



Commercial Hydrogen Products

The 5th Annual Hydrogen
Implementation Conference

Robert Friedland
President and CEO

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www.protonenergy.com

Proton Energy Systems

- **Manufacturer of Proton Exchange Membrane (PEM) hydrogen generation products using electrolysis**
- **Founded in 1996**
- **Located in Wallingford, Connecticut.**
- **ISO 9001:2000 registered**
- **Over 1,200 systems operating in 56 different countries.**
- **Current Employees - 70**



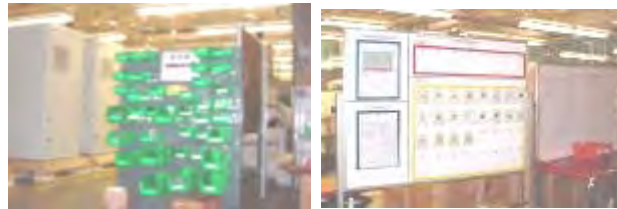
Proton Capabilities

- Electrolysis System & Cell Stack Development
- Product Manufacturing & Testing
- World-Wide Sales & Service

CELL STACK MANUFACTURING



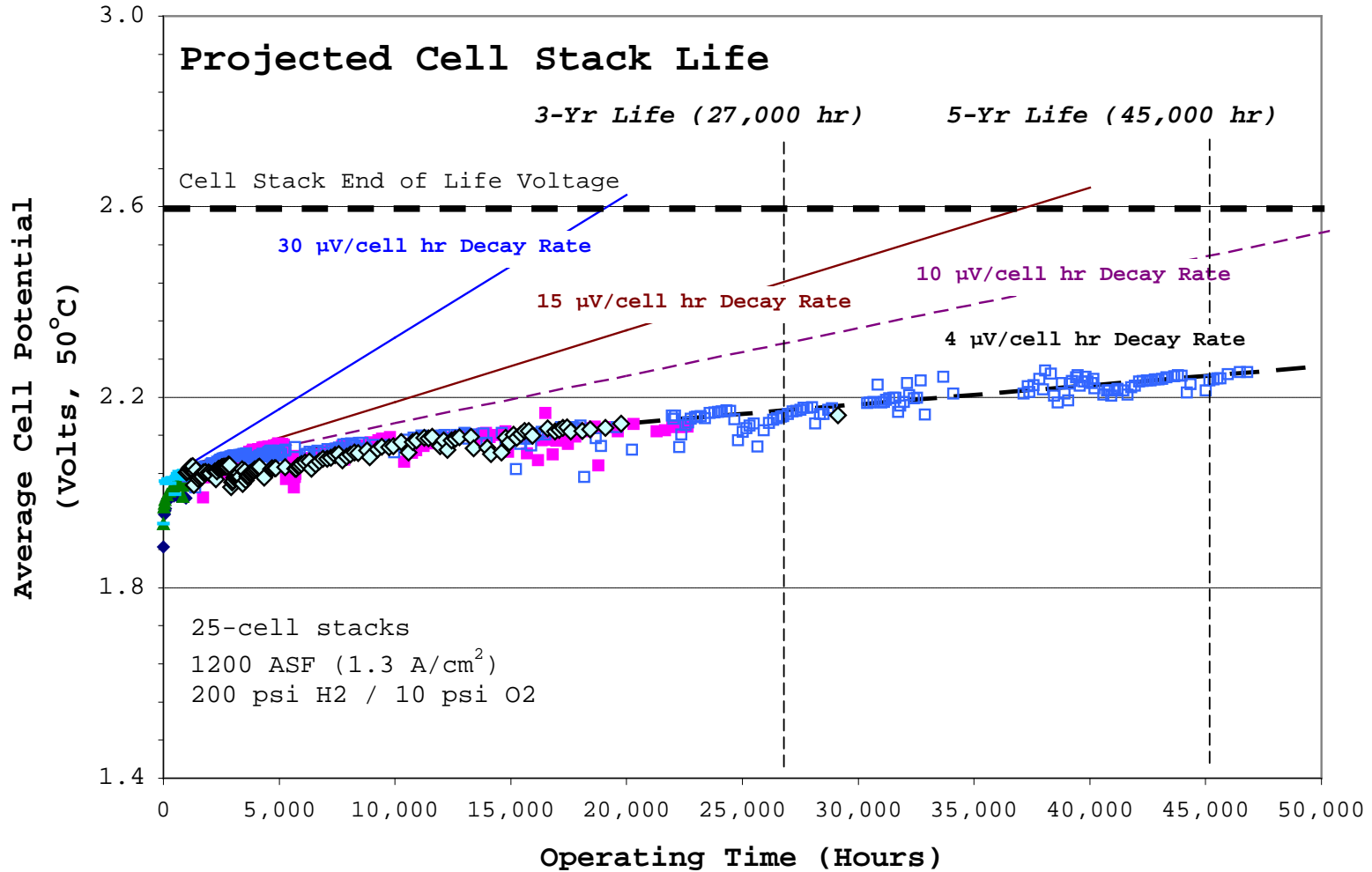
SYSTEMS MANUFACTURING



CELL STACK R&D



Cell Stack Reliability



Cell Stack Reliability Testing

- Combination of In-House Testing and Field Fleet Information Utilized to Track Cell Stack Reliability
- Extensive In-House Testing Of Design Changes Ahead of Field Introduction
- More Than 300,000 hr of In-System Testing Completed Over Last 4 Years
