

TABLE OF CONTENTS

FOREWORD		3
ACKNOWLEDGEMENTS		5
	PART I Summary:	
Chapter 1	Introduction	23
2	Assumptions	29
3	Principal Results	37
4	Climate Change Analyses	53
5	Conclusions	59
	PART II Outlook for Energy Supply:	
Chapter 6	Power Generation	63
7	Oil	83
8	Gas	123
9	Coal	143
10	Biomass	157
	PART III Outlook by World Regions:	
Chapter 11	OECD Europe	175
12	OECD North America	203
13	OECD Pacific	227
14	Transition Economies	249
15	China	273
16	East Asia	299
17	South Asia	323
18	Latin America	347
19	Africa	371
20	Middle East	393
	PART IV Tables for the Business As Usual Projection:	
	Energy Demand	411
	CO ₂ Emissions	
	Electricity Generation and Generating Capacity	
	Definitions (regions and units)	464

Boxes	Page
7.1 Oil Supply	83
7.2 Definitions	83
7.3 Alternative Explanation of the Range in Estimated Ultimate Oil Reserves	108
7.4 Uncertainty of Reserve Estimates	110
8.1 Gas Supply	123
9.1 Coal Supply	143
12.1 Energy Market Reforms in US	205
13.1 Regulatory Reforms in Japan and their Impacts	228
16.1 Asian Financial Crisis	301
17.1 Energy Pricing and Subsidies in the Indian Energy Sector	326
17.2 “Dieselisation” of the Indian Energy Sector	333
18.1 Restructuring of the Latin American Energy Sector	349

Tables	
2.1 Alternative Paths for Economic Growth Average Annual Growth Rates % in Gross Domestic Product	30
2.2 Effect of Changes in Economic Growth on World Energy Consumption and Energy-related CO ₂ Emissions in 2020	32
2.3 Population Growth Assumptions	33
2.4 Assumptions for Business-As-Usual World Fossil Fuel Prices	34
3.1 Oil Supply 1996-2020, Conventional Oil Reserves of 2.3 trillion barrels	45
3.2 Natural Gas Production and Net Imports (Mtoe)	47
4.1 Increases in Energy-Related CO ₂ Emissions (million tonnes CO ₂)	53
4.2 OECD Energy-Related CO ₂ Emissions in 2010 by Sector	54
6.1 World Electricity Generation, Fuel Consumption and Generating Capacity 1971-2020	64
6.2 New and Total Generating Plant Capacities and Plant Retirements 1995-2020	69
6.3 Capital Expenditure on New Generating Plant	71
6.4 Assumptions for Capital Costs and Efficiencies of New Generating Plants by Region 1995-2020	74
6.5 Assumptions for Nuclear Generating Capacity and Electricity Generation by Region 1995-2020	75
6.6 Assumptions for Hydropower Generating Capacity and Electricity Generation by Region 1995-2020	75

