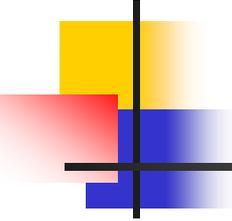


THERMOELECTRICAL ENERGY RECOVERY FROM THE EXHAUST OF A LIGHT TRUCK



2003 DEER Conference
August 24 - 28, 2003
Newport, Rhode Island

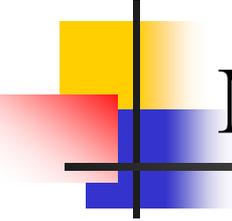




Topics

- Motivation and Project objective
- Team composition and tasks
- Funding and in-kind support
- System modeling and simulation
- Test plan
- Draft commercialization plan results
- Future Studies

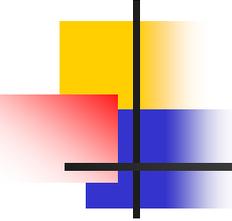




Motivation

- Increase fuel efficiency and reduce emissions
- Increasing electrical loads
- CAFE regulations





Project objective

Create a prototype exhaust thermoelectric generator that supplies a net 330 W to the vehicle bus

- Designed for nominal 12 V bus.
- Estimated fuel economy increase: 5% for typical driving cycle



Team composition and tasks

Eric F Thacher
Project Coordinator
Clarkson University
Vehicle Integration
& System Testing

Brian T Helenbrook
Madhav A Karri
Clarkson University
System Modeling

Marc S Compeau
Clarkson University
Commercialization

Aleksandr S. Kushch
Norbert B. Elsner
Hi-Z Technology, Inc.
TEG Design & construction

Mohinder Bhatti
John O' Brien
Delphi Corporation
Testing & Engineering
services

Francis Stabler
General Motors Corporation
Test Vehicle



Funding and in-kind support

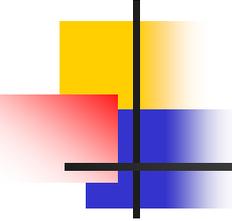
New York State Energy Research and Development Authority
Project Funding – Joseph R. Wagner **Senior Project Manager**
Transportation Research

Department of Energy
John W. Fairbanks – Project Manager
Light Truck Clean Diesel Program

Delphi Corporation
Wind tunnel testing services of up to 2 weeks
Engineering services of up to 160 hours

