

NISSAN MOTOR CORPORATION



Introduction of Variable Compression Turbo Engine

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- 1. Approach for Sustainability**
- 2. What's "Variable Compression Turbo" ?**
- 3. All Technical Features of VC-T Engine**
- 4. Performance of VC-T Engine**

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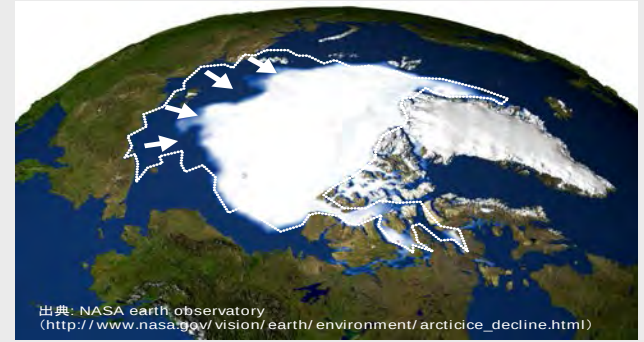
Requirements for Sustainability

Compliance

Energy Saving



GHG Reduction



Attractiveness

Driving Pleasure



Affordable Price



Approach for Sustainability

1. Conv. PT improvement


DST
engines
12V
48V


Diesel
engines
Idle stop/Coast stop
E recovery/Torque assist


CVTs



**Variable
Compression Turbo
(VC-Turbo) Engine**

2. Electrified Vehicle

More range

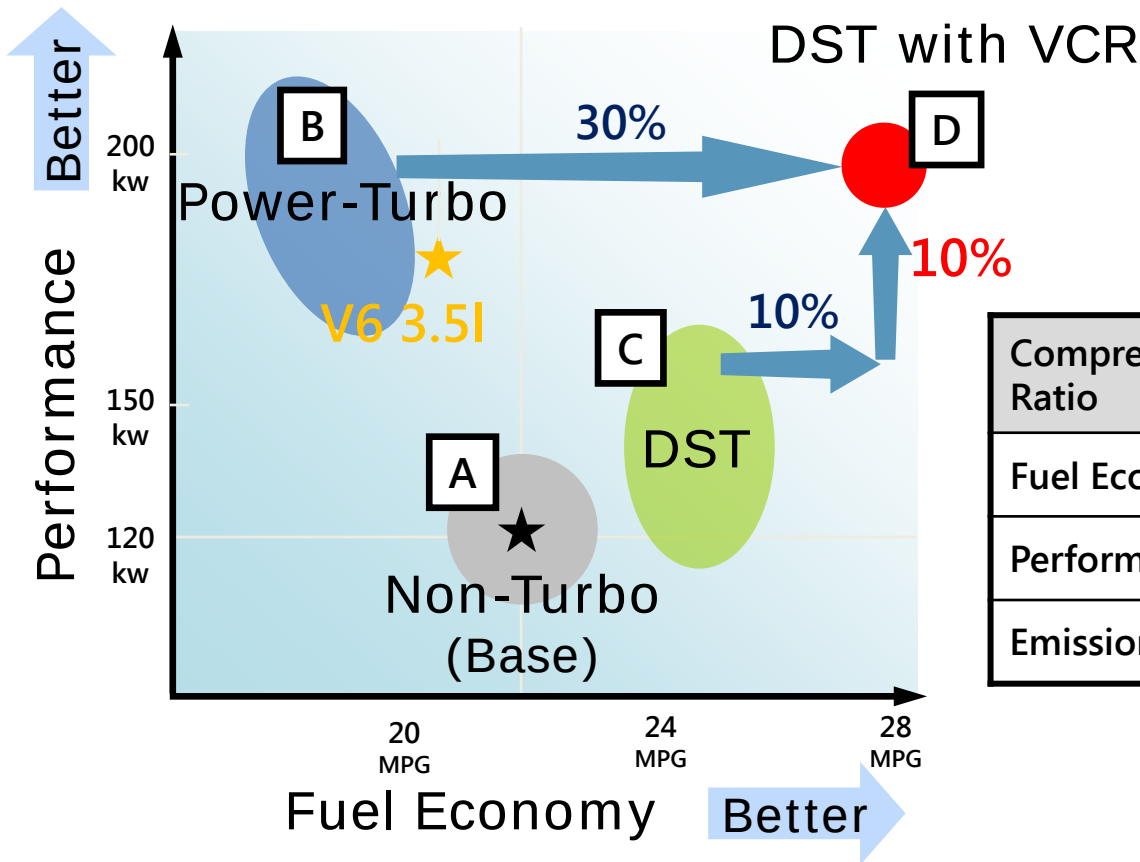
LEAF

24kWh
From 2012
30kWh
From 2015
Future



Contribution of compression ratio optimization

- High thermal efficiency
- High performance
- Clean emission



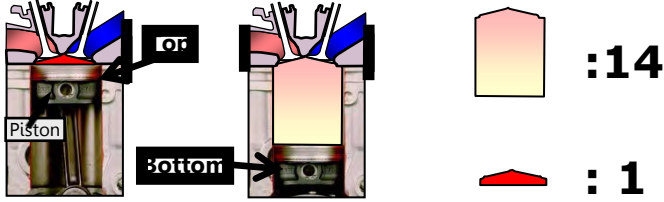
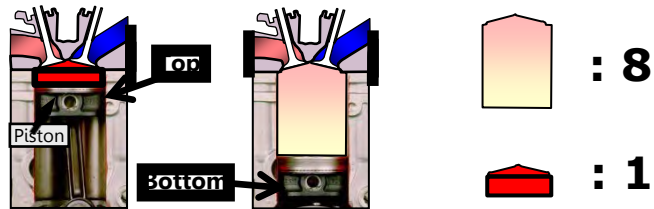
	Non Turbo	Turbo		DST VCR
		Power Turbo	DST	
	A	B	C	D
Compression Ratio	10-13	8-9	10-11	8↔14 Variable
Fuel Economy	=	-	+	++
Performance	=	++	+	++
Emissions	=	=	=	++

