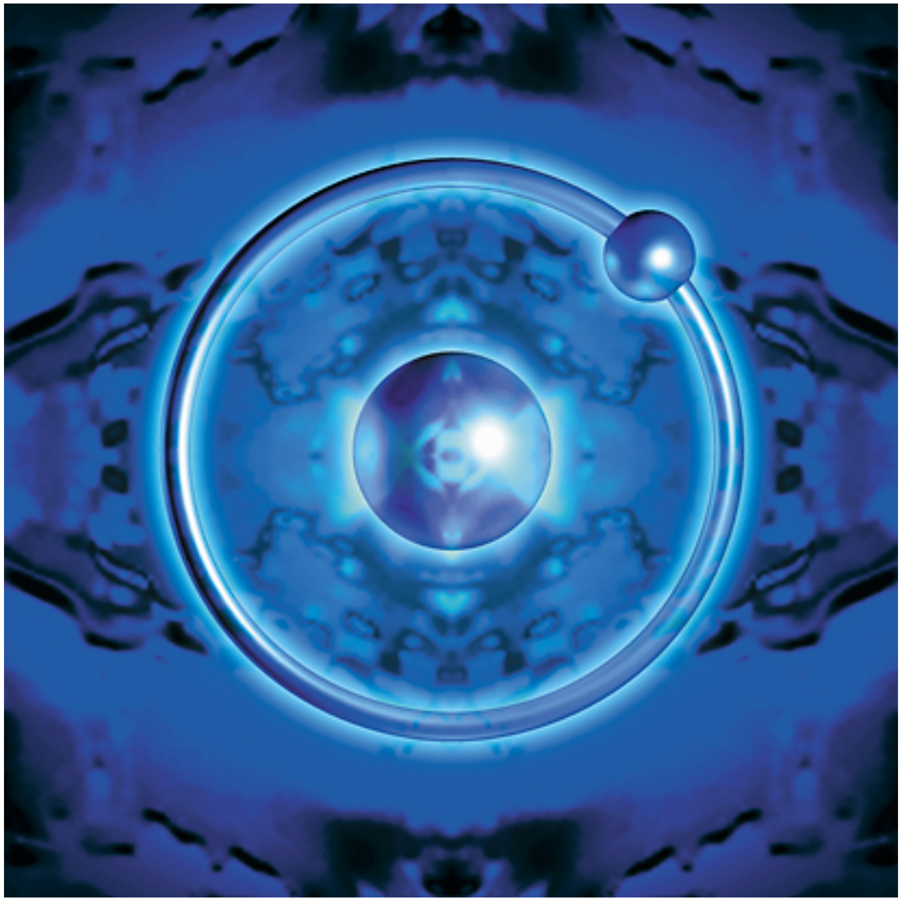


Dynamic Hydrogen Combustion

A Preferred Power Storage Technology

HYDROGEN
TECHNOLOGIES INC

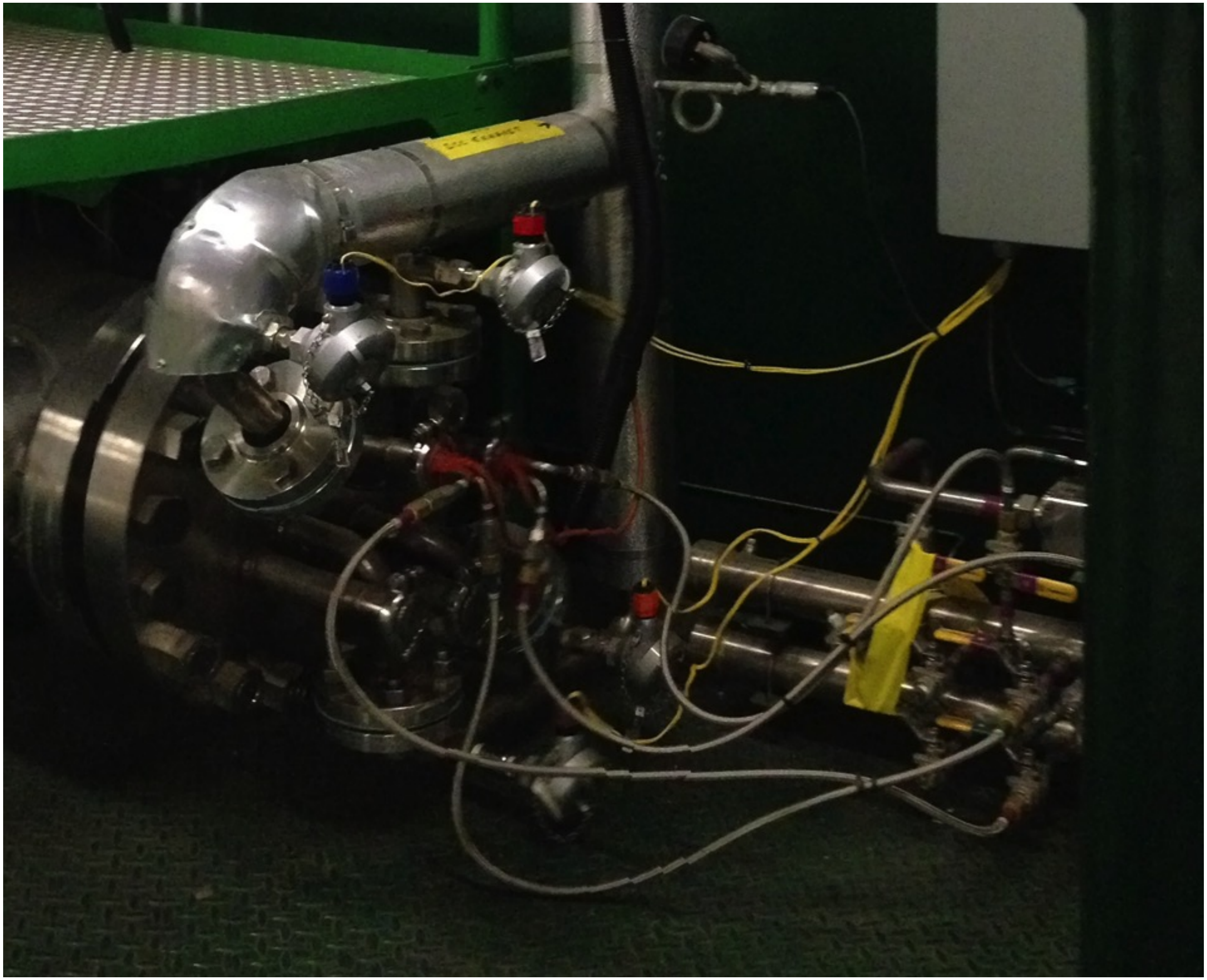
P.O. Box 8540
Stockton, CA 95208 USA
209-986-9346

www.hydrogentechnologiesinc.com

Hydrogen Technologies, Inc. has developed a steam boiler optimized for the combustion of hydrogen fuel in a pure oxygen environment. A small-scale (50 kW) prototype of the boiler is operating in Modesto, California, at the United Association of Plumbers & Pipefitters (UA) Local 442 training headquarters.

Known as the Dynamic Combustion Chamber (DCC), HTI's boiler produces process steam without generating any air pollutants. It does not require a smokestack or any other energy dissipating exhaust, and is nearly 30% more efficient in fuel usage than a typical conventional steam boiler. The DCC can be used for power generation and general industrial applications, water and wastewater treatment, food processing, and process steam generation in non-attainment air districts.

A DCC optimized for hydrogen fuel use can also be used as part of an energy storage system. Combined with water electrolysis, gas storage and conventional turbo-generator technology (see below), hydrogen-based storage has significant advantages over even the most advanced battery technology.



Value Proposition

Energy storage technology is of national interest in the U.S. power sector due the emergence of intermittent, renewable generating resources (solar, wind and small hydro). Despite their benefits, these resources concern system operators because their intermittency and time of delivery could destabilize power systems. Moving toward a solution to this problem, and not wanting to back up renewable generation resources with carbon-based generation resources (dispatch-able gas turbines), California is compelling its investor-owned utilities to procure energy storage resources beginning in 2015.