- Multiple stacks with >30,000 hr. of Demonstrated Continuous Operation



Hydrogen Products

Commercial Products

HOGEN™ Hydrogen Generators



GC



S-Series



H-Series

Hydrogen Control Systems



StableFlow™

Future Products



Fueling






Backup Power



Renewable Energy Storage

Commercial Product Details

	HOGEN® GC Series	HOGEN® S-Series	HOGEN® H-Series
			
Year Introduced	1999	2000	2004
Applications	Laboratories	Industrial Gas Generation Meteorological Industries Fuelling Industries	Power Plants Heat Treating PCB Industries
Generator Rate	300 or 600 cc/min	0.5 to 1.0 Nm ³ /hr H ₂ 1-2 kg/day	2-6 Nm ³ /hr H ₂ ; 4-12 kg H ₂ /day
Hydrogen Pressure	Pressure to 13 bar	15 bar	15 & 30 bar
Ultra-High Pressure Hydrogen Purity	99.9999+%	99.9995+%	99.9995+%
Dimensions	23 x 37x 52 cm	97 x 79 x 106 cm	200 x 80 x 200 cm
Weight	23 kg	215 kg	700-800 kg

Commercial Hydrogen: Power Plants



StableFlow™

- StableFlow Hydrogen Control System
 - Monitors power generator hydrogen:
 - Purity
 - Pressure
 - Dew Point
 - Optimizes to OEM specifications
 - One StableFlow system required per power generator

