ARCTECH
Preserving Tomorrow's World...Today

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ARCTECH USA Global Team Submission to XPRIZE -Musk Foundation: actosol®, a unique, organic humic-fulvic product, facilitates nature for increasing capturing the CO2 from the air and durably storing in farm and forest soils while increasing crop yields and sustainable forests

--- How does it work, where proven, what sets it apart, and a path for scaleup per XPRIZE goal for practical, economic value generation, for supporting the net-zero goal of 2050 per the UN Paris Agreement.

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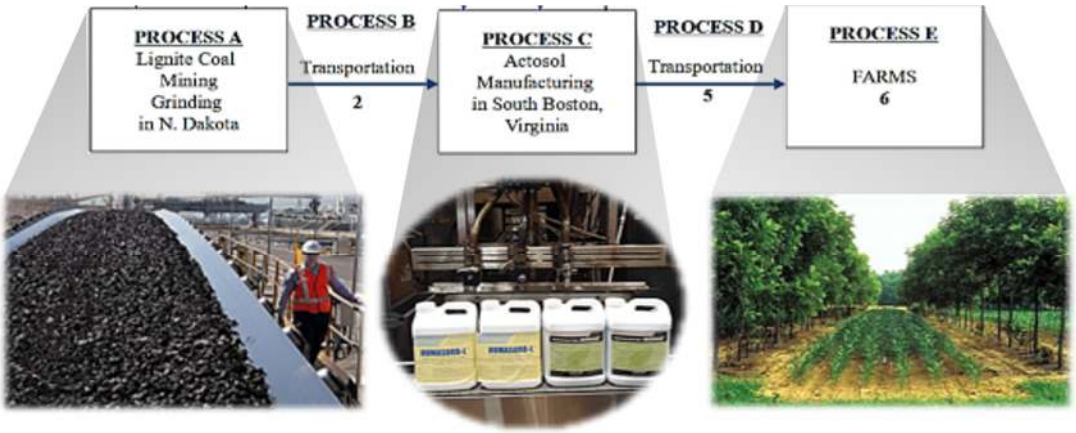
Loss of carbon in soils, the fourth largest storehouse of carbon is equally at peril as increasing in air. actosol addresses to rebalance both storehouses - Daman Walia, President/CEO ARCTECH Inc.

actosol® Process Flow Diagram



ARCTECH Team facilitates nature's photosynthesis with the use of its unique actosol® organic humic-fulvic fertilizer to increase the growth of plants and their roots, and thus increase the capture of CO2 from the air. actosol also enhances microbial activity in soils, which convert the crop residue, left after harvest, and roots to form humus-rich organic matter for durable storing in the soils. It also increases crop yields by 20%+ and replenishes depleted vital organic matter in soils. 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 CO2 in air. Reconfiguring these two storehouses is the lowest hanging fruit for speeding up the capturing from the air and becoming a major contributor for achieving net-zero CO2 emissions by 2050. A target set by the UN Paris Agreement needed to limit the mean global temperature rise well below 2 degrees Celsius (3.6 degrees F) above preindustrial levels and preferably limit the increase to 1.5 degrees Celsius (2.7 degrees F).

Our approach offers to make a major contribution in achieving the above stated target while ensuring economical food production for increasing populations of 7.5 billion today and is projected to increase to 9+ billion by 2050. It sets it apart and is a step-change for increasing the rate of CO2e capture by 2X to 5X from the air then with current approaches being advanced with increasing plantation of trees and on farms with no-till and cover crop practices. Our approach results in converting the captured CO2 in plants and their roots into soil organic matter for storing durably at a cost of $10 per tonne. Increased organic matter improves soil fertility and crop yields increase by 20%+. With monetization realized from the current US IRS Code Section 45 &48 of $35 credit per tonne of CO2, it will result in a net cost of -$21.80 per tonne based on the XPRIZE Cost worksheet at a megatonne scale. Worldwide, other countries are also implementing similar incentives to address this global challenge. Besides mandates and incentives, it shall foster an economic incentive path forward with the use of actosol to increase crop yields, quality, and added economic value realization.