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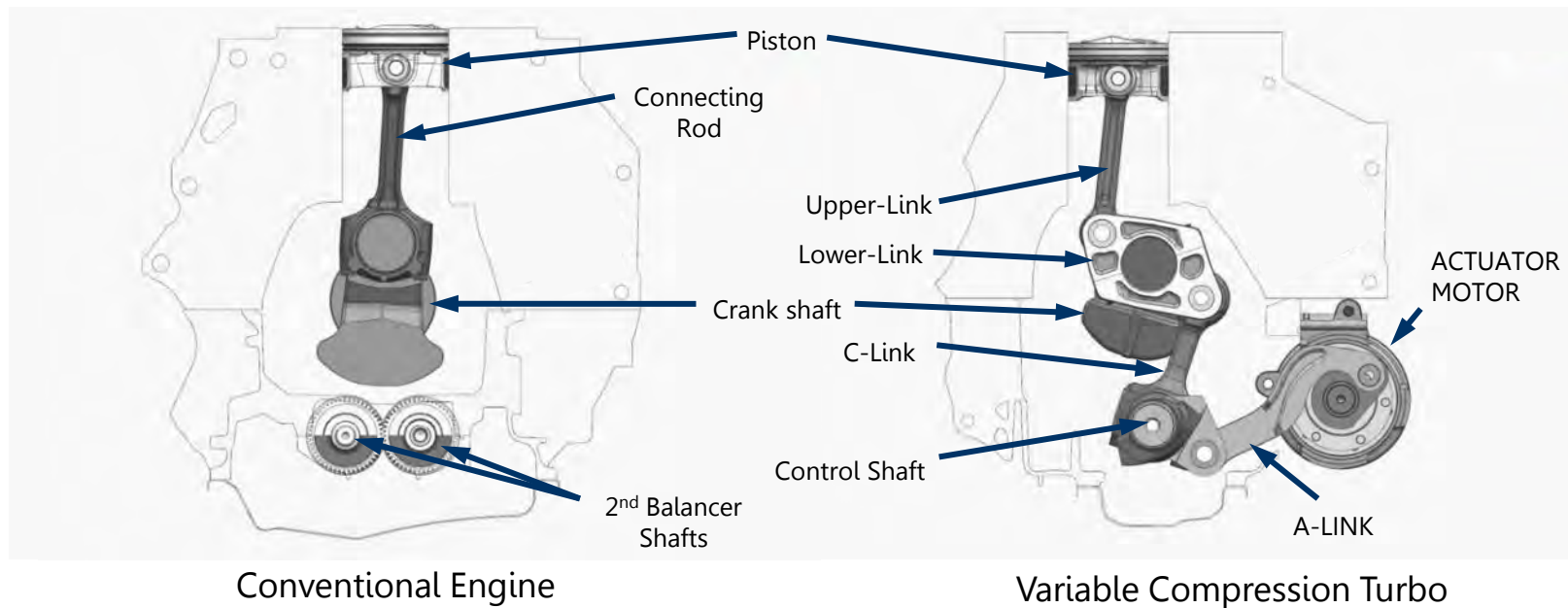
Compression Ratio

- Compression ratio is quite important spec. for designing engine characteristic.

	Pros	Cons
High Compression Ratio 	High Efficiency ✓ High Thermal efficiency	✓ High emission
Low Compression Ratio 	High Performance ✓ Enabling high charge Clean Emission ✓ Low S/V ✓ Fast Cat light off	✓ Low Thermal efficiency

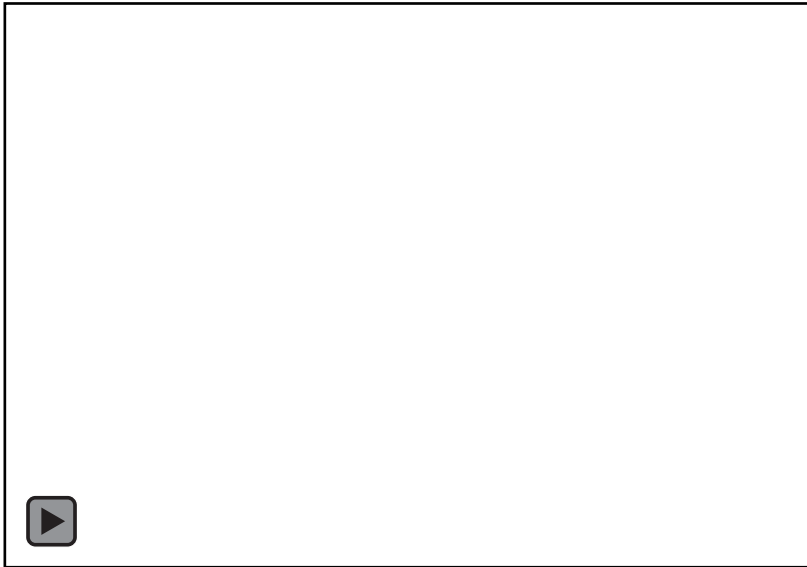
Mechanism of VC-Turbo

- World first mass production engine with variable compression ratio technology
- Variable compression ratio is achieved by the new multi link system

