Summary of Comments

Proposal 10-01-06T Natural Gas, Ranked # 1
Multi-fuel Super-Compound Engine Efficiency Analysis
David Onstenk

PROJECT OBJECTIVE:

- Proposes to determine the feasibility of multi-fuel super-compound engines for use in light-truck transportation. Target performance is a 30% increase in light-load efficiency over conventional naturally aspirated gasoline engines measured at 25% load and 2,500 rpm.

FUNDING RECOMMENDATION:

- Recommended for funding. Eligible for funding contingent upon a satisfactory response to request for clarification for minor modifications.

PUBLIC INTEREST BENEFITS:

- The proposed technology has the potential to increase fuel economy and mileage for individual and fleet consumers.
- The proposed technology has the potential to optimize total compression and expansion ratios based on fuel type, to achieve higher efficiency and power when using higher octane natural gas and ethanol fuels, thereby allowing multi-fuel vehicles to achieve superior efficiency to diesel technologies.

STRENGTHS:

- Successful application of this analysis will provide engine model performance in the public domain, which is currently not available.

WEAKNESSES:

- No significant weaknesses noted.

CLARIFICATIONS / CONDITIONS:

- Needs to address the numerous concerns raised by the technical reviewers regarding efficiency claims and technical detail.

California Energy Commission Energy Innovations Small Grant (EISG) Transportation Program **GRANT APPLICATION COVER PAGE**	**FORM A**

a. Project Title: Multi-Fuel Super-Compound Engine Efficiency Analysis
(not to exceed 10 words)

b. Project Subject Area: (*Indicate the one that most applies*)

☒ Vehicle Technologies ☐ Transportation Systems
☐ Alternative Fuels

c. Applicant Category:

☒ Individual ☐ Academic Institution
☐ Small Business ☐ Non-Profit

d. Grant Funding Requested: $ 95,000 ☒ Hardware $95K ☐ Modeling $50K

e. Proposed Project Duration: 12 months *(maximum duration 12 months)*

f. Principal Investigator/Project Manager: *(serves as single point of contact for all communications)*

Name: David Onstenk	Address: David Onstenk 1034 Summit Ave. Napa, Ca 94559
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Email: dave@ExergyTechnologies.com	
Organization: Exergy Technologies	
Position/Title: Founder	

g. Proprietary/Confidential Information:

☐ NO – Proposal does not contain proprietary information, unrestricted distribution authorized.

☒ YES - Proposal contains proprietary information, restrict distribution and disclosure.
(clearly mark and label those sections that are proprietary on all copies)

h. Application Status *(include only prior submissions on same concept)*

☒ First Submission ☐ Second Submission ☐ Third Submission

Provide the proposal number(s) assigned to prior submission(s): _____

i. Indicate the Solicitation Number Listed on the Solicitation Notice: _____

j. Indicate the Solicitation Number Printed on the Application Manual Used: _____
(the solicitation numbers listed in items i and j must match)

k. Principal Investigator/Project Manager Certification: To the best of my knowledge, I certify that the information contained in this grant application package is true, and discloses all requested information.

Principal Investigator/Project Manager Signature: David Onstenk **Date:** 3-28-10

Reserved for EISG Program Administrator Use		
Solicitation	Date Received	Proposal Number Assigned
10-01T NG		

Project Summary
Multi-Fuel Super-Compound Engine Efficiency Analysis
David Onstenk, Principal Investigator

The goal of the project is to determine the feasibility of multi-fuel super-compound engines for use in light-truck transportation, where fleet average vehicle mileage has improved less than 1 mpg over the last 25 years. Target performance for the project is a 30% increase in light-load efficiency for a GM Ecotec engine. This would exceed the averaged city/highway gains of 20% from the 2010 GM 1500 Hybrid and exceed new café regulation. The project will focus on light-load engine operation, where the vast majority of transportation fuel consumption occurs.

