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Revised Project 2030's Carbon Management Hub Concept

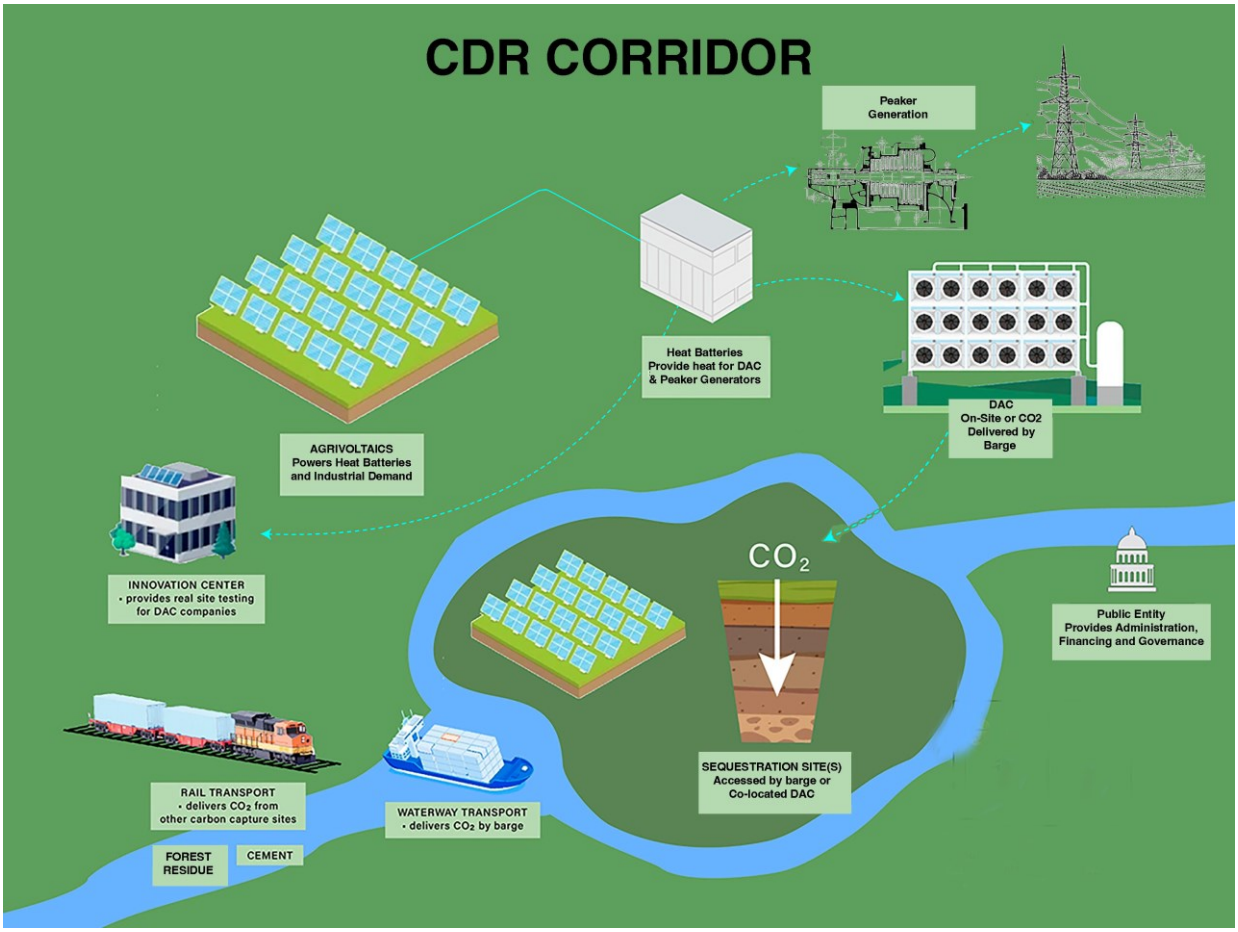
Additional submitted attachment is included below.

Carbon Management Corridor

A Concept Paper on the Nation′s First, Community Focused, Scalable Solution for Carbon Management

This concept paper describes an approach to carbon management that can achieve:

- Scalability to multiple geologic sequestration sites and capture sites along the proposed transport system
- CO_2 transport via barge and rail minimizing the need for pipelines
- A public entity to ensure the Carbon Management Corridor provides safety, economic and environmental benefits as a public good to the region and communities with transparency and accountability.
- Cost competitive, dedicated renewable energy through the use of thermal batteries, grid power and agrivoltaic energy sources
- Ability to redirect carbon-free power to serve as a zero-carbon peaker plant for the California grid



The illustration above is a concept of what a Carbon Management corridor could look like for the San Joaquin Delta and the San Joaquin Valley. It leverages the Port of Stockton and several deep-water docks along the rivers system to transport the CO_2 by

barge to sequestration sites in the Delta, eliminating the need to build pipelines. CO_2 could also be transported by rail from cement plants down valley to the Port of Stockton then to a barge for sequestration. CO_2 from forest residues and agricultural waste converted to energy could also be transported by rail from other parts of the region.

