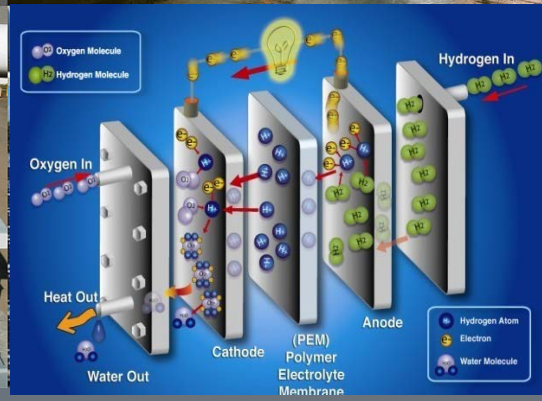
US DOE Hydrogen and Fuel Cell Technology – Composites in H_2 Storage & Delivery

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy



Fiber Reinforced Polymer Composite Manufacturing Workshop

Washington, DC

January 13, 2014

Scott McWhorter, PhD

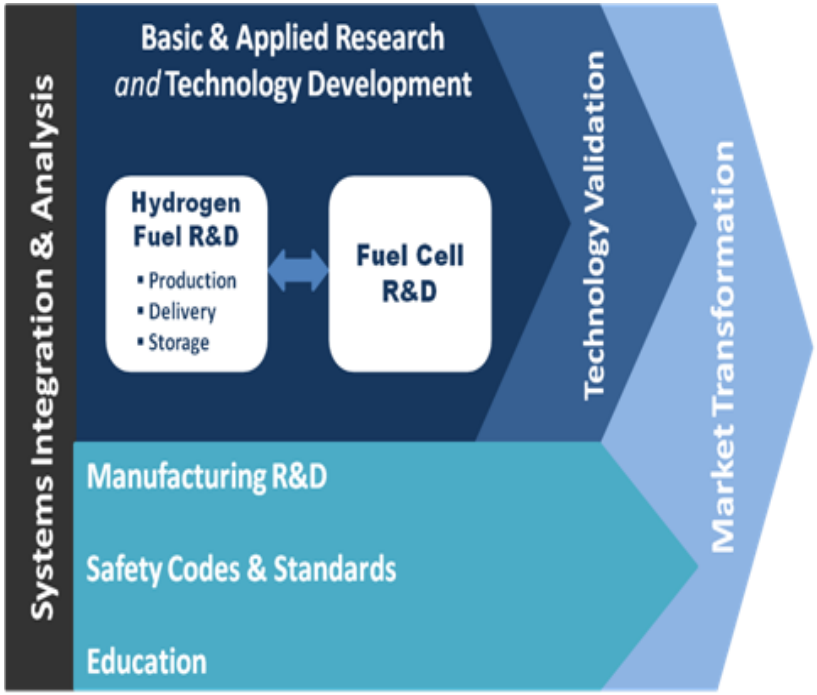
Representing:
U.S. Department of Energy
Fuel Cell Technologies Office

Hydrogen and Fuel Cells Program Overview

U.S. DEPARTMENT OF ENERGY

Mission: Enable widespread commercialization of a portfolio of hydrogen and fuel cell technologies through applied research, technology development and demonstration, and diverse efforts to overcome institutional and market challenges.

Key Goals : Develop hydrogen and fuel cell technologies for early markets (stationary power, lift trucks, portable power), mid-term markets (CHP, APUs, fleets and buses), and long-term markets (light duty vehicles).



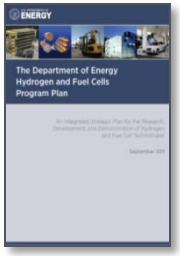
WIDESPREAD COMMERCIALIZATION ACROSS ALL SECTORS

- Transportation
- Stationary Power
- Auxiliary Power
- Backup Power
- Portable Power

Examples of Key Targets

- **Fuel Cells:**
  - **Transportation: $30/kW, 5K hours**
  - **Stationary: $1,500/kW, 60-80K hours**
- **Hydrogen: $2 to $4/gge**

DOE H_2 and Fuel Cell Program includes: EERE (Fuel Cell Technologies Office), and DOE Offices of Science, Fossil Energy and Nuclear Energy



EERE Multi-year RD&D Plan updated

Nearly 300 projects currently funded at companies, national labs, and universities/institutes

Program Plan at: http://www.hydrogen.energy.gov/pdfs/program_plan2011.pdf

Basic research conducted thru Office of Science; Applied RD&D conducted through EERE, FE, NE

