



High Temperature PEM Fuel Cells for
Micro-CHP Applications

Fuel Cell Seminar & Exposition 2011
Orlando, FL USA

Mohammad Enayetullah

November 03, 2011

Presentation Scheme



Company

- Early stage FC Integrator
- Location: Hopkinton, MA
- Founding Team
 - Norman Strate
 - Charlie Myers
 - ME & Others

Technology

- HT PEMFC: 160 – 180°C
- 1, 3 & 5 kW CHP Systems
- Multiple Fueling Options
 - Natural gas
 - Propane, Biofuels
 - Military fuels

Market

- Residential CHP (Off –Grid)
- Stationary back-ups
- Other Niche
 - Military
 - DHS
 - APU's, etc.

Issues

- Stack (Size/weight, Cost)
- Reformer (Durability?)
- CHP Mode: Optimal Operation
 - Durability
 - Start-up
 - Thermal/Mass Balance

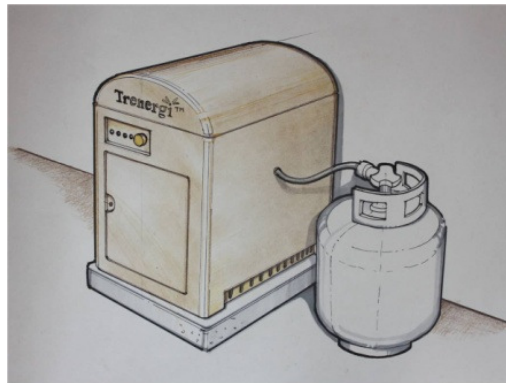


Trenergi, a generation skipping clean energy technology, offering residential combined heat and power solutions to the global residential energy market.

This presentation is incomplete without the accompanying oral discussion.

Trenergi Generation Skipping Technology Solution

A reliable and affordable global residential energy solution for places where energy is not available or the grid is unreliable and frequently not operating.



Multi-fueled – natural gas, propane, diesel
3-n-1 energy output – electricity, heat, hot water

Low maintenance

Near silent operation

High Temperature PEM (HTPEM)



Differentiators vs LTPEM

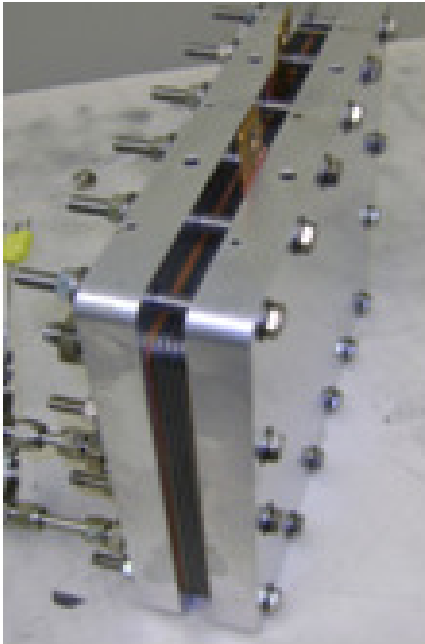
- Operating range 160 to 180°C
- Does not require high purity hydrogen
 - 70%
 - Up to 2% CO
- High efficiency (>80% in CHP mode)

Cost Benefits

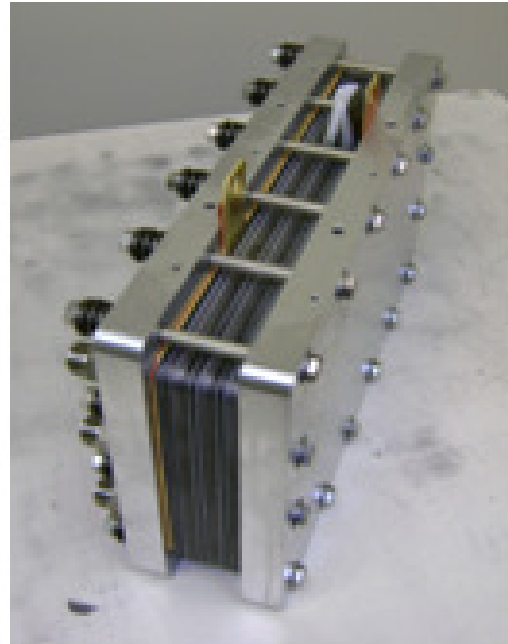
- Simple reformation process
 - Simplifies system controls
 - Lowers manufacturing costs
 - Physically small reformation system
- Projected life exceeds 40,000 hours



