

## TABLE OF CONTENTS

<b>INTRODUCTION</b> .....	<b>xxiii</b>
<b>HYDROGEN PRODUCTION AND DELIVERY</b> .....	<b>1</b>
HPD-1: Hydrogen Production and Delivery Sub-Program Review .....	4
HPD-2: Ceramic Membrane Reactor Systems for Converting Natural Gas to Hydrogen .....	7
HPD-3: Integrated Ceramic Membrane System for H <sub>2</sub> Production .....	10
HPD-4: Low Cost Hydrogen Production Platform .....	13
HPD-5: Defect-free Thin Film Membranes for H <sub>2</sub> Separation & Isolation .....	16
HPD-6: Autothermal Cyclic Reforming and H <sub>2</sub> Refueling System .....	20
HPD-7: Development of Supports and Membranes for Hydrogen Separation .....	23
HPD-8: Adapting Planar Solid Oxide Fuel Cells for Use with Solid Fuel Sources in the Production of Distributed Power .....	26
HPD-9: Maximizing Photosynthetic Efficiencies and Hydrogen Production in Microalgal Cultures .....	29
HPD-10: Biological Systems for Hydrogen Photoproduction .....	32
HPD-11: Photoelectrochemical Water Splitting .....	35
HPD-12: Photoelectrochemical Hydrogen Production Program .....	38
HPD-13: Discovery of Photocatalysts for Hydrogen Production .....	41
HPD-14: High Temperature Solid Oxide Electrolyzer System .....	44
HPD-15: Renewable Electrolysis Integrated System Development and Testing .....	47
HPD-16: Hydrogen Generation from Electrolysis .....	50
HPD-17: Development of Solar-Powered Thermo-Chemical Production of Hydrogen from Water .....	53
HPD-18: Moving Toward Consistent Analysis in the HFCIT Program: H <sub>2</sub> A .....	56
HPD-19: Hydrogen Transition Modeling and Analysis: HYTRANS v. 1.0 .....	59
HPD-20: WinDS- H <sub>2</sub> Model and Analysis .....	62
HPD-P1: Novel Catalytic Micro channel Fuel Processing Technology .....	65
HPD-P2: Startech Hydrogen Production .....	67
HPD-P3: Water-Gas Shift Membrane Reactor Studies .....	69
HPD-P4: Fluidizable Catalysts for Hydrogen Production from Complex Feedstocks .....	71
HPD-P5: Hydrogen from Biomass: Process Research .....	73
HPD-P6: Aqueous Phase Catalyzed Biomass Gasification .....	75
HPD-P7: Hydrogen from Biomass: Catalytic Reforming of Pyrolysis Vapors .....	77
HPD-P8: Creation of Designer Alga for Efficient and Robust Production of H <sub>2</sub> .....	79
HPD-P9: Hydrogen Reactor Development and Design for Photofermentation and Photolytic Processes ..	81
HPD-P10: Photoelectrochemical H <sub>2</sub> Prod. Using New Combinatorial Chemically Derived Materials .....	83
HPD-P11: High Efficiency Electrolysis Materials Research .....	85
HPD-P12: Low-Cost, High-Pressure Hydrogen Generator .....	87
HPD-P13: Hydride Based Hydrogen Compression .....	89
HPD-P14: Technical and Economic Studies of Regional Transition Strategies Toward Widespread Use of H <sub>2</sub> Energy .....	91
HPD-P15: Hydrogen Production in a Greenhouse Gas Constrained Situation .....	93
HPD-P16: Fuel Choice for FCVs: Hydrogen Infrastructure Costs .....	96
HPD-P17: New York State HI-Way Initiative .....	98
HPD-P18: EVermont Renewable Hydrogen Fueling Station .....	100
HPD-P20: Photopolymerization/Pyrolysis Route to Microstructured Membrane Development .....	102

HPD-P21: Developing Improved Materials to Support the Hydrogen Economy .....	104