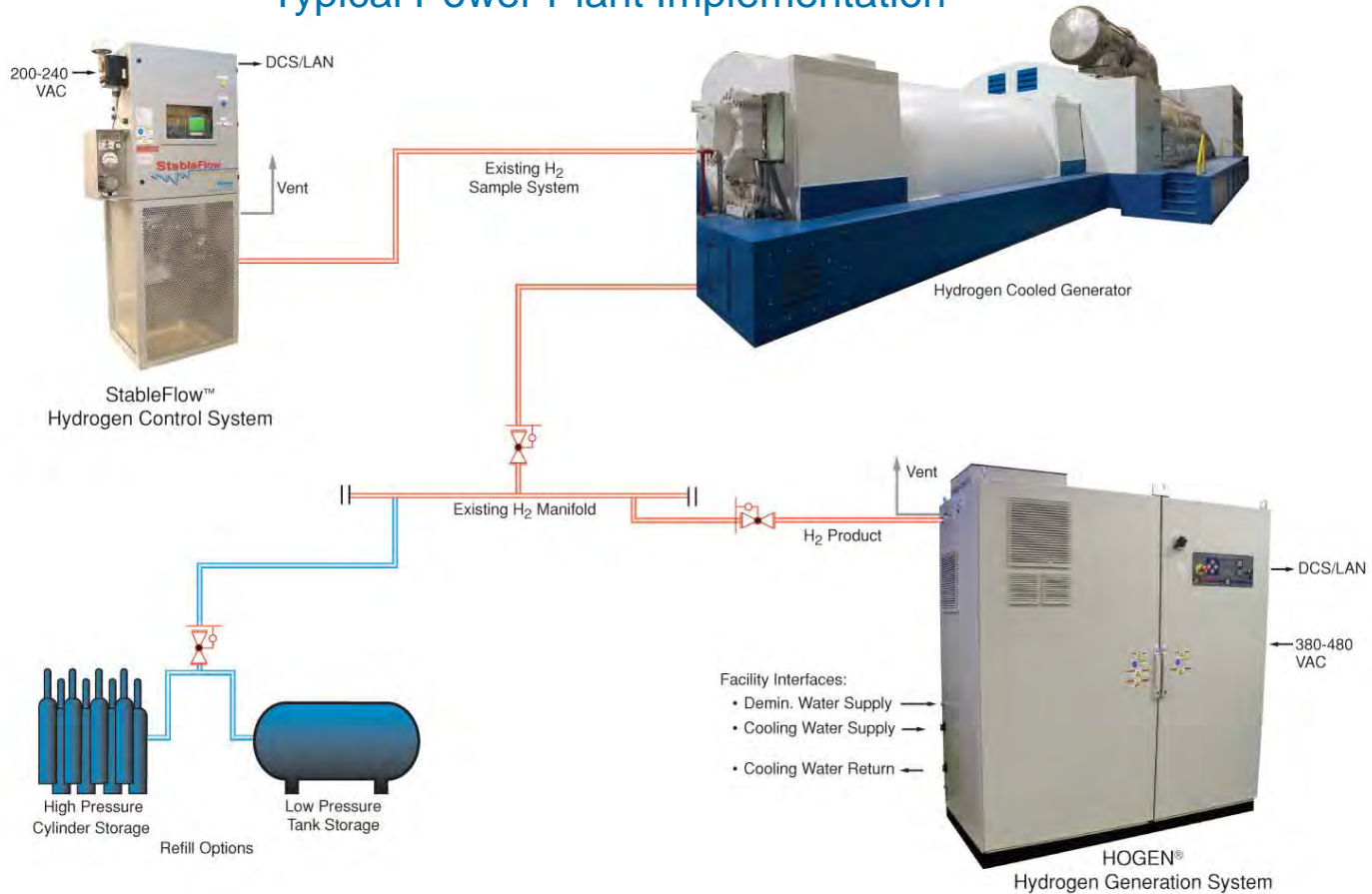
Power Plant Market

- Electric Power Generator Cooling
- Addressable market is estimated at over \$2.0 billion
- Value proposition
 - Improved plant efficiency
 - Increased plant output
 - Reduced greenhouse gas emissions
 - Payback typically less than one year
- Over 16,000 hydrogen-cooled generators world-wide
 - 25% North America, 75% ROW



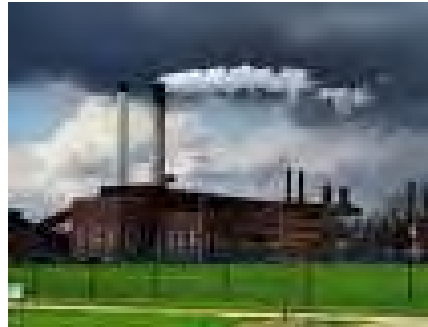
Commercial Hydrogen Application: Power Plants

Typical Power Plant Implementation



Efficiency and CO₂

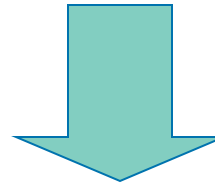
The average fossil fuel burning power plant in the US is operating at an average hydrogen purity of 95%.



