

CHAPTER ONE: : INTRODUCTION.....	1
STUDY GOALS AND OBJECTIVES.....	1
REASONS FOR DOING THE STUDY	2
INTENDED AUDIENCE.....	3
SCOPE OF REPORT	4
METHODOLOGY	5
INFORMATION SOURCES.....	5
ANALYST CREDENTIALS.....	5
RELATED REPORTS	6
BCC ONLINE SERVICES.....	6
DISCLAIMER	6
CHAPTER TWO: SUMMARY.....	7
SUMMARY.....	7
<i>SUMMARY TABLE GLOBAL LARGE AND ADVANCED BATTERY</i>	
<i>MARKET PROJECTIONS BY APPLICATION, THROUGH 2014 (\$</i>	
<i>MILLIONS)</i>	8
<i>SUMMARY FIGURE GLOBAL LARGE AND ADVANCED BATTERY</i>	
<i>MARKET PROJECTIONS BY APPLICATION, 2001-2014 (\$</i>	
<i>MILLIONS)</i>	9
CHAPTER THREE: TECHNOLOGY OVERVIEW.....	10
BATTERY BACKGROUND.....	10
<i>TABLE 1 LARGE AND ADVANCED BATTERY SYSTEMS</i>	11
<i>TABLE 1 (CONTINUED)</i>	12
BATTERY SYSTEMS	12
GENERAL BATTERY CHARACTERISTICS.....	12
Voltage	12
Capacity	12
Shelf Life.....	13
Drain	13
Safety	13
Safety (Continued)	14
Safety (Continued)	15
Alternative Designs	16
Alternative Designs (Continued).....	17
Material Safety Issues	18
Material ... (Continued).....	19
Energy Density	20
Power.....	20
Recharge Time	20
Cycle Life	20
Disposal Factors	21
COMMERCIAL SECONDARY BATTERY CHARACTERISTICS.....	22
<i>TABLE 2 COMMERCIAL SECONDARY BATTERY TYPES</i>	22

<i>TABLE 2 (CONTINUED)</i>	23
BATTERY DESCRIPTIONS	24
LEAD-ACID BATTERIES	24
Lead-Acid Traction Batteries	25
Lead-Acid Sealed Appliance Batteries	26
Lead-Acid UPS Batteries	26
State of the Art and Recent Developments	27
Firefly Energy Composite Foam.....	28
Firefly ... (Continued).....	29
KFOAM Mesophase Pitch	30
Axion Power Lead Carbon (PbC).....	30
Axion ... (Continued)	31
Lead-acid Battery Companies.....	32
<i>TABLE 3 LEAD-ACID BATTERY COMPANIES</i>	32
<i>TABLE 3 (CONTINUED)</i>	33
Applications and Markets	33
Lead-acid Motive Power Batteries	34
Lead-acid Portable Product Batteries.....	34
Lead-Acid Stationary Batteries.....	35
Technical and Market Challenges	35
Large and advanced Lead-Acid Market Summary	35
<i>TABLE 4 GLOBAL LEAD-ACID BATTERY MARKET PROJECTIONS</i> <i>BY APPLICATION, THROUGH 2014 (\$ MILLIONS)</i>	36
NICKEL-CADMIUM BATTERIES	36
State of the Art and Recent Developments	37
Nickel-Cadmium Battery Companies.....	38
<i>TABLE 5 NICKEL CADMIUM BATTERY COMPANIES</i>	38
Applications/Markets	38
Large and Advanced Nickel-Cadmium Market Summary	39
<i>TABLE 6 GLOBAL NICKEL-CADMIUM BATTERY MARKET</i> <i>PROJECTIONS BY APPLICATION, THROUGH 2014 (\$ MILLIONS)</i>	39
NICKEL-METAL HYDRIDE BATTERIES	40
State of the Art and Recent Developments	41
State of ... (Continued)	42
State of ... (Continued)	43
State of ... (Continued)	44
<i>TABLE 7 NICKEL-METAL HYDRIDE BATTERY COMPANIES</i>	45
<i>TABLE 8 OVONICS BATTERY JOINT VENTURES, LICENSING</i> <i>AGREEMENTS, AND OTHER STRATEGIC ALLIANCES</i>	45
<i>TABLE 8 (CONTINUED)</i>	46
Applications and Markets	46
Technical and Market Challenges	46
Large and advanced Nickel-Metal Hydride Market Summary	47

