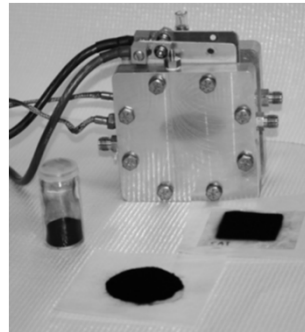
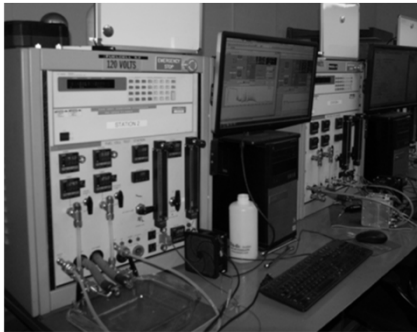




# Low Cost Catalysts



**Tom Stephenson (CEO & Chairman)**  
**Dr. Barr Halevi (CTO & President)**  
**Webb Johnson (Director of Bus. Dev.)**

317 Commercial St. NE  
Albuquerque, NM 87102

V: (505) 293-5367

F: (505) 244-8040

[info@pajaritopowder.com](mailto:info@pajaritopowder.com)

[www.pajaritopowder.com](http://www.pajaritopowder.com)

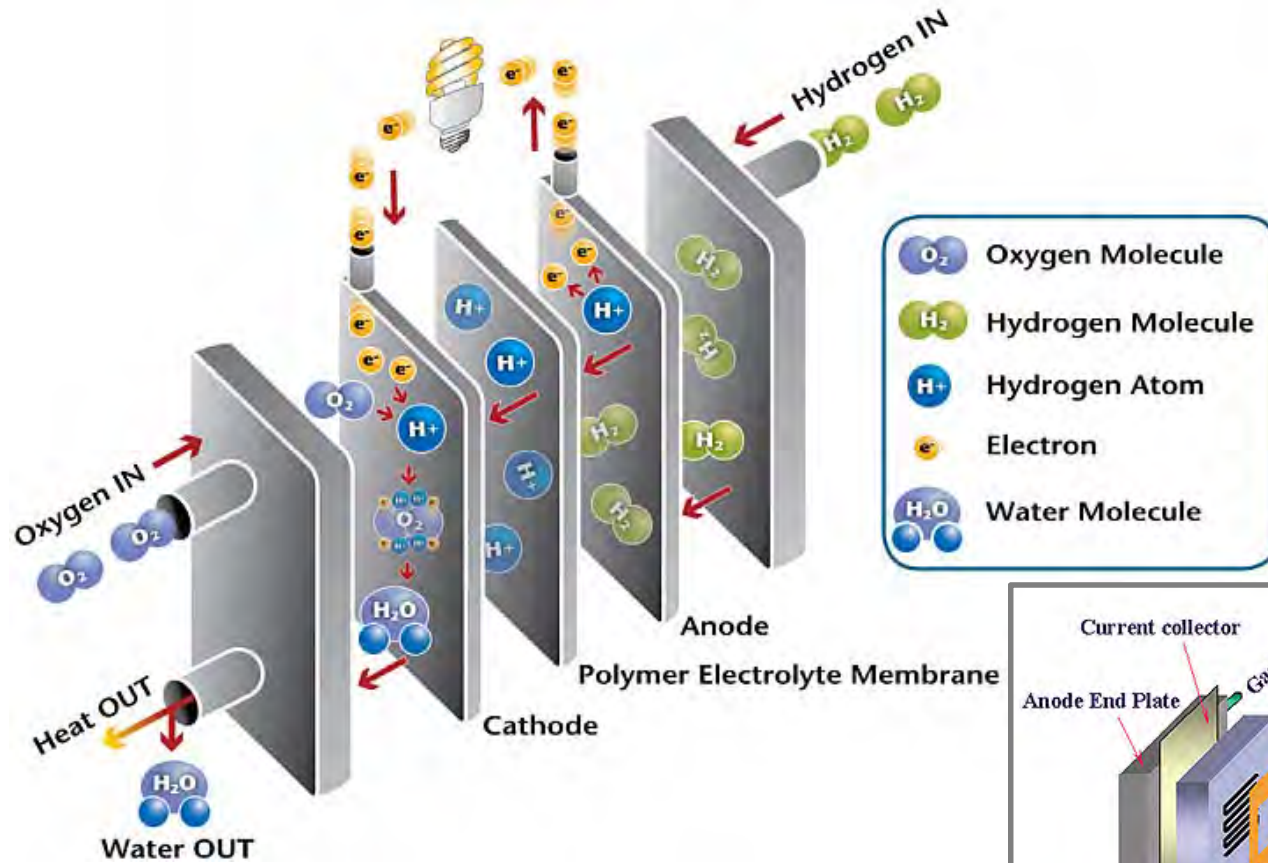
