

# **Low-Cost Manufacturable Microchannel Systems for Passive PEM Water Management IIPS Number 16910**

Ward TeGrotenhuis, Susie Stenkamp, Curt Lavender  
Pacific Northwest National Laboratories  
Richland, WA  
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# Project objective: **Create a low cost and passive PEM water management system**

Specific Targets Addressed for 3.4.2 Automotive-Scale: 80 kWe Integrated Transportation Fuel Cell Power Systems Operating on Direct Hydrogen

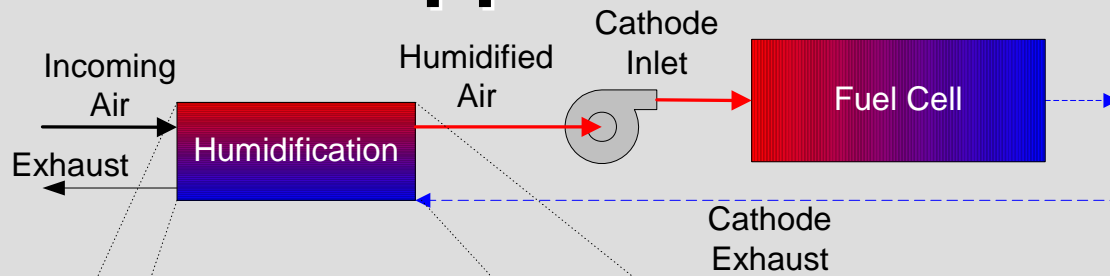
Target addressed	Target	80 kWe System Objective	% of System for Water Mgmt
Power Density	650 W/L	123 L	2 – 7%
Specific Power	650 W/kg	123 kg	2 - 9%
Cost	\$30/kWe	\$2400	< 7%

# Project objective: **Create a low cost and passive PEM water management system**

## Specific Barriers Addressed:

- ▶ **B: Cost:** *Balance-of-plant components specifically designed* for use in fuel cell systems need development in order to achieve cost targets. *Low-cost, high-volume manufacturing* processes are also necessary.
- ▶ **E: System Thermal and Water Management:** *Improved* heat utilization, cooling and *humidification* techniques are needed.

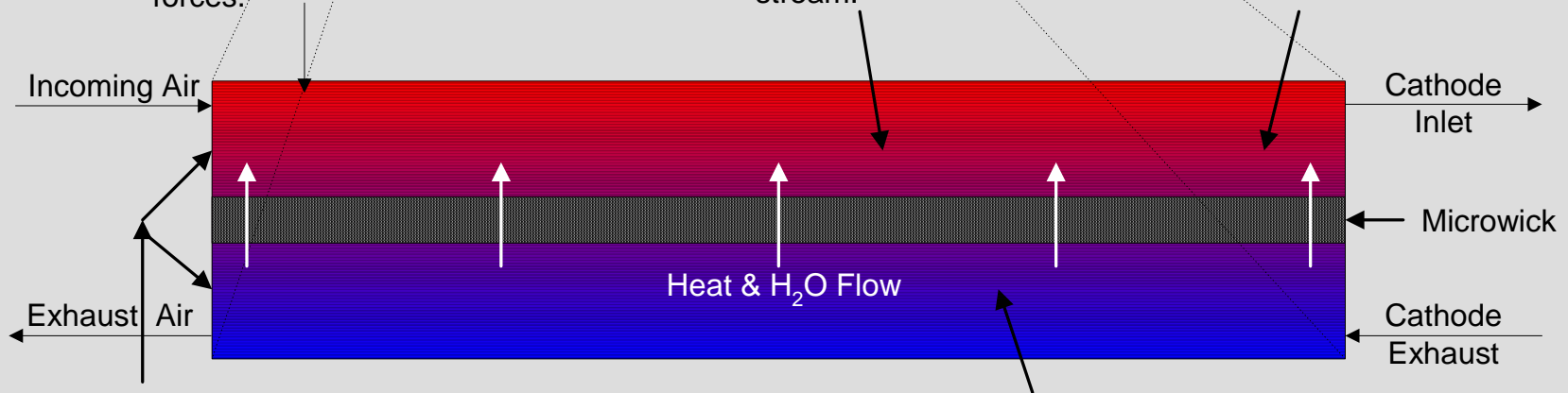
# Technical Approach: Humidifier



Water evaporates at the wick wall due to both a temperature and mass transfer driving forces.

