RESEARCH OPPORTUNITIES FOR NEGATIVE EMISSIONS AND CO$_2$ UTILIZATION AT THE GIGATONNE SCALE

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This talk will present key ideas from a recent report of the US Secretary of Energy Advisory Board (SEAB) on this topic. Looking at the global energy system, it is increasingly clear that there are viable options to reduce emissions in the electricity sector, although their implementation would require serious combination of policy measures and technological advancements. However, given the distributed nature of the emissions, lack of viable alternatives at scale and a variety of other factors, it is more difficult to do the same for the transportation and the industrial sectors. Hence, negative emissions and CO$_2$ utilization are worth considering as a counteractive measure as long as there is a net decrease in emissions. Furthermore, if the atmospheric CO$_2$ concentration rose above any dangerous threshold with zero net emission rate, technologies for negative emissions could play an important role to reduce the atmospheric concentration from increasing beyond that threshold. While the portfolio of pathways to manage carbon is rather large and complex, it is compounded by the fact that each pathway requires numerous questions about rates, locations, amounts, costs, infrastructures, chemical form, use, re-use, and fate of carbon, all of which need to be addressed systematically. In addition, the criterion for 1 GtCO$_2$/yr scale leads to some important considerations about finance, markets, regulations, and consequences on our biosphere that need attention. With this background, the research opportunities fall in five categories, namely: (a) systems modeling; (b) harnessing the natural biological carbon cycle; (c) synthetic transformations of CO$_2$; (d) CO$_2$ sequestration in geological formations through advanced enhanced oil recovery; (e) CO$_2$ capture and separation technologies. Details in each of these areas and their scientific justifications will be offered in this talk.