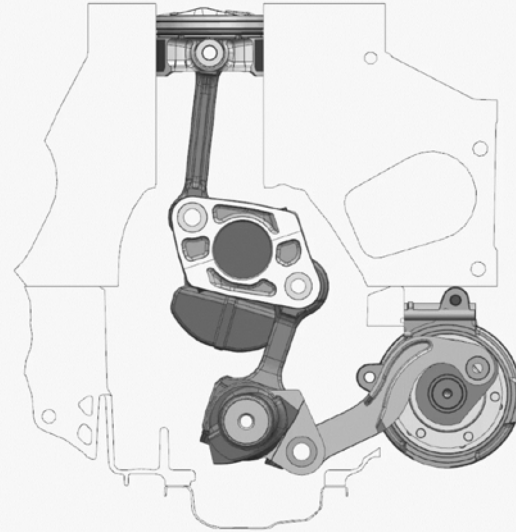


Mechanism of VC-Turbo

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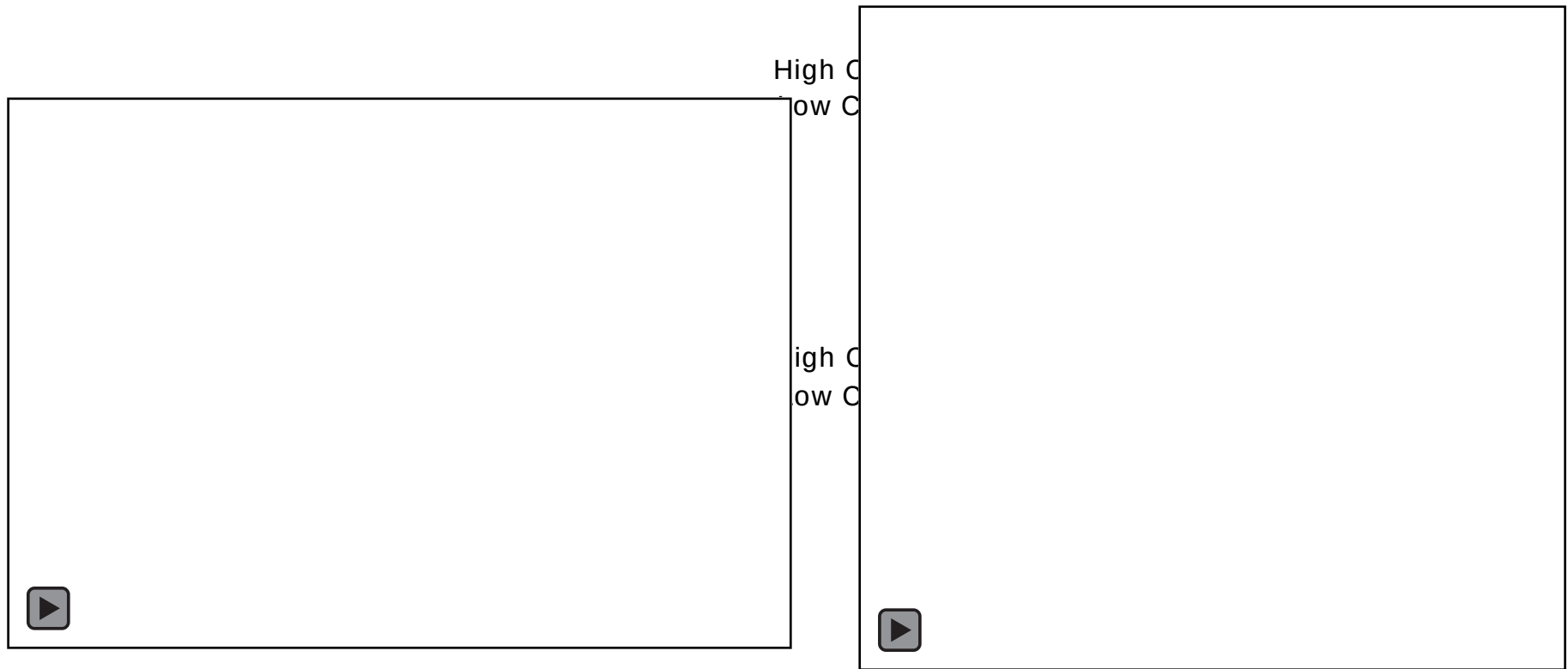
Conventional Engine