H_2 Storage: Compressed Tanks

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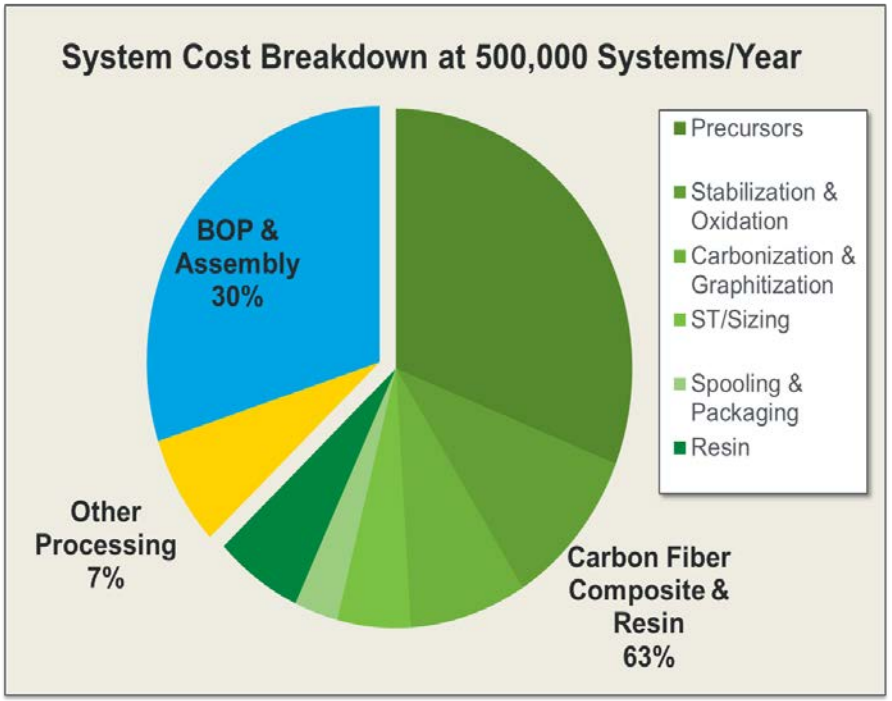
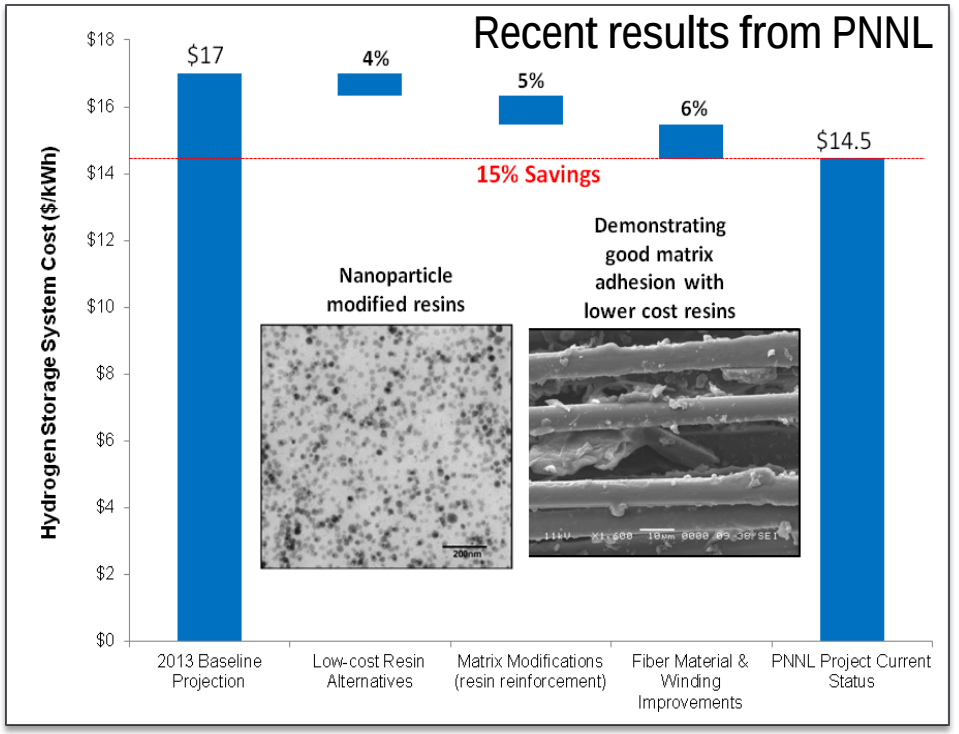
Cost is the key barrier.
Strategy is to reduce cost and quantity of CF composite used in systems





Cost Breakdown:

- Carbon fiber composite - ~63%
  - Precursor - ~30%
  - Conversion - ~26%
  - Resin - ~6%
- Manufacturing processes - ~7%
- Balance-of-plant and assembly - ~30%

Near-term Focus:

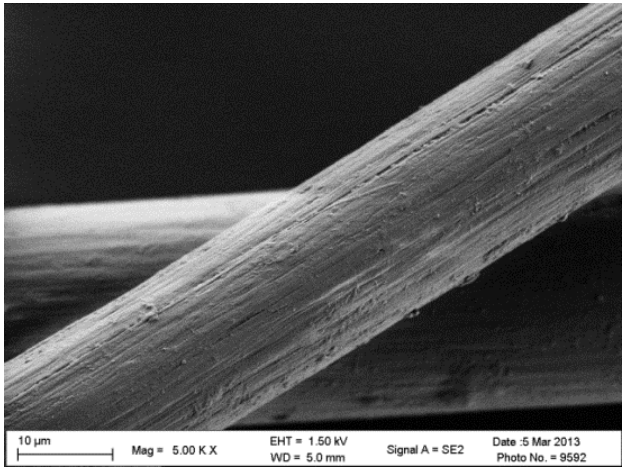
- Lower cost precursors
- Improved composites
- Improved pressure vessel design/manufacture
- Lower cost/lighter weight BOP

