BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF COLORADO

IN THE MATTER OF THE	**)**	
INVESTIGATION AND	**)**	
SUSPENSION OF TARIFF	**)**	
SHEETS FILED BY PUBLIC	**)**	
SERVICE COMPANY OF	**)**	
COLORADO FOR ADVICE	**)**	**Docket No 06S- 234EG**
LETTER NO. 1454-ELECTRIC	**)**	
AND ADVICE LETTER	**)**	
NO. 671 GAS	**)**	

TESTIMONY OF TOM KONRAD
IN OPPOSITION TO THE SETTLEMENT AGREEMENT

Q. Please state your name and business address.

A. My name is Tom Konrad. My business address is 1556 Williams St, Denver CO 80218.

Q. On whose behalf are you submitting this answer testimony?

A. Ratepayers United Colorado (RUC).

Q. Are you representing the view of the Colorado Renewable Energy Society in your testimony?

A: No, I am not.

Q. By whom are you employed and in what capacity?

A. I am self-employed as an investment advisor. I manage accounts for individuals, and provide individual financial advice and analysis of companies in the Renewable Energy and Energy Efficiency industries.

Q. What are your qualifications relevant to this case?

A. I have a Ph.D. in mathematics; my thesis was in chaos theory, and I studied economics extensively. I make my living by attempting to predict trends in the financial markets, so I have a profound understanding of the difficulty of accurate forecasts, and the necessity of having some financial stake in the outcome to focus the mind when making such forecasts. I have attached to this testimony further detail of my qualifications as Appendix A.

Q. Have you previously testified before the Public Utilities Commission of Colorado ("Commission")?

A. I participated in the public testimony on this settlement agreement on October 23rd, on my own behalf.

Q: Are you a member of RUC?

A: No, I am not.

Q. What is the purpose of your testimony today?

A. To demonstrate that PSCo is not shouldering risks sufficient to justify the proposed ROE of 10.5% and related rate hikes proposed in the settlement agreement; that the settlement agreement shifts risks that should rightfully be borne by shareholders to ratepayers, and that shifting these risks to ratepayers creates incentives which will exacerbate these risks.

Q. Is there some general economic principle to decide which party should bear a particular risk?

A. Yes. Risk should be divided in proportion to ability to take action to reduce that risk.

Q. Why is that?

A. If the party who has the ability to reduce the chance of a risk does not bear the consequences of that risk, he is less likely to reduce the risky behavior, and may actually increase risky behavior if there is some immediate benefit. For instance, a teenager who knows his parents will have his car fixed if he has an accident will be more likely to speed or drive while intoxicated than if he had to pay for the repairs himself.

Q. Applying this principle to the settlement agreement, which risks should be borne by PSCo, and which should be borne by ratepayers.

A. Price risks due to short term changes in energy costs and supply should be shared in proportion to the ability to modify behavior. To the extent that Time of Use (TOU) pricing and Demand Side Management (DSM) allow ratepayers to shift their use to times

when it is cheapest to supply, they should have rates that encourage them to do so. To the extent that PSCo can invest in technology that can quickly match supply and demand, they should bear the costs of short term fluctuations.

Modeling risk, the risk that the assumptions used in the PSCo's planning model (including assumptions about environmental regulation and costs and) are inaccurate, should be borne by the utility.

This is because only PSCo has the power to ensure that the model, is as accurate as possible. However, given this incentive to create a model that is as accurate as possible, ratepayers should accept price rises contained in the planning model, since PSCo is already obligated to choose the least cost generation mix based on its model. In addition, given known future price trends contained in the planning model, consumers have the ability to moderate their risk by adopting more energy efficient practices and technology.

Q. Turning to the Settlement Agreement, how does it allocate the risks between PSCo and ratepayers?

A. Settlement Agreement badly misallocates risk and creates perverse incentives in many cases:

Long term fuel price and capacity risks are borne by ratepayers, which is appropriate only to the extent that it conforms to PSCo's planning model. Modeling risk is borne by the ratepayers, while it should be borne by PSCo. It is not explicitly stated that environmental risks not contained in the planning model should be borne by PSCo.

Short term fuel price and capacity risks are borne by PSCo, with the small exception of the voluntary time of use pricing. A greater attempt should be made to share these risks with ratepayers, who can then modify their behavior.

Q. Tell us more about how the settlement misallocates the risk of long term changes in generation costs and environmental risks.

A. We feel that in the last generation planning case, PSCo's model badly underestimated the cost of coal fired generation. We feel that PSCo must accept the consequences of their poor judgment, and that the settlement agreement is placing the burden of the risks that were ignored by PSCo in that planning case, onto ratepayers through the Electric Commodity Adjustment. Proper allocation of the burden of these risks onto PSCo will create the proper incentive for PSCo to engage in more prudent planning in the future.