Variable Compression Turbo

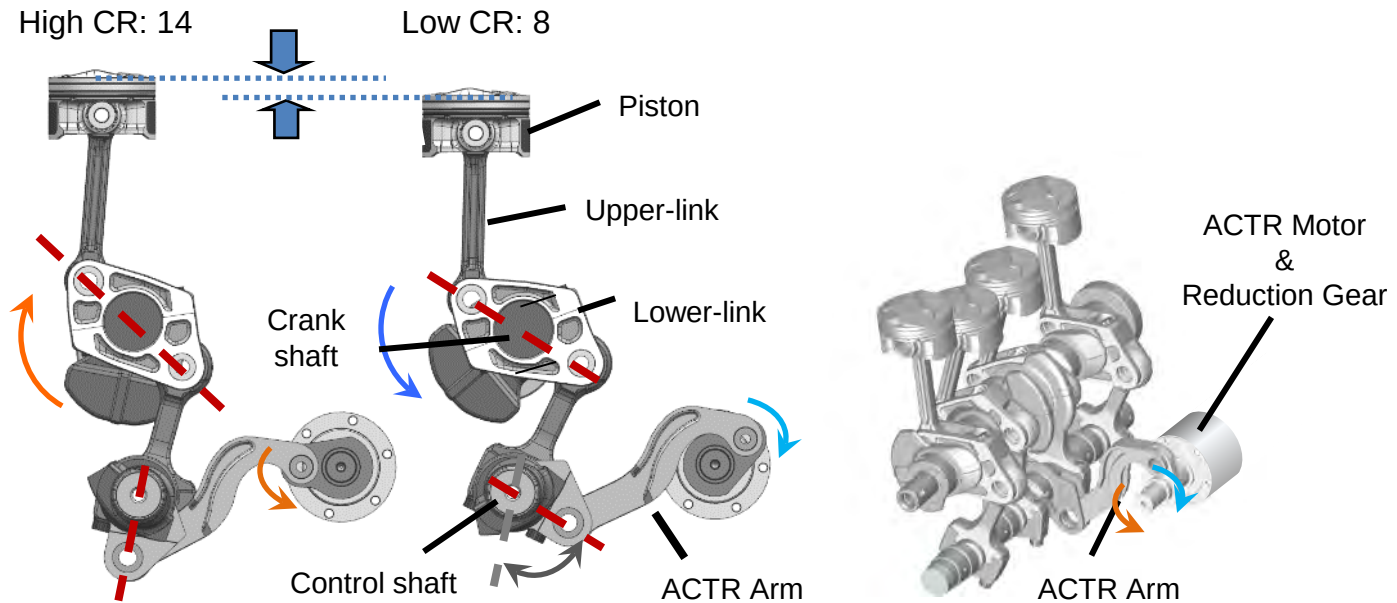
Principle of Variable Compression Ratio

- Compression ratio can be changed by control shaft angle and link position.



Principle of Variable Compression Ratio

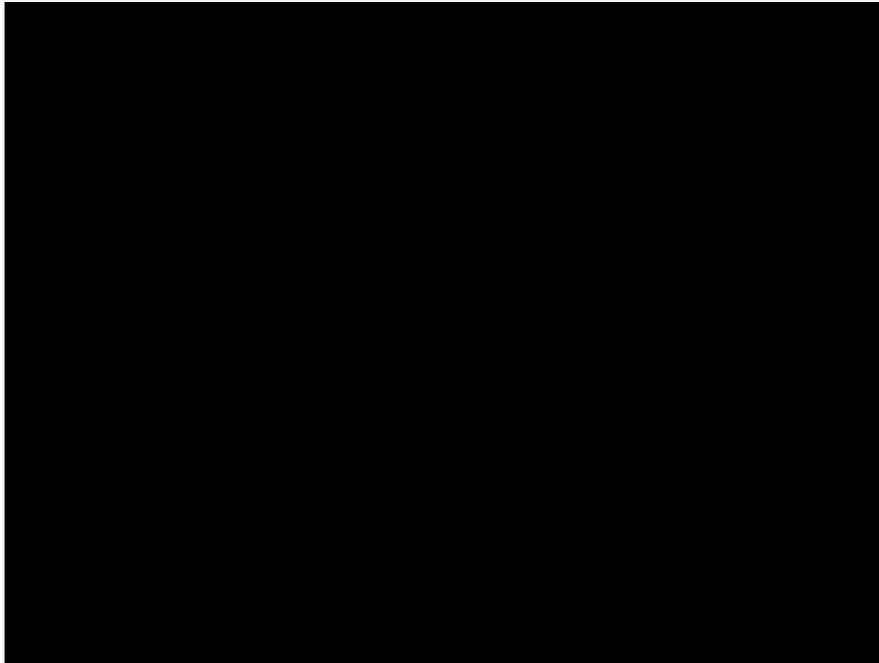
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Principle of Variable Compression ratio

Principle of Variable Compression Ratio

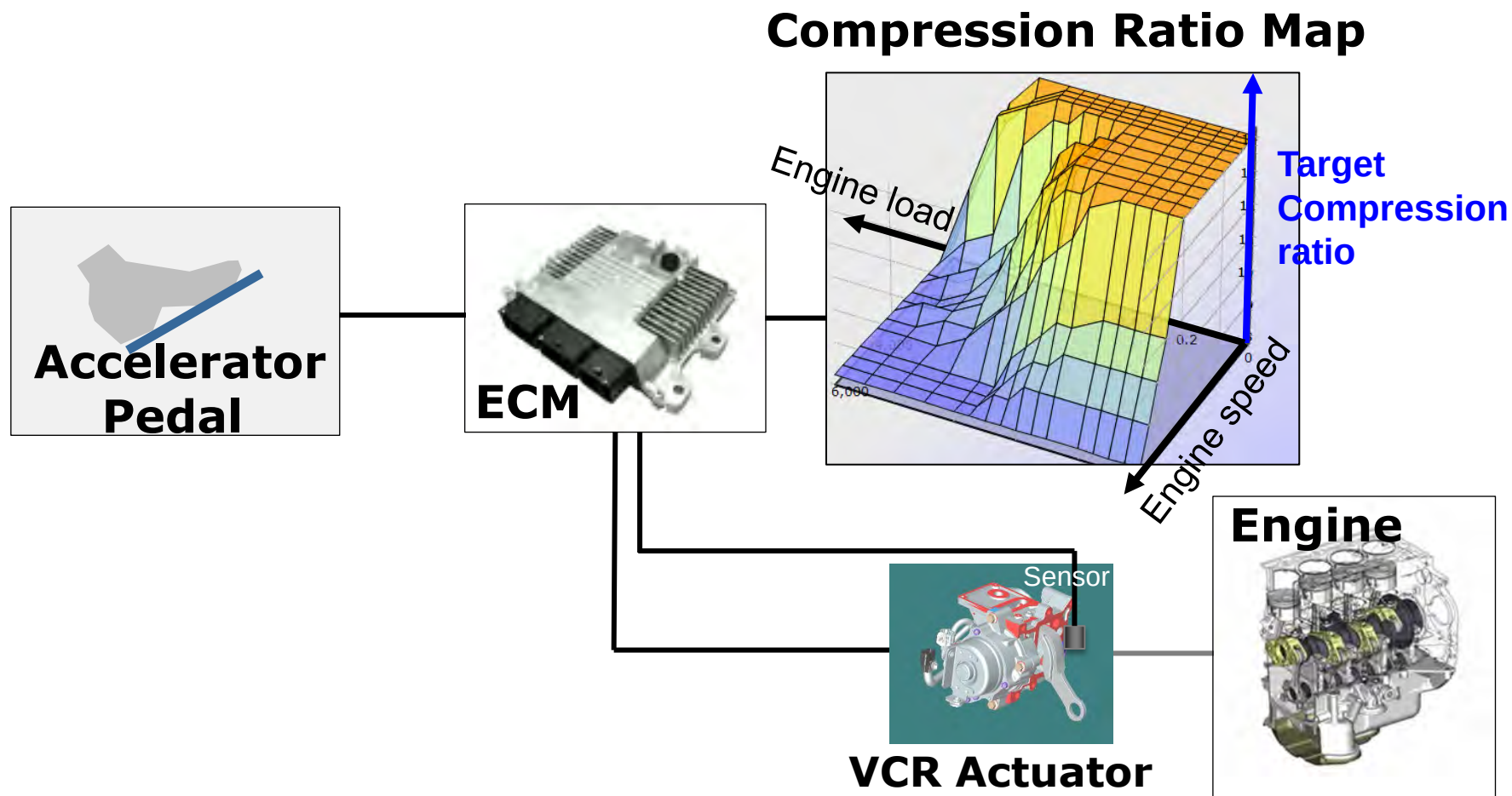
- Compression ratio can be changed by control shaft angle and link position.



