Solid-state ionic heat engine for CHP

OCTOBER 21-22, 2015
10 C-TEC CHP Generator

2500 $W_{LHV}$ to 1 $kW_{DC}$

95% LHV-heat combustion efficiency

38% LHV-e(DC) without bottoming cycle or inverter
Project Team

• NanoConversion Technologies, Inc.
  ◦ Developing C-TEC based on Sodium Cycle for commercial application in 2016
  ◦ 7 years, $5MM in investment to date
  ◦ PI: Evan Green, PhD (Vice President, Product Engineering)
  ◦ T2M Lead: Mike Staskus (Chief Executive Officer)

• Gas Technology Institute
  ◦ 40 years history in industrial combustion and natural gas research
  ◦ David Rue (Institute Engineer) - advanced industrial combustion and waste heat recovery

• North Carolina State University
  ◦ Alexei Saveliev, PhD – superadiabatic and recuperated combustion

• General Electric Appliances
100 $W_{DC}$ C-TEC power block

Sodium cycle’s inherent limit is near Carnot efficiency

42%$_{h-e}$ efficiency (925/275 C)

NCT’s patented stacked-cell architecture reduces thermal parasitic losses and limits device Ohmic losses
2.5 kW\textsubscript{th} Superadiabatic Burner

Porous media combustion and flow recovers nearly 100\% of exhaust heat

90-95\%\textsubscript{LHV-th} efficiency

NOx below 5 ppm
Combustion System

• SAC attains ultra-low NOx by firing with higher than normal excess air

• An SAC burner recoups nearly all heat from the exhaust gas by counter-flow through porous medium

• With low wall losses and near zero exhaust gas losses, all combustion heat is transferred to the load
2 year program deliverables

• Key technical milestones for 100W @ 42% C-TEC device

• 2.5 kW$_{th}$ SA burner at 90%$_{lhv-th}$
  ◦ Demonstrated NOx, CO, VOC, particulate, noise requirements
  ◦ Efficient heat exchange from 1600 K burner to 1200 K C-TEC hot side

• Integrated system for 3$^{rd}$ party testing
Kickoff meeting goals

• Introductions and access to:
  ◦ Affordable thermal and FEA analysis
  ◦ Electrochemical and mechanical design expertise
  ◦ System manufacturers and other technology adopters
  ◦ Utilities and users for field trials