

# ***2011 DOE Hydrogen and Fuel Cells Program Review Presentation***

## ***Landfill Gas – to – Hydrogen***

***Proving the Technology; Making the Business Case***

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**Project ID: MT007**

**This presentation does not contain any proprietary, confidential, or otherwise restricted information**

## ❑ Timeline Data:

- **Start Date:** April 2011
- **End Date:** July 2011
- **Percent Complete:** 5%

## ❑ Budget Data:

- **Total Project Cost:**
  - DoE: \$575,000 Market Transformation
  - State / Local / Private Sources: \$800,000

## ❑ Barriers:

- Technical and cost issues preventing wider commercialization of hydrogen and fuel cell technologies into known early markets

## ❑ Partners

- South Carolina Hydrogen and Fuel Cell Alliance
- ATI
- Gas Technology Institute
- Ameresco, Inc.
- Private Foundation(s)

## □ Vision, Scope and Timeline

- Genesis of the Idea
- Sponsors and Sources of Funding (and sponsor expectations)
- Two-pronged Mission
  - Validate there is a viable business case for scaling up the solution
  - Validate the end-to-end technology solution will work
- Project Team Members and Anticipated Roles
- Project “Deliverables”

## □ Project Concept and Initial Work Plan

- **Phase 1:** Validate the business case (such that if the technology works, we know the business case exists to move forward immediately)
- **Phase 2:** Validate the LFG-to-Hydrogen conversion process is stable under actual BMW operating environment
- **Phase 3:** Validate the hydrogen produced from LFG yields commensurate fuel cell performance and durability compared with hydrogen produced from “traditional” sources and delivered in bulk to the host site

## □ Post-project Aspirations / Expectations

- ❑ **Dec 2008:** BMW approaches SCRA with potential fuel cell MHE initiative and requests assistance in helping identify sources to support internal “due diligence” on feasibility and business case.
  - Includes short term and long term fueling infrastructure examination
- ❑ **Spring 2009:** DoE Hydrogen and Fuel Cell Technology Program focus expands to include producing “green hydrogen”
- ❑ **Fall 2009:** BMW concludes fuel cell MHE business case is viable
  - Sep 09: Industrial Gas and SMR OEM team approaches SCRA with LFG-to-Hydrogen project concept that could be executed at BMW
  - Oct 09: SCRA meets with DoE to suggest this concept as a more cost effective path for DoE to meet fuel cell market deployment goals for MHE
- ❑ **Apr 2010:** DoE expresses interest in co-funding the concept briefed in Oct 09
  - DoE requires competition for technology provider and 50% non-DoE cost share
  - SCRA assembles team capable of validating technology AND business case
  - Execution via modification to existing DoE – SCHFCA grant agreement

## ❑ US Department of Energy

- Hydrogen and Fuel Cell Technologies Program (\$575,000)
- Demonstrate end-to-end technical feasibility

## ❑ South Carolina Energy Office

- “Clean Green Investment Incentives” Program (\$250,000)
- Procure permanent equipment supporting renewable energy – focused expansion of facility

## ❑ Others

- SCRA
  - \$70,000 from internal sources based upon alignment with in-state mission
- Private Foundation #1
  - \$150,000 to establish tech college scholarship program (award pending)
- Private Foundation #2
  - \$120,000, under negotiation
- In-kind cost share from project partners (\$210,000)

- ❑ **Validate there is a viable business case for full scale operation at BMW should the technology prove viable**
  - Bound the cost competitiveness uncertainty versus long term delivered hydrogen solution
  - Gives BMW leadership confidence in moving forward with scale-up
    - Will be a BMW milestone decision point for proceeding with follow-on phases of the project
  - Lay the groundwork for proving the business case for future adopters
  
- ❑ **Validate the technical solution will work in the notional landfill gas – to – hydrogen environment**
  - DoE principal objective
  - None of the individual pieces are “new science” .... but no one has assembled these proven pieces into this particular “whole” ... until now

