XPrize Technical Submission 2.1.2022

(shiny version)

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Preface

On Feb 1, 2022 a few minutes before the deadline, ERA's XPRIZE working group leader Aniqa Moinuiddin submitted our entry for the Milestone prize (fifteen $1 million prizes to be awarded in April).

Subsequently, Cole Enos extracted the content from the maddening format required by the XPRIZE submission system, corrected typos and last-minute emendations, and put in hyperlinks for convenient reading and navigation. .

Also included here is Appendix A, Milestone Submission guidelines which should make the whole thing a little more comprehensible to the first time reader.

As Heather Wilber's cover letter observes, "We view the Xprize proposal as a learning experience and a launching point for conversations and actions that can help us grow the ERA into an ever-more transformative force."

This compilation is configured for comments. Have at it!

--Jon

Cover Letter

13 Feb. 2022

To the ERA membership,

Preparing the Xprize milestone submission materials was an exciting, challenging, and productive experience. We developed a plan for how we would create a support system, shaped by restorers, to aid in transforming over 150 million hectare of degraded land into flourishing biomes around the globe. Read more about it in our final draft (link).

This process shed light on the richness and diversity of the community that currently exists. Max came forward with every imaginable data point that the XPrize could want on SEKEM's performance on CO2 removal. If there is one person without whom we would be nowhere, it is Max. David guided Max and created a generalized model from SEKEM's use case and Anastassia created a detailed report of emissions life cycle so we had a clear (albeit carbon-centric) picture of what the XPrize committee was after. Heather took on the demonstration and verification with Max's help. Zuzka was steadily following all threads and amplifying issues and concerns on the technical side as they emerged and keeping us honest about areas where there was not enough focus or resourcing. Heather, Jon and Aniqa worked out estimates of costs, members, land, etc required to truly reach a massive scale, and Jan and Michal, along with Zuzka, developed helpful scaling models along with a snapshot of where we are now. Anastassia restlessly followed up on any open questions during building the model and filling out the needed equations. Peter and Philip were diligent about attending discussions and supplied essential feedback and input every step of the way. Cole was essential with administrative work ensuring that all of our efforts were coordinated and effective. And of course, Jon's words and pictures brought into reality what would otherwise be a hazy dream.

Editors, supporters and cheerleaders were there throughout, inspiring and encouraging those in the weeds. This includes Adam, Louise, Michal, Jan, Varaprasad, Marcel, and several others who learned about our efforts during the ERA town halls. Aniqa, Heather, and Jon took on the role of stewarding this initiative: extrapolating vision, defining gaps, pulling in new resources, and facilitating the difficult conversations for giving a single thread to a multi-faceted team. In the eleventh hour, when our tech strategy was still lacking, Patrick came in setting the stage for a partnership with JOGL that took our platform strategy from a D to an A-. David provided not just our impact measurement approach, but also was a primary contributor in translating the world of ERA to XPrize.

I usually go by a saying: Start where you are. Use what you have. Do what you can. With this incredible star-studded global team, we were starting from a place of knowledge and experience, using validated data. We did our best, but time was definitely a factor. In a typical scenario, a proposal of this size with this level of complexity would require at minimum 4-6 months of preparation. It would take 1-2 months just to align the interests of all the stakeholders involved in the project with the objectives of the granting institution/prize parameters. At minimum, one would like a project manager and copy editor to have at least a week to take the completed proposal and polish it and cross-check all the relevant details across worksheets and forms. Our Xprize team assembled and began working in earnest on the project with roughly *3 weeks(!) to the deadline*. It was always going to be a mad dash, and by the end, some of our team members were putting in 18 hour+ days to get the materials prepared. While we made tremendous and frankly surprising progress, the time limit was a major constraint that impacted our ability to polish and refine our final submission.

We view the Xprize proposal as a learning experience and a launching point for conversations and actions that can help us grow the ERA into an ever-more transformative force. It was great to get into the weeds and wrestle with issues related to massive scaling, as well as issues related to misconceptions and limitations that the broader world (and venture capitalists in particular) have when it comes to climate-related action plans. We strongly put forth our positions–there is no Planet B, robot trees can't compete with real trees, holistic solutions are essential as the damage of short-sighted solutions at these scales will be unprecedented–and at minimum, we hope that our message has some resonance. The land track (nature-based) Xprize subcommittee was surprisingly aware of how current "factory-based" evaluation metrics, standard in the industry, are woefully inadequate for illuminating the value that nature-based solutions supply. They mentioned several times that they hope to learn from nature-based Xprize applicants about better ways to incentivize progress in environments where leaders are not thinking about it correctly. We hope all our technical work can help make a difference in this respect.

We do not view the Xprize proposal in any way as a comprehensive plan encompassing the ERA's vision. In fact, our vision eclipses the most ambitious goal set by the Xprize, which narrowly ascribes the issue to CO_2 sequestration and aims for at least 1Gt CO_2 sequestration per year in 30 years time. As our current membership of restorers exemplifies, living in balance with our planet, respecting and honoring the biodiversity it generates, and designing equitable economic systems that support human thriving, is not out of reach for the human species. It requires a radical reorientation of our economics and culture, and our largest ambitions aim squarely for this lofty goal.

We sign off with gratitude to our co-members. We look forward to sharing insights in future meetings and correspondence, and welcome everyone to view and comment on the completed proposal (link).

Sincerely,

ERA Xprize technical team

APPENDIX A. Milestone Submission Questions

Proposal Instructions:
Milestone Submissions are due by **noon (12:00pm) PST on February 1, 2022**. Submissions can be modified or updated until this deadline. Submissions must be written in English. After the deadline, Judges may reach out for further clarification or additional information if needed.

The Milestone Submission will be completed in the XPRIZE Prize Operations Portal (POP) and will consist of the following three fillable forms:

1) Part 1: Shareable Team Summary

2) Part 2: Technical Submission
   - Written Questions. Maximum word counts are provided for each question.
   - Five templates are referenced in the written submission. These can be downloaded by clicking the hyperlinks below. They can also be found under the "Resources" tab in POP and in the POP submission directly.
     - Process Flow Diagram, Stream Table, and Mass & Energy Balance
     - Demonstration Performance Worksheet
     - Verification Checklist
     - Cost Worksheet
     - Lifecycle Emissions Intake Form
   - Other uploads are referenced in the technical submission. You may upload any supporting documents and files in response to these questions.

3) Part 3: Environmental Justice Questionnaire (See Appendix B).

IMPORTANT NOTE REGARDING CONFIDENTIALITY:

This submission may require you to disclose sensitive and confidential technical and commercial details to XPRIZE. All information submitted to XPRIZE is considered confidential (subject to section 11 of the Competitor's Agreement) except where explicitly indicated. Confidential information will not be shared with any individuals beyond the XPRIZE Carbon Removal project staff and Judges, all of whom are subject to non-disclosure agreements. XPRIZE does not claim or intend to claim any interest in any team Intellectual Property.

SHAREABLE TEAM SUMMARY

The information in the shareable section will be used publicly in XPRIZE communications if you are selected for a Milestone Award. Please do not include any confidential information in this section that you would not like shared about your project.

- Team Name: **EcoRestoration Alliance**
- Legal Entity Name (if different than Team Name): **Biodiversity for a Livable Climate**
- Type of Entity (e.g. startup, subsidiary, university group, etc.): **501(c)3 Non Profit**
- Name of Team Leader: **Jon Schull**
- Team Website: **EcoRestorationAlliance.net**
- Country: **Global/Multi-Biome**
- Project Description - What is your project's elevator pitch? What sets it apart from other ideas? Please describe your project at a high-level in language that the general public would understand.

  The EcoRestoration Alliance is engaged in what member John Liu calls "the great work of our time": restoring degraded ecosystems. Forty percent of the earth's land surface is now degraded. And hot. Ecorestoration sequesters vast amounts of CO2 and puts it to the best possible use: cooling the planet, stabilizing the climate, forestalling mass extinctions, preventing warming, storming, fires, floods and drought, and sustaining lives and livelihoods.

  Our members have already restored over a million acres using a variety of techniques adapted to local circumstances, as befits a diverse and varied biosphere. We will scale to a billion acres using an online platform and open-science strategy that will educate and recruit ecorestorationists and their backers, advance and explicate the emerging science and practice of ecorestoration, assess and document co-benefits that make ecorestoration cost effective, life affirming, and sustainable, and remove cognitive, cultural, political and economic barriers that have distorted our economy and degraded our planet.