## Company Overview



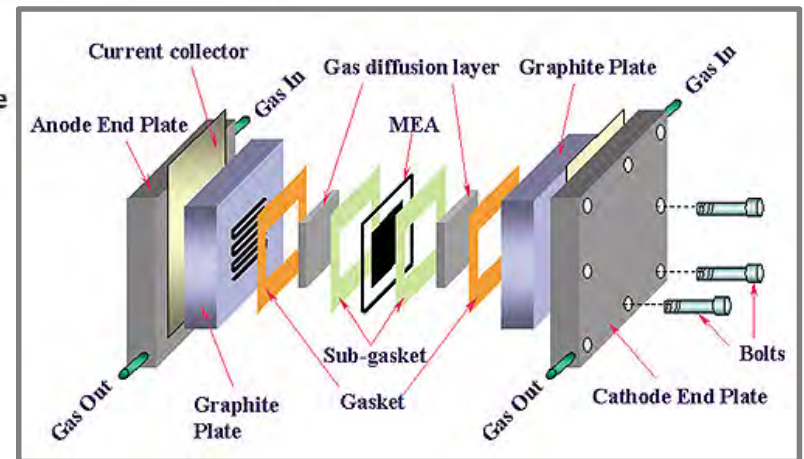
- Founded January 2012 in Albuquerque, NM
- Producer of PGM-Free catalysts and Engineered Carbon Supports for Fuel Cells
  - Two Primary products available now: NPC-2000 & PHC-3000
- Right-sized Production Plant
- Strong Team
  - Dr. Barr Halevi, CTO & President
  - Tom Stephenson, CEO & Chairman
  - World-Class Technical Advisory Board
- **IP Licensed from multiple sources**
  - **University of New Mexico**
  - **Los Alamos National Laboratory**