※This is actuator moving animation without engine running for easy understanding

VC-Turbo Control Strategy

- VC-Turbo is controlled by calibration map on Engine Control Module according to driver's accelerator pedal operation.

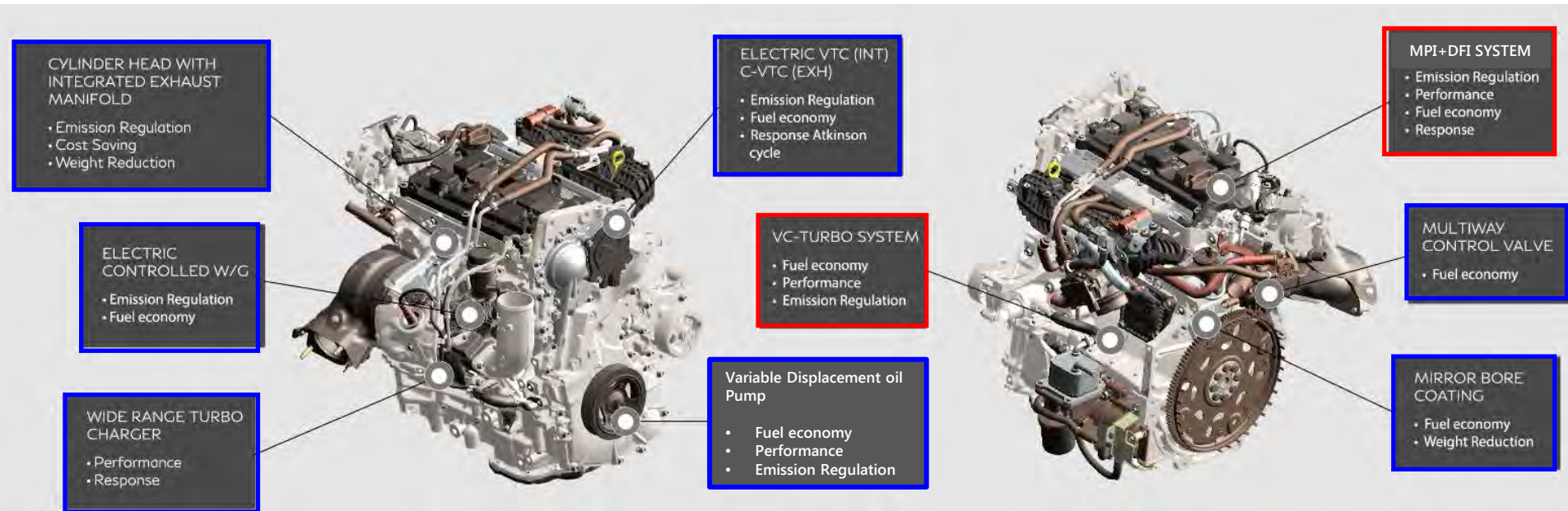


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All Technical Features of VC-Turbo

- Other Engine technologies contribute to achieve further dynamic performance and fuel economy

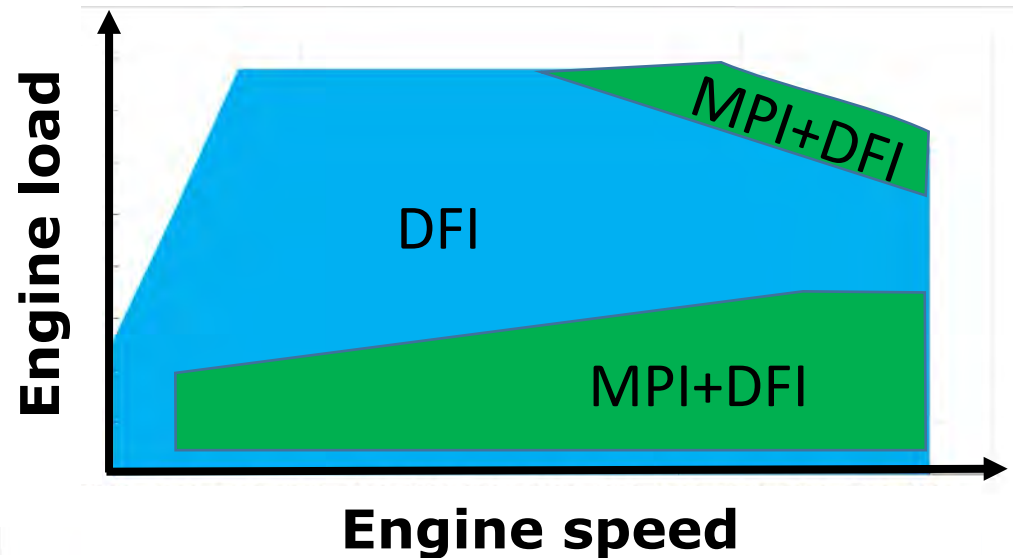
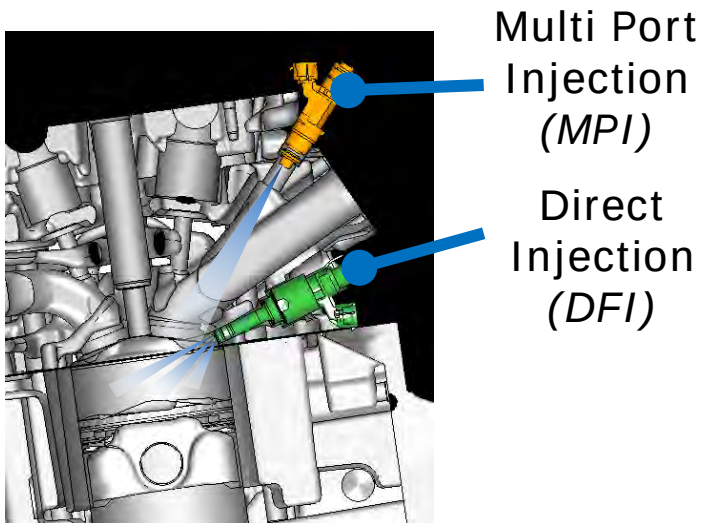