- University Affiliation (optional):

  Several ERA members have university affiliations. Some of the included universities are Univ. of Texas at Austin, Univ. of Massachusetts Boston, Petersburg Nuclear Physics Institute, Technical University of Munich, Seoul National University (South Korea), Univ. of Zadar (Croatia), Univ. of Split (Croatia), American Univ. of Beirut, South Bohemian Univ. České Budějovice (Czech Republic).
- Partner Affiliations (optional):

  Ecosystem Restoration Camps, Ecovillage Network, Sustainably Wise, Green Advocates International Liberia, Ľudia a Voda MVO, Enki o.p.s, Regeneration Canada, Gaia University, Community Managed Farming Systems Andhra Pradesh, WeForest, SoilWatch, EcoRestore GreenWaterCools, Soil Carbon Partners LLC,

Cranmoor Advisors, Markegard Family Grassfed, GPI2050.org, Green Harbors Project, Agroforestry Regeneration Communities, Blue-Green Futures, African Conservation, Inga Foundation, Zero Foodprint, Bionutrient Food Association, Renew Land and Water Union of Private Forest Owners, Martin House Farm, B Bar Ranch, Old Quarry Hill LLC, Mulloon Creek Institute Australia, IWA Rainwater Harvesting and Management Specialist Group, Biotic Pump Greening Group, Just One Giant Lab

  - **Appendix Doc (link)**

- Technology Readiness Level (TRL):
  8: The actual technology has been successfully commissioned for its target commercial application, at full commercial
- Track that most closely represents your carbon dioxide removal solution:
  Land Track: Trees, soil, plants, roots, agriculture, GMO plants, biochar…

TECHNICAL SUBMISSION: SUMMARY QUESTIONS

Data submitted in this section may be published in aggregated and anonymized form. Your answers will otherwise be kept strictly confidential.

Budget and Fundraising

- What stage of funding are you currently in?
  Not Applicable - Not Seeking Corporate Equity
- How much capital is required to compete in the 4 year competition (USD equivalent)?
  $1,000,000
  - **Alliance Members are self funded.**
  - **Above the budget for Alliance to create and operate a verifiable support system to incubate new restoration efforts and expand existing ones through synergistic collaborations**

- How much capital has been raised to date (USD equivalent)?
  None

- What type of funding are you seeking
  Philanthropic Funding: grants, Donations and Revenue from possible service channels

Tons of CO_2 Removed

- Is this a proposal for CO_2 removal from the air and/or oceans?
  Air
- How many tons are you currently removing annually? (Ok to enter 0)
  4.1 Million/annually (440,379 ha)
- Have you sold any carbon removal credits to date?
  Yes Sekem Report 2020
- IF YOU HAVE SOLD CARBON CREDITS, HOW MUCH HAVE YOU SOLD? ON WHAT

MARKET/PLATFORM? (OPTIONAL)(50 WORDS)

Alliance Members are currently responsible for seeking and leveraging carbon credit markets. SEKEM, our demonstration case in Egypt has reported selling carbon credits. We wish to take on this role in the future particularly for smaller Alliance members

- What is your estimated all-in cost of removal ($/tonne) for a Megatonne scale project? (refer to cost spreadsheet)

  Alliance cost $1/ton

  - **This is calculated from alliance costs + project-based costs (which vary and are excluded from our project costing structure; some projects (e.g. SEKEM) are at net negative cost!)**

- What is your estimated date of achieving 1 Megatonne (Mt/year) capacity?

  5 years (by 2027)
- What is your estimated date of achieving 1 Gigatonne (Gt/year) capacity?

  30 years (by 2052)
- What is the inherent durability of the sequestered CO_2 (years)? Time horizon is potentially unlimited as long as the ecosystem remains healthy.

  10,000 years (source)
- Do you have a plan to ensure the removed CO_2 remains durably sequestered for at least 100 years?

  Yes, See Section 6 of this document

Phase 1 Milestone Demonstration Details

- Where is your Phase 1 Milestone demonstration location (country)? **Egypt**
- What is your Phase 1 Milestone demonstration start date? **2008**
- What organization is your verifier affiliated with? **The Golden Standard Institute; Louis Bolk Institute**
- What is your date of verification?_**2009**
- Do you affirm that your verifier is independent of your team and free of any conflicts of interest? **Yes**

Phase 2 Demonstration Project Details

- Where is your proposed Phase 2 demonstration location (country)?

  Egypt and multiple sites around the globe
- Will the proposed 1000 t/year demonstration project be carbon negative on a lifecycle basis?

  Yes, See Section 7 of this document

TECHNICAL SUBMISSION: OPERATIONAL REQUIREMENTS

1. 1000 tonne/year Carbon Dioxide Removal Project Proposal

Use your answers in this section to describe the 1000 tonne/year (minimum) carbon dioxide removal project you intend to demonstrate to win the grand prize. If you have already achieved a scale of 1000 tonne/year, describe your current operating carbon dioxide removal project.

1.1. Project Description (200 words).

Briefly describe your proposed project in plain language.

We are growing and supporting a global decentralized network of nature-based CO2 removal projects that can reach the Gt/yr scale in 30 years or less.

Alliance members have already

- **collectively restored over a million acres of land in various biomes using a range of contextually-adapted ecorestoration techniques.**
- **built global platforms for collaborative development and deployment of pro-social open-source technologies, and for mobilizing and coordinating distributed action-oriented communities**
- **developed and validated open-source methodologies for validating CO2 removal and other co-benefits using real time high temporal frequency satellite data.**

During the 3 year timeline we plan to take a 2 pronged approach:

First, we partner with SEKEM to create an educational program and pilot an operation to *replicate* its model as shown in the PFD-Stream Table (link)(link), Mass Balance (link)(link), and LEIF (link) for the Phase 2 Demonstration.

Second, we build up our infrastructure which includes the following pillars detailed in Section 1.9 and 4.1 that allows us to ultimately remove CO2 at Gt/yr rate. We will do this by creating:

1. **a platform developed with JOGL (Operations)**
2. **a partnership program with restoration Members (Practice)**
3. **a marketing and sales approach (Story)**
4. **impact measurement system (Science)**

1.2. Technical Summary (200 words).

Provide a high-level written description of the major technological and scientific concepts which underlie your project. Include descriptions of:

- The mechanism of CO_2 capture.
- Any chemical and/or natural processes that describe the transformation, processing, or treatment of the captured CO_2.
- The mechanism of durable sequestration of the CO_2.

A variety of Nature-Based solutions (NbS) are now proven to capture and sequester CO2 with high efficiency and reliability even in degraded environments, which are (unfortunately) available in abundance. NbSs include agroforestry, rainwater retention, regenerative pastoralism and farmer-managed natural regeneration, and biodynamic organic agriculture. These methods regenerate degraded lands, and via photosynthesis turn sun, water, minerals and CO2 into biomass, soil organic matter, and stable by-products like timber.

Carbon sequestered in above and below ground is (dynamically) stable only insofar as the restored lands are maintained as healthy regenerative ecosystems. Emerging science demonstrates that land restoration delivers local as well as global co-benefits (food, livelihoods, local cooling, climate stabilization, water availability, prevention of fires and floods, etc.) that can be leveraged to ensure that restoration projects will be maintained either because they are commercially profitable or because they are incentivized by enlightened governments that recognize the these benefits and concomitant avoided risks/losses from e.g., fires, floods, warming, storming and drought.

Quantifying co-benefits of land restoration, and making those benefits actionably obvious to citizens, restorationists, and policy-makers, etc. is thus critical to our dubable sequestration strategy. Hence, our world class team of scientists, practitioners, and story-tellers.

1.3. Project Scale (150 words).

Discuss each of the following elements of your proposed 1000 tonne/year project.

- How many tonnes per year of CO_2 will your project capture from the air or ocean (gross removal)?
- What fraction of the captured CO_2 can be considered durably sequestered (ie, for more than 100 years)?
- How much Land or Ocean Area is required by your project (Ha)

- **The gross removal is calculated to be 1300 CO2 t/yr from the air. (See Table 1)**
- **Land required for this project is 130 ha**
- **Emission is expected to be 3t C02/yr/ha**
- **Net removal is thus 1170 CO2 t/yr.**

As well-documented in the scientific literature, virtually all of the CO2 sequestered in soil remains dynamically stable when socio-economic infrastructure that is baked into the project incentivizes continued land management.