***Mission:  
Fundamentally Change  
the Economics of Fuel  
Cell Catalysts***

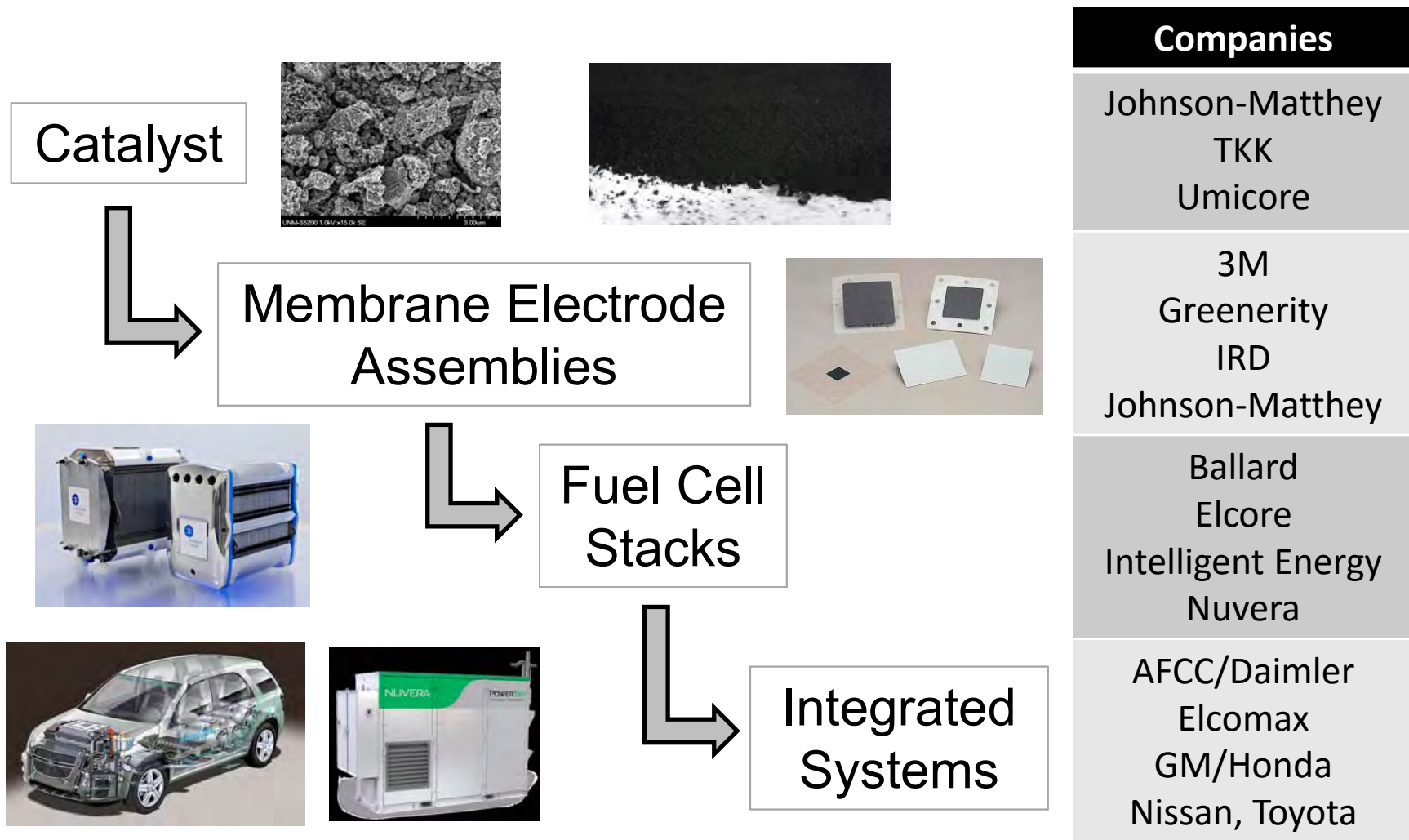
# What Is a Fuel Cell?



US DoE Fuel Cell Technologies Office



# Fuel Cell Component Chain



# End of Internal Combustion?

**Toyota Motor Company: *No New Internal Combustion Engines by 2050***



<b>2015 Mirai</b>	<b>Model</b>	<b>2015 Camry</b>
115 KW	<b>Engine Size</b>	115 KW
109.4"	<b>Wheelbase</b>	109.3"
<b>\$58,325</b>	<b><i>U.S. MSRP</i></b>	<b>~\$35,000 (*)</b>

