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Bright Energy Storage Technologies Comments: Carbon Capture & Storage supporting Renewable Generation

Additional submitted attachment is included below.

STATE OF CALIFORNIA
BEFORE THE CALIFORNIA ENERGY COMMISSION

Research Idea Exchange	**)**	**Docket No. 19-ERDD-01**

COMMENTS OF BRIGHT ENERGY STORAGE TECHNOLOGIES - regarding Carbon capture systems

Bright Energy Storage Technologies ("BEST") is pleased to respond to the issues raised by the California Energy Commission ("CEC" or the "Commission") in its Webinar pertaining to the Preliminary Draft Renewable Energy Generation Research Roadmap. In the Webinar held on June 28, 2019, the commission reviewed the draft roadmap (TN#228863) and the Technical Assessment of Grid Connected Renewable Energy and Storage Technologies and Strategies (TN#228862). Public comments were solicited.

I. COMMUNICATIONS

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II. ABOUT BRIGHT ENERGY STORAGE TECHNOLOGIES

Bright Energy Storage Technologies is an Arvada, Colorado based organization with 10 years of experience in developing very low cost storage technologies, and more recently is also developing cryogenic carbon capture systems. Our Concrete Thermal Energy Storage (“CTES”) systems are currently being evaluated by Electric Power Research Institute (“EPRI”) and we have provided comments on the role for thermal storage under separate cover.

III. COMMENTS

Research is needed to optimize the design and operation of carbon capture and storage (CCS) systems to reflect ongoing changes in the electrical grid associated with increased use of variable renewable resources. This increase will impact how existing thermal generators operate which raises questions about CO2 capture costs ($/tonne) under a range of reduced capacity factors.

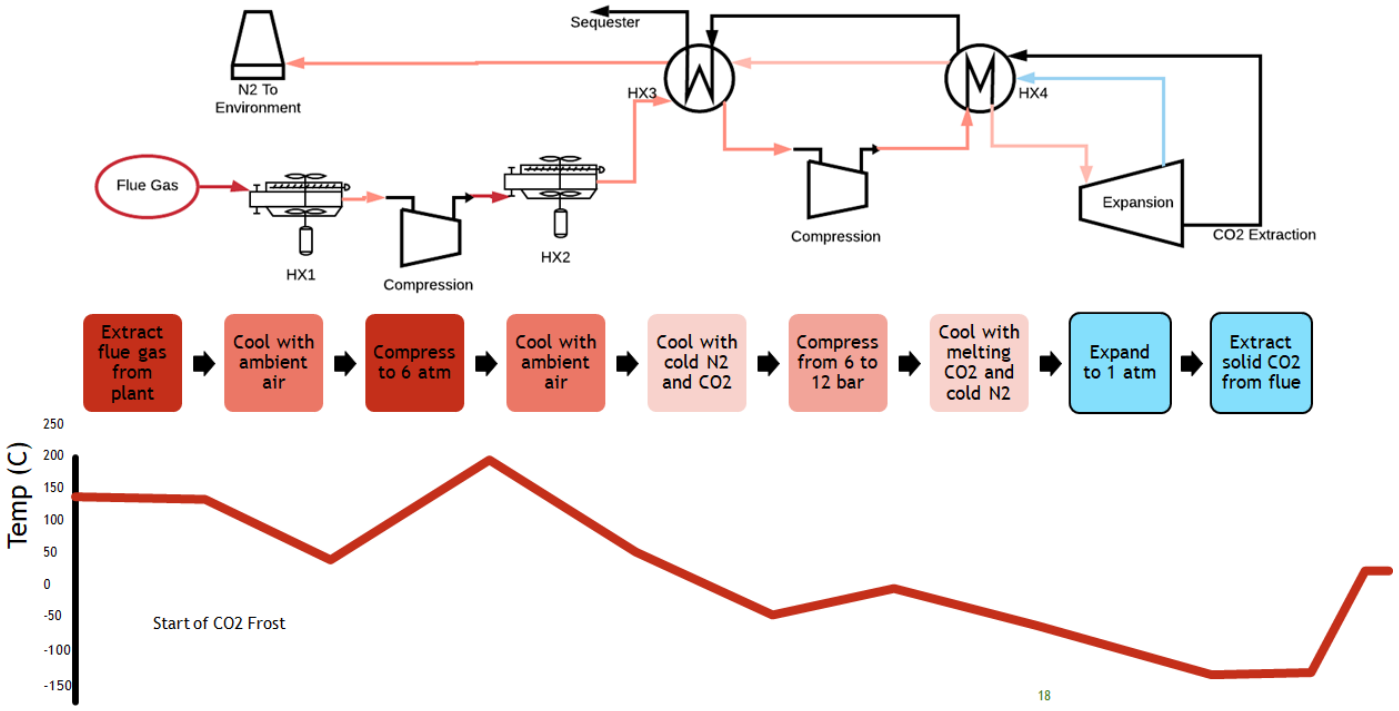
While there have been several high profile, under-performing or abandoned carbon capture systems, interest in CCS technologies at the federal level is at an all-time high; we believe it prudent for the CEC to expect future research funding from the Department of Energy as it finalizes its R&D roadmap and budget. For example, ARPA-e is hosting a workshop on Flexible Carbon Capture later this month to 1.) explore how the design and operation of CCS systems could be modified to lower the cost of capturing CO2 given certain operational constraints and 2.) explore innovative technologies to determine relevant and compelling metrics that will define a successful research program.