General Motors Corporation
Test Vehicle – 1999 GMC Sierra 1500





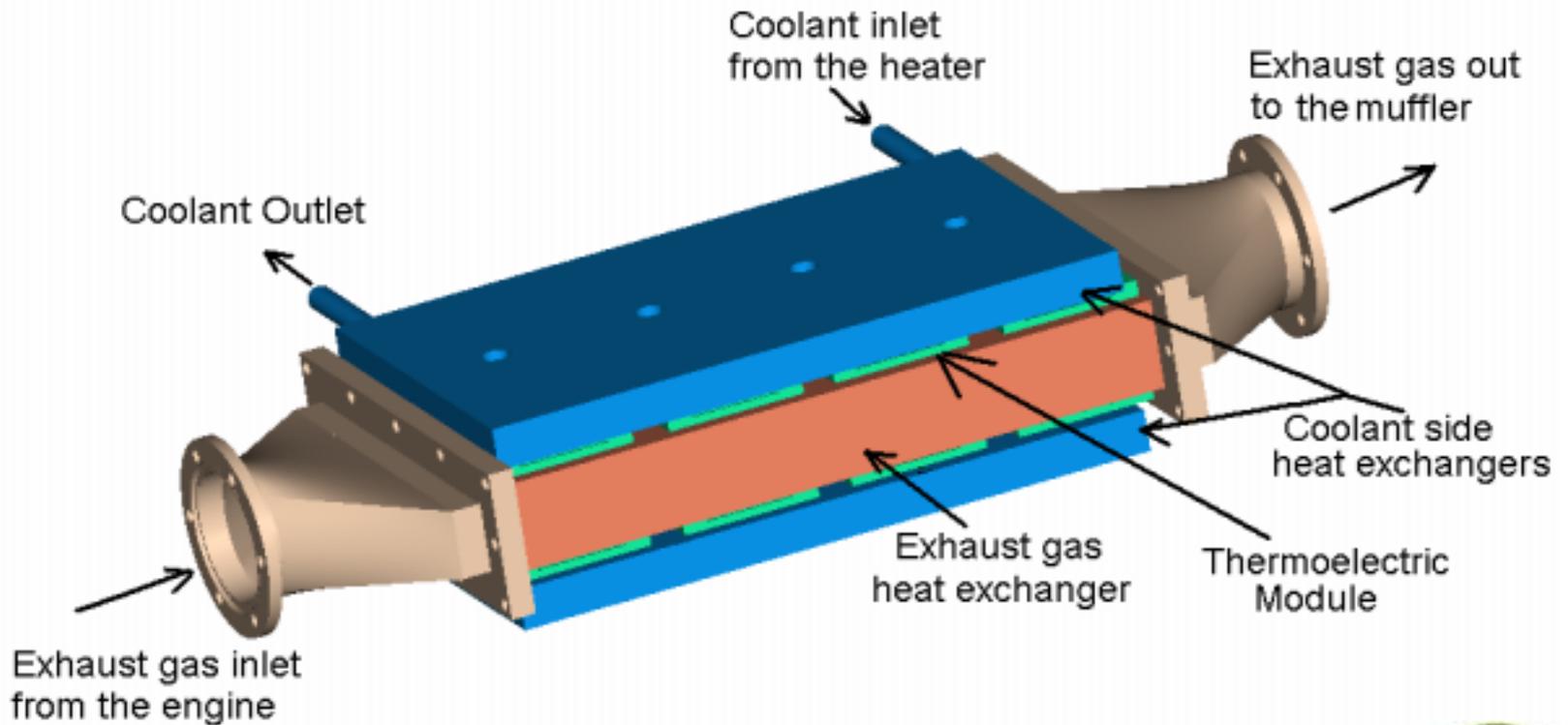
System

- Thermoelectric generator (TEG)
 - Heat source – Exhaust gas from the engine
 - Heat sink – Coolant tapped from the vehicle's Coolant system
 - Thermoelectric modules – Hi-Z's HZ-20
- Power conditioning unit



