

Utilizing By-Product Hydrogen and Fuel Cells for Distributed Power Generation - a California Example

Fuel cell distributed power generation systems are the smart choice for chemical production plant operators looking to capture the maximum economic and environmental benefits from their by-product hydrogen stream.

SITUATION

The chemical industry produces significant quantities of by-product hydrogen. Production of chlorine, sodium chlorate and ethylene/styrene are the largest sources. Currently, chemical manufacturers put this by-product hydrogen to a variety of uses, including:

- Combustion in a combined heat and power plant,
- Sell as chemical feed stock,
- Purification for sale to hydrogen distributors, or
- Venting to the atmosphere

When venting or burning hydrogen, chemical manufacturers are failing to capture the full potential value of this gas. With electricity representing approximately 70% of the production cost of chlorine, taking a waste product and turning it into clean energy on site is a very attractive proposition.

SOLUTION

With a fuel cell system, the by-product hydrogen can be used to produce clean, zero-emission electricity that is either sold back to the grid, through the electricity utility, or used to offset power demand on site. Power production through fuel cells is the highest efficiency, most environmentally responsible way to utilize the hydrogen. The customer benefits of this use of the excess hydrogen are both strategic and operational:

Strategic Benefits

• Incremental revenue and profit

The hydrogen will be used as a low-cost, high-value input to electricity production, rather than being vented into the atmosphere or burned. By taking advantage of existing government-sponsored feed-in tariff programs, chemical producers will gain an additional revenue stream, adding value to their bottom line.

• Supports corporate environmental objectives

Producing electricity from hydrogen is a clean, high-efficiency, electro-chemical process, with no combustion or emissions, contributing to a company's corporate sustainability and carbon reduction initiatives.

Operational Benefits

• Produce substantial amount of clean, reliable power

Excess hydrogen becomes a source of zero-emission electricity, effectively improving the efficiency of the plant.

• Scalable solution matches hydrogen availability

Ballard's modular fuel cell product has been designed in one-megawatt 500 kW PowerBanks, resulting in a system that can be customized to meet individual site requirements.

• Turn key solution simplifies deployment & siting

Ballard's system is a complete power generator, ready for siting and integration at the plant with minimal interfaces.

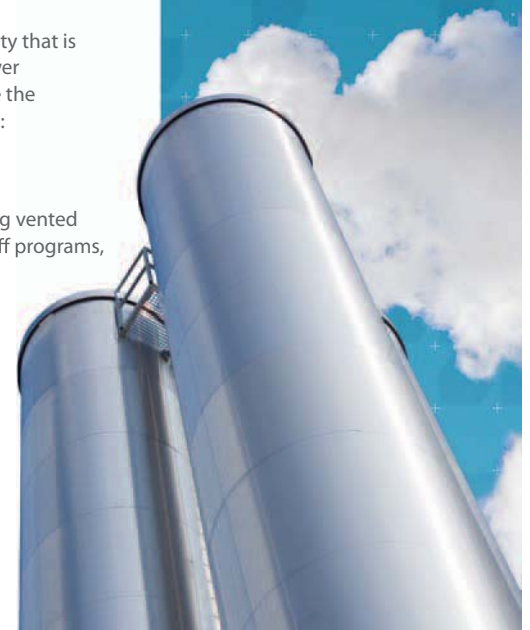


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Examples of regions with Feed-in Tariff Programs:

- Germany
- France
- Spain
- Italy
- California
- Korea

Economics are also compelling in regions with high industrial electricity rates.



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RETURN ON INVESTMENT MODEL - CALIFORNIA SCENARIO

This scenario demonstrates the internal rate of return possible over fifteen years with the installation of a fuel cell-powered distributed generation system in California. A one-megawatt system utilizing hydrogen from a non-renewable source will qualify for a California self-generation incentive program (SGIP) of \$2,250 per kilowatt. In addition, federal incentives of up to 30% of capital expenditures are also available. These incentives, coupled with the high base electricity rate of \$0.12/kWh and a hydrogen opportunity cost of \$0.60/kg (natural gas equivalent LHV price), drive an internal rate of return of approximately 20%.

ASSUMPTIONS:

Power output	1 MW
Hydrogen source	By-product hydrogen (non-renewable source)
California's Self-Generation Incentive Program (SGIP)*	\$2,250/kWh for the first MW (\$4,250/kWh if biogas)
Federal stimulus	30% of capital expenditures, less SGIP grant
Kilowatt hours generated	8,320 kWh hours per year, per MW installed
Amount of H ₂ consumed	63kg/hour
Up-time	>95%

* California's SGIP requires that power be used on-site, not sold to the grid.

KEY ENABLERS

Market analysis has shown that installation sites providing the most significant revenue opportunity have certain features in common:

1. Availability of By-Product Hydrogen

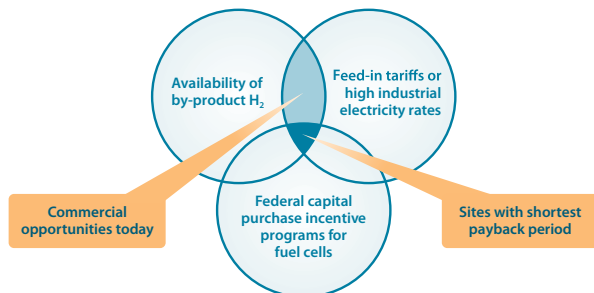
According to industry estimates, up to 15% of the by-product hydrogen produced by chemical plants is vented into the atmosphere or burned. This fuel is a potential low-cost power source and revenue stream for chemical producers.

2. Presence of feed-in tariff programs or high industrial electricity rates

Feed-in tariff programs encourage utilities to purchase electricity produced from new and renewable energy sources at a premium price, providing an additional revenue stream for chemical producers. And with electricity representing a very high proportion of the production cost of certain chemicals, such as chlorine, high industrial electricity rates charged by utilities can have negative impact on a producer's profit margin, making independent power sources an attractive alternative.

3. Federal capital purchase incentive programs for fuel cells

Globally, governments are supporting the acceleration of fuel cell product adoption in the marketplace with important fiscal incentives, including investment tax credits and financial grants. Although not required to provide a compelling business case, these programs help to accelerate the payback time.



▶ BALLARD'S FUEL CELL PRODUCTS



Ballard's CLEARgen™ hydrogen fuel cell system is a complete solution, generating clean, reliable energy. The system may operate continuously for baseload power generation, or intermittently, providing peak power during times of high demand. Modular 500 kW PowerBanks can be combined to produce multiple megawatts of electricity, right at the point of demand, with waste heat captured for district heating. Suitable for locations with a demand for clean energy and a source of hydrogen, customers range from chemical producers and remote communities, to utilities with a renewable power mandate.

▶ ABOUT BALLARD



Ballard Power Systems, Inc. is recognized as a world leader in the design, development, manufacture and sale of clean energy fuel cell products. Our **FCgen** family of stationary power products and **FCvelocity** family of motive power products offer important business benefits not available from traditional power sources.

Learn how to put fuel cells to work, contact us:

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