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California Carbon Management Hub Response by Solar Synergies

Additional submitted attachment is included below.

CALIFORNIA CARBON MANAGEMENT HUB

Response by Solar Synergies

Solar Synergies is a California-based company whose technologies are designed for, and team devoted to, the support of a full transformation to the green, all-electric future, and to returning the Earth to climate health and safety.

We address this RFI into two sections:

1. Solar Synergies DAC Technology and Capabilities
2. California DAC Hub(s) Opportunity

Solar Synergies Direct Air Capture Technology & Capabilities

Transitioning away from fossil fuels will take 10 – 20 years. Unfortunately, we are close to climate tipping points and cannot wait that long. Electric cars, smokestack capture of CO₂, and energy efficiency will not repair our climate fast enough. Globally we continue emitting CO₂ at record levels, nearly 40 billion tons per year. To date humanity has added 2.5 trillion tons of additional carbon, with 60% added just since the 1990s. By the mid 2030s we may exceed 3T tons of excess carbon in our atmosphere. The U.S. is responsible for over 20% of the total accumulated CO₂. Various scientific data show that in order to achieve climate safety (limit to 1.5C increase), we must remove 10 gigatons of CO₂ per year by 2050 and then 20 gigatons / year from 2050-2100.

We must remove billions of tons of CO₂ per year, directly from the air, at a selling price at or below \$100 per ton of CO₂. Taxpayers and consumers will not support removing CO₂ from the air if the cost is too high. Current efforts are symbolic/aspirational—less than 1M tons per year. Most cannot achieve selling prices below \$250 or even \$1000 per ton.



Solar Synergies has a patented design for direct air capture (DAC) of CO₂—a design that can achieve a selling price of \$100 per ton in the near term, not in a few decades. Our system uses lime, a cheap and robust CO₂ capture material that can be recycled 100's of times. CO₂ capture takes place outdoors and uses minimal energy for moving huge volumes of air and lime. There are no banks of high velocity, high pressure, high power fans to drive air and CO₂. Finally, we have a unique kiln to recycle the lime. Our kiln captures the heat from lime hydration, enabling it

to use ½ the energy of traditional lime kilns. With this combination, our system achieves a cost of \$76 per ton CO₂, with wholesale electricity priced at \$0.072 per kWh.

In 1 square mile of marginal farmland, with many identical CO₂ Capture Modules, we will capture 10 million tons of CO₂ per year. Components for the many identical Capture Modules can be mass produced to reduce CapEx and sold as a kit to reduce construction costs. Each Capture Module has an automated system that conveys powdered, hydrated lime onto a concrete slab, gently blows air over the lime, and stirs the powder to maximize the rate of CO₂ collection. The lime absorbs CO₂, converts to limestone, and is conveyed back to lime in our energy-efficient lime kiln for recycling. CO₂ is released in the kiln, compressed, and delivered to wells for permanent storage.

Our system is designed for maximum scalability anywhere in the world, capital and operating expenditures per ton CO₂ are far less than the current DAC market, energy use is less than ½ of current

market leaders, and our ambition is multiple gigatons captured each year by mid-2040s. All materials are abundant, non-toxic, recyclable, and the system runs very quietly.

CapEx: \$75 M for a facility capturing 1 million tons/year.

OpEx: \$76 per ton CO₂ captured, including \$5 per ton donated to local communities.

Solar Synergies has several patents related to the energy transition and carbon removal:

- Direct Air Capture System and Low Energy Kiln
- Ultra-compact, high-capacity transmission grid using no towers or wires, low cost, low loss, not subject to fires, highly resilient, secure, no terrorists, etc.
- Smokestack capture of CO₂
- Geoengineering emergency solution if we need to “break the glass and pull the alarm” (no Sulphur dioxide or other harmful chemicals)

Carbon Management Ecosystem Community Committed to Climate Health

CEC California DAC Hub: designing the largest DAC system in the world to capture a combined gigaton of CO₂ by 2040 and scale from there.

- 1. Our interest in partnering with other entities is to create the California DAC ecosystem capable of removing massive quantities of CO₂ from the atmosphere and seek funding to build out the Hub and its infrastructure, with urgency. and the role and expertise our organization would contribute to a carbon management hub.**

Applying for DOE and other funding for project scalability and success as a collaborative community is more likely to succeed than those that go it alone, especially in such a new industry. This is the opportunity to show a new way to meet such critical and daunting challenges and turn them into massive opportunities for job creation and to engage communities that have been left out of the economic benefits of the American promise.

