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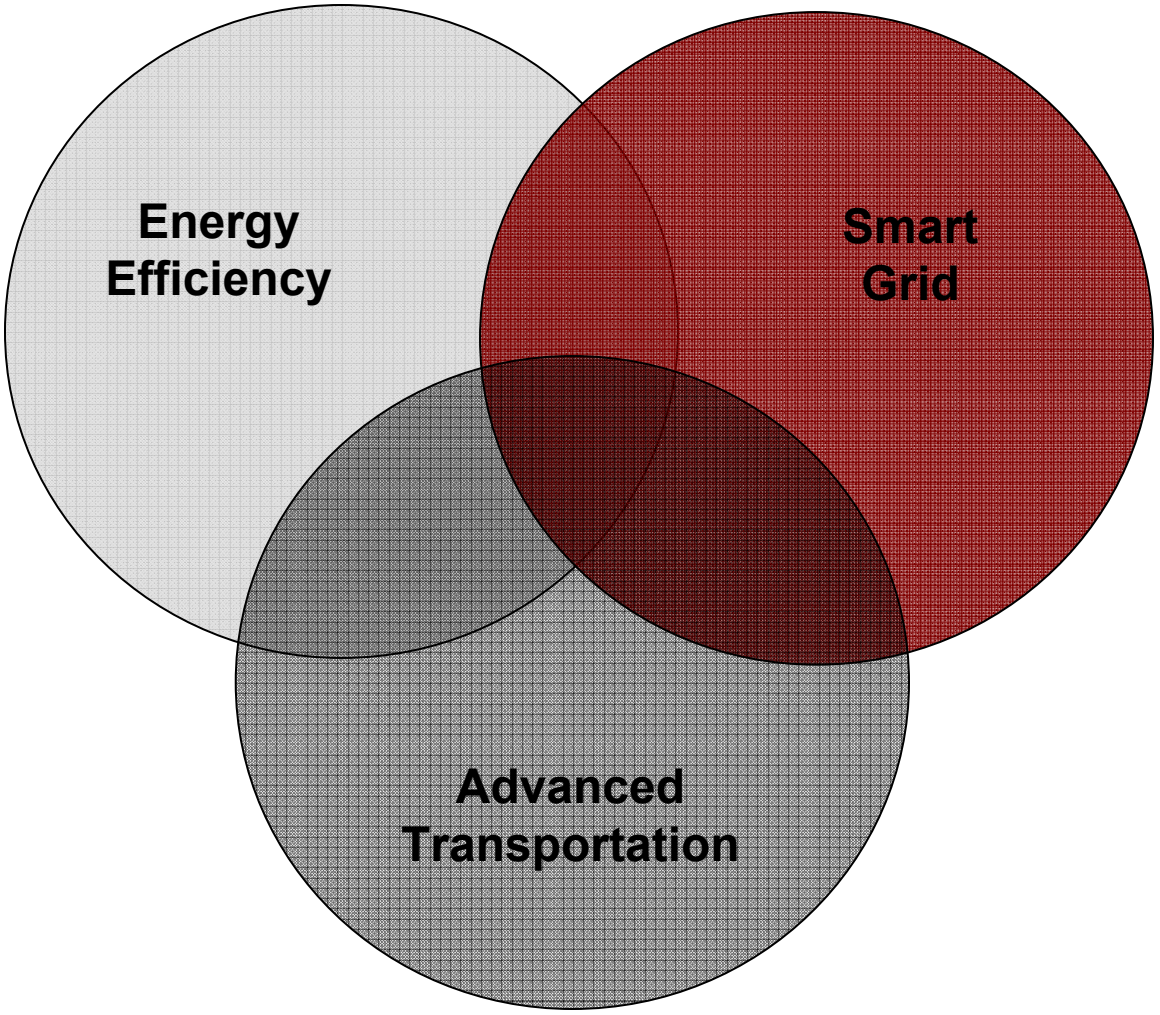
Advanced ENERGY

www.advancedenergy.org

Technology Assessment

- Is it technically feasible?
- Does it work in real applications?
- Can it work with other technologies?
- Does it have value to utilities or consumers?
- Does it demonstrate advanced services and products?

