

Applications where ITFCs are useful

- ▶ <100 W: Man portable, if 10X more energy than Li-Ion batteries
Emergency power capability for Marines to use local fuels- Roast your fuel cell in a charcoal fire to get 1-5 Watts.
- ▶ 100W-1kW: Replace 1kW generator, APUs for boats and trucks.
Scavenge agricultural or human waste to make electricity, applications in agriculture. Many international applications (developing world).
- ▶ 1-10kW:
 - Vehicle APUs
 - UAVs/UUVs
 - FOB generator systems
 - Turn human waste into energy on submarines
 - Use heat from a fuel cell to place under wings of the UAV to give it better lift
 - Applications where noise is a big problem
 - Provide low base load power alongside generator in hybrid systems

ITFCs Advantages and Liabilities

- ▶ ADVANTAGES over SOFCs
- ▶ Lower temp, therefore 10-100x more durable (less degradation) versus high temperatures
- ▶ More materials available
- ▶ Resistance losses might be lower
- ▶ Could replace 1kW generators more easily (less BOP?)
- ▶ Easier to move around than higher temperature systems.

- ▶ LIABILITIES
- ▶ Problems of maintenance
- ▶ Stack life could be less durable with more challenging fuel.
- ▶ Fuel flexibility could be a problem, due to poisoning relative to high temperature.
 - not a problem for special forces, or big military orgs, but USMC would not accept)
- ▶ Stacking smaller systems (making them modular) not advantageous

Metrics required to quantify ITFC performance

- ▶ Better than \$10/kWh (generator in a FOB) - ITFC benefit is hybridization.
- ▶ Must provide pulse power (with a battery)
- ▶ Harvest hydrogen across many different fuels
- ▶ Can run on emergency fuel (POX fuel processing from wood/plants?)
- ▶ >60% hybrid fuel utilization
- ▶ Performance degradation metric
- ▶ Define sulfur/oxygen/carbon dioxide conditions
- ▶ Number of fuel cell heat-cool cycles

Technology areas in ITFCs for improvement

- ▶ Materials to improve ORR efficiency
- ▶ Better ways to make carbon from fuels (coking)
- ▶ Make catalyst mechanism people work on this specific problem (not just on fundamentals)
- ▶ Reduce balance of plant (ancillary systems) on the fuel cell
- ▶ Reducing cooling power needs
- ▶ Build reversible fuel cells
- ▶ Metal Air batteries: look at metals or metal ions that oxidize, and then reverse if you heat them? Aluminum-air primary batteries?