Heat is delivered into the incoming air stream to maintain close temperature approaches along the device and provide heat needed to evaporate the water into the stream.

Efficient heat transfer, achieved using laminar microchannels, cools incoming cathode exhaust to close approach (~10C) to outgoing cathode air



Optional interconnect wick built into headers can remove excess water during normal operation and supply water during start up.

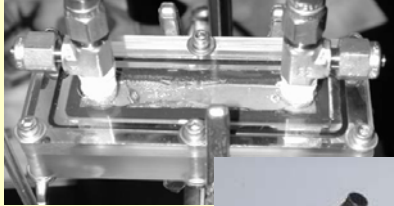
Capillary forces convey water from the humid exhaust to the dry incoming air and also prevent air intrusion to pores, preventing cross over of air.

# Advantages of Microwick Approach

- ▶ Passive operation
- ▶ Low pressure drop in device (operation with blower)
- ▶ Orientation independent
- ▶ Self recovery during process upsets

# Relevant Prior Work: Microwick Technologies

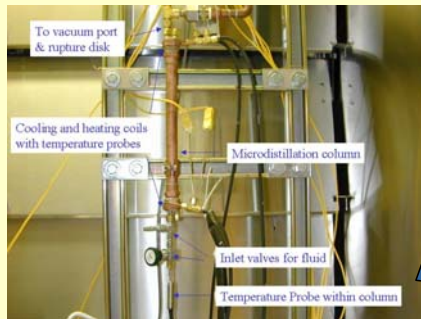
Single channel



Phase separation



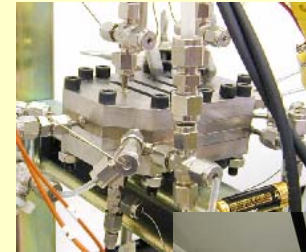
Multichannel



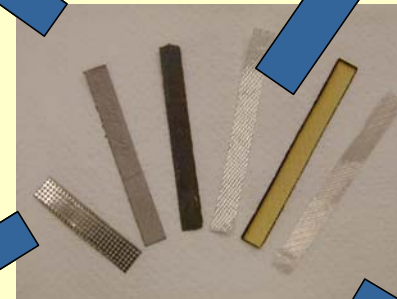
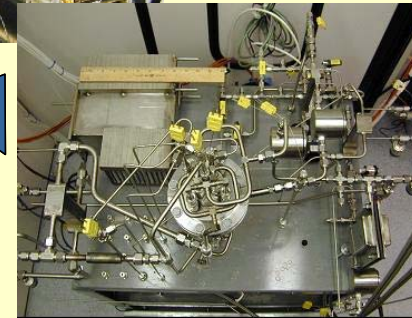
Distillation