6.7	Assumptions for Generating Capacity and Electricity Generation from Renewable Energy Forms by Region 1995-2020	76
7.1	Oil Demand Assumptions for the BAU Projection	84
7.2	BAU Projection - Total Oil Demand (Mtoe)	85
7.3	BAU Projection - Transport Sector Oil Demand (Mtoe)	86
7.4	BAU Projection - Power Generation Sector Oil Demand (Mtoe)	87
7.5	BAU Projection - Stationary Sectors Oil Demand (Mtoe)	88
7.6	1995 World Oil Demand - Oil Market Report Basis	89
7.7	World Oil Demand (Business As Usual) - Oil Market Report Basis (Mbd)	90
7.8	Reserve Estimates by Country (billion barrels)	94
7.9	1994 USGS Ultimate Oil Reserve Estimate as of 1/1/1993	95
7.10	Pessimists' View of Ultimate Oil Reserve Estimate as of 1/1/1997	96
7.11	Assumed Ultimate Conventional Oil Reserves (billions of barrels)	100
7.12	Oil Supply 1996-2020 (million barrels per day)	101
7.13	North Sea Oil Fields' Recoverable Oil Reserves	105
7.14	Conventional and Unconventional Oil Reserve Estimates	111
7.15	Production Cost Estimates	113
7.16	Identified Unconventional Oil Supply - Thousand Barrels per Day	114
7.17	Oil Stocks (million barrels)	116
7.18	Oil Demand, Supply and Net Imports Conventional Oil Reserves of 2300 Billion Barrels - BAU Projection (million barrels per day)	117
7.19	Oil Import Dependence (per cent)	118
7.20	Oil Supply USDOE / EIA - Reference Case (million barrels per day)	119
7.21	Oil Supply IEA WEO 1998 - BAU (million barrels per day)	120
8.1	Total Primary Energy Supply of Gas (Mtoe)	124
8.2	Total Final Gas Consumption (Mtoe)	125
8.3	Stationary Sector Gas Demand (Mtoe)	125
8.4	Power Generation Gas Demand (Mtoe)	126
8.5	Summary Table for the BAU Gas Projection (Mtoe)	127
8.6	Total Primary Energy Supply (tcf)	128
8.7	USGS Ultimate Conventional Gas Reserves (tcf)	130
8.8	Estimates of Gas Reserves in the United States	132
8.9	Estimates of Canadian Gas Reserves (tcf)	133

8.10	BAU Gas Supply and Demand Projections (tcf)	134
8.11	Cumulative Gas Production as a Percentage of the USGS' Estimated Conventional Gas Reserves	137
8.12	USDOE versus IEA Gas Demand Projections - Annual Growth Rates 1995 - 2020	138
8.13	EU versus IEA Gas Demand Projections - Annual Growth Rates 1995 - 2020	139
8.14	OECD Gas Balances in 2020 IEA BAU versus EU CW (Mtoe)	140
9.1	Total Primary Coal Demand (Mtoe)	144
9.2	Total Final Consumption (Mtoe)	145
9.3	Power Generation (Mtoe)	147
9.4	Coal Reserves and Production	148
9.5	Percentage of World Coal Reserves by Country (1996)	148
9.6	Percentage of World Coal Production by Country (1996)	149
9.7	Total Primary Energy Supply (1995 - 2020), Annual Growth Rates	155
10.1	Per Capita GDP, Levels and Growth Rates	166
10.2	Total Final Energy Consumption including Biomass Energy (Mtoe)	168
10.3	Charcoal Production (Mtoe)	169
10.4	Total Primary Energy Supply including Biomass Energy (Mtoe)	171
11.1	Assumptions for OECD Europe	175
11.2	Total Primary Energy Supply (Mtoe)	176
11.3	Total Final Energy Consumption (Mtoe)	177
11.4	Energy Use in Stationary Sectors (Mtoe)	178
11.5	Energy Use for Mobility (Mtoe)	181
11.6	Total Final Electricity Consumption (Mtoe)	183
11.7	Electricity Generation in OECD Europe (TWh)	183
11.8	Electricity Generating Capacity by Fuel (GW)	185
11.9	Combined Cycle Gas Turbine Capacity (MW)	186
11.10	Nuclear Plants Under Construction and Completed: 1995-2000	188
11.11	OECD Europe Oil Balance (Mbd)	189
11.12	OECD Europe Gas Reserves at 1/1/1993 - Trillion Cubic Feet (tcf)	189
11.13	Gas Balance for OECD Europe (Mtoe)	190
11.14	OECD Europe 1996 Steam Coal Imports by Source (percentage)	192
11.15	Electricity Generation in OECD Europe and European Union - 1995 (TWh)	197
11.16	Comparison of Power Generation Projections 1995 - 2020	198

