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Variable Capacity Engine (VCE)

Imagine Having a "3 in 1" Vehicle

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PROTON

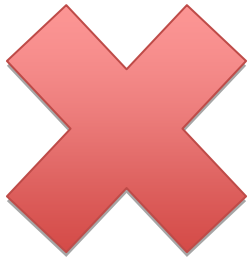
A Practical Family Car

A Nippy Compact Car

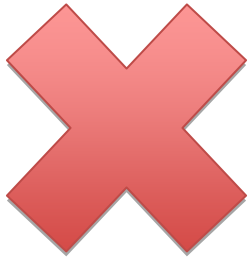
A Prancing Sports Car

The Craving for Power
vs.
The Remorse for Economy

Sweep Volume Enlargement (Higher Displacment Engines)

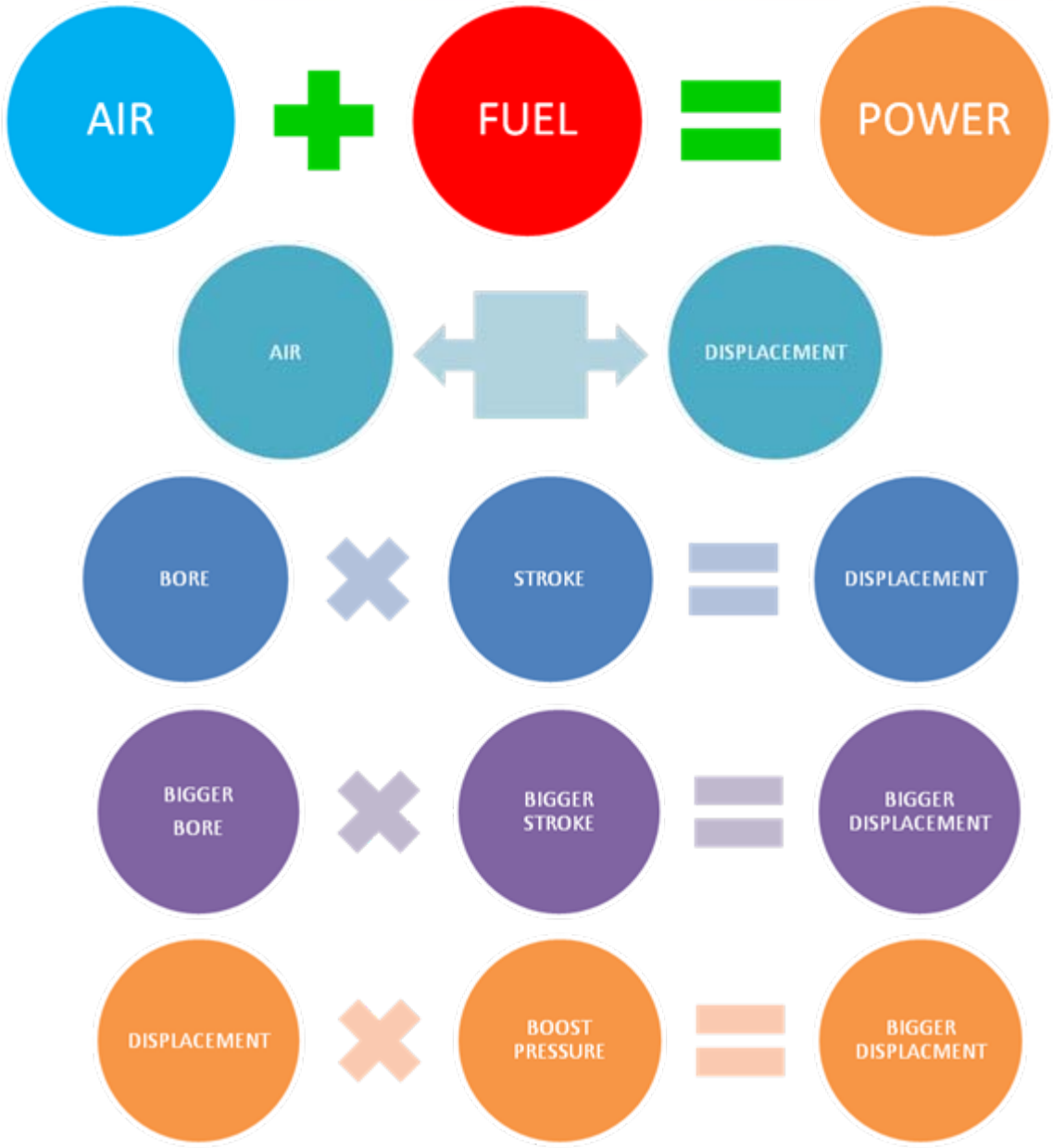


Increased Engine Speeds (Higher Operating RPM's)