Thermoelectric generator

Shown without case



Hi-Z's HZ20 Thermoelectric Module & Properties

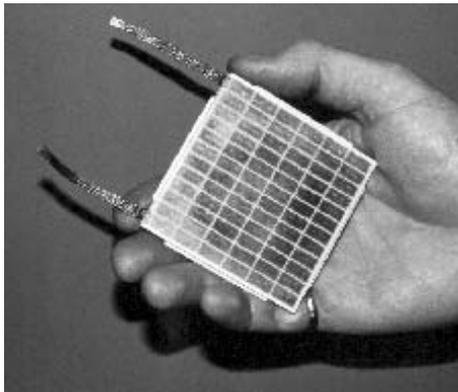
Value

Thermal Properties

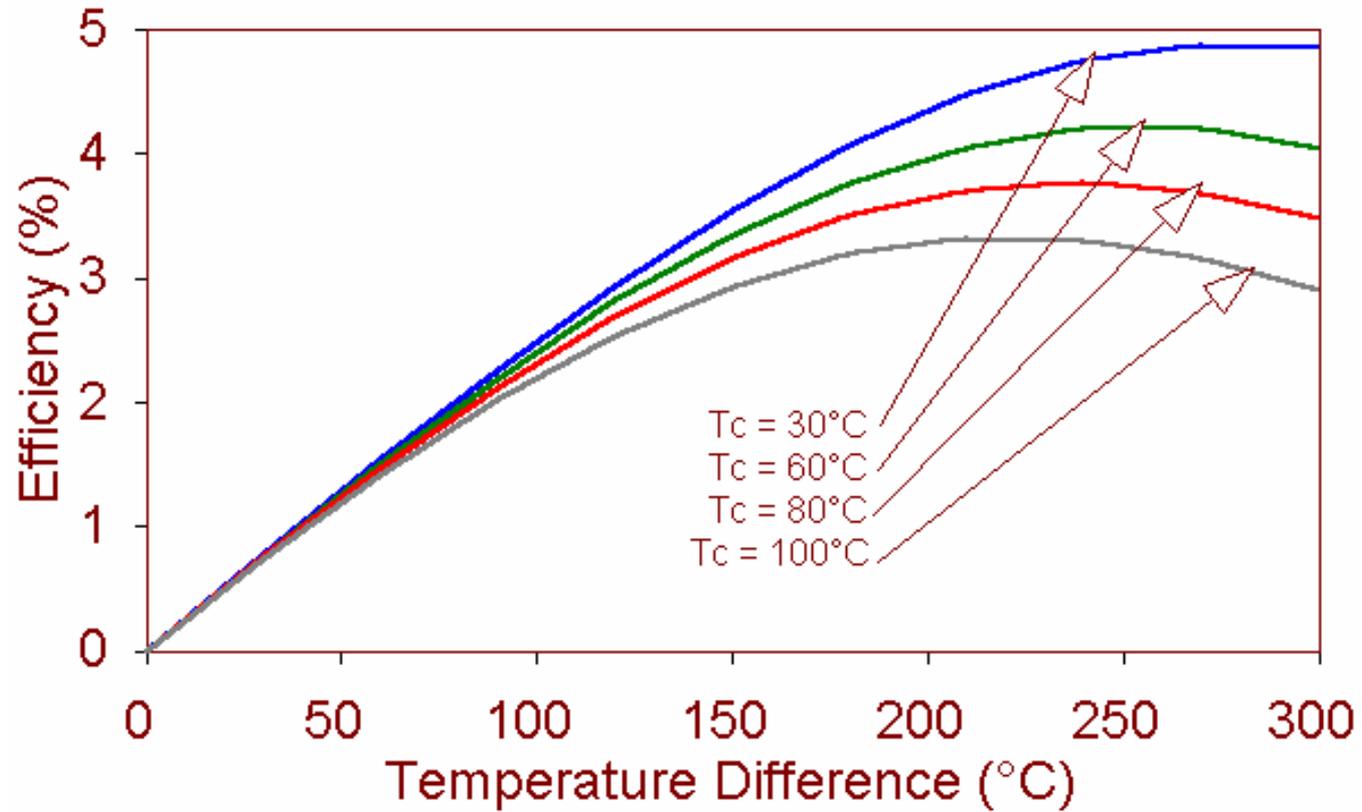
Design hot side temperature	230 C
Design cold side temperature	30 C
Maximum continuous temperature	250 C
Maximum intermittent temperature	400 C

