

## Acronyms and Abbreviations

Δspec	Absorbance-difference kinetic spectrophotometry	CaBr <sub>2</sub>	Calcium Bromide
Å	Angstrom (one hundred-millionth of a centimeter)	CAD	Computer Aided Design
A/C	Air Conditioner	CAE	Computer Aided Engineering
ABET	Accreditation Board for Engineering and Technology	CaO	Calcium Oxide
AC	Alternating Current	CARB	California Air Resources Board
ACR	Autothermal Cyclic Reforming	CATA	Center Area Transport Authority
AER	Absorption-Enhanced Reforming	CBS	Specific Strain of Rubrivivax Gelatinosus
AFC	Alkaline Fuel Cell	CCH	Complex Compound Hydride
Ag	Silver	CCHS	Complex Compound Hydrogen Storage System
AGB	Anode Gas Burner	CCM	Catalyst Coated Membrane
AHC	Ad Hoc Committee	Ce	Cerium
AirCred	Air Quality Credits	CE	European Conformity
Al	Aluminum	CEC	California Energy Commission
Al <sub>2</sub> O <sub>2</sub>	Aluminum Oxide	CEM	Compressor Expander Motor/Continuous Emissions Monitoring
AlCl <sub>3</sub>	Aluminum Chloride	CERMET	Ceramic and Metal
ANL	Argonne National Laboratory	CESI	Catalytic Energy Systems Inc
ANT	Albany NanoTech	CF	Capacity Factor
APU	Auxiliary Power Unit	CFA	Community Fuel Appliance
a-Si	Amorphous Silicon	CFD	Computational Fluid Dynamics
ASME	American Society of Mechanical Engineers	CFR	Code of Federal Regulations
ASR	Area Specific Resistance	CGA	Compressed Gas Association
ASU	Air Separation Unit	CGO	Cerium-Gadolinium Oxide (Ce <sub>0.8</sub> Gd <sub>0.2</sub> O <sub>1.9</sub> )
atm	atmosphere	CH <sub>2</sub>	Compressed Hydrogen Gas
ATMI	Advanced Technical Materials Incorporated	CH <sub>2</sub> -ISS	Compressed Hydrogen Gas Integrated Storage System
ATP	Adenosine Triphosphate	CH <sub>4</sub>	Methane
ATR	Autothermal Reformer/Reforming/Reactor	Chl	Chlorophyll
Au	Gold	CIGS	Copper-Indium-Gallium-Diselenide
B	Boron	CL&P	Connecticut Light and Power
barg	Bar Gauge	CLV	City of Las Vegas
bdt	Bone Dry Ton	cm <sup>2</sup>	Centimeters Squared
BNL	Brookhaven National Laboratory	CMS	Crash Management System
BOP	Balance of Plant	CMWG	Carbon Materials Working Group
BP	British Petroleum	CNG	Compressed Natural Gas
BPSH	Biphenyl sulfones	CNR	Center for Neutron Research
Br	Bromine	CO	Carbon Monoxide
BSE	Back Scattered Electron	CO <sub>2</sub>	Carbon Dioxide
BTU	British Thermal Unit	COE	Cost of Electricity
C	Carbon	COGEN	Combined Building Heat and Power
°C	Degrees Centigrade	COS	Carbonyl Sulfide
C <sub>2</sub> H <sub>4</sub>	Ethylene	CPO	Catalytic Partial Oxidation
Ca	Calcium	CPS	Chemical Process Simulation
		psi	cells per square inch

CPSS	Combinatorial Powder Synthesis System	EMI	Electromagnetic Interference
Cr	Chromium	EMPA	Electron Microprobe Analysis
CS	Constant Stoichiometry	EPA	U.S. Environmental Protection Agency
CS&D	Compression, Storage and Dispensing	EPR	Electron Paramagnetic Resonance
CSMP	Cabot Superior Micropowders	EPRI	Electric Power Research Institute
