DARDEN Graduate School of Business Administration
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ENRON CORPORATION'S WEATHER DERIVATIVES (A)

Everybody talks about the weather, but nobody does anything about it.[1]

In October 2000, Mary Watts, the chief financial officer of Pacific Northwest Electric (PNW), a utility servicing the Pacific Northwest Region of the United States, reviewed the financial plan for PNW's 2000-2001 forthcoming winter season. Winter temperatures affected the firm's revenues: the colder the season, the greater the electricity usage. She recalled that the last few years had offered a warmer-than-average winter climate, resulting in adverse financial results for PNW. The weather, combined with rapid deregulation in PNW's market area, meant that the firm reported substantially no EPS growth from 1995 to 1999, in an otherwise buoyant economic setting. PNW's stock price had suffered accordingly. On her desk was a report from a weather advisory service predicting another unseasonably warm winter.

Watts remembered a recent conversation with Mike James, a representative of Enron Corporation. Mike had presented a new "weather derivative" product from Enron that he claimed could minimize PNW's weather related volume risk. Watts wondered how these derivatives worked, and how they might be used to help restore PNW's credibility in the capital markets. Should she consider purchasing Enron's weather protection products for the upcoming winter season? She would need to decide soon about the use of these derivatives if she wanted to put in place a hedge for the winter months ahead.

Pacific Northwest Electric

PNW was a significant producer of electric power, with primary coverage in parts of Oregon, Washington, Northern California, Idaho, and Montana. Its revenues in 1999 were $11 billion; net income was $800 million. Earnings per share were $1.04 in 1999, up from $1.03 in 1995. Noting the basically flat EPS trend for PNW and expressing concern for the firm's dividend coverage, securities analysts were reluctant to advocate holding PNW's shares. Thus, the utility's share price underperformed broad market indexes, and indexes of the utility industry.

[1] Charles Dudley Warner, in an editorial in *Hartford Courant*, 1897.

This case was prepared from field research by Mari Capestany and Professors Robert Bruner and Samuel Bodily. It is intended to serve as a basis for classroom discussion rather than to illustrate effective or ineffective managerial decision making. Certain names, facts, and financial data have been disguised to preserve confidential information and/or sharpen the managerial issues in the case. The resulting presentation, however, reasonably reflects the actual managerial setting. The assistance and cooperation of Enron Corporation is gratefully acknowledged.

Mary Watts estimated that the warmer-than-usual weather of the past four years had accounted for about two-thirds of the firm's underperformance in earnings.

PNW was a capital-intensive firm, spending about $1 billion per year in capital projects. The firm's recent record of financial performance held important implications for PNW's ability to finance its capital spending. First, it contributed to a higher cost of capital for PNW. The firm's share prices had been more volatile than usual for a public utility, yielding a higher beta and cost of equity. Similarly, the firm's debt rating had slipped from A- to BBB+, producing a cost of debt higher by 75 basis points at the margin. In the former environment of return regulation, it might have been possible for PNW to recover the higher capital costs from consumers. But in the current deregulating environment, where consumers could purchase power from a variety of producers on the power grid, cost disadvantages would lead to a loss of market share. Second, slippage in financial performance might restrict the firm's access to capital in a restrictive financial climate.

Weather Risk

The U.S. Department of Commerce estimated that at least $1 trillion of the total U.S. gross national product (about $7 trillion) was sensitive to variations in weather. This reflected economic sectors as disparate as agriculture, apparel retailing, and ski resorts that depended on *appropriate* variations in weather. "Weather" subsumed a variety of specific conditions such as temperature, wind, precipitation, type of precipitation, storms and hurricanes, haze, and "misery" (i.e., the combination of heat and humidity)—adverse changes in any of these could correlate with lost demand, lost workdays, or generally lost ability to fill demand. Theoretically, any of these forms of weather risk could be the focus of risk hedging by firms. Indeed, it was possible to purchase insurance from catastrophic loss due to extreme events such as tornadoes, tsunamis, and floods. But only since 1997 could companies could purchase protection from the more normal variations in weather.

