Commercialization Effort for 1 Watt Consumer Electronics Power pack

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MTI Micro Fuel Cells Inc.

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Project ID:
ARRAH2001

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Overview

Timeline

- Start date: July 15, 2009
- End date: November 30, 2010
- 75% complete

Barriers

- Manufacturability
- Cost
- Performance & degradation
- Market acceptance

Budget

- Total project funding: $6,003,092
  - DOE share: $2.99M
  - Contractor share: $3.01M

Partners

- Methanol Foundation
- Component suppliers
- Project lead: MTI Micro Fuel Cells

Relevance: Project Objectives

Demonstrate and field test a commercially viable one Watt Direct Methanol Fuel Cell (DMFC) charger for consumer electronic devices

- Reduce cost to attain a competitively priced product
- Design for manufacture & ease of assembly
- Demonstrate performance across range of environmental conditions
- User field test of 75 fuel cell powered chargers

Project Application

DMFC powered charger for consumer electronics

Current mobile power source:

Bring all your chargers

Find a wall outlet

Wait for battery charging

The new DMFC mobion power source:

All you need is one DMFC charger to power all your devices

+

Methanol Fuel Cartridge

And a Methanol cartridge for instant power

=

Carry with you and charge on the go

Relevance to ARRA

- Alignment with ARRA goals of saving and creating jobs:
  - Directly created/ retained 14 FTE jobs in NY state
  - The leverage DOE funds offered enabled MTI to obtain private investment.
  - DOE funds used by MTI for labor – no direct materials or capital
- Alignment with FCT ARRA project goals of accelerating the commercialization and deployment of fuel cells:
  - Fuel cell charger will be commercial ready at end of program
  - Components have been redesigned for low cost, high volume manufacturing.
  - 75 fuel cell systems to be deployed in 2010 during field test

Approach

Development followed by deployment

- Developed and submitted environmental and safety plans in 2009

- Phase I: Redesign for low cost manufacturing
  - Redesigned all components to be produced using processes capable of low cost and high volume.
  - Test stacks/engines for improved performance & degradation
  - Build and test Alpha level systems for performance and robustness

◊ *Go/No-Go PHASE GATE:* Must meet predetermined performance, cost, and manufacturing metrics.

- Phase II: Complete tooling for all components
  - Build and test Beta systems with components from hard tooling

- Phase III: Deploy 75 units in the field and execute field test
  - Build and test all units to quantify performance prior to shipping
  - Test all units when they return to quantify loss in performance
  - Analyze any field failures to determine root cause

Approach

Development detail

- Redesign components for reduced cost and high volume manufacturing:
  - Plastic components went from machined to injection molded
  - Sheet metal components went from machined to formings and stampings
  - Laser cut free-standing gaskets were replaced with profiled gaskets over-molded onto components they seal
- Subsystem performance/ life improvements
- System Integration and testing
  - Algorithm development
  - Performance & qualification testing
  - Life testing
    - Steady state
    - User profile

Approach:

Go/No-Go metrics & results

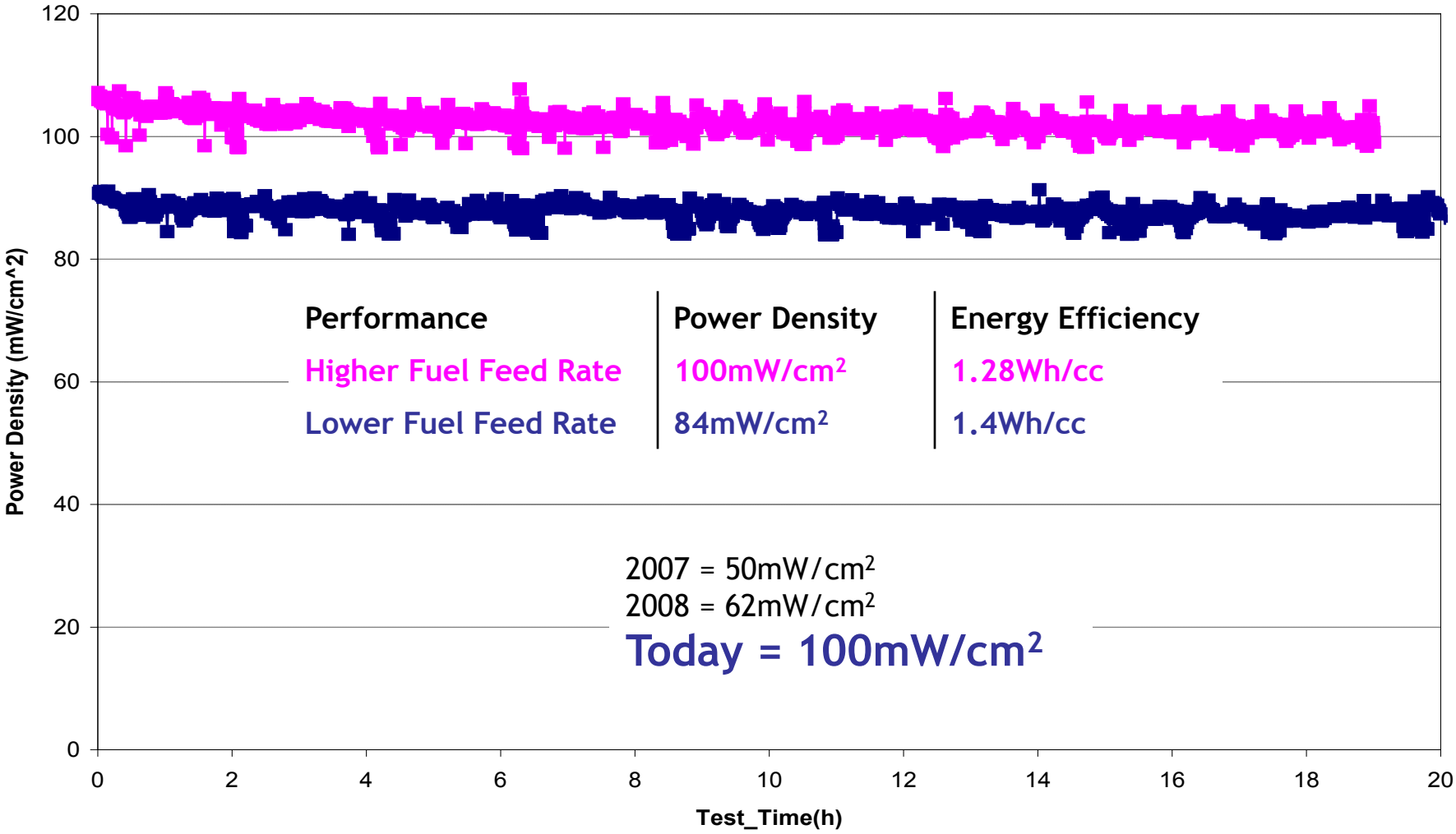
- To pass phase gate system had to achieve predetermined levels of
  - ✓ Continuous run power (Achieved 1.04W net, Target was 1W net)
  - ✓ Energy from 1st cartridge (Achieved 28.9Whr, Target was 26Whr)
  - ✓ Life time (Target of 2000 hrs)
    - Achieved over 6000hrs at 5% loss per 1000 hrs on Stack/Engine
    - Achieved over 2000 hrs of run time on complete system
  - ✓ High volume unit production cost projection ($ MSRP target achieved but confidential
  - ✓ Total labor content reduction (Achieved 74% reduction, Target was 50%)

- Demonstrate robust operation for consumer electronics application:
  - ✓ 0-40C temperature operation with 10%-90% relative humidity
  - ✓ 0-8K Feet altitude operation
  - ✓ Orientation Independence

Achieved metrics and passed Phase gate on-schedule (November 2009)

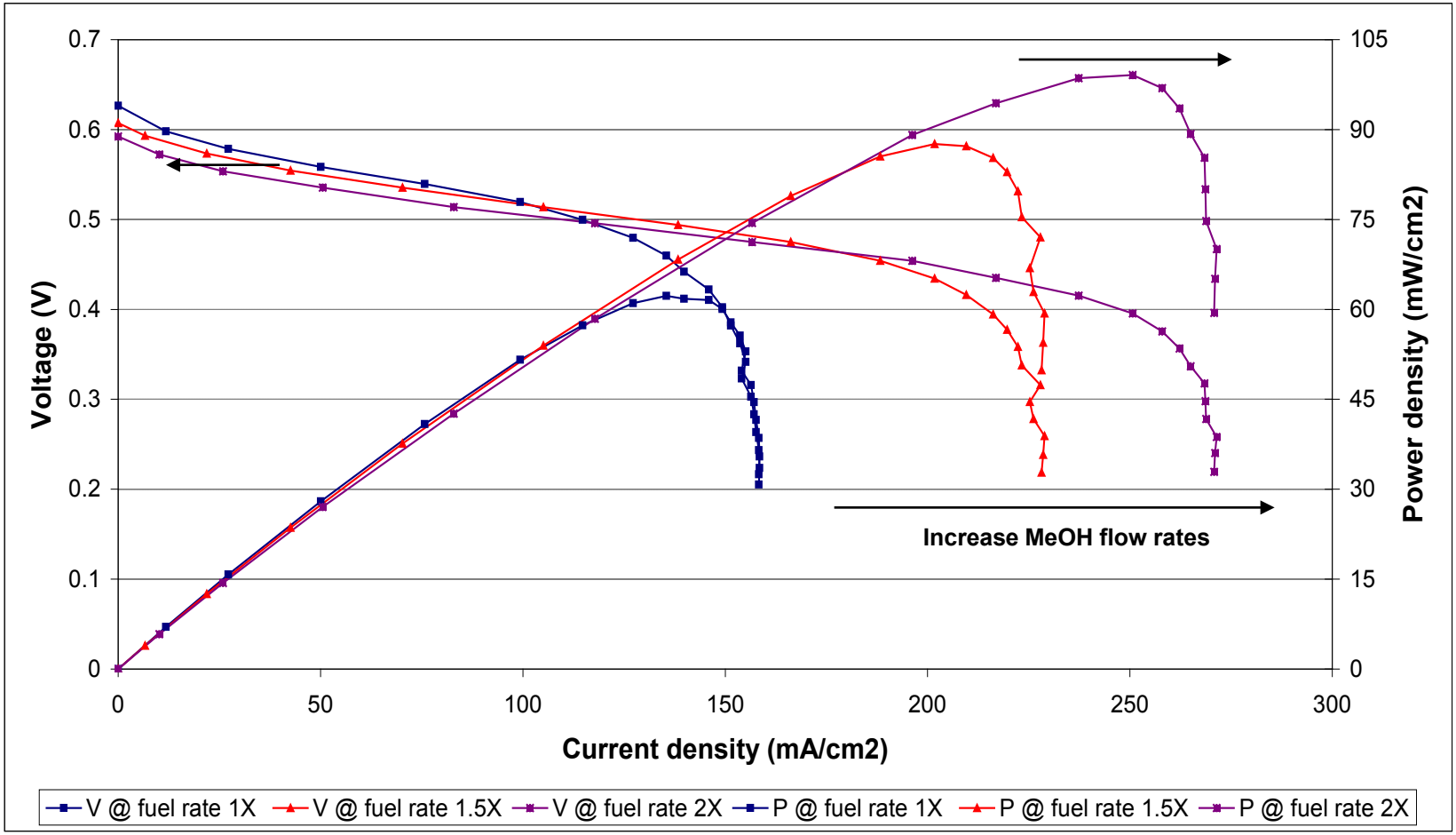
Technical Accomplishments:

Achieving high stack/ engine performance



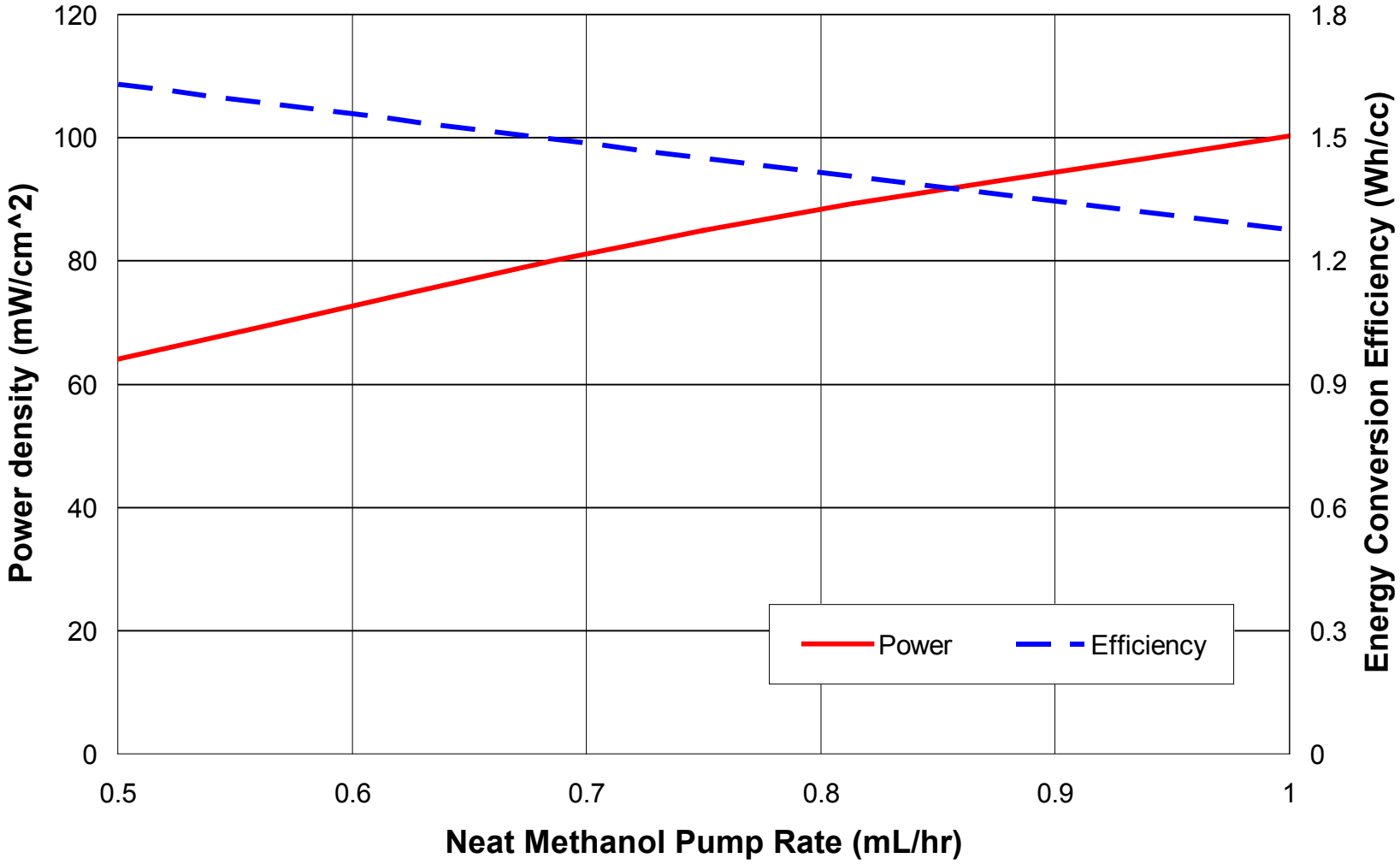
Technical Accomplishments:

Variable fuel flow to adjust power level



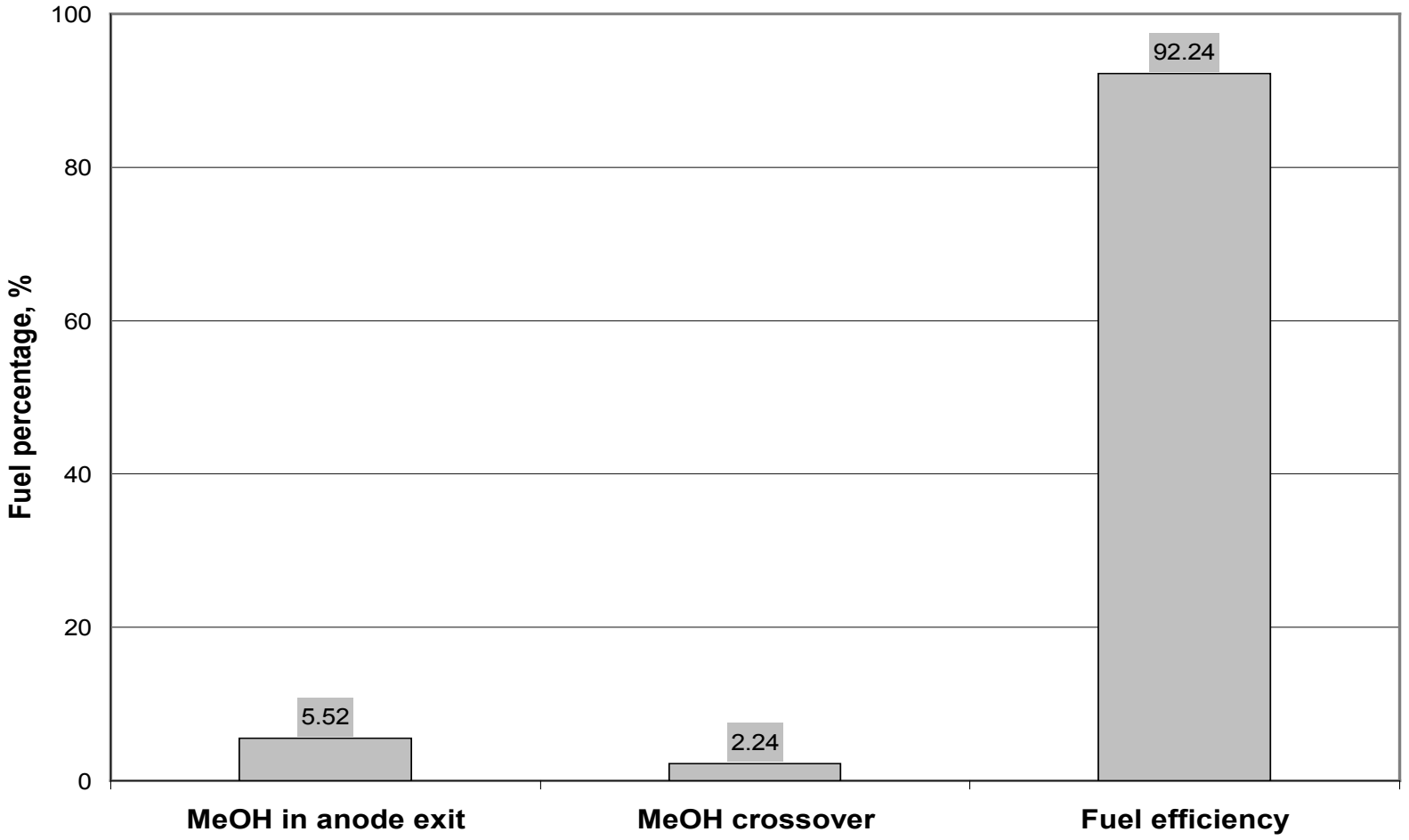
Technical Accomplishments:

