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consideration of biomethane and methane option

Additional submitted attachment is included below.

The SB 100 report states in Table 4: Considered Technologies Excluded from Modeling

Drop-in renewable fuels (hydrogen and biomethane)	Technology for synthetic drop-in renewable fuels not yet commercially available in California and/or inadequate cost and supply data for modeling, inadequate supply potential for biomethane in the power sector.
Natural gas generation with carbon capture and sequestration	Lack of cost data and performance data for 100% carbon capture

In a summary to Policymakers, from the "An Action Plan for Carbon Capture and Storage in California: Opportunities, Challenges and Solutions", Energy Futures Initiative/Stanford Precourt Institute for Energy project significant expansion in the hydrogen fuel cell vehicle marketplace as well as the need to convert the existing electric generation infrastructure. As such they recommend a policy that looks strongly at the need for hydrogen produced for the vehicle and electric power markets, which will represent 72% of the demand be generated from biomass and natural gas. That report identified underground saline cavities within the State that can store the carbon dioxide from the electric generation system for a 1000 years. By not considering the above, the strategy will fall primarily to "the Green New Deal", which relies solely on wind/solar as the sources for the hydrogen. Such an approach will require seasonal/operational storage, which will be excessive and a reliance on lithium batteries. By not considering the ability of biomethane and methane with CCS to produce lower cost options with the amount of biomass being able to overcome greater than 100% carbon capture eliminates the low cost option per the above report and leads to a severely restrictive set of policy options. In addition, the development of the Mitsubishi 3100 F hydrogen turbine, which will be demonstrated in Utah as part of the "400 MW LADWP Green New Deal plant in Utah", will have significant impact on also bettering the economics of the Above Action Plan. It will lead to a plan where all electric generation and fuel for hydrogen fueled vehicles and commercial and industrial applications will be produced in State thereby improving California's economy, NOT REQUIRE THE NATURAL GAS PIPELINE SYSTEM OR PEOPLE'S HOMES TO BE MODIFIED TO ACCEPT HYDROGEN, AND THAT WILL REMOVE CARBON DIOXIDE FROM THE AIR. It can lead to a 400 MW demonstration of the same turbine demonstrating the above also by 2028 with a more robust and economical system that will remove carbon dioxide from the air. The recommended study below can identify an action plan to support these conclusions. It can be performed by recognized governmental laboratories and/or institutions as has been previously documented by Lawrence Livermore National Laboratory (reference 6, Oak Ridge National Laboratory references 4 and 5, and EFI/Stanford Precourt Institute for Energy reference 3, or others).

It would be frankly tragic and short sighted and an unconscionable oversight to not perform the following study. I therefore recommend the following study be funded:

An Electric Generation and Hydrogen Fuel Providing Approach with CO_2 Capture and Storage Generated by Biomethane/Methane Power Plants

Estimated Budget: $750,000 per year

Project Duration: 12 months

Project Objective: The Green New Deal proposes to introduce the hydrogen economy by using solar and wind energy to electrolyze water to produce hydrogen for the electric power generation and fuel for hydrogen fuel cell vehicles (HFCVs). An alternative option has been proposed by LLNL (reference 6) and EFI/Stanford Precourt Institute for Energy (reference 3) and Oak Ridge National Laboratory (references 4 and 5) to utilize biomass and/or natural gas with carbon capture and sequestration, which can be used to supplement the Green New Deal option or replace it. Reference 3 estimates that these two market areas can represent 72% of the hydrogen market area. While the above two studies identified favorable economics for their systems, they did not include the impacts of the development of the Mitsubishi 3100 F hydrogen turbine, development of carbon dioxide turbines (Clean Energy Systems) nor the benefits of maintaining individual homes on biomethane/methane rather than convert them to hydrogen.