 Conventional technology

 New technology

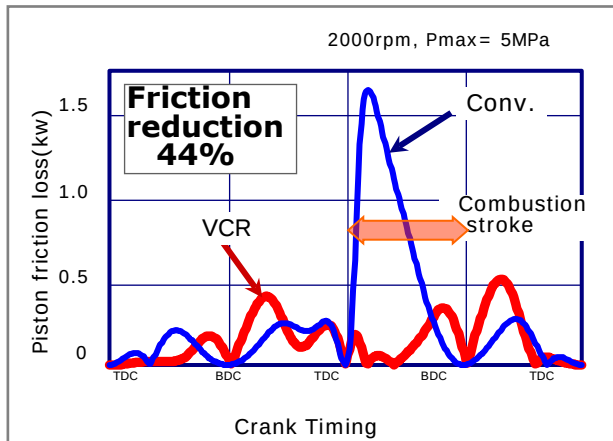
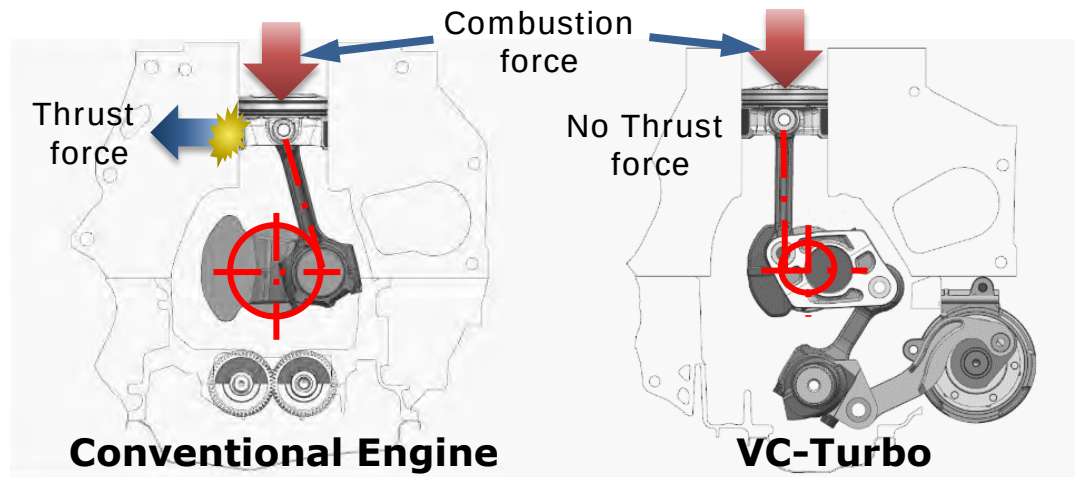
MPI+DFI SYSTEM

- DFI is good for more power due to Heat absorbing effect by fuel vaporization.
- MPI can reduce PN, PM emission.
- MPI+DFI system contributes also fuel economy by utilizing each strength.

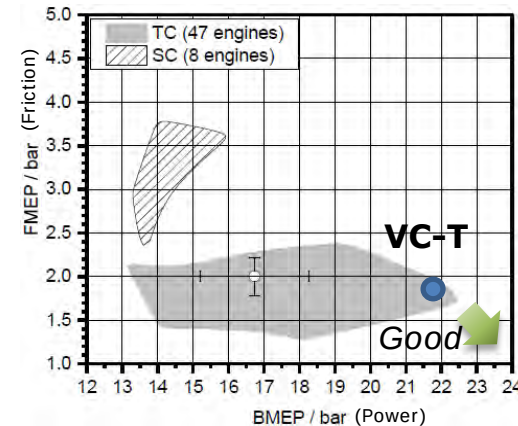


Friction Reduction

- Because angle of Upper-Link is almost vertical, thrust force on cylinder bore can be reduced. $\Rightarrow$ Good for Friction



