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## HYBRID ELECTRIC VEHICLES

A hybrid electric vehicle (HEV) combines at least two energy converters, such as internal combustion engines (ICE), electric drives, hydraulic drives, etc. The ultimate goal of the HEV is to provide the equivalent power, range and safety as a conventional vehicle while reducing fuel consumption and harmful emissions. Hybrid Vehicles have the potential to realize several advantages, including the following:

- Regenerative braking: A regenerative brake is an energy mechanism that reduces vehicle speed by converting some of its kinetic energy into a storable form of energy for future use instead of dissipating it as heat as with a conventional brake.
- Higher electric machine efficiency: In comparison with the ICE, the electric machine is a simpler and more efficient machine. For instance, the moving parts of an electrical machine consist primarily of the armature (DC motor) or rotor (AC motor) and bearings.
- Improved torque characteristics: Electric machines are more suited to vehicle applications, with high torque at low speed and less torque at cruising speed.
- Reduced emissions - through transients smoothing and idle elimination.
- For selected configurations, optimal engine operation - operate the engine in its "sweet spot", staying close to its best efficiency line.
- Engine downsizing might be possible to accommodate average load (not peak load) and consequently reduce engine and powertrain weight.
- Engine shut-off is possible, thereby reducing fuel consumption, emissions and NVH.
- Accessory electrification allows parasitic loads to run on as-needed basis.

However, HEV disadvantages include:

- Increased powertrain and electronic complexity
- Increased vehicle mass due to addition of components
- Increased cost due to additional components and complexity of the power management
- Overall system reliability can be lower due to increased complexity
- If not optimized for the appropriate drive cycle, benefits may not be fully realized.

A number of different system architectures are being considered to meet different applications. They are broadly classified as series, parallel, and power split. Selection of system architecture depends mainly on the application.

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HEVs

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