Of paramount concern to the U.S. public utility industry was variation in temperatures. "Weather risk is the biggest independent variable in the power business," noted an industry publication.[2] Customer demand for power was highly correlated with seasonal temperatures. Unexpected decreases in demand (e.g., from a warm winter or cool summer) could have a detrimental impact on a company's earnings. One analyst noted that over a "recent 15-year period … temperature variations in 10 major population centers in the U.S. caused the cost of energy consumed for space heating and cooling to vary by an average of $3.6 billion per year."[3] Utilities typically determined their seasonal budgets from historical averages of temperature and demand. However, if winter temperatures, for example, were warmer than average, customers used less heat—therefore utilities' revenues fell below budget. Historically, utilities and Wall Street had discounted weather-related earnings' volatility because weather was seen as an

[2]*Energy & Power Risk Management* 2, no. 8 (Dec. 1997/Jan. 1998).
[3]Ibid.

uncertainty that could not be hedged. Weather risk was therefore a company's exposure to volume changes as a result of variability in temperature.

The utility industry measured weather conditions in terms of heating or cooling degree-days (HDD, CDD). Degree-days were determined by the deviation of the average daily temperature from an established benchmark of 65 degrees Fahrenheit. It was assumed that, at 65 degrees, customers used neither heat nor air conditioning. Therefore, a mean temperature of 55º on February 1, 2000, would equal 10 heating degree-days (65º – 55º) for that day. Weather conditions for a particular season were stated in terms of degree days accumulated across the entire period.

The *risk* associated with temperature lay in the uncertainty surrounding the mean temperature for a season. Effects such as El Nino[4] and La Nina[5] created cyclical variations in temperature. And over the past 100 years, there had been an unmistakable increase in temperature—this was attributed, variously, to global warming and "heat island" effects.[6] Compounding matters were possible asymmetries in risk exposure across competitors in an industry. Competitors might be fully exposed, partially hedged, or fully hedged regarding weather risk—these differences in exposure might elicit different competitive reactions to variations in weather. For instance, the fully hedged firm might seek to exploit adversity imposed on the unhedged firm.

Motives and Instruments for Hedging Weather Risk

Firms might seek to manage their exposure to weather risk for a variety of reasons[7]:

- **Smooth revenues** or compensate for the loss of demand. An ice cream manufacturer might seek insurance against an unseasonably cool summer.
- **Cover excess costs.** An unexpected frost could destroy crops and raise the costs to a consumer foods manufacturer. Industrial consumers of energy might seek to hedge against "spikes" in the cost of purchased electricity associated with peak load demand in the summer.
- **Reimburse lost opportunity costs.** Ideally, manufacturers would produce, and retailers would stock, the exact quantity of product that customers would buy. Weather

[4]The El Nino effect is a cyclical warming of the tropic region of the Pacific Ocean associated with increased rainfall in the southern United States, and drought in the western Pacific region, warmer winters in the north-central United States, and cooler winters in the Southeast and Southwest of the United States. The name means "little boy" in Spanish, and derives from the arrival of this effect around Christmas. El Nino occurs on an approximate seven-year cycle.

[5]La Nina is a countervailing cooling of the tropic Pacific Ocean that tends to occur after El Ninos, and is associated with warmer-than-normal winter temperatures in the southeastern United States and cooler temperatures in the Northwest.

[6]A "heat island" reflected the increased retention of radiant energy from the sun, associated with the increased mass of cities, paved roads, use of concrete construction, etc. Cities such as Orlando, Florida, and Phoenix, Arizona, which had grown rapidly in the preceding 30 years, reported significant increases in mean temperature, associated with the heat-island effect.

[7]The following points draw upon *Managing Weather* (Enron Corporation, 1999).

introduced uncertainty into estimates of customer demand. In the event of stock-outs, businesses lost the opportunity to sell their products. Firms might seek to hedge this risk, e.g., the ice cream manufacturer might seek weather insurance against stock-outs in an unseasonably hot summer.

- **Stimulate sales.** Customers may delay their purchase decision until a seasonal trend in weather becomes apparent. Cruise lines, resorts, and ski lift operators, witness this behavior annually. Firms might use weather derivatives to back up their "money back guarantee" of consumer satisfaction.
- **Diversify investment portfolios.** Financial investors might seek to exploit the low correlation between returns associated with weather, and returns from other financial instruments. Weather derivatives could potentially reduce risk, and/or increase returns in a portfolio.

