Heat Recovery on the Road - Part 1 - Sizing up the Opportunity

Understanding the untapped potential in our vehicles

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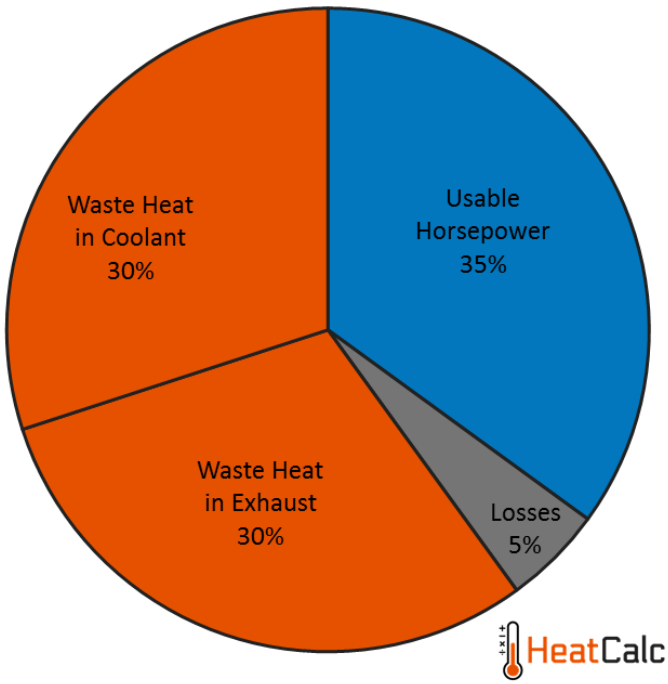
It would be great if we could use 100% of the energy contained in fuel to move us around. Unfortunately, we live in the real world, constrained by physical limitations. Efficiency differs from engine to engine but generally around 35% of the input energy (fuel) is converted to usable horsepower. With about 5% going to losses, the remaining 60% of the input energy (fuel) is wasted as heat. Think about that for a second. For every mile you travel, you are wasting enough heat to move you almost 2 additional miles!



Distribution of heat in average engine

Of course it is not so simple. You have to capture that heat with additional equipment and convert it to mechanical work (at an efficiency loss of course!). Neither of those are easy tasks when you consider the limited real estate available under the hood of a car. So why should we even consider taking on the challenge?

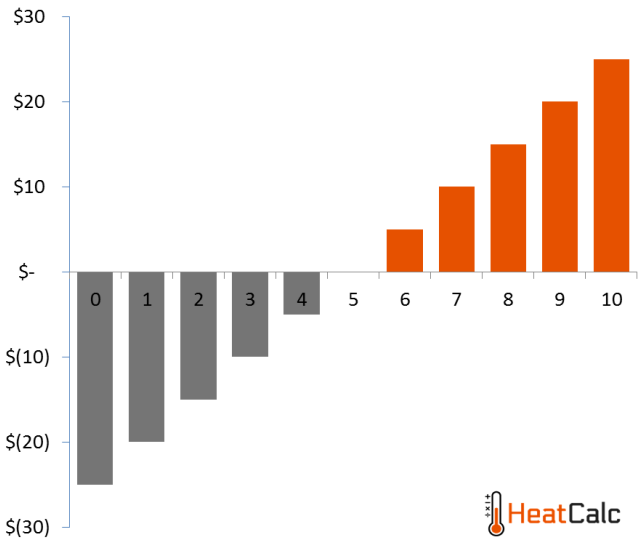
According to AllTrucking, a typical long haul trucker will log about 2,500 miles per week [LINK]. With an average fuel economy of 6 MPG [LINK] and diesel price of $2.50 [LINK], that comes out to about 20,000 gallons and $50,000 spent on fuel per year. If we could recover the wasted heat from the engine to improve fuel economy by 10%, that would come out to $5,000 per year in savings plus the reduction in GHG emissions. Multiply that by the 2 million trucks on the road [LINK] and you are looking at $10B in savings each year.

What would it take to improve MPG by 10%? Assuming a truck engine can provide 500 HP (373 kW) of mechanical power to the wheels [LINK], that gives us 320 kW of heat in both the exhaust and coolant (640 kW total). In order to improve MPG by 10% we would need our heat recovery system to provide 50HP (37 kW). So that means we need a system that is roughly 6% efficient (37kW / 640kW) in converting heat to mechanical power, assuming we are using both exhaust and coolant heat. That puts us within striking distance of the efficiency of existing technologies (more on that in Part 3 of this series).

From a financial standpoint, saving $5,000 per year on fuel sounds pretty good, but it all depends on the up front cost of the heat recovery system. A typical payback period for a new technology like this would need to be 5 years or less to make it commercially viable. That means that we need our heat recovery system to cost less than $25,000.

So there is the task: Design a system that is 6% efficient using two heat sources, costs under $25,000, and fits on a vehicle. Sounds easy enough right!?

In this series, we will take a look at some practical solutions being developed that may be able to meet the requirements for a viable commercial product. First, we need to understand just where heat can be found in an automobile.



10-yr payback for proposed heat recovery system (in Thousands USD).

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About the Author

Matt has 7 years of experience in the heat recovery and power generation industry. He also founded HeatCalc, which facilitates heat recovery projects around the world.