11.17	WEO 1998 BAU versus IEO 1998 Reference Case	199
11.18	Average Annual Growth Rate in Total Final Electricity Demand 1995 - 2020	200
11.19	Oil Price Assumptions Real \$ per Barrel	200
12.1	Retail Gasoline Prices and Taxes 1997 (US cents per litre)	204
12.2	OECD North America Assumptions	205
12.3	Total Primary Energy Supply (Mtoe)	207
12.4	Total Final Energy Consumption (Mtoe)	208
12.5	Energy Consumption in Stationary Sectors (Mtoe)	209
12.6	Fossil Fuel Use for Mobility (Mtoe)	210
12.7	Total Final Electricity Demand (Mtoe)	212
12.8	Electricity Generating Capacity by Fuel (GW)	214
12.9	Planned Capacity Additions in US Electric Utilities, 1996 to 2005	214
12.10	Canadian Nuclear Plants Temporarily Shut Down	216
12.11	Average Power Production Expenses for US Nuclear and Fossil-fuelled Steam Plants (cents per kWh), 1996	217
12.12	OECD North America's Oil Balance (Mbd)	218
12.13	OECD North America's Gas Balance (Mtoe)	220
12.14	Comparison of Key Assumptions for the USDOE and the BAU Projections	222
12.15	Comparisons of Growth Rates of Total Primary Energy Supply for the USDOE and the BAU Projections	222
13.1	Assumptions for the OECD Pacific Region	230
13.2	Total Primary Energy Supply (Mtoe)	230
13.3	Total Final Energy Consumption (Mtoe)	232
13.4	Energy Use in Stationary Services (Mtoe)	233
13.5	Energy Use for Mobility (Mtoe)	236
13.6	Total Final Electricity Demand (Mtoe)	236
13.7	Electricity Generation Mix, 1995 (TWh)	238
13.8	Non-Hydro-Renewable Electricity Generation (TWh) and Capacity (MW)	241
13.9	Electricity Generating Capacity GW	241
13.10	Fuel Consumption in Power Generation (Mtoe)	242
13.11	OECD Pacific Oil Balance (Mbd)	242
13.12	OECD Pacific Gas Balance (Mtoe)	243
13.13	Comparison of Assumptions for the OECD Pacific Region	245
13.14	Comparisons of Projections of Total Primary Energy Supply by Fuel for the OECD Pacific Region	246
13.15	Comparison of Power Generation Projections	247

14.1	Eastern European Parameters (excluding Russia)	250
14.2	Russian Energy Parameters	250
14.3	GDP Assumptions	250
14.4	Total Primary Energy Supply by Fuel (Mtoe)	252
14.5	Total Primary Energy Supply (Mtoe)	253
14.6	Total Final Energy Consumption 1990-1995 (Mtoe)	254
14.7	Total Final Energy Consumption (Mtoe)	255
14.8	Per Capita Income Comparison (Based on Official Data)	256
14.9	Energy Consumption in Stationary Sectors (Mtoe)	257
14.10	Energy Consumption in Stationary Sectors (Mtoe)	258
14.11	Energy Demand for Mobility (Mtoe)	258
14.12	Energy Demand for Mobility (Mtoe)	259
14.13	Total Final Electricity Consumption (Mtoe)	260
14.14	Electricity Generation in the Transition Economies (TWh)	262
14.15	Nuclear Power Statistics, 1995	263
14.16	Transition Economies Energy Balance 1995 (Mtoe)	265
14.17	Transition Economies Oil Balance - Million Barrels per Day	265
14.18	Transition Economies Conventional Oil Reserves (Billion Barrels)	266
14.19	Transition Economies Gas Balance 1995 - 2020 (Mtoe)	267
14.20	Annual Growth Rates of Total Primary Energy Supply (1995 - 2020)	268
14.21	Transition Economies Oil Balance (Mbd)	270
15.1	Importance of China in the World (Percentage of World Total)	274
15.2	Estimates of China's GDP (\$Billion 1990 and PPP) and GDP per Capita (\$ per person)	278
15.3	Assumptions for China Region	280
15.4	Total Primary Energy Supply (Mtoe)	281
15.5	Total Final Energy Consumption (Mtoe)	282
15.6	Energy Use in Stationary Sectors by Fuel (Mtoe)	283
15.7	Energy Use for Mobility (Mtoe)	285
15.8	Total Final Electricity Demand (Mtoe)	286
15.9	Ownership of Major Durable Consumer Goods per 100 Households	286
15.10	Electricity Generation in China (TWh)	287
15.11	Committed Nuclear Projects in China	290
16.1	Economic and Population Data for Selected East Asian Countries	301
16.2	Energy Demand in Selected East Asian Countries, 1995 (Mtoe)	301