High power density & efficiency of stack/engine



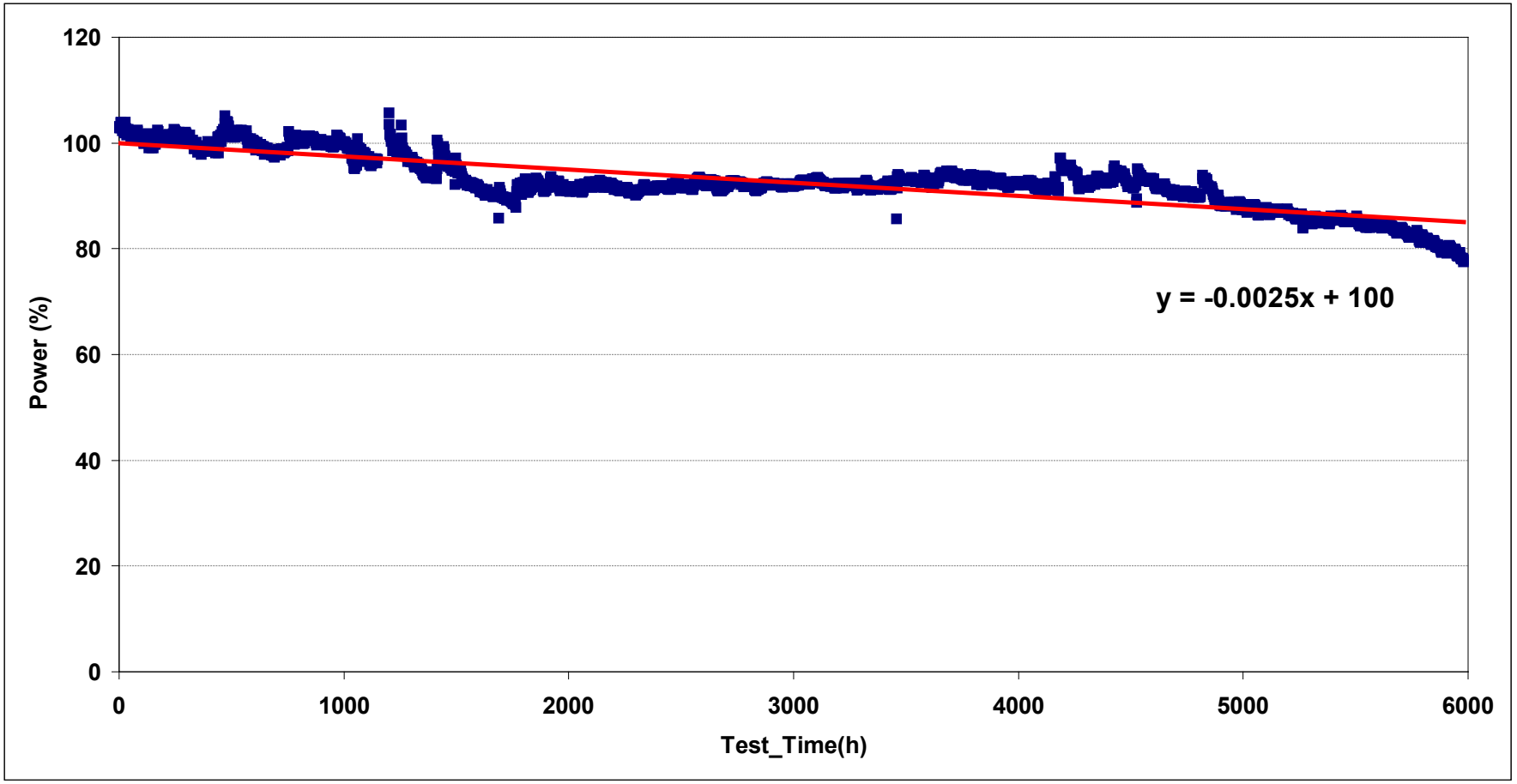
Technical Accomplishments:

Over 90% fuel utilization of stack/engine



Demonstrated Low Decay

Normalized stack/engine power

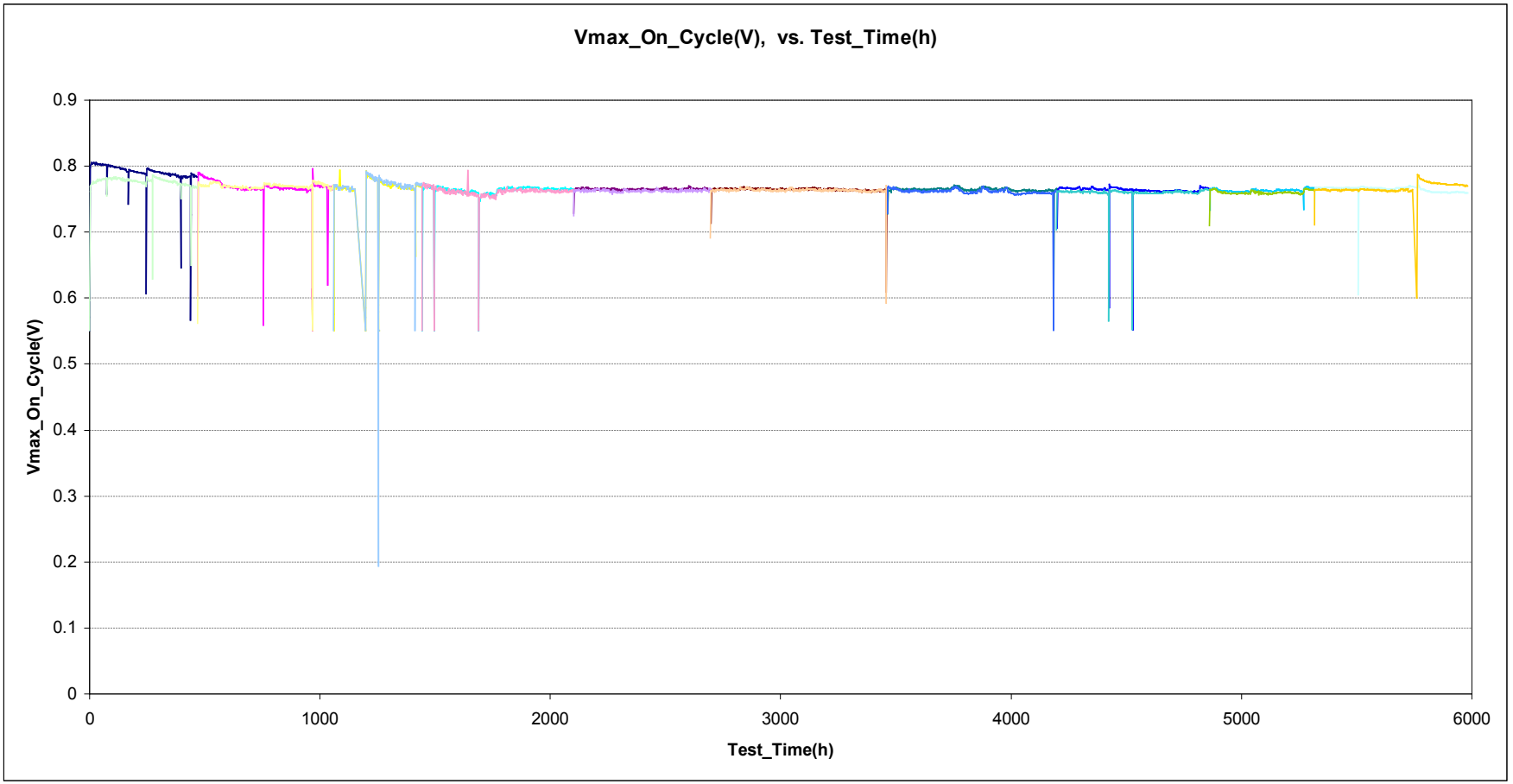


2008 = 2,700 hours at 15% decay per 1000 hours

2009 = 6,000 hours at 5% decay per 1000 hours

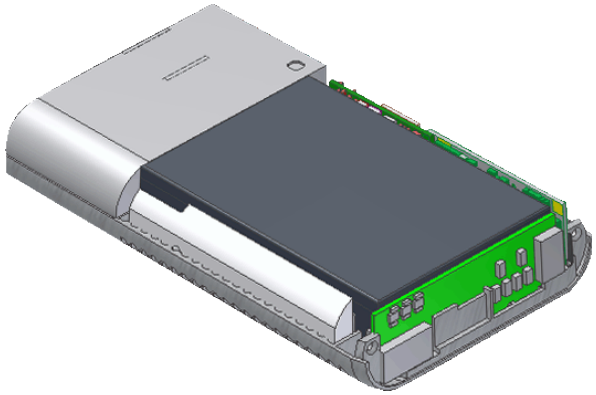
Technical Accomplishments

Stable Open Circuit Voltages over 6000 hr run



Technical Accomplishments

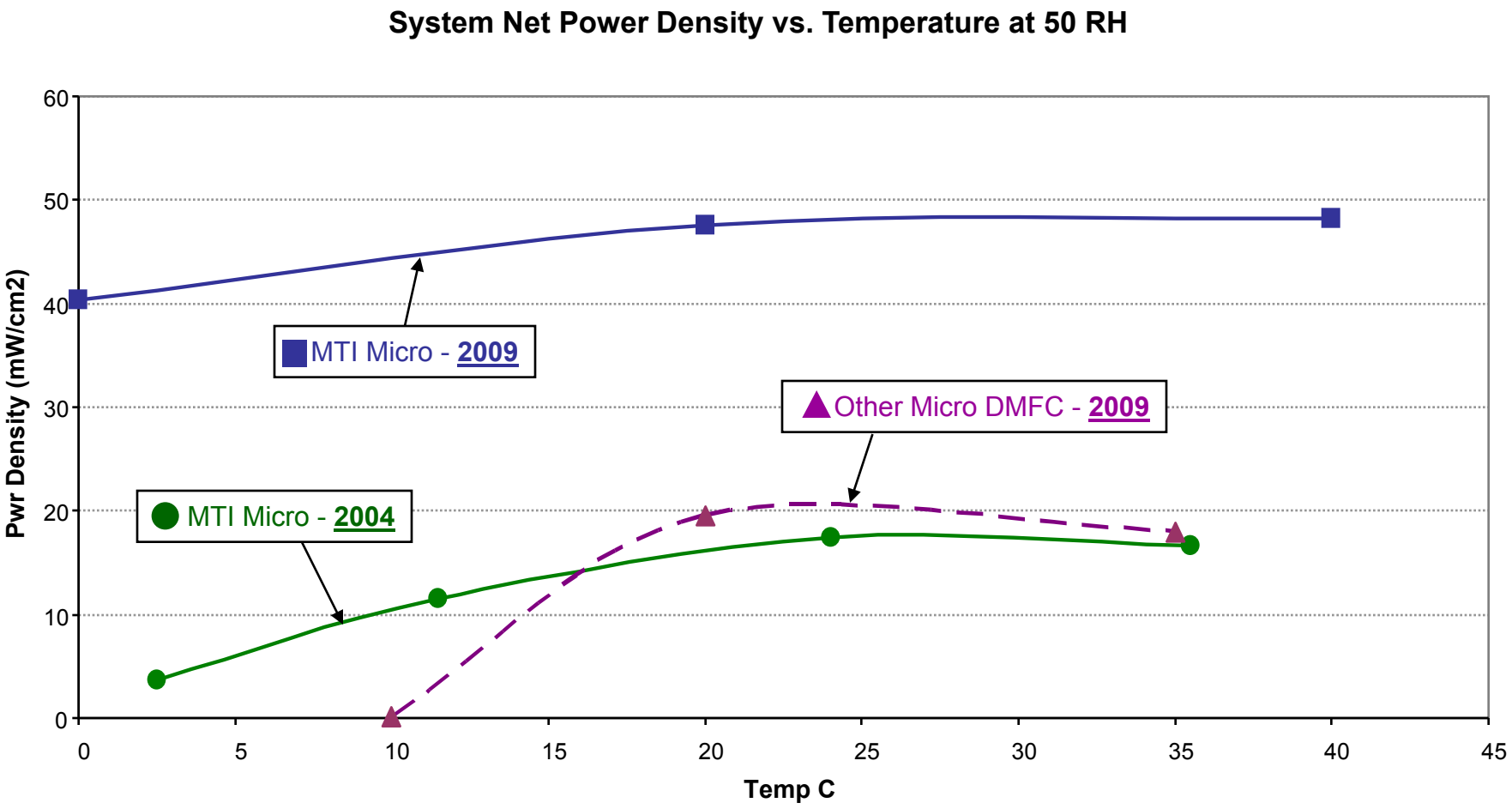
System Level Testing



System level testing completed:

- ✓ Environmental latitude
  - 0C-40C
  - 0-90% RH
- ✓ Cold and hot ambient start-up
- ✓ Completed sound testing
- ✓ Surface temperature measurement
- ✓ Drop testing
- ✓ Orientation independence
- ✓ Altitude testing

Ambient Temperature Latitude



MTI system provides stable power and more than twice the power density within the Consumer Electronics temperature range of 0 to 40°C