The first weather protection contract was arranged in August 1997 between Enron Capital and Trade Resources (ECT) and an eastern U.S. electric utility. Enron Corporation was the world's leading integrated natural gas and electricity company. The company delivered physical commodities, risk management and financial services to provide energy solutions to customers around the world. By the year 2000 Enron had been named "most innovative company" by *Fortune Magazine* for five years in a row.

Upon discovering a methodology for hedging its own weather risk, Enron believed that this innovation could be useful for its customers as well, and set out to create customized products to help customers manage their own weather risk. Enron's weather protection products were targeted at power producers and utilities or any company that was exposed to volume risk as a result of changes in weather. A big challenge facing Enron and other marketers of weather protection products was that utilities were very slow, conservative and resistant to the use of derivative financial instruments.

Although historically utilities only hedged price risk (through the use of futures), the introduction of weather protection products now allowed "companies to protect against weather conditions adversely affecting volume-related revenues.[8]"

Specifically, weather derivatives provided protection against the deviation of actual cumulative degree-days from an established threshold. Degree-days were calculated using the average temperature readings for a predetermined geographic location (usually the closest airport) as measured by the National Weather Service. Depending on the sensitivity of demand to cumulative degree-days, the utility was able to determine how much margin it would lose if seasonal temperatures deviated from the average. The degree-day threshold was determined by the utility's level of risk tolerance—how much income it is willing to lose as a result of weather variability. (Most weather derivative contracts were short term, with an average transaction period equal to 5 months.)

[8] *Hedging Weather Risk* (Enron Corporation, 1998).

If, at the end of the transaction period, the actual cumulative degree-days were below the established threshold, the utility would receive a payment to offset the loss in income associated with lost demand (volume).

Weather protection products could take on several structures:[9]

- A **floor** provides the customer with downside protection when the underlying variable, such as degree-days, **falls below** the established threshold. The upside opportunity remains unconstrained. The payout for the floor is equal to the degree day differential times a $/dd. Most sellers of weather derivatives, however, were unwilling to accept all of the downside risk associated with a floor and therefore set a payout limit.
- A **cap** provides the customer with compensation if the underlying weather variable goes **above** a predetermined level. The seller of the cap pays this compensation to the buyer. A Midwestern state might buy a snowfall cap that would compensate it if snowfall exceeded a certain level—this payment would help to reimburse the state for excessive snow removal expenses. Temperature caps could be stated in degree-days or payout limits.
- A **collar** is a two-part transaction in which a customer buys a cap or a floor to provide financial protection against adverse weather conditions, and simultaneously sells a floor or a cap at a different strike price that limits its financial upside if weather is favorable. The second part (the sale) helps to finance the first part (the purchase of the insurance.)
- A **swap** allows the customer to generate a fixed revenue stream. If actual degree days were less (greater) than the threshold, the utility receives a payment equal to the degree day differential times an agreed upon price per degree day ($/dd.) If actual degree-days were greater (less) than the threshold, the utility pays the seller. A swap was generally similar to the collar in its economic effect, except that it offered a single trigger level, whereas the collar offered two. For instance, a utility might enter into a 30-day HDD swap with a reference temperature of 65 degrees Fahrenheit. If the actual average temperature turns out to be 55 degrees, the utility is due 300 degree-days [30 H (65-55)) multiplied by the amount of money agreed for each degree-day.
- **Futures contracts** can be purchased on the Chicago Mercantile Exchange, and were introduced for trading in 1999. Generally, a futures contract is a legal agreement to deliver or accept a commodity at a specified time and an agreed price. The CME contracts are specifically designed around temperature variations, i.e., HDD or CDD. The buyer and seller agree upon a price for a contract tailored to a specific month, one of 12 city locations, and a HDD/CDD index level. Variations in temperature above or below the value lead to a daily cash settlement between the buyer and seller.
- **Option on a futures contract.** The CME also permitted trading in options on futures.