We achieve the above-stated goal by using our unique, regulatory accepted, and proven actosol organic humic-fulvic fertilizer to augment natural photosynthesis by increasing plant growth, crop yields by 20%+, and root mass by 4X. Plus enables crop residue humification in soils with the increased microbial activity in soils to convert crop residue into humic-rich organic matter. UNFAO reports that it remains stable for 100 years. USDA and other scientific studies with radio dating of carbon in humic matter in soils today that they are 10,000 to 30,000 years old. Thus, offering a path to well over 100 years of durability, also a key target set forth per the XPRIZE.

Humic and fulvic acid are the two active components of humus. The third component is known as "humin", which is inert as it lacks functional groups. Humic-fulvic acid

in actosol has oxygen-containing multiple functional groups, such as carboxylic, hydroxyl, and enolic. These functional groups are responsible for numerous interactions with plants and soil components through, ion exchange, chelation, hydrogen bonding, and electron donor-acceptor complexations. Thus, allowing our actosol to be multifunctional. It is proven to impart biological benefits as a biostimulant to increase cell division along with chemical benefits to increase uptake of mineral nutrition, retention, and recycling. On its cumulative use the physical benefits by increasing moisture-holding capacity of soils and the tilth by aggregation of soil particles in increasingly hardened soils. These multiple attributes increase soil health or fertility, increase the growth of plants and roots while increasing crop yields and quality. In contrast biochar, a pyrolyzed biomass also being considered for the same need, is charcoal and lacks functional groups. It is like inert component humin in soil humus. Prof. Davies of Northeastern University, a leading researcher on humic substances explains that fulvic acid is the baby, being a smaller molecule, humic acid is the adult made up of larger molecule and do the most lifting. Whereas humin is the deceased ancestors. The primary components of our actosol are fulvic and humic acid as water-soluble liquid and synergistically increase the growth of plants and roots starting from the first application. It is applied in soils at planting and as well as a foliar spray on the plants.

We currently manufacture actosol from humic-rich lignite coals readily available in worldwide coal fields. We have developed our MicGAS Coal Biotechnology for making multiple humic and clean fuels products from all types of coals. Please note www.arctech.com. Current approaches of coal use by burning results in excessive carbon emissions and polluting emissions of sulfur, nitrogen, and toxic metals. In our process, coal is not burned but instead converted into products at ambient conditions. Thus, no polluting gases and no toxic metals emissions. The mineral components in coals remain intact without releasing toxic metals. Our actosol product on testing showed non detect USEPA designated following toxic metals: Cu, Zn, Ni, Hg, Se, As, Cd, Cr, Pb, and Mo. No regulated toxic organics and pesticides were also found. actosol is approved for growing organic food by USDA and OMRI listed. US EPA per FIFRA allows combining with pesticides etc. as an adjuvant, UV Protectant and mitigates harm to plants. South Carolina DOT requires its use as a biostimulant to cultivate trees and green spaces for increasing roots and sustainability in sandy soils, approved by Virginia and several states in the USA. It is also permitted in China, India, Egypt, and Turkey per their governmental regulations. We have reimagined coal that it is not fossil fuel but biomass albeit ancient biomass. It is a rich source of humic matter and is proven over 20+ years that actosol made from coals improves soil fertility and increases crop yields and quality. In December 2021, IHS Markit at their international Crop Science Forum gave an award to actosol for its improving delivery and efficiency of fertilizers while increasing soil fertility and sequestration of carbon in soils.

We calculate based on present applications underway with increased organic matter in soil with the use of our actosol, resulting in net capture 10 tonnes CO2e /Acre/Year average at a cost of $10 per tonne. We project revenues of $35 per tonne based on prevailing IRS Tax Credit, thus resulting in -$21.80 per tonne net cost (per XPRIZE Xcel set cost calculations) of CO2 removed from the air and stored in the land. We also support planting trees on the farmlands as well as in forest lands. Trees are well recognized for capturing about 4 tonnes of CO2 per acre per year and releasing 6 tonnes of oxygen. There are already increasing activities underway worldwide by NGOs who are supporting the planting of trees. In the USA, commercial companies are also planting trees for carbon credits to monetize per the IRS tax code. We are making a case for actosol to plant both trees and grow crops for almost 2X to 5X increase in the carbon capture per unit of land. While the use of actosol for trees will increase root biomass for added carbon retention in soils. It is also proven to increase moisture in soils and trees and thus will prevent natural fires. Even proven for maintaining sustained growth on impaired and or desert lands. Our submission includes our project report in 2005 in Sadat City in Egypt, where we recycled sewage water into actosol organic fertilizer water for planting cotton, sorghum, and Cupresis sp. trees. Trees were planted on a portion of land in compliance with the UN Kyoto Clean Development Mechanism, which requires tree crowns to cover at least 10-30% of the land. With only 1/3rd rate of irrigation than conventional, the cotton yield increased 40% and sorghum 35%. The survival rate was increased by 10%, an important factor in the arid high temperature of desert land in Egypt. The height of trees increased 7% more with actosol use during their first four months of growth. It was validated that trees captured 3 tons of CO2e per acre per year. Our submission also includes scientific studies of actosol modes of action and a summary of field applications at farms in the USA, China, India, Egypt, and Saudi Arabia reporting increased plant, root biomass, crop yields, and organic matter.