A. Overview of alternative carbon capture systems - specifically cryogenic separation processes

a. Process overview - separate physically with a phase change

For example, cryogenic carbon capture processes, or 'frosting' processes are an emerging area of interest because of their inherent advantages in the design, opportunity for cost reductions and applicability to a range of applications. The process cools flue gas down to where the CO2 changes from gas phase into dry ice, then physically separated from the other flue gases (primarily nitrogen). A Utah company, Sustainable Energy Solutions (SES), has been pursuing this for about 10 years with considerable, ongoing support from the Dept. of Energy and others. Bright has a process shown below that is a bit different than SES, with projected lower capital costs, shorter, cheaper development timelines, and shorter manufacturing timelines using more mass-production techniques at scale. However, both approaches offer economics that are

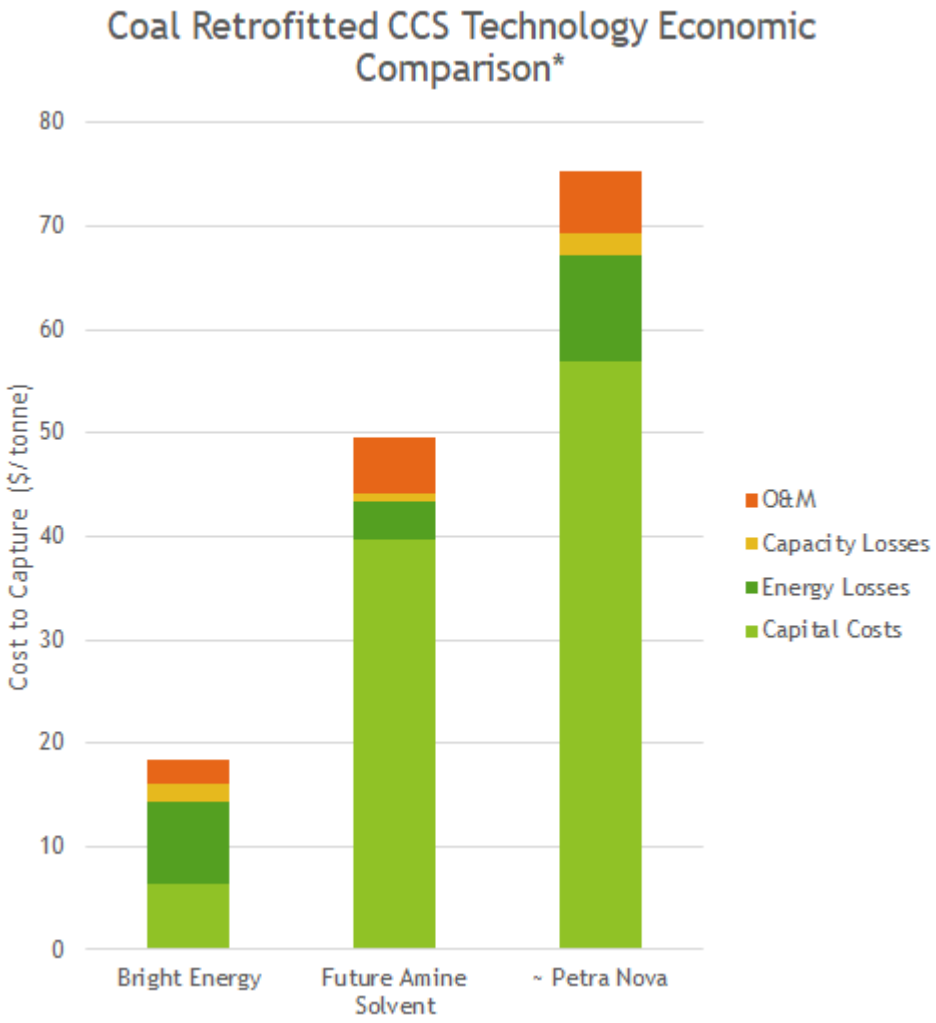
substantially better than conventional amine sorption systems and improved robustness to other chemicals into the flue gas that can be problematic and expensive to deal with. In fact, many of these benefits were identified in **CEC-500-2017-007-APH Comparative Assessment of Technology Options for Biogas Clean-up.**