Number of hydrogen cooled generators in the US	
Coal	1045
Oil	2621
Natural Gas	3829
	7495

250 kW of energy is lost for every 1% drop in hydrogen purity below 99%.

That's an average of 1 MW or roughly 8000 MW/hrs annually per generator!



As presented in "Power Engineering November, 2004"

250 kW x 4% = 1 MW

1 MW = 1 ton of CO₂

8000 tons/yr/generator

44 Million tons of CO₂ generated annually in US due to poor efficiency

The Value Proposition is Broad



StableFlow costs \$80,000 per power generator and delivers:

- An average 1 MW/hr improvement in efficiency
- An average 1 ton of CO₂ reduction per hour

\$1,000 per installed MW of annual savings is achievable for the average power plant – *without CO₂ cost benefit!*

Utility Benefits:

- Fuel savings
 - \$2-10 per MBTU
- Additional MW/hrs
 - \$40-100 per MW/hr
- CO₂ credits
 - \$5-10 per ton of CO₂

Environment Benefits:

- Pollution reduction
 - 1 ton of CO₂ for every MW/hr improvement

Fuel Savings: Efficiency Gain x Heat Rate x Fuel Cost

Emerging Market: Hydrogen Fueling



Proton Installations:



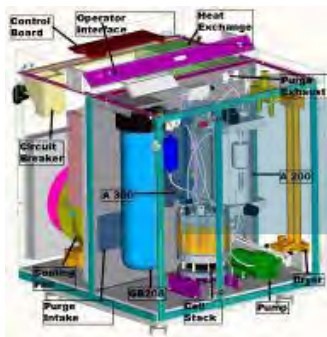
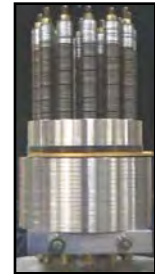
Existing



Planned

Current High Pressure H₂ Generator

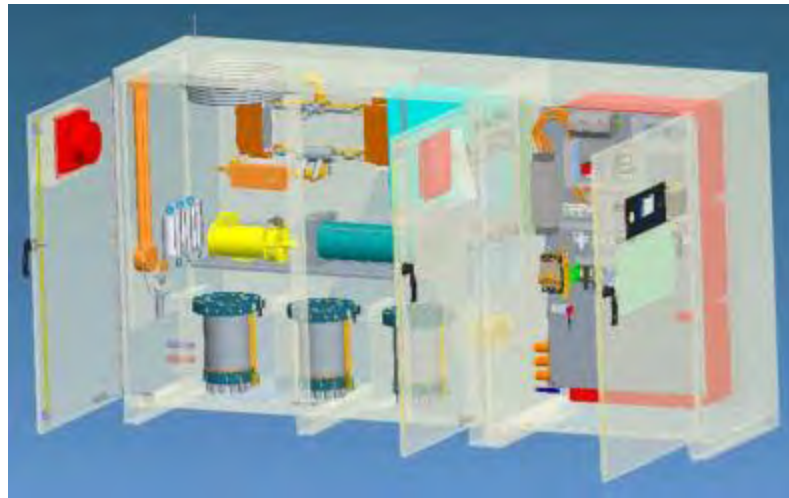
- 2,400 psi (165 bar) differential pressure
- 0.6-2.2 kg H₂/day for Backup Power market
- Field demonstrations underway
- Over 17,000 hr of continuous operation
- Stack & system durability demonstrated



HOKEN C Series

Max Capacity: 1140 scf/hr H₂ (65 kg/day)

- Objective: New product for high hydrogen demand applications.
- Development cycle: 12 months to working prototype (11/09).
- Commercial availability: Q3 2010.
- 5 times the hydrogen output of the H-Series, **only 1.5x the foot print.**
- Uses modified NexGenHDP cell stacks.



Summary

- Leverage today's commercial markets and products to maintain a stable, profitable company.
 - Continued deficit spending in this industry is not sustainable.
- Use selective investments, timed with market maturation, to create new products and technologies.
- Rigorously create, improve and enhance organizational excellence and customer service at all levels of the company.



Thank you!

Questions?