Profile of Piston Friction loss



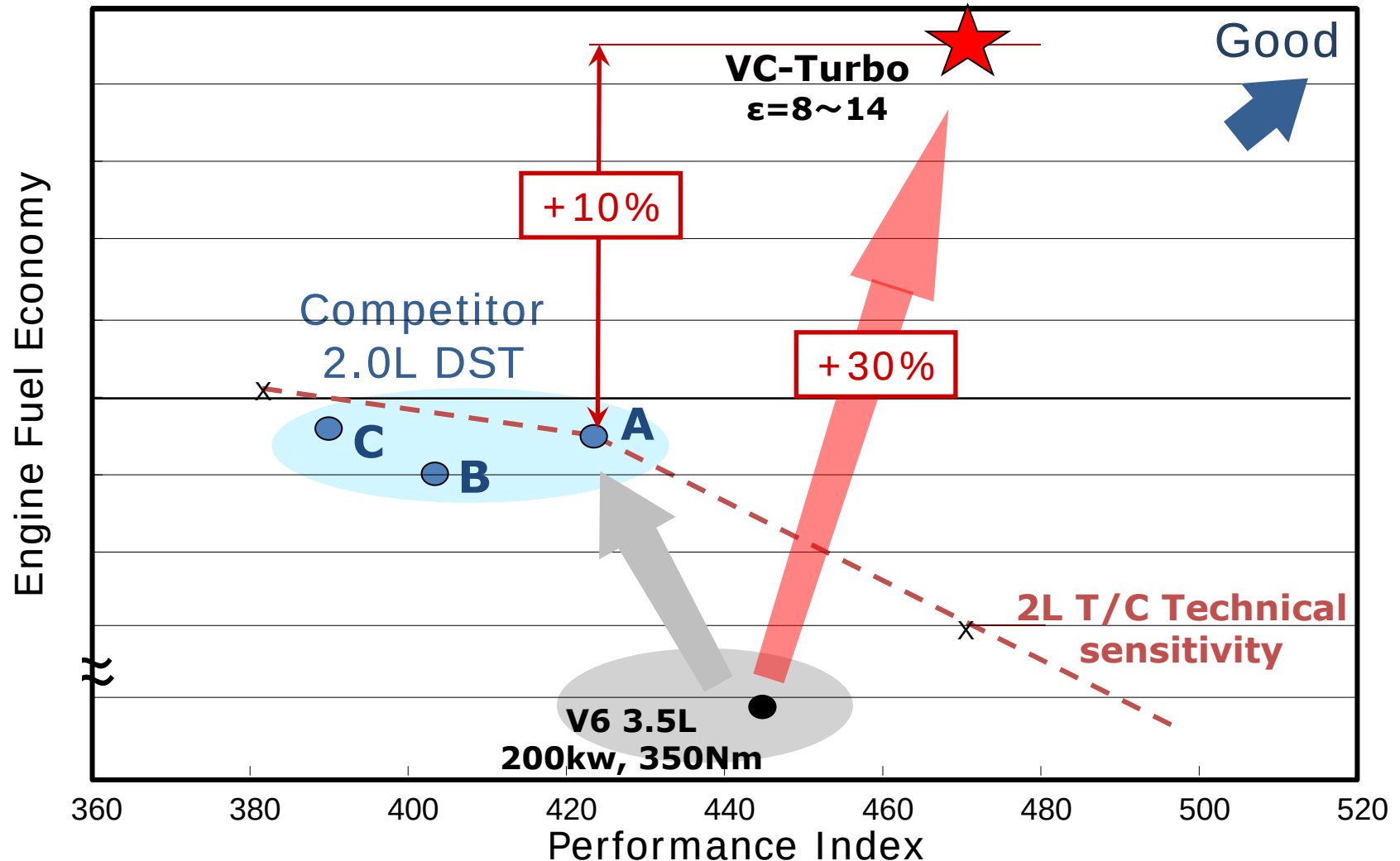
FEV scatter band of FMEP vs BMEP at Max power

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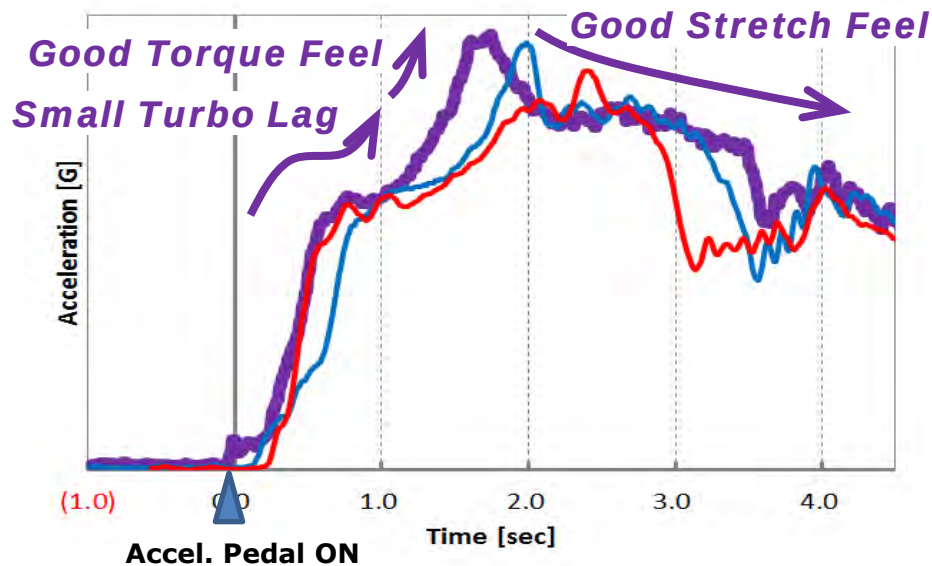
Fuel Economy

- Outstanding FE with top level Acceleration Performance
- Approx. 30% FE improvement compared with V6 3.5L Engine

