11. Acronyms and Abbreviations

°C	Degrees Celsius
µm	Microns
3D	Three-dimensional
3GAHSSS	Third-Generation Advanced High-Strength Steel
A	Ampere
ABR	Advanced Battery Research
ACC	Automated Cruise Control
ACEC	Advanced Combustion and Emissions Control
ACI	Advanced compression ignition
AEC	Advanced Engine Combustion
AER	All-electric range
AFC	Alternative Fuel Corridor
AFDC	Alternative Fuels Data Center
AFLEET	Alternative Fuel Life-Cycle Environmental and Economic Transportation tool
AFM	Atomic force microscopy
AFV	Alternative fuel vehicle
Ag	Silver
Ah	Ampere-hour
Al	Aluminum
Al_2O_3	Aluminum oxide
AlCuEx	Aluminum copper alloy
ALD	Atomic layer deposition
AlF_3	Aluminum fluoride
AlNiCo	Aluminum-nickel-cobalt
AMBER	Advanced Model Based Engineering Resource
AMD	Automated Mobility Districts
AMR	Annual Merit Review
ANL	Argonne National Laboratory
API	American Petroleum Institute
APRF	Advanced Powertrain Research Facility
ARL	Army Research Laboratory
A_{rms}	Ampere root mean square
ARPA-E	Advanced Research Projects Agency-Energy
ATP	Advanced Technology Powertrain
ATR	Attenuated total reflectance
AV	Automated vehicle
BEAM	Behavior Energy Autonomy Mobility
BES	Basic Energy Sciences
BET	Battery electric truck
BEV	Battery electric vehicle
BMEP	Brake mean effective pressure

BMR	Battery Materials Research
BMS	Battery management system
BNL	Brookhaven National Laboratory
BOB	Blendstock for oxygenated blending
BOPP	Bi-oriented polypropylene
BSFC	Brake-specific fuel consumption
BTE	Brake thermal efficiency
C	Carbon
CA50	Crank angle position at which 50% of heat is released
CABS	Consortium for Advanced Batteries Simulation
CACC	Cooperative Adaptive Cruise Control
CAE	Computer-aided engineering
CAEBAT	Computer-aided engineering of batteries
CAMP	Cell Analysis, Modeling, and Prototyping Facility
CARB	California Air Resources Board
CAV	Connected and Autonomous Vehicle
CAV	Connected and automated vehicle
CB	Carbon black
CCC	Clean Cities Coalitions
CCD	Critical current density
CDC	Conventional diesel combustion
CDOT	Colorado Department of Transportation
Ce	Cerium
CE	Coulombic efficiency
CEC	California Energy Commission
CEI	cathode electrolyte interfacial
CF	Carbon Fiber
CFD	Computational fluid dynamics
CFRP	Carbon Fiber-Reinforced Polymer
CGI450	compacted graphite iron 450
CHA	Chabazite
CHT	Conjugate heat transfer
CI	Compression Ignition
CLEERS	Cross-cut Lean Exhaust Emissions Reduction Simulations
cm	Centimeter
CMC	Carboxymethyl cellulose
CN	Combustion noise
CN	Cetane number
CNG	Compressed natural gas
CNT	Carbon nanotubes
CO	Carbon monoxide
Co	Cobalt
CO_2	Carbon dioxide
Co-Ex	Co-extrusion
CPE	Composite polymer electrolytes

CPEC	Close Proximity Electromagnetic Carbonization
CPOX	Catalytic partial oxidation
CRADA	Cooperative Research and Development Agreement
CRC	Coordinating Research Council
CRF	Combustion Research Facility
Cu	Copper
CuF_2	Copper (II) Fluoride
CuOH	Copper hydroxide
CuZ	Copper sulfanide
CV	Connected Vehicle
CY	Calendar Year
dBA	A-weighted decibels
DC	Direct current
DCFC	Direct-current fast charging
DEC	Diethyl carbonate
DEF	Diesel emission fluid
DEGR	Dedicated exhaust gas recirculation
DEMS	Differential electrochemical mass spectroscopy
$DeSO_x$	de-sulfur oxide
DFC	Detroit Future City
DFT	Density functional theory
DI	Direct injection
DNS	Direct numerical simulation
DOC	Diesel oxidation catalyst
DOE	U.S. Department of Energy
DOE	Design of experiments
DOT	U.S. Department of Transportation
DOT	U.S. Department of Transportation
DP	Dynamic Programming
DPF	Diesel particulate filter
DREaM	Development of Radically Enhanced alnico Magnets
DST	Dynamic stress test
E10	10% ethanol blend with gasoline
E20	20% ethanol blend with gasoline
E30	30% ethanol blend with gasoline
EAVS	Electrically Assisted Variable Speed
EB	Electron beam
ECN	Engine Combustion Network
ED	Electric drive
EDAX	Energy-dispersive X-ray spectroscopy
EDS	Energy dispersive spectroscopy
EDT	Electric Drive Technologies
EDV	Electric drive vehicle
EEMS	Energy-Efficient Mobility Systems
EERE	Office of Energy Efficiency and Renewable Energy