<i>TABLE 9 GLOBAL NICKEL-METAL HYDRIDE BATTERY MARKET PROJECTIONS BY APPLICATION, THROUGH 2014 (\$ MILLIONS)</i>	47
LITHIUM-ION AND LITHIUM-POLYMER BATTERIES	47
Lithium-ion ... (Continued).....	48
Lithium-Ion Compared with Lithium-Ion Polymer	49
Lithium-Ion as Smart Batteries	50
Lithium-Ion ...(Continued).....	51
Lithium-Ion ...(Continued).....	52
<i>TABLE 10 SMART BATTERY SYSTEM (SBS) STAKEHOLDERS</i>	53
State of the Art and Recent Developments	54
<i>TABLE 11 LITHIUM-ION BATTERY COMPANIES</i>	55
<i>TABLE 11 (CONTINUED)</i>	56
Applications and Markets	57
Technical and Market Challenges	57
Large and Advanced Lithium Market Summary	57
<i>TABLE 12 GLOBAL LARGE AND ADVANCED LITHIUM BATTERY MARKET PROJECTIONS BY APPLICATION, THROUGH 2014 (\$ MILLIONS)</i>	58
SILVER-ZINC BATTERIES	58
Silver-Zinc Batteries (Continued).....	59
Silver-Zinc Batteries (Continued).....	60
SILVER-CADMIUM BATTERIES	61
Silver Battery State of the Art and Recent Developments	61
Silver Battery Applications and Markets.....	62
NICKEL-HYDROGEN BATTERIES.....	62
State of the Art and Recent Developments	63
Applications and Markets	63
Technical and Market Challenges	64
NICKEL-ZINC BATTERIES	64
State of the Art and Recent Developments	64
State of ... (Continued)	65
State of ... (Continued)	66
<i>TABLE 13 BENEFITS COMPARISON OF POWERGENIX NIZN HIGH DISCHARGE BATTERY</i>	67
Applications/Markets	68
Technical and Market Challenges	68
METAL-AIR BATTERIES	68
Aluminum-Air Batteries	69
Aluminum-... (Continued).....	70
<i>TABLE 14 SUMMARY OF CURRENT AND HISTORIC ALUMINUM- AIR BATTERY COMPANIES AND DEVELOPMENTS</i>	71
Zinc-Air Batteries	72
<i>TABLE 15 SUMMARY OF CURRENT AND HISTORIC ZINC-AIR BATTERY COMPANIES AND DEVELOPMENTS</i>	73

<i>TABLE 15 (CONTINUED)</i>	74
<i>TABLE 15 (CONTINUED)</i>	75
Hybrid Zinc-Air/Manganese-Dioxide Batteries	75
Iron-Air Batteries	75
Lithium-Air Batteries.....	76
Lithium-Air ... (Continued)	77
Lithium-Air ... (Continued)	78
Lithium-Air ... (Continued)	79
Magnesium-Air Batteries	80
Magnesium-Air ... (Continued)	80
Ionic Liquids and Metal Air Batteries	81
Metal-Air Battery Market Trends	82
LARGE AND ADVANCED SPECIALTY MARKET SUMMARY	82
<i>TABLE 16 GLOBAL SPECIALTY BATTERY MARKET PROJECTIONS</i>	
<i>BY APPLICATION, THROUGH 2014 (\$ MILLIONS)</i>	83
SODIUM-SULFUR BATTERIES	83
Sodium-sulfur Batteries (Continued)	83
Sodium-sulfur Batteries (Continued)	84
State of the Art and Recent Developments	85
<i>TABLE 17 SUMMARY OF CURRENT AND HISTORIC SODIUM-</i>	
<i>SULFUR BATTERY COMPANIES AND DEVELOPMENTS</i>	86
<i>TABLE 17 (CONTINUED)</i>	87
<i>TABLE 17 (CONTINUED)</i>	88
Sodium-Sulfur Battery Market Trends	88
HIGH-TEMPERATURE LITHIUM BATTERIES	89
<i>TABLE 18 HIGH-TEMPERATURE LITHIUM-IRON SULFIDE</i>	
<i>BATTERY R&D</i>	89
High-temperature ... (Continued).....	90
Applications and Markets	91
REDOX AND FLOW BATTERIES.....	91
Zinc-Chloride Batteries	91
Zinc-Bromine Redox Batteries	92
Zinc-Bromine ... (Continued).....	93
Zinc-Bromine ... (Continued).....	94
Chromium-Chloride/Iron-Chloride Redox Batteries	95
Vanadium Redox Batteries (VRBs).....	95
Vanadium ... (Continued).....	96
Vanadium ... (Continued).....	97
Vanadium ... (Continued).....	98
Sodium-Bromide Batteries	99
NICKEL-IRON BATTERIES.....	99
CALCIUM-METAL-SULFIDE BATTERIES	100
SODIUM-METAL CHLORIDE BATTERIES (ZEBRA)	101
Sodium-Metal Chloride ... (Continued)	102

