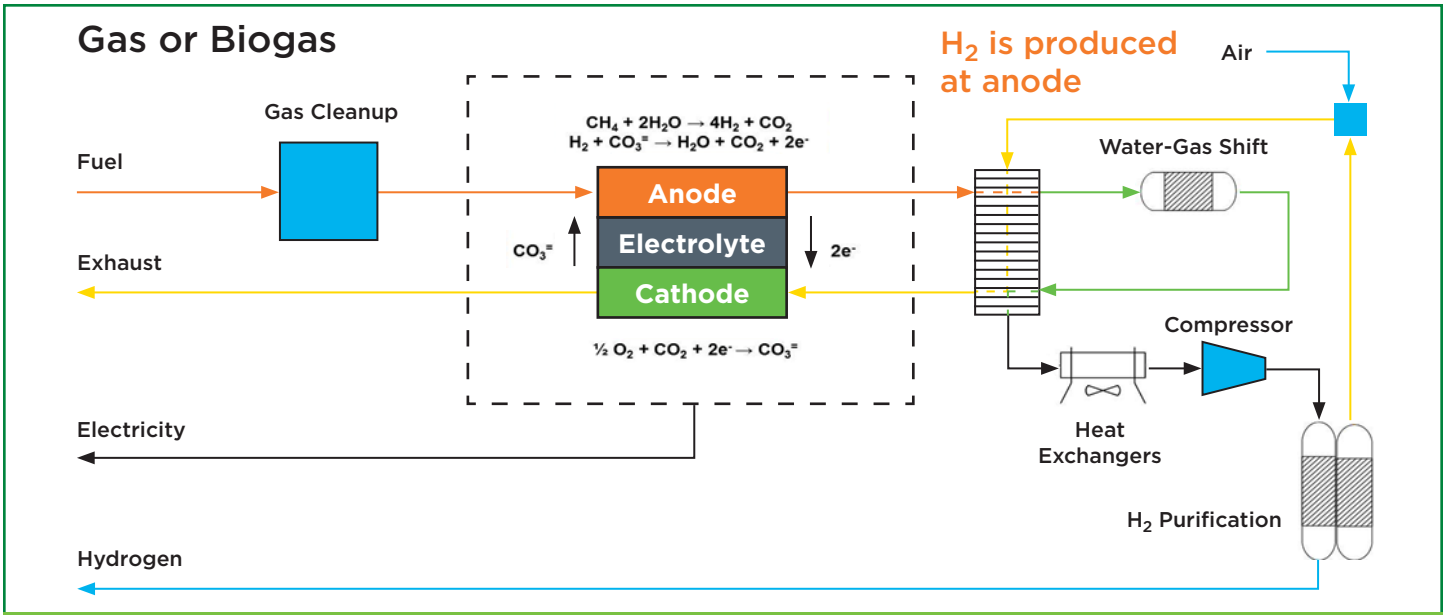
Tri-Generation Success Story

World's First Tri-Gen Energy Station–Fountain Valley

The Fountain Valley energy station, supported in part by a $2.2 million grant from the Energy Department, was the world's first tri-generation hydrogen energy and electrical power station to provide transportation fuel to the public and electric power to an industrial facility. Located at the Orange County Sanitation District's wastewater treatment plant in Fountain Valley, California, the unit was a combined heat, hydrogen, and power (CHHP) system that co-produced hydrogen in addition to electricity and heat, making it a tri-generation system. The hydrogen produced by the system supplied a hydrogen fueling station that was open to the public and could support between 25 and 50 fuel cell electric vehicle fills per day. The fuel cell also produced approximately 250 kW of power for use by the wastewater treatment plant with nearly zero criteria pollutant emissions. In addition, since the power was made from a renewable waste stream, greenhouse gas emissions were substantially reduced.

Photograph of the state-of-the-art hydrogen fueling station with fueling at 5,000 and 10,000 psi according to the latest SAE protocols for rapid 3-minute complete tank refueling.

The Fountain Valley energy station used anaerobically digested biogas from the municipal wastewater treatment plant as the fuel for a fuel cell. The CHHP system used a molten carbonate fuel cell, chosen for its high efficiency and the capability to co-produce hydrogen. The system was integrated with a hydrogen purification system to produce approximately 100 kg of hydrogen per day. The hydrogen was stored onsite in high pressure tubes at <7,000 psi near the tri-generation system and next to the fueling station.