CST	Compact Stuart Technology	ERD	Energy Recovery Device
Cu	Copper	ESA	Electrochemical Surface Area
Cu <sub>2</sub> O	Cuprous Oxide	ESR	Electron Spin Resonance
CVD	Chemical Vapor Deposition	ESS	Energy Storage System
CVI	Chemical Vapor Infiltration	ETS	Engelhard Titanosilicate (commercial membrane material name)
CWRU	Case Western Reserve University	EXAFS	Extended X-ray Absorption Fine Structure
CY	Calendar Year	F	Force
DBEDT	Department of Business, Economic Development and Tourism (Hawaii)	FASTER	Feasibility of Acceptable Start Time
DC	Direct Current	FC	Fuel Cell
DCF	Discounted Cash Flow	FCCP	carbonyl cyanide <i>m</i> -chlorophenylhydrazone
DCM	Dichloromethane	FCE	Fuel Cell Energy
DEP	Department of Environmental Protection	FCEV	Fuel Cell Electric Vehicle
DER	Distributed Energy Resources	FCPI	Fuel Cell Propulsion Institute
DFMA	Design for Manufacture and Assembly	FCPS	Fuel Cell Power System
DG	Distributed Generator	FCS	Fuel Cell System
DME	Dimethylether	FCTF	Fuel Cell Test Facility (Hawaii)
DMFC	Direct Methanol Fuel Cell	FCV	Fuel Cell Vehicle
DNA	Deoxyribonucleic Acid	Fd	Ferredoxin
DNS	Direct Numerical Simulation	Fe	Iron
DOD	U.S. Department of Defense	Fe <sub>2</sub> O <sub>3</sub>	Ferric Oxide
DOE	U.S. Department of Energy	Fe <sub>3</sub> O <sub>4</sub>	Magnetic Iron Oxide
DOT	U.S. Department of Transportation	FeCl <sub>3</sub>	Ferric Chloride
DP	Differential Pressure	FePO <sub>x</sub>	Iron Phosphate
DRIFTS	Diffuse Reflectance mid-Infrared Fourier Transform Spectroscopy	FET	Field Effect Transistor
DSC	Differential Scanning Calorimetry	FID	Flame Ionization Detector
DTI	Directed Technologies Inc.	FIT	Florida Institute of Technology
EB/GDL	Electrode Backing/Gas Diffusion Layer	FMEA	Failure Mode and Effect Analysis
EdNet	Educational Network	FP1	Fuel Processor One
EDS	Engineering Development Specification	FPD	Flame Photometric Detector
EERE	Energy Efficiency and Renewable Energy	FPES	Fluorinated Polyether Sulfone
EIHP	European Integrated Hydrogen Project	FPS	Fuel Processing System
ELAT <sup>®</sup>	Registered Trademark of De Nora North America, Inc., covers GDLs and GDEs	FRACAS	Failure Reporting, Analysis and Corrective Action System
EMF	Electromagnetic Field	FreedomCAR	U.S. Department of Energy Automotive Research Partnership
		FS-PEEK	Fluorinated Sulfonated Polyetheretherketone
		FTA	Federal Transportation Administration

FTE	Full Time Equivalent	HFCIT	Hydrogen, Fuel Cells, and Infrastructure Technologies
FUDS	Federal Urban Driving Schedule	HHV	Higher Heating Value
g	Gram	HI	Hydroiodic Acid
GA	General Atomics Corporation	HiQ	High-Efficiency, Quick Start Fuel Processor
gal	Gallon	HNEI	Hawaii Natural Energy Institute
GaN	Gallium Nitride	HPA	Heteropolyacid
GC	Gas Chromatograph/Gas Chromatography	HPE	Hybrid Photoelectrode
GCtool	Power system analysis software developed by ANL	H-PEDOT	Poly-3,4-ethylenedioxythiophene and ethylene glycol