Cross section of needs



Energy Efficiency/Demand Response

- Measures that can be affected by real-time communications (prices and reliability)
- Direct load control (HVAC, water heating, etc.)
- Smart load control in response to price signals
- Distributed generation (solar, fuel cells, CHP)
- Curtailable load for manufacturing
- Energy storage (thermal and electric)

Smart Grid

- End-to-end real-time communications
- Prices to devices
- Open architecture; standard protocols
- Plug and play connectivity
- Self diagnostics and self healing
- AMI

Advanced Transportation

- Plug-in hybrid electric vehicles (PHEVs)
- Charging station monitoring and control
- Carbon impacts
- Grid connectivity with communications
- Multiple platforms (passenger, light-duty and heavy duty)

Variable Speed Pool Pumps

- Estimated savings from converting pumps for approximately 5,000,000 in-ground pools to variable speed.
  - National
    - 8,434 MW peak demand
    - 9,466 GWh annually
  - Per Unit
    - 1.54 kW[1]
    - 2,000 kWh annually[1]

> 1.9 million tons of coal avoided annually[2]

> 7.2 million tons of CO^2 avoided annually[2]

Pentair Water Pool and Spa®

Sanford, NC

[1] Calculated by utility using DEER methodology

[2] Calculated using national average fuel mix 62% coal

Incentive Programs

- Variable speed pool pump incentive programs
  - > SCE*
  - > PG&E*
  - > SDG&E
  - > Various CA Municipalities
  - > Austin Energy
  - > Nevada Power*

    * Offer third-party outsourced programs

Hybrid Plug-In Electric School Buses

- Facts
  - > Initiated by Advanced Energy in 2002
  - > The most viable plug-in platform to commercialize at the time
  - > Available for purchase today
  - > Built by International Corporation
  - > Lifecycle savings expected in full production volumes
  - > U.S. EPA helped many districts with Clean School Bus USA funds

Nationwide plug-in deployment

Delivered

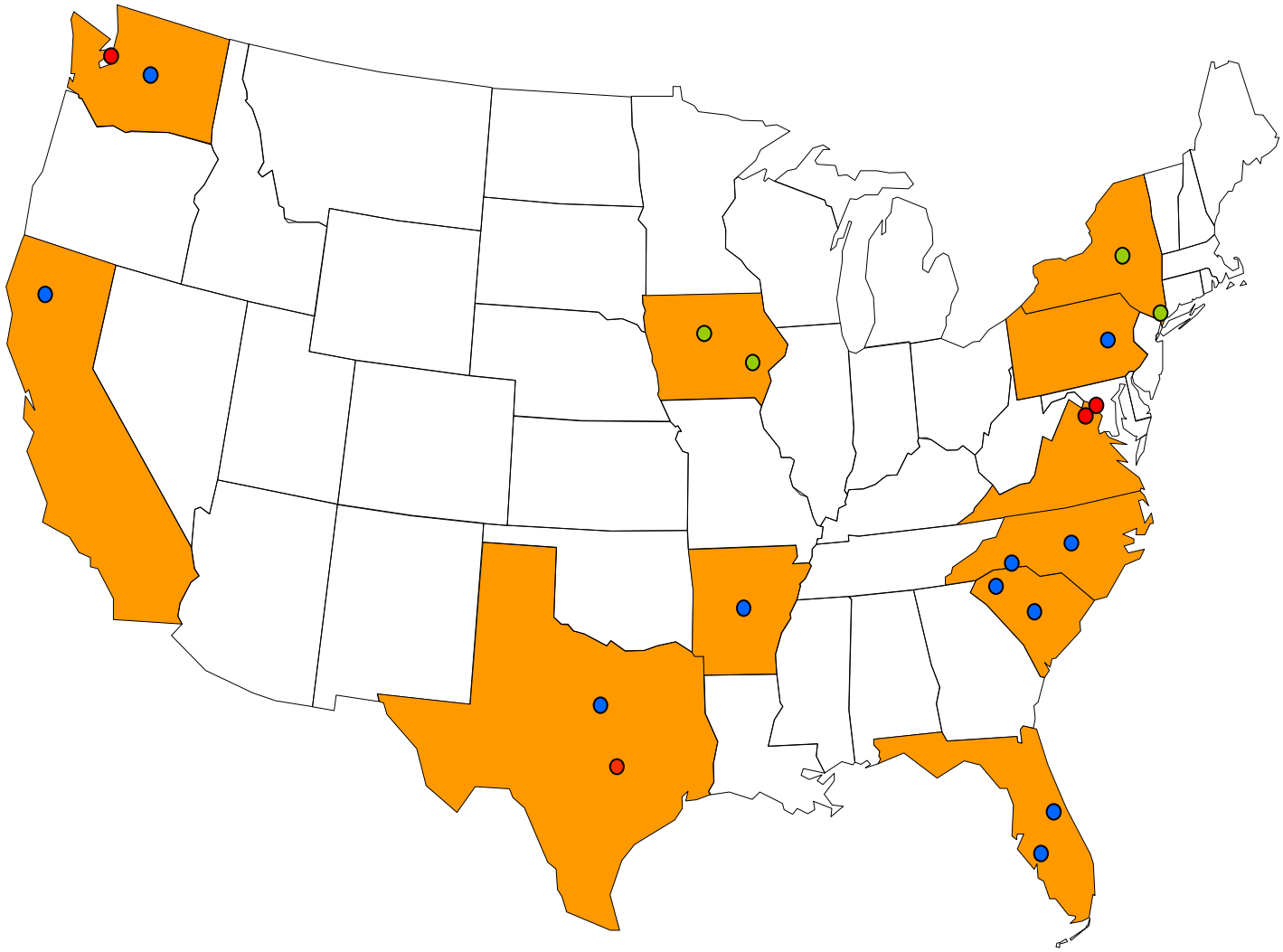
- Arkansas (1)
- California (1)
- Florida (2)
- North Carolina (2)
- Pennsylvania (1)
- South Carolina (2)
- Texas (1)
- Washington (1)

