Sediments	2,000,000
Fossil fuels	10,000

Sources: B. Bolin Science, **196**, 613 (1977); B. Bolin and R. B. Cook, Eds. *The Major Biogeochemical Cycles and Their Interactions*, Wiley, New York, 1983.

HUMASORB®

Solution To Pollution

Low Cost for Simultaneous Cleanup of Heavy Metals, Radionuclides and Organics

Metals, Radionuclides, Organics

Multi-Purpose Adsorber

High Cation -Exchange Capacity

Can Be Regenerated

Cost-Effective

Environmentally Friendly

Balanced Susta

ARCTECH

ARCTECH

... today

HUMASORB® Product and Technology Applications Proven in Multiple Markets

Military Wastes Applications

HUMASORB®TREATED AND DISPOSED SPENT DECONTAMINATION SOLUTION FROM US ARMY CHEMICAL WEAPONS DEMIL FACILITY AT JOHNSTON ATOLL

US ARMY

- Successfully completed treatment of approximately 24,000 gallons of Spent Decontamination Solution (SDS) that contained RCRA hazardous levels of arsenic, lead and mercury.

DESTRUCTION OF LEWISITE IN TON CONTAINER SLUDGE AND ONSITE SECONDARY WASTE MANAGEMENT AT PINE BLUFF ARSENAL WITH HUMASORB® TECHNOLOGY

US Army Chemical Material Agency and EAI Corporation

- Pine Bluff Arsenal (PBA) has approximately 4,400-Ton Containers (TCs) requiring final disposal. The ton containers were originally used to store variety of chemical agents since almost World War I.
- The micro-scale destruction experiments were conducted by EAI Corporation in 15-mL glass vials with TFE/silicone lined phenolic caps. A total of 24 decontamination reagents were evaluated by EAI, including five (5) HUMASORB decontamination reagents. Only HUMASORB reagents included hydrolysis, oxidation and adsorption mechanisms.
- HUMASORB decontamination reagents were effective even at 100°F compared to other reagents, which required higher temperatures (150 or 180°F).
- The results from the secondary waste minimization tests show that after the HUMASORB® treatment, arsenic levels are reduced to non-detect levels (Detection Limit: 0.6 ppm). The Resource Conservation and Recovery Act (RCRA) limit for arsenic is 5 ppm.

HUMASORB® and Advanced Actodemil® Neutralization Technology for Safe Destruction of Picric Acid and Arsenic

KOBE STEEL, LTD

Table 1. Results of Analyses for Contaminants in the Treated Sample

Compound	Concentration	Regulatory Limit
Arsenic	ND	5.0 mg/L TCLP
Barium	1.3 mg/L TCLP	100 mg/L TCLP
Cadmium	ND	1.0 mg/L TCLP
Chromium	1.3 mg/L TCLP	5.0 mg/L TCLP
Lead	ND	5.0 mg/L TCLP
Mercury	ND	0.2 mg/L TCLP
Selenium	ND	1.0 mg/L TCLP
Silver	ND	5.0 mg/L TCLP
Semivolatile Organic Compounds – None Detected		
Volatile Organic Compounds – None Detected		

- Using the Actodemil® technology for destruction of the explosive material picric acid from aqueous solution and the HUMASORB® technology for the removal of As (V) from an aqueous solution.
- initial concentration of picric acid of 6,600 mg/L. However, picric acid was not detected after treatment with the a-HAX reactant. A summary of the results from the TCLP analyses are presented in Table 1. No organic compounds were detected.

HUMASORB® Product and Technology Applications Proven in Multiple Markets

Industrial Wastes Applications

HUMASORB® REMOVING MERCURY <5 ppt AND PCB NON-DETECT FROM STORM WATER AT A SCRAP METAL YARD IN MICHIGAN

- To date over 3 million gallons of wastewater has been treated without requiring HUMASORB® replacing.

HUMASORB® TECHNOLOGY DEMONSTRATED FOR REMEDIATION OF METAL-CONTAMINATED TANNERY AND ELECTROPLATING WASTE STREAMS IN INDIA

National Association of State Development Agencies, Washington, D.C.

- For treatment of waste streams containing multiple metals in India. The results with the streams from the tannery showed chromium removal of more than 93-99% and with electroplating streams containing multiple toxic metals, the removal of metals was more than 95%.

Technical Feasibility of Polychlorinated Biphenyls (PCBs) Removal from Liquids by HUMASORB®-CS

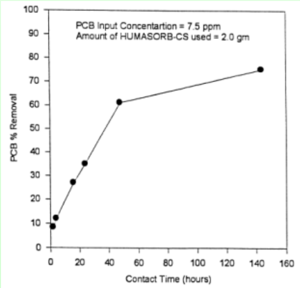


Table 1. PCBs Removal with HUMASORB®-CS

Contact Time, hours	Input concentration, ppm	Output concentration, ppm	Removal %
24	7.511	4.9	35
48	7.511	2.95	61
144	7.511	1.87	75
168	7.511	2.03	73

Table 2. Extraction of PCBs from Spent HUMASORB®-CS

Contact Time, hours	PCBs concentration, ppm	Recovery %
1	5.81	52
24	8.22	73
48	8.76	78
72	8.81	78

- HUMASORB® technology successfully adapted to provide a solution to Mason & Hanger at the Iowa Army Ammunition Plant for the simultaneous destruction of M30 propellant and recovery of Depleted Uranium (DU) contamination.