Gd <sub>2</sub> O <sub>2</sub> S:Eu	Gadolinium Oxy-Sulfide doped with Europium	HTE	High Temperature Electrolysis
GDATP	General Dynamics Armament & Technical Products	HTGR	High Temperature Gas-cooled Reactor
GDE	Gas Diffusion Electrode	HTM	Hydrogen Transport Membrane/High Temperature Membrane
GDL	Gas Diffusion Layer	HTS	High Temperature Shift
GDS	Galvanodynamic Scan	HWCVD	Hot Wire Chemical Vapor Deposition
Ge	Germanium	HX	Heat Exchanger
GEAE	General Electric Aircraft Engines	HydA1	Algal Hydrogenases
GGA	Generalized Gradient Approximation	HYSYS	Aspen Technologies' CPS
gge	Gasoline Gallon Equivalent	I	Electrical Current
GHG	Green House Gas	ICC	International Code Council
GHSV	Gas Hourly Space Velocity	ICE	Internal Combustion Engine
GJ	Gigajoule (10 <sup>9</sup> joules)	ICEV	Internal Combustion Engine Vehicle
GREET	Greenhouse Gas Energy and Emissions in Transportation	ICR	Interfacial Contact Resistance
GRPE	Working Party on Pollution and Energy	IEA	International Energy Agency
GTI	Gas Technology Institute	IEC	International Electrotechnical Commission
ΔH <sup>o</sup>	Heat of Formation	IFS <sup>TM</sup>	Interactive Future Simulations
H <sub>2</sub>	Hydrogen	IIT	Illinois Institute of Technology
H <sub>2</sub> O	Water	INEEL	Idaho National Engineering and Environmental Laboratory
H <sub>2</sub> S	Hydrogen Sulfide	INS	Inelastic Neutron Scattering
HAZOP	Hazardous Operations	IOS	Intelligent Optical Systems, Inc.
HBr	Hydrobromic acid	IPA	International Platinum
HBT	Hydrogen Burner Technology	Ir	Iridium
HC	Hydrocarbon	IR	Infrared
HCCI	Homogeneous Charge Compression Ignition	ISO	International Organization for Standardization
HCl	Hydrochloric Acid	ISS	Integrated Storage System
HCN	Hydrogen Cyanide	ISURF	Iowa State University Research Foundation
HCNG	Hydrogen Compressed Natural Gas	ITM	Ion Transport Membrane
HCSCC	Hydrogen Codes and Standards Coordinating Committee	ITO	Indium Tin Oxide
HDPE	High Density Polyethylene	JHU/APL	Johns Hopkins University Applied Physics Laboratory
HECO	Hawaiian Electric Company	JPL	Jet Propulsion Laboratory
HELCO	Hawaii Electric Light Company	K/°K	Degrees Kelvin
HEV	Hybrid Electric Vehicle		
HF	Hydrogen Fluoride		

K <sub>2</sub> O	Potassium Oxide	mole/(m <sup>2</sup> Pa•s):	Mole per Meter Squared Pascal
KBM	Knowledge Based Management		Second
KC <sub>x</sub>	Potassium Carbon when used with Intercalated Graphites	MPa	Mega Pascals
kg	Kilogram	mpeg	Miles per Equivalent Gallon
KTH	Swedish Royal Institute	mpg	Miles Per Gallon
kW	Kilowatt	MRI	Magnetic Resonance Imaging
kW <sub>e</sub>	Kilowatt electric	MSE	Mercury/mercurous Sulfate reference Electrode
kWh	Kilowatt hour	MSHA	Mine Safety and Health Administration
kW <sub>th</sub>	Kilowatt Thermal	MSU	Montana State University
La	Lanthanum	MSW	Municipal Solid Waste
La-Ni-Al	Lanthanum-Nickel-Aluminum alloy	mV	MilliVolts
LANL	Los Alamos National Laboratory	mW	Megawatt
