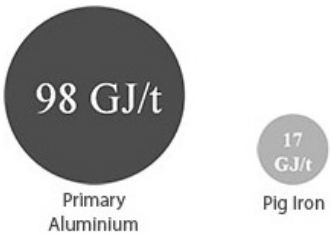
Cast Iron vs Aluminium: Life Cycle Energy

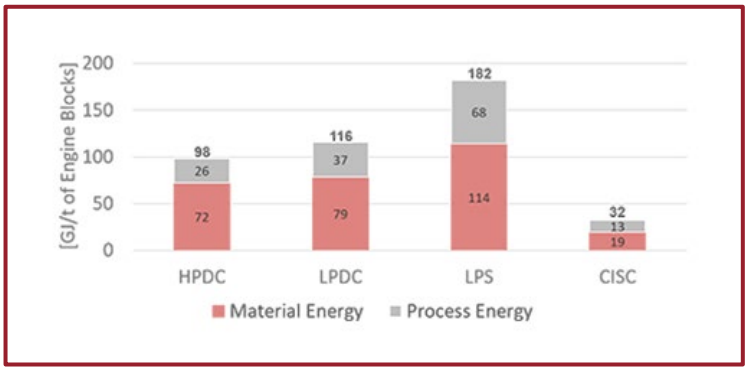
The production of primary aluminium from ore requires approximately five times more energy than the mining and smelting of iron. The foundry processing of aluminium also requires more energy than cast iron. To provide a net benefit to society, the reduced weight of the aluminium engine must provide fuel savings that are larger than the extra energy contained in the raw materials plus the extra energy consumed to produce the cylinder block. For a typical 1.6 litre four-cylinder engine, the weight difference between an aluminium engine and a cast iron engine is usually less than 10 kg. Weight reduction in passenger vehicles saves approximately 0.2 litres of petrol (0.15 litres of diesel) for each 100 km driven and 100 kg of weight saved. Considering the 34.2 MJ/litre energy content of petrol (38.6 MJ/litre for diesel), a 10 kg lighter aluminium engine must drive approximately 200,000-500,000 km before the initial energy penalty is recovered. This is beyond the life of most vehicles.

For V-type engines, CGI engines are often lighter than aluminium engines. For these engines, it is impossible for aluminium to provide a CO_2 payback to society.



Embodied Energy in GJ per tonne of Engine Blocks

The total energy embodied in a component is the sum of the energy in all of the raw materials arriving at the foundry, plus the energy consumed by the manufacturing processes needed to produce the component. The plot shows the total energy for cylinder blocks produced in aluminium (High Pressure Die Casting; Low Pressure Die Casting and Low Pressure Sand Casting) and in Cast Iron Sand Casting. To provide a net benefit to society, the higher energy consumed during the production of an aluminium cylinder block must be recovered through reduced fuel consumption during the life of the vehicle.



Breakeven distances

The plot shows the driving distance required to payback the higher energy consumed during the manufacture of an aluminium cylinder block. Each recycling ‘loop’ dilutes the embodied primary energy in an aluminium cylinder block. The dark blue bar represents the total energy after one recycling loop. The light grey bar represents infinite recycling. Most aluminium cylinder blocks in service today have been recycled less than five times. The horizontal black line represents the average life of a passenger vehicle – 210,000 km. Under most production conditions, the use of aluminium does not provide a net energy benefit to society.