No-till farming where crops are cultivated with crop residue harvested crop left on soil and cover crop planting such as rye, alfalfa, clovers, etc. in between crop cultivation cycles, are the two practices in use to stop erosion, keep the moisture, and maintain the soil health. These are also being attributed to capturing 2-3 tons of CO2 per acre per year. But these practices do not increase soil organic humus matter, so durability is uncertain. A recent survey of farmers by Sustainable Agriculture Research and Education Outreach, reports that carbon sequestration rates that were offered to them, approximately 80% said payment rates were $20 per acre or less, with about half of those indicating a payment rate of $10 per acre or less. Growers spend more on cover crops than they would see in a carbon payment at those prices. The seed, equipment, and labor for cover crops range from $15 to $75 an acre. Today the average cost of verification by soil sampling and analysis is about $14 and thus

not economically attractive to farmers. Farmers are also reluctant to adopt these practices as it leads to the carry-over weeds to subsequent crops.

In contrast to above, increasing to 10 tonnes per acre per year; becomes economically attractive as demonstrated with the use of actosol at Lawson Farm in Gordonsville, Virginia over ten years. Farmer Lawson also reports with residue mulched in soils, sprouting of weeds is mitigated. Following are results based on 360-acre Lawson Family Farm now in the third generation from the use of actosol. It rejuvenated soil in less than two years which had high amounts of residual salts from excessive use of chemicals. He has increased yields by 20-50% of Soybean, Wheat, Corn, and Sorghum while increasing organic matter in soils by mulching in crop residue and roots along with actosol. Following are the calculations for CO2e capture on his farm:

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

The above data from Lawson Farm corroborates the net removal rate given below based on calculations considering the CO2e intensity of 0.1 tonne CO2e released for making actosol and its use at the farm for mulching in increased crop residue and roots. We used average leakage of 30% during the conversion of crop residue and roots into organic matter. Details are given in the excel files.

Net Removed CO2e/Acre/Year= Gross16.09 tonnes (1-30% Leakage %) =11.26 tonnes

Primary economic incentives farmers derive from actosol are from additional revenues from 20%+ increased crop yields and cost savings for reduced input fertilizers and plant protection chemicals due to improved soil health. CO2 capture offers additional revenues to the farmers. Depending on crop and number of crop cycles per year, it offers an opportunity to farmers to increase monetization by an average of a net $400 per acre per year by incurring $100 for the cost of actosol ($200 from CO2 capture +$200 from increased crop yield based on two crop cycles per year) -almost doubling their income. A game-changer economic incentive in the large agriculture sector to become engaged in mitigating climate concerns. actosol approach increases capture to 10 tonnes of CO2 e per acre per year compared to 2-3

tons with no-till or cover crops and about 4 tonnes by trees. It will result in durably storing in soils as organic humus known to remain stable over thousands of years as validated by USDA and academic scientists with radio dating of carbon in humic matter in present-day soils. Scientists explain this due to their aromatic molecular structure, which resists mineralization or decomposition to CO2.

Humus is a word of Greek origin and was recognized by Romans as fertile soil. They needed fertile soils to quickly grow crops to feed the armies and horses on the battlefields. Based on this knowledge they inhabited the Nile Delta, formed from flooding with enriched humus organic matter brought by the Nile River from Lake Victoria. Yajurveda from India in Verse 30 guides that soils containing soul or juice are the basis of growing plants for nourishment and health. Scientists today are advising for soil centric green revolution and UNFAO in 2015 declared the Year of Soil and reports 25 billion tonnes of topsoil being lost every year, 6 billion tonnes in the USA. The government of France has set a goal of increasing 0.4% carbon in soils every year. It has established www.4p1000.org to lead this effort. We are one of the affiliates of this.