(\*) Fully Loaded

# Other Fuel Cell Vehicles

**2015 Tucson CUV**



**2016 Honda Clarity FCV**



**2018 Mercedes GLC SUV Hydrogen**



# What is the Problem?



*Catalyst is 30-50% of today's Fuel Cell Cost*



*Platinum, at \$40-60/g, drives Catalyst cost*



*High-volume economies of scale do not help to reduce Platinum cost*



Platinum Catalyst costs will go up as a percentage of total Fuel Cell cost

**% of Total Stack Cost**



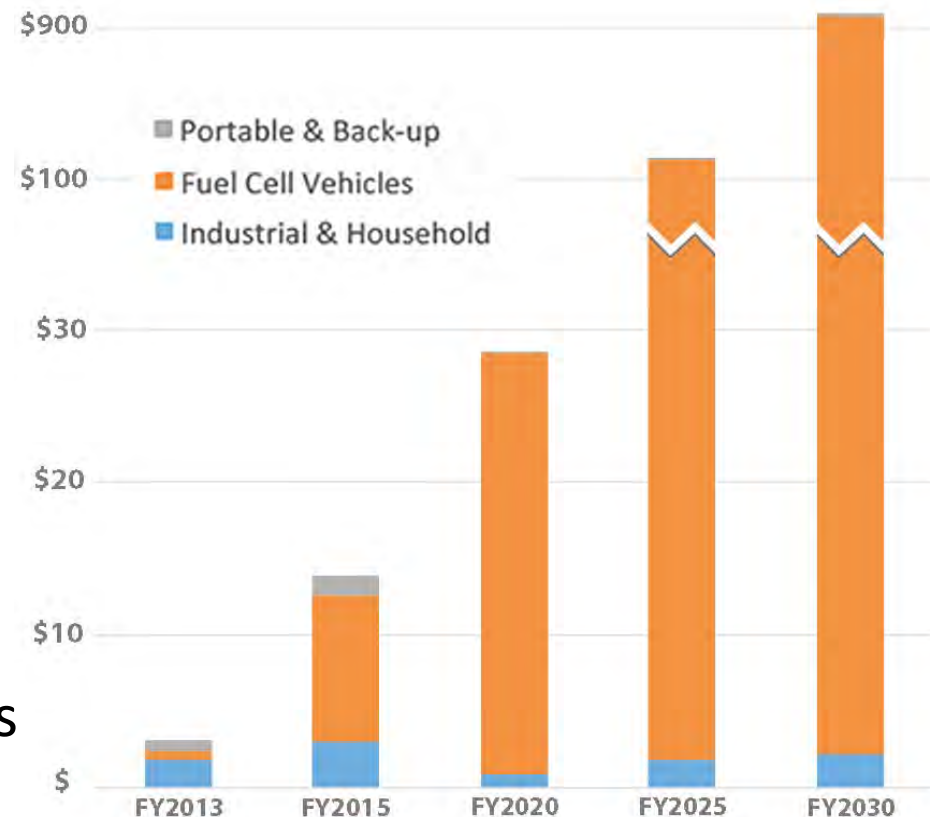
***Pt Catalyst Cost is Preventing Market from Achieving Full Potential***

# Applications and Markets



- **Fuel Cell Vehicles**
  - Today: Forklifts, Buses
  - Future: Cars
- **Industrial & Household**
  - Today: Cell Towers
  - Future: Residential
- **Portable & Back-up**
  - Today: Camping, Toys
  - Future: Aux. Power Units

## Total Available Market: Fuel Cell Catalyst



Source: Fuji Keizai 2015; Market numbers in Millions of US Dollars



# Fuel Cell Catalyst Needs



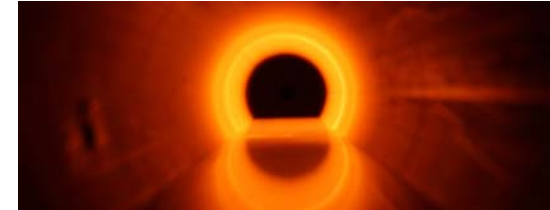
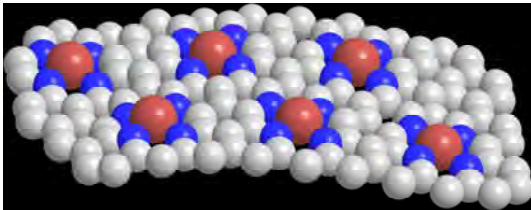
## New Materials

- Reduce platinum loadings for catalysts
- Harden catalyst layers against corrosion



## *Multiple Formulations Made*

- *Tunable to specific customer needs*
- *Emphasis on scalability*



## New Manufacturing

- Build inexpensive processes
- Design scalable processes



## *Economic Production of Many Supports/Catalysts*

- *Scaled for today, designed for tomorrow*

# Pajarito Product Offerings



- **NPC-2000**

- PGM-free cathode catalyst
- Customizable formulations
- Manufactured today in ~0.2Kg batches → Path to 0.5Kg+
- *Cost-effective solution for lower power density applications*