Feasibility Tests with HUMASORB® for Removal of Ba and Sr from Frac Wastewater

Sample ID		Sample C F'Sure only*		Frac Water NY	
Contaminants		Ba, ppm	Sr, ppm	Ba, ppm	Sr, ppm
Provided Data		1520	3120	13.7	50.8
HUMASORB®-CS	Untreated	1313.2	2762.4	5.7	44.0
	Treated	797.7	2177.5	0.318	7.0
	Reduction %	39.26	21.17	94.39	84.06

HUMASORB®-CS Treated and Untreated Frac Wastewater

Balanced Sustainability

ARCTECH

Preserving tomorrow's world... today

HUMASORB® Product and Technology Applications Proven in Multiple Markets

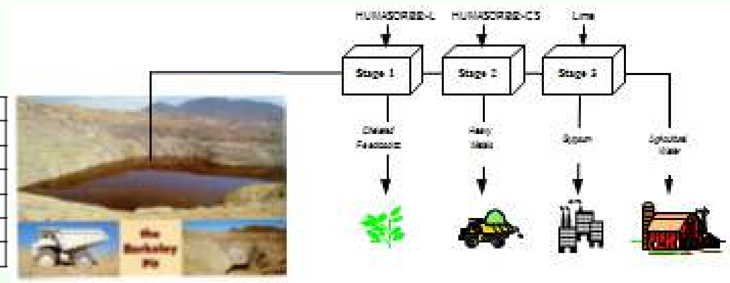
Mining Industry Wastes Applications

HUMASORB® TECHNOLOGY DEMONSTRATED FOR RESOURCE RECOVERY FROM BERKELEY PIT ACID WATERS IN BUTTE, MONTANA

U.S. Department of Energy/MSE Technology Applications, Inc.

- PILOT TESTING RESULTS

METALS	DEMONSTRATION OBJECTIVES	PROCESS PERFORMANCE
Arsenic	< 0.5 ppm in product	0.294-0.481 ppm in product
Cadmium	< 0.5 ppm in product	0.280-0.360 ppm in product
Cadmium	> 70% Removal in Stage 2	67.56-98.93 % Removal in Stage 2
Copper	> 70% Removal in Stage 2	85.44-99.96 % Removal in Stage 2
Iron	> 70% Removal in Stage 2	73.15-99.97 % Removal in Stage 2
Zinc	> 70% Removal in Stage 2	48.02-99.90 % Removal in Stage 2

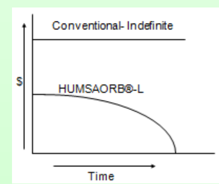


- ARCTECH's HUMASORB® process is an effective approach for economically viable treatment of acid mine waters such as Berkeley Pit water.

Demonstration of HUMASORB® Technology for In-situ Treatment of Acid Mine Drainage in the Abandoned Tide Mine Site, Indiana County, PA

Pennsylvania Department of Environmental Protection (PA DEP) and Blacklick Creek Watershed Association, Inc.

- HUMASORB®-L treatment meets the success criteria for removing metals to > 90% and raising the pH to more than two units, criteria set forth for this project by the PA DEP.
- The HUMASORB®-L treated acid mine water enhances growth of SRB which can lead to improving the operation of the passive treatment system.
- HUMASORB®-L system can be easily deployed at mine sites.
- HUMASORB®-L can be utilized as active treatment for metal recovery as a micronutrient fertilizers.
- HUMASORB®-L Offers Lower Life Cycle Costs for AMD Treatment



HUMASORB®-CS Feasibility Test for Selenium and Other Toxic Chemicals from the Runoff Water from Coal Waste Pile at Mammoth Coal Co., Montgomery, WV

- Selenium and Other Toxic Chemicals are Removed from the Runoff Water from Coal Waste Pile.

Toxic Metal	Untreated, ppb	HUMASORB Treated, ppb	NPDES Permit Limit
As	24	n.d.	n.a.
Cd	n.d.	n.d.	n.a.
Cr	n.d.	n.d.	n.a.
Hg	n.d.	n.d.	n.a.
Pb	n.d.	n.d.	n.a.
Se	13	n.d.	8 ppb

n.d.: not detected
n.a: not available

Sample Submitted by SNF Flomin, Inc.

