# Hydrogen Recycling System Evaluation and Data Collection

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***TV018***

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# Overview

**Limited Liability Corporation with headquarters in Latham, NY**

- **Founded in October of 2005**
- **Hydrogen reclamation and recycling solutions**
- **Recipient of R&D awards from the US Department of Energy, US Department of Defense and New York State Energy Research and Development Authority**
- **InterTech Group is a strategic partner and investor**
- **18 employees**

# Commercial Hydrogen Market

**Industrial Processes Using Hydrogen:**

- **Metals processing (steel, annealing, sintering, brazing)**
- **Semi-conductor & LED processing**
- **Ceramics processing**
- **Chemical by-product H2**
- **Float glass manufacturing**

**LED Fabs**

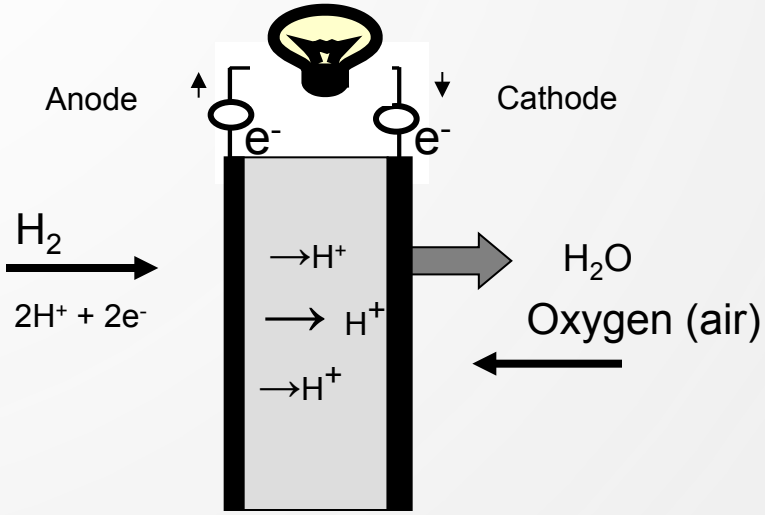
**Reduction Furnace**

# The Opportunity

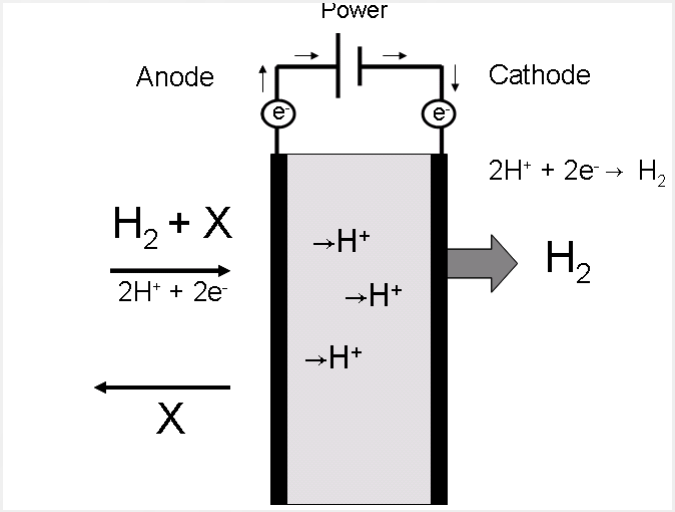
Industrial operations flare or vent hydrogen rich furnace exhaust gas into the atmosphere today