In collaboration with us, Prof. Davies and his team at Northeastern University reported based on testing of 24 agriculture topsoil samples from 24 counties in Southern Idaho, that samples contain humic-fulvic acid as low as 0.31% with an average of 1.9 ± 1.1%. Agronomists and Soil Scientists report today that the required amount is 8%. Historians report it used to be as high as 20% in the fertile soils. Even today prairie lands in use for grazing in the Midwest USA, contain high amounts of deep, dark humus matter-rich soils called Mollisols (Latin for soft). Prof. Tan of the University of Georgia, who conducted the first research studies on actosol in the early 1990s, reported that humic matter in actosol is the same as in Mollisols based on NMR analysis (Nuclear Magnetic Resonance measurements for larger organic molecules) . USDA states each pound of organic matter can hold up to 20 pounds of water. Every 1% increase in organic matter results in as much as 25,000 gallons of soil water per acre. Each 1% increase in organic matter can also provide up to 30 pounds of more available nitrogen per acre. That means less money and time spent on inputs like water and fertilizer, which make farm operations more profitable.

Our planet's land area is 36 billion acres. UNIPPC reports that in 2015, it is comprised of 2% infrastructure, 12-14% cropland, 30-47% pasturelands, 16-23% forestlands, and 24-31% minimum human use ecosystems, deserts, and rocks. They also state that about a quarter of the Earth's ice-free land area is subject to human-induced degradation. Soil erosion from agricultural fields is almost 100X higher than the soil formation rate. So, as we stated above soils which are one of our must-have need to feed us, is at peril. By fixing this we believe our approach will make a major contribution to addressing climate change while increasing food production and contributing to economic growth.

For a megatonne removal per year, will require based on removal rates achieved at the Lawson farm, will require to use actosol on 100,000 acres of land. It will amount to 0.0015% of farmland in use today. For one gigatonne removal on 100 million acres amounting to 1.5% of farmlands. While also increasing the food supply by 20% for populations expected to grow also by 20% from about 7.5 billion today to reach 9 billion by 2050. Plentiful coal reserves are also available worldwide. US EIA reports proven worldwide reserves amount to 1.16 trillion short tons, half of these are lower rank coals, lignite, and sub-bituminous coals. more than sufficient and suitable for making actosol organic humic-fulvic fertilizer gigatonne projects. For example, for a gigatonne, we will need one billion gallons of actosol. It will require only half a million tonnes of coals per year. Though coal use is decreasing even worldwide, still almost eight billion tons of coal were mined in 2020 and used worldwide. As explained above, our approach of conversion of coal at ambient conditions does not produce polluting chemicals and carbon dioxide. It will provide an economic boost for increased monetization of plentiful lower-rank coals while mitigating their pollution concerns and supporting the chronically lower-value agriculture economy, which we all must have to feed and nourish ourselves.

In fact, our approach to the use of coal offers a path for not only mitigating concerns from coal use but also addressing the human battle for equity of resources almost since inception by producing the must-have needs of humans at lower cost, our planet and ecological balance for its other inhabitants. A path for democratization as computer chips has enabled access to lower-cost IT for almost all globally. We make the case same is feasible for balanced sustainability while addressing climate change and other issues with a value generation approach and fostering a “green industrial revolution”. We have explained this as per Free Entry allowed for this submission by XPRIZE.

Our approach supports the vision of Carbon 180 and is espoused by the XPRIZE vision to foster an environment and resources justice. Today marginal, subsistence farmers make up 84% or 475 million farms with <2 hectares (5 acres) out of 570 million farms worldwide. Based on the rate measured on Lawson Farm, it will take almost 200+ years to build up 20% of humus, believed to be historical levels for fertile soils in one acre of land to a depth of four feet. So, soils have a huge capacity to store carbon taken from air as stable useful humus. The use of our actosol offers the most practical and economically sustainable opportunity for increasing the pace of moving large volumes of carbon from air to land while fixing the prevailing imbalance in air and soils, the two most critical carbon storehouses of our planet for maintaining its viability. We envision its applications in the forest lands to increase carbon capture with increased tree roots, on farms for increased carbon capture in plants and in roots. However, on farmlands along with trees cultivation offers both

a faster rate and highest carbon capture per unit of land while durably storing in soils, while rendering them more fertile. Also, it will result in added income to the farmer from both increased crop yields and from sequestration of carbon, Thus, offering a path for economic sustainability and even for marginal and subsistence farmers to increase income, and participate in combating increasing adverse impacts of climate change and share in resulting environmental justice.

