Following the **energy flow** in an internal combustion engine.

**Target Grade Levels:** 9-12

**Subject Areas:** Industrial technology, PLTW, vocational agriculture.

**Time Required:** 6-7 45 minute class periods

**Lesson Objectives:**
1. Theory of operation of an internal combustion engine
2. Energy balance on ICE engine
3. Ethanol as a fuel
4. Thermodynamics
5. Fluids
6. Stoichiometry calculations
7. Carbon footprint
8. Math: calculating volume of a cylinder

**Learner Objectives:**
1. Explain four strokes in an engine
2. Explain the difference between chemical energy, thermal energy, and mechanical energy
3. Follow the flow and transfer of energy through and engine.
4. Compare and contrast parts of a single cylinder engine to a four-cylinder engine
5. Configure a carburetor on an engine that is very efficient.

**Materials Required:**
- Small engines from the shop
- Calculators
- Dial calipers
- Skype capability
- YouTube video from 449 engines lab
- Baja and or Formula One vehicle

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**Lesson Summary**

There is a finite amount of fossil fuels found on the earth’s surface. In order for America to retain its competitive edge in a global market place it must conserve the consumption of fossil fuels. America has developed an effective ground transportation system across the entire country. Industries and businesses in America rely heavily on moving raw materials and finished consumer goods quickly, reliably, and at a nominal price. The United States has built an entire infrastructure based upon the utilization of the internal combustion engine.

The energy balance method accounts for energy flow in a system. By accounting for all known energy flows, sources of loss and inefficiency can be identified. The basic function of the internal combustion engine has not changed since its inception. The potential fuel energy going into an engine is 100% and the output will be far less than 100% due to the following; 40% exhaust, 30% coolant, 5% friction and parasitic loss, and the rest 25%, will move the vehicle down the road.

The American government has already mandated laws that will increase fuel economy and reduce emissions in the transportation industry.

It is imperative for students to realize that one day that the inhabitants of the earth will run out of fossil fuels. Current high school are in a position to make a difference by doing the following; selecting a more fuel efficient car to drive, or becoming an mechanical engineer and designing a more efficient car.
Lesson Plans

This activity on will be conducted with the introduction to technology class. This is a class typically composed of freshman and sophomore students. The introduction to technology class will have several small engines to work on. Students will have to take engines apart in order to identify the various component and parts. Students will also be given worksheets and formative tests to determine content knowledge. Students will also perform a series of real world tests in order to obtain the best stoichiometry for the engine.

Dr. Kong, Ryan Ogren, and Aaron Bertram will be communication via e-mail with the industrial technology instructor. The ISU representatives will share a YouTube video with our students on the diagnostic tests covered in the 449 engines class at ISU. There will be a series of Skype sessions in order to give the high school students insight into an actual teaching and research engine(s) lab. The capstone activity for the 2015 partnership will be a visit from Dr. Kong and the graduate students from ISU. The visit may include engineering student groups such as the Baja and the Formula One club. These clubs will bring a vehicle to our school in order to demonstrate engineering concepts that went into the design and construction of the various vehicles.

Outcomes from an ISU partnership

Promote Mechanical Engineering as a viable career choice

A STEM education will open opportunities for the students

Math, Physics, Chemistry, Biology are all important to engineers

Students have to transform into informed consumers and citizens

ISU Partners

Dr. Kong, Professor Mechanical Engineering, Graduate students Ryan Ogren, Aaron Bertram