Each member of our team brings complimentary skills and experience that address the most important aspects of creating and building a community ecosystem or “hub” of diverse interests and capacities.

Designing and creating the culture of our choice is a critical aspect for any organization, though few even think deeply about culture. Creating the culture of choice for California’s DAC Hubs is a unique and powerful opportunity and we have the experience and understanding of how to do it.

To quote a famous 20th century management guru, “Culture eats strategy for breakfast.” Each DAC Hub partner brings its own unique culture to the hub. The Hub itself will develop a culture designed with its mission and purpose at the forefront.

We believe that it is essential to create a full DAC ecosystem or hub, including CO₂ capture, CO₂ sequestration, and a methodology for confirming that the CO₂ will remain sequestered for a very long time. A complete ecosystem is in everyone’s interest, especially those of us who are at least as passionate about climate health and safety as they might be about the scale of economic returns.

The need is so large and with no time to lose, no one can or should even try to “go it alone”. The need is to develop not only individual companies but to create an “ecosystem” encompassing key aspects of what it takes to build many successful DAC enterprises so that we can reach the first gigaton of yearly carbon capture as soon as possible and scale up to 10-20 gigatons per year, worldwide. Creating a comprehensive DAC Hub will benefit all Hub members, including the local community. Once successful, we can then replicate hubs statewide and nationally.

Demonstrating a successful California Carbon Management Hub will inspire others to do the same. The successful community hub approach and culture will also demonstrate that “coopetition” (integrating competition, cooperation and collaboration) is preferable to and more effective than the current paradigm of “predatory” competition. The economics are important. The impact is critical for us all. The hub can demonstrate both.

In Summary:

- The value of a CEC Hub is to pull together the three key parts of direct air capture: the capture, the sequestration, and the certification that the CO₂ is sequestered for a long enough time
- The Hub can create a cooperative community among these three aspects, even though there will be competition among companies within each
- The existence of a cooperative community will help each company focus on their piece and know that they have good access to the other pieces of the three-leg stool
- The CEC can use the Hub to facilitate permitting for DAC sites and access to hundreds of megawatts of electricity at wholesale rates

Solar Synergies’ team brings relevant experience to the DAC Hub Community:

- Founded OptiSolar and created the 1st completely automated solar panel manufacturing line and was awarded the contract for the largest solar farm in the world in 2007 – in California
- High level electrical and mechanical technologies and machine design
- Large-scale high-tech R&D at Hewlett-Packard
- Design / build large scale manufacturing systems – HP, solar, DAC, transmission grid tech
- Ran large organization in the oil and gas sector: Abu Dhabi National Energy Company (TAQA), with over \$30 billion in assets globally
- Bellnote Partners – Impact investing – founder, CEO
- Just Desserts – business and community entrepreneurship – created one of the most well-known, socially and environmental responsible businesses in California & U.S.; recognized as one of 10 best places to work in CA
- Highly successful general community and disadvantaged community engagement – ex: Garden Project for ex-offenders in Bayview Hunter’s Point community – partnered with SF County Sheriff
- SF Small Business Network - brought diverse community of 1000s of small businesses together for common benefit. We created the first Small Business Commission in any U.S. city (San Francisco)
- REV Sustainability: Worked with CA utilities and other large and mid-size CA organizations and companies to create implementable sustainability and climate action plans focused on energy efficiency, reduce waste and costs
- Successful highly impactful energy and climate policy business leadership in California – gained high level business support for passage of CSI in 2005 and passage of AB23 – 2006, other local policy initiatives for small business and general community benefit

2. State-level support beyond grants for a hub-based approach

- It can be the enticement for companies to become a part of the community, rather than developing partnerships on their own.

- Resources to create a DAC Hub culture of community, collaboration, “coopetition” to benefit all participants and communities
- Discussions concerning the various potential partners of the hub ecosystem and how we can support the internal and external communities in ways that foster the hub’s success as measured by the tons of certified CO₂ captured at what costs and the benefits to the local community
- Bring together research expertise such as LBNL, LLNL, UC System, Stanford, CalTech, MIT and other qualified technical expertise
- Support for grants, loans as a hub and individual partners
- Permitting support for all key components of the DAC systems
- Develop education, certification, innovation, workforce development and community partnering opportunities for the hub and partners to engage with
- The Hub as a showcase for potential investments
- Promote policy and legislation supporting DACs, DAC hubs – carbon purchases by the state; loans, loan guarantees, introduce offset buyers to the hub and its partners, develop supportive policy
- Spur innovation across all stages of carbon management, including capture, verification, processing, storage, and utilization
- Ensure the local community is engaged, heard, and lifted by the Hub

3. Technology Readiness Level & Outcomes: Partnering with Solar Synergies

Our current TRL is 5 and when stage 2 is complete in 2026 (1 module capturing 5600 tons/year) TRL will be 7. After successful completion of stage 2 we will then build our first full DAC system with 36 modules on 10 acres in 2027. This equipment will capture 200,000 tons of CO₂/year. We plan to build 4-5 full systems to capture and sequester 800,000-1,000,000 tons/year by 2030 and scale quickly to gigatons/year by 2045 or before.