Most interest within the overall energy storage sector is centered on batteries of various types and technologies. Battery technology is certainly achieving maturity, and is attracting significant investment. However, there are disadvantages to a power storage strategy focused solely on batteries.

An alternative to battery storage is a system based on the hydrogen fuel cycle. By using the DCC technology in combination with a hydrogen-fuel storage system, several advantages over battery and related chemical technologies can be realized.

Better Than Batteries

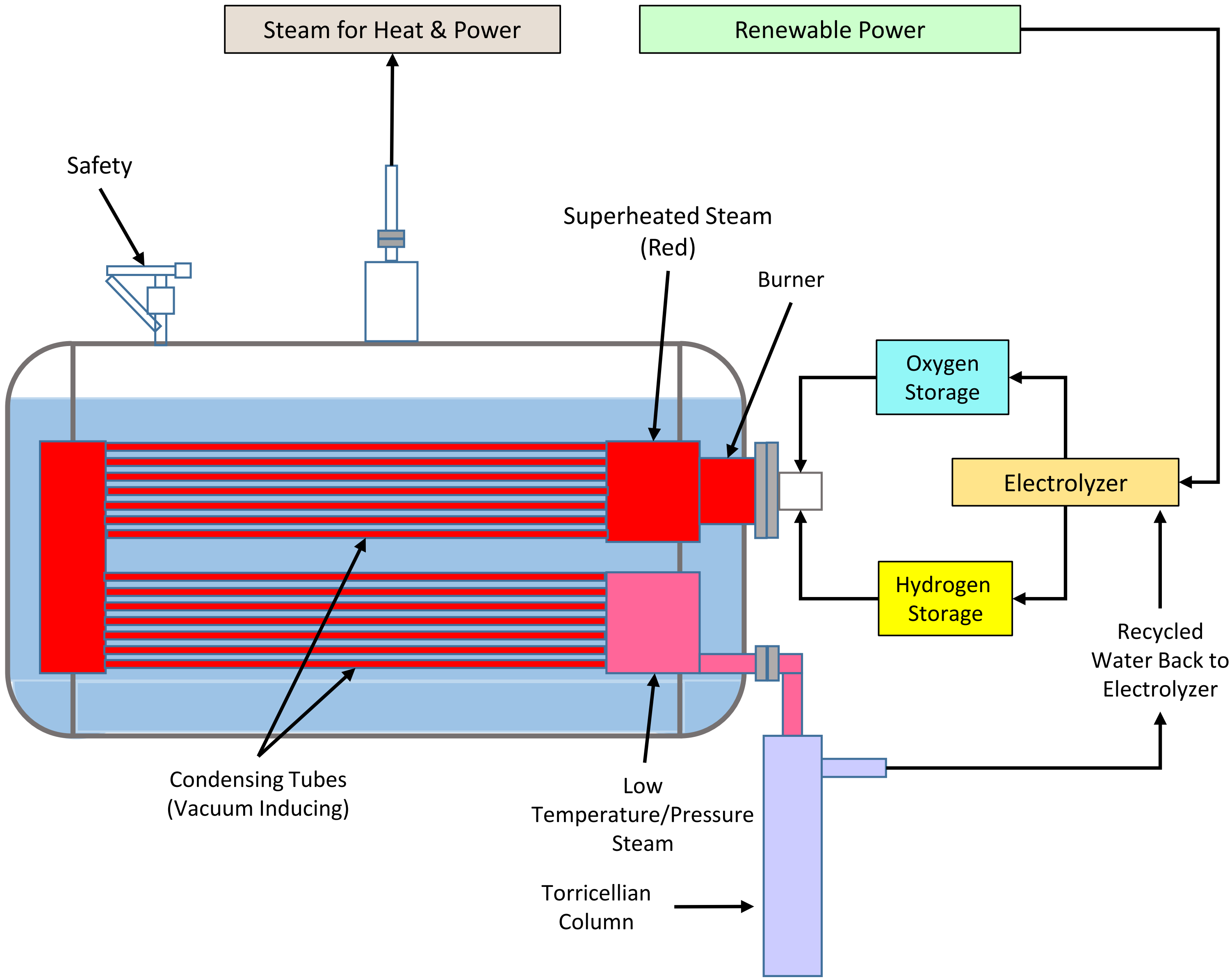
- No limits in its ability to convert intermittent solar, wind and small hydroelectric generation into fully dispatch-able power.
- No limits in the amount of time over which the power can be stored, whether it is hours later, days later, across a week or across a season.
- No offset limitations between charges.
- No limits on scalability (sub-megawatt level to utility-scale).
- No byproducts or emissions from its operations other than water.
- No costly mandated disposal issues at end-of-life.
- No losses in storage efficiency through time.