This is important and unique pioneering research into the field of piston compound engines: a field of research that has been dormant for over 80 years, and a field that offers great promise for reducing criteria and carbon emissions from transportation and power generation markets.

Current state-of-the-art in light-truck transportation is represented by naturally aspirated port-injected four-stroke gasoline engines. Turbocharged gasoline and gasoline hybrid powertrains each represent < 1% of vehicle sales, and diesel engines represent < 2% of vehicle sales. The problem being addressed is natural gas transportation energy efficiency; a core subject for PIER. Currently, 75-80% of light-duty transportation fuel is wasted by the engine during energy conversion due to poor light-load efficiency. These core technologies will also address natural gas environmentally preferred advanced generation (EPAG) research areas of PIER.

The project will establish light-load thermal efficiency for a stock GM Ecotec engine through dynamometer testing. The test results will be used to validate commercial and private engine models based on the tested Ecotec engine. The models will then be modified to a proprietary tri-flow supercharged compound configuration of the same Ecotec engine and used to establish efficiency estimates for the proposed designs. This is the best possible evaluation short of physical prototyping and testing, which are beyond the budget limits of this grant program. The results established in this project would provide solid justification for funding of physical prototyping and testing under a different grant program such as PIER or SBIR.

California rate payers could save on the order of 5 billion dollars per year by 2030 through successful commercialization of these technologies. Low manufacturing costs, low emissions, low noise, fuel flexibility, weight savings, high performance, high efficiency and short payback periods would allow significant market penetration where other technologies have failed.

A typical Ford F-250 NG truck that currently achieves only 15 mpg equivalent could achieve up to 25 mpg equivalent with these technologies. High net efficiencies would allow for smaller tanks, greater range and lower operating costs for NG and multi-fuel vehicles, increasing the adoption rate and use of NG and multi-fuel vehicles. Commercialization would be by licensing to major engine and vehicle manufacturers such as Cummins and Ford. Patents are being filed and private capital is being pursued over the next few months to support commercialization. A successful grant proposal through EISG would be key in securing the first round of investment.

Statement of Work

Multi-Fuel Compound Engine Efficiency Analysis
David Onstenk, Principal Investigator

Project Goal: The goal of the project is to determine the feasibility of multi-fuel super-compound engines for use in light-truck transportation.

A stock Ecotec engine will be operated on gasoline during dynamometer testing. Data will be collected and evaluated at 1,500 rpm, 2,500 rpm and 3,500 rpm operating points at 100%, 50%, 25% and 10% load. Light-load efficiency will be based on operation at 25% load (25% of peak engine torque), a good estimation for average use during driving cycles.

Commercial and private engine models will be developed based on the stock engine and cross validated with each other and test data to within +/- 5% at 25% load operation. The private engine models will allow analysis of instantaneous engine friction, crevice, heat and component losses; information not available in commercial engine simulation programs. These models will then be modified to the compound configuration of the same engine and cross validated for accuracy. Final performance estimates will be analyzed and compared with the stock test data and stock engine models. Progress and final reports will be delivered per the project schedule.

Project Tasks	Performance/Cost Objectives
1) Dynamometer testing of stock Ecotec engine	
2) Simulation of stock Ecotec engine with commercial engine simulation program and highly detailed private spreadsheet model	
3) Cross validate program and model	Demonstrate simulation agreement for efficiency to within +/- 5% at 25% load
4) Validation of program and model with test data	Demonstrate simulation accuracy for efficiency to within +/- 5% of test data at 25% load
5) Modify program and model for compound configuration	
6) Cross validate program and model	Demonstrate simulation agreement for efficiency to within +/- 5% at 25% load
7) Generate performance estimations	Demonstrate 25% load thermal efficiency improvement of 30% or more above the stock engine configuration

Reporting Requirements:

Submit Progress Reports and Final Report in accordance with the proposed Project Schedule/Deliverables Chart.