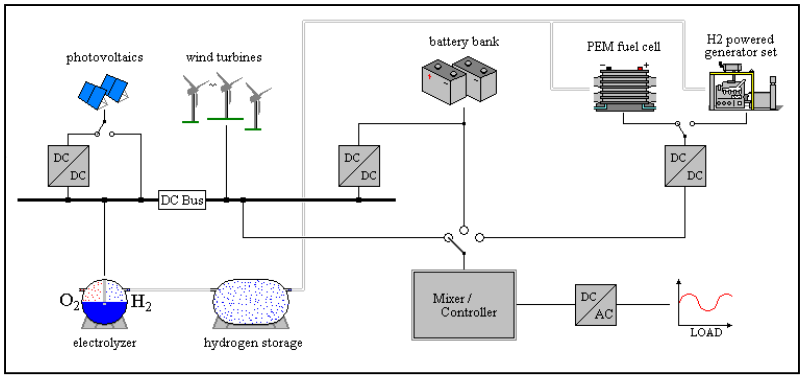
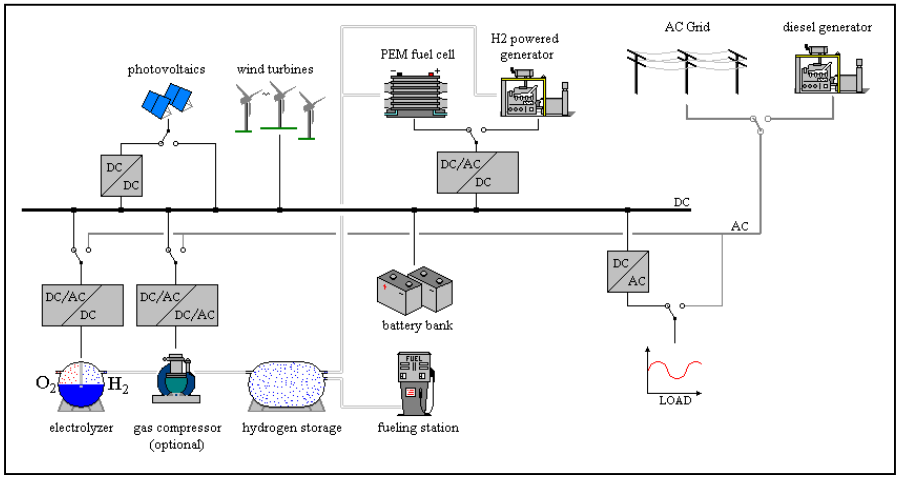
Hybrid Hydrogen Power Systems

One of TRNSYS's long standing strengths has been the ease with which users can add models of new technologies to the library and the user's ability to connect those components together to form interesting and innovative systems. While the focus of TRNSYS's standard component library has long been thermal devices (buildings, pumps, fans, chillers, thermal storage, etc.) and renewable energy systems (solar thermal, wind turbines and photovoltaics), with the release of version 16.0, TRNSYS includes a set of hydrogen power system components: alkaline and PEM fuel cells, a battery bank, an engine generator set, an electrolyzer, a gas compressor to name a few. With these new components comes the new challenge of system dispatching. When a system is comprised of various sources (AC grid, renewable power sources, fuel cells, power generators, and batteries) and various loads (end use electric loads, hydrogen fueling loads and batteries), it is of critical importance to decide when loads should be met directly by renewables, when the battery should be charged, when it should be discharged, when the electrolyzer should be run, when the fuel cell should be brought online, when the grid should be fed by the system and when the system should draw power from the grid. In Thermal Energy System Specialists, LLC was honored to be asked to create simulations of the two hybrid renewable / hydrogen power systems shown in the figures below.



In the first of the two systems (pictured to the left) a mixer / controller (essentially an intelligent load transfer switch) chooses the most appropriate power source to meet the load based on the amount of power required by the load at the current time and on the amount of power currently available from each of the sources. Available renewable energy in excess of the power load is used to run an electrolyzer that generates and stores hydrogen gas for later use.

In the second, more complex of the two systems, system dispatching was based on a complex set of control algorithms, on the state of charge of the battery and on the volume of hydrogen available in the storage tank. As in the first system, excess available renewable energy was used to run an electrolyzer and potentially also a gas compressor that generates and stores hydrogen gas. Unlike the first system, the second system included the ability to switch the load from the renewable / hydrogen power system to a standard AC grid when needed.



It was also configured in such a way that the AC grid could be the main power source and the renewable / hydrogen system could be used as an uninterruptible power supply in case that the grid either went down for maintenance or went down randomly.

During the course of the project, Thermal Energy System Specialists developed and implemented a number of new components. In addition to the system Controller / Power Manager models, various power converters, an AC power grid that includes both planned and random outages, and a battery charge controller model that limits the allowable battery charging current so as to keep a battery bank at or below its manufacturer recommended float voltage.