

The Scuderi Split Cycle (SSC) Miller Turbocharged Engine

Overview

May 17, 2011



Scuderi Split Cycle Engine

Basic Concepts

- Two adjacent cylinders joined by a crossover (Xovr) gas transfer passage
- One cylinder is compressor, the other an expander.
- Expander is 20°CA in advance of compressor
- Cylinders may be offset
- Combustion after TDC
- Fuelling in Xovr or expander cylinder
- 4-stroke cycle achieved by Split 2-cycle compressor & expander cycles



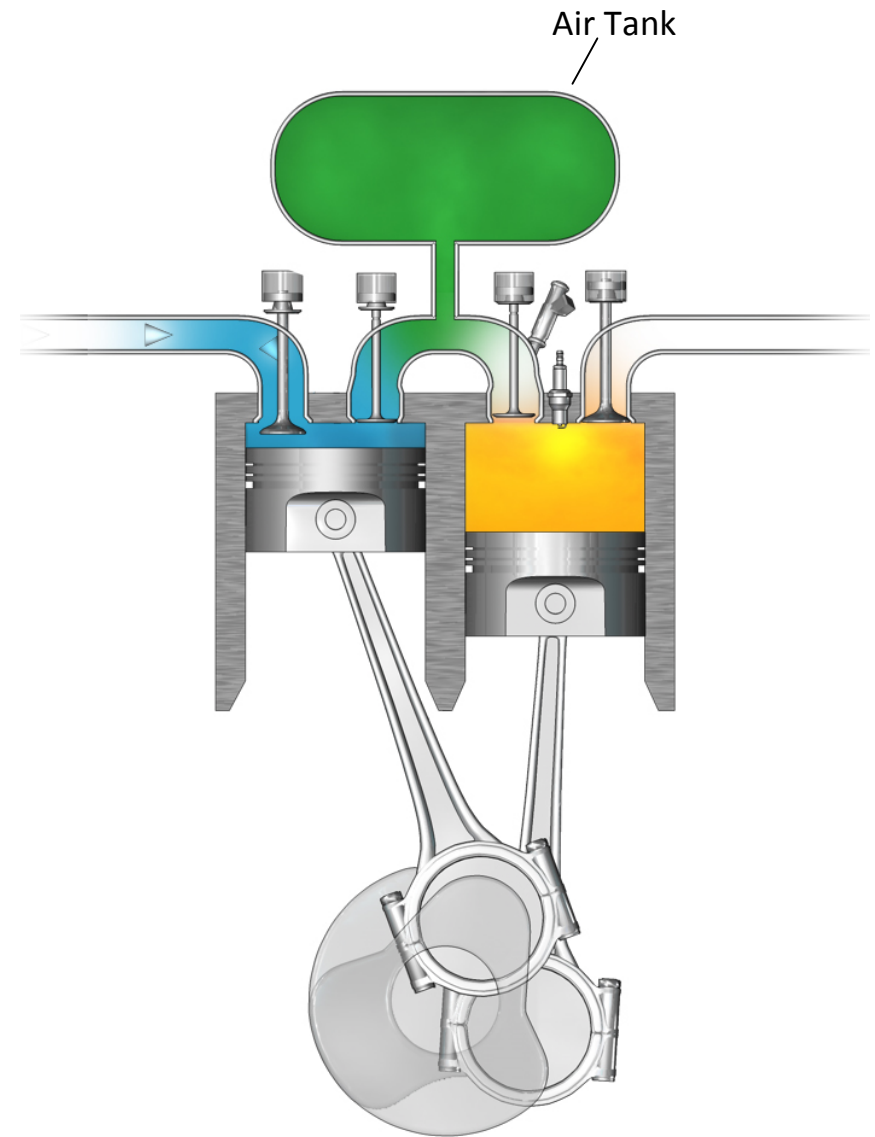
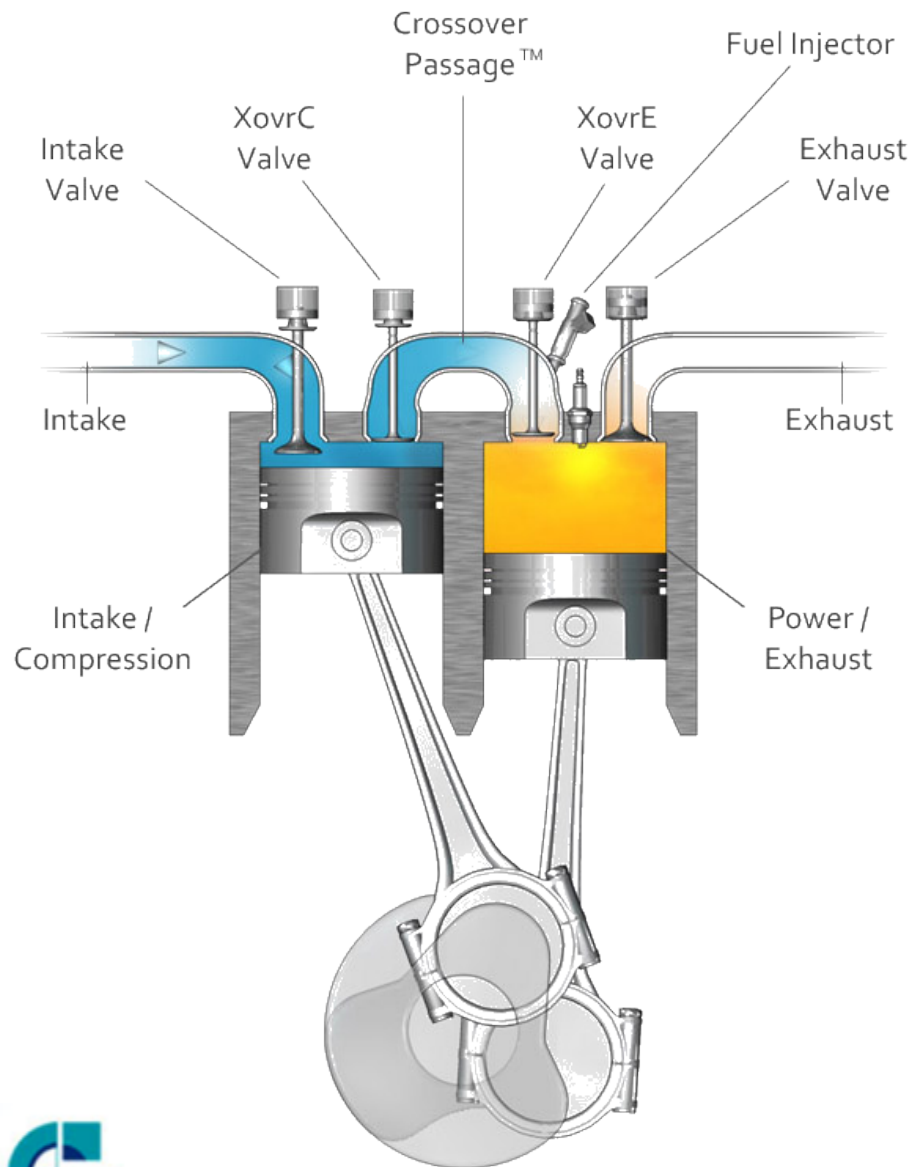
Scuderi Split Cycle Engine