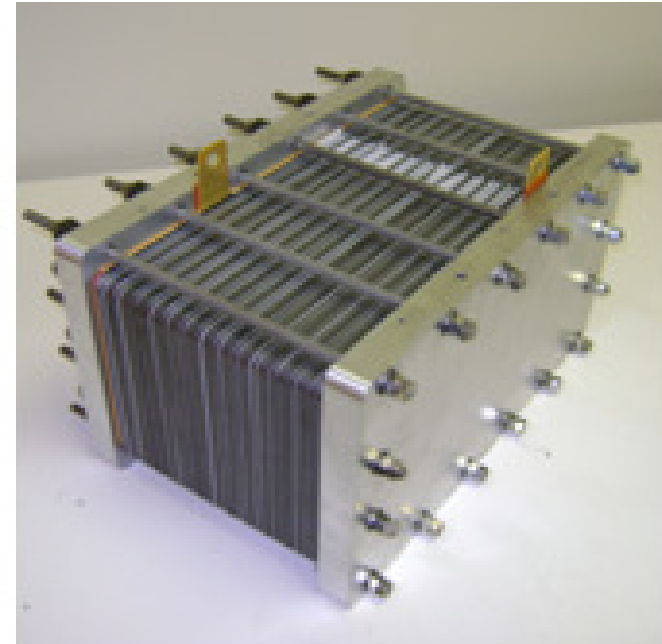
Stack Evolution



Gen I – 3 Cells

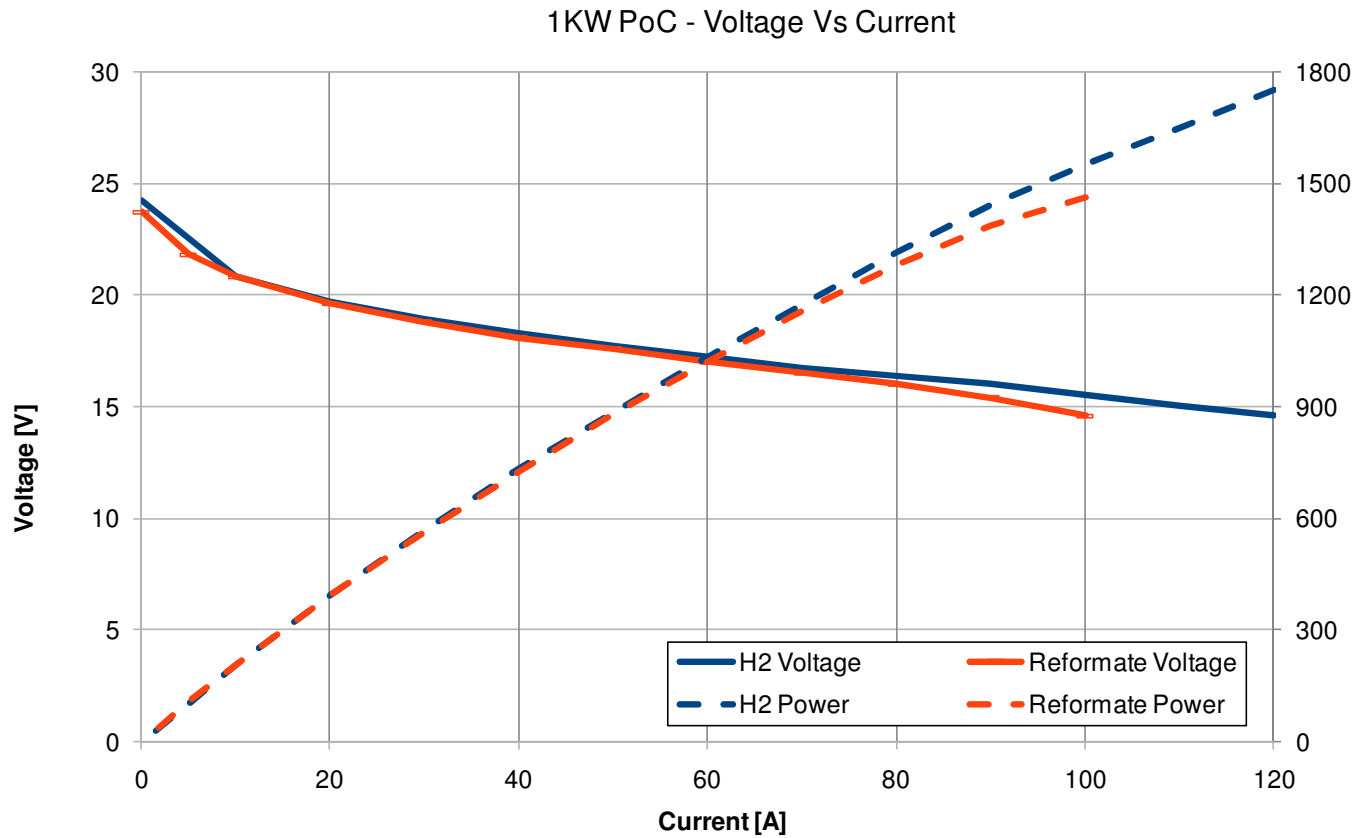


Gen II – 6 Cells

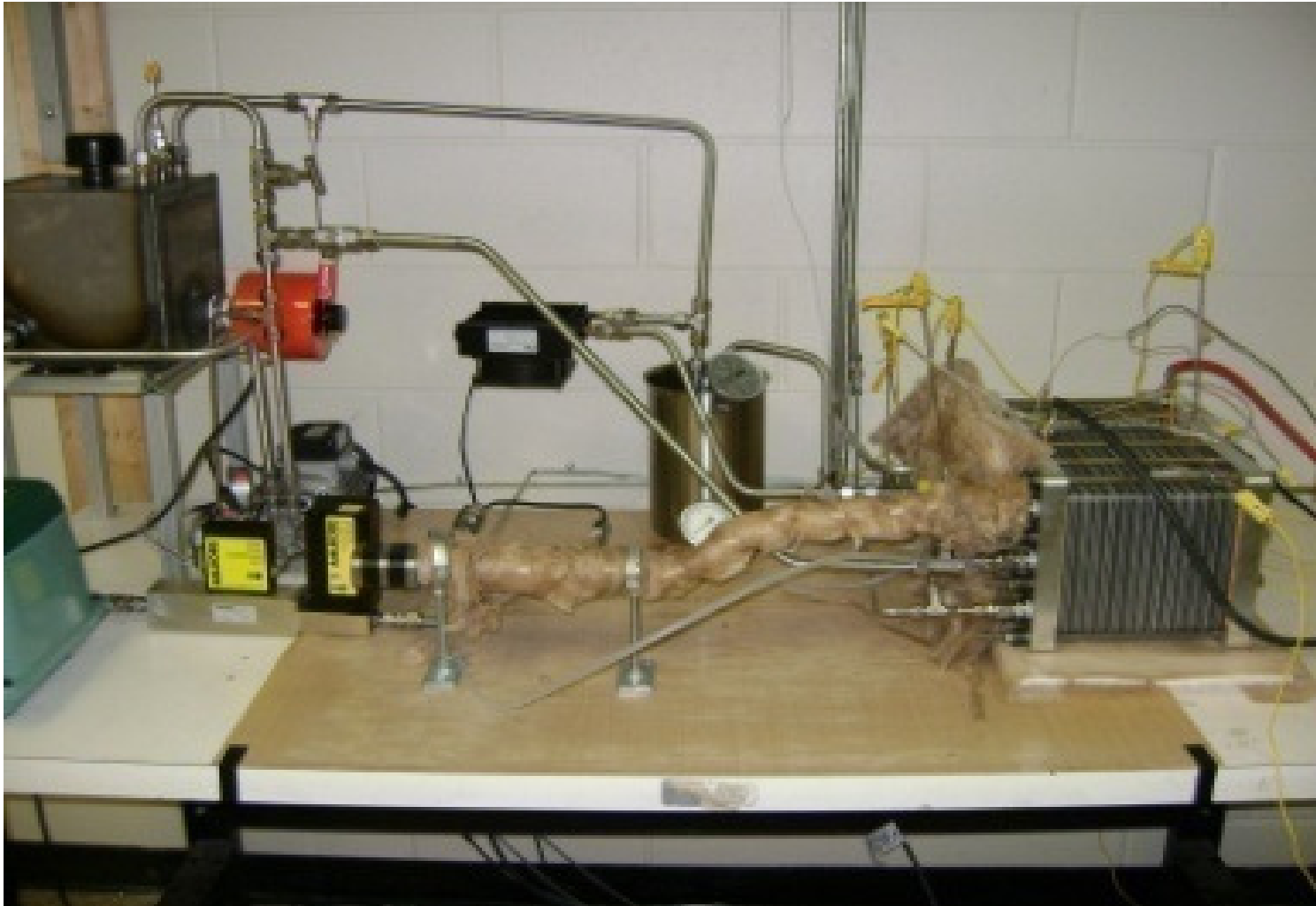


Gen III – 26 Cells

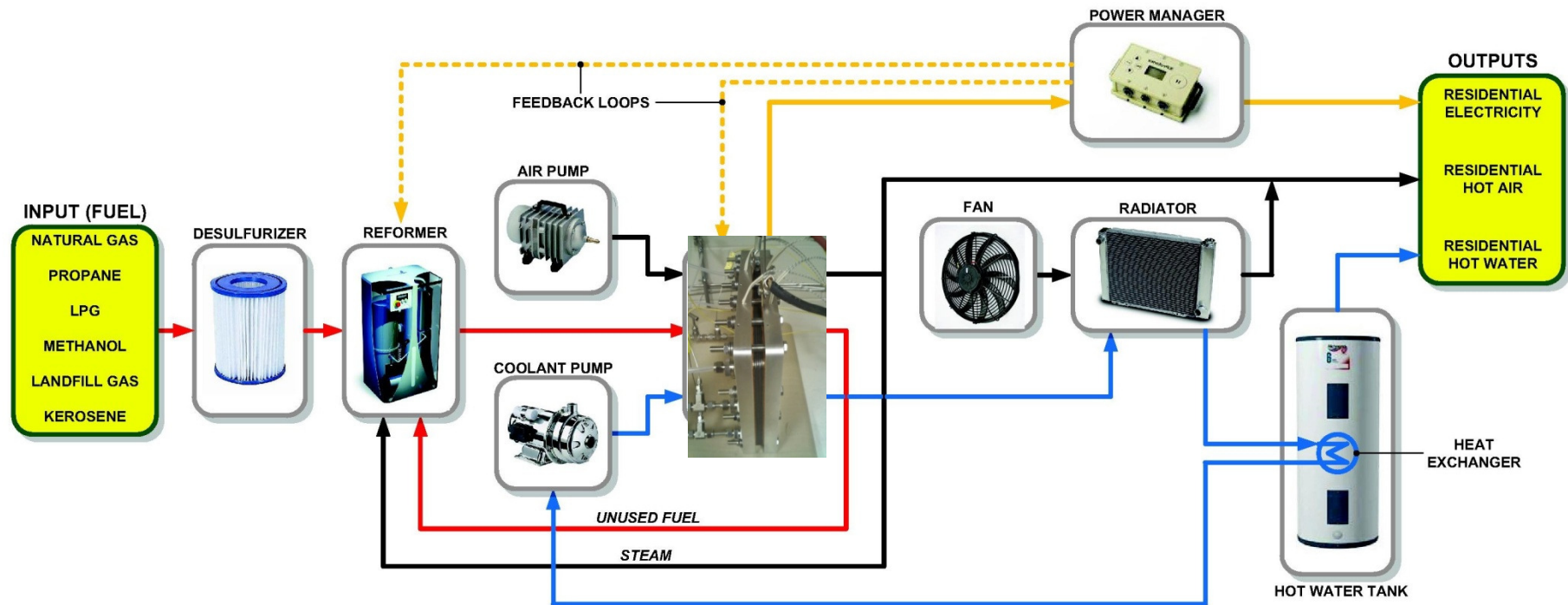
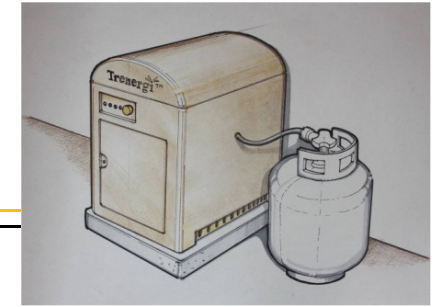
1.2 kW Stack Performance



POC Breadboard Demo



Trenergi micro-CHP System



Our system is less complex, carries a lower manufacturing cost and provides a higher efficiency 3-n-1 source of electricity, heat and hot water.

Patents Pending

Stack Manufacturing

Covers both the mechanical design of stack and the assembly process to reduce cost and ease manufacturability.

MEA Structure

Covers advanced MEA technology yielding increased power density and durability:
Contributes to higher output stack at lower cost.

More in the pipeline

What is the market saying



Global Market

Disruptive Technology

Significant Growth Forecast

“Global shipments of grid tied residential fuel cell mCHP systems could reach 6 million units, annually, by 2017 under a base case forecast.”