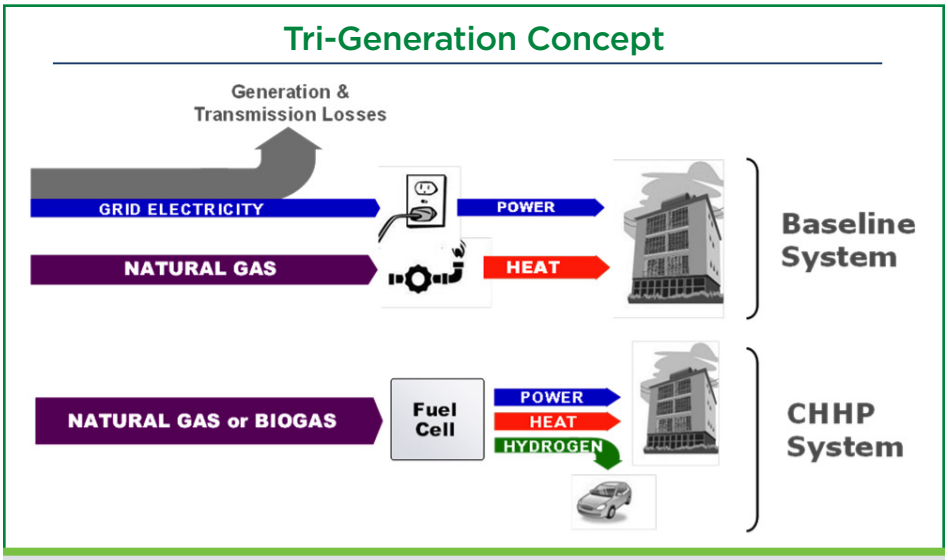


Anaerobic digester gas fuel is cleaned and then sent to a molten carbonate fuel cell that converts the hydrocarbons to a hydrogen rich mixture and produces electricity. Careful design modifications allow extra production of hydrogen that is separated, compressed, and dispensed to fuel cell vehicles.

The project was developed as a partnership between the U.S. Department of Energy, California Air Resources Board, Orange County Sanitation District, academia, and private industry. The project was managed by Air Products and additional partners included FuelCell Energy, Inc., the South Coast Air Quality Management District, and the University of California, Irvine.

Tri-Generation as an Infrastructure Bridge

Early infrastructure deployment presents a challenge to the hydrogen and fuel cell industry because station investment often needs to come before vehicle demand. Auto manufacturers from around the world have announced plans to commercialize fuel cell electric vehicles (FCEVs) and have called for increased investment in refueling infrastructure. One of the most notable developments in 2015 was the launch of commercially available FCEVs. As of 2016, Hyundai's FCEV is for lease and Toyota's Mirai is for sale in Southern California. Honda is selling their FCEVs in Japan and Daimler plans a commercial fuel cell hybrid in 2017. General Motors, BMW, and others all plan to release FCEVs. This significantly increases the need for investment in refueling infrastructure,



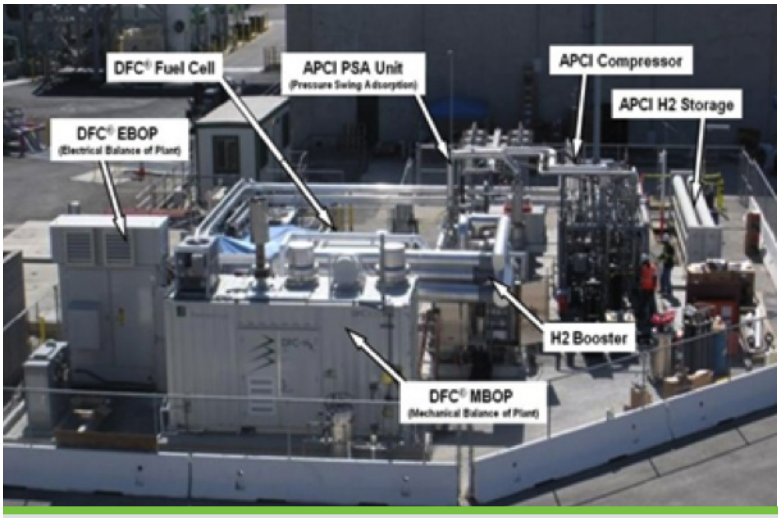
Tri-generation, or combined heat, hydrogen, and power (CHHP), systems can locally produce useful power, heat, and fuel with low emissions and high efficiency that avoids the energy and emissions penalties of transmission/transportation of traditional methods.

With a tri-gen system, product hydrogen is only generated when it is needed for refueling. Otherwise the hydrogen is used internally, and the system continuously produces heat and electricity, thereby leveraging all of the capital that is invested in the plant and helping to mitigate potential stranded capital investments.

The Fountain Valley tri-generation fuel cell system also demonstrated the versatility of fuel cells to utilize multiple feedstocks, such as biogas and natural gas, to produce power and renewable hydrogen that can be used to fuel light duty vehicles. Primarily running on biogas, the system can also use natural gas to sustain a consistent fuel flow in the case of any disruption in biogas availability or quality.

Early market projects, like this tri-generation system, are addressing many of the logistical and other real-world challenges that will confront fueling stations of the future. Tri-gen will help to open regional markets where investment can yield synergies and value.

The high efficiency and low emissions of local production of hydrogen, electricity, and heat may make tri-generation systems a bridge technology for introducing and sustaining hydrogen infrastructure.



A photograph of the Fountain Valley tri-generation system shows the fuel cell from FuelCell Energy and the hydrogen separation and compression equipment from Air Products and Chemicals, Inc. (APCI).

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