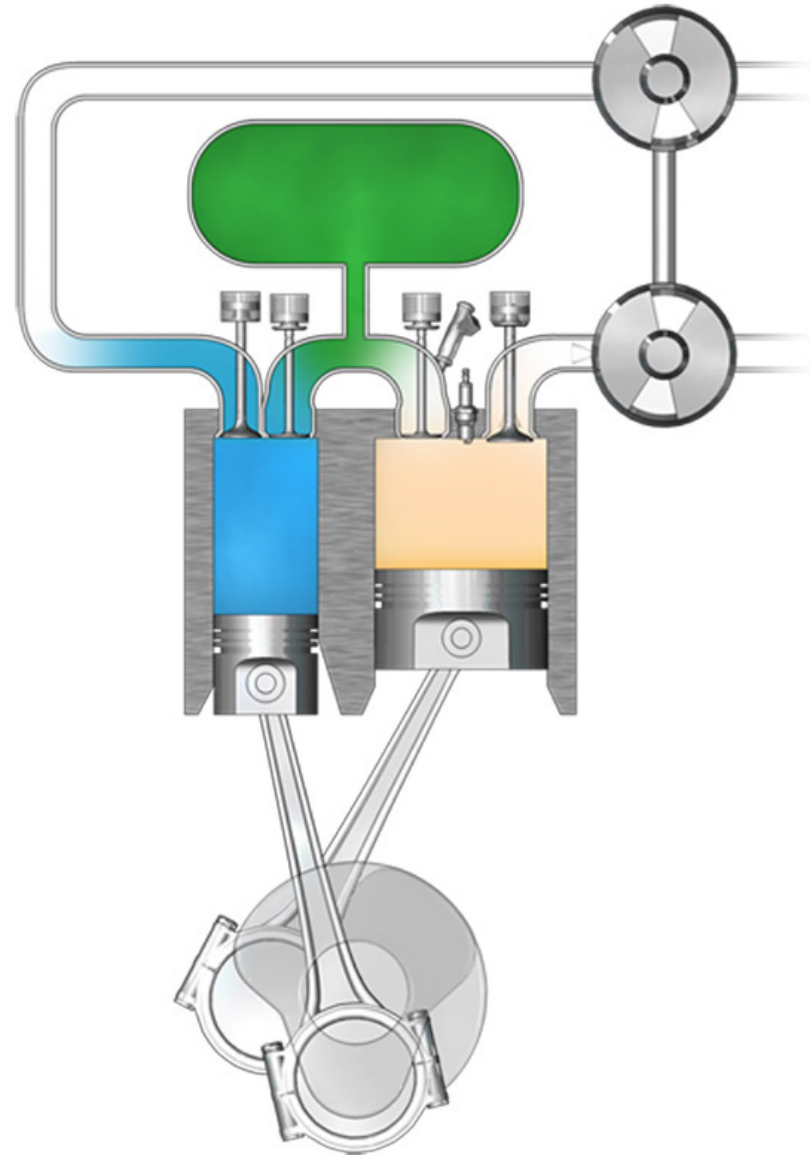
Potential Advantages

- Engine architecture is very conducive to Miller Cycle operation and subsequent efficiency benefits
- Relative ease of air hybrid vs. conventional due to separated compressor & expander cylinders
- Very low NOx by rapid burning after TDC, even without EGR
- Potentially reduced detonation tendency vs. conventional Spark Ignition (SI) combustion
- Applicable to SI and compression ignition cycles



Naturally Aspirated SSC





Advantages Over Standard Miller Engine

- **Miller cycle application to the split-cycle engine is a good match**
- **Advantage over standard Miller engine is that with the split-cycle:**
 - **do not have to carry around the full size of the compression cylinder and then waste part of that displacement on the compression side through either early or late IVC**
 - **do not have the breathing losses associated with closing intake valves at high piston velocities that standard engines with Miller cycle experience**
- **Spark-ignited Miller/split-cycle is able to reach much higher BMEP than SC NA and approaches diesel BMEP levels**