# H2Pump Core Technology

Utilizing modified fuel cell technology for hydrogen recovery and recycling



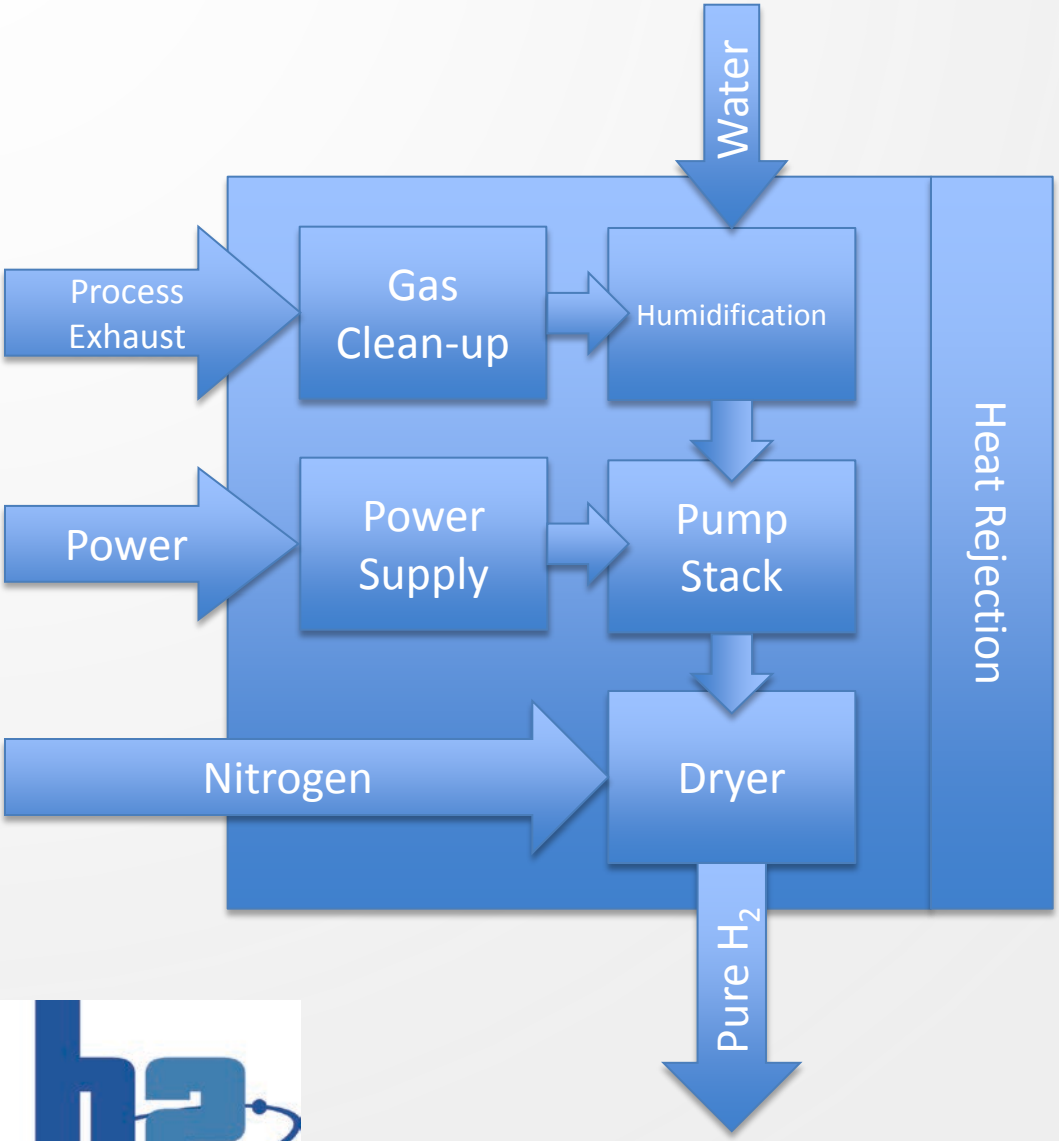

*Fuel Cell*
*Chemical energy converted directly to electricity*




*Hydrogen Recycling*
*Electricity utilized to drive separation process*

- Purify, pressurize and "pump" in a single step
- Reliable non-mechanical process
- Ambient pressure exhaust gas operation
- Up to 90% recovery of hydrogen
- Leverages existing fuel cell supply base
- Eliminates Oxygen associated failures modes

# HRS-100™


Water
Process Exhaust
Gas Clean-up
Humidification
Power
Power Supply
Pump Stack
Nitrogen
Dryer
Heat Rejection
Pure $H_2$

# Overview

## Timeline

- Project start date: 1/2/13
- Project end date: 6/30/14*
- Percent complete: 15%

* Project continuation and direction determined annually by DOE

## Budget

- Total project funding $1.06M
  - DOE share: $499K
  - Contractor share: $567K
- Funding for FY13: $966K
  - DOE share: $453K
  - Contractor share: $514K