HPD-P23: Hydrogen Generation from Electrolysis .....	106
<b>HYDROGEN STORAGE .....</b>	<b>108</b>
ST-1: Hydrogen Storage Sub-Program Review .....	111
ST-2: Low Cost, High Efficiency, High Pressure Hydrogen Storage .....	114
ST-3: Optimum Utilization of Available Space in a Vehicle through Conformable Hydrogen Tanks .....	119
ST-4: Radiolysis Process for the Regeneration of Sodium Borate to Sodium Borohydride .....	124
ST-5: Low Cost, Off-Board Regeneration of Sodium Borohydride .....	129
ST-6: Chemical Hydride Slurry for Hydrogen Production and Storage .....	133
ST-7: Hydrogen Storage by the Reversible Hydrogenation of Liquid and Solid Substrates .....	137
ST-8: Doped Sodium Alanates: Fundamental Studies and Development of Related Hydrogen Storage Materials .....	141
ST-9: Hydride Development for Hydrogen Storage .....	146
ST-10a: Development of a High Density Hydrogen Storage System Prototype Using Doped Sodium Alanate Complex Hydrides .....	150
ST-10b: Complex Hydride Compounds with Enhanced Hydrogen Storage Capacity .....	154
ST-11: Discovery of Novel Complex Metal Hydrides for Hydrogen Storage through Molecular Modeling and Combinatorial Methods .....	157
ST-12: Sub-Nanostructured Non-Transition Metal Complex Grids for Hydrogen Storage .....	160
ST-13: Hydrogen Storage in Carbon-based Materials .....	644
ST-14: Standardized Testing Program for Chemical Hydride & Carbon Storage Technologies .....	169
ST-P1: Next Generation Physical Hydrogen Storage .....	173
ST-P3: Fuel Cell and Hydrogen Research .....	176
ST-P4: Development of Complex Hydride Hydrogen Storage Materials and Engineering Systems .....	179
ST-P5: Advanced Manufacturing Technologies for Renewable Energy Applications .....	182
<b>FUEL CELLS .....</b>	<b>185</b>
FC-1: Fuel Cells Sub-Program Review .....	188
FC-2: Integrated Manufacturing for Advanced Membrane Electrode Assemblies .....	191
FC-3: Development of High Temperature Membranes and Improved Cathode Catalysts .....	194
FC-4: Advanced MEAs for Enhanced Operating Conditions .....	197
FC-5: Dev. of High-Perf., Low-Pt Cathodes Containing New Catalyst & Layer Structures .....	199
FC-6: High-Temperature Membranes .....	201
FC-7: Electrodes for Hydrogen-Air PEM Fuel Cells .....	204
FC-8: High-Temperature Polymer Membranes .....	208
FC-9: Development of Polybenzimidazole-based, High-Temperature MEAs .....	211
FC-10: Enabling Commercial PEM Fuel Cells with Breakthrough Lifetime Improvements .....	214
FC-11: MEA and Stack Durability for PEM Fuel Cells .....	216
FC-12: Development of a Low-Cost, Durable Membrane and Membrane Electrode Assembly .....	218
FC-13: New Electrocatalysts for Fuel Cells .....	221
FC-14: Low-Platinum Catalysts for Oxygen Reduction at PEM Fuel Cell Cathodes .....	224
FC-15: Low-Platinum Loading Catalysts .....	227
FC-16: Dev., Char. and Eval. of Transition Metal/Chalcogen Based Cathode Catalysts for PEM Fuel Cells .....	230
FC-17: Novel Approach to Non-Precious Metal Catalysts .....	233

FC-18: Novel Non-Precious Metals for PEMFC: Catalyst Selection Through Molecular Modeling and Durability Studies.....	237
FC-19: Scale-Up of Carbon/Carbon Bipolar Plates .....	240
FC-20: Cost-Effective Surface Modification for Metallic Bipolar Plates.....	243