Forced Induction (thus allowing downsizing)

Fundamental Operating Principle



VCE Operation Flowchart (Setup 1)

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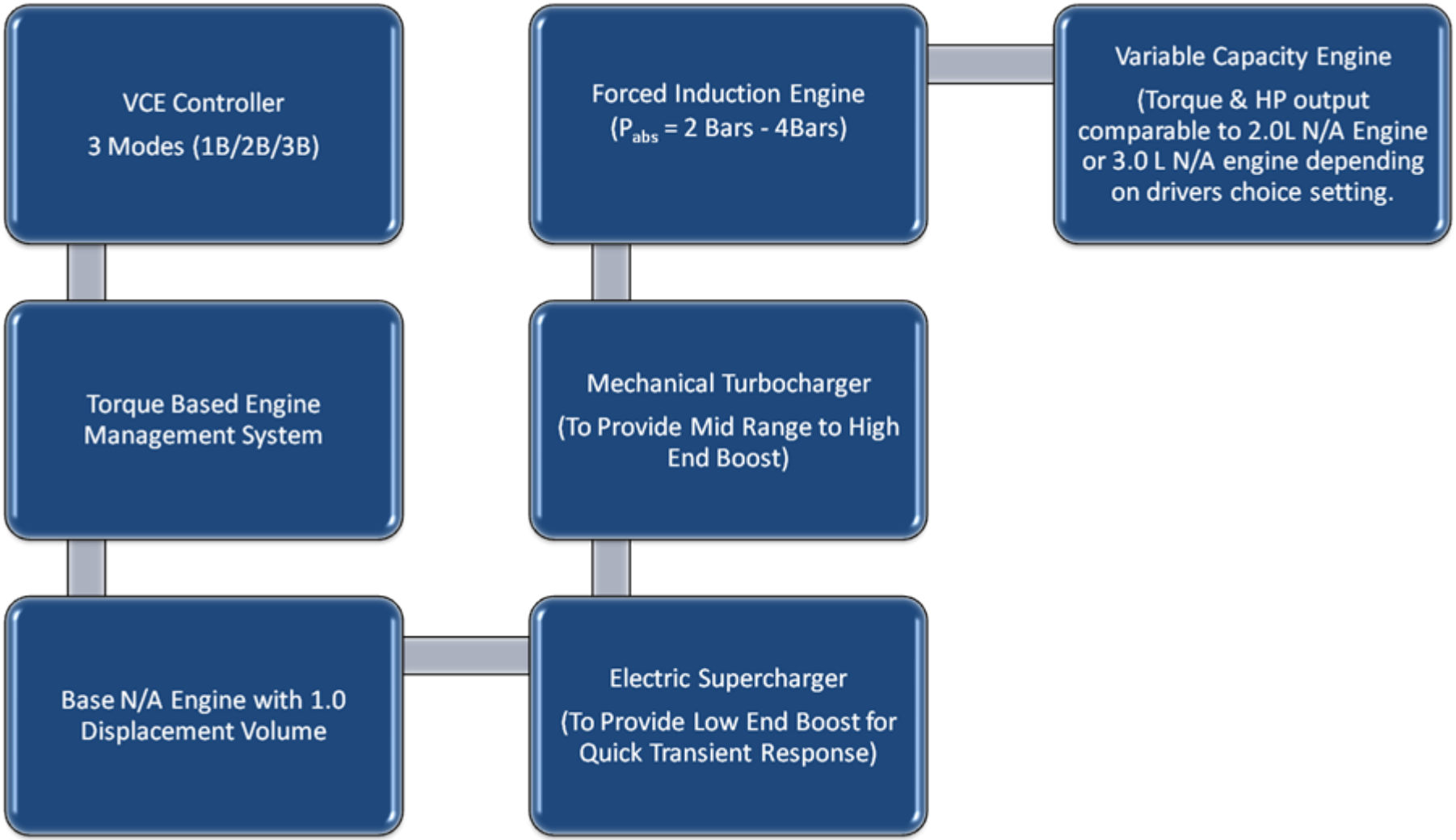

VCE Operation Flowchart (Setup 2)

