

Utilizing By-Product Hydrogen and Fuel Cells for Distributed Power Generation - a German 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 building blocks, 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.

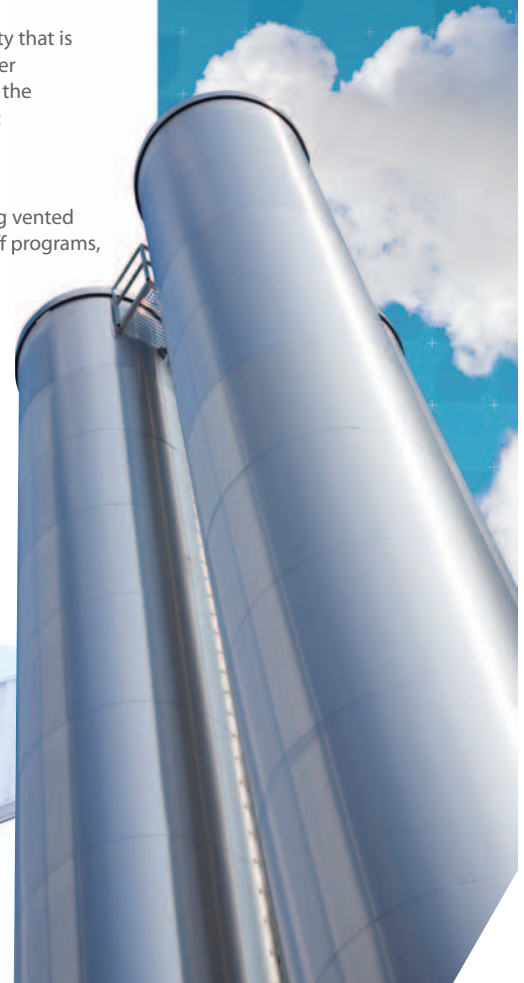


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Examples of regions with Feed-in Tariff Programs:

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

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



RETURN ON INVESTMENT MODEL - GERMAN SCENARIO

This scenario demonstrates the internal rate of return possible over fifteen years with the installation of a fuel cell-powered distributed power generation system. A 7MW system installed in Germany will qualify for a feed-in tariff rate of approximately \$165/MWhr USD, resulting in yearly gross revenue from power sales of over 9.5 million. This translates to an IRR of > 20%, assuming the hydrogen has an opportunity cost of \$0.50/kg.

ASSUMPTIONS:		RESULTS:	
Power output:	7 MW	Yearly gross revenue from power sales:	~ \$9.5 million USD
Hydrogen source:	By-product hydrogen, no purification required	15 year IRR:	> 20% – with hydrogen opportunity cost of \$0.50 USD/kg
Feed-in tariff rate:	\$165/MWhr USD		
Plant capital upgrades:	\$2million USD (Heat transfer system, transformer, concrete pad)		

*FIT rate as per Germany Trade & Investment GmbH

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

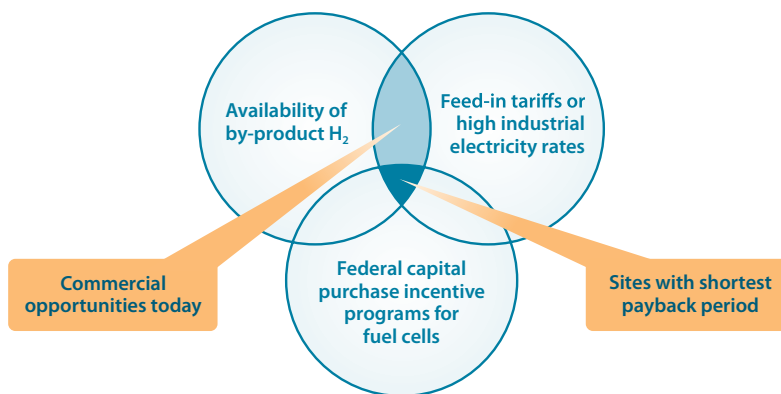
According to industry estimates, up to 15% of the by-product hydrogen produced by chemical plants is vented into the atmosphere or burned. This fuel is a potential low-cost power source and revenue stream for chemical producers.

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.



Specifications and descriptions in this document were in effect at the time of publication. Ballard Power Systems, Inc. reserves the right to change specifications, product appearance or to discontinue products at any time (03/2010).

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BALLARD'S FUEL CELL PRODUCTS



Ballard's 1MW fuel cell product is a turnkey solution, designed to provide a supply of continuous (>95%) zero-emission power. Suitable for siting at chemical production plants, the self-contained power modules utilize by-product hydrogen as a source of clean, reliable, zero-emission power. The modular units are available in one-megawatt building blocks, which can be combined to produce electricity, as determined by the plant's power requirements and hydrogen availability.

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.

To learn how our products deliver the Power to Change business results, contact us at marketing@ballard.com or call (+1) 604.454.0900.

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