Balanced Sustainability

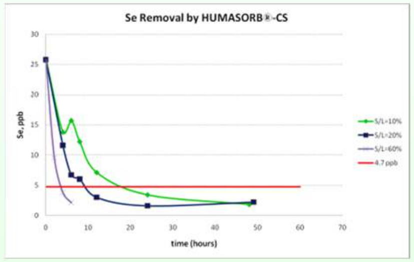
ARCTECH
Preserving tomorrow's world... today

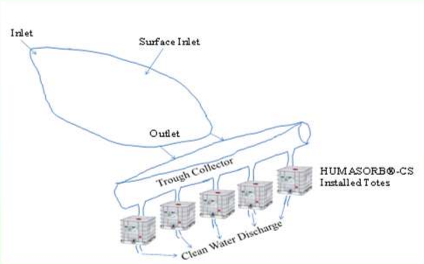
HUMASORB® Product and Technology Applications Proven in Multiple Markets

Mining Industry Wastes Applications

HUMASORB® Treatment for Selenium Removal from Coal Mine Discharge Water in West Virginia

- HUMASORB®-CS had good capability to remove Se in the WV Coal Mine Discharge water that can meet the more stringent NPDES regulation. About three hours contact time with 60% of S/L loading, selenium went down less than 4.7 ppb.



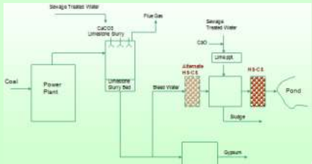


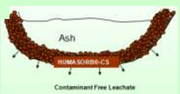
HUMASORB®-CS Implementation Approach for Removal of Selenium from Coal Mine Discharge Wastewater.

Power Plant Wastes Applications

HUMASORB®-CS Feasibility Test Showed that Toxic Metals are Removed from Spent Scrubber Wastewaters at Dominion Resources Chesterfield Power Plant-Virginia

Dominion Resources





Toxic Metals (mg/L)	Chesterfield Unit6 Bleed Slurry (2/25/2010)		Chesterfield WWTP Effluent (2/25/2010)		Regulatory Limit	HUMASORB® Compliance
	Initial	HUMASORB Treated	Initial	HUMASORB Treated		
As	0.598	nd	0.696	nd	0.20	Yes
Ba	0.427	0.33	0.416	0.303	3.00	Yes
Cd	0.108	nd	0.119	nd	0.05	Yes
Cr	0.175	nd	0.150	nd	0.60	Yes
Hg	0.785	nd	0.674	nd	0.05	Yes
Pb	6.966	nd	5.832	nd	0.10	Yes
Se	1.030	0.133	1.070	0.103	2.00	Yes
Ag	nd	nd	nd	nd	0.10	Yes
Cu	nd	nd	nd	nd	0.10	Yes
Fe	nd	nd	0.155	nd	1.00	Yes
Ni	1.084	nd	0.143	nd	0.50	Yes
Tl	0.87	nd	0.799	0.011	0.50	Yes
Zn	1.801	nd	0.067	nd	0.10	Yes

nd: not detected

scrubber waste water

Toxic Metals (mg/L)	Ash Pond Leachate (mg/L)			HUMASORB Treated (mg/L)			TCLP Hazardous Waste Limit, mg/L
	pH3	pH5	pH6.5	pH3	pH5	pH6.5	
As	1.163	1.135	1.580	nd	nd	nd	5.0
Ba	1.220	0.608	0.680	0.011	0.006	0.003	100.0
Cd	0.193	0.183	0.183	nd	nd	nd	1.0
Cr	0.090	0.090	0.095	nd	nd	0.006	5.0
Hg	nd	nd	nd	nd	nd	nd	0.2
Pb	1.055	1.118	1.028	nd	0.052	0.037	5.0
Se	1.165	1.215	1.585	nd	nd	nd	1.0
Ag	nd	nd	nd	nd	nd	nd	5.0
Cu	9.023	nd	nd	nd	nd	nd	
Fe	0.683	nd	nd	nd	nd	nd	
Ni	2.315	1.258	0.193	0.045	0.072	0.011	
Tl	1.345	1.208	1.288	nd	nd	0.045	
Zn	1.003	0.143	nd	nd	nd	nd	

nd: not detected
TCLP: Toxicity Characteristic Leaching Procedure

ash pond leachate

Balanced Sustainability

ARCTECH

Preserving tomorrow's world... today

HUMASORB® Product and Technology Applications Proven in Multiple Markets

Municipal Wastes Applications

HUMASORB®-CS Amended Smart Sponge® Feasibility Proven For Removal of Toxic Metals, PCB and Oils

AbTech Industries Inc.

- All RCRA heavy metal mix (As, Ba, Cd, Cr, Pb, Hg, Se and Ag) and Cu are removed completely to 100% by HUMASORB®-CS amended Smart Sponge® except As. Removal % of As was 95.7%.
- The result of TCLP test shows that heavy metal leaching complies with the TCLP Regulatory Level.

Metal	Leachate, ppm	TCLP Regulatory Level, ppm	Compliance
Ag	ND	5	Yes
As	0.074	5	
Ba	0.034	100	
Cd	ND	1	
Cr	ND	5	
Cu	ND	Not Listed	
Hg	0.006	0.2	
Pb	0.92	5	
Se	ND	1	

- PCB removal was 43.75%.
- Phosphorus was removed 97.56 % by HUMASORB®-CS Amended Smart Sponge®.