LITHIUM-SULFUR BATTERIES.....	102
LARGE AND ADVANCED DEVELOPMENTAL MARKET SUMMARY.....	103
<i>TABLE 19 GLOBAL DEVELOPMENTAL BATTERY MARKET PROJECTIONS BY APPLICATION, THROUGH 2014 (\$ MILLIONS).....</i>	<i>103</i>
COMPETING ENERGY STORAGE SYSTEMS	103
Capacitive Energy Storage.....	103
<i>TABLE 20 COMPARISON BETWEEN CAPACITIVE ENERGY STORAGE AND LARGE ELECTROCHEMICAL STORAGE BATTERIES.....</i>	<i>104</i>
<i>TABLE 21 COMPARISON OF CAPACITOR, ULTRACAPACITOR AND BATTERY CHARACTERISTICS.....</i>	<i>105</i>
Nuclear Batteries.....	106
Nuclear Batteries (Continued)	107
Flywheel Energy Storage	108
Fuel Cells	108
Alkaline Fuel Cells	109
Phosphoric Acid Fuel Cells.....	109
Solid Oxide Fuel Cells.....	109
Molten Carbonate Fuel Cells.....	110
Proton Exchange Membrane Fuel Cells	110
 CHAPTER 4: LARGE AND ADVANCED BATTERY MARKET	
APPLICATIONS.....	111
SUMMARY OF LARGE AND ADVANCED BATTERY MARKETS	111
LARGE AND ADVANCED BATTERY MARKET ANALYSIS	
CONVENTIONS	111
Market Value Model	111
Market Value ... (Continued)	112
Definitions of Regions.....	113
Analysis Duration.....	113
Monetary Conventions	113
MOTIVE POWER LARGE AND ADVANCED BATTERY MARKETS	114
TRACTION AND MARINE BATTERIES.....	114
Traction and Marine Battery Background	114
Traction and Marine Battery Market Summary.....	115
<i>TABLE 22 GLOBAL TRACTION AND MARINE BATTERY MARKET PROJECTIONS BY TECHNOLOGY, THROUGH 2014 (\$ MILLIONS).....</i>	<i>116</i>
<i>TABLE 23 GLOBAL TRACTION AND MARINE BATTERY MARKET PROJECTIONS BY REGION, THROUGH 2014 (\$ MILLIONS)</i>	<i>117</i>
AVIATION BATTERIES.....	117
Aviation Battery Background	117
Aviation Battery Market Summary.....	118
<i>TABLE 24 GLOBAL AVIATION BATTERY MARKET PROJECTIONS BY TECHNOLOGY, THROUGH 2014 (\$ MILLIONS).....</i>	<i>118</i>

<i>TABLE 25 GLOBAL AVIATION MARKET PROJECTIONS BY REGION, THROUGH 2014 (\$ MILLIONS)</i>	119
PORTABLE PRODUCT LARGE AND ADVANCED BATTERY MARKETS	119
COMPUTER BATTERIES	119
Computer Battery Background.....	119
Computer Battery Market Summary	120
<i>TABLE 26 PORTABLE COMPUTING PRODUCT MARKET DEVELOPMENTS</i>	120
<i>TABLE 27 PORTABLE COMPUTER BATTERY DRIVING FORCES AND MARKET DEVELOPMENTS</i>	121
<i>TABLE 28 GLOBAL PORTABLE COMPUTER BATTERY MARKET PROJECTIONS BY TECHNOLOGY, THROUGH 2014 (\$ MILLIONS)</i>	121
<i>TABLE 29 GLOBAL PORTABLE COMPUTER BATTERY MARKET PROJECTIONS BY REGION, THROUGH 2012 (\$ MILLIONS)</i>	122
HAND TOOLS AND LAWN CARE PRODUCT BATTERIES	122
Hand Tools and Lawn Care Product Background.....	122
Hand Tools ... (Continued)	123
Hand Tools and Lawn Care Product Market Summary	124
<i>TABLE 30 PORTABLE TOOLS DRIVING FORCES AND MARKET DEVELOPMENTS</i>	125
<i>TABLE 31 PORTABLE TOOL BATTERY DRIVING FORCES AND MARKET DEVELOPMENTS</i>	126
<i>TABLE 32 GLOBAL HAND TOOL AND LAWN CARE PRODUCT MARKET PROJECTIONS BY TECHNOLOGY, THROUGH 2014 (\$ MILLIONS)</i>	126
<i>TABLE 33 GLOBAL HAND TOOL AND LAWN CARE PRODUCT MARKET PROJECTIONS BY REGION, THROUGH 2014 (\$ MILLIONS)</i>	127
MILITARY/AEROSPACE PORTABLE PRODUCT BATTERIES	127
Military/Aerospace Portable Product Battery Background.....	127
<i>TABLE 34 MILITARY/AEROSPACE PRIMARY LITHIUM BATTERY APPLICATIONS</i>	128
<i>TABLE 34 (CONTINUED)</i>	129
Military/Aerospace Portable Product Battery Market Summary	129
<i>TABLE 35 PORTABLE MILITARY PRODUCT DRIVING FORCES AND MARKET DEVELOPMENTS</i>	130
<i>TABLE 36 GLOBAL PORTABLE MILITARY PRODUCT BATTERY MARKET BY TECHNOLOGY, THROUGH 2014 (\$ MILLIONS)</i>	131
<i>TABLE 37 GLOBAL PORTABLE MILITARY PRODUCT BATTERY MARKET PROJECTIONS BY REGION, THROUGH 2014 (\$ MILLIONS)</i>	131