Background: The above approach will deliver biomethane/methane feedstocks to the point of utilization prior to the production of hydrogen to be utilized at City-Gate plants similar to the Toyota/Fuel Cell Energy 2.35 MWe co-production facility at Long beach Harbor to fuel Toyota HFCVs and electricity for the Harbor. The proposal here will be to extend this approach to a 400 MW and greater biomethane and methane (BAM) option based on the Mitsubishi 3100 F hydrogen turbine, which is earmarked to be utilized by LADWP Green New Deal project in Utah for the late 2020s. One of the options to be analyzed is based on STARS Technology Corporation's system to heat the steam/methane reformer operation with electricity. It will require one third the electricity and half the water of the water electrolysis option of the Green New Deal system, which will be in short supply in the State. The utilization of BAM will not require the natural gas pipeline system to be modified to transport up to 30% hydrogen or significant infrastructure changes to produce a cost-effective hydrogen economy. It will also enable biomethane accreditation for residences and eliminate the need for hydrogen systems to be used in the individual home marketplaces.

Burning fossil fuels has led to an increase in the atmospheric CO_2 concentration by more than 45% relative to the pre-industrial era. Recent studies indicate that limiting global warming below 2°C by the end of this century will require drastic reductions in CO_2 emissions, as well as removal of CO_2 from ambient air.[1,2] In 2018, emissions of CO_2 by the U.S. electric power sector were 1,763 million metric tons, which corresponds to 33% of the U.S. energy related CO_2 emissions. One third of this CO_2 emissions (588 million metric tons) is generated from burning natural gas. As a result of increasing shale gas production in recent years, the number of coal power plants has been declining and more natural gas is used to generate power. The concentration of CO_2 in flue gas emitted from burning natural gas or syngas is less than half the concentration of CO_2 in flue gas emitted from burning coal; this is one of the reasons that the use of natural gas for power production is increasing. On the other hand, syngas is generated during coal or biomass pyrolysis along with solid char that can be stored as a form of carbon storage in soil. This proposed project is focused on CO_2 capture from natural-gas or syngas power generators. Syngas (biomethane) has been estimated to cost between ($17/mBTUs (GTI) and $20/mBTUs (ICF), which will be far more expensive than natural gas at $2 to 3/mBTUs). It is proposed to consider forest management and poplar tree farms to produce the biomethane. This will permit the multi-year storage of carbon dioxide in the trees with 6 to 7 year harvests for poplar trees allow an average of three year carbon dioxide store to be considered. It is proposed that the CCS protocol be established in the Cap and Trade program. Today California provides a Low Carbon Fuel Standard credit but not Cap and Trade.

As such SoCalGas has a project with Clean Energy Systems where electricity is generated from the carbon dioxide and stored, but the hydrogen is sold into the vehicle marketplace where the LCFS exists. Such an environmental consideration will bring biomethane closer to methane costs but will probably need the preponderant feedstock to be methane for the foreseeable future.

Critical Technical Challenges to be Addressed: References 1 and 2 indicate technologies that involve carbon capture and storage (CCS) for CO_2 emissions will significantly increase the cost of electricity. When this option was investigated for coal plants (Reference 4), the cost of electricity rose from 6 cents/kWh to 11.5 cents/kWh. The development of a 3100 F hydrogen turbine was able to reduce that cost to 7 cents/kWh. The co-production of electricity from the carbon dioxide was not evaluated, which would further reduce the costs. The EFI/Stanford study (reference 3) identified a basin throughout the entire State that can store 60 Mtons/year of carbon dioxide for 1000 years and two particular basins in the LA and San Francisco areas as excellent sites for a plant.

Proposed Work: The ultimate goal of the project is to develop a competitive, cost-effective, industrial-scale process for CO_2 capture from natural-gas and syngas power plants that preserves the existing natural gas pipeline system without modification to transport hydrogen as either as a supplement or replacement for the Green New Deal and is capable of removing carbon dioxide from the air cost effectively as being required to truly achieve California's climate objectives.

Budget: The proposed budget is $750k/year for 1 year.

