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Comments regarding Initiatives 7, 25, 27

Additional submitted attachment is included below.

Date: August 16, 2021
To: California Energy Commission
From: Sunvapor, Inc.
Re: Docket # 20-EPIC-01, Development of the California Energy Commission Electric Program Investment Charge Investment Plans 2021-2025

Comment re: Initiative 7 (Green Hydrogen Roadmap Implementation to Support Grid Reliability). We agree with the Green Hydrogen Coalition, the Bioenergy Association of California, and the International Renewable Energy Agency [Reference: IRENA (2020), Green Hydrogen: A guide to policy making, International Renewable Energy Agency, Abu Dhabi] that steam methane reforming of biogas is a valid form of green hydrogen inasmuch as it does not rely on fossil fuel feedstock. We further recommend that the EPIC Green Hydrogen Roadmap includes advanced biogas reforming technologies, such as solar steam reforming, that are proven to increase the yield of hydrogen from methane (e.g., biogas) feedstock while capturing carbon [Reference: M. Dolan *et al*, "An experimental and techno-economic assessment of solar reforming for H2 production", International Journal of Hydrogen Energy 41 (2016)].

Comment re: Initiative 25 (Low-Carbon / High-Temperature Industrial Heating). We observe that there are technical limitations to what can be achieved by heat pumps and direct electrification, and recommend consideration of an additional alternative that does not suffer from these limitations and builds on the success of the Energy Commission's FPIP Program. We can say from having actual on-site experience at dozens of industrial facilities that the steam temperature supplied to the plants' steam network is always above 169 Celsius. A recent review of the state of the art for high temperature heat pumps shows zero products that can generate this temperature with any source temperature [Reference: C. Arpagaus, "High Temperature Heat Pumps: Market Overview, State of the Art, Research Status, Refrigerants, and Application Potentials," 17th International Refrigeration and Air Conditioning Conference at Purdue, July 9-12, 2018]. Two thermodynamic obstacles stand in the way of delivering the temperatures of interest from heat pumps for industrial steam: the very high temperature lift leads to low COP, and the lack of available refrigerants with a sufficiently high critical temperature. Direct electrification is a limiting case of a heat pump with a COP of unity. Concentrating solar thermal energy has been proven to deliver >169 Celsius steam at efficiencies 4X greater than that from photovoltaics and would be a preferred alternative to heat pumps or direct electrification for renewable high-temperature industrial heating when land is available. For the same heat rate, a solar photovoltaic system would occupy four times the land required for concentrating solar thermal systems. Solar thermal has the additional advantage of lower cost energy storage. Solar thermal energy is currently being deployed to generate steam for food processing plants under Energy Commission FPIP awards.

Comment re: Initiative 27 (Energy Efficient Separation Processes). We observe that for a number of important separation processes such as desalination, electrically-driven membrane separation methods are inadequate and cannot achieve sufficient recovery. Indeed, reverse osmosis *produces* an industrial brine waste that must be further processed by thermal separation [Reference: U.S. Department of the Interior Bureau of Reclamation, "Executive Summary Southern California Regional Brine-Concentrate Management Study – Phase I Lower Colorado Region, 2009]. We recommend that this Initiative includes advances in efficient, modern thermal separation processes such as membrane distillation and forward osmosis that can play a role in achieving more complete separations that improve environmental outcomes. We further observe that the U.S. Department of Energy [Reference: U.S. DOE, "American-Made Challenges: Solar Desalination Prize Official Rules", April 2020] is promoting the exclusive use of solar thermal heat to drive thermal separations, and we recommend that the EPIC Initiative also includes solar thermal routes to more efficient thermal separation processes.