STATIONARY POWER LARGE AND ADVANCED BATTERY MARKETS	132
UNINTERRUPTIBLE POWER SUPPLY BATTERIES.....	132
UPS Battery Background.....	132
UPS Battery Market Summary	132
<i>TABLE 38 GLOBAL UPS BATTERY MARKET PROJECTIONS BY TECHNOLOGY, THROUGH 2014 (\$ MILLIONS)</i>	<i>133</i>
<i>TABLE 39 GLOBAL UPS BATTERY MARKET PROJECTIONS BY REGION, THROUGH 2014 (\$ MILLIONS)</i>	<i>134</i>
EMERGENCY LIGHTING BATTERIES.....	134
Emergency Lighting Battery Background.....	134
Emergency Lighting Battery Market Summary	134
<i>TABLE 40 GLOBAL EMERGENCY LIGHTING BATTERY MARKET PROJECTIONS BY TECHNOLOGY, THROUGH 2014 (\$ MILLIONS)</i>	<i>135</i>
<i>TABLE 41 GLOBAL EMERGENCY LIGHTING BATTERY MARKET PROJECTIONS BY REGION, THROUGH 2014 (\$ MILLIONS)</i>	<i>135</i>
REMOTE POWER AND ALTERNATIVE ENERGY STORAGE BATTERIES	136
Remote Power and Alternative Energy Storage Battery Background.....	136
Remote Power and Alternative Energy Storage Battery Market Summary	136
<i>TABLE 42 GLOBAL REMOTE AND ALTERNATIVE ENERGY STORAGE BATTERY MARKET PROJECTIONS BY TECHNOLOGY, THROUGH 2014 (\$ MILLIONS)</i>	<i>137</i>
<i>TABLE 43 GLOBAL REMOTE AND ALTERNATIVE ENERGY STORAGE BATTERY MARKET PROJECTIONS BY REGION, THROUGH 2014 (\$ MILLIONS)</i>	<i>138</i>
HYBRID ELECTRIC VEHICLES	138
HEV BACKGROUND	138
Pollution Abatement.....	139
Pollution Abatement (Continued)	140
<i>TABLE 44 PROJECTED ANNUAL GREENHOUSE GAS EMISSIONS REDUCTIONS FROM PHEVS IN THE YEAR 2050 (MILLION MT)</i>	<i>141</i>
<i>TABLE 45 PEAK NEW VEHICLE MARKET SHARE IN 2050 FOR THE THREE PHEV ADOPTION SCENARIOS (%)</i>	<i>142</i>
Electric Utility Efficiency	142
Promotion of Domestic Energy Sources.....	143
Maintaining Technological Competitiveness	144
HEV BATTERY MARKET SUMMARY	144
<i>TABLE 46 GLOBAL HEV MARKET PROJECTIONS BY TECHNOLOGY, THROUGH 2014 (\$ MILLIONS)</i>	<i>145</i>
<i>TABLE 47 GLOBAL HEV MARKET PROJECTIONS BY REGION, THROUGH 2014 (\$ MILLIONS)</i>	<i>145</i>

DEVELOPMENTAL MARKETS.....	145
AUTOMOTIVE BATTERIES	146
Automotive Battery Background	146
Automotive Battery Market Summary.....	146
<i>TABLE 48 GLOBAL LARGE AND ADVANCED AUTOMOTIVE BATTERY MARKET PROJECTIONS BY TECHNOLOGY, THROUGH 2014 (\$ MILLIONS)</i>	147
<i>TABLE 49 GLOBAL LARGE AND ADVANCED AUTOMOTIVE BATTERY MARKET PROJECTIONS BY REGION, THROUGH 2014 (\$ MILLIONS)</i>	147
PLUG-IN VEHICLE BATTERIES	147
Plug-in Battery Background	147
Plug-in ... (Continued).....	148
Plug-in ... (Continued).....	149
Plug-in ... (Continued).....	150
<i>TABLE 50 ELECTRIC VEHICLE BATTERY MANUFACTURING INITIATIVE WINNERS</i>	151
<i>TABLE 50 (CONTINUED)</i>	152
Plug-in ... (Continued).....	153
Plug-in ... (Continued).....	154
PHEV Battery Market Summary	155
<i>TABLE 51 GLOBAL PLUG-IN BATTERY MARKET PROJECTIONS BY TECHNOLOGY, THROUGH 2014 (\$ MILLIONS)</i>	155
<i>TABLE 52 GLOBAL PLUG-IN BATTERY MARKET PROJECTIONS BY REGION, THROUGH 2014 (\$ MILLIONS)</i>	156
UTILITY LOAD LEVELING	156
Utility Load Leveling Background.....	156
<i>TABLE 53 JABEESS LOAD-LEVELING OPTIONS</i>	157
Utility Load ... (Continued).....	158
Utility Load-leveling Battery Market Summary	159
<i>TABLE 54 GLOBAL LOAD-LEVELING BATTERY MARKET PROJECTIONS BY TECHNOLOGY, THROUGH 2014 (\$ MILLIONS)</i>	159
<i>TABLE 55 GLOBAL LOAD-LEVELING BATTERY MARKET PROJECTIONS BY REGION, THROUGH 2014 (\$ MILLIONS)</i>	160
DEVELOPMENTAL MILITARY/AEROSPACE ADVANCED BATTERIES	160
Developmental Military/Aerospace Background.....	160
Developmental Military/Aerospace Market Summary	161
Military Electric Vehicles Scenario.....	161
Battery-Powered Fighting Vehicle Scenario.....	161
Battery-... (Continued).....	162
Battery-... (Continued).....	163
Battery-... (Continued).....	164
Battery-... (Continued).....	165