Dynamic stability in moist, deep soil means that C from plants and animals is repeatedly captured, ingested, and egested by microorganisms without significant leakage back to the atmosphere.

Our measurement methodology takes these dynamic movements into account through the use of multiple process models (e.g. RothC, Century, Yasso) in parallel and the citing of the most conservative results where there is a variation.

1.4. Energy Sources (150 words). - Max & David

- What sources of energy (electricity, fuel, or other sources) will you rely on for your demonstration? If multiple energy sources are used, what is the breakdown? If steam is required, specify the quality of steam required.
- If renewable sources of energy are used, explain how you will overcome the intermittency of the energy source.

Our phase 1 project relies primarily on renewable energy provided by photo-voltaics for water pumping, and on the (free) solar energy that drives agriculture. Photovoltaics operate at high levels in sun-rich Egypt. The vegetation in well-hydrated soil that provides our photosynthetic services is well-adapted to night-time darkness and intermittent lapses in irrigation.

Non-renewable energy is used for transportation and for network infrastructure Diesel fuel is required for transportation. Remote monitoring, machine learning and process modeling uses data freely provided by the European Union and high efficiency renewable powered cloud computing by servers based in the EU. These costs, divided by the CO2 tonnage we sequester, are negligible. See the LEIF worksheet and PFD for details.

1.5. Project Plan (100 words). — Discussion

- Describe 5 major milestones of the project over the full life of the project (through least February 1 2025, and beyond if applicable).

Once ERA operations and staff is set up (See 1.9 - Diagram 2 and Cost Worksheet), each of our 4 pillars described in 1.1 will lead to its own milestones (A-E):

A: ERA operations kickoff: governance model, partnership terms and ERA staff hired.

B: 100 ERA Staff and members actively recruit and collaborate on the existing JOGL platform, simultaneously guiding the build-out of additional functionality required by ERA.

C: Team for SEKEM replication project successfully settled into 130 ha of land

D: 5 Templates for biomes other than Egyptian desert model developed via partnership with the members

E: SoilWatch data management integrated into JOGL to display 1Kt/yr net removal of CO2+co-benefits achieved by ERA initiatives

1.6. Intellectual Property (150 words).

- Describe the relevant IP required for the project, explain who currently owns it, and your plan for licensing or acquiring it.

We use public disclosure and open source licensing to ensure that effective ecorestoration practices are maximally accessible to practitioners whether they belong to the Alliance or not.

Our practice work and our platform is based on peer-reviewed research and open-source methodologies.

Our monitoring, reporting and verification software, published (by ERA member Soilwatch) on github, is similarly peer-reviewed and open-source. It uses Earth Observation data provided free of restrictions by the European Union. The data and reports it creates are owned by the restoration members involved, but the Alliance encourages sharing, and Soilwatch agrees to use the data and software for collective monitoring, reporting, analysis and verification purposes.

Some members (e.g., Ed Huling of SoilCarbonPartners) may offer proprietary products or systems to other Alliance members and other XPrize teams under commercial or non-commercial terms. But no proprietary IP is essential to our practice.

1.7. Permits & Regulatory Compliance (100 words). - Jon

- List the permits that you will need to acquire before constructing and/or operating your carbon dioxide removal project, and the dates by which each permit will need to be acquired.

Alliance members are responsible for any permits required for their projects. In iIn some locales, permits are not even required.

We support those efforts with whitepapers, scientific and policy documents, media templates, and explainers to help to convince local authorities that NbSs are superior to (e.g.) energy and pesticide-intensive extractive practices that degrade local conditions or pollute.

For example, the Alliance is already facilitating collaborations between members and government officials in Greece and Colorado who are coping with fires and floods, and with urban and suburban governments to remove zoning and other impediments to backyard rewilding, permaculture, and Miyawaki Forests.

- If there is no jurisdiction in which you can lawfully operate your project today, explain your strategy for operating legally by February 2024.
  Not Applicable

1.8. Upload a *Process Flow Diagram (PFD), Stream Table, and Mass & Energy Balance* for the proposed 1000 tonne/year project.

- **PFD for planned 1000 tonne/year project**

1.9. Upload any additional engineering drawings, schematics, or renderings of your project design (Optional).

- **Overall vision for outcomes of ERA infrastructure and operations**
- **Internal organizational outline/teams**
- **SEKEM 2020 annual report**

2. Demonstration of Key Component

Each team must demonstrate the operation of a "key component" of their Carbon Dioxide Removal solution. The demonstration should establish the team's ability to successfully complete their proposed 1000 tonne/year Carbon Removal project.

2.1. Demonstration Description (500 words).

Describe the demonstration of the key component of your carbon dioxide removal project. Include the following:

- What was demonstrated?
- What makes the demonstrated component(s) the 'key component'?
- Discuss how your demonstration is critical to the performance of your proposed 1000 tonne/year carbon dioxide removal project.

What was demonstrated:

With its 300 ha desert farm, a single Alliance member (SEKEM) is already sequestering, not 1000, but 4,572 tCO2 per year. This sequestration rate comes from soil (672 tCO2/y) and trees (3900 tCO2/y). Our key component demonstration focuses on trees because they dominate the sequestration data. We consider sequestration rates calculated for a young farm (El Wahat),because our proposed phase 1 project is replication from scratch. With proper ecorestoration methodologies (regenerative agriculture combined with afforestation in the Egyptian desert) and by balancing tree planting (20% area with a mix of variety), rotational farming (70%) and hardscape (10%), a regenerative biosocial community of plants, animals and humans embedded in a favorable institutional context can sustain itself profitably enough to grow (gradually) over time.

The tree farm model is a "key component" because it validates our predictions and functions in a restoration setting that is a proof of biological and socio-economic concepts, and supplies a model system and test-bed as a foundation of the work to follow as we strive for Gt scale. Additional tabs in the demonstration worksheet describe our model, a list of sources, and tabs of raw data with computed outputs.

It is critical to our proposed 1000 tonne/year carbon dioxide removal project because although we have already blown past the 1000 tonne/year benchmark with negative cost per ton of carbon(!), the Alliance's critical mission is to replicate and "speciate" ecorestoration projects all over the world. Our 1000/ton project will use Sekem to establish our ability to replicate ecorestoration projects and validate remote assessment techniques. (We will similarly use the Megatonne/yr project to "speciate" ecorestoration projects, i.e., establish and assess new self-sustaining projects appropriately adapted to local circumstances in other biomes).

Our replication plan will build on Sekem's existing "living lab" and its past achievements in education and policy advocacy for equity and climate justice. This entails:

1) **Develop a plan and budget adequate for net new 1000/tonne per year from scratch via replication. This is budgeted in our worksheet and explained below.**

2) **Explicate, market, finance, and execute the following plan:**

   2a) In partnership with ERA member Dr. Maximilian Abouleish-Boes of Sekem and Helipolois University for Sustainable Development, the Alliance will develop and fund an education initiative for a full-time community-based-learning apprenticeship program over four seasons. Upon completion of the program newly trained restorers along with mentors from Sekem, will sequester 1000t/CO2/yr from a new site near Sekem in 2025.

   2b) We will also help 500 local small-scale farmers transition to regenerative carbon-sequestering agriculture and tree planting. With little marginal increase in cost, this program will also be used to help local small-scale farmers transition to regenerative carbon-sequestering agriculture and tree planting. Due to the different location of small-scale farmers in the Nile Delta the expansion will require much less energy to pump water (which comes from the river Nile). The advantage is that SEKEM already has longstanding relationships with more than 500 farmers. This will grow substantially using an ecorestoration buddy-mentorship program.

This partnership has strategic significance. In connection with COP27 in Egypt in 2022 we expect to garner global attention and monetary and in-kind support from the Egyptian government.

2.2. Demonstration Results (500 words).
Include descriptions of:

- The major strengths of the key component which was demonstrated.
- Any weaknesses and areas for improvement.
- Steps that need to be taken to integrate the demonstration into a complete carbon dioxide removal system.

Strengths:

Gold Standard's verified CO2 sequestration rate for SEKEM's tree mix is very conservative and implies that we could reach 1 kt/ yr 2025 by replicating 73

SEKEMs in Egypt. That is not our (only) goal, but analysis of El Wahat farm indicates this scaling is possible and the land is available.

We document the contrasting contributions of tree growth vs farming. Studies in SEKEM show that soil sequestration rates from ground crops increase rapidly (e.g., from 18 t CO2/ha in year 1 to 55 t CO2/ha in year 5), and then begin decelerating logarithmically, at the same time tree growth becomes substantial enough to complement and overtake soil rates.