Our goal is to capture 2,000,000 tons by 2032 at a cost of \$76/ton. From there we will replicate and scale. By modularizing our capture system, we will lower CapEx with volume manufacturing of components, and a kit approach to construction. We plan to maximize tonnage of CO₂ captured and sequestered at the lowest cost, both CapEx and OpEx, to provide the lowest cost offsets to the marketplace.

Co-benefits will be a highly scalable system to capture large quantities of CO₂ in order to drive atmospheric carbon down as quickly as possible, to meaningfully engage the communities in which we operate and provide offsets to customers at prices that attract companies, institutions of all kinds, including local, state and national governments to invest the trillions of dollars needed over the next 2 decades to scale to the 10-20 gigatons as quickly as possible.

We are committed to supporting the local communities in which we operate by providing them with \$5 per ton CO₂ captured by us. Too often, local communities get no direct benefit from projects that provide state or national benefits. As a specific example, a key missing aspect of public elementary school education (K-8 especially) in disadvantaged communities is the absence of a science teacher due to funding cuts. Specifically, in meetings with a local K-5 school principal in the Bayview Hunters Point community in SF, he told us that not one of the 4 elementary schools in the Bayview community had a science teacher. We then made a commitment to donate \$5 per ton of CO₂ captured if we were able to build our DAC site at the closed Hunters Point Naval shipyard (closed about 50 years ago and contamination is still not cleaned up). There are unlimited opportunities to engage and support such disadvantaged communities via a DAC system and / or DAC hub and we have the experience and relationships to help make this happen, ideally with DAC hub partners.

4. Challenges: current and anticipated

Our current challenge is funding. PR funding by private companies is likely to top out at \$1B - \$3B per year. Even at a price of \$100 per mton CO₂, this market will only support the removal of 10 – 30 million tons of CO₂ per year. To have a substantial impact on climate change, DAC must be funded by governments around the world. California can lead the way. Initial government funding from California for pilot demonstration is a great way to bring additional private investment on board.

The CEC grant currently being considered would be augmented by private capital and enable us to conclusively demonstrate that our DAC technology works. The other key challenge is the cost of electricity in California. Although our DAC system uses much less energy than others, we will be large consumers of electricity and will need to buy our electricity at wholesale rates.

Given the new administration in Washington DC, it's hard to say what unexpected challenges we might all face. However, given the early stage of most DAC systems, it is likely that we will have a much clearer idea of what challenges and opportunities this and the next administration might throw in the mix. Once we prove that our system is working, gaining long term CO₂ offset agreements will be key. Though we are confident that our pricing will be more attractive than what is being offered by DAC companies today, support with high level introductions to potential offset customers are important.

The California hub being considered today is similar to hubs in other states. The key difference is the cost of land and energy. However, assuming the CA hub becomes a reality, there may be sufficient energy demand as a community to justify building a dedicated solar farm and / or other energy source(s) to provide energy at a far lower cost to the hub partners. This can be a major benefit for the Hub community and a model for others.

Challenges of a Hub can be a combination of the following:

- The need to gain agreements as to rules and regs of the hub
- Integrating cooperation and competition (coopetition) among hub partners
- Building a culture of trust & balancing secrecy & transparency
- Funding
- Land – how much and where
- Energy needs and cost
- Ensuring the components & partners make the hub an attractive ecosystem for all participants
- Securing offtake agreements for carbon offsets at large scale is critical

Finally, the reality is that, as the IPCC and the vast majority other science-based institutions clearly state, there is no way to get to a healthy climate without removing the existing and additional carbon we continue to emit from the atmosphere as quickly as possible. There is no way to do this without taking some risks. The DAC systems operating today are a start, and we need to lower costs, scale massively and California is the place to show the way. Though energy and land costs are high, the energy and climate policy leadership is second to none and the rest of the nation will continue to look to us for that leadership. Well-designed DAC Hubs with state-of-the-art energy, certification and sequestration systems are critical climate solution models for Californians, Americans and all people.

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