lb	Pound	mWh	Megawatt hour
LC	Lumped Capacitance	MWNT	Multi-Wall Nanotubes
LCHPP	Low Cost Hydrogen Production Platform	N <sub>2</sub>	Nitrogen
LDA	Local Density Approximation	Na	Sodium
LDRD	Laboratory Directed Research and Development	NaAlH <sub>4</sub>	Sodium Aluminum Hydride
LDV	Light Duty Vehicle	NaBH <sub>4</sub>	Sodium Borohydride
LED	Light Emitting Diode	NAFION <sup>®</sup>	Registered Trademark of E.I. DuPont de Nemours
LEL	Lower Explosion Level	NASA	National Aeronautics and Space Administration
LES	Large Eddy Simulation	Nb	Niobium
LH <sub>2</sub>	Liquid Hydrogen	NbPO <sub>x</sub>	Niobium phosphate
LHC	Light Harvesting Complex	NEBS	Network Equipment Building Standards
LHV	Lower Heating Value	NELHA	Natural Energy Laboratory Hawaii Authority
LiAlH <sub>4</sub>	Lithium Aluminum Hydride	NERI	Nuclear Energy Research Initiative
LiF	Lithium Fluoride	NETL	National Energy Technology Laboratory
LLNL	Lawrence Livermore National Laboratory	NFC	Near Frictionless Carbon
LME	London Metals Exchange	NFPA	National Fire Protection Association
LOX	Liquid Oxygen	NG	Natural Gas
LP	Linear Polarization	NGASE	Natural Gas Assisted Steam Electrolyzer
LTS	Low Temperature Shift	NH <sub>3</sub>	Ammonia
LV	Level Indicator	NHA	National Hydrogen Association
mA	MilliAmps	NHE	Normal Hydrogen Electrode
MC	Multicomponent	Ni	Nickel
MDPD <sup>®</sup>	Market Driven Product Definition	NICC	Natural Gas Infrastructure Component Cost
MEA	Membrane Electrode Assembly	NIF	Neutron Imaging Facility
MEMS	Micro Electromechanical System	NiO	Nickel Oxide
mg	Milligrams	NIST	National Institute of Standards and Technology
Mg	Magnesium	nm	Nanometer
MgH <sub>2</sub>	Magnesium Hydride	Nm <sup>3</sup>	Normal Cubic Meter
MgO	Magnesium Oxide		
MMBtu	Million British Thermal Units		
MMD	Mass Median Diameters		
Mn	Manganese		
Mo	Molybdenum		
MOFS	Multiplexed, Optical Fiber Sensor		

NMHC	Non-Methane Hydrocarbon	PFCT	Porvair Fuel Cell Technology, Inc
NMOG	Non-Methane Organic Gases	PFD	Process Flow Diagram
NMR	Nuclear Magnetic Resonance	PFSA	Perfluorinated Sulfonic Acid
NO <sub>x</sub>	Nitric Oxides	PGM	Platinum Group Metal
NPW	Net Present Worth	pH	Power of the Hydrogen Radical
NREL	National Renewable Energy Laboratory	PHA	Preliminary Hazard Analysis
NRL	Naval Research Laboratory	PI	Principal Investigator
NSLS	National Synchrotron Light Source	PM	Particulate Matter/ Particulate Membrane/ Precious Metal
Ωcm <sup>2</sup>	Ohm-Centimeter-Squared	PNA	Palladium Nanowire Arrays
O	Oxygen	PNNL	Pacific Northwest National Laboratory
O&M	Operation and Maintenance	POTW	Publicly Owned Treatment Works
O/C	Oxygen to Carbon ratio	PO <sub>x</sub>	Partial Oxidation
O <sub>2</sub>	Oxygen	PP	Polypropylene
OCP	Open Circuit Potential	PP1R	Power Plant One Reformate
OEM	Original Equipment Manufacturer	ppb	Parts Per Billion
OH	Hydroxal Radical	ppbv	Parts Per Billion by volume