Drinking Water Applications

HUMASORB® MATKA UNIT FOR SAFE DRINKING WATER

- MATKAs, a common word from the Hindi language and Kolshi in Bangladesh, are in common use in rural and poor households on the Indian subcontinent.

Tests conducted in Prototype HUMASORB® Matka System

Contaminant	Untreated Water, ppm	Treated Water, ppm	WHO Guideline for Drinking Water System, ppm
Lead	5-20	ND	0.01
Arsenic	5-20	ND	0.01
Chromium	5-20	ND	0.05
Fluoride	5-20	ND	1.50
Hardness	451	19.75	NE
Nitrate	95.54	ND	50

ND: Not Detected, NE: Not Established

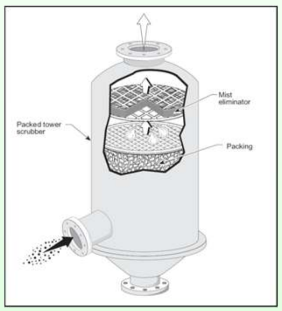
ECO

- ➢ Total System under 300-500 Rupees for a 3-gallon (11 litres) MATKA
- ➢ Provide 300-360 gallons (1,130-1,360 litres of drinking water
- ➢ HUMASORB ® recharge cost : less than 500 Rupees

Carbon Dioxide Along with Other Contaminants are Recycled into HUMASORB® Water Filter

CO_2, NOx, SOx, and toxic metals from combustion gases

Coal

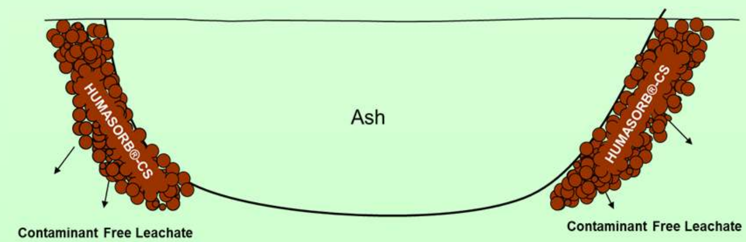


Gas Scrubber

HUMASORB®-CS

HUMASORB®-CS Feasibility Test for Contaminant of Toxic Chemicals form Ash Pond Leachate

Toxic Metals (mg/L)	Ash Pond Leachate (mg/L)			HUMASORB Treated (mg/L)			TCLP Hazardous Waste Limit, mg/L
	pH3	pH5	pH6.5	pH3	pH5	pH6.5	
As	1.163	1.135	1.580	nd	nd	nd	5.0
Ba	1.220	0.608	0.680	0.011	0.006	0.003	100.0
Cd	0.193	0.183	0.183	nd	nd	nd	1.0
Cr	0.090	0.090	0.095	nd	nd	0.006	5.0
Hg	nd	nd	nd	nd	nd	nd	0.2
Pb	1.055	1.118	1.028	nd	0.052	0.037	5.0
Se	1.165	1.215	1.585	nd	nd	nd	1.0
Ag	nd	nd	nd	nd	nd	nd	5.0
Cu	9.023	nd	nd	nd	nd	nd	
Fe	0.683	nd	nd	nd	nd	nd	
Ni	2.315	1.258	0.193	0.045	0.072	0.011	
Tl	1.345	1.208	1.288	nd	nd	0.045	
Zn	1.003	0.143	nd	nd	nd	nd	



Balanced Sustainability

ARCTECH

Preserving tomorrow's world... today

Actodemil

The Solution to Munitions Waste Disposition

Energetics - Chemical Agents - Biological Agents

SAFE:
Permanently Destroys Energetics, Chemical and Biological Agents

ENVIRONMENTALLY SOUND:
Non Polluting and Non Hazardous Product

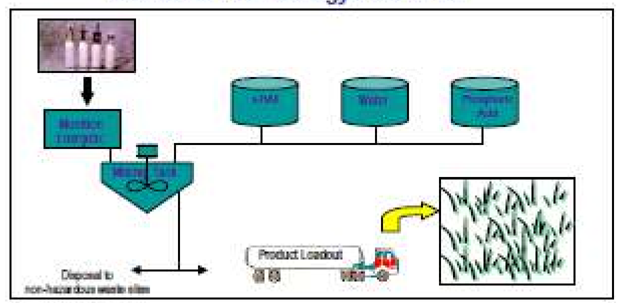
COST EFFECTIVE:
Lower Cost Than Thermal Destruction Methods
Recycles Energetic Into Saleable Fertilizer

A CLEAR CUT ALTERNATIVE TO INCINERATION AND OB/OD.