Going beyond carbon sequestration, commercial outputs from both trees and ground crops demonstrably sustain operations. The full picture requires thoughtful analyses of trees, soils and humans working in concert. Building a sustainable community with educational, health and other economic and cultural activities keeps humans "in the game," and durably-sequestered carbon in the ground.

Weaknesses to address:

In contrast to tree data, we do not have raw data for soil. However, an independently prepared soil study report summaries on-site measurements. When we project conservatively with megaton and gigaton scales in mind (which are our ultimate targets),the short timescales and limited soil samples of our current data underestimates the full potential value of agroforestry in addressing both local and global planetary and human needs.

For that reason, a second goal of our focus on Sekem is to develop and validate satellite-based data collection methods and based on open-source software developed by ERA member David Morrison of SoilWatch that can operate in near-real-time and with efficient large computational capacity. This will allow us to capture a range of ecorestoration co-benefits in addition to CO2 sequestration (e.g., local cooling and enhanced water retention) correlate them with ground truth data, and use the data to promote and obtain support for ecorestoration both locally and globally.

A complete CO2 removal system:

In principle, SEKEM's agroforestry model alone is a complete and sustainable CO2 removal system. However, SEKEM's agroforestry model and farming practices, including the specific ground and tree species that are cultivated, are finely-tuned to meet the needs and opportunities of the Egyptian desert building on the abundant water resources available from the Nubian aquifer for the next 100 years and more. The usage of groundwater requires a thorough water management is a long term where ecorestoration plays a significant role. In other settings and climate zones where water is more easily accessible, water management and retention practices will be more cost efficient and essential early steps in the restoration process and will add substantially to the rate of CO2 removed (see example).

Although SEKEM's specific tactics cannot be arbitrarily scaled to reach gigaton levels of sequestration at the global scale, SEKEM's general strategy --of locally attuned, well documented practices offered to communities through systematic outreach, training and education and economic value creation--can be be scaled globally. The Alliance's long term plan is to develop and disseminate a broad portfolio of verified practical templates, training programs, assessment programs and policy guides that will allow communities in a wide variety of biomes to sustain themselves and regenerate the planet by turning degraded landscapes into healthy carbon-sequestering, life-sustaining, climate stabilizing ecosystems.

2.3. Upload a *Demonstration Performance Worksheet*.

- Demonstration Performance Worksheet.
- Include a chart showing the performance of your demonstration over time
- Include a process flow diagram (if applicable, this may be an annotated version of the PFD provided in your 1000 tonne/year carbon dioxide removal Project Proposal) which indicates how your demonstration fits within the full carbon dioxide removal project proposal.
- Include summary-level data showing the performance of your demonstration over time or over a range of performance conditions (as applicable).

SEKEM PFD

2.4. Upload technical documentation showing the design of your key component demonstration.

- Provide additional drawings and schematics which show the design of the demonstrated system. Include specifications, data sheets, or other engineering documentation for each of the major pieces of equipment included in the key component demonstration. (See below, section 2.5 and the attachment: Documents sources.)
  - Annual report
  - Photos/Videos (see drive folder)
  - Business Model (see our annual report 2020, financials included)

X technical_documentation_Tree Data.xlsx

2.5. Upload any additional performance data related to your demonstration (Optional).

- Sekem annual report
- **Soil sequestration report**
- Gold Standard reports and docs

additional_performance_data_SEKEM_soil_study.pdf

additional_performance_data_Annual-report-2020.pdf

2.6. Upload photos of the key component demonstration setup.

- Photo1, Photo 2,
- more photos

photos_GS4894 Key Project Information.pdf

photos_RemoteMediaFile-6554037-0-2021-09-17-16-40-40.jpg

2.7. Upload video of the demonstration being operated (maximum 2 minutes).

video_SEKEM Gold Standard Tree Project VAL Report_TR_VT_TÜV …

3. 3rd Party Verification

Independent verification of the team's solution is focused on ensuring that:

- There is quality evidence that the technology is operational, and that observation of its operation supports the team claims that it can achieve specified levels of performance;
- The data collected and submitted to document claimed technology performance is collected using acceptable and defensible methods, approaches, and test equipment, resulting in high quality data.

3.1. Verification Summary (250 words).

Describe what steps have been taken to verify your demonstration:

- Who performed the verification? When?
- Summarize the verification process
- Discuss the results and conclusions of the verification process.

We submit a Gold Standard verification report completed on-site for the SEKEM El Wahat farm in 2019. The Gold Standard is an independent, third party verifier used primarily for the purposes of issuing carbon credits. Credits aside, their report includes validation of SEKEM's applied agroforestry models and estimated carbon sequestration rates in tree biomass (see Demonstration table). Validation is based on not only inspecting the El Wahat farm and collecting measurements on-site, but in additionally inspecting all of the SEKEM farms, and in particular those that are at least 30 years old. It is on this basis that our 30 year model for estimating sequestration rates in El Wahat was validated. The Gold Standard revised estimates include accounting for risk mitigation concerns, e.g., from wildfire, tree species survival rates. Based on these reports, our models were realigned until they were approved. Our stream table numbers for the kt scale are based on these estimates, and from additional outside verification via soil sample studies (see docs). The Gold Standard verification process includes visits every 5 years, where data is collected for ongoing validation and, if required, more realignment is applied to our prediction models.

The Gold Standard report verifies that SEKEM maintains humane, equitable and safe working conditions for laborers, does not harm or displace local and indiginous populations, and that its practices do not negatively impact biodiversity. These concerns and co-benefits are critical to our goal to develop a universal template for sustainable projects within the Alliance.

3.2. Upload a completed *Verification Checklist.*

- **Link to Verification Checklist**
- **https://docs.google.com/spreadsheets/d/1kTjdNtBMWahZuXVABmy8KsI7ELa7tyFY/edit?usp=sharing&ouid=116726501268293682738&rtpof=true&sd=true**

3.3. Upload a Verification Report, prepared by your verifier, with any additional attachments and evidence of the verification activities defined in the checklist.

- **Gold Standard Key Project Information**
- **GS4894 Key Project Information**
- **Gold Standard PFA Report**
- **Pre-Feasibility Assessment (PFA) Report**
- **Gold Standard Monitoring Sheet**
- **GS 4894 Monitoring data sheets 2016-2020**
- **GS Validation Report**
- **SEKEM Gold Standard Tree Project VAL Report_TR_VT_TÜV NORD**

TECHNICAL SUBMISSION: FULLY CONSIDERED COST PER TONNE

The cost assessment is intended to provide an estimation of technology costs consistently across all teams in the competition, and include all significant drivers of the solution cost at an average net rate of 1 million tonnes of CO_2 durably sequestered per year.

4. Definition of the Megatonne Scale (Mt/year) Project

This section defines the Megatonne scale project that will be the basis for the cost estimate.

4.1. Megatonne Scale Project Description (250 words).

- Briefly explain what the 1Mt/year project will look like and how it will operate.
- Discuss any key design changes required to scale up from 1000 tonnes/year to 1Mt/year.

We now shift to a global strategy based on a digital collaboration platform to be developed by ERA technology partner Just One Giant Lab (JOGL) (see Appendix C)

I. **[Collaboration] Our digital platform will help activate new restorationists, helping them find projects and sponsors, advocate for pro-restoration policies, display, celebrate individual and collective achievements, and develop meaningful lives and productive livelihoods.**

II. **[Practice] By fostering shared learning, collaboration, partnerships and cross-pollination, we will develop and disseminate training programs, and restoration and advocacy "templates" which will "speciate" as they are progressively adapted to local circumstances (cultural, political, economic, and biological).**

III. **[Story] While the mainstream narrative about GHGs and climate change is discouraging, de-motivating, and mind-numbingly technical, the emerging science and practice of ecorestoration is wondrous, inspiring, and actionable. World-class eco-communicators like members John Liu and Judith Schwartz will use our platform to explicate, visualize and communicate this new vision, bringing land owners, restorers, scientists, entrepreneurs, and consumers into synergistic alignment.**

IV. **[Science] Because bio-climate interactions are hard to computer-model, mainstream IPCC models have assumed that they are negligible. Theoretical and empirical work by ERA scientists Anastasia Makarieva, Michal Kravchik, Jan Pokorny, and Millan Millan among others now suggests he assumption is wrong. Their work will guide our practice, inform an alternative and actionable narrative and help us develop, refine and interpret satellite monitoring, measuring and reporting methodologies.**

ERA members Jon Schull (e-NABLE) and Thomas Landrain (JOGL) previously pioneered science platforms that continue to galvanize thousands. We can do this.