Ohm-cm <sup>2</sup>	Ohm-centemeter-squared	ppm	Parts Per Million
OMB	Office of Management and Budget	ppmv	Parts Per Million by Volume
OPP	Office of Physical Plant	ppmw	Parts Per Million by Weight
ORNL	Oak Ridge National Laboratory	PR	Progress Ratio
ORR	Oxygen Reduction Reaction	PROX/PrOx	Preferential Oxidation
OTM	Oxygen Transport Membrane	PS	Photosystem
OTT	Office of Transportation Technologies	PSA	Pressure Swing Adsorption
P	Pressure	psi	Pounds Per Square Inch
PADT	Phoenix Analysis and Design Technologies	PSI	Paul Scherrer Institute
PAFC	Phosphoric Acid Fuel Cell	psia	Pounds Per Square Inch Absolute
PAMPAS	Poly 2-acrylamino-2-methyl-1- propanesulfonic acid-co-styrene	psig	Pounds Per Square Inch Gauge
PATH	Partnership for Advancing the Transition to Hydrogen	PSII	Photosystem II
PBI	Polybenzimidazole	PSU	Pennsylvania State University
PCR	Polymerase Chain Reaction	Pt	Platinum
PCT	Pressure Composition Temperature	Pt-WO <sub>3</sub>	Platinum-Tungsten Oxide
Pd	Palladium	PV	Photovoltaic
PDPA	Phase Doppler Particle Analyzer	R&D	Research and Development
PDU	Process Development Unit	RAM	Reliability and Maintenance
PEC	Photoelectrochemical	RD&D/R,D&D	Research, Development & Demonstration
PEDOT	Poly-3,4-ethylenedioxythiophene	RDE	Rotating Disk Electrode
PEEK	Polyetheretherketone	Re	Rhenium
PEFC	Polymer Electrolyte Membrane Fuel Cell	REI	Reaction Engineering International
PEM	Proton Exchange Membrane/ Polymer Electrolyte Membrane	RFC	Regenerative Fuel Cell
PEMFC	Proton Exchange Membrane Fuel Cell	RFG	Reformulated Gasoline
PEN	Positive Electrolyte Negative	RH	Relative Humidity
PFA	Personal Fuel Appliance	Rh	Rhodium
		RHE	Real Hydrogen Electrode/ Reversible Hydrogen Electrode
		RI	Receding Interface
		ROI	Record of Invention
		RPI	Rensselaer Polytechnic Institute

rpm	Revolutions per Minute	SPC	Statistical Process Control
RRDE	Rotating Ring-disk Electrode	SR	Steam Reforming/Reformer
RTI	Research Triangle Institute	Sr	Strontium
Ru	Ruthenium	SRTC	Savannah River Technology Center
Rz	Roughness (vertical)	STAR	Substrate-based Transportation
S	Sulfur		Autothermal Reformer
S/C	Steam to Carbon ratio	STEM	Scanning Transmission Electron
S/cm	Siemens per Centimeter		Microscope
S300	Series 300 Fuel Processing and PEM	STH	Solar To Hydrogen
	Cell System	SULEV	Super Ultra Low Emissions Vehicle
S-A	Sulfur-Ammonia	SUNY	State University of New York
SAE	Society of Automotive Engineers	SUV	Sport Utility Vehicle
SC	Single Component	SV	Space Velocity
SCAQD	South Coast Air Quality District	SVT	Single Vane Test
Scm	Standard Cubic Centimeters per	SWNT	Single Wall Nanotubes
	Minute	SWPO	Supercritical Water Partial
SCFD	Standard Cubic Feet per Day		Oxidation
SCFH	Standard Cubic Feet per Hour	SwRI	Southwest Research Institute
SCFM	Standard Cubic Feet per Minute	T	Temperature
SCONO <sub>x</sub>	Selective Catalytic Reduction of	Ta	Tantalum