Military Automated Factory Scenario	166
Strategic Defense Initiative (SDI) Revival Scenario	166
Developmental Military Battery Market Summary	167
<i>TABLE 56 GLOBAL DEVELOPMENTAL MILITARY BATTERY MARKET PROJECTIONS BY TECHNOLOGY, THROUGH 2014 (\$ MILLIONS)</i>	167
<i>TABLE 57 GLOBAL DEVELOPMENTAL MILITARY BATTERY MARKET PROJECTIONS BY REGION, THROUGH 2014 (\$ MILLIONS)</i>	167
LARGE AND ADVANCED BATTERY MARKET SUMMARY	168
<i>TABLE 58 GLOBAL LARGE AND ADVANCED BATTERY MARKET PROJECTIONS BY TECHNOLOGY, THROUGH 2014 (\$ MILLIONS)</i>	168
<i>FIGURE 1 GLOBAL LARGE AND ADVANCED BATTERY MARKET PROJECTIONS BY TECHNOLOGY, 2001-2014 (\$ MILLIONS)</i>	168
<i>TABLE 59 GLOBAL LARGE AND ADVANCED BATTERY MARKET PROJECTIONS BY APPLICATION, THROUGH 2014 (\$ MILLIONS)</i>	169
<i>FIGURE 2 GLOBAL LARGE AND ADVANCED BATTERY MARKET PROJECTIONS BY APPLICATION, 2001-2014 (\$ MILLIONS)</i>	170
<i>TABLE 60 GLOBAL LARGE AND ADVANCED BATTERY MARKET PROJECTIONS BY REGION, THROUGH 2014 (\$ MILLIONS)</i>	170
<i>FIGURE 3 GLOBAL LARGE AND ADVANCED BATTERY MARKET PROJECTIONS BY REGION, 2001-2014 (\$ MILLIONS)</i>	171
CHAPTER FIVE: INDUSTRY STRUCTURE AND COMPETITIVE ASPECTS.....	172
THE DRIVING FORCES OF THE INDUSTRY	172
TREND ANALYSIS.....	172
<i>TABLE 61 LARGE AND ADVANCED BATTERY MARKET (END-USE) TRENDS</i>	173
DRIVING FORCE NUMBER 1: PATENT SITUATION	173
University of Texas, Hydro Quebec, and NTT, and Others	173
University of ... (Continued)	174
3M, Sony, and Lenovo	175
3M and Panasonic.....	175
DRIVING FORCE 2: IMPROVING BATTERY TECHNICAL MATURITY	175
DRIVING FORCE 3: DEVELOPING NEW APPLICATIONS FOR LARGE AND ADVANCED BATTERIES.....	176
DRIVING FORCE 4: ADVANCED MATERIALS FOR ADVANCED BATTERIES.....	177
Fullerenes	178
Fullerenes (Continued)	179
Conductive Polymers	180
<i>TABLE 62 CONDUCTIVE POLYMER BATTERY ENERGY DENSITIES</i>	181
Battery Separators	181

DRIVING FORCE 5: PUBLIC SECTOR R&D.....	182
Ames National Laboratory	182
Argonne National Laboratory	182
Argonne ... (Continued)	183
Argonne ... (Continued)	184
Argonne ... (Continued)	185
Arizona State University.....	186
Battelle Memorial Institute	187
Brookhaven National Laboratory	187
California Institute of Technology	187
California (Continued).....	188
California Nanosystems Institute.....	189
CNSI at UCSB	189
Center for Nanoscale Science (CNS).....	190
Clark University	190
Ecole Polytechnique Fédérale De Lausanne	190
Florida State University.....	190
Georgia Institute of Technology, Polymer Research Center....	191
Hunter College.....	191
Idaho National Engineering Laboratory	191
Iowa State University, Ames Laboratory	192
John Hopkins University, Applied Physics Laboratory.....	192
Kyoto University.....	192
Kyushu University	192
Laboratoire diElectrochimie Organique Et De Photochimie Redox	192
Lawrence Berkeley National Laboratory	192
Lawrence Livermore National Laboratory	193
Los Alamos National Laboratory	193
Massachusetts Institute of Technology	193
Massachusetts Institute ... (Continued)	194
Massachusetts Institute ... (Continued)	195
Max Planck Institut Für Festkorperforschung	196
Michigan State University	196
National Nanotechnology Initiative	196
<i>TABLE 63 NATIONAL NANOFABRICATION INFRASTRUCTURE</i> <i>NETWORK</i>	197
National Aeronautics and Space Administration (NASA).....	197
NASA Ames Research Center	197
Center for Nanotechnology (CNT).....	198
NASA Jet Propulsion Lab	199
National Renewable Energy Laboratory (NREL)	200
North Carolina Center for Nanoscale Materials (NCCNM)	201
North Carolina State University	202