4.2. Project Scale (150 words).

- Describe the land or ocean area required for the project.
- Describe the raw materials that will be needed to construct/build the project.
- Describe the requirements for water consumption and management.

Conservatively, removal of 1Mt per year of CO2 will require restoration of 142,857 ha of land area, based on a sequestration rate of 10t/ha/yr and an emissions rate of 3t/ha/yr.

Alliance members have already restored more than that worldwide. With our remote monitoring methodologies will demonstrate that a Mt/year is being durably sequestered at those sites, and in new sites whose restoration the Alliance will catalyze.

Raw materials for the demo project are documented above. Globally all restoration sites have similar inputs and materials (seeds and seedlings, nutrients, labor, etc.) but some require nothing but knowledge to effect restoration (e.g., water management, Farmer-Managed Natural Regeneration and Rotational Grazing).

Water limits many restoration efforts precisely because land degradation reduces water availability. However, in all but the most arid deserts, relatively low-tech water harvesting and management practices can capture enough water to begin rehydrating the soil and supporting plant growth. As bare ground is supplanted by biomass, soil becomes more absorbent thanks to roots growth, mycorrhizal fungi, soil organic carbon, animal tunnels and burrows, etc. Over time, evapotranspiration and plant-generated aerosols stimulate rain, and aquifers refill. In some cases restoration of land turns water from a limiting resource into a renewable commercial co-benefit.

4.3. Energy Sources (150 words).

- Describe the major energy sources used by the project.
- If steam is being used, describe how the steam is generated, and the quality of steam required.
- If renewable sources of energy are used, explain how you will overcome the intermittency of the energy source.

Our major energy input is solar energy captured by photosynthetic plants. A co-benefit of this "technology" is that evapo-transpired water vapor carries latent-energy away from land, creates shade-causing clouds, and releases heat. This stands in marked contrast to the heat-producing outputs of conventional energy sources.

Farm and transportation equipment does use fossil fuels, as may generators for human-support systems. However our demonstration project uses

photovoltaics and batteries for electricity.

Our demonstration project methodology internally sources agricultural inputs (like fertilizers, composts, etc.) whenever possible, but transportation costs and carbon expenditures for external inputs can be significant during the early stages of a project.

Our monitoring, reporting and verification system is computer based. Energy for computing is provided by the EU free of charge and machine learning and modeling taking place on EU based cloud servers is powered by renewable energy.

4.4. Upload a *Process Flow Diagram (PFD), Stream Table, and Mass & Energy Balance* for the Megatonne scale system.

- **Link to sheet**

5. Cost of Carbon Dioxide Removal

Use the provided worksheet to calculate your cost per tonne, using the project basis described in the previous section.

5.1. Cost Summary (50 words).
Summarize the following from the completed Cost Worksheet:

The alliance does not directly manage restoration projects. The costs outlined are the costs associated with scaling our infrastructure to supporting and growing members. We have two member reported numbers on cost of CO2 removal solutions based on - on the ground efforts

SoilWatch $4/tonne

Following supplemental breakdowns and calculations are provided on the Cost Worksheet:

- **A ERA Staffing cost breakdown - YR1 and YR5**
- **B Cost growth - shows how different categories of cost on Nominal sheet are growing based on our calculations**
- **C Land and CO2 removal growth: contains our starting landmass with existing members (~440,000 ha) and grows at a 1.21 rate year over year.**
    - **Annual tonnes durably removed (tonnes)**
        - **5.3Mt CO2 / yr - this is based on the land growth model on the Cost Worksheet.**
        - **Key inputs: 7 CO2/ha/yr of land - across varying biomes and techniques based on Table 1**
        - **We expect to grow land acquisition through growing existing member capacity and reach and new member acquisition and this rate of growth is set at 1.21**
    - **Capacity Factor (unitless) Alliance costing at 80%**
    - **Capital Recovery ($/tonne)**
        - **The key capital cost is the tech infrastructure set up in the first year**
        - **Total is estimated at $ 267,221.88**
        - **$/tonne= 5 cents**
    - **Fixed Operating Expense ($/year)**
        - **$ 706,207.73**
    - **Fixed Operating Expense ($/tonne)**
        - **The Year 5 estimate is : 13.5 cents**
    - **Anticipated Revenues ($/tonne)**
        - **11cents**
    - **Total Cost ($/tonne)**
        - **36 cents**

5.2. Revenue & Value (250 words).

- Describe any valuable goods that may be sold (including CO_2 derived products or valuable co-products). What is the quality of these products? What emissions are associated with the goods' use and end of life?

At any given time our goal is to cover costs and channel additional funding towards direct restoration efforts. The following revenue streams can be considered for financing our activities sustainably.

- **Brokering CO2 credits: as we educate and support our Members in working with the CO2 markets - we would expect a reasonable margin of earnings as Alliance revenue.**
- **Membership and fees - we will charge a nominal membership fee to members for participating in the communities and regular events facilitated by the Alliance and also for taking advantage of CO2 removal reporting tools that we are building for the community.**
- **Conference and Events: given that our Alliance members are managing expanses of natural landscape - we hope to collectively host retreats and conferences that offer hands-on experience of natural scenery. These events can be topical and significant fund raisers.**
    - **Describe any tangible & measurable environmental co-benefits (e.g. improved biodiversity, improved crop yields, improved fisheries, ecosystem services, removal of other greenhouse gasses, etc.).**

The tangible co-benefits we are looking to directly measure are improved biodiversity and water retention in soil. A key piece of the CO2 puzzle in NbS is the role of water. As water content rises it can improve sequestration levels significantly. This is based on research underway by two Alliance Members - Jan Pokorny and Michal Kravich - and we are looking to verify and incorporate this metric into our monitoring systems.

5.3. Upload a completed *Cost Worksheet*.

Cost Worksheet - Complete

TECHNICAL SUBMISSION: SUSTAINABLY SCALEABLE

6. Durable Sequestration

The goal of the competition is to ensure that at least 1000 tonnes/year of CO_2 will remain sequestered for at least 100 years. Teams must account for any anticipated re-emission within that time frame in their project design and management approach.

6.1. Description of Sequestered CO_2 (100 words).

- What is the final chemical form of the sequestered CO_2?
- How stable is the CO_2 in its final form, without any intervention or active management?
- Describe exactly where and how the CO_2 will be sequestered.

For simplicity, we state that the final chemical form of the sequestered CO2 is Soil Organic Carbon. However, this is not the full story. The stability and permanence of CO2 sequestered in the soil is dynamic, with C traveling up and down layers and changing form multiple times as it is ingested and egested by microbes. The majority of C in the top meter of soil is found deeper than 30 cm according to sampling. Hence the need for process models such as in our system, verified through experts like Gold Standard and Louis Bolk institute for measurement.

6.2. Durable Carbon Dioxide Removal (500 words).

- What fraction of the total sequestered CO_2 can be expected to remain sequestered for longer than 100 years? What fraction is expected to be re-emitted?
- What risks exist that would lead to partial or complete re-emission of the sequestered CO_2?
- How have you accounted for expected or unexpected re-emission of the sequestered CO_2 in your designs or management strategy?

In continuously healthy ecosystems carbon leakage is negligible, even after accounting for periodic forest fires. However, if a restoration site is allowed to revert to a degraded state, re-emission will occur. (Indeed, carbon and water vapor from degraded and dehydrated landscapes are major contributors to the greenhouse layers).

Our strategy crucially guards against regression by ensuring that ecorestoration delivers ongoing, substantial and apparent local co-benefits (beyond the long term global benefits of carbon sequestration). This incentivizes preservation (and extension) of restored ecosystems.

Our assessment methodologies will facilitate quantitative monitoring of ongoing benefits.

Our story telling work will advance the interpretation of those

quantitative benefits, and advance the appreciation of qualitative benefits, thus making them more apparent. This will help citizens and restorers perceive and appreciate the intrinsic rewards that come from living and working near restored ecosystems. At the same time our our advocacy templates will will restorers and citizens garner extrinsic rewards from local and global partners who recognize that investing in ecorestoration avoids monetary and societal risks and costs of warming, storming, fires, floods and drought.