Funded / Ordered

- Iowa (2)
- New York (2)

Pending

- Texas (1)
- Virginia (1)
- Washington (1)
- Washington DC (1)



Hybrid Plug-In Electric School Buses

- 50-100% estimated improvement in fuel economy
- ~30% carbon reduction when recharged with normal power generation

Solar Energy – MegaWatt Solar

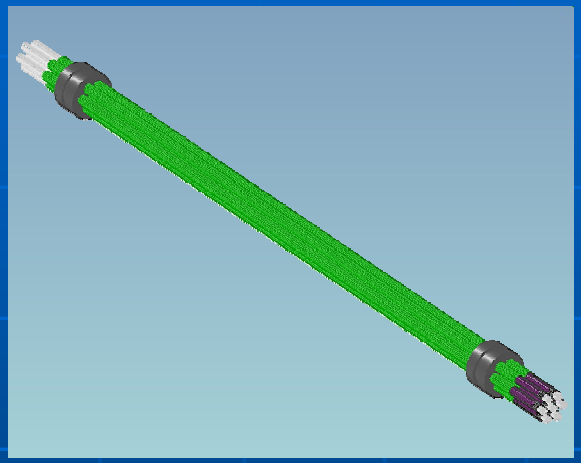
- Concentrating
- Two axis tracking
- Based in Hillsborough, N.C.
- Motto
  - > “Solar without subsidies”
- Production costs significantly lower than existing solar
- 3.5 kW test unit operating

Current “Plate & Frame” Technology Fuel Cell Stack

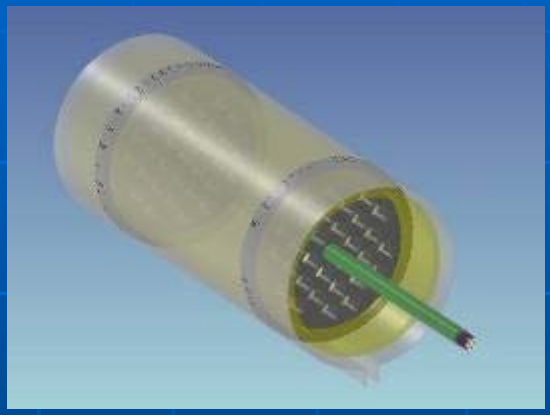
How is Microcell's fuel cell different?

Technology – Microcell Assembly

- 1-1.5 Watts per cell
- Mass produced on high speed extrusion line



- Replaceable Unicell (10-15W)
- Fuel, air and thermal management incorporated
- Inserted into module and sealed
- About the size of a pencil



- Building block for larger systems (25 or 50kW)
- Currently 1-2kW module is 4'' in diameter and contains 120 Unicells
- Separate chambers to feed fuel, air and coolant
- End caps contain "quick connect" electrical connections

MICROCELL

Significant Competitive Advantages

Lower Production Cost

- Continuous automated extrusion process
- Derived from raw materials compared to purchasing components
- Elimination of expensive bipolar flow field plates
- Reduced auxiliary and control equipment requirements; no humidification equipment
- Simplified design and fabrication processes = lower labor costs

High Power Density

- Simplified design and no humidification system = compact and lightweight
- Cylindrical shape provides the ideal fibrous geometry, resulting in the highest possible surface area / volume ratio
- Power density results exceed 1kW/L

Ease of Repair, Serviceability

- Individual Microcell cores are inserted into a fuel cell module
- Individual cores can be replaced without replacing the entire module

High Thermal Efficiency

- Heat removal occurs from every inch of every single cell
- Design allows for optimal heat removal to reduce cell degradation

Quick Start Operation

- Metallic current collectors heat up much faster than graphite plates
- Reach operating temperature quickly; essential for operating effectively in cold weather conditions

MICROCELL

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