FC-21: Platinum Recycling Technology Development .....	246
FC-22: Platinum Group Metal Technology Development .....	249
FC-23: Advanced High Efficiency, Quick Start Fuel Processors for Transportation Application .....	251
FC-24: Fuel Processors for PEM Fuel Cells .....	253
FC-25: Plate Based Fuel Processing System.....	255
FC-26: Quick Starting Fuel Processors - A Feasibility Study.....	258
FC-27: Development Status of a Rapid-Cold-Start, On-Board, Microchannel Steam Reformer .....	261
FC-28: Catalysts for Autothermal Reforming.....	263
FC-29: Water Gas Shift Catalysis .....	265
FC-30: Selective Catalytic Oxidation of Hydrogen Sulfide.....	268
FC-31: Development of a 50kW Fuel Processor for Stationary Fuel Cell Applications Using Revolutionary Materials for Absorption-Enhanced NG Reforming .....	270
FC-32: Advanced Buildings PEM FC Project.....	272
FC-33: 150 kW PEM Fuel Cell Power Plant Verification .....	274
FC-34: Back-up/Peak-Shaving Fuel Cells.....	276
FC-35: Economic Analysis of Stationary PEM Fuel Cell Systems .....	278
FC-36: Fuel Cell Systems Analysis.....	280
FC-37: Development of a Thermal and Water Management (TWM) System for PEM Fuel Cells.....	283
FC-38: Fiber Optic Sensors for Fuel Cell Applications .....	286
FC-39: Atmospheric Fuel Cell Power System for Transportation .....	288
FC-40: Cost and Performance Enhancements for a PEM Fuel Cell Turbocompressor .....	290
FC-41: Development and Test of the Toroidal Intersecting Vane Machine (TIVM) Air Management System .....	293
FC-42: Development of Sensors for Automotive PEM based Fuel Cells.....	296
FC-43: Sensor Development for PEM Fuel Cell Systems .....	299
FC-44: Neutron Imaging Study of the Water Transport Mechanism in a Working Fuel Cell.....	302
FC-45: Microstructural Characterization of PEM Fuel Cells.....	304
FC-46: Stack Durability on Hydrogen and Reformate.....	306
FC-47: Direct Methanol Fuel Cells .....	308
FC-48: Modeling and Control of a Solid Oxide Fuel Cell Auxiliary Power Unit .....	311
FC-49: Bipolar Plate-Supported Solid Oxide Fuel Cell “Tuffcell”.....	313
FC-P1: Fuel Cells Vehicle Systems Analysis .....	315
FC-P2: Cost Analyses of Fuel Cell Stacks/Systems.....	318
FC-P3: Development of Novel CO <sub>2</sub> -Selective Membrane for H <sub>2</sub> Purification.....	321
FC-P4: Microchannel Reformate Cleanup: Water Gas Shift and Preferential Oxidation.....	323
FC-P5: Effects of Fuel Composition on Fuel Processing.....	325
FC-P6: Development of Advanced Catalysts for Direct Methanol Fuel Cells .....	327
FC-P7: Non-Precious Metal Cathode Electrocatalysts (new project) .....	329
FC-P8: Low-Friction Coatings and Materials for Fuel Cell Air Compressors .....	332
FC-P9: Montana PEM Membrane Degradation Study.....	334
FC-P10: High Temperature MEA for PEMFC Device Based on SPEEK Blends .....	336
FC-P12: Polymer Blend Proton Exchange Membranes .....	339

FC-P13: High Temperature, Low Relative Humidity PEM Fuel Cell Membranes .....	341
FC-P14: High Temperature Polymer Electrolytes Based on Ionic Liquids .....	344
FC-P19: New Polymeric Proton Conductors for High Temperature Applications .....	346
FC-P20: Fuel Cell Reformer Emissions .....	349
FC-P22: Residential Fuel Cell Demonstration by the Delaware County Electric Cooperative .....	352