6.3. Monitoring, Measurement & Verification (100 words).

- Describe your planned Monitoring, Measurement, or Verification activities.
  ERA member David Morrison of soilwatch.edu is a pioneer in computer-based monitoring of satellite data.

Our platform incorporates open-source monitoring measurement and verification technology developed by ERA member David Morrison of soilwatch.eu via Copernicus satellite data, machine learning, process models (Century, RothC etc,) and highly optimised field soil sampling. Samples, combined with satellite imagery-enabled field survey, machine learning situate samples which are then combined with process modeling to create a baseline. Then, ongoing observation without sampling provides near real-time feedback to inform local decisions and global assessments. Sampling is repeated every 5 years to recalibrate and confirm results. This offers global reach and substantial economies that should maximize ERA utility and member revenue.

7. Net Negative Performance (Lifecycle Analysis)

The Lifecycle Analysis must indicate a reasonable likelihood that the proposed system can achieve the target 1000 tonnes/year of net sequestration.

7.1. Assuring CO_2 Negative performance (250 words).
Describe what steps you have taken to ensure that your proposed demonstration will achieve net CO_2 removal of 1000 tonnes/year.

In deserts and some other biomes, initial sequestration rates are often higher in the earlier years of a restoration project, and then they decline but remain positive over time. This has little impact on our scalability, which comes primarily from geographic expansion of existing projects, from recruitment of existing projects, and catalysis of new projects across a variety of biomes. The demonstration has already removed 1000 tonnes/year. This was ensured by creating an economically self-sustaining community of practitioners whose needs (personal, financial, social, familial, etc.) are met by the co-benefits (food, employment, security, etc.) of the same process that sequesters carbon (e.g., regenerative agriculture). The continuing sustainable harvest and distribution of local co-benefits, coupled with educational programs that illuminate the linkage of benefits with regenerative practices, is the glue that keeps the bio-social-machine going, both within our demo site and in the Alliance as a whole.

7.2. CO_2 Negative performance at larger scale (250 words).
Describe how you expect your lifecycle analysis to change as your solution scales to sequester Megatonnes of CO_2 per year?

- What economies of scale can be expected that will improve your lifecycle emissions?
- What aspects of the process will become more emissive at scale?

In deserts and some other biomes, initial sequestration rates are often higher in the earlier years of a restoration project, and then they decline but remain positive over time. This has little impact on our scalability, which comes primarily from geographic expansion of existing projects, from recruitment of existing projects, and catalysis of new projects across a variety of biomes.

We might eventually deplete our stock of degraded land suitable for sustainable restoration but (a) we should be so lucky, and (b) by then we will have blown past the benchmarks. Indeed leaving our primary target of degraded land aside, according to Zomer et al 2017 the current area of croplands and rangelands alone available for carbon sequestration is equivalent to 3.24 - 6.67 Gigatonnes CO2 per year. One might similarly imagine that we will so deplete the pool of recruitable humans that growth rates decline; but recruitment efficacy should become easier with improvements in our methods, in

societal appreciation of them, due to our own development, collection and dissemination of best practices at biological, social, and technological levels of organization, and due to growing pressure from climate change.

The system for optimizing field soil sample locations becomes more efficient and accurate at scale. This is the first reason why the process becomes less emissive and the costs reduce as we scale. The second reason for economy of scale is that larger areas allow for the nature-based solutions that have lower sequestration rates and also lower costs to also sequester large quantities of CO_2

7.3. Upload a *Lifecycle Emissions Intake Form.*

- **Refer to the template provide**

8. Social License & Environmental Justice

Complete the provided ***Sustainability, Social License, & Environmental Justice Submission Questionnaire.*** (See Appendix B).

Solutions must demonstrate that they can, in principle, achieve Gigatonne scale (at least 1 billion tonnes of CO2 removal per year),and that there are no fundamental natural or physical barriers to achieving that scale. Teams must also articulate whether and how their solutions can be deployed in an environmentally sustainable way now (i.e., at the 1000 tonne/year scale), and in the future as they scale to consume Gigatonnes of CO2 per year and more.

8.1. SCALING TO GIGATONNES PER YEAR (150 WORDS). *

Describe at a high-level how Gt/year scale can be achieved using your specific carbon dioxide removal approach. How can Gt/year scale be achieved? (e.g., increase size of each project? Increase number of projects? Both? Other?) What key design elements will need to be altered to facilitate massive scale?

We have described and budgeted for net removal of 1 Gt/y in 30 years. See Cost Worksheet: Tab C: Land and CO2 Removal for details.

The Alliance will grow and evolve bio-mimetically as a regenerative bio-socio-technical ecosystem whose components interact symbiotically and sustainably. Growth: our efforts will increase the efficiency and growth of existing projects. Replication: we will use educational programs and targeted investments to replicate existing sustainable bio-social ecosystems, and their well-informed human subcomponents. Speciation: new sustainable bio-social ecosystems will emerge through cross-pollination, and innovation among Alliance member to create practical and advocacy templates adapted to local circumstances around the globe. (Example, our Eastern European ERA water management pioneers Michal Kravchik and Jan Pokorny are now working with government officials in Colorado and Greece, to develop playbooks for rehydrating and restoring forests damaged by fire and to prevent the fires, floods and droughts.) There is no Planet B.

8.2. LIMITS OF SCALE (150 WORDS). *

Describe the major potential constraints your carbon dioxide removal approach will encounter on the path to the Gt/year scale (e.g., energy, land, raw material) and how you will navigate these constraints. What are the issues that are most likely to limit growth?

Entrenched cognitive, social, economic, and scientific and political barriers have distorted economies and degraded planetary ecologies. Our ability to dissolve barriers with actionable insights and facts on the ground is not assured. Specific risk include: Funding - ecorestoration is often resource-limited and even with modern platform technologies, and inexpensive global networks, the Alliance itself will need funding to

scale rapidly. Execution: New ventures often fail. Rapid growth and infrastructure development brings additional hazards. Multi-organizational alliances are dynamic and dicey. Governance: ERA members Schull and Landrain are pioneers in online governance of pro-social distributed networks. They are keenly aware that techno-centrism, hubris, and mission-drift can be fatal. Servant leadership, humility, transparency, and active inclusion of indigenous underserved stakeholders as leaders as well as beneficiaries is itself challenging. But that's the job. We engage these risks through weekly town hall meetings and asynchronous discussions.

8.3. ENVIRONMENTAL IMPACT & RISK (500 WORDS). *

Describe the most significant non-CO2 environmental impacts (and risks of impact) associated with your solution, both positive and negative, and how these may be mitigated or managed as the solution reaches scale.

Our ultimate vision is no less than a radical and complete re-imagining of how humans across the globe engage with the biosphere for their economic and agricultural sustainment. We create a path for experimental first adopters (like SEKEM) to pave the way and illustrate the potential of new and creative models for re-engineering our technological, political and cultural ways of life so that capital and human well-being can be generated in more sustainable ways. Our approach is inherently dedicated to homeostasis in a way that makes it massively scalable. In fact, the scaling of our vision is ultimately a necessary component, alongside other technological innovations, to the invention of a new human phase of life on this planet. The greatest risks with typical technological solutions is to either overengineer or intervene with nature's natural processes. Therefore when attempting to fix one element - the process can easily break another element - particularly when scaling up. For instance - chemical fertilizers trying to increase crop yields can rob soil of its nutrients in the absence of active processes that can help re-nurture the soil. Nature's systems are intricately linked at the most micro and macro levels and our tendency to use the same solution across the globe irrespective of local community, biomes. See the analysis for the renewed water resources, additional biomass yield, additional CO2 sequestration, and the water retention and vegetation cooling effect on the latent heat transfer to the higher layers of the atmosphere: See Table 2: 30_1 ERA SCALING UP Our intent within the restoration movement is to first and foremost identify the best methods that will nurse back an area of degraded land to its highest potential of health given its surroundings, climate and net supportive and appropriate technological solutions advocated by experts in a global community of restorers. We use land restoration techniques focused on seeing nature as an end and not the means. All efforts and inputs are directed to reinvigorate nature's support system by restoring the carbon and water levels to a degree that can create either a natural ecosystem (e.g., forestry) or managed ecosystem that is producing food and raw materials without depleting the land. It takes time, land and patience. Yet it is the only way we can reach the scale we want without breaking the planet in another way. The way we propose

is a viable demonstrated plan of doing so and we hope you will join us.