## Barriers

- TV 3.6D. Lack of Hydrogen Refueling Infrastructure Performance and Availability Data
  - Efficiency: 10 kWhr/kg
  - Availability: 80%
- TV 3.6G. Hydrogen from Renewable Resources

## Partners

- NYSERDA & NREL
- Site Hosts:
  - Ulbrich Stainless Steel
  - Pall Corporation
  - Rome Strip Steel
  - SUNY, Albany- College of Nanoscale Sciences and Engineering (CNSE)

# Relevance

***Objective:***

- To ***demonstrate*** the product readiness and quantify the ***benefits*** of H2Pump's Hydrogen Recycling System (HRS-100™) by ***installing and analyzing*** the operation of eight pre-commercial 100 kg per day systems in real world customer locations.
- H2Pump will ***install, track and report*** multiple field demonstration systems in industrial heat treating, LED Fabs and semi-conductor applications.
- The demonstrations will be used to ***develop case studies*** and showcase the benefits of the technology to drive market adoption.

# Relevance

| DoE Barrier | Metric | Target 2013- 2014 |
|---|---|---|
| D. Lack of Performance and Availability Data | System Efficiency<br>• Recycling rate (kg/day)<br>• Electrical consumption (kWhr/kg) | <br>> 80<br>< 10 |
| | Availability % | > 80% |
| | Annual run time (24/7) - hours | > 7,000 |
| | Mean time between failure - hours | > 1,200 |
| G. Hydrogen from Renewable Resources | Stack life time - hours | > 14,000 |
| | Annual service cost | $15,000 |
| | Annual projected savings | $40,000 |

# Plan & Approach

| | | % Complete |
|---|---|---|
| Phase 1 | Task 1.0: Data Collection and Reporting Tool | 30% |
| | Task 2.0: System #1 at Ulbrich | 90% |
| | Task 3.0: System #2 at Ulbrich | |
| | Task 4.0: System #3 at Pall Corporation | 100% |
| | Task 5.0: System #4 & #5 at Rome Strip Steel | 100% |
| | Go/ No Go Decision | |
| Phase 2 | Task 6.0: System #6 at TBD | |
| | Task 7.0: System #7 at CNSE- MOCVD | |
| | Task 8.0: System #8 at CNSE- EUV | |
| | Task 9.0: Program Management | |
| | Task 10.0: Extended Runtime | |

# Plan & Approach

**Site Requirements & Plan**

- Site Visits- Site Requirements
- Gas Sampling, Single Cell Testing
- Installation Document - P&ID

**System Build & Test Site Prep**

- Build by Contract Manufacturer
- Debug, Leak Check, Test and Qualification at H2Pump
- Site Electrical, Internet, Nitrogen, Water and Exhaust