16.3	Economic Assumptions	304
16.4	Total Primary Energy Supply (Mtoe)	305
16.5	Total Final Energy Consumption (Mtoe)	306
16.6	Energy Use in Stationary Sectors by Fuel (Mtoe)	307
16.7	Energy Use for Mobility (Mtoe)	308
16.8	Total Final Electricity Demand (Mtoe)	309
16.9	Electricity Sales per Capita and per Customer in Indonesia (kWh)	310
16.10	Per Capita Income and Per Capita Electricity Generation in East Asian Countries, 1995	311
16.11	Electricity Generation in East Asia (TWh)	312
16.12	Nuclear Plants under Construction in the Republic of Korea	313
16.13	Fuel Use in Power Stations and as a Share of TPES	314
16.14	East Asia Oil Balance (Mbd)	316
16.15	Final Biomass Energy Use in East Asia, 1995	318
17.1	South Asian Statistics	324
17.2	Comparison of Average Electricity Retail Price and Supply Costs in India	327
17.3	Assumptions for South Asia	328
17.4	Total Primary Energy Supply (Mtoe)	329
17.5	Total Final Energy Consumption (Mtoe)	329
17.6	Energy Use in Stationary Sectors by Fuel (Mtoe)	331
17.7	Energy Use for Mobility (Mtoe)	332
17.8	Evolution of India's Diesel Consumption and Imports (1990-1996)	334
17.9	Total Final Electricity Demand (Mtoe)	335
17.10	Electricity Generation in South Asia, 1995 (TWh)	336
17.11	South Asia Electricity Generation (TWh)	337
17.12	Indian Nuclear Plant Performance	338
17.13	India's Estimated Renewable Energy Potential (GW)	339
17.14	Indian Coal Reserves by Type and State, as of January 1995 (billion tonnes)	340
17.15	South Asia Oil Balance (Mbd)	341
17.16	Final Biomass Energy Use in South Asia, 1995	343
18.1	Economic and Population Data for Selected Latin American Countries	348
18.2	Energy Consumption in Selected Latin American Countries, 1995 (Mtoe)	348
18.3	Energy Price Assumptions for Latin America	351
18.4	Total Primary Energy Supply (Mtoe)	352

18.5	Total Final Energy Consumption (Mtoe)	352
18.6	Energy Use in Stationary Sectors by Fuel (Mtoe)	353
18.7	Energy Use for Mobility (Mtoe)	355
18.8	Total Final Electricity Demand (Mtoe)	356
18.9	Electricity Generation Mix (TWh)	357
18.10	Operating Nuclear Power Plants in Latin America	359
18.11	Hard Coal Production - Colombia and Venezuela (Mt)	365
18.12	Final Biomass Energy Use in Latin America, 1995	367
19.1	Economic Performance and Population of Selected African Countries	373
19.2	Energy Consumption in Selected Africa Countries (Mtoe)	373
19.3	Assumptions for the African Region	375
19.4	Total Primary Energy Supply (Mtoe)	376
19.5	Total Final Energy Consumption (Mtoe)	376
19.6	Energy Use in Stationary Sectors by Fuel (Mtoe)	377
19.7	Energy Use for Mobility (Mtoe)	378
19.8	Total Final Electricity Demand (Mtoe)	380
19.9	African Capacity (GW) and Electricity Generation (TWh)	381
19.10	Hard Coal Production - South Africa (Mt)	386
19.11	Final Biomass Energy Use in Africa, 1995	387
20.1	Middle East Assumptions	393
20.2	Total Primary Energy Supply (Mtoe)	396
20.3	Total Final Energy Consumption (Mtoe)	396
20.4	Energy Use in Stationary Sectors (Mtoe)	398
20.5	Energy Demand for Mobility (Mtoe)	398
20.6	Total Final Electricity Consumption (Mtoe)	400
20.7	Electricity Generation (TWh) and Capacity (GW)	402
20.8	Middle East Oil Balance (Mbd)	404
20.9	Middle East Gas Balance (Mtoe)	405
20.10	TPES by Fuel (Annual Growth Rates 1995-2020)	407