	NO <sub>x</sub>	TCD	Thermal Conductivity Detector
SCW	Supercritical Water	TCD	Thermocatalytic Decomposition
SCWO	Supercritical Water Oxidation	TCWSC	Thermochemical Water-Splitting
SDS-PAGE	Sodium-Dodecyl-Sulfate		Cycle
	Polyacrylamide Gel Electrophoresis	TEM	Transmission Electron Microscopy
SDSU	San Diego State University	TEOS	Tetraethyl Orthosilicate
Se	Selenium	TEX	Texas Energy System, LLC
SEM	Scanning Electron Microscope	TGA	Thermal Gravimetric Analysis
SEP	Subscale Engineering Prototype	THC	Total Hydrocarbons
SERC	Schatz Energy Research Center	Ti	Titanium
SF <sub>6</sub>	Sulfur Hexafluoride	TiCl <sub>3</sub>	Titanium Trichloride
SGS	Subgrid Scale	TiCl <sub>4</sub>	Titanium Tetrachloride
SHE	Standard Hydrogen Electrode	TiO <sub>2</sub>	Titanium Dioxide
SHTC	Southeast Hydrogen Technology	TIVM	Torroidal Intersecting Vane Machine
	Consortium	<i>tla</i>	Truncated Light-Harvesting
S-I	Sulfur-Iodine		Chlorophyll Antenna
SiC	Silicon Carbide	TMI	Technology Management, Inc.
SLPM	Standard Liters Per Minute	TMY	Typical Meteorological Year
SMP	Superior MicroPowders	tpd	English tons per day
SMR	Steam Methane Reformer	T-RFLP	Terminal Restriction Fragment
SN	Tin		Length Polymorphism
SNG	Synthetic Natural Gas	TRU	Truck Refrigeration Unit
SNL	Sandia National Laboratory	TVA	Thermovolumetric analyzer
SNLL	Sandia National Laboratory	UAB	University of Alabama at
	Livermore		Birmingham
SnO <sub>x</sub>	Tin Oxide	UC	University of California
SO <sub>2</sub>	Sulfur Dioxide	UGA	University of Georgia
SOA	State-Of-the-Art	UGCM	Unitary Gas Control Module
SOEC	Solid Oxide Electrolysis Cell	UH	University of Hawaii
SOFC	Solid Oxide Fuel Cell	UHC	Unburned Hydrocarbons

UHM	University of Hawaii at Manoa	Vol.%/Vol%	Percent by volume
UHV	Ultrahigh Vacuum	w	Width
UK	University of Kentucky	W	Tungsten
UL	Underwriters Laboratory	W <sub>e</sub>	Watts electric, typically refers to the output from a PEM fuel cell
UNIGEN <sup>®</sup>	A Registered Trademark of Proton Energy Systems, Inc.	WGS	Water Gas Shift
UOP	Universal Oil Products	WO <sub>3</sub>	Tungsten Trioxide
UPS	Uninterruptible Power Supply	wt	Weight
US DOE	United States Department of Energy	Wt	Watts thermal, typically refers to heat transfer duty
USC	University of South Carolina		
UT-3	University of Tokyo-3	wt.%/wt%	Weight percent
UTC	United Technologies Corporation	XRD	X-ray diffraction
UTCFC	United Technologies Corporation Fuel Cells Division	Y	Yttrium
UTRC	United Technologies Research Center	YAg:Cr	Yttrium Aluminum Garnet doped with Chromium
UV	Ultraviolet	yr	Year
V	Volt	YSZ	Yttria Stabilized Zirconia (Zr <sub>0.85</sub> Y <sub>0.15</sub> O <sub>1.95</sub> )
V	Vanadium	Z-60	0 to 60 mph Acceleration
VASP	Vienna Ab Initio Simulation Package	ZEV	Zero Emission Vehicle
VC	Vulcan Carbon	Zn	Zinc
VNT <sup>®</sup>	Variable Nozzle Turbine	Zr	Zirconium
V <sub>oc</sub>	open circuit potential	ZSM	Zeolite Type Membranes