Electrical properties at design temperatures

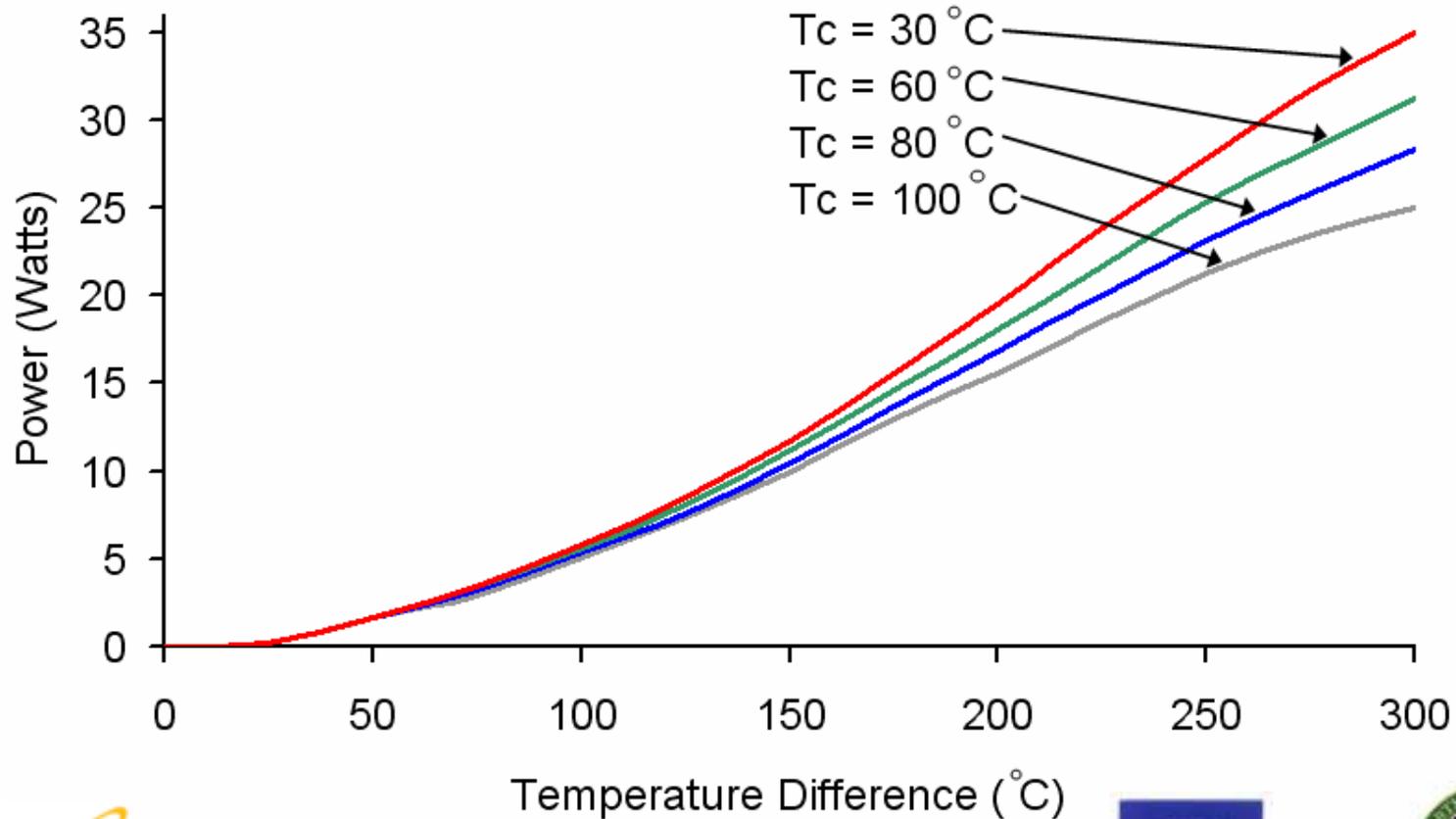
Power	19 Watts