The diagram above illustrates how the cold nitrogen (all non-CO2 flue gases actually) that emerge downstream of the CO2 frosting process is recovered or recuperated making the energy required to run the process very competitive with other capture processes. Several key advantages include

- The ability to retrofit to existing power plants - substantially lowering costs of the CCS system when existing plants provide system reliability and flexibility. This process has minimal integration requirements with the plant - divert the flue gas to the process and operate as usual to produce (now carbon-free) electricity.
- Very low capital costs - this helps with the project economics of course, but also in the technology development phase where relatively inexpensive field installations can be built,

deployed, tested and validated. The plot below illustrates that capture costs are expected to be much lower in the future- primarily because the selected equipment is much lower cost.



- Scalable. Some cryogenic carbon capture processes can be cost effective at fairly small scale. This allows early validation for projects that deliver carbon reduction value at modest scale.
- Using the flue gas as the refrigerant (versus an external refrigeration process that may have high global warming potential). The use of the flue gas as refrigerant offers value in heat exchanger costs and effectiveness, albeit with complexities of the dry ice formation various parts of the refrigeration system.

- Other pollutant cleanup. Cooling to the frosting temperatures has a large fraction of the SOx and NOx (and mercury, arsenic, etc.)

B. Relevance of CCS for California's decarbonization goals

These examples of innovative, lower cost CCS technologies can certainly be applied to biogas cleanup processes and Bio-Energy with Carbon Capture and Sequestration (BECCS) as already identified by the Commission. Equally important is that the benefits associated with cryogenic capture processes extend to other sectors where California is targeting CO2 reductions, including:

a. Power plants - Prospect of far lower energy costs for dispatchable power

   i. Natural gas power plants. These plants are already fairly flexible dispatchable power that complement variable renewable energy resources which increasingly face the potential for curtailment. With CCS, natural gas plants can have effectively infinite "storage" or dispatchable energy durations with minimal carbon emissions. Low-cost carbon capture technology solutions for natural gas plants can be far more cost-effective than some other electricity storage options such as new pumped-hydro; the ability to rapidly and inexpensively decarbonize flexible generation resources is important to achieving the state's carbon reduction goals.

   ii. Biomass / Steam - BECCS/BioCCS/BioCCUS Bioenergy use with carbon capture can enable net carbon negative operation and cryogenic/frosting processes can be scaled to the size of the facility. Federal incentives for CCS through the 45Q tax legislation could provide an economic boost to biomass power plants while helping mitigating the risk of wildfires.

b. Hydrogen production: for refineries or dedicated hydrogen production facilities for transport or natural gas replacement with hydrogen in power applications.

c. Building materials/Cement plants - Captured CO2 has the potential to be mineralized in the production of cement to help reduce carbon emissions associated with building construction.

IV. CONCLUSION

Bright Energy Storage Technologies appreciates the opportunity to provide these Comments. Including research support for the development and demonstration of cost effective carbon capture systems such as those described here is integral California ability to achieve its goal of 100% carbon free energy.

Respectfully submitted,

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Dated: July 12, 2019