- **PHC-3000**

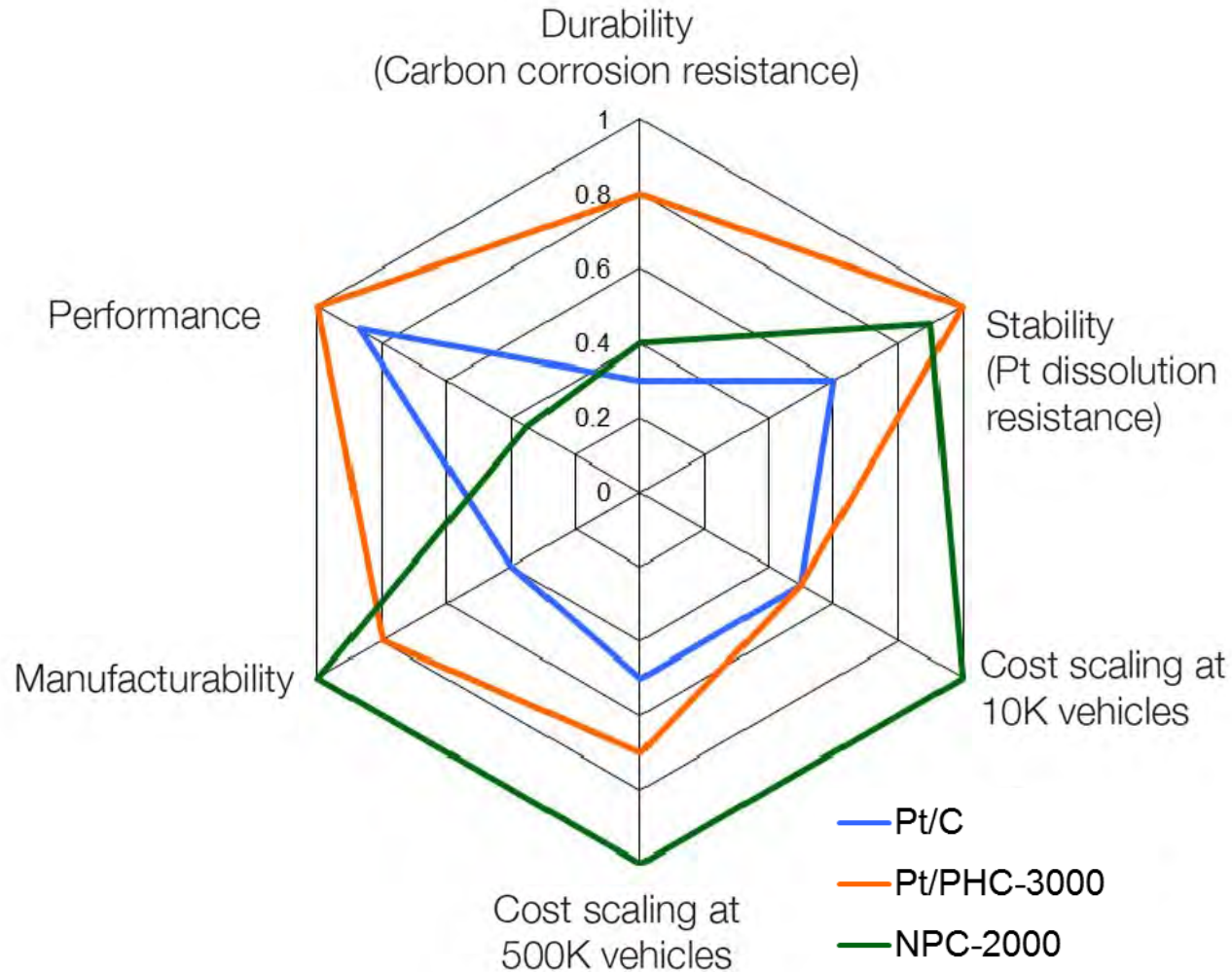
- Engineered Carbon Support for low-loaded Pt catalysts
- High corrosion resistance (durability) & dispersion of Pt
- *Near-term solution for improved End of Life performance*