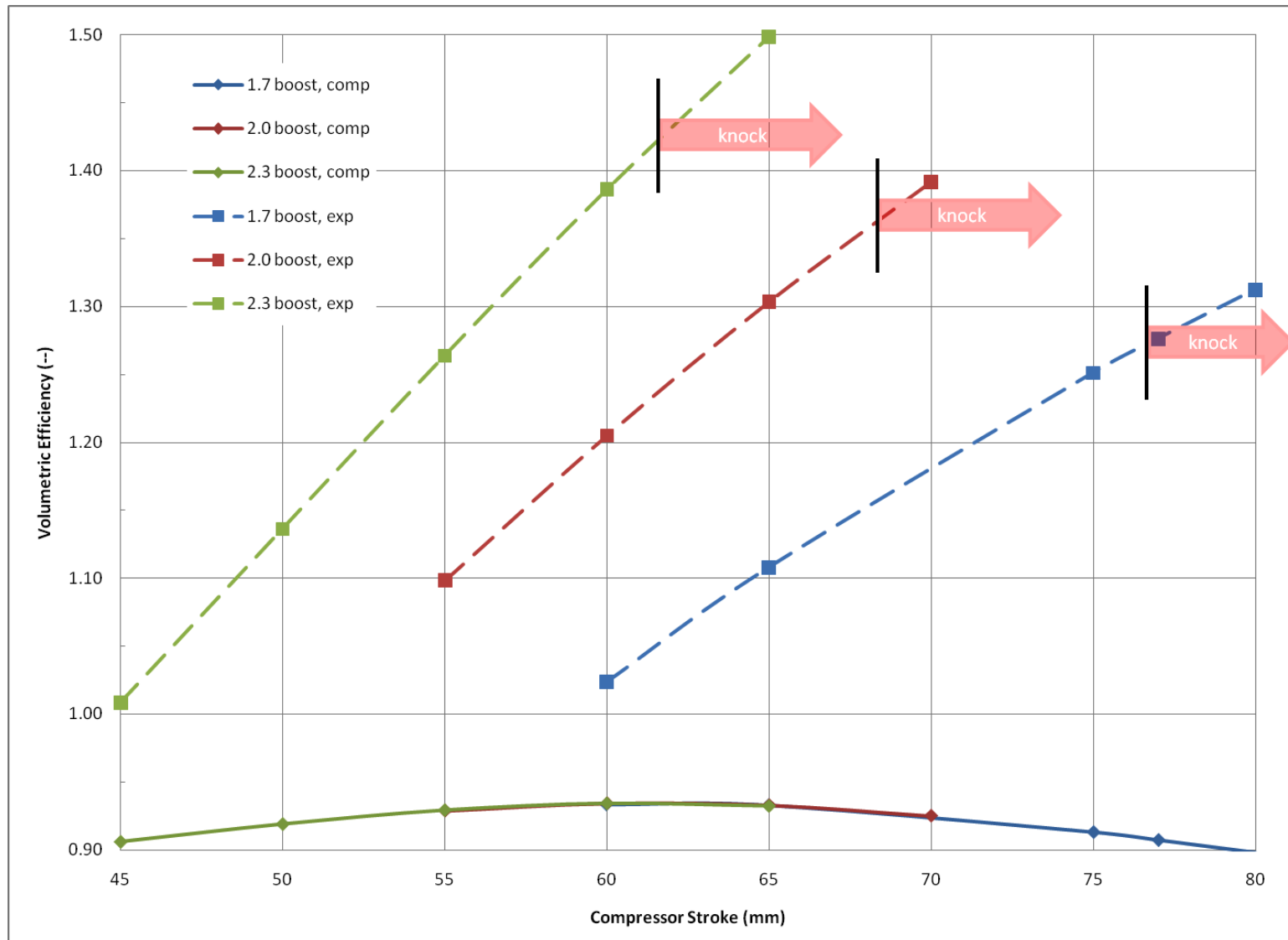
Volumetric Efficiency Definition

- Volumetric efficiency: the ratio of the mass trapped in the cylinder during the closed portion of the cycle, compared to the mass that would be trapped in the cylinder if it were filled at its maximum volume point with contents of the same makeup, pressure, and temperature as the reference location. The reference location is typically either ambient (i.e. air at atmospheric temperature and pressure) or intake manifold conditions (air, or air/fuel mixture at intake manifold temperature and pressure).