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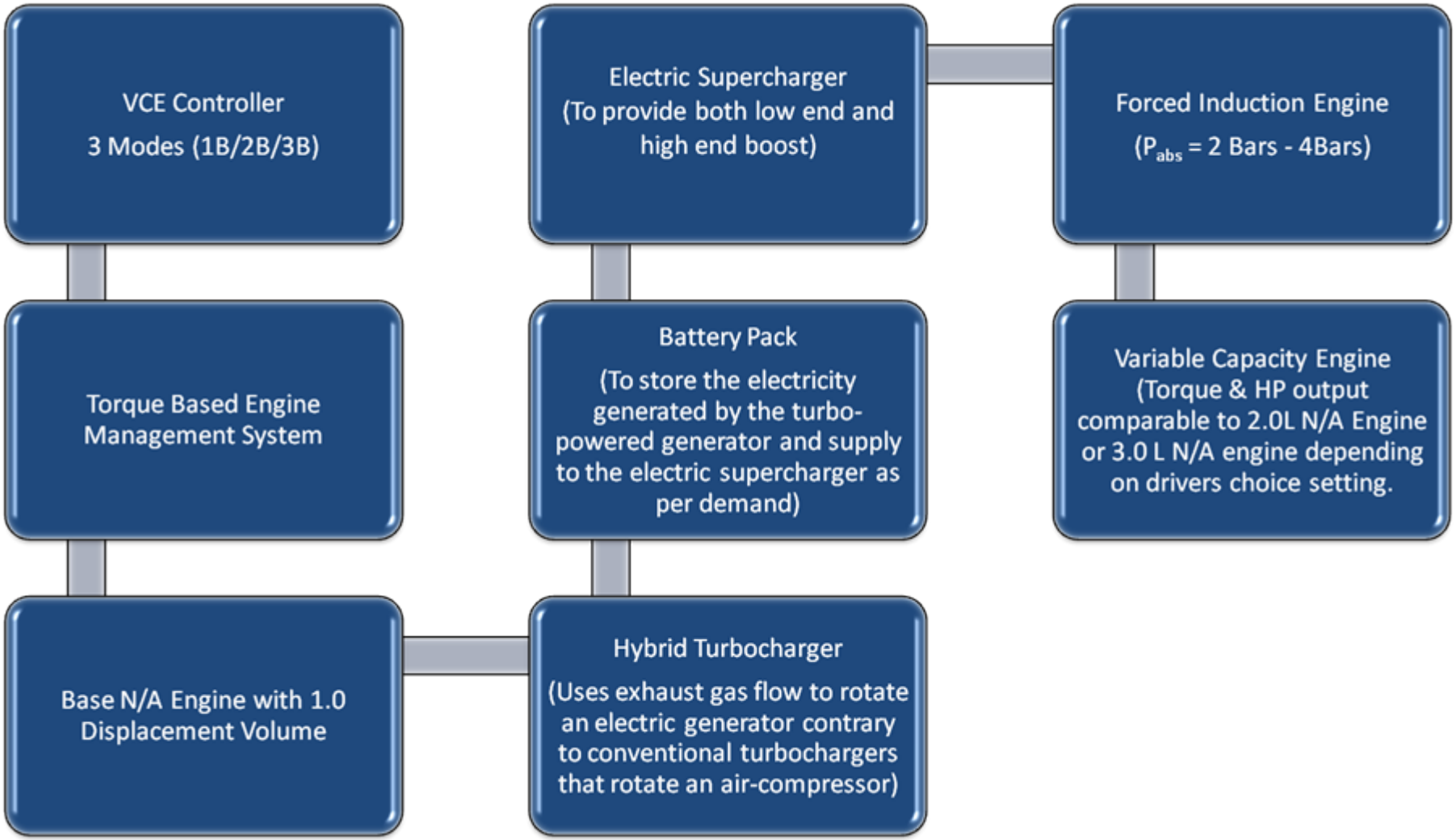

VCE in a Nutshell

- The **fundamental operating principle** of the Variable Capacity Engine (VCE) is basically **varying the boost pressure on the intake air supply** to the engine by using **both an electrical supercharger and mechanical turbocharger** so that the driver literally has the chance of **choosing different power outputs akin to driving engines with various capacities** but this time around with **boost pressure being the variable instead of displacement volume.**

So What Exactly is VCE???

- The fundamental operating principle of the **Variable Capacity Engine (VCE)** is basically **varying the boost pressure** on the intake air supply to the engine so much so we can possibly vary the performance output of the engine between the performance of a **1.0 L – 3.0 L engine.**

- This is done by building an **ultra-durable 1.0L (displacement volume)** engine with hardware that's **capable of withstanding boost pressures up to 4 bars** (absolute pressure) during peak loads.

- A dial with **VCE-1B, VCE-2B** and **VCE-3B** would be **located on the dashboard** of the vehicle.

- **VCE-1B** simply means the engine will **run as a normally aspirated engine**. In this case it will be a 1.0L N/A engine since this is what the base engine geometry is designed to be.