Direct air capture facilities could either be co-located with the sequestration site or located anywhere along the river system with a deep water dock to deliver CO_2 to the barge. The transport system could be optimized to transport the CO_2 in a "supercritical" state so it is ready for injection into a sequestration well without any significant additional energy required.

The major components of the Carbon Management Corridor could be:

1. Sequestration wells
2. CO_2 transport by barge and rail in a supercritical state ready for injection
3. Heat batteries combined with Direct Air Capture (DAC)
4. Renewable electricity from the grid during periods of low demand/high generation
5. Public Entity or Special District providing Carbon Management as a public service with regional governance, coordination, transparency and accountability
6. Solar-electric power from agrivoltaics
7. DAC Testing and Innovation Center to assist DAC startups
8. Optional electric generation turbine powered from heat battery to grid during power shortages (i.e., fossil free peaker plant)

A brief description of each component follows:

Sequestration Wells: The San Joaquin Delta is known to have excellent pore spare for sequestration and a relatively small number of surface rights landowners that would need to agree to pursue the development of a sequestration site. The first "Class 6" sequestration application in the Delta is already underway and U.S. EPA is expected to finish the approval process in 2025.

CO_2 Transport in Supercritical State: CO_2 could be transported in its super-critical (has both gas and liquid properties) state for pipelines but currently is liquified for transport in a container for rail and truck. The Carbon Management Corridor could include new containers that will be designed for the safe transport of CO_2 by barge, rail and truck in a supercritical state. This avoids the energy needed to liquify and maintain the liquid state and the energy needed to recondition the liquid for injection.

Heat Batteries and Direct Air Capture: An expensive operating cost for DAC is the heat needed to separate the CO_2 from the material that captured it. To drive down the cost of DAC, we not only need creative companies to design the CO_2 absorption process but also an inexpensive source of renewable energy for the heat. Heat Batteries are a relative new product that can store large amounts of heat produced from

renewable electricity. They are made from simple materials like bricks and carbon blocks. Typically 4-5 hours of renewable electricity coming any time during the day will provide enough energy for 24+ hours of heat.

Renewable Electricity from the Grid: The California Grid annually curtails (or disconnects power) up to 11% of the available renewable generation due to a lack of demand for the power and lack of storage to save the power for later usage. During these periods, un-contracted power is offered at low and even negative prices. Heat batteries can take advantage of this otherwise surplus power because it is a flexible demand that can match its demand to surplus power.

Public Entity or Special District:

A Carbon Management Public Entity could be created for the greater public good either at the state, county or special district level.[1] This entity could focus on economic, environmental, regional and community benefits, i.e., not focused on profits. It could ensure the highest air quality and safety standards and it could create a regional sequestration planning roadmap to ensure the most efficient use of the region′s sequestration and pore space resources. Since the Carbon Management services connected to the public entity would be provided at cost, this entity would encourage competition to a dominant private monopoly. [2]

Solar-electric Power from Agrivoltaics: Agrivoltaics or Agrisolar uses solar panels interspersed with row crops or pastures to produce renewable energy and provide production benefits for the farm crop. Currently no farms in California use agrisolar with row crops, though there are farms in other parts of the U.S. and in Germany. The concept, yet to be proven, would be to contract for power generated by agrisolar arrays on one or more farms to power heat batteries servicing DAC. This would provide benefits to the farmer as well as low-cost price of energy for the heat battery.

Optional electric generation turbines: A Carbon Management Corridor has a significant amount of energy stored in the heat batteries. With the addition of steam turbine generators, the heat could be converted to steam which powers the generators. In many cases the waste heat could still be used by DAC. The ″standby" generation could put power back onto the grid through the grid connections of the DAC facilities. This capability could provide energy services such as Resource Adequacy (RA) and peaking power when the grid is temporarily short on power. Unlike the current California Peaker Plants, this power would be 100% renewable with near zero or zero air quality

[1] We are exploring many models of what a public entity could look like.

[2] Some of the other functions a public entity could provide include acquiring permits for the Carbon Management corridor, accessing low-cost financing, ensuring strong MRV standards, providing access to affordable renewable power for Carbon Management projects. emergency preparedness, long-term site care, liability, and financial assurances.

impacts. The economics of providing this power would make sense if there were no fixed costs that had to be borne by the California energy customers and the returns from providing stand-by contracts and peaker power covered the cost of the turbines.