The Synergistic Development of Materials to Solve Issues in Sustainable Energy or Water Use.

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According to the US census bureau the worlds population on May 28th 2013 was 7,088,246,000. The amount of CO_2 in the atmosphere as measured at the observatory on Mauna Loa in the spring of 2013 now exceeds 400 ppm, a level not seen in human history and certainly caused by anthropogenic activity. It has been shown that the mean planet temperate tracks with the concentration of CO_2 in the atmosphere. The current path to energy independence in North America involves both fracking for natural gas and oil from tight shale deposits, and the exploitation of heavy and viscous oil deposits. The exploitation of these non-conventional hydrocarbon resources is very water intensive and results in large quantities of in potable water that must be treated or pumped back into the ground. One quarter of the worlds population does not have access to electricity, and 11% of the population does not have access to clean water. To continue on a path of unsustainable economic growth on an energy economy based on hydrocarbons it is clear that the planets atmosphere will result in a planet that will warm by much more than the 2^{o}C agreed on by the Kyoto protocol and that the planets water resources will become extremely stressed.

The ultimate goal of scientific research in energy and water should be clean abundant renewable energy and water for all, through technology that is manufacturable and constructed from components that are derived from earth abundant elements. An intermediate goal would be that all energy be consumed by the most efficient processes possible, with the minimum of capital expenditure. To achieve this it is highly desirable that energy be converted by electrochemical devices, which are not carnot limited, at moderate temperatures at which the waste heat can still be utilized. The proton exchange membrane fuel cell (PEM FC) is a very impressive device when powered by hydrogen. But the PEM FC is only a true solution if the hydrogen can be generated from renewable resources. The anion exchange membrane fuel cell (AEM FC) is in principal, much more fuel flexible, but needs a dramatically ramped up investment in the technology if it is to be fully utilized. With inexpensive abundant energy electrochemically derived water purification also becomes feasible.

Over the last year the Herring group at CSM that specializes in electrochemical energy conversion and the Greenlee group at NIST that specializes in water treatment solutions have been collaborating. Membranes and catalysts developed for either application find uses in the other. For example earth abundant nano-metallic particles developed as NIST for composite membrane components can be utilized at CSM as catalyst particles in AEM FCs anodes for fuel flexible fuel cells. Membrane materials developed at CSM may find application sin water treatment solutions being developed at NIST.

After an introduction on our perspective to the energy-water nexus, we will show examples of potential materials solutions to both energy conversion and water purification. This talk will emphasize electrochemical solutions to hydrogen production from solar, wind or biomass. Fuel utilization in fuel cells, and water purification by polymer based systems.