- **VCE-2B** means the engine will run in such a way the performance output matches that of a **2 Litre N/A engine.**

- **VCE-3B** means the engine will run in such a way the performance output matches that of a **3 Litre N/A engine.**

- This increased performance is achieved via **boosting the air-intake supply** of the engine with a **combination of an electric supercharger** and a **mechanical turbocharger** or a **hybrid turbo-electric supercharger.**

- **At VCE-1B (zero boost)** the engine would be a humble normally aspirated 1.0L workhorse **with adequate power** just to move the vehicle around decently (suitable for city driving in heavy traffic jams etc) but would transform to a beast the moment the boost controller on the dashboard is set to **VCE-3B.**

- All boost up to **2 bars** would be supplied by the **electric supercharger** after which the **mechanical turbocharger** would come into play to supply the remaining boost pressures of **up to 4 bars.**

- The use of the **electric supercharger** for supplying **boost below 2000 RPM** will enable the use of bigger **high output turbochargers without sacrificing transient acceleration** on demand as that would be taken care of by the electric supercharger which **instantaneously produces boost pressures** of up to **2 bars. (P_{abs})**

- However for **ultimate performance flexibility**, the VCE works best when coupled to a **hybrid turbo-electric supercharger** since customers could literally choose the "power output" of their engine akin to how they adjust their air-conditioner/heater thermostats currently.

- Therefore the driver literally has the chance of **choosing different power outputs** akin to driving engines with **various capacities** but this time around with **boost pressure being the variable** instead of **displacement volume.**

- This not only means the vehicle will have a **smaller physical geometry** that enables it to fall into a **lower tax bracket** but would also be **really frugal** and **environment friendly** when the power is not needed.

Torque Characteristics

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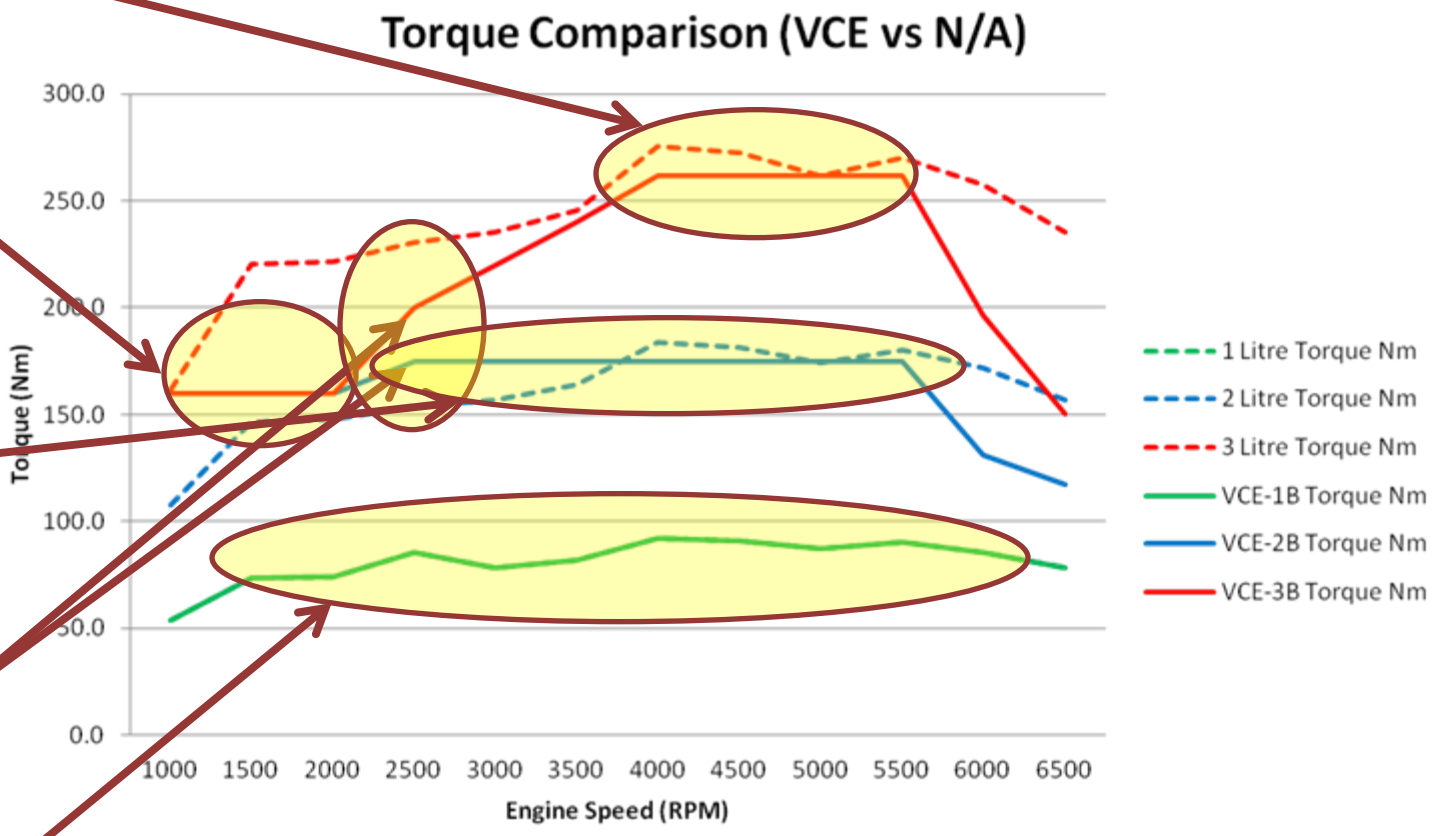
The VCE-3B matches the output of a 3.0 Litre N/A engine across a narrow band from 4000 – 5500 RPM.