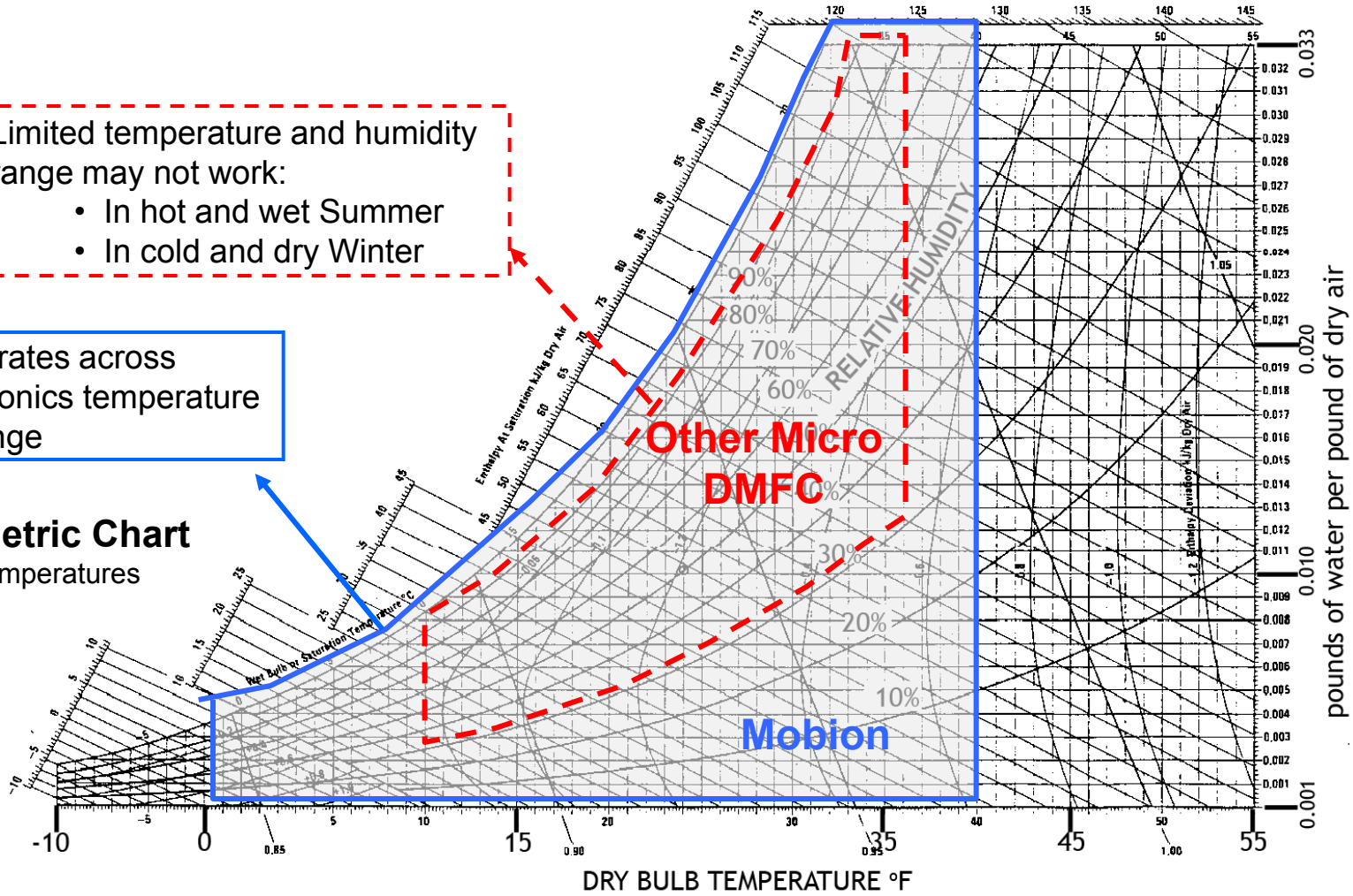
Demonstrated Performance over Ambient Temperature & Humidity

Limited temperature and humidity range may not work:

- In hot and wet Summer
- In cold and dry Winter

MTI system operates across consumer electronics temperature and humidity range

Psychrometric Chart
Normal Temperatures



Below 0°C Properties and Enthalpy Deviation Lines Are For Ice

Reproduced courtesy of Carrier Corporation

Collaboration

- Methanol Foundation:
  - Consumer and environmental safety & associated regulatory standards development and compliance
  - Working with key states EPA on cartridge & system end-of-life disposal and recycling
- Fuel cell component suppliers:
  - MEA, membranes, plate and seal materials
  - Share performance and life test results with partners
  - Qualified multiple sources of supply for key components

Future Work

- Execute Field Test:
  - Procure and qualify components and subsystems for field test units
  - Build & test all systems
  - Identify target end users
  - Deploy and support systems during field test
    - Methanol cartridge supply
    - Address/ resolve fields issues
- Evaluate system performance and degradation in field conditions
- Analyze user feedback from field test and prepare comprehensive report
- Test fuel cell systems and Methanol cartridges for IEC compliance

Summary

- Relevance:
  - Project is in direct alignment with ARRA and FCT ARRA goals
    - 14 FTE jobs retained in NY state
    - Improved manufacturability to accelerating commercialization
    - Deploying 75 fuel cell systems into field for critical user feedback
- Approach:
  - All technical performance targets/metrics have been achieved
  - Passed Go/No-Go phase gate in November 2009
- Technical Accomplishments:
  - Reduced cost and improved manufacturing
    - Machined components to plastic injection molding or metal stamping
    - Over 50% reduction in labor content to build a system
  - Demonstrated high performance, fuel efficiency, and low degradation
  - Demonstrated system temperature & humidity latitude (0C-40C, 0-90%RH)
- Collaborations
  - Methanol Foundation:
    - Cartridge and system regulatory standards development & compliance
    - End of life disposal and recycling
  - Component suppliers/ commercialization partners
- Future work
  - Deploy and support 75 field test systems during 2010
  - Evaluate system performance and degradation in field conditions

Thank You!

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