H_2 Storage: Improved CF composites

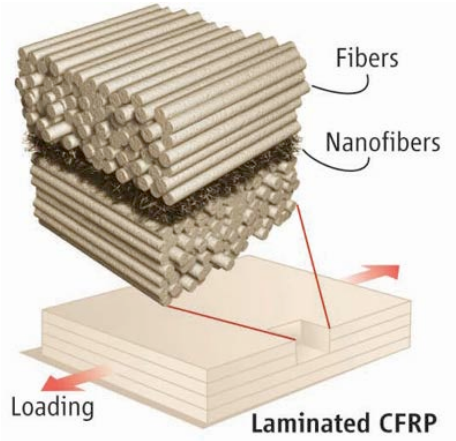
Precursor fibers account for > 50% of cost of high-strength carbon fiber, - opportunity to significantly reduce CF costs

Efforts in Carbon Fiber:

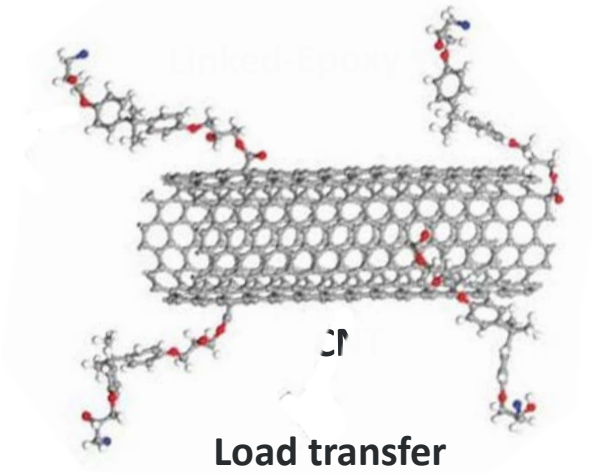
- Produce high strength CF from commodity textile based precursors
- Demonstrate melt spinnable PAN/MA with physical properties approaching commodity grade PAN



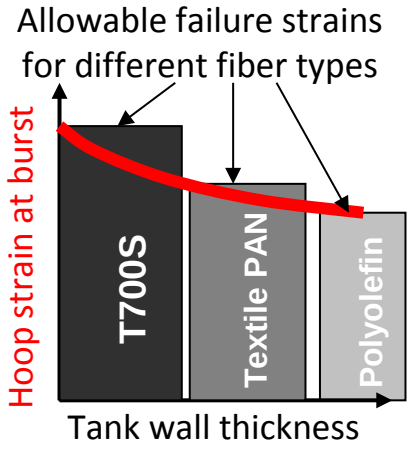
Investigating novel composite design and advanced materials to optimize cost and performance of carbon fiber composites.



Interlaminar shear strength



Load transfer



CF Optimization

Fiber reinforced polymer (FRP) pipelines as a low cost H_2 delivery pathway

FRP Pipeline

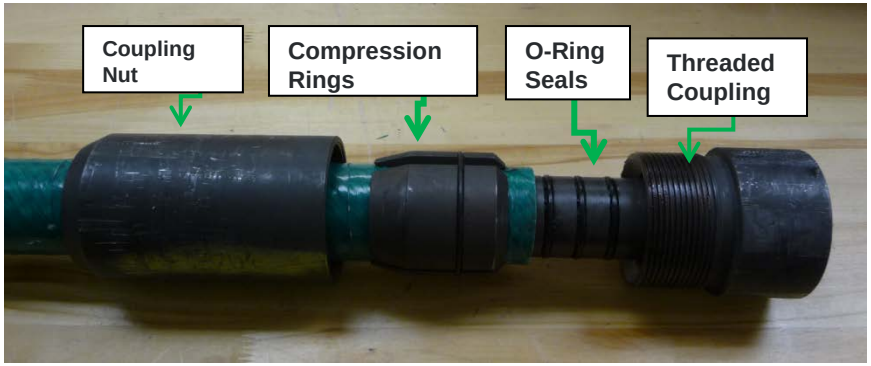
Can reduce installation costs by 20– 40%

- ✓ Fatigue testing completed over the range of 750 to 3000 psig
- ✓ Excellent burst pressure ratings
- ✓ Superior chemical and corrosion resistance
- ✓ Can be installed from spools over long lengths
- ✓ Commercial product up to 6” dia. And 2500 psig

FRP Section Showing HDPE Inner layer and Fiberglass Structural Layer

Issue

- ✓ Utilizes O-Ring Seals to ensure a leak tight joint
- ✓ Pipeline manufacturers have expressed concern about using a mechanical seal requiring long-term maintenance



Need

Develop a low-cost, no maintenance plastic joining method that retains FRP strength properties that can be applied in the field