Figures

2.1	World GDP Growth, Data and Alternative Projections (\$ Billion at 1990 Prices & PPP)	31
2.2	Business-As-Usual Assumptions, Fossil Fuel Prices	35
3.1	World Primary Energy Supply and CO ₂ Emissions 1971-2020	37
3.2	World Primary Energy Supply by Fuel 1971-2020	38
3.3	Ratio of World Primary Energy Supply to GDP 1971-2020	38
3.4	World Primary Energy Supply by Fuel Type 1971-2020	39

3.5	Annual Rates of Growth 1995-2020 in Total Primary Energy Supply, CO ₂ Emissions and Energy Intensity	40
3.6	World Primary Energy Supply	40
3.7	World Energy-Related Services 1971-2020	41
3.8	OECD Energy-Related Services 1971-2020	42
3.9	Oil Supply Profiles 1996-2030	45
3.10	World Power Generation Inputs by Fuel 1971-2020	49
3.11	Shares of Fuel Inputs into Power Generation in 2020	50
4.1	Comparison of Power Generation by Fuel between BAU and Kyoto Analyses in 2010 for the Three OECD Regions	57
6.1	World Electricity Generation by Region	66
6.2	World Electricity Generation by Fuel	66
6.3	World Fuel Consumption for Electricity Generation by Region	67
6.4	World Fuel Consumption for Electricity Generation by Fuel	67
6.5	World Electricity Generating Capacity by Region	68
6.6	World Electricity Generating Capacity by Fuel	68
7.1	BAU Projection -World Fuel Shares	88
7.2	World Oil Official (proved) Reserves & Production	91
7.3	Non-OPEC Official (proved) Oil Reserves & Production	92
7.4	OPEC Official (proved) Oil Reserves	93
7.5	Generalised Hubbert Curve	96
7.6	Percentage of Discovered Oil Reserves in Production	97
7.7	Oil Supply Profiles 1996-2030 Ultimate Conventional Oil Reserves of 2300 Billion Barrels	100
7.8	Oil Supply Profiles 1996-2030 Ultimate Conventional Oil Reserves of 2000 Billion Barrels	103
7.9	Oil Supply Profiles 1996-2030 Ultimate Conventional Oil Reserves of 3000 Billion Barrels	104
7.10	World outside North America: Giant Oil Fields Recovery Factor Distributions 1996-1987	107
8.1	OECD Europe's Gas Balance	136
8.2	World Gas Production	137
9.1	World Coal Supply and Demand (Mtoe)	154
10.1	Per Capita Biomass versus per Capita GDP in Developing Countries	157
11.1	Total Primary Energy Supply in OECD Europe	177
11.2	Fossil Fuel & Heat in Stationary Sectors	178
11.3	Stationary Energy Uses by Fuel	179
11.4	Heating Degree Days	179