9. Scaling to Gigatonnes per Year (Gt/year)

Solutions must demonstrate that they can, in principle, achieve Gigatonne scale (at least 1 billion tonnes of CO_2 removal per year), and that there are no fundamental natural or physical barriers to achieving that scale. Teams must also articulate whether and how their solutions can be deployed in an environmentally sustainable way now (i.e. at the 1000 tonne/year scale), and in the future as they scale to consume Gigatonnes of CO_2 per year and more.

9.1. Scaling to Gigatonnes per year (150 words).
Describe at a high-level how Gt/year scale can be achieved using your specific carbon dioxide removal approach.

- How can Gt/year scale be achieved? (eg. increase size of each project? Increase number of projects? Both? Other?)
- What key design elements will need to be altered to facilitate massive scale?

We have described and budgeted for net removal of 1 Gt/y in 30 years. See Cost Worksheet: Tab C: Land and CO2 Removal for details.

The Alliance will grow and evolve bio-mimetically as a regenerative bio-socio-technical ecosytem whose components interact symbiotically and sustainably.

- **Growth: our efforts will increase the efficiency and growth of existing projects.**
- **Replication: we will use educational programs and targeted investments to replicate existing sustainable bio-social ecosystems, and their well-informed human subcomponents.**
- **Speciation: new sustainable bio-social ecosystems will emerge through cross-pollination, and innovation among Alliance members to create practical and advocacy templates adapted to local circumstances around the globe. (Example, our Eastern European ERA water management pioneers Michal Kravchik and Jan Pokorny are now working with government officials in Colorado and Greece, to develop playbooks for rehydrating and restoring forests damaged by fire and to prevent them, along with floods and droughts.)**

There is no Planet B.

9.2. Limits of Scale (150 words).

- Describe the major potential constraints your carbon dioxide removal approach will encounter on the path to the Gt/year scale (e.g. energy, land, raw material) and how you will navigate these constraints.
- What are the issues that are most likely to limit growth?

Entrenched cognitive, social, economic, and scientific and political barriers have distorted economies and degraded planetary ecologies. Our ability to dissolve barriers with actionable insights and facts on the ground is not assured.

Specific risk include:

1. **Funding - ecorestoration is often resource-limited and even with modern platform technologies, and inexpensive global networks, the Alliance itself will need funding to scale rapidly.**

2. **Execution: New ventures often fail. Rapid growth and infrastructure development brings additional hazards. Multi-organizational alliances are dynamic and dicey.**

3. **Governance: ERA members Schull and Landarain are pioneers in online governance of pro-social distributed networks. They are keenly aware that techno-centrism, hubris, and mission-drift can be fatal.**

Servant leadership, humility, transparency, and active inclusion of indeginous underserved stakeholders as leaders as well as beneficiaries is itself challenging. But that's the job.
We engage these risks through weekly town hall meetings and asynchronous discussions.

9.3. Environmental Impact & Risk (500 words).

- Describe the most significant non-CO_2 environmental impacts (and risks of impact) associated with your solution, both positive and negative, and how these may be mitigated or managed as the solution reaches scale.

Our ultimate vision is no less than a radical and complete re-imagining of how humans across the globe engage with the biosphere for their economic and agricultural sustainment. We create a path for experimental first-adopters (like SEKEM) to pave the way and illustrate the potential of new and creative models for re-engineering our technological, political and cultural ways of life so that capital and human well-being can be generated in more sustainable ways. Our approach is inherently dedicated to homeostasis in a way that makes it massively scalable. In fact, the scaling of our vision is ultimately a necessary component, alongside other technological innovations, to the invention of a new human phase of life on this planet.

The greatest risks with typical technological solutions is to either overengineer or intervene with nature's natural processes. Therefore when attempting to fix one element - the process can easily break another element - particularly when scaling up. For instance - chemical fertilizers trying to increase crop yields can rob soil of its nutrients in the absence of active processes that can help re-nurture the soil. Nature's systems are intricately linked at the most micro and macro levels and our tendency to use the same solution across the globe irrespective of local community, biomes.

Our intent within the restoration movement is to first and foremost identify the best methods that will nurse back an area of degraded land to its highest

potential of health given its surroundings, climate and net supportive and appropriate technological solutions advocated by experts in a global community of restorers. We use land restoration techniques focused on seeing nature as an end and not the means. All efforts and inputs are directed to reinvigorates nature's support system by restoring the carbon and water levels to a degree that can create either a natural ecosystem (eg. forestry) or managed ecosystem that is producing food and raw materials without depleting the land. It takes time, land and patience. Yet it is the only way we can reach the scale we want without breaking the planet in another way. The way we propose is a viable demonstrated plan of doing so and we hope you will join us.

See the analysis for the renewed water resources, additional biomass yield, additional CO_2 sequestration, and the water retention and vegetation cooling effect on the latent heat transfer to the higher layers of the atmosphere: link | link

APPENDIX B. Sustainability, Social License, & Environmental Justice

The following questionnaire will be available as a fillable form on POP:

Carbon180 | XPRIZE CARBON REMOVAL | MUSK FOUNDATION

Sustainability, Social License, & Environmental Justice Phase 1 Submission Questionnaire

Overview: Environmental Justice (EJ) is a critical component of climate innovations and solutions. Historically, issues of equity and justice have been considered very late in the lifecycle of a project, if at all. Experience in many industries and communities has shown that this leads to worse outcomes for solution developers and local communities. In an effort to establish a more productive conversation around EJ and carbon dioxide removal, we are introducing equity and justice considerations earlier in the development cycle of new solutions, so that issues can be identified and addressed well before project implementation. We understand that many solution developers are not experts in EJ — that is why we see this process as one of learning and exploration. Judges will have access to these questions and to your responses, but they will not be used for the Phase 1 Milestone Award submissions to either award or eliminate any team from the competition at this stage. XPRIZE will then work with Carbon180 to refine the requirements for EJ considerations in Phase 2.

Over the course of the XPRIZE Carbon Removal, the collective data and experience of the teams competing in the prize will be analyzed by a panel of EJ advocates organized by Carbon180. The learnings from these experiences will be published for the benefit of the carbon dioxide removal community. All data collected on this form will be aggregated and anonymized in any analysis.

Reading Materials
Please familiarize yourself with the resources on the provided list available here, and fill in this questionnaire with these materials in mind.

Submission Questions

Project Description

1. Provide an overview of your demonstration project for the XPRIZE Carbon Removal. (200 words)

Our 1Kt demonstration project will take place in Egypt and will replicate a community supporting and supporting a mix of regenerative agriculture and forestry in a desert environment, can profitably sequester millions of tons of carbon while sustaining a thriving community of practitioners and their families. It is an example of how nature-based solutions can have massive impact and be scalable even in the most extreme of conditions where land is severely degraded.

Project Location

2. Where will your XPRIZE Carbon Removal demonstration project occur? Why did you choose the project location that you did for your carbon dioxide removal Project? Have you already started work at this location, or have your plans for this location been finalized? (100 words)

Sekem (Sekem for Land Reclamation), located 60 km northeast of Cairo in Egypt, was established over 30 years ago. Systematic analysis of carbon sequestration began in 2008. It is growing and has plans for expansion. It is located 60 km northeast of Cairo in Egypt and was established 30 years ago. Systematic analysis of carbon sequestration began in 2008. Our plans for this project have been finalized but not started.

Demographic Information

3. What are the demographics of the populations in the areas local to your demonstration project? What percentage are low income (X% below poverty line)? (100 words)

Egypt is a country with a 90 million population. 95% of its residents live in the Nile Valley and Delta -on only FOUR percent of the total area. The young population under the median 25 years of age represents the primary demographics in Egypt. These demographics place considerable stresses on natural resources, employment, infrastructure, education, and health care. Population below the poverty line is as high as 26.3% in Egypt. The unemployment rate reaches 12.8%, and literacy rate is 76% according to data at Egypt's first biennial report to the UNFCCC (United nations framework convention on climate change) in 2018.

Our demonstration project is at the site of previous desert, north of Cairo. Since the project began, its managers created a sustainable farming community out of bare desert, proving sustainable employment and livelihood to many, including the suppliers. In 2022, these farmers were able to provide education to 733 pupils and 2729 university students.

4. What existing environmental burdens have been identified in the local region of your proposed project? (100 words)

Population growth caused a sharp decline in Egypt's annual freshwater resources per capita, pushing the country closer to the severe water scarcity threshold of 500 m3/per capita/year. The recurrence of extreme storms and weather events would affect ecosystems and is expected to exacerbate water stress in Egypt.