An important difference between the exchange-traded contracts on one hand, and the insurance and tailored weather protection contracts on the other hand lay in their accounting treatment. Under the new FAS Rule 133, risk hedges of all sorts would need to be marked-to-market frequently *as long as the hedge was pegged to a market index.* One prominent auditor remarked

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[9]The description of instruments paraphrases a discussion in *Managing Weather.*

that most weather derivatives would not require this accounting treatment since inches of rainfall or heating degree days would be outside of the scope of the rule.[10]

The Market for Weather Protection

Several markets converged in weather protection instruments:

- **Insurance.** The insurance industry provided weather-related protection, typically for catastrophic events such as hurricanes, floods, and tornadoes. Players in this market sought to pool risks across a large number of insured parties. As long as the insured events were independent, cross-sectionally and over time, pooling would pay. Typically, coverage arranged through insurance companies was tailored and dealt with catastrophic events.

- **Capital and commodities markets.** In 1997, Enron had originated standardized contracts in weather protection that were relatively liquid securities and dealt with standard variations in weather. In 1999, the CME began trading in weather futures and options, which also were standardized contracts. The rise of this market as a second source for weather protection reflected the growing trend of *securitization* of assets through capital markets. Market makers in weather derivatives included Enron, Koch Energy Trading, Aquila Energy, Southern Company Energy Marketing, and Duke Power—firms with a historical basis in the energy industry.

One participant observed that "The truth is that the convergence of these two industries is well under way…the question isn't which industry wins the battle for business, but what these institutions, whatever their background, will look like, and who will best be able to meet customer demands."[11]

Potential users of weather protection were widely distributed through the U.S. economy. Some of the most active players were heating oil distributors and local gas distribution companies, firms who, because of their deregulated markets, could not pass along the costs of weather variation to customers. Public utilities were significantly exposed to weather risk, but slow to come into the weather protection market because of regulations which did permit them to pass along costs to consumers.

Enron's objective was to balance the market for weather protection through aggregation of contracts.

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[10]Based on a remark by Deirdre Schiela, partner at PricewaterhouseCoopers, quoted in "No Hedging for Weather Derivatives?" *American Banker and Bond Buyer CFO Alert* (October 12, 1998).

[11]Quotation of William Jewett, senior vice president and chief underwriting officer of Centre Re, division of Zurich Reinsurance, in "New Kids on the Capital Markets Block; Reinsurers Want Not Only to Securitize Every Insurance Risk Imaginable, But to Go Head-to-Head with Wall Street in Other Key Areas Too," *Investment Dealer's Digest* (August 3, 1998).

Determining PNW's Need for Weather Protection

PNW's winter season lasted from November through March. Mary Watts would need to make a decision soon about hedging PNW's weather risk. The first step in her analysis was to determine how sensitive PNW's earnings are to changes in weather. She gathered historical weather information and calculated the correlation of PNW's winter demand to historical seasonal heating degree-days. Watts remembered hearing that the average temperature of metropolitan areas was increasing due to increased population, automobiles and other demographic trends. Watts's weather data would have to be adjusted for this historical trend or she may run the risk of undervaluing the cost of protection. The load data should also be trend adjusted to eliminate the impact of increased overall demand due to new customers. Watts's analysis revealed that seasonal demand has a 76 percent correlation with a one percent change in cumulative seasonal heating degree-days.

Using PNW's residential tariffs and its cost to generate the power to supply demand, Watts could calculate the gross margin per heating degree-day and the loss in income for a corresponding loss in volume. She could then translate that loss in income to a $/HDD. On average, PNW received $60.30/MWH for power sold to residential customers and paid $20/MWH to generate or purchase power to supply its demand.

Because PNW was exposed to volume risk if weather were warmer than average, PNW would want protection from winter heating degree-days falling significantly below the average. Watts believed that PNW would accept no more than a 5 percent variability in HDD.

Hypothetical Weather Derivative Contract for PNW

Exhibit 1 presents a hypothetical contract of the sort that Enron would negotiate with PNW to cover its weather exposure for the forthcoming winter. The contract specified that in return for the initial purchase of the contract, PNW would receive a one-time payment at the expiration of the contract determined by the extent of the adverse deviation from the HDD target.