EGR	Exhaust gas recirculation
EM	Electron microscopy
EMA	ElectroMechanical Associates
EMC	Electromagnetic compatibility
EOL	End-of-life
EOS	Equation of state
EPA	U.S. Environmental Protection Agency
EPMA	Electron Probe Micro-Analyzer
EPRI	Electric Power Research Institute
ERC	Engine Research Center
ESS	Energy storage system
Eu	Europium
EV	Electric vehicle
EVSE	Electrical Vehicle Supply Equipment
eWHR	Electric waste heat recovery
FBJ	Friction Bit Joining
FCA	Fiat Chrysler Automobiles
FCEV	Fuel cell electric vehicle
FE	Fuel economy, fuel efficiency
Fe	Iron
FE	Fuel economy
FEA	Finite element analysis
FEC	Fluoroethylene carbonate
FEM	Finite element modeling
FeSi	Ferrosilicon
FHWA	Federal Highway Administration
FIE	Fuel injected engine
FIM	Freeway incident management
FLD	Forming Limit Diagram
FOA	Funding opportunity announcement
FRESCO	Fast and Reliable Engine Simulation Code
FSS	Friction Stir Scribe
FSW	Friction Stir Weld
FTA	Federal Transit Administration
FTIR	Fourier transform infrared
FTP	Federal Test Procedure
FV	Finite volume
FY	Fiscal year
g	Gram
G	Giga
GaN	Gallium nitride
GCI	Gasoline compression ignition
GDCI	Gasoline direct compression ignition
GDI	Gasoline direct injection
GHG	Greenhouse gas

GM	General Motors Corporation
GMU	George Mason University
GPF	Gasoline particulate filter
GPS	Global Positioning System
GPU	Graphics processing unit
GSF	Generic speed form
GTI	Gas Technology Institute
H/D	Hydrogen/Deuterium
H_2O	Water
HA	High active
HATCI	Hyundai American Technical Center, Inc.
HAZ	Heat-Affected Zone
HC	Hydrocarbon
HCCI	Homogeneous charge compression ignition
HCl	Hydrochloric acid
HD	Heavy-duty
HDV	Heavy-Duty Vehicle
HECC	High efficiency clean combustion
HET	Hybrid electric truck
HEV	Hybrid electric vehicle
HIL	Hardware-in-the-loop
HPC	High-performance computing
HPC	High-Performance Computing
HPDC	High-Pressure Die Cast
HP-RTM	High-Pressure Resin Transfer Molding
hr	Hour
HRR	Heat release rate
HRTEM	High-resolution transmission electron microscopy
HVAC	Heating, ventilating, and air conditioning
HXN	Hard X-ray nano-probe
Hz	Hertz
ICE	Internal combustion engine
ICME	Integrated Computational Material Engineering
ID	Ignition delay
IGBT	Insulated-gate bipolar transistors
IL	Ionic liquid
INL	Idaho National Laboratory
IP	Intellectual property
IQT	Ignition quality tester
ITS-JPO	Intelligent Transportation System Joint Program Office
K	Kelvin
KERS	Kinetic recovery system
kg	Kilogram
KH-RT	Kelvin-Helmholtz Rayleigh-Taylor
kW	Kilowatt