Kerry Ann Adamson, **Pike Research, July 2011**

“Fuel Cells Represent Disruptive Technology.”

James Horwitz, Fuel Cell Intelligence, April 2009

“Global demand for stationary fuel cells is projected to increase from \$122.9 million in 2010 to \$2.6 billion in 2017.” WinterGreen Research, March 2011

“Fuel cell technology is the answer the user’s demand for increased power.” Frost & Sullivan, Industry Progress Report, February 2010

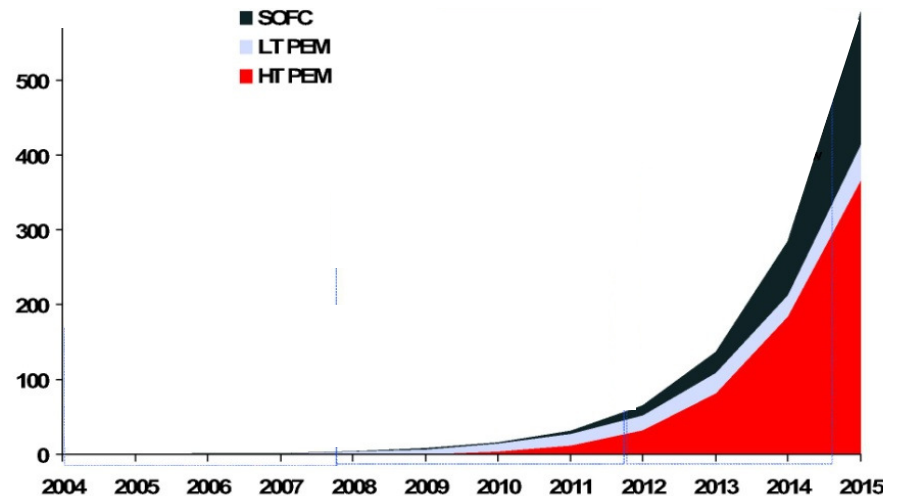
“Air pollution emissions from FCSs are reported as the lowest of any fossil-fuel-based power generation, and significantly lower than engine or gas turbine combustion.” DOE PNNL December 2010

“Renewable energy is intermittent and needs stationary fuel cells to achieve mainstream adoption as a stable power source.” WinterGreen Research, March 2011

“Combined Heat and Power (CHP) offers several distinct advantages over many other electricity and thermal energy generating technologies with regard to performance, availability, and cost.” DOE NETL June 2009

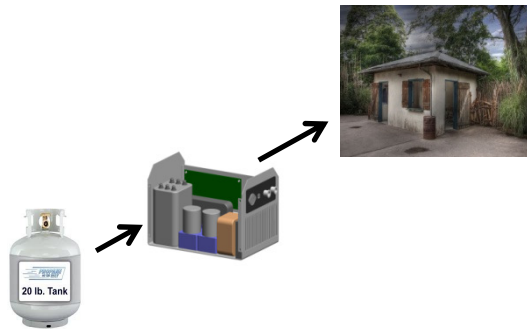
m
W

Residential Fuel Cell CHP Market Growth



Source: Fuel Cell Intelligence, James Horwitz Assoc. Oct 2008

Points of View



Developing Country Needs

- First Power
- Fuel Flexible Power
- Power Without the Grid

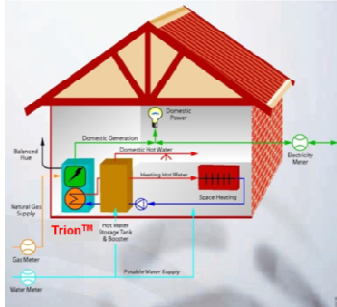
Developed Country Needs

- Energy Reduction
- Reduce Emissions
- Power Generation
- Financial Payback



Global Market Applications

Home, Condo and Apartments



Multi-fueled high efficiency 3-n-1 energy source. Low maintenance. Silent power.

Cell Tower Back Up



Easily refillable energy for long duration power outages. Silent power.

Police & Fire Station Back Up Power



Silent power. Easily refillable energy. Hot water source. High quality power.

Auxiliary Power Units



Uses common fuel. Silent power. Reduced to no vibration. Light weight.

Synergistic Department of Defense Applications

Silent Fuel Efficient Replacement
Of Tactical Quiet Generators (TQG)



For only 2 kW & 3 kW the potential is to
replace 30,000 units over 4 - 5 year period.