The Decision

Mary Watts knew that PNW was a very conservative company that would not be persuaded easily to use derivative hedging products. Although PNW's revenues were extremely sensitive to weather conditions, weather protection required a rather sizable up-front premium. But because 2000-2001 was expected to be an unseasonably warm winter, the impact on earnings could be devastating. Given the unpredictability of weather, however, PNW might not want to hedge all of its weather exposure; this would also minimize the cost of protection by effectively reducing the $/HDD. Additionally, the cost of protection could be reduced if she chose a lower HDD threshold.

Questions

1. Why do they call these contracts, "derivatives?" Where is the optionality in these contracts?
2. Please draw a diagram of payoffs at the end of the life for the contract presented in **Exhibit 1**.
3. Please deconstruct the options embedded in the contract given in **Exhibit 1** (Are they puts or calls? Are the positions long or short from PNW's standpoint?)
4. What are the pros and cons of weather protection from PNW's perspective?
5. Why is Enron in this situation? What does Enron stand to gain?
6. How should Mary Watts proceed to assess, and decide upon, the use of weather protection for PNW? What criteria should she use to make her decision?

Exhibit 1

ENRON CORPORATION'S WEATHER DERIVATIVES (A)

Sample Contract

[Date]

[Counterparty Name – ABC Co]
[Address]
[Address]
Attention: [Name]

Fax No.:
Telephone No.:

Re: FLOOR TRANSACTION Contract No. WR[ ]

Reference is made to the Master Agreement dated as of [ ] (the "Agreement") between ABC Co and XYZ Co pursuant to which this Confirmation is delivered and to which the Transaction contemplated herein is subject.

This is confirmation of the following Transaction:

Option Type:	HDD Weather Floor
Notional Amount:	$20,000 Per Heating Degree Day
Trade Date:	October 23, 2000
Effective Date:	November 1, 2000
Termination Date:	March 31, 2001
Premium Payment Details:	ABC Co shall pay XYZ $[premium] two Business Days after the Trade Date.
Determination Period:	The period from and including the Effective Date to and including the Termination Date.
Payment Date(s):	The fifth Business Day after the Floating Amount for the Determination Period is determinable, **provided, however,** that a one time adjustment in the amount paid will be made by the appropriate party, if applicable, if the National Climatic Data Center ("NCDC")

	makes any correction or adjustment to the reported daily high and low temperatures within 95 days of the end of the Determination Period for any day within the Determination Period.
Fixed Amount Payer: (Buyer of the Floor)	ABC Co
Floating Amount Payer: (Seller of the Floor)	XYZ Co
Strike Amount:	400 HDD
Floating Amount:	The sum of the Heating Degree Days ("HDD") for each day during the applicable Determination Period. HDD for each day is equal to the greater of (i) 65 minus the non-rounded average of the daily high and daily low temperatures in degrees Fahrenheit from and including 12:01 AM on that day to and including 12:00 AM on the next day local time as measured by the National Weather Service ("NWS"), and reported by the NCDC, for the Reference Weather Station or (ii) zero. The daily high and low temperatures measured by the NWS and reported by the NCDC shall be rounded to whole numbers prior to the calculation of HDDs as follows: if the first number after the decimal point is five (5) or greater then the whole number shall be increased by one (1), and if the first number after the decimal point is less than five (5) then the whole number shall remain unchanged (the "Rounding Convention").
Reference Weather Station:	Seattle-Tacoma International Airport, Washington.
Fallback Reference Weather Station:	If for any day during the Determination Period a daily high or daily low temperature is unavailable for the Reference Weather Station then the missing temperature(s) for that day at such Reference Weather Station shall be calculated in accordance with the following procedure: (i) the daily high (if the missing temperature is a daily high) or daily low (if the missing temperature is a daily low) temperature for the corresponding day of each of the previous 30 years at such Reference Weather Station shall be identified as reported in Fahrenheit by the NCDC (which numbers as reported by the NCDC shall not be rounded by the parties) and an average temperature shall be determined, which average temperature shall be determined to and including four decimal points; (ii) in accordance with the above procedures, the daily high or daily low temperature as appropriate shall be determined for the corresponding day of each of the previous 30 years at the Weather Station at Portland, Oregon Airport (the "Fallback Reference Weather Station") as reported in Fahrenheit by the NCDC (which numbers as reported by the NCDC shall not be rounded by the parties), and an average temperature shall

