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## **Ammonia Energy Storage, Transmission and Usage Development for Offshore Wind and Applicability to OTEC**

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### **Abstract**

Analysis has indicated the cost effectiveness of anhydrous ammonia for energy storage and transmission with many potential fuel uses as well as value as a fertilizer. New solid state techniques for ammonia synthesis from electricity, air and water in a single step process when coupled with recent innovations in highly efficient offshore wind and Ocean Thermal Energy Conversion (OTEC) energy generation open up the possibility of economically producing power, liquid fuels, fertilizer, and desalinated water simultaneously. Ammonia production by offshore energy sources has been carefully analyzed in terms of present and projected economic viability for various locations around the world. In the case of wind, ammonia generation can serve as a way of dealing with the wind intermittency. Ammonia can enable energy storage. Ammonia can also serve as a way of transmitting energy whether by pipeline, train, truck or tanker from a far offshore OTEC plantship. In terms of energy usage there is the exciting possibility of its immediate applicability with minimum conversion costs in both gasoline and diesel engines. This ammonia energy storage and transmission analysis as related to offshore wind and OTEC power is part of a program of energy technology development being executed by the Ocean Energy Institute (OEI). This analysis has explored enabling technologies related to energy generation, usage, storage and transmission of direct relevance to OTEC to assess its economic feasibility. Information gathered will support data-based modeling of OTEC's economic benefits. OEI was founded by Matthew Simmons to accelerate the development of ocean energy technologies. The primary mission is speeding the United States towards energy security with a special emphasis on liquid fuels for transportation. Because offshore wind and OTEC hold the promise of the largest scale of energy production initial attention has been focused on these two technologies by OEI. Offshore wind, both fixed and floating platform, is the nearer term option with technology transfer from European projects being a path for hastening implementation.

### **Introduction**

To understand, plan, and effectively move into the new world of energy which we are experiencing on both the conventional and renewable fronts requires that we view energy as a system including as its four main components: Generation, Usage Storage, and Transmission, or GUST for short. Most of the time emphasis lies heavily, almost exclusively, on generation. But equal attention needs to be paid to usage, storage, and transmission. For example in the state of Maine attention is being paid to how transitioning from oil furnaces and conventional automobiles to cold climate heat pumps and plug in electric hybrid vehicles could cut energy consumption by roughly a factor of three for the average family. That is regardless of what the source of electricity is. Energy transmission is often in the news in the form of smart grid technology. But it is important to remember that things like oil tankers and natural gas pipelines are also critical forms of energy transmission.

Energy storage is usually solely associated with the problem of coping with the intermittency of many renewable energy sources. But in thinking about energy storage only with respect to the intermittency problem in renewables an important opportunity is lost to use the capital invested in already existing conventional power generation and transmission assets far more effectively (Energy Advisory Committee 2008). Much is made of the fact that solar wind and ocean energy typically have capacity factors (the fraction of time in which useful power can be extracted from the devices) of between 30 and 40%. Overlooked is the fact that conventional power plants on the average have a capacity factor of only 40%. This is actually a severe underutilization of capital assets that would be extraordinarily expensive to replace. The same applies to the already existing transmission and distribution grid. Here again we have a huge capital investment which is grossly underutilized in terms of capacity factor. Much time is spent worrying about energy efficiency. In a world in which some 20 trillion dollars of wealth has been recently destroyed capital efficiency is equally if not far more important.