kWh	Kilowatt-hour
L	Liter
LBNL	Lawrence Berkeley National Laboratory
LCA	Life-cycle analysis
LCO	Lithium cobalt oxide
LD	Light-duty
LDD	Light-duty diesel
LDV	Light-duty vehicle
LES	Large eddy simulation
LEV	Low-emission vehicle
LFO	Lithium iron oxide
LFP	Lithium iron phosphate
Li	Lithium
Li_3PO_4	Lithium phosphate
LIB	Lithium-ion battery
$LiCoO_2$	Lithium cobalt oxide
LiFSI	Lithium bis(flurosulfonyl)mide
Li-ion	Lithium Ion
$LiPF_6$	Effective electrolyte salt for lithium-ion battery
LiPON	$Li_{2.88}PO_{3.86}N_{0.}14$
Li-S	Lithium-sulfur
LL	Layered-layered
LLNL	Lawrence Livermore National Laboratory
LLS	Layered-layered spinel
LLZO	Lithium lanthanum zironate
LMNO	Lithium manganese nickel oxide
LMO	Lithium manganese oxide
LMR	Lithium manganese rich
LNC	Lean NO_x catalyst
LNMO	Lithium nickel manganese oxide
LNT	Lean NO_x trap
LPG	Liquefied natural gas
LSPI	Low-speed pre-ignition
LT	Low temperature
LT SCR	Low-temperature selective catalytic reduction
LTAT	Low-temperature aftertreatment
LTC	Low-temperature combustion
LTGC	Low temperature gasoline combustion
LTO	Lithium titanium oxide
m	Meter
M&S	Modeling and simulation
mA	Milliampere
MA3T	Market Acceptance of Advanced Automotive Technologies
MATSim	Multi-Agent Transport Simulation
MD	Molecular dynamics

MDV	Medium-duty vehicle
MERF	Materials Engineering Research Facility
Mg	Magnesium
MIT	Massachusetts Institute of Technology
MLD	Molecular layer deposition
mm	Millimeter
MMFC	Multi-mode fluid controller
Mn	Manganese
Mn	Manganese
MON	Motor octane number
MORPC	Mid-Ohio Regional Planning Commission
MOSFET	Metal–oxide–semiconductor field-effect transistor
MOU	Memorandum of Understanding
MPC	Model-Predictive Control
MPG	Miles per gallon
MRI	Magnetic resonance imaging
ms	Milliseconds
MW	Megawatt
MYPP	Multi-Year Program Plan
N_2O	Nitrous Oxide
N_2O	Nitrous Oxide
NACFE	North American Council on Freight Efficiency
NARC	National Association of Regional Councils
NASA	National Aeronautics and Space Administration
NCA	Battery cathode material (nickel cobalt aluminum oxide)
NCM	Nickel cobalt manganese oxide
NDE	Non-Destructive Evaluation
NEAT	Non-Light Duty Energy and GHG Emissions Accounting Tool
NESCAUM	Northeast States for Coordinated Air Use Management
NETL	National Energy Technology Laboratory
NEVA	National Economic Value Assessment
NH_3	Ammonia
NHTSA	National Highway Traffic Safety Administration
Ni	Nickel
NMC	Nickel manganese cobalt oxide
NMO	Nickel manganese oxide
NMP	N-methylpyrrolidone
NMR	Nuclear magnetic resonance
NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
NP	nanoparticles
NREL	National Renewable Energy Laboratory
NSC	NO_x storage catalyst
NSLSII	National Synchrotron Light Source II

NTEA	National Truck Equipment Association
NU	Northwestern University
NVO	Negative valve overlap
NYBEST	New York Battery and Energy Storage Technology Consortium
O_2	Oxygen
OAS	Open architecture software
OBD	On-board diagnostics
ODD	Operational Design Domain
OEM	Original equipment manufacturer
OH	Hydroxide
OI	Octane index
OpenFOAM	Open source Field Operation And Manipulation
ORAD	On-Road Automated Driving
ORNL	Oak Ridge National Laboratory
OS	Organosilicon
OSC	Oxygen storage capacity
P	Phosphorus
PAA	Polyacrylic acid
PAG	Polyalkylene glycol
PAN	Polyacrylonitrile
*P*c	Compressed pressure
Pd	Palladium
PDF	Paired distribution function
PEMS	Portable emissions monitoring system
PEV	Plug-in electric vehicle
PGM	Platinum group metals
PHET	Plug-in hybrid electric truck
PHEV	Plug-in hybrid electric vehicle
PHS	Press-Hardening Steels
PI	Principal investigator
PM	Particulate matter
PMI	Particulate matter index
PMP	Pontryagin's Minimum Principle
PN	Particulate number
PNA	Passive NO_x adsorber
PNNL	Pacific Northwest National Laboratory
POLARIS	Planning and Operations Language for Agent-based Regional Integrated Simulation
PPy	Polypyrrole
PRT	Personal Rapid Transit
PSD	Particle size diameter
Pt	Platinum
PTWA	Plasma transfer wire arc
PVDF	Polyvinylidene difluoride
R&D	Research and development
RANS	Reynolds-Averaged Navier Stokes