## ❑ To DoE:

- Merit Review progress updates
- Final report
- One or more journal articles (TBD)

## ❑ To South Carolina Energy Office

- Certification that SCEO funding provided was used for permanent improvement(s) connected to renewable energy

## ❑ To Private Foundation Sponsor(s)

- Inclusion in visible PA / PR activities (cited as a sponsor)

- ❑ **BMW**
  - Host site; on-site engineering and services support
  
- ❑ **ATI (SCRA's federal program management affiliate)**
  - Overall program management; financial management; subcontracts administration; compliance and reporting to sponsors
  
- ❑ **Ameresco**
  - Lead for scale-up business case analysis; on site engineering support
  
- ❑ **Gas Technology Institute**
  - Principal equipment provider for technical validation portion of the project
  
- ❑ **South Carolina Hydrogen and Fuel Cell Alliance**
  - Education and public outreach

- **Validate the scale-up business case for the specific BMW situation**
  - Ameresco lead; BMW and GTI support
  - Objective: find the win-win-win price point
    - Assess optimum balance between on-site production and delivered liquid hydrogen demand
    - Identify mix of new capital equipment (including lifecycle costs)
      - LFG clean-up
      - Steam-methane reformation
      - Integration of back-up methane source for reformers
  - Output – cost per kilogram of hydrogen guarantee on long term services contract ... ideally commensurate with or better than delivered hydrogen

- ❑ **Validate the LFG – to – Hydrogen conversion process under actual BMW LFG supply conditions**
  - Can variations in composition of incoming BMW LFG stream (methane, CO<sub>2</sub> and trace contaminants) be accommodated by conversion equipment such that peak input variations do not:
    - Cause damage to reformation equipment and
    - Result in unacceptable variations in output hydrogen purity
  - Gather at least two months of performance data
  - “Go – no go” decision for commencing Phase 3 based upon repeatability of collected data

## □ Side-by-side operational verification of fuel cell MHE performance and durability

- 3-5 fork lifts from new production facility fueled from delivered hydrogen source as “control group”
- 3-5 fork lifts from existing production facility fueled from LFG-converted hydrogen as “test group”
- Install pressurized hydrogen piping run to existing production facility (permanent install, procured with SCEO funds)
- Operate test group in similar duty cycle as control group
- Have MHE/fuel cell provider inspect fuel cells in both groups periodically; monitor maintenance records for both groups over approximately 25,000 hours of run time (nominally 6 months)

- ❑ First-of-its-kind proof of principle that landfill gas can be used as an economically viable source of producing hydrogen for various mobility applications
  - **And can be replicated elsewhere in the state and in the nation**
- ❑ Support the largest single deployment of fuel cell-powered material handling equipment anywhere to date
- ❑ Provide a unique and highly visible “follow-on” environmental success story to BMW’s widely-acclaimed landfill methane program that began in 2002
- ❑ Enhance South Carolina’s reputation as a thought leader in commercializing clean energy technologies involving hydrogen and fuel cells
- ❑ Create a demand signal for new “green collar” job skill sets to service the fuel cell equipment
- ❑ Provide a case study for widespread public outreach and education that focuses on a “win-win” combination of energy efficiency and environmental stewardship

## ❑ Relevance

- Addresses last remaining significant cost barrier to widespread fuel cell MHE deployment (infrastructure cost)
- “Building block” for investigating other waste-to-energy opportunities to derive hydrogen for early market applications

## ❑ Approach

- Focus on a known competitive early market (MHE in this case)
- Examine BOTH the business case AND the technical viability

## ❑ Technical Accomplishments and Progress

- Feasibility study in early stages now; more to report next year

## ❑ Technology Transfer / Collaborations

- Feasibility study to be shared widely
- Immediate scale-up decision possible at host site

## ❑ Proposed Future Research

- None at present

# Questions?

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