Efficiency	4.5 %



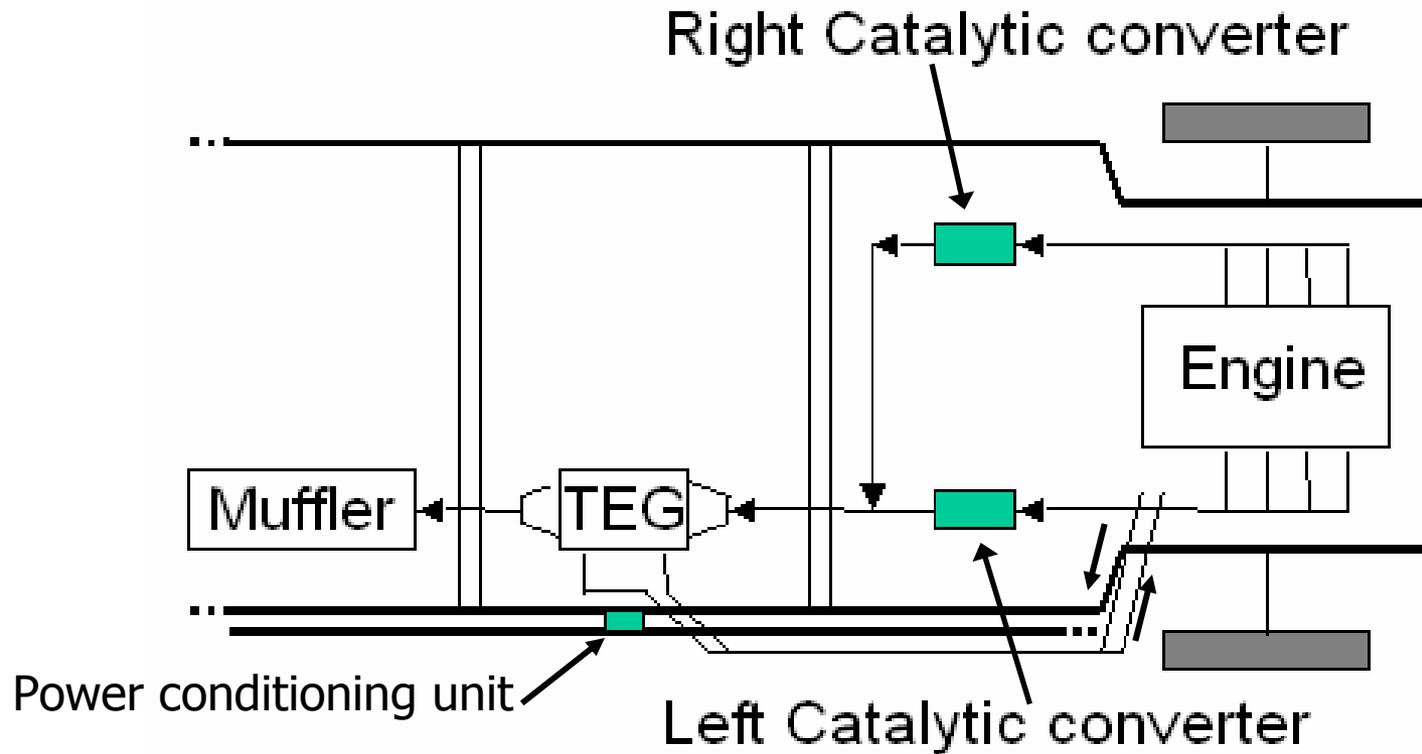
Hi-Z's HZ20 Thermoelectric Module Efficiency Curves