Sekem believes that showing sustainable agriculture and community building in the desert is an important priority to respond to Egypt's burning issues, which often requires tapping into fossil sources. That is not sustainable. The strong environmental pollution in the crowded delta and Nile region makes it strategically important to grow organically and biodynamically in the desert. Greening the desert project at Sekem offers solutions that can be upscaled in other parts of the world. There is a risk of over-exploitation of groundwater at the oasis. However, the extraction is managed and mitigated by carefully managing groundwater levels. Furthermore, the cultivation of Casuarina & other trees is more water saving. It positively influences the microclimate, reducing the evaporation effect substantially.

Legacy Pollution Analysis

5. How have you considered relevant public health data concerning the potential for exposure to human health and environmental hazards? Specific to the region you identified in question 1, are there any historical patterns of exposure to environmental hazards, to the extent such information is reasonably available? (200 words

Due to the prolonged electricity blackouts in 2012, the Egyptian government dispatched natural gas from energy-intensive enterprises to power plants used to generate electricity for the residential sector in Egypt. The intensive usage of fossil fuels to provide for the crowded residential areas cause water and air pollution, a substantial environmental hazard.

The Greening desert project at Sekem and its holistic farming practices provide relief, food, and health security to its communities. The abundant sunshine and installed solar photovoltaic equipment power the solar pumps to tap into the water resources and supply energy and heat to the communities. The use of diesel, which constitutes a significant part of carbon emissions in conventional agriculture, is more than offset by carbon sequestration in soil. Increased arable land and land and animal diversity are the main benefits of Sekem. Soil conditions will improve considerably through the use of organic compost and the accumulation of organic matter in a previously barren area. Air quality is also expected to improve with increased tree species and tree populations.

Environmental Sustainability

6. For your demonstration project, what are the local environmental impacts from your project (including from your sources of energy and materials) on air and water quality,

as well as biodiversity or other natural resources? Thinking ahead to the full deployment of your solution up to Gigatonne scale, how do the impacts change or grow as you move to Gigatonne scale?

We will not scale to Gigatons on this site alone. But it is worth noting that Sekem is currently drawing water from a regional aquifer that could be depleted over a very long time scale. As our scientific team has documented, a rarely-recognized consequence of ecorestoration, especially at scale, is that over time it replenishes aquifers by capturing atmospheric water that originates on land and sea. By expanding our practices we expect to lower temperatures, rehydrate the land, as wella s incidentally improve air quality.

In other regions of severe land degradation in India, the Sahel and East Africa, the solutions and their impacts vary based on what the most contextually appropriate activity is. For regions with a pastoralist tradition, rotational grazing is most appropriate whereas in other regions farmer managed natural regeneration is appropriate. Many of our members implement various rainwater retaining measures, regenerating their landscapes, reducing flood and drought risks, improving water quality, and sustaining biodiversity. All of the nature-based solutions and activities have the effect of restoring lands while removing CO_2 at varying rates which we monitor with our transparent MRV system.

a) What are the negative environmental impacts? (200 words)

Because humans, plants and animals are adapted to historical healthy ecosystems ecorestoration (done right) , our project has positive rather than negative environmental impacts, locally and globally, and for plants and animals.

Done wrong, mass monoculture plantings, the callous monetization of natural assets, and the imposition of outsider values and practices on local populations is does not result in biodiverse ecosystems, and can disempower local and indigenous cultures and communities that need to be seen as critical long term stewards and beneficiaries of the ecosystems we seek to restore.

b) What are the positive environmental impacts (aside from CO_2 removal itself)? (200 words)

When ecosystems are restored, biodiversity returns, atmospheric rivers revive, climates stabilize, temperatures are reduced through evapotranspiration, cooling rains hydrate soils, and buffer against drought while sustaining subterranean and terrestrial life. Lives and livelihoods are improved, increased soil carbon content means increased water absorption resistance to flooding and drought.

These co-benefits directly address core causes and symptoms of global warming and environmental degradation. Our members have already restored 440 380 hectares of degraded land, converting 4 million tonnes of CO_2 from the atmosphere. Further planned land restoration of half a million hectares will increase our impact to

8.8 million tons of captured CO2. Our integrative watershed management will implement 282 million m3 of rainwater retaining measures, recharging our aquifers by 23,855 l/s, annually and periodically, while 1.5 billion m3 of moisture will be available for evapotranspiration. The conserved water will support an additional biomass yield of 1.9 million tonnes, sequestering an extra 752,303 tonnes of carbon. Recycled moisture in nature will provide a free air conditioning effect by transferring more than 1.1 million GWh latent heat to the higher layers of the atmosphere, reducing heat waves and temperature at the relevant regions. Renewed watersheds will sustain biodiversity and reduce air pollution.

Incorporating Community Engagement

7. What steps will you take to ensure that voices from the communities in which you are building projects are represented in a way that ensures their concerns are being met? (200 words)

Promotion and distribution of local benefits are key to our strategy for recruiting, engaging, sustaining, and retaining restorationists. Indigenous peoples worldwide are simultaneously among the most successful stewards of some of the most important biomes remaining on the planet, and the most exploited victims of extractive and exploitative practices that have led to displacement and damage to environment, culture and livelihoods. With increasing scientific and ethical appreciation in the efficacy of traditional practices and norms, ecorestoration is an opportunity to redress these wrongs and invest in historically underserved and exploited communities. In order to ensure their buy-in and long term success, we help community members prioritize local benefits, analyze local opportunities, choose, develop and implement local solutions.

This must be done in a manner appropriate to the local socio-cultural and environmental context which the specific nature-based solution will reflect. But earning and building trust is a universal requirement. The Alliance will be a clearing house for success stories, cautionary tales, and general guides drawn from work in a diversity of projects around the world, our distributed governance model aims to ensure that underserved populations guide, inform, and benefit from our efforts.

Quantitative Assessment

8. Based on the provided EJ reading materials (see link above), discuss what you think are the most important EJ considerations for your project. (200 words)

To a large extent, the modern science and practice of ecorestoration involves rediscovery and reverse engineering of practices developed over millennia by indigenous peoples whose lands and lives have been confiscated, degraded and/or depleted by cultures that thrive on extractive rather than regenerative practices.

As we approach planetary limits, it will become increasingly clear that extractive methodologies are no longer sustainable and that all of us need to learn from, empower, reward and honor cultures and practitioners who work with nature. EcoRestoration of, by, and for those who work with nature, is arguably the only carbon sequestration

technique that can address the root causes of environmental justice as well as environmental degradation.

9. Please rate your level of concern for each of the following issues as they relate to your project. Your selections will be used for research purposes only.
    a. Moral hazard - Moral hazard - the perception that the development of your CDR solution lessens or eliminates the urgency and need to reduce current GHG emissions . **LOW**
    b. Involvement of the oil and gas industry- any investments or ties to companies that participate in oil and gas. **MEDIUM.**
    c. Expansion of infrastructure (such as transportation pipelines or truck traffic) **LOW**
    d. Land use competition (such as growing food, siting renewable energy, preserving biodiversity, and timber harvesting, among others) **LOW**
    e. Environmental health (such as groundwater contamination or seismic activity). **LOW**
    f. Workforce development - making sure good-paying, local jobs are readily available for community members. **LOW**
    g. Other (free entry). **Cultural imperialism. We do not want to impose our values or even methods on those who will not benefit from them, by their own standards. Yet we do want to provide knowledge and data on impacts so that informed decisions can be made at the grassroots level and that will help practitioners recognize the true benefits of ecorestoration.**

APPENDIX C: Revision History

Version 1.1, November 29, 2021

- Initial Release

Version 1.2, December 9, 2021

- Page 4, updated and clarified language to define "net CO2 removal".
- Page 16, Appendix A, added hyperlinks to templates for Milestone Submission.
- Page 19, Technical Submission question 1.3, minor text clarification that the question is referring to “Gross tonnes removed”.
- Page 20, Technical Submission question 1.8, minor text clarification that the scope of the required upload is the 1000 tonne/year system.
- Page 21, Technical Submission questions 2.3 & 2.4, minor text update to more accurately reflect the scope of the “Demonstration Performance Worksheet”.
- Page 22, Technical Submission question 4.4, minor text update to clarify the scope and purpose of the required upload.
- Page 26, added link to Carbon180’s environmental justice reading materials.
- Page 28, Appendix B, Revised question 9a.