RCCI	Reactivity controlled compression ignition
RCM	Rapid compression machines
RDE	Real-world driving emissions
Rds(on)	Resistance from drain to source
RE	Rare earth
RF	Radio frequency
RNG	Renewable natural gas
ROI	Return on investment
RON	Research octane number
RPM	Revolutions per minute
RPT	Reference performance test
RT	Room temperature
S	Sulfur
SAE	Society of Automotive Engineers
SBD	Schottky barrier diodes
SBIR	Small Business Inngovation Research
SCC	Stress-Corrosion Cracking
SCO	Selective catalytic oxidation
SCR	Selective catalytic reduction
SCRF	Selective catalytic reduction on filter
SD	Standard deviation
SEI	Solid electrolyte interface
SEMCOG	Southeast Michigan Council of Governments
SHRP2	Second Strategic Highway Research Program
SI	Spark ignition
Si	Silicon
SiC	Silicon carbide
Si-C	Silicon Carbon
SIDI	Spark ignition direct injection
SiO_2	Silicon dioxide
SiO_x	Silicon oxide
SLAC	Stanford Linear Accelerator Center
SLTNR	Sustained low-temperature NO_x reduction
SMART	Specific, measurable, achievable, relevant, and time bound
SMART	Systems and Modeling for Accelerated Research in Transportation
SMD	Sauter mean diameter
SME	Subject matter expert
Sn	Tin
SNL	Sandia National Laboratories
SOA	Semiconductor optical amplifier
SOC	State of charge
SOI	Start of ignition
SPH	Smoothed particle hydrodynamics
SRL	Surface reconstruction layer
$SrTiO_3$	Strontium titanate

SSRL	Stanford Synchrotron Radiation Lightsource
STEM	Scanning transmission electron microscopy—electron energy loss spectroscopy
SULEV	Super ultra-low emission vehicle
SUNY	State University of New York
SUV	Sport Utility Vehicle
SWCNT	Single wall carbon nanotube
SwRI	Southwest Research Institute
SynchRel	Synchronous reluctance
T50	Temperature at which 50% conversion occurs
*T*c	Compressed temperature
TCO	Total cost of ownership
TEA	Technology-Economic Analysis
TEEM	Transportation Energy Evolution Modeling
TEM	Transmission electron microscopy
TEY	Total electron yield
TFM	Thickened flame model
TI	Technology Integration
TIM	Thermal interface material
TM	Transition metal
TMS	Thermal management system
TNC	Transportation Network Company
TRB	Transportation Research Board
TRC	Transportation Research Center
TRL	Technology Readiness Level
TSDC	Transportation Secure Data Center
TUMS	Toolbox for Urban Mobility Simulation
TWB	Tailored-Welded Blanks
TWC	Three-way catalyst
TXM	Transmission X-ray microscopy
U.S.	United States
U.S. DRIVE	United States Driving Research and Innovation for Vehicle efficiency and Energy
UC	Ultra-capacitor
UHSS	Ultra-High Strength Steels
UIC	University of Illinois at Chicago
UM	University of Michigan
UPS	United Parcel Service
UQ	Uncertainty quantification
USABC	United States Advanced Battery Consortium
USAMP	United States Automotive Materials Partnership
USCAR	United States Council for Automotive Research
USPS	U.S. Postal Service
UTEMPRA	Unitary thermal energy management for propulsion range augmentation
UV	Ultraviolet
UW	University of Wisconsin
V	Volt

V2G	Vehicle to grid
VAN	Vehicle Analysis
VC	Vinylene carbonate
VCR	Variable compression ratio
VERIFY	Virtual Engine Research Institute and Fuels Initiative
VMT	Vehicle miles traveled
VN	Vanadium nitride
VOF	Volume of fluid
VOPO4	Vanadium phosphate
VOTT	Value of Travel Time
VTO	Vehicle Technologies Office
VVA	Variable valve actuation
VVT	Variable valve timing
W	Watt
WBG	Wide bandgap
WFO	Work-for-others
Wh	Watt hour
Wh/l	Watt hour per liter
WHR	Waste heat recovery
WPT	Wireless power transfer
WTP	Willingness-to-Pay
XANES	X-ray absorption near edge structure
XAS	X-ray absorption spectroscopy
XFC	Extreme fast charging
XPD	X-ray powder diffraction
XPS	X-ray photoelectron spectroscopy
XRD	X-ray diffraction
ZECT	Zero emission cargo truck
ZEV	Zero-emission vehicle
Zr	Zirconium
ZrO_2	Zirconium dioxide
μ	Micron