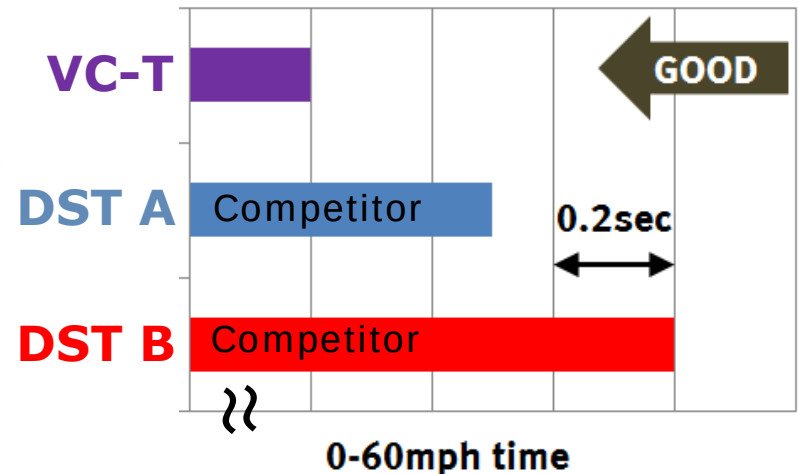


Acceleration

- Segment top level acceleration performance
- Good Torque and Stretch Feel

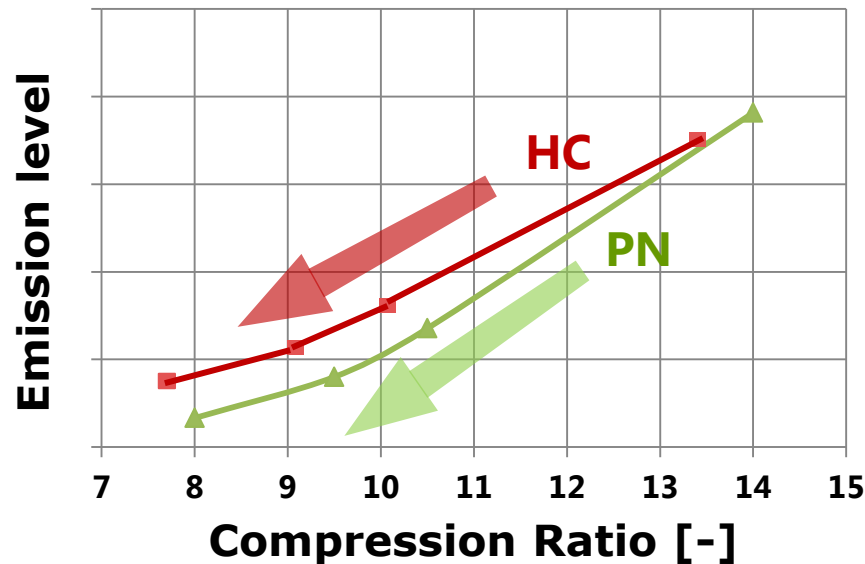


**Acceleration G - T curve
(standing start, WOT)**



Emission Performance

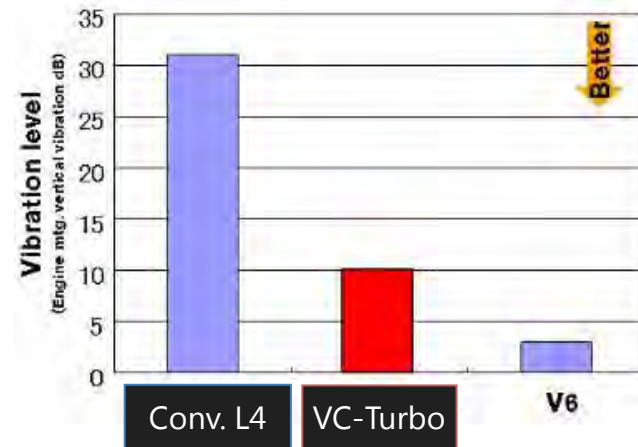
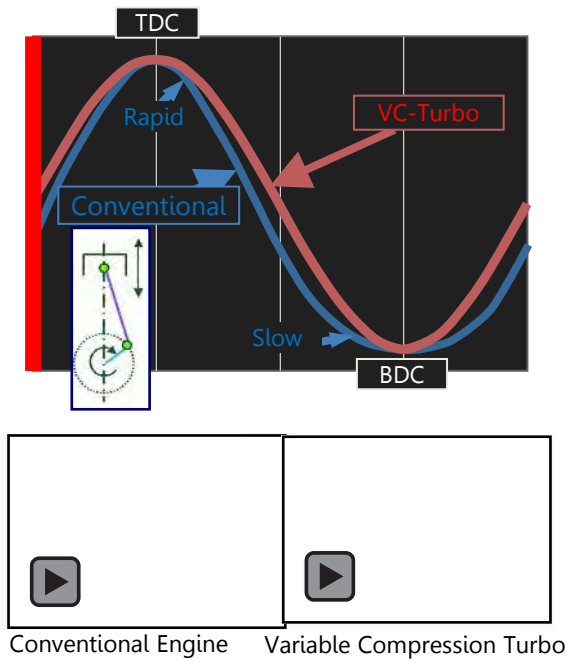
- VC-T Engine can use lower compression ratio during cold condition to improve emission performance
- Lower compression ratio contributes as follows
 - Lower Engine Out HC emission level due to small S/V ratio
 - Quick catalyst warm up from higher exhaust gas temperature
 - Lower PN emission



*Cold condition

NVH

- With the multilink mechanism, piston motion achieves ideal sine wave, resolving the unbalance. 2nd order balancer shaft is not necessary
- This enable low vibration property of in-line 4 cylinder engine close to that of V6 engines.



VC-Turbo achieves good vibration level

Summary

- “Variable Compression Turbo”(VC-T) is one of the key technologies to meet future requirements with sustainability
- VC-T can be an Ultimate Eco NA engine and High Power Sport Turbo engine. VC-T technology enables engine to achieve clean emission, good F.E. and attractiveness at the same time.
- Conventional technologies can generate synergy in performance improvement with VC-T technology.

Thank you!