FC-P23: Fuel Cell Operated Smart Home .....	354
FC-P24: Graphite-based Thermal Management System Components for Fuel Cell Power Systems .....	356
FC-P25: CO Sensors for Fuel Cell Applications .....	358
<b>TECHNOLOGY VALIDATION .....</b>	<b>360</b>
TV-1: Technology Validation Sub-Program Review .....	362
TV-2: Power Parks System Simulation .....	365
TV-3: Hawaii Hydrogen Power Park .....	367
TV-4: DTE Energy Hydrogen Technology Park .....	369
TV-5: Hydrogen from Biomass for Urban Transportation .....	372
TV-6: Alkaline Fuel Cell-Battery Hybrid Systems with Ammonia or Methanol as H <sub>2</sub> -Supply .....	374
TV-7: UNIGEN® Regenerative Fuel Cell for Uninterruptible Power Supply .....	377
TV-8: Controlled H <sub>2</sub> Fleet & Infrastructure Analysis .....	380
TV-9: Development of a Turnkey H <sub>2</sub> Refueling Station .....	383
TV-10: Development of a Natural Gas-to-Hydrogen Fueling System .....	385
TV-11: Novel Compression and Fueling Apparatus to Meet Hydrogen Vehicle Range Requirements .....	387
TV-12: Auto-Thermal Reforming Based Refueling Station at SunLine .....	390
TV-13: R&D of a PEM Fuel Cell, Hydrogen Reformer, and Vehicle Refueling Facility .....	392
TV-14: LAX Airport Hydrogen Fueling Station - Small Footprint H <sub>2</sub> Capability at the Corner Filling Station .....	395
TV-15: Hydrogen and Natural Gas Blends: Converting Light and Heavy Duty Vehicles .....	397
TV-16: Fuel Cell Powered Underground Mine Loader Vehicle .....	399
TV-P1: Validation of an Integrated System for a Hydrogen-Fueled Power Park .....	401
TV-P2: Fuel Cell Installation and Demonstration Project In Gallatin County, Montana .....	403
TV-P3: Global Assessment of Hydrogen Based Technologies .....	405
TV-P4: Hydrogen Power Park Business Opportunities Concept Project .....	408
TV-P5: NextEnergy Microgrid and Hydrogen Fueling Facility .....	410
TV-P7: Hydrogen Fuel Project .....	413
TV-P9: Renewable Hydrogen Fueling Station System .....	415
TV-P11: Hawaii Hydrogen Center for Development and Deployment of Distributed Energy Systems .....	417
<b>SAFETY AND CODES &amp; STANDARDS .....</b>	<b>419</b>
SCS-1: Safety and Codes & Standards Sub-Program Review .....	421
SCS-2: Hydrogen Codes and Standards .....	424
SCS-3: Electrochemical Sensors for PEMFC Vehicles .....	426
SCS-P1: Interfacial Stability of Thin Film H <sub>2</sub> Sensors .....	429
SCS-P2: Codes & Standards Analysis .....	432
<b>HYDROGEN EDUCATION .....</b>	<b>435</b>
ED-1: Education Sub-Program Review .....	437
ED-2: Baseline Knowledge Assessment .....	439

ED-P1: Demonstration of a PEM Fuel Cell with On-Site Generation of Hydrogen.....	441
ED-P2: Washington State Fuel Cell Education and Demonstration Program .....	443
ED-P3: Development and Dissemination of PEM Fuel Cell Educational Modules .....	445
ED-P4: Lansing Community College Alternative Energy Center .....	447
ED-P5: Shared Technology Transfer Project .....	449
<b>APPENDIX A: HFCIT FY 2004 MERIT REVIEW AND PEER REVIEWER ATTENDEES LIST</b> .....	<b>451</b>
<b>APPENDIX B: HFCIT FY 2004 MERIT REVIEW AND PEER REVIEWER AND PARTICIPANT FEEDBACK</b> .....	<b>464</b>
<b>PROJECT EVALUATION FORM</b> .....	<b>470</b>