**Installation & Commissioning**

- Ship system
- Locate and Hook-up
- Training and continuous operation

**Data Collection & Monitoring**

- 12- 18 months
- NREL detailed analysis
- Identification of improvements

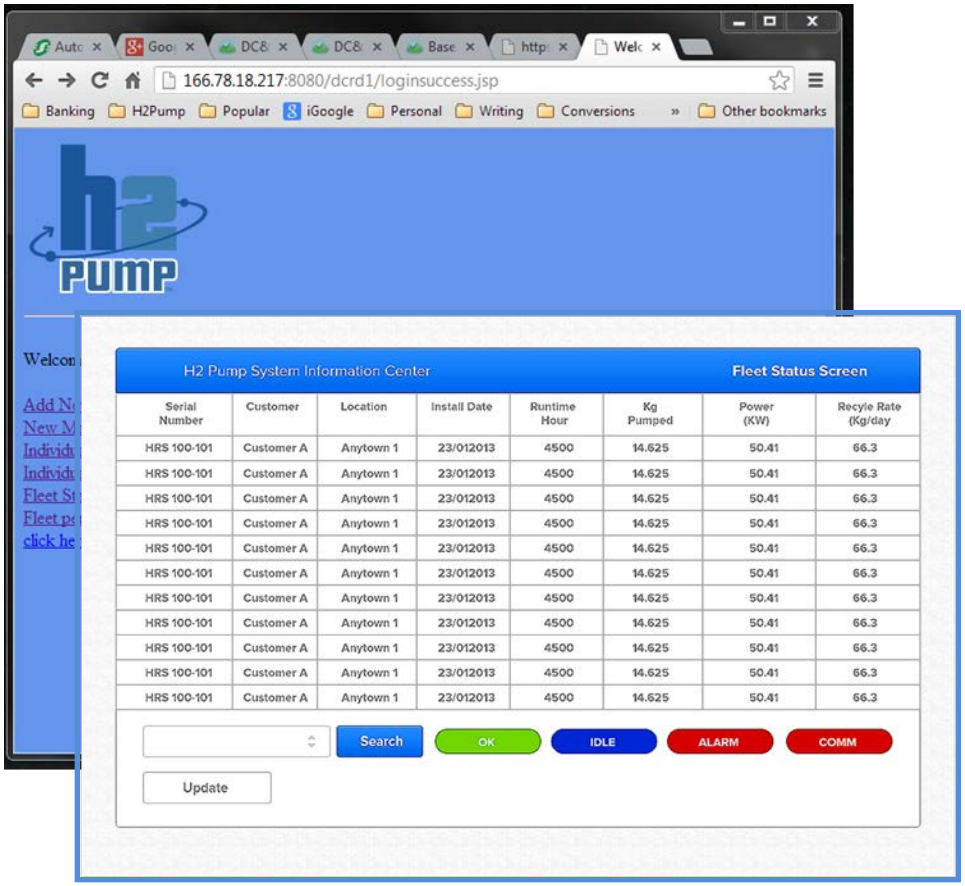
**Operation, Maintenance**

- Service calls
- Service cost
- MTBF

# Accomplishments and Progress

Task 1.0: Create Data Collection, Monitoring and Reporting Tool and Database

- ✓ Create a Requirements Document
  - Fleet Status
  - Customer Screen
  - Database
  - Administration
- ✓ Select a supplier
- • Access to NREL
  - Stack degradation
  - Efficiency improvements
  - Sensor elimination
  - Optimization



# Accomplishments and Progress

## Site: Ulbrich Specialty Strip Mill- Wallingford, CT

### Task 2.0 Ulbrich (System #1)

- Many types of SS foil
- Multiple continuous furnaces
- Varying Oil and CO

✓ Site Requirements and Plan
✓ System Build, Test, Site Prep
✓ Installation and Commissioning

### Task 3.0 Ulbrich (System #2)

✓ Site Requirements and Plan
✓ System Build, Test
• Installation delayed pending #1

# Accomplishments and Progress

## Site: Pall Corporation- Cortland, NY

**Task 4.0 Pall (System #3)**

- Annealing of SS filters
- Two bell furnaces
- Cyclic operation

✓ Site Requirements and Plan
✓ System Build, Test, Site Prep
✓ Installation and Commissioning

h2 PUMP™

# Accomplishments and Progress

## Site: Rome Strip Steel- Rome, NY

### Task 5.0 Rome (System #4 & #5)

- Integrate 16 bell furnaces
- Varying  operation
- High Oil content
- High CO content
- Dual HRS-100™ units

✓ Site Requirements and Plan
✓ System Build, Test, Site Prep
✓ Installation and Commissioning

# Proposed Future Work

**April 2013- Go/ No Go Decision Meeting, Database On-line**

**April 2013- Complete Site Plan and Install- CNSE- MOCVD**

**May 2013- Complete Site Plan and Install at CNSE- EUV**

**June 2013- Complete Site Plan and Install at Site TBD**

**Quarterly data reviews with NREL**

# Collaborations

**NREL- Data Analysis**

**NYSERDA- NYS Demo Cost share**

**NYS Engineering Firms- Hesnor Engineering, Zeller Corporation, O'Brien and Gere and Edwards Vacuum**

**Site Hosts (Industry)- Ulbrich, Pall, Rome Strip Steel, CNSE**

# Summary

**Four of eight installs completed in 1Q13**

**Database and reporting tool complete by April 2013**

**Remaining installs complete in 2Q13**

**Operation and maintenance thru 2013 and 2014**