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Derivatives and Risk Management in the Petroleum, Natural Gas, and Electricity Industries

Table 1. Major U.S. and Foreign Futures Exchanges

Exchange	Country	Primary Commodities
Chicago Board of Trade (CBOT)	USA	Grains, US Treasury notes and bonds, other interest rates, stock indexes
Chicago Mercantile Exchange (CME)	USA	Livestock, dairy products, stock indexes, Eurodollars and other interest rates, currencies
Kansas City Board of Trade (KCBT)	USA	Wheat and stock indexes
Minneapolis Grain Exchange (MGE)	USA	Spring wheat
New York Board of Trade (NYBOT)	USA	Sugar, coffee, cocoa, cotton, currencies
New York Mercantile Exchange (NYMEX)	USA	Metals, crude oil, heating oil, natural gas, gasoline
Philadelphia Board of Trade (PBOT)	USA	Currencies
Bolsa de Mercadorias & Futuros (BMF)	Brazil	Gold, stock indexes, interest rates, exchange rates, anhydrous fuel alcohol, coffee, corn, cotton, cattle, soybeans, sugar
EUREX	Germany/Switzerland	Interest rates, bonds, stock indexes
Hong Kong Futures Exchange (HKFE)	Hong Kong	Stock indexes, interest rates, currencies
International Petroleum Exchange (IPE)	England	Crude oil, gas oil, natural gas, electricity
London International Financial Futures Exchange (LIFFE)	England	Interest rates, stock indexes, bonds, coffee, sugar, cocoa, grain
London Metals Exchange (LME)	England	Copper, aluminum, lead, zinc, nickel, tin, silver
Marche Terme International de France (MATIF)	France	Bonds, notes, interest rates, rapeseed, wheat, corn, sunflower seeds, stock indexes
MEEF Renta Fija	Spain	Bonds, interest rates, stock indexes
Singapore Futures Exchange	Singapore	Interest rates, stock indexes, crude oil
Sydney Futures Exchange	Australia	Interest rates, stocks, stock indexes, currencies, electricity, wool, grains
Tokyo Grain Exchange (TGE)	Japan	Corn, soybeans, red beans, coffee, sugar
Tokyo International Financial Futures Exchange (TIFFE)	Japan	Interest rates, currencies

Source: Commodity Futures Trading Commission.

Table 2. Example of an Oil Futures Contract

Date	Prices per Barrel		Contract Activity	Cash In (Out)
	WTI Spot	December Future		
January	$26	$28	Refiner "buys" 10 contracts for 1,000 barrels each and pays the initial margin.	($22,000)
May	$20	$26	Mark to market: (26 - 28) x 10,000	($20,000)
September	$20	$29	Mark to market: (29 - 26) x 10,000	$30,000
October	$27	$35	Mark to market: (35 - 29) x 10,000	$60,000
November (end)	$35	$35	Refiner either:	
			(a) buys oil, or	($350,000)
			(b) "sells" the contracts. Initial margin is refunded.	$22,000

Source: Energy Information Administration.

Table 3. Spot Market Price Volatility for Selected Commodities

Commodity	Average Annual Volatility (Percent)	Market	Period
Electricity			
California-Oregon Border	309.9	Spot-Peak	1996-2001
Cinergy	435.7	Spot-Peak	1996-2001
Palo Verde	304.5	Spot-Peak	1996-2001
PJM	389.1	Spot-Peak	1996-2001
Natural Gas and Petroleum			
Light Sweet Crude Oil, LLS	38.3	Spot	1989-2001
Motor Gasoline, NYH	39.1	Spot	1989-2001
Heating Oil, NYH	38.5	Spot	1989-2001
Natural Gas	78.0	Spot	1992-2001
Financial			
Federal Funds Rate	85.7	Spot	1989-2001
Stock Index, S&P 500	15.1	Spot	1989-2001
Treasury Bonds, 30 Year	12.6	Spot	1989-2001
Metals			
Copper, LME Grade A	32.3	Spot	January 1989-August 2001
Gold Bar, Handy & Harman, NY	12.0	Spot	1989-2001
Silver Bar, Handy & Harman, NY	20.2	Spot	January 1989-August 2001
Platinum, Producers	22.6	Spot	January 1989-August 2001
Agriculture			
Coffee, BH OM Arabic	37.3	Spot	January 1989-August 2001
Sugar, World Spot	99.0	Spot	January 1989-August 2001
Corn, N. Illinois River	37.7	Spot	1994-2001
Soybeans, N. Illinois River	23.8	Spot	1994-2001
Cotton, East TX & OK	76.2	Spot	January 1989-August 2001
FCOJ, Florida Citrus Mutual	20.3	Spot	September 1998-December 2001
Meat			
Cattle, Amarillo	13.3	Spot	January 1989-August 2001
Pork Bellies	71.8	Spot	January 1989-August 1999

Sources: Energy Information Administration and Commodity Futures Trading Commission. Data are available from the authors on request.

Table 4. Expected Annual Net Cash Flows and Net Present Value (NPV) of Investment in a New Generator

Year	After-Tax Net Cash Flows		Electricity Price (Cents per Kilowatthour)		Fuel Cost (Dollars per Million Btu)	
	Outflow	Inflow	Mean	Standard Deviation	Mean	Standard Deviation
2001	$236,000,000	—	—	—	—	—
2002	—	$36,397,248	4.215	3.246	2.590	1.218
2003	—	$34,065,271	3.983	3.067	2.921	1.373
2004	—	$31,645,037	3.974	3.060	3.123	1.468
2005	—	$29,628,339	3.902	3.004	3.194	1.501
2006	—	$27,823,397	3.816	2.938	3.225	1.516
2007	—	$26,633,754	3.769	2.902	3.258	1.531
2008	—	$25,720,350	3.737	2.878	3.313	1.557
2009	—	$33,451,675	3.719	2.864	3.343	1.571
2010	—	$26,061,919	3.741	2.881	3.381	1.589
2011	—	$25,939,059	3.758	2.894	3.460	1.626
2012	—	$25,134,117	3.732	2.874	3.524	1.656
2013	—	$38,647,637	3.746	2.884	3.572	1.679
2014	—	$25,094,989	3.735	2.876	3.610	1.697
2015	—	$41,493,066	3.740	2.880	3.654	1.718
2016	—	$25,627,301	3.760	2.895	3.685	1.732
2017	—	$23,837,762	3.797	2.924	3.729	1.752
2018	—	$22,297,428	3.847	2.962	3.777	1.775
2019	—	$22,945,190	3.877	2.985	3.818	1.795
2020	—	$23,656,442	3.916	3.015	3.871	1.819
2021	—	$24,295,166	3.916	3.015	3.871	1.819
NPV at 11.03 percent weighted average cost of capital = $2,118,017			Rate of return on investment = 11.18 percent			

Sources: **Expected Mean Prices:** Energy Information Administration, *Annual Energy Outlook 2002*, DOE/EIA-0383(2002) (Washington, DC, December 2001), Tables A3 and A8. **Standard Deviations:** Calculation based on historical data from Platts.

Table 5. Summary of Simulation Results

Statistic	Net Present Value (NPV)
Mean	$110,004,525
Median	$95,713,767
Standard Deviation	$120,382,899
Maximum	$1,187,415,173
Minimum	-$213,218,338
Probability of NPV > 0	82.97%
Coefficient of Variation	1.09

Sources: **Expected Mean Prices:** Calculated from Energy Information Administration, *Annual Energy Outlook 2002*, DOE/EIA-0383 (2002) (Washington, DC, December 2001), Tables A3 and A8. **Standard Deviations:** Calculation based on historical data from Platts.