Northwestern University	202
McCormick School of Engineering and Applied Science.....	202
McCormick ...(Continued).....	203
McCormick ...(Continued).....	204
Oak Ridge National Laboratory.....	205
Ohio State University.....	205
Oregon State University.....	205
Penn State University	205
Pennsylvania State University, Center for Advanced Materials.....	206
Purdue University Birck Nanotechnology Center	206
Polytechnic University	207
Princeton University	207
Rensselaer Polytechnic Institute (RPI)	207
Rice University	208
Rochester Institute of Technology	209
Rutgers, The State University of New Jersey	209
Sandia National Laboratory	209
Sandia ... (Continued)	210
Simon Fraser University.....	211
Sophia University.....	211
Stanford University.....	211
State University of New York (SUNY)	211
University of Kentucky	212
Università La Sapienza.....	213
University of Oklahoma Carbon Nanotubes Technology Center (CaNTeC).....	213
Universität Tübingen Institut Für Organische Chemie.....	214
University of California, Institute for Polymers and Organic Solids	214
University of Chicago	214
University of Colorado.....	214
University of Dayton Research Institute.....	215
University of Durham	215
University of Illinois.....	215
University of Kentucky	215
University of Massachusetts.....	215
University of Minnesota	215
University of Missouri.....	216
University of Missouri-Rolla	216
University of Nevada at Las Vegas	217
University of New Mexico	218
University of New South Wales	218

University of North Carolina	218
University of Pennsylvania	218
University of Rhode Island.....	219
University of Southern California	219
University of St. Andrews	219
University of Texas.....	219
University of Tokyo	219
USCAR	220
Waseda University, Department of Chemistry, School of Science and Engineering.....	220
DRIVING FORCE 6: BATTERY QUALITY CONTROL AND PRODUCT SAFETY	220
The Manufacturing and Assembly Process	220
<i>TABLE 64 GENERIC BATTERY MANUFACTURING TREE.....</i>	<i>221</i>
Product Safety Issues	221
Alternative Designs	222
Alternative ... (Continued).....	223
Recent Lithium Battery Patents that Address Battery Safety.....	224
Material Safety Issues.....	225
Material Safety ... (Continued).....	226
MARKET SEGMENTATION AND INDUSTRY CONCENTRATION FACTORS	227
<i>TABLE 65 LARGE AND ADVANCED BATTERY CONCENTRATION FACTORS.....</i>	<i>228</i>
<i>TABLE 65 (CONTINUED).....</i>	<i>229</i>
MARKET SEGMENTATION FACTORS.....	229
<i>TABLE 66 LARGE AND ADVANCED BATTERY MARKET SEGMENTATION AND MARKET FORCES.....</i>	<i>229</i>
<i>TABLE 66 (CONTINUED).....</i>	<i>230</i>
<i>TABLE 66 (CONTINUED).....</i>	<i>231</i>
INDUSTRY ENVIRONMENT AND TRADE PRACTICES	231
DISTRIBUTION CHANNELS	231
<i>TABLE 67 LARGE AND ADVANCED BATTERY DISTRIBUTION CHANNELS</i>	<i>232</i>
<i>TABLE 67 (CONTINUED).....</i>	<i>233</i>
INDUSTRY PURCHASING INFLUENCES	233
PRICE INFLUENCE	233
<i>TABLE 68 LARGE AND ADVANCED BATTERY PURCHASING INFLUENCES</i>	<i>233</i>
<i>TABLE 68 (CONTINUED).....</i>	<i>234</i>
RETAIL PRICE TRENDS.....	234
<i>TABLE 69 TYPICAL RETAIL ADVANCED BATTERY PRICES, 1996– 2009 (\$).....</i>	<i>235</i>

CHAPTER SIX: COMPANY PROFILES AND RECENT DEVELOPMENTS.....	236
A123SYSTEMS	236
A123SYSTEMS (CONTINUED).....	237
A123SYSTEMS (CONTINUED).....	238
<i>TABLE 70 A123 BATTERY COMPARED TO OTHER HIGH-CAPACITY</i>	
<i>BATTERY SYSTEMS</i>	239
<i>TABLE 71 A123 BATTERY PULSE DURATION AND POWER DENSITY</i> ...	239
A123SYSTEMS (CONTINUED).....	240
A123SYSTEMS (CONTINUED).....	241
A123SYSTEMS (CONTINUED).....	242
ABSL POWER (AEA BATTERY SYSTEMS, AGM BATTERIES LTD.).....	243
AC DELCO	243
ACME ELECTRIC CORP.....	243
ADVANCED BATTERY SYSTEMS.....	244
ADVANCED BATTERY TECHNOLOGIES, INC. (ABAT).....	244
ADVANCED BATTERY TECHNOLOGIES... (CONTINUED).....	245
AEA TECHNOLOGY.....	246
ALCAD, LTD.....	247
ALL POWER BATTERY.....	247
AMERICAN ELECTRIC POWER (AEP).....	248
AMERICAN ELECTRIC POWER (AEP) (CONTINUED).....	249
ANTIQUÉ AUTO BATTERY.....	250
APPLE COMPUTER, INC.....	250
APPLIED POWER, INC.	250
AROTECH CORP.....	250
ARTHUR D. LITTLE, INC.	251
ATLANTIC BATTERY CO.	251
AVESTOR (HYDRO-QUÉBEC AND KERR MCGEE).....	251
AVESTOR ... (CONTINUED).....	252
AVESTOR ... (CONTINUED).....	253
AXEON	254
AXION POWER INTERNATIONAL, INC.....	254
AXION POWER INTERNATIONAL, INC. (CONTINUED)	255
AXION POWER INTERNATIONAL, INC. (CONTINUED)	256
BATTERY-BIZ	257
BATTERY BUILDERS, INC. (BBI)	257
BATTERY CLINIC, INC.....	257
BATTERYCORP	258
BATTERY SYSTEMS, INC.	258
BATTERY TECHNOLOGY, INC. (BTI)	259
B.B. BATTERY.....	259
BELL CITY BATTERIES	259
BOLDER TECHNOLOGIES (GP BATTERIES INTERNATIONAL).....	259
BOLLORÉ GROUP	260

