

Conventional Powertrain Cheat Sheet

ICE driveline layout, BSFC, efficiency and gear force

ENGINEERING
CHEAT SHEET

Key equations

Quantity	Equation	Notes
Brake specific fuel consumption	$BSFC [g/kWh] = 3,600 \cdot \dot{m}_f / P_e$	$\dot{m}_f$ in g/s, P_e = brake power in kW. Lower is better
Engine power	$P_e = \tau_e \omega_e$	$\omega_e = 2\pi \text{ RPM} / 60$
Thermal efficiency (gasoline)	$\eta \approx 1 / (BSFC \times 0.0122225)$	Diesel uses 0.0119531
BSFC example	8 g/s at 90 kW → 320 g/kWh → $\eta \approx 26\%$	Roughly a quarter of the fuel energy becomes useful work
Driveline efficiency	$\eta = \eta_{\text{gearbox}} \cdot \eta_{\text{shaft}} \cdot \eta_{\text{diff}}$	$0.94 \times 0.98 \times 0.93 \approx 0.86$, so a 150 kW engine gives about 129 kW at the wheels
Max wheel force (gear i)	$F_i = \tau_{e,\text{max}} \cdot GR_i \cdot FD \cdot \eta / R_{\text{tire}}$	Plot against speed for each gear to see the traction envelope
Gearbox relation	$\omega_{\text{out}} = \omega_{\text{in}} / GR, \tau_{\text{out}} = \tau_{\text{in}} GR \eta$	Gearbox trades speed for torque

Key takeaways

- Conventional powertrain path: **engine → transmission → driveshaft → differential → axles → wheels**. Torque is the push; power sustains speed.
- Rear-wheel drive sends power only to the rear wheels, leaving the fronts to steer, and gives good weight distribution and handling.
- An engine needs spark, air, fuel and compression. Max and min engine torque are functions of engine speed.
- Engine efficiency depends on speed and torque. Gasoline averages about 322 g/kWh; the best production units reach ~225. Diesels dip below 200 g/kWh at low speed, high torque.
- The optimal operating line (OOL) is the set of lowest-BSFC points along each constant-power curve. Hybrids and CVTs try to keep the engine on it.
- Every driveline stage loses a few percent to friction; the losses multiply.

Example vehicle from the guide

Item	Value
Gear ratios	5.25, 3.03, 1.95, 1.46, 1.22, 1, 0.81, 0.67
Final drive / tire radius	2.8 / 0.32 m
Mass / frontal area / Cd	1,500 kg / 1.6 m ² / 0.25