Actodemil® technology - Description and Applicability

Actodemil® technology is based on naturally occurring coal-derived humic acid for accomplishing a series of useful reactions to decompose highly toxic and hazardous chemicals. Humic acid is a water soluble colloidal solution. It is a reducing agent and thus it promotes reductive hydrolysis. In addition, it has a strong affinity for organic molecules and metal ions, and is thus effective for absorption of reaction products. The key reactant material in the reaction is the ARCTECH proprietary a-HAX reagent. The reaction is carried out in a reaction vessel operating at atmospheric pressure and at a temperature of 160 to 180ºF. Following completion of reaction (between 2 to 4 hours), the product is neutralized and is then ready for application as a fertilizer or safe disposal.

Actodemil® Technology Flow Sheet



Actodemil® TECHNOLOGY SUCCESSFULLY TESTED ON:

Energetics	Chemical Agents	Biological Agents
Large-Bore Gun Propellants	*Nerve Agents*	*E. coli*
- 3"/50, 6"/47, M6 (NC based)	GB, VX	
- 105 MM (NC/NG based)	*Blistering Agents*	
- 106 MM - M30, M30A1(NC/NG/NQ)	HD, HT, H	
Rocket Propellant		
- 2.75" AA (NC/NG based)		
Other Explosives - HMX, RDX, TNT, DNT, Lead Azide, PETN, and AP		

In addition, a variety of energetic wastes treated such as: Rags, Turnings, Dust, Overcast, Off Spec, Rejected Propellants, Explosives, Filters contaminated with Explosives, Unstable, Out of Date Materials, Floor Sweepings, Expended Samples from Lab, Manufacturing Wastes, etc.

Actodemil® Technology Supported by EPA regulators and the Public

.....the Agency has determined the recycling of propellants or explosives into fertilizer may be a permissible activity under RCRA..........the use of an unused explosive or propellant as an ingredient to produce commercial fertilizer would be exempt from regulation under RCRA.....

Excerpts from U.S. EPA Military Munitions Rule

40CFR Section 266.202.
April 1997

GOING GREEN AT THE DOD. Defense Department Scientists Agree Army Depot uses obsolete Demil Technology. Actodemil® Technology fulfills the biblical prophecy of tuning swords into plowshares

- Reno News
May 29, 2001

STATE OF NEVADA
KENNY C. GUINN
Governor

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
DIVISION OF ENVIRONMENTAL PROTECTION
333 W. Nye Lane, Room 138
Carson City, Nevada 89706-0851

February 25, 1999

Dear Mr. Kaushik:

The Division first became aware of the ARCTECH study during an inspection at HWAD in March/April 1997. The Division later learned in July 1997 that fertilizer produced during the study was ultimately applied to the land as a fertilizer at the Gomes property in Fallon, Nevada. In response to concerns regarding the suitability of the product as fertilizer and adequate treatment of the waste munitions, the Division reviewed data provided by ARCTECH, as well as soil samples taken by the Division, and determined that the **"Actosol" product did not exhibit any of the characteristics of a "hazardous waste."** However, because the waste munitions were being recycled in "a manner constituting disposal" (i.e., placed on the land), the Division was concerned that the laboratory data did not adequately demonstrate compliance with the applicable treatment standards of 40 CFR 268 Subpart D (see 40 CFR 266 Subpart C). ARCTECH later provided data indicating that the presence of the underlying constituent(s), specifically Barium, could be adequately addressed during the fertilizer manufacturing process.

Because waste munitions do share many of the same components of common fertilizers, the Division **commends ARCTECH's efforts** to develop fertilizers from this otherwise discarded material. Notwithstanding the potential merits of your process, the Division wishes to reiterate the importance of demonstrating compliance with 40 CFR 266 Subpart C and the applicable state requirements as conveyed in my letter to HWAD (dated November 18, 1998).

Balanced Sustainability

ARCTECH

Preserving tomorrow's world...today

ActoCLEANSE™ is a natural, organic product to meet the demands for healthy & environmentally friendly approaches...

One Step Control of odor from ammonia, hydrogen sulfides, mercaptans, biologicals as well as safe elimination of toxic organics, energetics, & the binding of toxic metals & radionuclides.

ActoCLEANSE™

EcoFriendly General Purpose Industrial Cleaner

CAUTION:
Please apply wearing a protective rain suit, eye protection, face mask, & gloves. In case of contact, flush with plenty of water.

ARCTECH
Preserving Tomorrow's World...Today
P.O. Box 323
South Boston, VA 24592 USA
www.arctech.com

KEEP OUT OF REACH OF CHILDREN
NET 55 US GALLONS (213 LITERS) ~ 560 LBS

humaxx USA
offering balanced sustainable solutions

HUMAXX Coal Products offers to Capitalize on Prevailing Various Market Drivers Resulting from Government Mandates, Policies Corporates initiatives, and Public **Preferences**