How The DCC Works

The combusting of hydrogen fuel in the DCC takes place in a vacuum with an equal amount of oxygen. The only byproducts from this combustion are heat and water. The DCC is also capable of burning any gaseous hydrogen fuel source, including hydrogen, methane, ethane, propane, butane, ammonia or natural gas, or a combination of any or all of these fuels.

The hydrogen and oxygen combust in the burner with little or no radiant heat (5,080 degrees Fahrenheit/2,804 degrees Celsius). Heat from the combustion in the form of superheated steam is transferred via the condensing tubes to the water contained inside the boiler. By virtue of the vacuum maintained by the Torricellian Column, nearly all of the thermal energy carried in the superheated steam is transferred from the condensing tubes into the boiler water. Water inside the boiler is heated and pressurized to 580 PSIG, with steam production for a one-megawatt machine rated at 13,228 pounds/hour. Water generated inside the condensing tubes is collected and recycled back into the electrolyzer to power the DCC in a continuous loop.

The prototype DCC has demonstrated efficiencies greater than 95%.

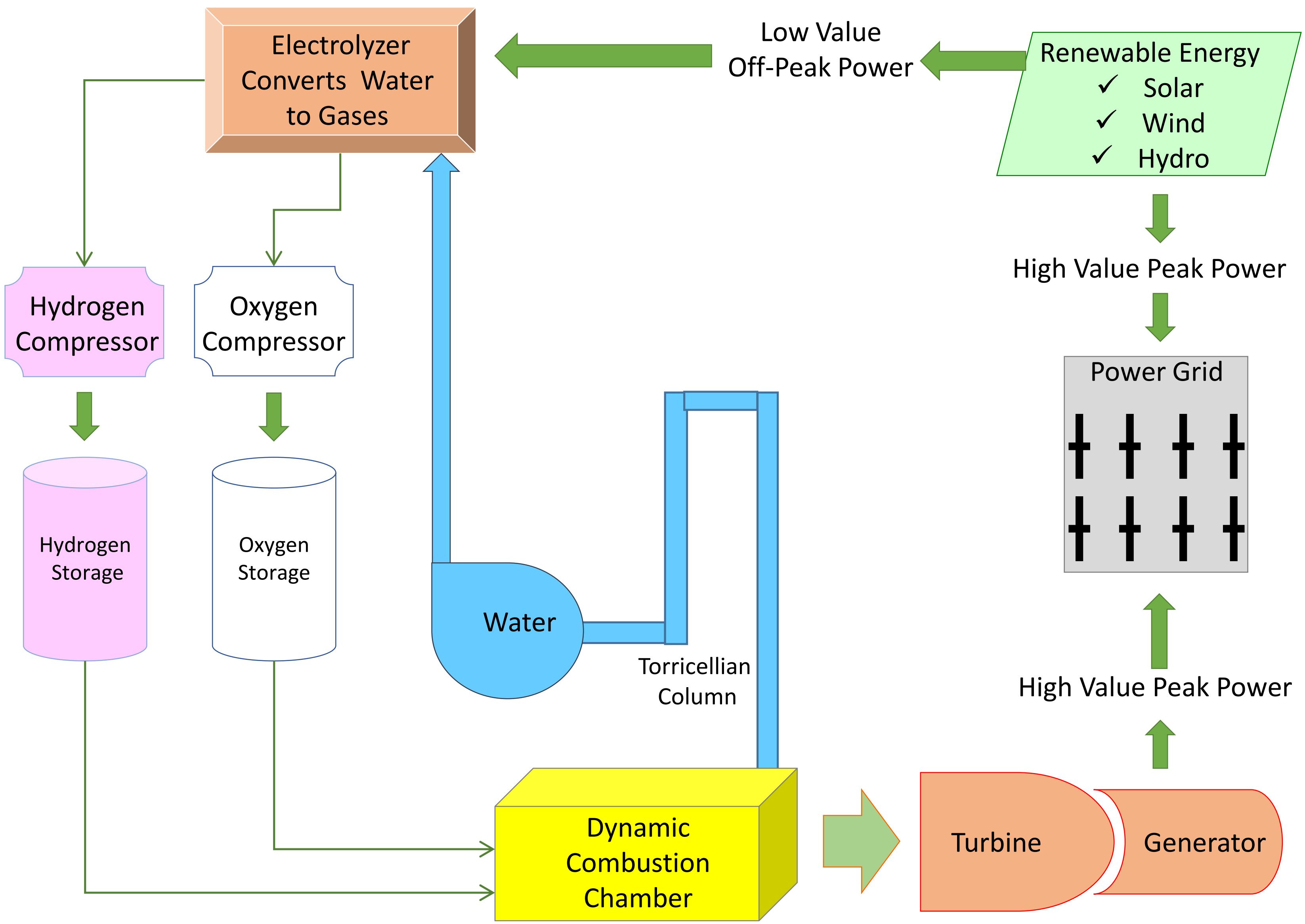


Steam for Heat & Power
Renewable Power
Safety
Superheated Steam (Red)
Burner
Oxygen Storage
Electrolyzer
Hydrogen Storage
Recycled Water Back to Electrolyzer
Condensing Tubes (Vacuum Inducing)
Low Temperature/Pressure Steam
Torricellian Column

Putting a DCC Hydrogen Storage System on the Ground

Using hydrogen as an energy storage medium for renewable energy involves the integration of several components. With the exception of the DCC itself, all of this technology is proven and currently available in the market. The general approach to energy storage using the DCC and hydrogen as a fuel medium is presented in the figure below:

The process utilizes power from renewable generation resources to run an electrolyzer and separate water into its component gases – hydrogen and oxygen – which are compressed and stored for future use. During times when the value of electricity is high (periods of peak electricity demand), the gases are dispatched to the DCC power block (hydrogen boiler) to create steam, which is then directed to a turbo-generator for power production. The by-product of boiler combustion is water, which is recycled to the electrolyzer.


Electrolyzer Converts Water to Gases
Low Value Off-Peak Power
Renewable Energy
✓ Solar
✓ Wind
✓ Hydro
Hydrogen Compressor
Oxygen Compressor
High Value Peak Power
Power Grid
Hydrogen Storage
Oxygen Storage
Water
Torricellian Column
High Value Peak Power
Dynamic Combustion Chamber
Turbine
Generator