# Engineered Carbon Supports

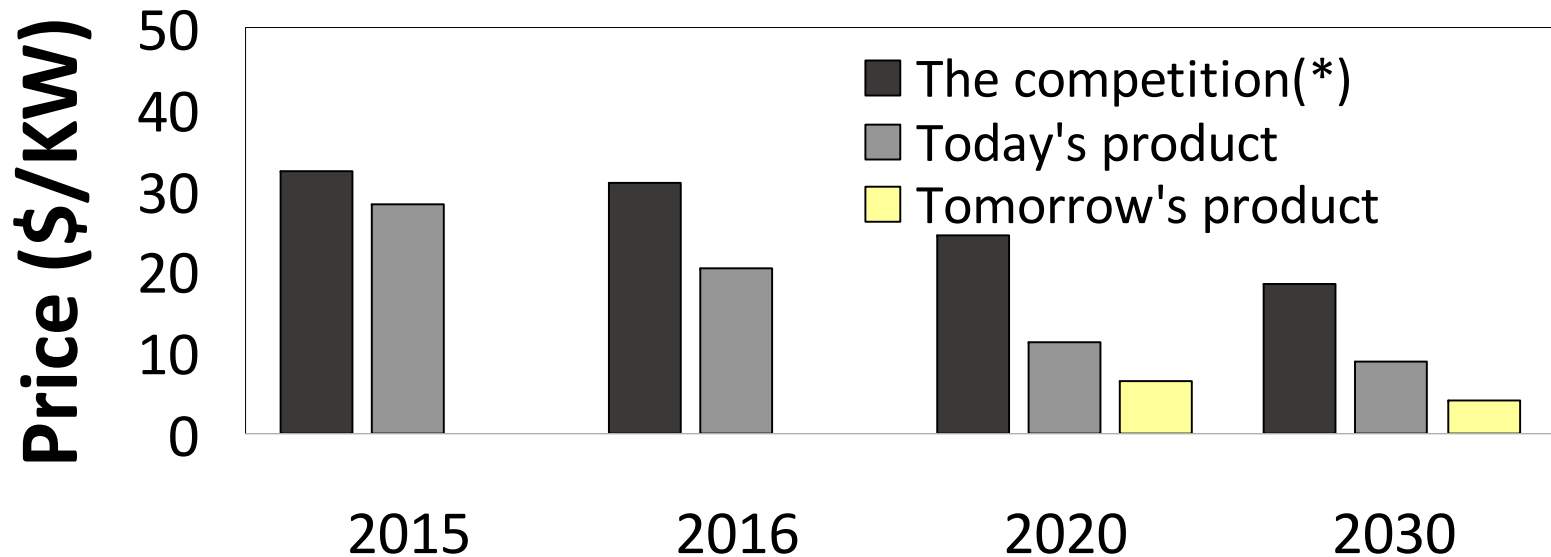


- Optimized for corrosion resistance (durability) and dispersion of Pt
  - Higher graphitization
  - Targeted morphology
    - Support particle size and pore size distribution
    - Surface area
    - Surface functionalization
- Pt deposition done in house and by partners
  - Pt particle size control achieved
  - Long-term goal to use partners for Pt deposition

# Promising Solutions



# High Benefit/Price at Scale



<b>Production (Kg/Mo.)</b>	<b>10</b>	<b>100</b>	<b>1,000</b>	<b>10,000</b>
<b>Price (\$/Gram)</b>	<b>\$10</b>	<b>\$3</b>	<b>\$1.20</b>	<b>\$0.75</b>

Bulk raw materials

(\* ) From DOE "Fuel Cell System Cost – 2015"; Pt price fixed at 2015 levels

## Strong and Growing IP



- **Multiple Intellectual Property Sources**
  - Los Alamos National Laboratory
  - University of New Mexico
  - INRS
  - Northeastern University
  - “Native” intellectual property
- **Partners on U.S. Government Grants**
  - U.S. DOE ARPA-E Grant (prime)
  - U.S. DOE “Incubator” grants (sub-awardee)
  - SBIR grant (sub-awardee)
  - U.S. DOE Small Business Voucher pilot