be determined, which average temperature shall be determined to and including four decimal points; (iii) the average temperature generated in (ii) above shall be subtracted from the average temperature generated in (i) above (with the resulting number (whether positive or negative) referred to as the "Average Temperature Difference Number");
(iv) the daily high or daily low temperature as appropriate for the corresponding Fallback Reference Station for the day for which the daily high or daily low temperature is missing for the Reference Weather Station shall be identified as reported in Fahrenheit by the NCDC (which number as reported by the NCDC shall not be rounded); and (v) the temperature determined in (iv) shall be adjusted by adding the Average Temperature Difference Number if it is a positive number and subtracting the absolute value of the Average Temperature Difference Number if it is a negative number, with the resulting number being rounded in accordance with the Rounding Convention. The final rounded whole number determined in (v) shall be deemed the daily high or daily low temperature as appropriate for the Reference Weather Station for the relevant day and shall be the number used to make the calculations as required pursuant to the procedures set forth in the "Floating Amount" above.

Data Sources: The data used to determine the Floating Amount (and to the extent required, data for any Fallback Reference Weather Station) shall be obtained from the NCDC's official website located at http://www.nndc.noaa.gov/cgi-bin/nndc/ph2_lcd_v2.cgi, or any successor thereto; provided, however, if data is not reported for any particular day at such website, then the data for such day shall be obtained from the website for the appropriate Regional Climate Data Center located at http://www.nws.noaa.gov/regions.shtml, or any successor thereto; and provided further to the extent that (i) the NCDC data is corrected or adjusted within 95 days of the end of the Determination Period or (ii) the data is temporarily sourced from the Regional Climate Data Center, then the data for such new, adjusted or corrected number(s) shall be obtained from the NCDC's official website located at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?WWNolos~Product~PB-078. Notwithstanding the foregoing, if neither the Regional Climate Data Center nor the NCDC issues data for the Reference Weather Station, then the procedures set forth under "Fallback Reference Weather Station(s)" shall be utilized to determine the missing data.

Strike Amount Differential: The amount equal to the excess (if a positive number) of (i) the Strike Amount over (ii) the Floating Amount

Payment Amount: Notwithstanding any provision of the Agreement to the contrary, if the Strike Amount is greater than the Floating Amount, the Floating Amount Payer shall pay the Fixed Amount Payer an amount in US Dollars equal to the product of (i) the Notional Amount and (ii) the

Strike Amount Differential, which amount shall be due and payable on the applicable Payment Date, **provided, however**, that the maximum amount payable by the Floating Amount Payer shall not exceed $800,000.

Exhibit 2

ENRON CORPORATION'S WEATHER DERIVATIVES (A)

Glossary of Terms

Demand: The rate at which power is being used by consumers.

Energy: Actual electrical flow, sold on an hourly, monthly or similar basis.

IPP: The passing of PURPA (1978) gave rise to Qualified Facilities, which were cogeneration facilities selling surplus power to the utilities. Since EPAct of 1992 IPPs are now also often referred to as EWGs.

Kilowatt (KW): One thousand watts.

Kilowatt-hour (KWh): One kilowatt of power supplied for a continuous period of one hour. This is the principal unit used for pricing retail electrical energy.

Load: The electric current being transmitted or demanded.

Megawatt (MW): One million watts or one thousand kilowatts.

Megawatt-hours (MWh): One thousand kilowatt-hours.

Power Marketer: A company that buys and resells electricity, and therefore assumes economic risk in the transactions. Power Marketers are usually independent entities, although some electric utilities have set up their own marketing operations. Power Marketers are responsible for arranging the transmission of power to the purchaser.

Public Utility Regulatory Policies Act, 1978 (PURPA): PURPA was passed as part of the National Energy Act. It set out to create incentives for the development of cogeneration facilities. Qualifying Facilities (QFs) had to produce electric and thermal power and could sell all, or only their excess electric power to utilities. Utilities were required to purchase this power at their Full Avoided Cost.

Tick Size: Notational amount of a contract—the dollars per HDD to be paid out.