The VCE-2B & VCE-3B have a similar output between 1000 – 2000 RPM whereby the instantaneous boost comes from the electric supercharger.

The VCE-2B exceeds and continually matches the output of a 2.0 Litre N/A engine across a wide band from 1000 – 5500 RPM.

The exhaust driven turbocharger begins to spool after 2000 RPM and starts supplying boost at 2500 RPM – 5500 RPM

The VCE-1B torque curve is exactly the same as a 1.0 Litre N/A engine since there is no boost at this stage.



Power Characteristics

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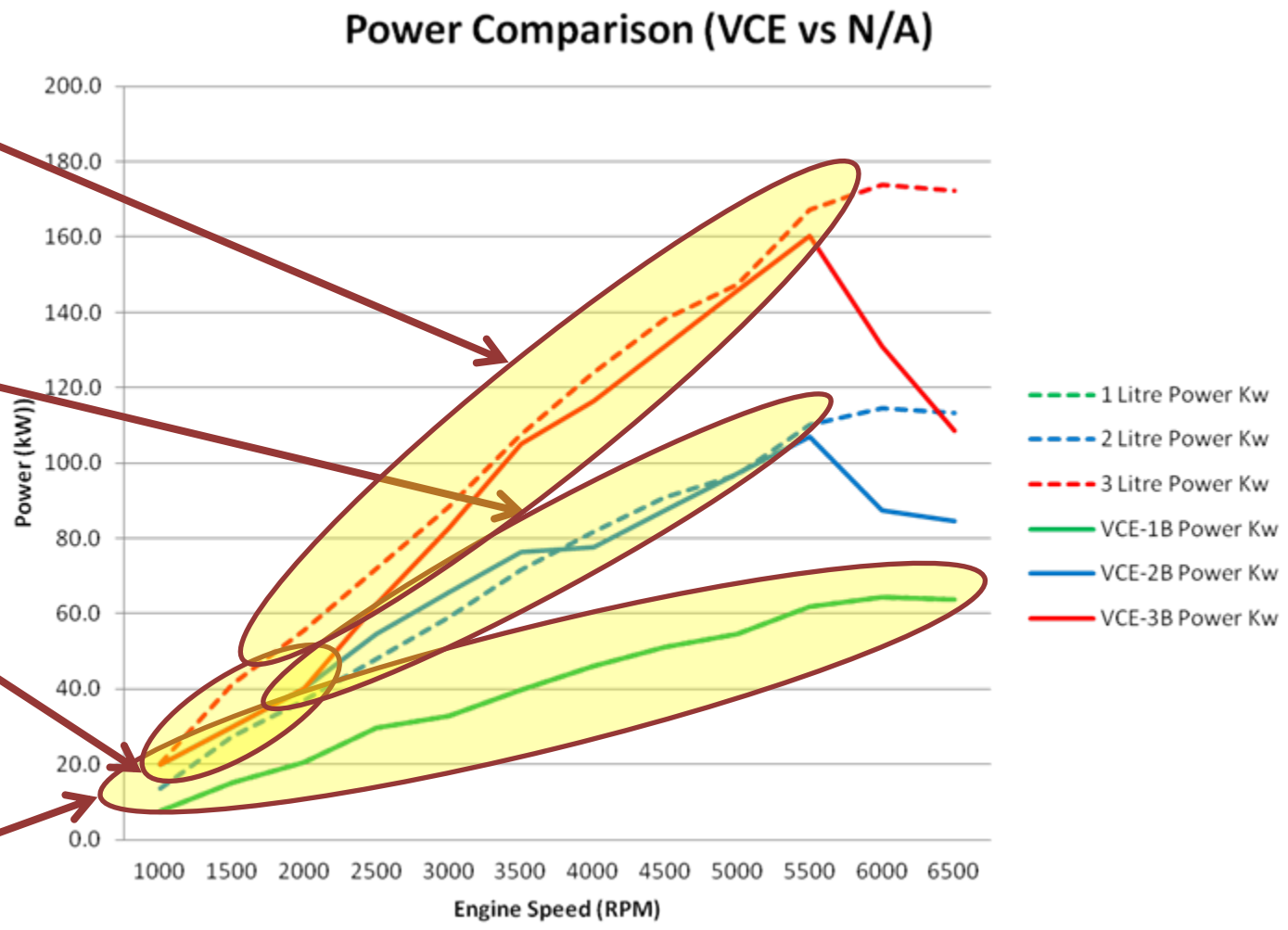
The VCE-3B initially has a lower output than a 3.0 Litre N/A engine but catches up after 3500 RPM once there is sufficient boost supplied from the turbocharger.