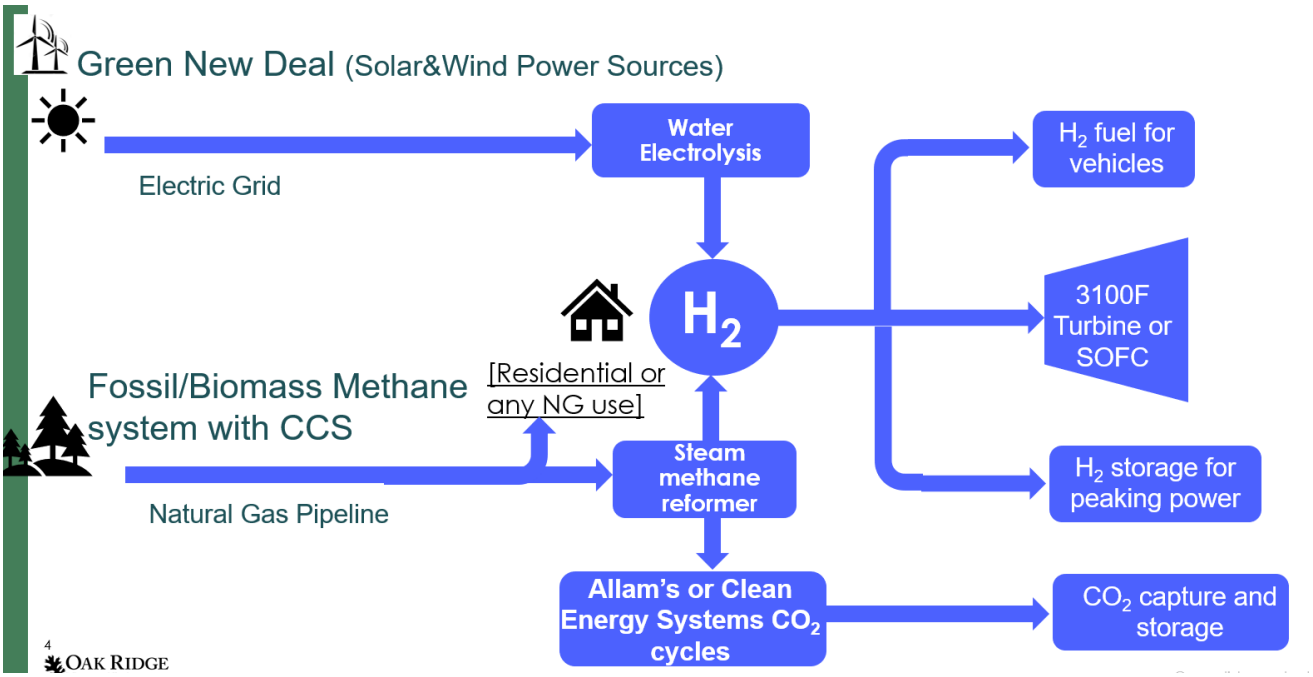

Figure 1: Conceptual diagram of a complete renewable grid system.

References:

1. Current and Future Technologies for Gasification –Fossil Based Power Generation, Revision 1, November, 2010, DOE/NETL –2009/1389

2. Cost and Performance Baseline for Fossil Energy Plants, Volume 1, Bituminous Coal and Natural

Gas to Electricity, Revision 2a, September 2013, DOE/NETL –2010/1397

3. Sarah E. Baker, et al., Getting to Neutral: Options for Negative Carbon Emissions in California, January, 2020, LLNL, LLNL-TR-796100 An Action Plan for Carbon Capture and Storage in California: Opportunities, Challenges, and Solutions, Stanford Research Center, Energy Futures Initiative, Stanford Precourt Institute of Energy, Stanford Earth

4. USDOE (2016). 2016 Billion-Ton Report: Advancing Domestic Resources for a Thriving Bioeconomy, Volume 1: Economic Availability of Feedstocks. M. Langholtz, B. Stokes and L. Eaton. Oak Ridge, TN, Oak Ridge National Laboratory: 448. https://bioenergykdf.net/billionton2016/overview

5. Langholtz, M., et al. (2020). "The Economic Accessibility of CO2 Sequestration through Bioenergy with Carbon Capture and Storage (BECCS) in the US." Land 9(9). https://doi.org/10.3390/land9090299

6. Getting to Neutral, Options for Negative Carbon Emissions in California, January 2020