BOLLORÉ GROUP (CONTINUED).....	261
ROBERT BOSCH GMBH (SB LIMOTIVE CO. LTD)	262
ROBERT BOSCH GMBH ... (CONTINUED)	263
BOSTON-POWER.....	264
BOUNDLESS CORP.....	265
BREN-TRONICS.....	266
BYD BATTERIES	266
CADEX	267
C&D TECHNOLOGIES, INC.....	267
CELL-CON.....	268
CHINA BAK BATTERY, INC.	268
CHINA BAK BATTERY, INC. (CONTINUED)	269
CHINA BAK BATTERY, INC. (CONTINUED)	270
CHINA SUN (DALIAN XINYANG HIGH-TECH DEVELOPMENT CO.)	271
COBASYS (SB LIMOTIVE CO. LTD.).....	272
COBASYS (SB LIMOTIVE CO. LTD.) (CONTINUED)	273
CONCORD BATTERY CORP.....	274
CONTINENTAL CORPORATION.....	274
COVALENT ASSOCIATES, INC.....	274
CROWN BATTERY MANUFACTURING CO.....	275
CSB BATTERY OF AMERICA CORP.....	275
DOUGLAS BATTERY MANUFACTURING CO.....	275
DYNACELL CORP.....	276
DYNO BATTERY, INC.....	276
EAGLEPICHER CORP. (OM CORP.).....	276
EAGLEPICHER CORP...(CONTINUED).....	277
EAST PENN MANUFACTURING CO. (DEKA BATTERIES).....	278
EIC LABORATORIES	279
ELECTRO ENERGY.....	279
ELECTROVAYA (ELECTROFUEL).....	280
ELECTROVAYA ... (CONTINUED)	281
ENER1, INC. (ENERDEL).....	282
ENER1, INC. ... (CONTINUED).....	283
ENER1, INC. ... (CONTINUED).....	284
ENER1, INC. ... (CONTINUED).....	285
ENERGY CONVERSION DEVICES (ECD OVONICS).....	286
OVONIC BATTERY CO.....	286
<i>TABLE 72 OVONICS BATTERY JOINT VENTURES, LICENSING AGREEMENTS, AND OTHER STRATEGIC ALLIANCES.....</i>	<i>287</i>
<i>TABLE 72 (CONTINUED).....</i>	<i>288</i>
Ovonic Battery Co. (Continued)	289
Ovonic Battery Co. (Continued)	290
ENERIZE CORP. (FIFE BATTERIES).....	291

FIFE BATTERIES LTD.....	291
ENERGIZER HOLDINGS.....	292
ENERSYS, INC.....	293
ENERSYS, INC. (CONTINUED).....	294
ENFUCELL.....	295
E-ONE MOLI ENERGY.....	295
E-ONE MOLI ENERGY (CONTINUED).....	296
ERGENICS.....	297
EVERCEL, INC.....	298
EVEREXCEED INDUSTRIAL CO., LTD.....	298
EVONIK INDUSTRIES AG.....	299
EXIDE TECHNOLOGIES.....	300
EXIDE TECHNOLOGIES (CONTINUED).....	301
FARASIS ENERGY.....	302
FIAMM TECHNOLOGIES, INC.....	302
FIREFLY ENERGY.....	303
FIREFLY ENERGY (CONTINUED).....	304
FIREFLY ENERGY (CONTINUED).....	305
FLUIDIC ENERGY.....	306
FUJI PHOTO FILM CO., LTD.....	306
FURUKAWA BATTERY CO.....	306
GENERAL MOTORS.....	307
GENERAL MOTORS (CONTINUED).....	308
GP BATTERIES (GOLD PEAK INTERNATIONAL).....	309
GREATBATCH, INC.....	309
HARDING ENERGY, INC.....	310
HITACHI MAXELL CORP.....	310
HONEYWELL BATTERIES.....	311
HONG KONG HIGHPOWER TECHNOLOGY.....	311
HYB BATTERY CO., LTD. (HUA-YUE-BAO BATTERY).....	312
HUANYU BATTERY.....	312
HYMOTION (A123SYSTEMS).....	312
IBM CORP.....	313
ALMADEN RESEARCH CENTER.....	313
IMARA CORP.....	314
INDUSTRIAL BATTERY ENGINEERING.....	314
INDUSTRIAL BATTERY PRODUCTS.....	315
INDUSTRIES INTERNATIONAL, INC. (INDI).....	315
INFINITE POWER SOLUTIONS.....	316
INNERGY POWER CORP. (PORTABLE ENERGY PRODUCTS, INC.).....	316
INTERNATIONAL BATTERY.....	316
IQ POWER AG.....	317

