Fusion Production of Hydrogen; How Fusion Energy Can Fuel the *Hydrogen Economy*

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The United States has embarked on a serious effort to transform our transportation economy from one that is largely petroleum-based to one based on hydrogen. This has come to be known as *the Hydrogen Economy*. If successful, this transition will result in significant improvements in energy efficiency and environmental quality. A hydrogen economy can be based on domestic energy resources and would make possible a high degree of energy security.

Hydrogen is an energy carrier, not an energy source. While hydrogen is the most plentiful element on earth, virtually all of it is chemically bound. Energy must be invested to separate hydrogen from the water, hydrocarbons or carbohydrates in which it is bound. The most straightforward, cleanest and sustainable pathway to hydrogen is decomposition of water. This can be accomplished by electrolysis using electricity, by high temperature electrolysis using both heat and electricity, and by a variety of thermochemical water-splitting cycle processes using only heat. Radiolysis is a potential technique for splitting of water that could use fusion energy directly to make hydrogen.

Fusion energy could be the ultimate best source of the energy needed to make the vast amounts of hydrogen needed for a hydrogen economy. Several studies done over the years have all concluded that production of hydrogen is well suited to the characteristics of fusion energy production, and could be a larger market for fusion energy than even electricity production. These studies have shown that electrolysis, high temperature electrolysis and thermochemical water-splitting all have the potential to be attractive techniques for the production of hydrogen using fusion energy.

The DOE hydrogen program is currently developing these techniques, and is also developing high temperature nuclear fission reactors that could use these techniques for hydrogen production. Fusion can take benefit from this development. Use of fusion for low temperature electrolysis will have no impact on the fusion designs envisioned for electricity production. High temperature electrolysis and thermochemical water-splitting, which offer the potential for higher efficiency and lower costs, would have impact on the fusion designs and would add additional requirements and constraints to the already difficult fusion reactor design process. Strict control of tritium to avoid contamination of the hydrogen product will be especially important. Several fusion design concepts have been developed that appear to successfully meet the requirements for hydrogen production.

Production of hydrogen for the *Hydrogen Economy* is an attractive mission for fusion energy and could be a much larger ultimate use of fusion than electricity production. Special fusion reactor designs will be needed for high efficiency production of hydrogen, but low temperature electrolysis could be used with no constraints on fusion design. Fusion does have the potential to provide the ultimate source of fuel for the *Hydrogen Economy*.