The VCE-2B exceeds and continually matches the output of a 2.0 Litre N/A engine across a wide band from 1000 – 5500 RPM.

The VCE-2B and VCE-3B have a similar output between 1000 – 2000 RPM whereby the instantaneous boost comes from the electric supercharger.

The VCE-1B power curve is exactly the same as a 1.0 Litre N/A engine since there is no boost at this stage.



Overview of the VCE

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Variable Capacity Engine (VCE)

The engine will run just like a 1.0 Litre N/A engine as there is absolutely no boost at this point.

The engine will run like a 2.0 Litre N/A engine at this point with boost supplied from both the electric supercharger and turbocharger.

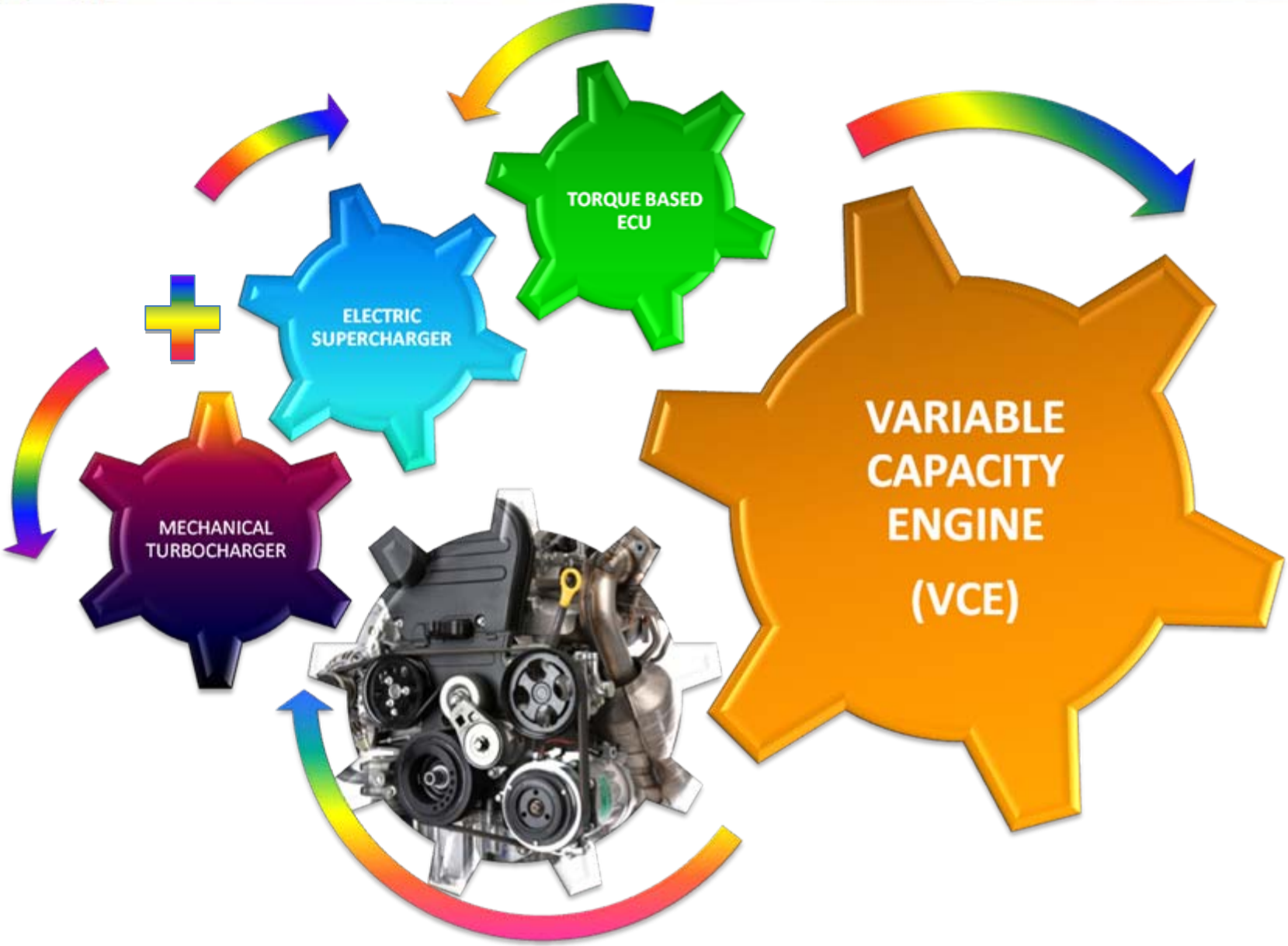
The engine will run like a 3.0 Litre N/A engine at this point with boost supplied from both the electric supercharger and turbocharger.