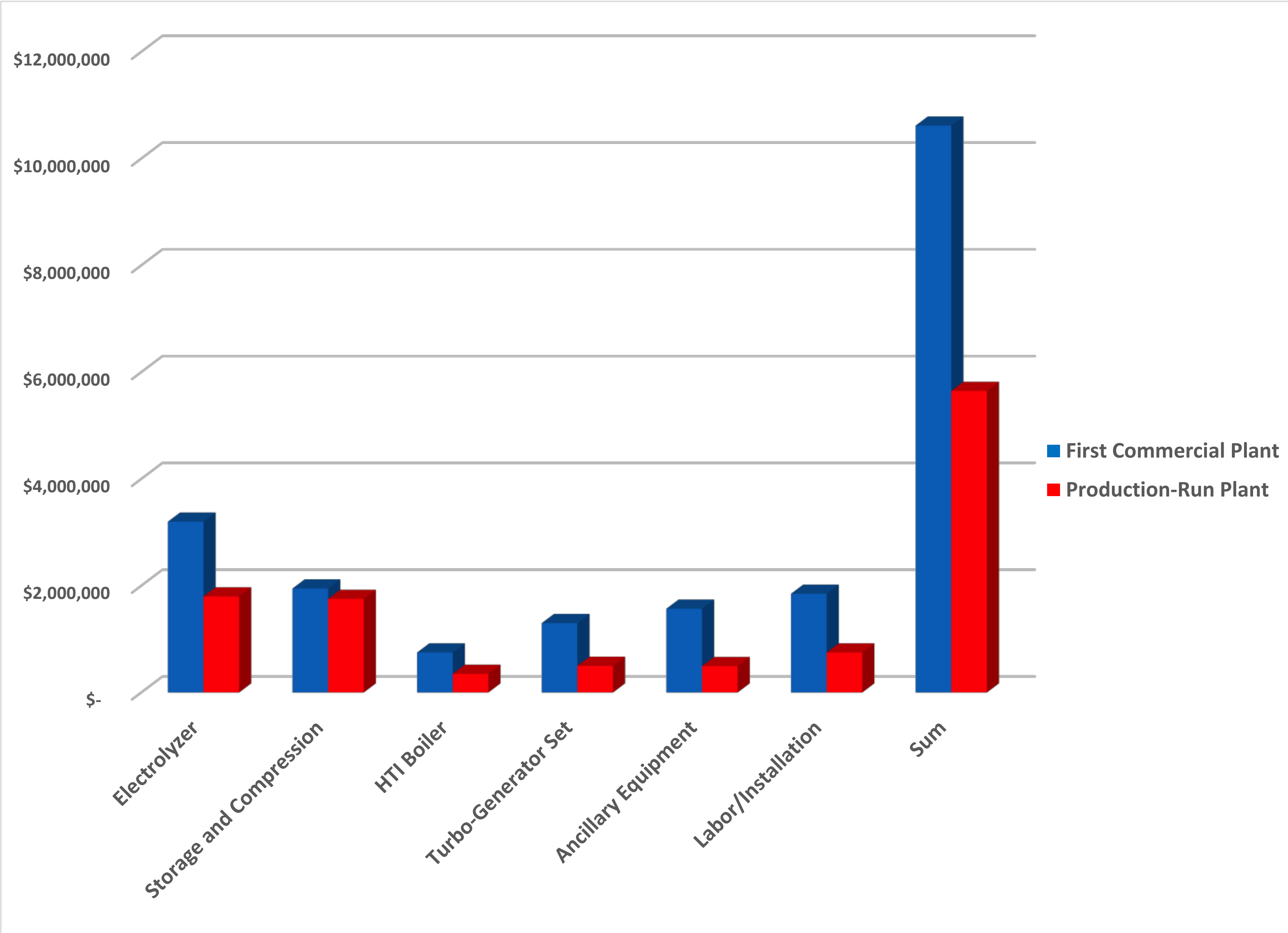
Projected Cost and Payback

The estimated capital cost for constructing the first one-megawatt commercial DCC storage and power production system capable of operating eight hours during peak demand is $10 million.

The high cost of the first DCC facility is driven by the very high initial capital cost for key components of the system. In particular, today's electrolyzers are virtually handcrafted. A cost reduction of 50-75% is expected for these devices as their manufacturing takes on assembly-line characteristics.

Costs for gas compression and storage, as well as the DCC itself, will reduce as these components benefit from improved efficiencies in manufacturing. Labor and assembly costs will likewise reduce as more construction site experience is gained through time.

Over the next ten years, the cost of a DCC energy storage system is expected to be as low as $5.5 million/megawatt as the economics of "production run" manufacturing are realized. At this cost, a 10% return on investment can be realized over the life of the facility.



$12,000,000
$10,000,000
$8,000,000
$6,000,000
$4,000,000
$2,000,000
$-
Electrolyzer
Storage and Compression
HTI Boiler
Turbo-Generator Set
Ancillary Equipment
Labor/Installation
Sum
First Commercial Plant
Production-Run Plant