Miller Cycle Volumetric Efficiency Characteristics

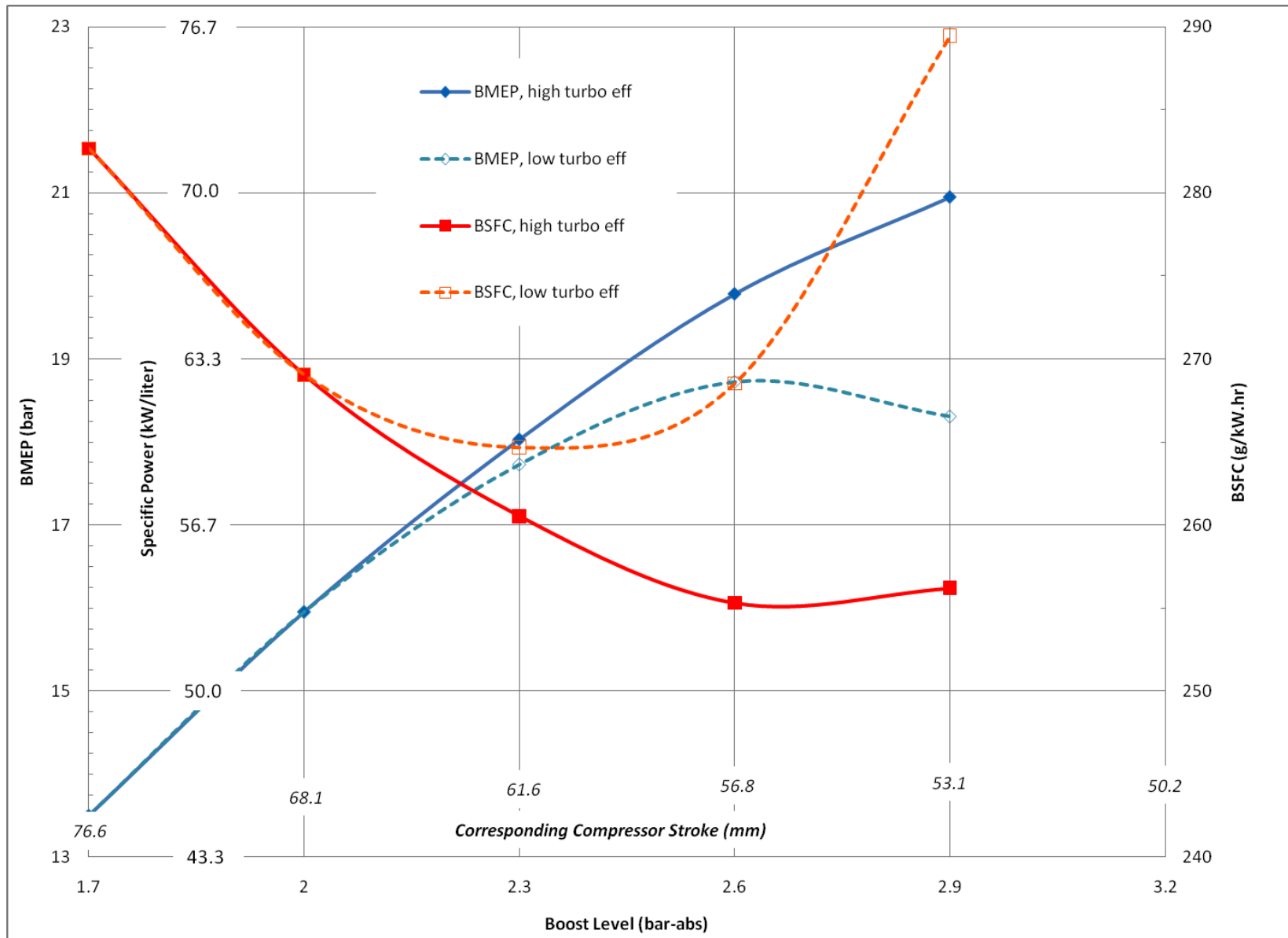
4000 rpm Full Load



Miller Cycle Knock-Limited 1400 RPM Performance



Miller Cycle Knock-Limited 4000 RPM Performance



Predicted Full Load BMEP – NA & Miller

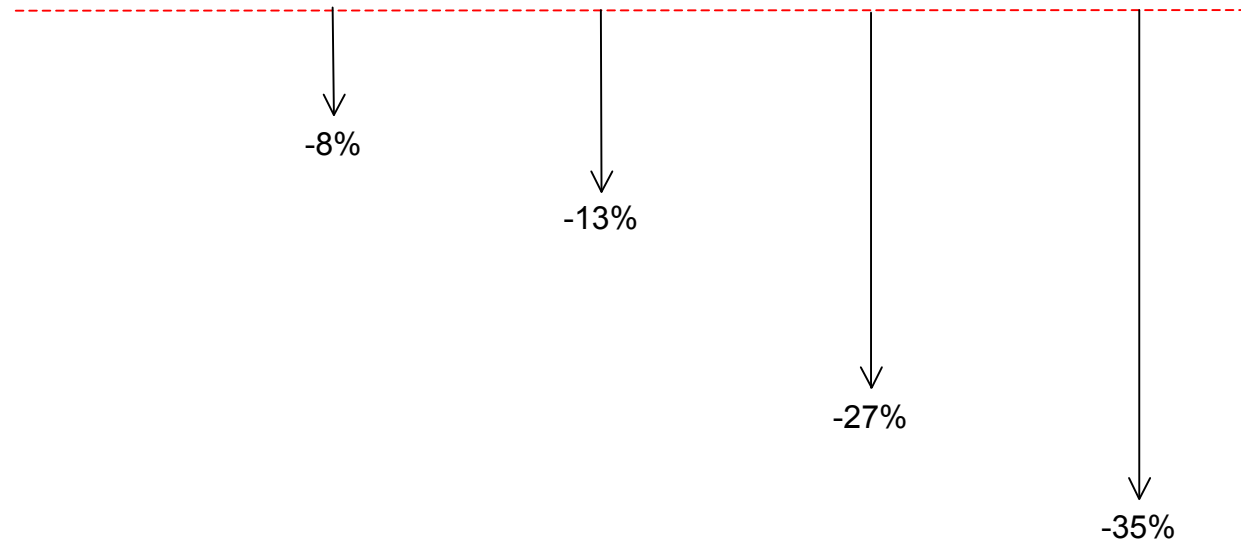


NISSAN SENTRA BASE VEHICLE MODEL

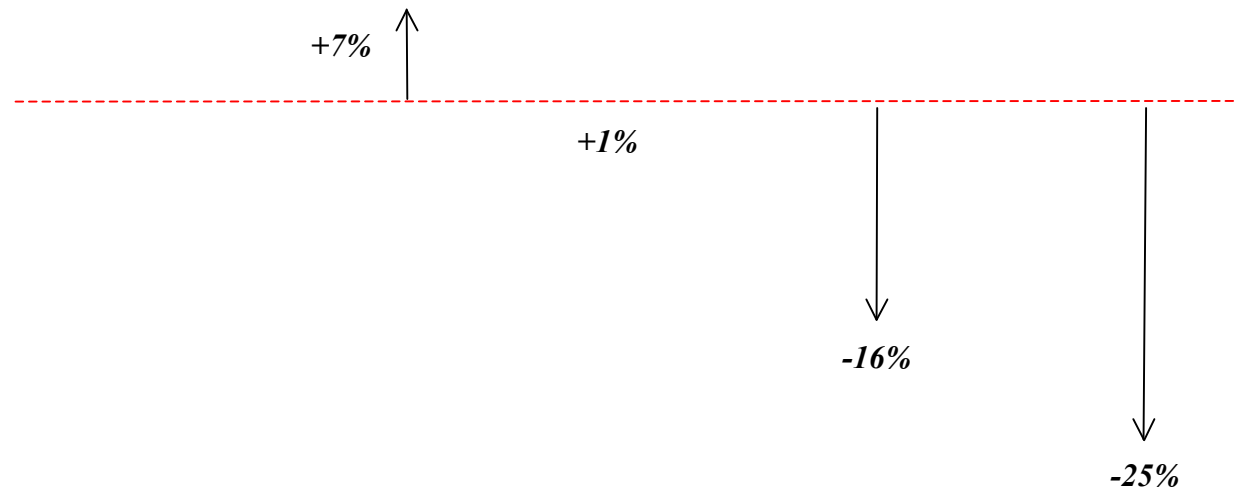
- 2011 MY Nissan Sentra chosen as reference vehicle for Scuderi engine in vehicle analysis
- Key features of Nissan Sentra
 - 2.0L I4
 - 16V + VVT
 - 140bhp @ 5100rpm
 - 6 speed manual transmission
- Variety of drivecycle tests performed on chassis dyno facility at SwRI including FTP75, NEDC & New York Bus
- Results used to develop & correlate a vehicle model to allow analysis of Scuderi engines & air hybrid applications



SENTRA VEHICLE WITH SCUDERI ENGINES MODEL RESULTS



SENTRA VEHICLE WITH SCUDERI ENGINES MODEL RESULTS



Scuderi Split Cycle Miller Turbocharged Engine

Thank you for your attention

Any Questions?