1. ENERGY SECTOR	**HUMAXX SOLUTION**
• Mercury and Air Toxics Standards for Electric Generation Units – MATS • Cross State Air Pollution Rule – **CSAPR** • Carbon Pollution Standards for New, Modified and Reconstructed Power Plants • Cooling Water Intake Systems Rule – 316(b) • Steam Electric Power Generating Effluent Guidelines • Coal Combustion Residuals Rule • Federal IRS 45Q Tax Incentives for Carbon Reduction • State Mandates Incentives for Clean Fuels	• Produces lower carbon gas and liquid fuels with zero to negative carbon foot print, and no liquid and solid wastes • Eliminates GHG and air toxic pollutants emissions from coal uses • Enables extraction of clean energy from coal without mining • Potential path for the low-cost hydrogen fuel

Balanced Sustainability

ARCTECH
...ing tomorrow's world... today

2. AGRICULTURE SECTOR	HUMAXX SOLUTION
• USDA National Organic Program Regulations 2005 • The Soil and Water Resources Conservation Act of 1977 • USDA Nutrient Management Policy **Nutrient management** is the science and practice directed towards linking soil, crop, weather, and hydrologic factors, with cultural, irrigation and soil and water conservation practices, to achieve optimal nutrient use efficiency, crop yields, crop quality, and economic returns, while reducing off-site transport of nutrients (fertilizer) that may impact the environment.[1] It involves matching a specific field soil, climate, and crop management conditions to rate, source, timing, and place (commonly known as the **4R nutrient stewardship**) of nutrient application. • **USDA Soil Conservation Policy** In addition to preserving soil life and organic matter, other principles of soil conservation are to: manage surface runoff, protect bare exposed soil surfaces and highly susceptible sites (e.g. steep slopes), and to protect downstream running water-courses from sedimentation and pollution.	• Increases efficiency of uptake of mineral nutrition • Decreases nutrient run-off/nutrient leaching, improve water quality • Increases erosion resistance and decrease soil loss • Enables biomass cultivation in impaired soils for increasing carbon sequestration • Increases sequestration of stable carbon in form of humic matter in soils • Conserves water usage • Enhances biomass and will help in carbon sequestration and improve air quality • Allows for organic food productions per USDA National Organic Program • Reduces adverse impact of pesticide chemicals approved per USEPA FIFRA Regulations • Reduces ammonia odor from poultry house • Sanitizes and reduces pathogens and viruses

humaxx USA
offering balanced sustainable solutions

3. ENVIRONMENT SECTOR	HUMAXX SOLUTION

• The Clean Air Act (1970)
• The Clean Water Act (1977)
• The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (1980)
• The Emergency Planning & Community Right-to-Know Act (EPCRA)(1986)
• The Endangered Species Act
• Federal Insecticide, Fungicide & Rodenticide Act (FIFRA)
• Securities & Exchange Commission
• NON GOVERNMENTALS AND CORPORATES:
  • Sierra Club at local levels seeking close of coal use
  • River Keepers Association seeking to stop pollution of water sheds and rivers
  • The Nature Conservancy seeking deployment of solutions for climate change concerns
  • Green Peace Corp, actively battling to protect planets and its inhabitants.
  • Earthjustice, seeking environmental and climate justice in minority communities.
• Corporate Initiatives:
  • Bill Gates/Microsoft— Breakthrough Energy with $1 Billion fund to support scale of energy technologies.
  • Elon Musk/Musk Foundation, $100 Million XPRIZE to demo by 2025 removal of CO2 from air and permanent sequester in our planet. *Actosol* is one of the qualified approaches for this global competition.
  • Jeff Bezos/Amazon $2 Billion pledges to NGO's to increase awareness of climate change concerns.
  • Major public and private corporations are adopting sustainability initiatives, including reduction of carbon footprint in their operations.
	• Removes pollutants from water and wastes
	• Allows passive treatment for remediation storm water, ground water, and leachate from waste piles
	• Removes radioactive contaminants for secure storage
	• Recycles hazardous wastes, such as sewage water, manure, and explosives into safe fertilizer
	• Mitigates emission of green house gases and air pollutants

HUMAXX Coal Products & Solutions Mitigates Pollution and Carbon Emissions from Coal Mining, Coal Power Plants and Other Sources

