Electric Vehicle Technology Explained

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Abbreviations

AC	Alternating current
BLDC	Brushless DC (motor)
BOP	Balance of plant
CARB	California air resources board
CCGT	Combined cycle gas turbine
CNG	Compressed natural gas
CPO	Catalytic partial oxidation
CVT	Continuously variable transmission
DC	Direct current
DMFC	Direct methanol fuel cell
ECCVT	Electronically controlled continuous variable transmission
ECM	Electronically commutated motor
EMF	Electromotive force
EPA	Environmental protection agency
EPS	Electric power steering
ETSU	Energy technology support unit (a government organisation in the UK)
EUDC	Extra-urban driving cycles
EV	Electric vehicle
FCV	Fuel cell vehicle
FHDS	Federal highway driving schedule
FUDS	Federal urban driving schedule
GM	General Motors
GM EV1	General Motors electric vehicle 1
GNF	Graphitic nanofibre
GTO	Gate turn off
HEV	Hybrid electric vehicle
HHV	Higher heating value
IC	Internal combustion
ICE	Internal combustion engine
IEC	International Electrotechnical Commission
IGBT	Insulated gate bipolar transistor
IMA	Integrated motor assist
IPT	Inductive power transfer

kph	Kilometres per hour
LHV	Lower heating value
LH_2	Liquid (cryogenic) hydrogen
LPG	Liquid petroleum gas
LSV	Low speed vehicle
MeOH	Methanol
mph	Miles per hour
MEA	Membrane electrode assembly
MOSFET	Metal oxide semiconductor field effect transistor
NASA	National Aeronautics and Space Administration
NiCad	Nickel cadmium (battery)
NiMH	Nickel metal hydride (battery)
NL	Normal litre, 1 litre at NTP
NTP	Normal temperature and pressure (20°C and 1 atm or 1.01325 bar)
NOX	Nitrous oxides
OCV	Open circuit voltage
PEM	Proton exchange membrane or polymer electrolyte membrane: different names for the same thing which fortunately have the same abbreviation
PEMFC	Proton exchange membrane fuel cell or polymer electrolyte membrane fuel cell
PM	Permanent magnet or particulate matter
POX	Partial oxidation
ppb	Parts per billion
ppm	Parts per million
PROX	Preferential oxidation
PWM	Pulse width modulation
PZEV	Partial zero emission vehicle
SAE	Society of Automotive Engineers
SFUDS	Simplified federal urban driving schedule
SL	Standard litre, 1 litre at STP
SOFC	Solid oxide fuel cell
SRM	Switched reluctance motor
STP	Standard temperature and pressure (= SRS)
SULEV	Super ultra low emission vehicles
TEM	Transmission electron microscope
ULEV	Ultra low emission vehicle
VOC	Volatile organic compounds
VRLA	Valve regulated (sealed) lead acid (battery)
WTT	Well to tank
WTW	Well to wheel
WOT	Wide open throttle
ZEBRA	Zero emissions battery research association
ZEV	Zero emission vehicle

Symbols

Letters are used to stand for variables, such as mass, and also as chemical symbols in chemical equations. The distinction is usually clear from the context, but for even greater clarity italics are use for variables, and ordinary text for chemical symbols, so H stands for enthalpy, whereas H stands for hydrogen.

In cases where a letter can stand for two or more variables, the context always makes it clear which is intended.

a	Acceleration
A	Area
B	Magnetic field strength
C_d	Drag coefficient
C	Amphour capacity of a battery OR capacitance of a capacitor
C_3	Amphour capacity of a battery if discharged in 3 hours, the '3 hour rate'
C_p	Peukert capacity of a battery, the same as the Amphour capacity if discharged at a current of 1 Amp
CR	Charge removed from a battery, usually in Amphours
CS	Charge supplied to a battery, usually in Amphours
d	Separation of the plates of a capacitor OR distance traveled
DoD	Depth of discharge, a ratio changing from 0 (fully charged) to 1 (empty)
E	Energy, or Young's modulus, or EMF (voltage)
E_b	Back EMF (voltage) of an electric motor in motion
E_s	Supplied EMF (voltage) to an electric motor
e	Magnitude of the charge on one electron, 1.602×10^{-19} Coulombs
f	Frequency
F	Force or Faraday constant, the charge on one mole of electrons, 96 485 Coulombs
F_{rr}	Force needed to overcome the rolling resistance of a vehicle
F_{ad}	Force needed to overcome the wind resistance on a vehicle
F_{la}	Force needed to give linear acceleration to a vehicle
F_{hc}	Force needed to overcome the gravitational force of a vehicle down a hill
$F_{\omega a}$	Force at the wheel needed to give rotational acceleration to the rotating parts of a vehicle
F_{te}	Tractive effort, the forward driving force on the wheels
g	Acceleration due to gravity

G	Gear ratio OR rigidity modulus OR Gibbs free energy (negative thermodynamic potential)
H	Enthalpy
I	Current, OR moment of inertia, OR second moment of area, the context makes it clear
I_m	Motor current
J	Polar second moment of area
k_c	Copper losses coefficient for an electric motor
k_i	Iron losses coefficient for an electric motor
k_w	Windage losses coefficient for an electric motor
KE	Kinetic energy
K_m	Motor constant
k	Peukert coefficient
L	Length
m	Mass
$\dot{m}$	Mass flow rate
m_b	Mass of batteries
N	Avogadro's number, 6.022×10^{23} OR revolutions per second
n	Number of cells in a battery, OR a fuel cell stack, OR the number of moles of substance
P	Power OR pressure
P_{adw}	Power at the wheels needed to overcome the wind resistance on a vehicle
P_{adb}	Power from the battery needed to overcome the wind resistance on a vehicle
P_{hc}	Power needed to overcome the gravitational force of a vehicle down a hill
$P_{mot\text{-}in}$	Electrical power supplied to an electric motor
$P_{mot\text{-}out}$	Mechanical power given out by an electrical motor
P_{rr}	Power needed to overcome the rolling resistance of a vehicle
P_{te}	Power supplied at the wheels of a vehicle
Q	Charge, e.g. in a capacitor
q	Sheer stress
R	Electrical resistance, OR the molar gas constant $8.314\,\mathrm{JK^{-1}\,mol^{-1}}$
R_a	Armature resistance of a motor or generator
R_L	Resistance of a load
r	Radius, of wheel, axle, OR the rotor of a motor, etc.
r_i, r_o	Inner and outer radius of a hollow tube
S	Entropy
SE	Specific energy
T	Temperature, OR Torque, OR the discharge time of a battery in hours
T_1, T_2	Temperatures at different stages in a process
T_f	Frictional torque, e.g. in an electrical motor
t_{on}, t_{off}	On and off times for a chopper circuit
v	Velocity
V	Voltage

W	Work done
z	Number of electrons transferred in a reaction
Φ	Total magnetic flux
δ	Deflection
δt	Time step in an iterative process
Δ	Change in …, e.g. ΔH = change in enthalpy
σ	Bending stress
ε	Electrical permittivity
η	Efficiency
η_c	Efficiency of a DC/DC converter
η_{fc}	Efficiency of a fuel cell
η_m	Efficiency of an electric motor
η_g	Efficiency of a gearbox
η_0	Overall efficiency of a drive system
θ	Angle of deflection or bend
λ	Stoichiometric ratio
μ_{rr}	Coefficient of rolling resistance
ρ	Density
ψ	Angle of slope or hill
ω	Angular velocity