Though actosol use at 360-acre Lawson Farm has been verified by an independent technical expert in humic science. Our proposed submission's objective is to revalidate this at kilotonne CO2e removal level and obtain rigorous data of plant and root growth, microbial activity, and conversion to organic humus matter. Tests will also be conducted to determine the release of CO2 by respiration by microbes, nitrogen release by nitrifiers (nitrate-reducing microbes), and by methanogens, methane-producing microbes. Also, field-deployable rapid detection systems for cost-effective determination of build-up organic humus matter in soils and leakage factor for a scale-up project to megatonne. During the kilotonne demo, multiple pilot feeder tests will be established with our affiliates in the USA and other countries to prove out and train our affiliates teams to scale up to achieve megatonne and then to gigatonne scale removal of CO2e per year successfully and convincingly so it will become sustainable path forward for addressing the global challenge.

We are mindful that collateral damages can result from technologies as we are addressing fixing today from technologies of the past two centuries which fostered the industrial revolution. Though deployment of these set us on a path to unprecedented economic growth. We seek wisdom from Iroquois Indians 7th generation criteria to look at the impacts of decisions today to seven generations from now on. Our systematic quantitative calculations support that our approach offers a path of fostering a legacy for subsequent generations to address challenges with value generation solutions and in a "Balanced Sustainable " approach. The US EPA Director of Air pollution Control Division, Mr. Frank Princiotta, after his team's due diligence of our solutions, stated in writing that " our approach lowers the environmental footprint from coal use and creative approach for lowering carbon emissions".

So, what we envision challenges are to deploy large-scale and even fast-tracking solutions to address this large global issue? UN Paris Agreement is only based on intentions, with no enforceable mandates. Some countries are encouraging and reporting carbon, environmental footprint, for good corporate governance and even tax incentives. There is no price set for carbon for emitters to pay or for mandates for mitigating it as being required for control of pollutants. In our approach, we will need to incentivize the farmers, who generally are reluctant to adopt changes and become carbon farmers. We will offer a business proposition to Mr. Musk, who recently tweeted that he will be paying $11 Billion for 2021 taxes to the US IRS.

Going forward to use the prevailing tax credit of $35 million per year from megatonne projects being offered to XPRIZE. Similarly, the gigatonne project generating $35 billion tax credits can be offered to Mr. Musk and other large taxpayers to lower their taxes and support the deployment of solutions. So, this global challenge can be met with truly a 'democratization" of our affordable and value-generating solution as espoused in our team's guidebook, entitled "BOLD" by the founder of XPRIZE.

Worldwide the soils contain different mineral constituents depending on the underlying geological rock formations, but humic matter in these is identical in composition and of its functionalities. Experts recognize it to be fundamental to maintain the viability of our planet and its sustainability of vegetative growth on it. We are making a case for replenishing at an increased pace to build up soil carbon capture from air to 20% historical levels. We also suggest it offers a plausible path to mine the enriched soils with the humic matter for applying to desert lands and make them fertile for inhabitation. Desert lands currently cover about 33% of the land area of our planet. It is also conceivable that it may enable us to establish farmlands on other planets as we explore this new frontier. The mined soils can be replenished with humus by capturing CO2 from the air, thus offering a practical value generation path forward for centuries.

A SUPPLEMENTARY NOTE: Prof. Anastasios Melis, of the Department of Plant Biology at the University of California, Berkely studied the effect of actosol® on cell growth and biomass production compared to a mix of optimum nutrients, known as Hoagland Nutrient Solution, used for lab tests. He conducted his experiments with the unicellular green algae Dunaliella Salina (D. Salina), which is an ideal model organism for higher plants. Studies on this single-celled model organism provide growth information for plant roots and shoot. He reported with adding actosol to Hoagland solution increased growth by 40%. Another scientific evidence of actosol ability to increase plant growth but reported here as it may help to increase algae growth for ocean track XPRIZE seeks to support.