Watt: The standard measure of electricity's capacity to do work. It is the voltage (pressure) multiplied by the amperage (or speed).

ENRON CORPORATION'S WEATHER DERIVATIVES (B)

Mary Watts, the chief financial officer of Pacific Northwest Electric (PNW), was intrigued by the possibilities for reducing her company's exposure to volume risk during the upcoming winter season. As a regulated utility, for a while longer, PNW was protected from price risk, but her company had always been exposed to volume risk.

Watts had before her 11 years of data for winter demand (megawatt hours, MWh) and cumulative heating degree-days (HDDs) in PNW's service area (**Exhibit 1**). The data had been trend-adjusted, putting each year on an equivalent footing, accounting for (1) a slight temperature increase at the measurement point over the 18 years and (2) increases in demand due to growth in usage. In the trend adjustment, it was assumed that historical changes in temperature have been roughly linear in nature since the beginning year of the data. To isolate the trend, the average daily November-March temperature averages (i.e., average of high and low temperature of the day) were regressed against calendar year to obtain a slope *m*. Given that the goal was to produce from the historical temperatures a distribution of scenarios that could occur in the target year (assumed to be 2001), one would boost the November-March temperatures in year YYYY by the factor (TargetYR - YYYY) * m. The HDDs would be calculated directly from these boosted temperatures.

One question in Watts's mind was whether she should be even cleverer with her forecasting and adjust not only for the long-term trend, but also for potential cyclical effects. For example, El Nino made the winter warmer than usual as recently as 1998. Her valuation of a weather-derivative contract would clearly depend on a forecast of next winter's demand and cumulative HDDs, and she wanted to do her best with her forecast, especially as she knew that Enron would be very good at pricing any contract it would offer in order to protect its side of the contract.

Enron had offered several specific contracts to Watts (see **Exhibit 2**), complete with associated prices. Her recommendation regarding which of the contracts PNW should take was to be made in two days to PNW's finance committee. Opening the *Wall Street Journal,* Watts

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found the current Treasury bill rates to be 6.24 percent for the 3-month and 6.3 percent for the 6-month.

A critical issue in the upcoming meeting would be an appropriate risk-tolerance level for PNW. Being a regulated utility, PNW had historically been able to pass on to ratepayers the effects of risk. Now, in the move toward deregulation, the company would operate more like other companies in the face of risk exposure. She might as well begin now to learn how to protect the company from risk.

Questions

1. Which, if any, of the available contracts would you be willing to accept?
2. Which is the best contract for you?
3. If you could design your own contract to reduce your exposure to the greatest extent, what would it be?

Exhibit 1

ENRON CORPORATION'S WEATHER DERIVATIVES (B)

PNW Seasonal Demand and Cumulative HDDs
Season: November through March

Year	Volume (MWh)*	HDD*
1990	8,825,019	2,978
1991	9,077,284	3,207
1992	8,490,052	2,665
1993	9,190,089	3,410
1994	9,018,775	3,156
1995	8,970,078	3,037
1996	8,994,810	3,032
1997	9,146,973	3,212
1998	8,962,612	2,892
1999	8,998,800	3,105
2000	8,989,312	3,094
Average	8,969,437	3,072
Standard deviation	186,249	192

*Trend adjusted data.

Exhibit 2

ENRON CORPORATION'S WEATHER DERIVATIVES (B)

Option-Contract Offers and Swap-Contract Bid from Enron

	Basic Floor	**Reduced tick size**	**Lower Strike**	**Swap**
Option type	HDD floor	HDD floor	HDD floor	HDD swap
Notional Amount	$35,750/HDD	$33,500/HDD	$35,750/HDD	$35,750/HDD
Effective Date	Nov. 1, 2000	Nov. 1, 2000	Nov. 1, 2000	Nov. 1, 2000
Premium Payment	$1,338,000	$1,253,641	$230,745	N/A
Determination Period	Nov 1, '00 – Mar 31, '01	Nov 1, '00 – Mar 31, '01	Nov 1, '00 – Mar 31, '01	Nov 1, '00 – Mar 31, '01
Strike amount	2925	2925	2771	3035
Cap	$14,588,000	$15,265,000	$14,588,000	$14,588,000