Name of Co: PRV Performance, www.prvperformance.com
Technology on which company is based: Air/fuel induction for improving automotive fuel economy and performance.
Funding Stage: mid
Business and Business Model
1. **Inception:** 2004

2. **Value Proposition:** The automaker will receive rights to an innovative, cost effective device that will improve engine torque and fuel efficiency of their engines -- with a small production cost differential. The manufacturing cost of PRV is estimated to be the same as a conventional manifold.

During the marketing phase, licenses will be sold to major auto manufacturers. For the cost of the license, the auto maker receives all technology developed to date for PRV including prototype development, engine laboratory development reports, specifications, drawing and test results. The automaker also receives the right to participate in development decisions at the test facility. Finally, the automaker will have PRV Performance available for consultation.

The initial cost of the license is $500,000 for the first automaker and $1,000,000 for each successive automaker. The license fee will offset most of the development costs, thereby accelerating revenue to a joint venture with the venture capital firm.

After the automaker completes design and testing for specific vehicles, a $100 royalty payment will be paid for each PRV fuel induction system installed. In recent years, global car and light truck production has average about 52 million vehicles. The Pro Forma indicates a market penetration of 0.1% in year 5, up to 15% in year 10, yielding a year 10 gross profit of US $800 million annually.

3. **Current Structure:** LLC owned by inventor.
4. **General Description: PRV performance has developed a** patented fuel-air induction to improve the performance of spark-ignited automotive engines system (U.S. patent 6,868,830). The proposed induction system uses a pintle-regulated Venturi (PRV) to create a convergent-divergent nozzle that significantly recovers the pressure drop across the pintle body and maintain a higher engine intake manifold pressure to boost engine torque. With a higher engine torque using the same amount of fuel, the fuel economy will be increased significantly. On the contrary, a conventional throttle plate causes unrecoverable pressure loss, reducing engine torque and efficiency. Specifically, engine torque is increased and fuel economy is improved while exhaust pollutants and greenhouse gases are significantly reduced by exchanging a conventional intake manifold with a pintle-regulated Venturi (PRV) induction system on a conventional spark-ignited engine.

Product
1. **Product:**

2. **Function and Benefit:** The principal investigator has been developing the proposed system for five years and a recent on-road test indicated that the gasoline engine vehicle could achieve 58 mpg for a 204-mile round trip with an average speed of 65 mph.* This proposal seeks further scientific, quantitative measurements and

* The principal investigator adapted a prototype Venturi induction system to a Honda Civic. The vehicle

characterization on engine and vehicle performance using turbochargers as well as using ethanol as a primary fuel based on the proposed PRV system. It is anticipated that the successful completion of this SBIR project will help bring this innovative technology to the market. Recently, the Obama Administration declared that vehicles must reach an average of 35.5 mpg before 2016. PRV technology will enable troubled US automakers to produce cars and trucks to meet the new fuel/emission standards with little or no expense to retool their factories, making it imperative to bring this proposed technology to market. The engine performance improvement using the proposed system is derived from four attributes of a PRV induction system:

PRV induction improves fuel economy. First, PRV fuel induction substantially reduces piston pumping losses. With a conventional manifold, pumping losses account for 16 to 40% of an engine's efficiency loss under normal cruising conditions because the air intake is at vacuum pressure (Heywood, 1988; Ferguson and Kirkpatrick, 2001). The air intake plenum of a PRV is never under vacuum and consequently, the piston pulls initially against full ambient (or turbo) pressure. Fuel efficiency is substantially improved because the wasted work of pulling against a vacuum is eliminated. Second, PRV induction vaporizes the fuel before the engine whereas a conventional manifold does not fully vaporized fuel until the compression stroke. The compression work used to vaporize fuel is eliminated with PRV induction. Third, the cooler, denser charge reduces the friction loss across the intake valves thereby further reducing pumping loss.

Engine power output is increased. Engine power is directly proportional to air flow capacity. PRV induction vaporizes fuel upstream of the engine by injecting fuel directly into the high-velocity air stream at the low-pressure throat of the Venturi. By conservation of energy, the latent heat of the fuel is transferred into a cooled fuel/air mixture. Since a higher mixture flow rate is enabled with a cooled charge, the specific power output of the engine is increased. The cooler (higher density) charge allows the engine to produce more torque and horsepower.

PRV induction reduces exhaust emission of CO_2, CO and unburned hydrocarbons. A conventional fuel injection system sprays droplets into the cylinder. Some of the droplets impinge on the cylinder walls. Those impinged droplets become entrained into crevices in the cylinder wall, resulting in incomplete combustion of the fuel and the generation of CO and unburned hydrocarbons. CO_2 reduction is accomplished by improving fuel economy.

PRV induction will deliver an even greater benefit for ethanol-fueled engines than gasoline-fueled engines. The power increase has been demonstrated on a dynamometer with a gasoline-fueled engine. PRV will use the higher latent heat of ethanol to provide additional charge cooling and in turn, a greater percentage increase in power relative to a conventional manifold.

3. **Development Stage:** fully tested prototype

Competitive Position

1. *Competitors:*

Direct Injection

Direct injection is competitive technology to PRV induction. Kevin M. Kelly

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tested on May 15, 2009 on a closed-circuit test loop between Denver, CO and Brush, CO -- the same test used since June 2007.

wrote in *Automotive Design & Production*, "The hype around ethanol continues to build as automakers and politicians promote the fuel as a viable alternative to pure petroleum, but there's one problem that continues to plague the biofuel: an average 30% reduction in miles per gallon compared to gasoline. Ricardo's Ethanol Boosted Direct Injection system uses several technologies found on diesel engines -- solenoid injectors, variable turbocharging, direct injection, variable valve timing, and exhaust gas recirculation -- to reduce ethanol's drawbacks through improving thermal efficiency and engine performance. Commercialization could occur in 3 years" (Kelly, 2009).

Direct injection must be coupled with either variable valve timing or variable valve lift to reduce pumping loss. The added technology is costly. Aaron Gold writes in *about.com*, "Direct injection systems are more expensive to build because their components must be more rugged -- they handle fuel at significantly higher pressures than indirect injection systems and the injectors themselves must be able to withstand the heat and pressure of combustion inside the cylinder." Gold adds that a Cadillac CTS is available with or without direct injection. The increase in torque is only 8%, the increase in fuel economy is only 1 mile per gallon while the highway fuel economy is the same (Gold, 2009), in spite of the high pressure fuel injectors, before the intake valve closes (Taylor, 1985).

In contrast, PRV induction could be commercially installed at practically no additional cost. A PRV manifold is made as a casting just like a conventional manifold. PRV is simply a better configuration based on sound scientific principles.

Hybrid Technology

PRV fuel induction is complementary to hybrid technology. Fuel economy gains from PRV will be additive to the regenerative braking efficiency gain of a hybrid. The author envisions a turbocharged PRV induction hybrid as the ultimate fuel efficient engine.

2. **Edge over competition:** they benefit automakers at low cost.
3. **Sustainability:** yes, spark ignited engines will be around for long time.
4. **IP Protection:** patented, US 6,868,830.
1. **Target Market:** automakers worldwide
2. **Barriers to Entry:** one-of-a-kind product protected by a US patent.

Automakers worldwide

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