JOHNSON CONTROLS (JOHNSON CONTROLS-SAFT ADVANCED POWER SOLUTIONS)	318
JOHNSON CONTROLS ... (CONTINUED)	319
JOHNSON CONTROLS ... (CONTINUED)	320
JOHNSON CONTROLS ... (CONTINUED)	321
K2	322
KEYSTONE BATTERY CORP.....	323
KOKAM AMERICA, INC.	323
LG CHEMICAL.....	324
LITHIUM POWER TECHNOLOGIES	324
LITHIUM TECHNOLOGY CORP. (LTC).....	325
GAIA AKKUMULATORENWERKE GMBH	325
GAIA ... (Continued).....	326
GAIA ... (Continued).....	327
GAIA ... (Continued).....	328
MAGPOWER SYSTEMS, INC.	329
MARATHONNORCO AEROSPACE, INC.....	329
MAXPOWER, INC.	329
MEDTRONIC, INC.	330
MES-DEA SA	330
MICROCHIP TECHNOLOGY, INC.....	330
MINIMAX ENERGY TECHNOLOGY	331
MITSUBISHI INTERNATIONAL	331
MITSUBISHI INTERNATIONAL (CONTINUED)	332
MOLTECH CORP.	333
MULTIPLIER INDUSTRIES	333
NAMIL BATTERY	333
NANOEXA.....	334
NEC CORP. (E-ONE MOLI ENERGY).....	335
NEC CORP. ... (CONTINUED).....	336
NEXCELL BATTERY (BATTERY RESOURCE CO.).....	337
NEXERGY (PROMARK ELECTRONICS, DC BATTERY PRODUCTS, TAUBER)	337
NISSAN MOTOR CO.....	337
NISSAN MOTOR CO. (CONTINUED)	338
NGK INSULATORS	339
NGK CERAMICS USA, INC.....	339
ODYNE CORP.....	340
PANASONIC (MATSUSHITA ELECTRIC INDUSTRIAL CO.)	340
PANASONIC (AMERICA)	340
PANASONIC BATTERIES	340
POLYPLUS BATTERY COMPANY.....	341
POROUS POWER TECHNOLOGIES, LLC	342
POWER BATTERY CO.....	342

POWERGENIX	342
POWERGENIX (CONTINUED)	343
POWER PAPER, LTD.....	344
POWER-SONIC CORP.	345
POWERZINC ELECTRIC, INC.	345
PRUDENT ENERGY (VRB POWER SYSTEMS)	346
PRUDENT ...(CONTINUED)	347
PRUDENT ...(CONTINUED)	348
PURE ENERGY VISIONS, INC. (ENERGY VISIONS, INC.)	349
QUALLION LLC	350
REACO BATTERY SERVICE CORP.....	351
REGENESYS TECHNOLOGIES, LTD./INNOGY	351
RENATA BATTERIES	352
RICARDO, INC.	352
ROLLS BATTERY ENGINEERING	353
SAFT (JOHNSON CONTROLS-SAFT ADVANCED POWER SOLUTIONS).....	353
SAFT AMERICA, INC.	353
Saft America, Inc. (Continued)	354
SAMSUNG	355
SANYO ELECTRIC CO., LTD.	356
SANYO ELECTRIC CO. USA	356
Sanyo Electric Co. USA (Continued)	357
SETO HOLDINGS, INC.	358
SION POWER	358
SOLICORE, INC.	359
SOLICORE, INC. (CONTINUED).....	360
SONY CORP.....	361
SONY CORP. (CONTINUED)	362
<i>TABLE 73 COMPARISON BETWEEN CONVENTIONAL BATTERY AND NEXELION</i>	<i>363</i>
SRI INTERNATIONAL	364
STORAGE BATTERY SYSTEMS, INC.	364
SUPERIOR BATTERY MANUFACTURING	365
SUPERLATIC POWER.....	365
SWIFT INDUSTRIAL POWER.....	365
TIAX	365
TIAX (CONTINUED)	366
TOSHIBA	367
<i>TABLE 74 SCIB SPECIFICATIONS</i>	<i>368</i>
TNR TECHNICAL, INC.	368
TRACER TECHNOLOGIES.....	368
TROJAN BATTERY CO.	369
TUNGSTONE BATTERIES, INC.	369

ULTRALIFE BATTERIES, INC.	369
ULTRALIFE BATTERIES, INC. (CONTINUED)	370
UNIROSS BATTERIES CORP.....	371
UNIROSS BATTERIES CORP (U.S.)	371
U.S. BATTERY MANUFACTURING CO.....	372
VALENCE TECHNOLOGY, INC.....	373
VALENCE TECHNOLOGY, INC. (CONTINUED)	374
VALENCE TECHNOLOGY, INC. (CONTINUED)	375
VALENCE TECHNOLOGY, INC. (CONTINUED)	376
VARTA AG (VARTA BATTERIES, INC).....	377
VARTA MICROBATTERY (USA).....	378
YARDNEY (LITHION, ENER-TEK).....	378
YUASA, INC. (GS YUASA CORP., YUASA BATTERY AMERICA, INC., YUASA-EXIDE).....	379
YUASA, INC. (CONTINUED)	380
ZBB ENERGY CORP.....	381
ZBB ENERGY CORP. (CONTINUED)	382
ZPOWER	383