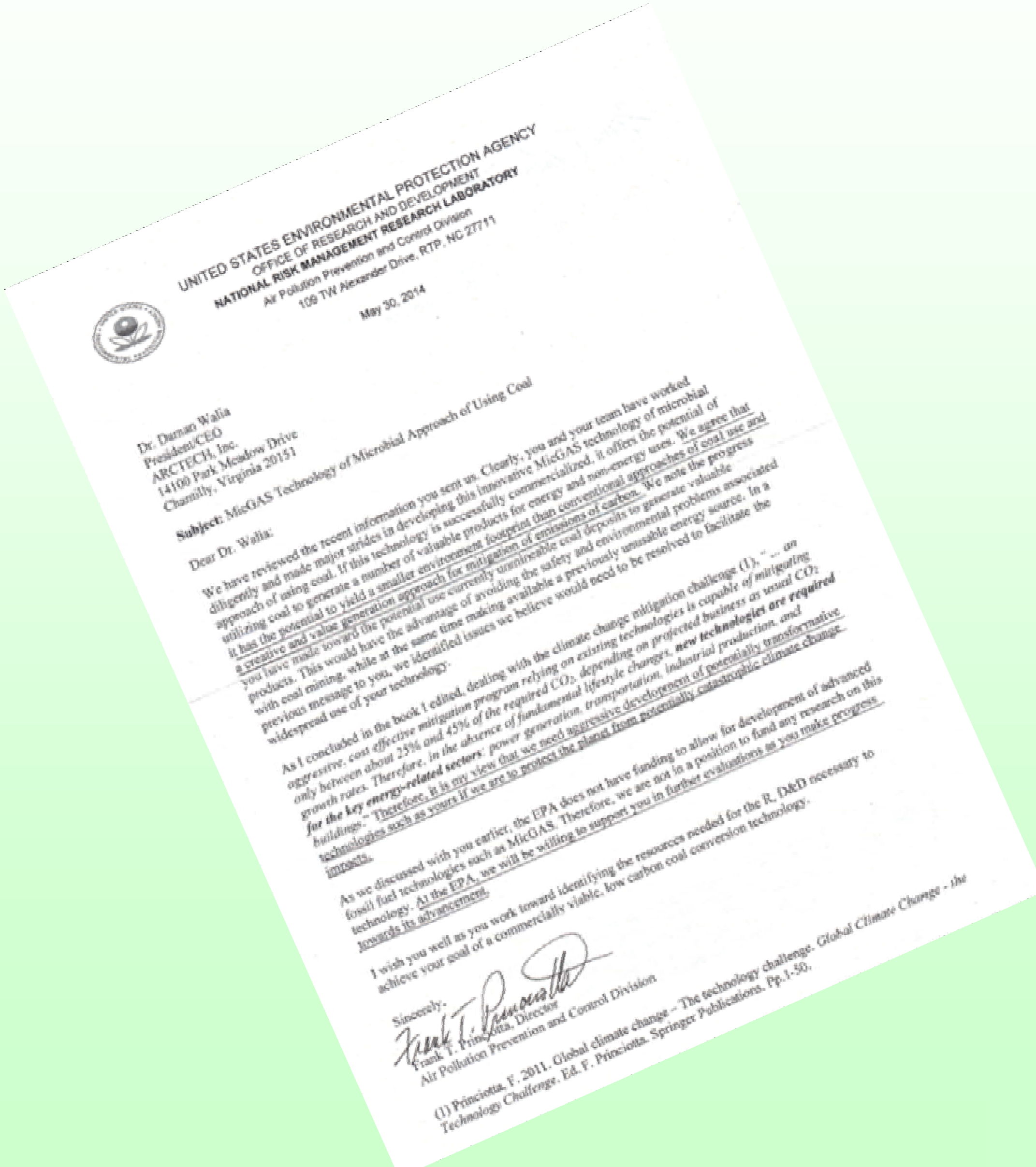
A. Coal Mining: actosol for Reclamation and HUMASORB for Water Pollution

B. Coal Power Plants: HUMASORB for Mitigating Carbon & Pollutants from Stack and Ash Ponds, while extending the Life of the Plant to continue to operate in compliance with increasingly stringent regulations

C. OIL, Gas & Carbon-Based Existing Plants: HUMASORB for mitigating pollutants and carbon emissions

D. Recycling of Waste: HUMASORB and ActoDEMIL for wastes and wastewaters Treatment and Recycling

USEPA recognized "the potential to yield a smaller environment footprint than conventional approaches of coal use and a creative and value generation approach for mitigation of emissions of carbon"



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
NATIONAL RISK MANAGEMENT RESEARCH LABORATORY
Air Pollution Prevention and Control Division
109 TW Alexander Drive, RTP, NC 27711

May 30, 2014

Dr. Daman Walia
President/CEO
ARCTECH, Inc.
14100 Park Meadow Drive
Chantilly, Virginia 20151

Subject: MicGAS Technology of Microbial Approach of Using Coal

Dear Dr. Walia:

We have reviewed the recent information you sent us. Clearly, you and your team have worked diligently and made major strides in developing this innovative MicGAS technology of microbial approach of using coal. If this technology is successfully commercialized, it offers the potential of utilizing coal to generate a number of valuable products for energy and non-energy uses. We agree that it has the potential to yield a smaller environment footprint than conventional approaches of coal use and a creative and value generation approach for mitigation of emissions of carbon. We note the progress you have made toward the potential use currently unminable coal deposits to generate valuable products. This would have the advantage of avoiding the safety and environmental problems associated with coal mining, while at the same time making available a previously unusable energy source. In a previous message to you, we identified issues we believe would need to be resolved to facilitate the widespread use of your technology.

As I concluded in the book I edited, dealing with the climate change mitigation challenge (1), "... *an aggressive, cost effective mitigation program relying on existing technologies is capable of mitigating only between about 25% and 45% of the required CO_2 depending on projected business as usual CO_2 growth rates. Therefore, in the absence of fundamental lifestyle changes,* ***new technologies are required for the key energy-related sectors****: power generation, transportation, industrial production, and buildings.*" Therefore, it is my view that we need aggressive development of potentially transformative technologies such as yours if we are to protect the planet from potentially catastrophic climate change impacts.

