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- Working for DOE renewable energy programs since 1985
- Supporting FEMP with renewable energy tracking, analysis of DG potential
- Research & education in energy and natural resource economics, energy and environmental policy



Key Numbers

- PV: \$6-\$9K/kW; efficiency NA because of \$0 fuel costs; capacity factor: 20% or less
- Wind: \$1,500/kW, efficiency NA because of \$0 fuel costs; 30% or higher
- PAFC Fuel Cell: \$3000-\$4000/kW; 40% electrical efficiency; up to 60-70% CHP
- PEM Fuel Cell: \$4000-\$5000/kW; 40% electrical efficiency; CHP in theory



PV Observations

- Sources: lots of experience and sources of data from installations at NPS, DoD, Coast Guard, BLM, USFS
- \$6-9/W among highest first costs; compares to Distribution Lines, Remote Power, Peak Rates
- O&M costs 1/10th cost of fuel cells



Wind Power Observations

- Sources:
 - Large and small federal installations, lots of commercial experience
 - Low costs from utility size turbines – smaller turbines cost more per per kWh
- \$1500/kW (large turbines; less than half fuel cell costs, ¼ the cost of PV)
 - compares to grid extension, remote power, utility power in wind farms
- O&M costs 1-2 cents/kWh, declining



Fuel Cell Observations

- Sources: DoD fuel cell program, numerous private sector characterizations
- PAFCs proven – potential for niche applications with high value combined heat and power or reliable backup power supply
- PEMs are still in demonstration
- O&M in the 1-2 cents/kWh range – lots of variation
- Important numbers that didn't fit:
 - PAFC temperatures at: 140-250°F
 - PEM temperature at: 135-165°F
 - Natural gas costs at \$4.69 to \$5.06/MMBTU on July 30



**1 MW PAFC Fuel Cell Demonstration,
USPS Facility, Alaska**