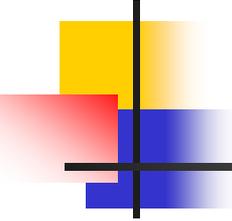


Hi-Z's HZ20 Thermoelectric Module Power Curves



AETEG system physical layout



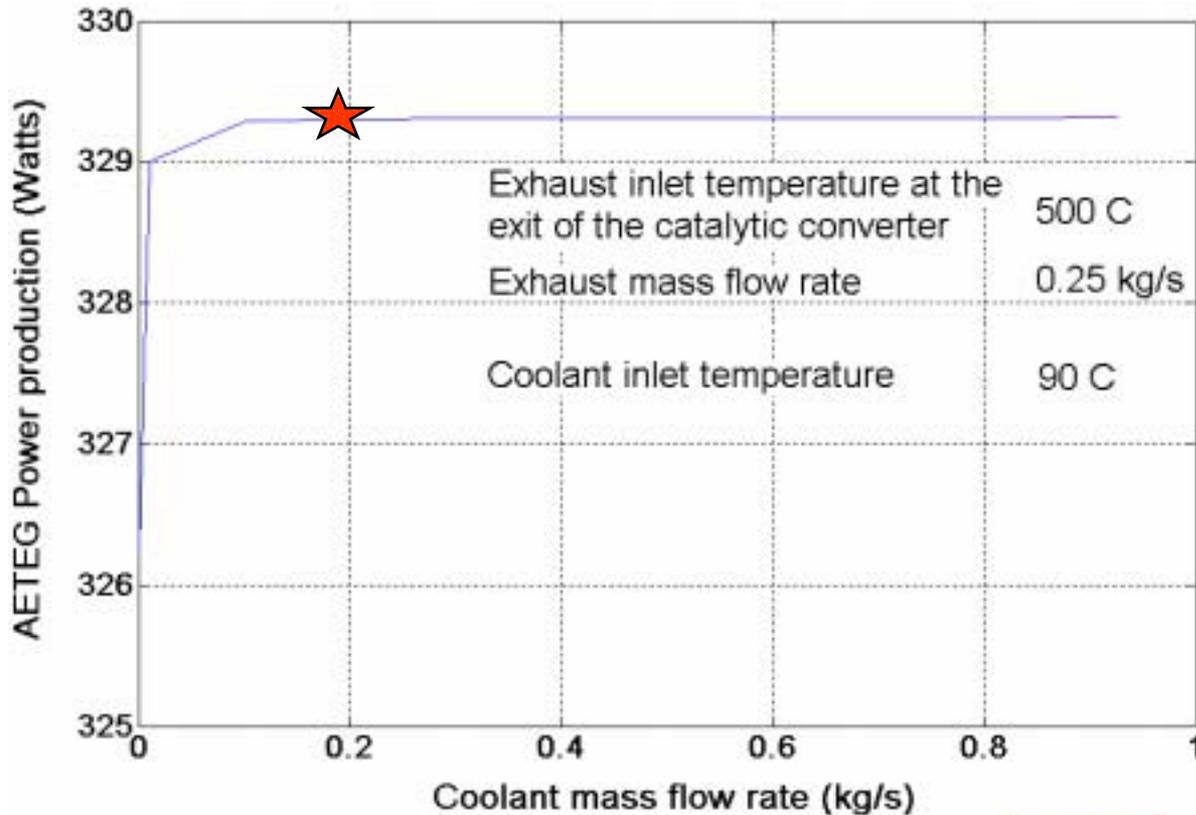


System modeling – components

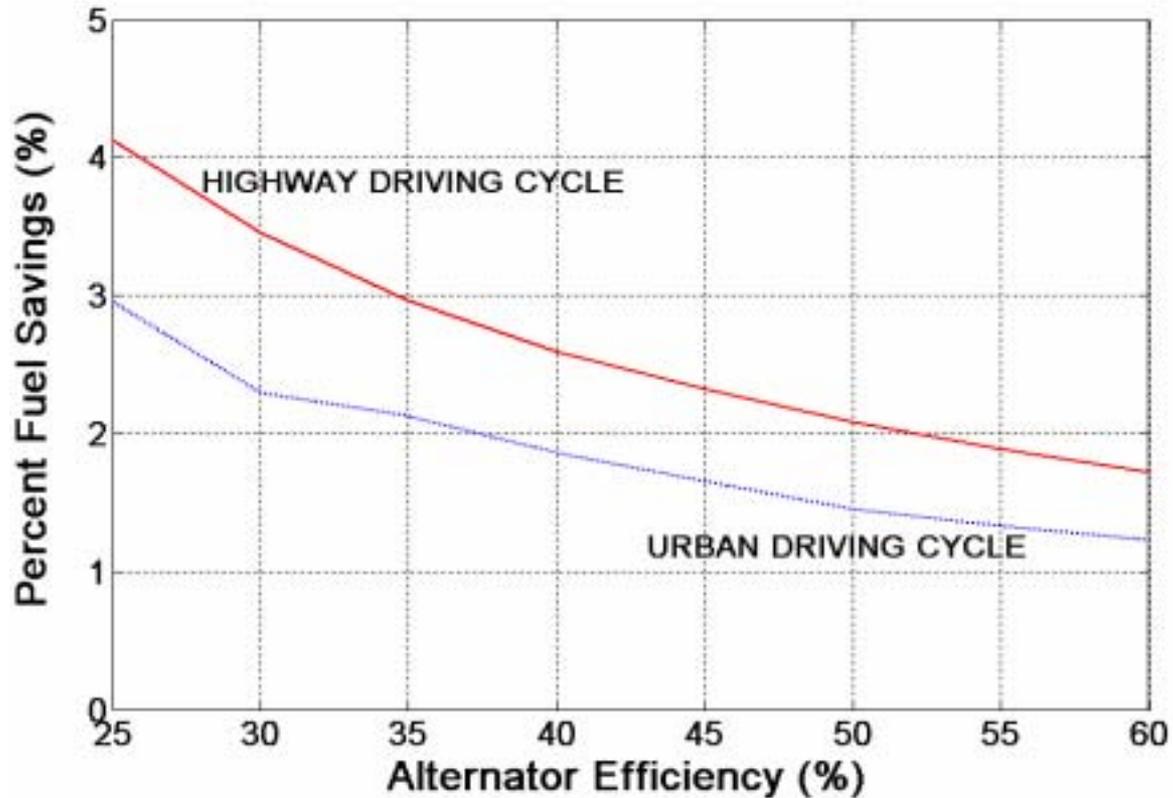
- Exhaust system
- Coolant system
- TEG
- Electrical system
- Simulation platform – Matlab/Simulink
ADVISOR