As we discussed with you earlier, the EPA does not have funding to allow for development of advanced fossil fuel technologies such as MicGAS. Therefore, we are not in a position to fund any research on this technology. At the EPA, we will be willing to support you in further evaluations as you make progress towards its advancement.

I wish you well as you work toward identifying the resources needed for the R, D&D necessary to achieve your goal of a commercially viable, low carbon coal conversion technology.

Sincerely,

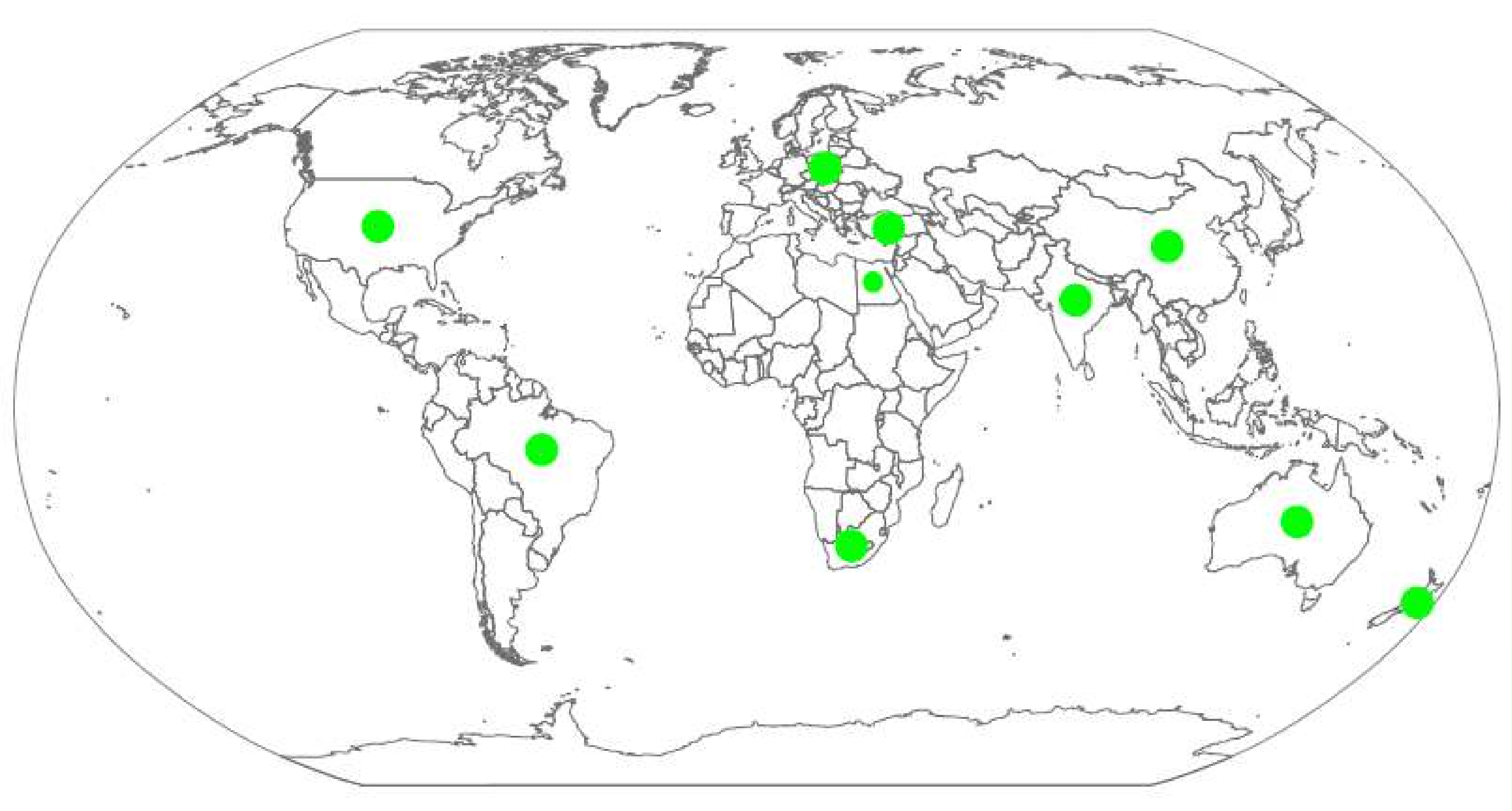
Frank T. Princiotta, Director
Air Pollution Prevention and Control Division

(1) Princiotta, F. 2011. Global climate change – The technology challenge. *Global Climate Change - the Technology Challenge*. Ed. F. Princiotta. Springer Publications. Pp.1-50.

Balanced Sustainability

Preserving tomorrow's world... today

Worldwide HUMAXX™ Envisioned Plant Location



Balanced Sustainability

Preserving tomorrow's world... today