11.5	Stationary Sectors Energy Demand 1971 - 1995	180
11.6	Energy Use in Mobility	182
11.7	Total Final Electricity Consumption (Mtoe)	182
11.8	Fuels used in Power Generation in OECD Europe 1971-2020	187
11.9	Gas Balance for OECD Europe	190
11.10	Total Primary Energy Supply/GDP Ratio	194
11.11	Transport Energy Demand/GDP Ratio	195
11.12	Electricity Demand/GDP Ratio	196
11.13	Stationary Sectors Energy Demand/GDP Ratio	196
11.14	Electricity Generation (1995 = 100)	198
11.15	Fuel Use in Power Stations (1995 = 100)	198
12.1	Energy Intensities of Selected OECD Countries	203
12.2	Total Primary Energy Supply, OECD North America	208
12.3	Stationary Uses by Fuel	209
12.4	Mobility	210
12.5	Incremental Changes in Oil Consumption	211
12.6	Electricity Demand	212
12.7	North American Electricity Output	213
12.8	Comparison of the Generating Costs of New Steam Coal and CCGT Plants, 2000	215
12.9	Hard Coal Production and Exports	221
12.10	Comparison of the Price Assumptions for the USDOE and the IEA Projections	223
13.1	Total Primary Energy Supply, OECD Pacific	231
13.2	Energy Intensity Developments by Industry 1974=100	233
13.3	Energy Use in Stationary Services by Fuel	234
13.4	Energy Demand for Mobility	235
13.5	Ownership of Passenger Cars in Japan (More than 660 cc)	235
13.6	Total Final Electricity Demand	237
13.7	Fuel Consumption in Power Generation	239
14.1	Transition Economies Energy and GDP 1990-1995	251
14.2	Total Primary Energy Supply by Fuel (Mtoe)	252
14.3	Total Primary Energy Supply versus GDP (1990-2020)	254
14.4	Total Final Consumption versus GDP (1990-2020)	256
14.5	Energy Consumption in Stationary Sectors (1990-2020)	257
14.6	Mobility versus GDP 1990 - 2020	259
14.7	Total Final Electricity Consumption versus GDP (1990-2020)	261
15.1	Shares in Incremental World Primary Energy Supply Growth (1995-2020)	275

15.2	Comparison of Energy Intensities Based on Official and Maddison GDP Figures (1978 = 100)	279
15.3	Total Primary Energy Supply	281
15.4	Energy Use in Stationary Sectors by Fuel	283
15.5	Energy Use for Mobility	284
15.6	Total Final Electricity Demand	285
15.7	Domestic Supply and Net Oil Imports in China	293
15.8	Total Primary Energy Supply including Biomass, 1995-2020	297
16.1	Average GDP Growth and 1995 GDP Per Capita	300
16.2	Total Primary Energy Supply	303
16.3	Energy Use in Stationary Sectors by Fuel	307
16.4	Energy Use for Mobility	308
16.5	Vehicle Ownership versus GDP per Capita	309
16.6	Total Final Electricity Demand	310
16.7	Total Primary Energy Supply including Biomass, 1995 - 2020	320
16.8	Energy Intensity with and without Biomass, 1995-2020	321
17.1	GDP per Capita by Region	324
17.2	Total Primary Energy Supply	326
17.3	Energy Use in Stationary Sectors by Fuel	330
17.4	Energy Use for Mobility	332
17.5	Total Final Electricity Demand	334
17.6	Total Primary Energy Supply including Biomass, 1995-2020	345
17.7	Energy Intensity with and without Biomass, 1995-2020	345
18.1	Total Primary Energy Supply	350
18.2	Energy Use in Stationary Sectors by Fuel	354
18.3	Energy Use for Mobility	355
18.4	Total Final Electricity Demand	356
18.5	Total Primary Energy Supply including Biomass, 1995-2020	368
18.6	Energy Intensity with and without Biomass, 1995-2020	369
19.1	GDP and Energy Consumption per Capita by Region	372
19.2	Total Primary Energy Supply	374
19.3	Energy Use in Stationary Sectors by Fuel	377
19.4	Passenger Vehicle Ownership	378
19.5	Energy Use for Mobility	379
19.6	Total Final Electricity Demand	379
19.7	Oil Supply and Demand	384
19.8	Average Per Capita Final Energy Use in Africa, 1995	387
19.9	Energy Intensity with and without Biomass, 1995	388
19.10	Total Primary Energy Supply including Biomass, 1995-2020	390
20.1	Total Final Energy Consumption versus GDP (1971-2020)	397

20.2	Energy Use in Stationary Sectors versus GDP (1971-2020)	398
20.3	Energy Demand for Mobility	399
20.4	Total Final Electricity Consumption	400
20.5	Middle East Oil Balance	405
20.6	Middle East Gas Production (tcf)	406