Power Source For Long Duration
Unmanned Underwater Vehicles (LDUUV)

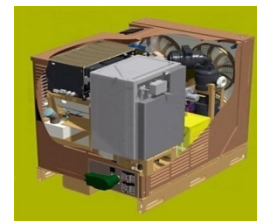


Priority program has potential to yield
significant development funding.

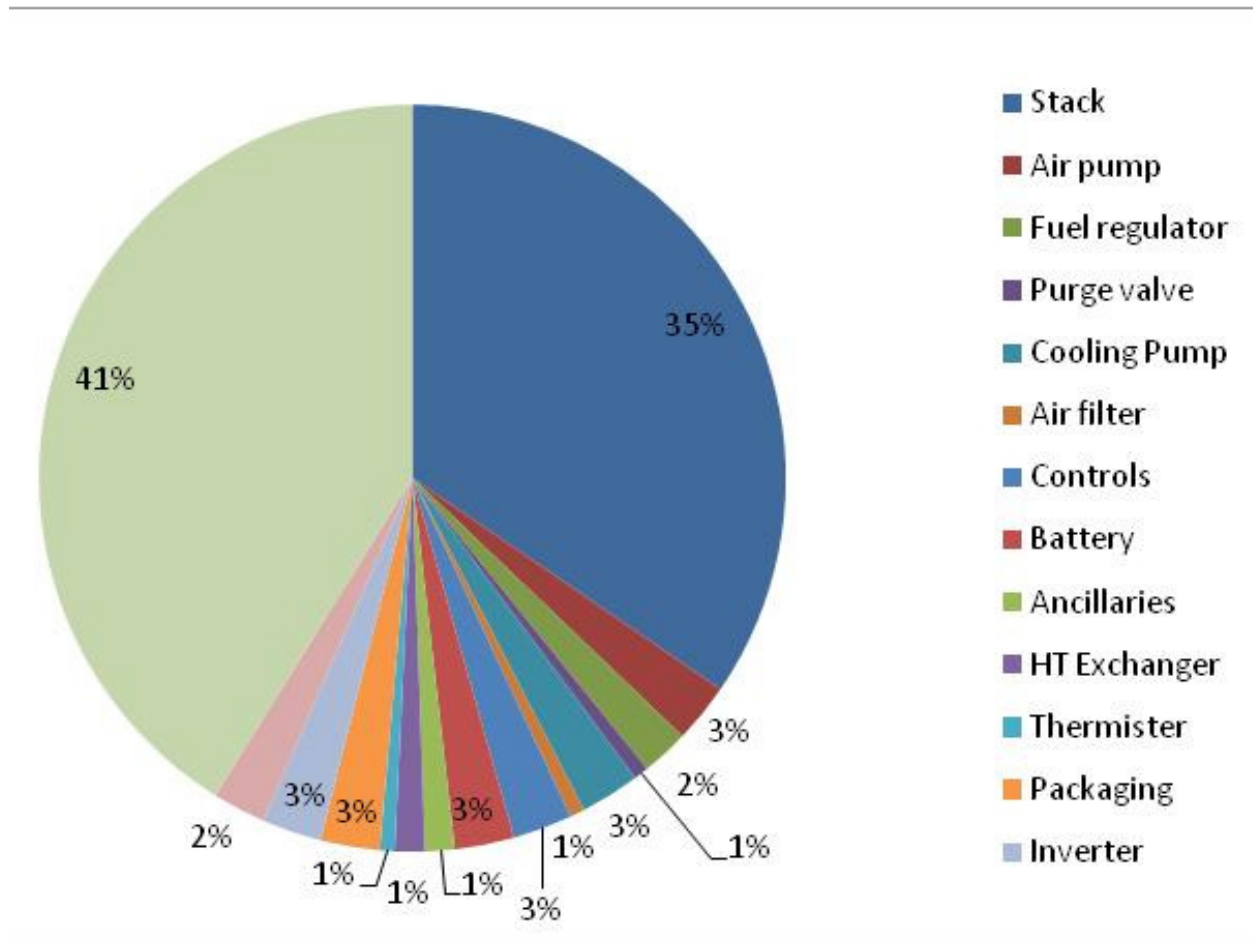
Forward Operating Base Power
Primary, Back Up, Kitchens



Auxiliary Power Units (APU)
Aircraft, Combat Vehicles, Other



System Cost Breakdown



It's Your Turn

Questions?

Comments??