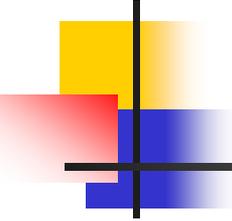


Sensitivity of power to coolant flow rate



% Fuel savings vs. Alternator system efficiency





Test plan

Objectives

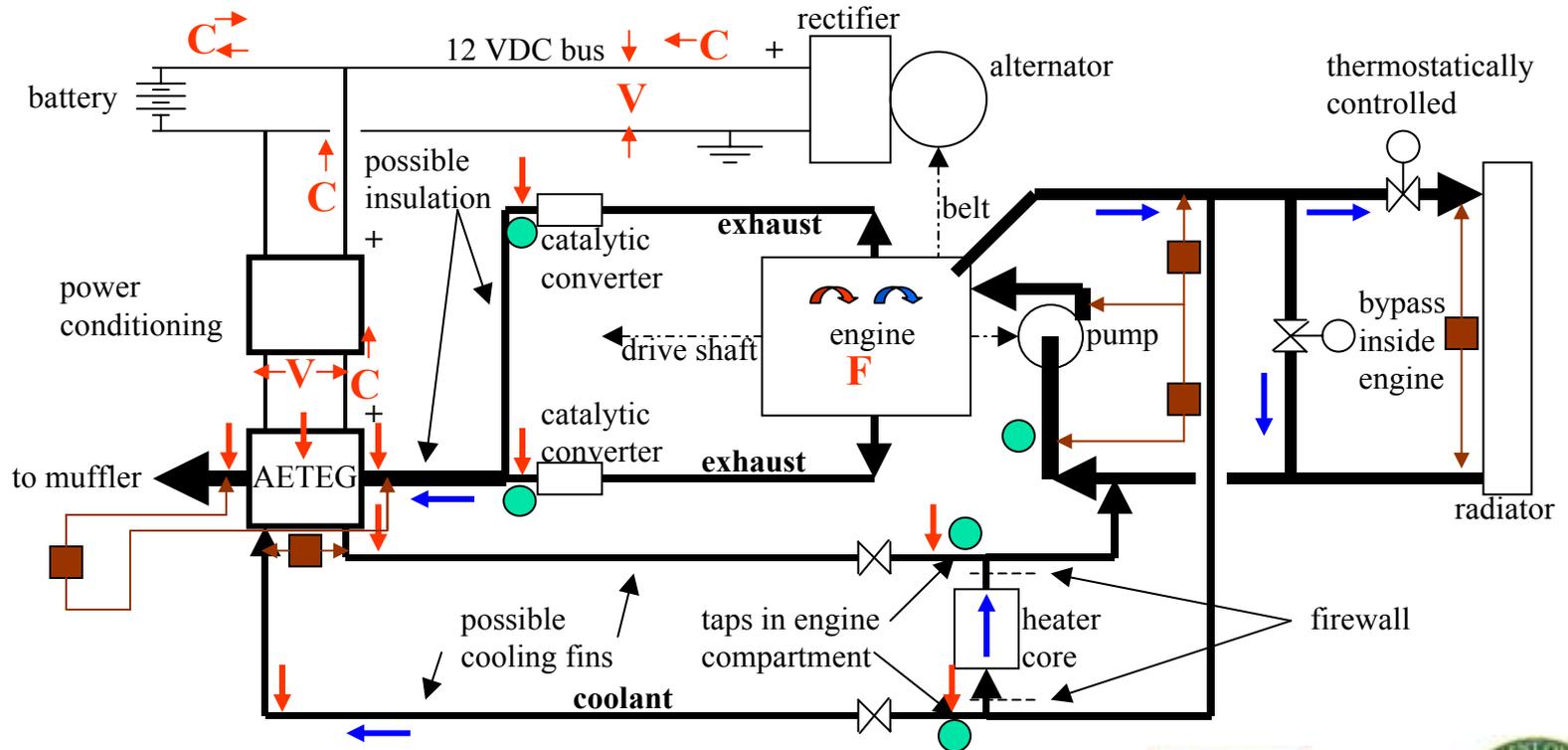
- To evaluate the performance of TEG
- Validation of system modeling and simulation code
- Effect of TEG on the complete system



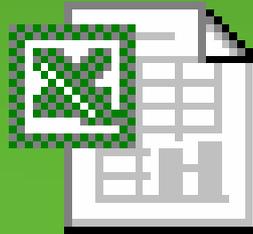
Test plan

Measurements

Voltage V Current C Fuel consumption F

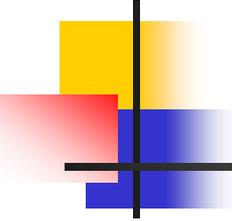


Draft commercialization plan results



DRAFT
COMMERCIALIZATION
PLAN RESULTS

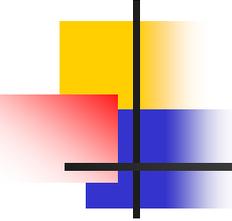




Future performance studies

- Application of AETEG to HYBRID Vehicles
- Application of AETEG to Natural Gas-fueled generator
- Current and Quantum well modules
- System optimization studies





Conclusions

- TEG is potentially commercially viable especially with quantum well technology
- 330 Watts generation is feasible
- More work needed in integrated design