VCE 1B

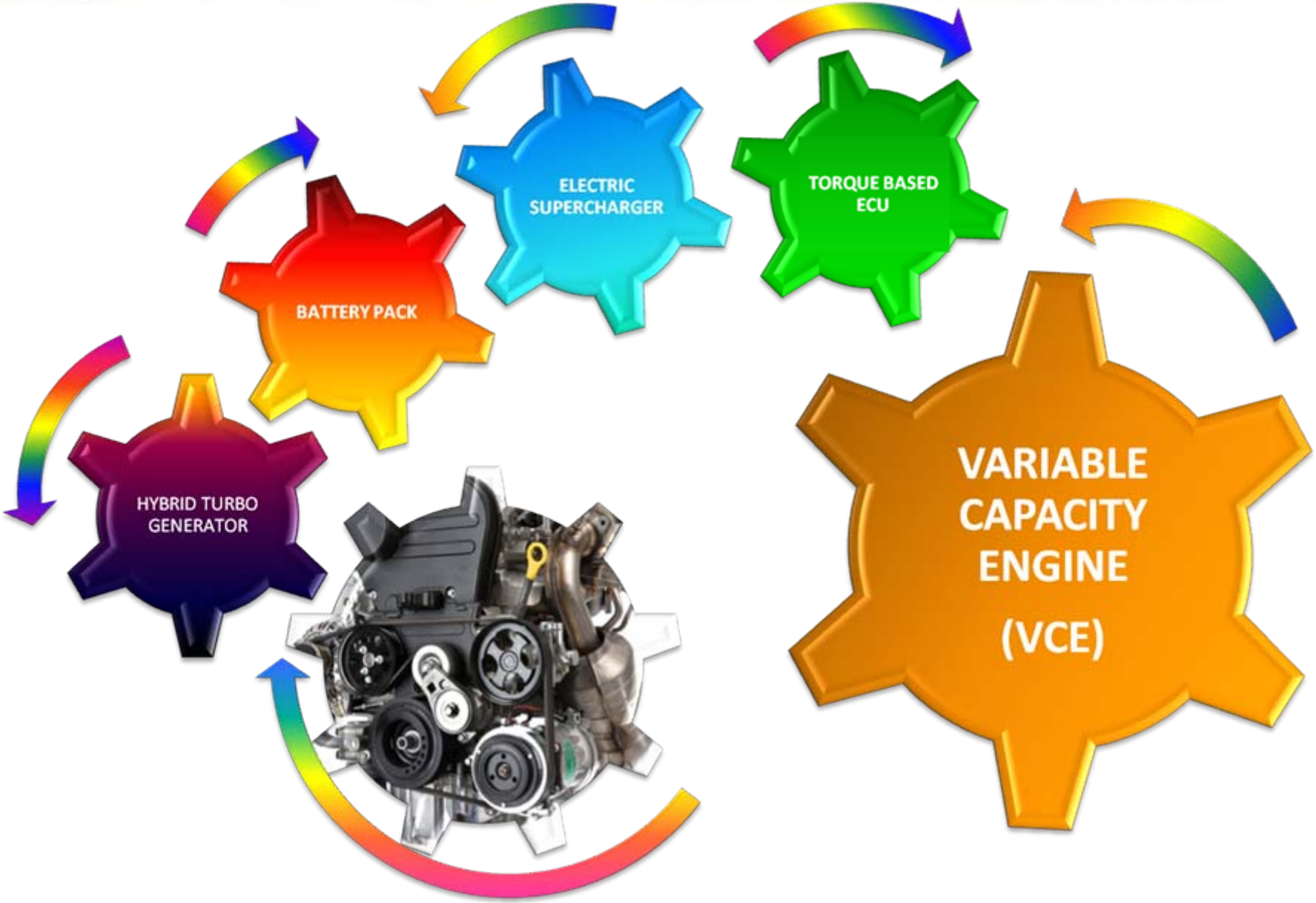
VCE 2B

VCE 3B

VCE Operating Principle (Setup 1)



VCE Operating Principle (Setup 2)



VCE Control Knob Location

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Why VCE ???

