

MANUFACTURING SUBCOMMITTEE (MSC)

Draft Report Summary to HTAC

November 19, 2014

Charter and Formation

Investigate potential opportunities for advanced manufacturing to benefit H2 and Fuel Cell production and commercialization

| Name | Organization and background |
|------------------|---|
| Adrian Coreless | Plug Power (participant for first half, expertise in material handling fuel cells and operations) |
| Gary Flood | HTAC/CEO Relion, Inc. Backup power fuel cell company. |
| Charles Freese | HTAC/General Motors fuel cell vehicle development. |
| Robert Friedland | President and CEO, Proton Onsite. Commercial hydrogen generators. |
| Nancy Garland | Department of Energy |
| Cassidy Houchins | Department of Energy |
| Maurice Kaya | HTAC/Energy, Renewable Consulting |
| Arianna Kalian | Clear Edge Power. (participant for first half) VP operations, stationary fuel cell products |
| Hal Koyama | HTAC/CEO H2 PowerTech. Hydrogen reforming, backup power fuel cell products |
| Robert Shaw | HTAC/Energy technology, Venture Capital |
| Robert Stokes | VERSA Power Systems. Solid oxide fuel cells. |
| Levi Thompson | HTAC/energy Technology Research |
| Joe Triampo | HTAC Clear Edge Power (participant for first half) |
| Michael Ulsh | National Renewable Energy Laboratory |

Focus and Process

- Sample industry to identify the range of manufacturing technologies and processes which could be considered.
- Focus on a subset of commercial or near commercial fuel cell and hydrogen production products / technologies to determine where there might be an opportunity to applying advanced manufacturing techniques.
- Develop hypotheses on opportunities with advanced manufacturing.
- Test, validate and refine hypotheses and update status of advanced manufacturing in the industry using questionnaire.
- Target output is a report on the status of use of manufacturing techniques, identification of additional opportunities for advanced manufacturing and identification of facilitation opportunities to enable further exploration and use.

Key Activities

- Identified and researched relevant published reports
- Participated in Clean Energy Manufacturing Initiative Toledo, Ohio regional summit, 6/21/13
- Participated in Clean Energy Manufacturing Initiative Western Regional Summit, San Francisco, California, 4/17/14
- Conducted initial informal hydrogen and fuel cell industry interviews with industry participants
- Generated and, in conjunction with NREL, implemented an industry questionnaire to target specific areas of feedback

Industry Questionnaire

Range of industry represented. Total number of participants limited to 9. Questionnaire administered by Mike Ulsh of NREL to ensure confidentiality of individual responses.

| Company | Industry Segment |
|----------------|---|
| General Motors | Fuel cell vehicle automotive OEM |
| Proton Onsite | Hydrogen generator OEM |
| Hydrogenics | Stationary fuel cell OEM |
| Plug Power | Material handling fuel cell OEM |
| Alteryx | Stationary backup power fuel cell OEM |
| Ballard Power | Stationary and bus fuel cell OEM |
| Eaton | Fuel cell balance of plant component supplier |
| 3M | Fuel cell MEA supplier |
| American Trim | Fuel cell component supplier |

Questionnaire Feedback Areas

- Topic Area A: Volume and Capacity
- Topic Area B: Automation
- Topic Area C: Standardization
- Topic Area D: Quality Systems
- Topic Area E: Opportunities for Advanced Manufacturing
- Topic Area F: Status and Opportunities for Tooling
- Topic Area G: Market Concerns
- Topic Area H: Funding
- Topic Area I: Other Comments

* Letter and questionnaire provided for reference.

Executive Summary

- Significant progress has been made in commercialization of fuel cells and hydrogen generation – products accepted in industry
- Adoption is at a “tipping point” requiring further cost reductions to achieve self-sustaining growth.
- Suppliers and OEMs are reluctant to invest in areas which could achieve these cost reductions, due to uncertain demand and timing of demand.
- Initiatives in a few key areas could have significant positive impact on moving the industry into the next phase of growth.
- Recommending three areas for further work.

Recommendation 1: Targeted demand stimulation programs, including deployments in and outside the United States

- Focus on proven commercial products
- Include existing customers, but attract new ones
- Emphasis on accessing export opportunities / non-USA markets
- Participants should demonstrate integration of products into their normal purchasing and decision processes
- Participants should provide purchasing criteria feedback for next level of volume adoption

Recommendation 2: Selected key component cost reduction and standardization

- A few components could have significant impact on total product cost.
- There may be significant opportunity at this time to leverage synergy between automotive and stationary volumes and supply chains.
- Recommend deep dive, quantitative assessment of standardizing and/or consolidating specific components and materials, and the potential intersection between stationary and automotive

Recommendation 3: Greater access to additive manufacturing and other advanced manufacturing techniques

- Additive manufacturing may be valuable at this stage for lowering the cost barrier to innovating on parts and tooling which could lead to product cost reductions, even without volume increases.
- Access to additive manufacturing and other advanced manufacturing methods, seems to be limited by fragmentation and/or cost, creating a barrier to fuel cell companies to take advantage of these resources.
- Recommend focused (specific parts/components) assessment of additive manufacturing potential impact on cost for fuel cell OEMs and suppliers.
- Recommend assessment of how to better coordinate and make available advanced manufacturing tools to fuel cell and hydrogen OEMs and suppliers, e.g. network, central facility, etc.

Next Steps

- Receive input from HTAC over the next 2 weeks
- Refine and submit final report (draft included in HTAC material binder)