**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).

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

DOE H₂ 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


Basic research conducted thru Office of Science; Applied RD&D conducted through EERE, FE, NE
H₂ Storage: Compressed Tanks

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

System Cost Breakdown at 500,000 Systems/Year

- BOP & Assembly 30%
- Carbon Fiber Composite & Resin 63%
- Other Processing 7%

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

Recent results from PNNL
- Nanoparticle modified resins
- Demonstrating good matrix adhesion with lower cost resins
- 15% Savings

Cost Breakdown:
- 2013 Baseline Projection: $17
- Low-cost Resin Alternatives: 4%
- Matrix Modifications: 5%
- Fiber Material & Winding Improvements: 6%
- PNNL Project Current Status: $14.5

Value Breakdown:
- Precursors: 30%
- Stabilization & Oxidation: 15%
- Carbonization & Graphitization: 10%
- ST/Sizing: 7%
- Spooling & Packaging: 10%
- Resin: 6%
- Manufacturing processes: 7%
- Balance-of-plant and assembly: 30%
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.
**H₂ Delivery**

**Fiber reinforced polymer (FRP) pipelines as a low cost H₂ 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

**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