- Increasing Prices of Fuel
- Stringent Emission Requirements
- Government Restrictions
- Insurance Policies
- Market Requirements
- Powertrain Weight
- Global Economy
- Procurement & BOM Cost Advantages
- Reduced Assembly Line Complications
- Residential Trends
- The GREEN Lifestyle

Increasing Fuel Prices

- Any form of **reduction in fossil fuel usage** is always a welcomed trend due to the **ever soaring price of crude** which is so easily influenced by economic and political instability around the globe.

Stringent Emission Requirements

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- As emission requirements across the globe get more stringent, no amount of after-treatments could beat the effect of reducing the mass of pollutant substrates generated by an engine in the first place as the common saying goes **“prevention is better than cure”.** However the greatest obstacle is doing this whilst maintaining the desired performance from an engine and this is where the VCE shines**.**

Government Restrictions

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- **Higher displacement volumes** are increasingly becoming subject to **exorbitant government tax** and **levy** as part of an initiative to **reduce dependence on fossil fuel** as well as **minimize the carbon footprint** left behind by each vehicle so the VCE is **a way for automakers** to **outsmart** the way the tax structure is set to work.

Insurance Policies

- Insurance companies around the globe are taking on a more **stringent approach** against vehicle owners with larger engine displacements due to the **assumption that the higher power output** they produce puts them at a **higher risk** of being involved in an accident but having a **high power output without a big displacement** is a move that **outsmarts** the way their policies are set to work.

- Many consumers in emerging markets are **reluctant to buy larger displacement** engines due to the higher cost of ownership associated with it but the **higher engine performance** is sure set to be an influential factor in their decision on which vehicle to purchase.

- People are becoming increasingly fuel-conscious and as such downsizing is the only option but whichever automaker **maintains or increases** the performance output of the vehicle **while downsizing** has a sure-fire way to the top of the sales chart.

- Customers are becoming increasingly prudent where they **only want to pay for the power they use** just like a prepaid mobile phone package so having a variable output engine to suit their driving demands gives them the benefit of a **“pay as you use”** whereby most of the time they can drive on fuel economy mode but can unleash the extra ponies whenever the need arises albeit willing to pay the price for that moments of pleasure.

- **Increasing demands for fuel economy** not only mean automakers around the globe have to **downsize their engine displacements** but it also **involves downsizing their engine dimensions** in their bid to **reduce overall vehicle weight.** In this aspect, having a **physically small engine** capable of **high performance outputs** when needed is a great consolation.

- The **volatile global economy** always makes a fertile ground for **affordable vehicles** and as such automakers that have a **“universal engine” @ one size fits all vehicle segments** always stand a better chance to **survive an economic crisis** as their engines can be **electronically manipulated to suit market demands** for the various vehicle segments/models being rolled out of their plants.

Procurement & BOM Cost Advantage

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- Having a single engine with multiple performance outputs contrary to different engines for different outputs **enables automakers to get better pricing from Tier 1 & Tier 2 suppliers** due to the larger volume of components ordered which subsequently **reduces the engine bill of material (BOM) cost** and also **eliminates the need for additional procurement activities** for each new engine variant.

- Having a separate assembly line for each new engine variant simply means more investments in both manpower and machinery but the VCE overcomes this problem since one common engine hardware can be electronically suited for different vehicle applications. This also prevents mix-ups and confusion of parts at the engine assembly line since there is essentially only one “physical” engine variant to be manufactured.

Residential Trends

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- As **apartments** with **limited parking bays** become the **residential norms** of our day, the idea of having **multiple vehicles** for different occasions is fast becoming a **thing of the past** and thus a **“3 in 1” engine** would prove a good solution for those who want a **frugal daily transporter, a decent family vehicle or a wild stallion for that weekend spin.**

- Automakers around the globe are **compelled** to go **GREEN wherever possible** due to **legislative requirements** as well as a growing community of **environment conscious consumers** and as such **any form of downsizing** is definitely a **correct move.**

Thank You!