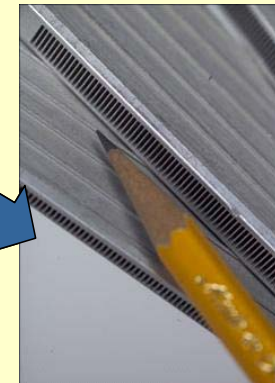
Absorption & Desorption



Integrated heat pump

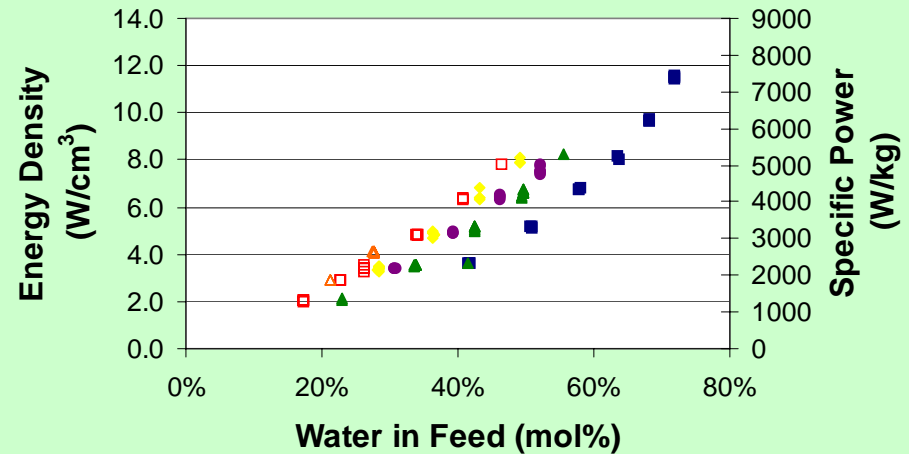
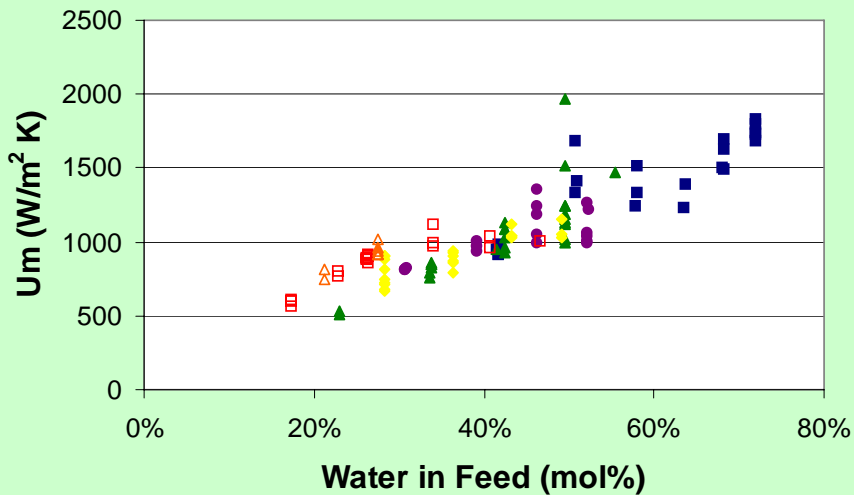
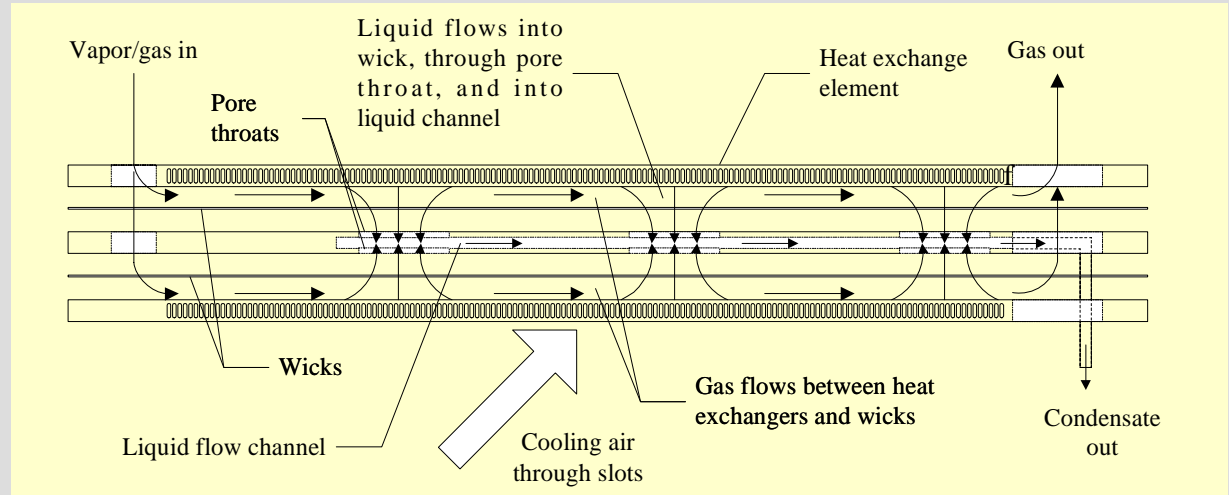


Microwicks allow two phase flow



Phase separation with partial condensation

# Performance for Phase Separation with Partial Condensation



- Air flow = 5 slpm    ▲ Air flow = 7 slpm    ● Air flow = 8 slpm
  - ◆ Air flow = 9 slpm    □ Air flow = 10 slpm    △ Air flow = 11 slpm
- Specific Power Axis

# Fabrication Approach:

## Raw materials:

Powder metal  
Injection moldable polymer  
Bonding resin

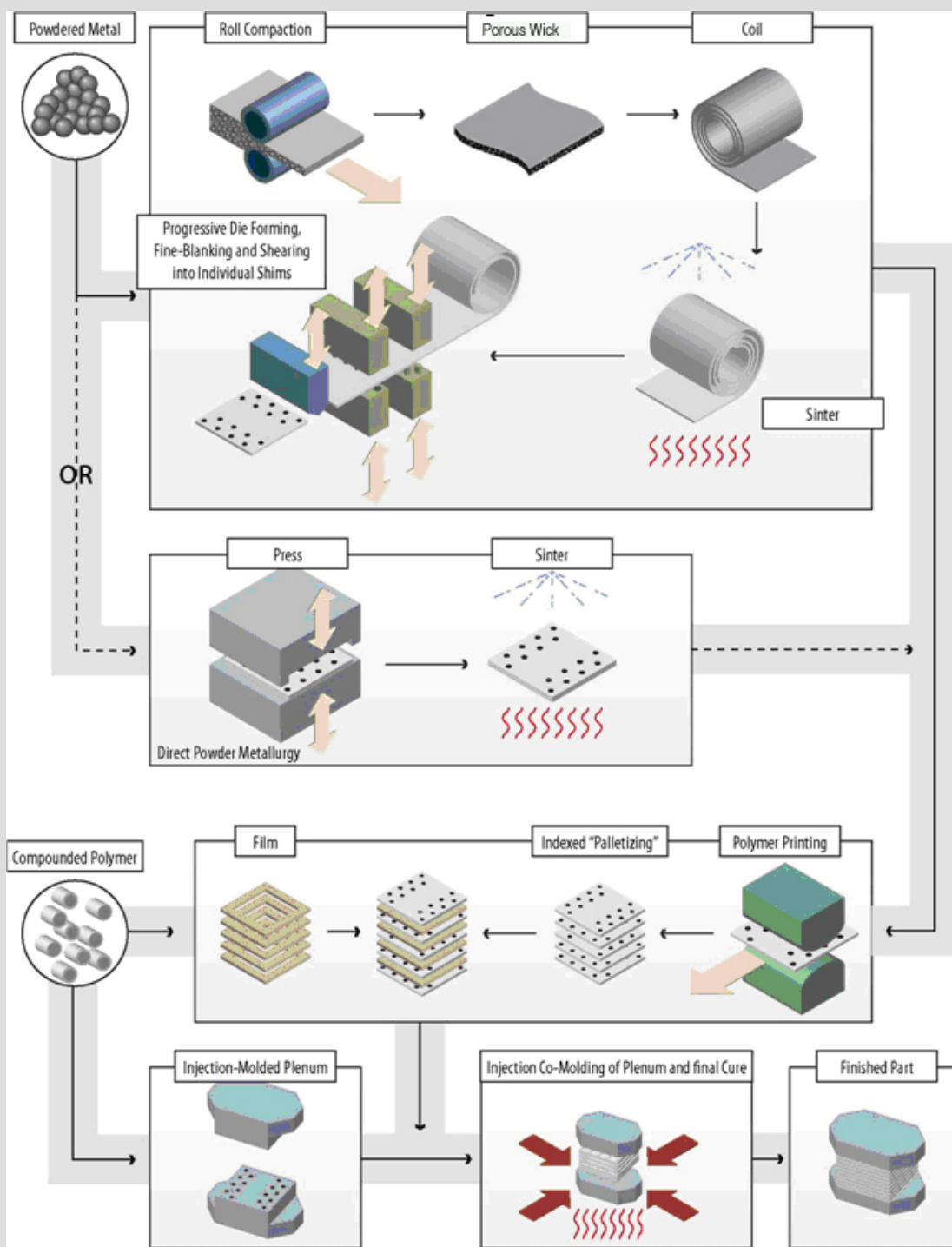
## Wicks:

Powder rolling/  
Progressive die stamping

## Bonding layer:

Screen printing, pad  
stamping, robotic, discrete  
film, co-molding

## Final co-molding and assembly





# Relevant Prior Work in Manufacturing



PACCAR Hybrid Door

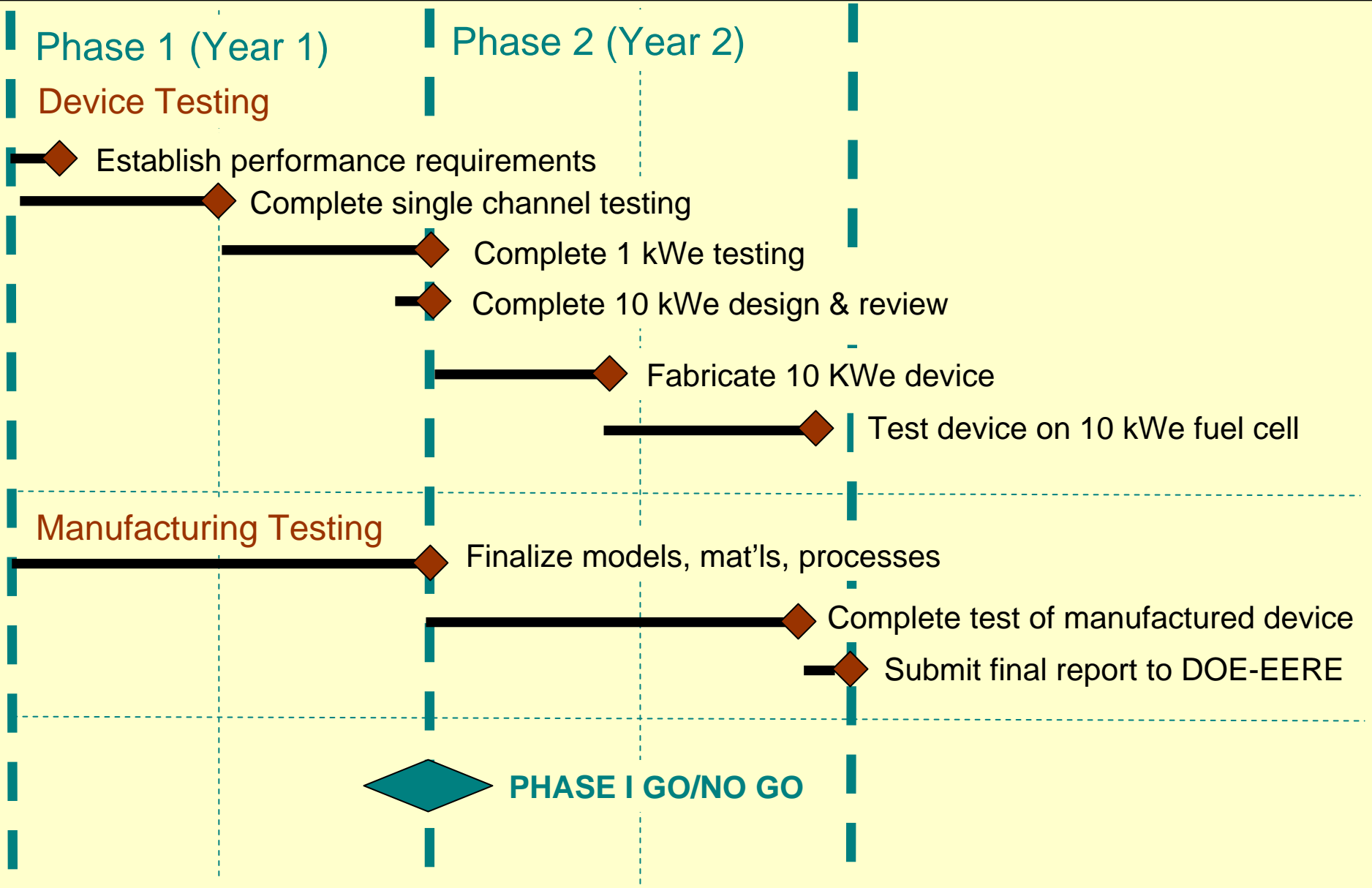


Novel automotive components and processes for high volume production



Superplastic aluminum Malibu Maxx lift gate

# Project Timeline (Start Date: February 2007)



# Go – No Go Decision Point 12 Months/ End of Phase I

## Evaluation Criteria

- ▶ Ability of device to meet weight and size targets
- ▶ Ability of device to handle varying conditions
- ▶ Costs for fabrication <\$100 per device

# Organizations and Budgets

## ► Organizations:

- PNNL
  - Environmental Technology Directorate
  - Energy Science and Technology Directorate
- Manufacturing Support
  - ADMA Product Inc. – Porous sheets for wicks
  - Protonex – Fabrication methods
- System Testing Support
  - Hydrogenics

## ► Budget

- FY 2007: \$300K
- FY 2008: \$700K

## ► Needs/inputs –

- Revise scope and schedule to reflect budget