Q. What particular risks were ignored or minimized in the last planning case?

A. The risks of higher prices, transportation costs, and disruption of supply of coal; the costs to the environment due to mercury, SOx, NOx, particulates, and other pollutants, and the possible future costs of their clean up; the costs of compliance with regulation of CO2 emissions due to carbon regulation; the risk that there will be insufficient water for power generation, a risk that will be exacerbated by global warming, were all ignored or minimized in the last planning case. PSCo should bear these future costs and risks to the extent that they were not contained in the planning model.

Q. How does the Settlement Agreement misallocate short term price and supply fluctuations?

A. The Settlement Agreement makes a small step towards transferring some of the cost of short term fluctuations in demand to ratepayers through the Time of Use (TOU) pricing mechanism, but it does not go nearly far enough.

Q. How could the TOU pricing be improved?

A. In several ways. First, where the benefits to the system of implementing TOU pricing exceed the costs, TOU pricing should be mandatory. As witness Ahrens of PSCo states in his direct testimony, a mandatory TOU rate would more fairly recover costs from customers who impose costs, and would encourage customers to usage to off-peak periods. Fairness would be improved by expanding TOU pricing as quickly as practicable, but partial implementation should not be delayed until TOU pricing is available to all customers, as witness Davis of Commission Staff suggests. TOU pricing will benefit the whole system, and thereby benefit even rate classes who do not participate, although it may benefit them less than it would if they were able to participate. Other possible improvements would come from using the availability of hourly data to develop an hourly rather than two-tier rate structure that varies by month, as well as a rate structure that takes into account the likely availability of renewable energy generation that is dependant on seasonal weather patterns.

Q. How are environmental and regulatory risks misallocated?

A. PSCo has a history of underestimating regulatory risk. For instance, during the last LCP hearing, they based their estimates of regulatory costs on the Clear Skies Act, which was never passed, and would have placed a lower burden for complying with emissions controls than Clean Air act, which remains the law of the land. Given its lobbyists in Washington and other political consultants, Xcel is in a much better position

than ratepayers to make an accurate estimate of the chance of passage of environmental regulation, and what the real costs of compliance will be. Given this, we feel that the Commission should set the precedent that all environmental compliance costs with the Clear Skies Act in excess of their estimates in the last LCP should be borne by Xcel and PSCo.

Q. Are there other cases where PSCo denied, minimized, ignored, or simply chose not to investigate a risk during the last LCP which they are now asking ratepayers to bear?

A. Yes. In PSCo witness Imbler's direct testimony, he states that in 2005 rail tracks in Wyoming were unexpectedly "damaged due to the infiltration of coal dust over a period of years, disrupting coal deliveries to PSCo's coal fired generating plants." I submit that if this dust infiltration was "unexpected," then it was unexpected due to PSCo's negligence in having a complete understanding of their supply chain. While no company can be expected to be perfect, protecting PSCo from the consequences of their mistakes is a lousy incentive to having them take proactive action to insure against future mistakes.

Moreover, Xcel has testified before the U.S. Senate on Energy and Natural Resources, that the railroads, upon which utilities are dependent for delivery of coal are in dire straits. Delivery of coal from the Powder River Basin, from where PSCo obtains its coal, has been especially impacted by the inadequacy of the rail system. All of PSCo's coal plants have been severely impacted by these problems. Some 153 new coal plants are being proposed in the United States, which will place significantly higher demands on an already inadequate system. However, at least as of July, 2006, PSCo has

failed to perform any analyses on future problems or constraints on delivery of coal to PSCo's plants. Placing these risks upon ratepayers allows this type of negligence in planning.

In short, PSCo has been negligent in assuring the supply of coal in the past. Now they are asking ratepayers to provide them an inventive under the BLEB which will reward them for insuring the supply of coal in the future, because a reliable supply of coal will allow them to burn more. This is something that they should have been doing all along.

Rewarding someone not to be negligent actually encourages them to be negligent in the future, because they will then have a reasonable expectation of future handouts in the event of the next form of negligence in some other arena.

Q. Do you have more examples?

A. One possible future situation where PSCo is seeking to shift modeling risk to ratepayers is future compliance costs with a national carbon emission cap-and-trade program, a system which Xcel actively supports. We feel that the Commission should make it clear that the costs of compliance with any such system that are in excess of the amount allocated for planning in the last LCP should be entirely borne by PSCo. This will create the greatest possible incentive for PSCo to mitigate the costs by shifting generation away from carbon-intensive generation and towards other forms of generation which have lower environmental impacts.

Q. Are there other risks that PSCo is shifting to ratepayers you have not yet mentioned?

A. Without doubt. The worst risks are unknown risks, because the effects are often worse due to lack of preparation. The best preparation is wide consultation and openness to outside views. This is the best possible process for making unknown risks known, allowing us to prepare and minimized the potential damage. As the party with the broadest perspective and ability to gather information, PSCo should bear the risks of any future costs that they could have been able to discover given diligent effort. Given the public testimony on this settlement agreement on October 23rd, I think it is safe to say that all future and potential costs of Global Warming and regulation designed to combat Global Warming should therefore be borne by PSCo, and I encourage the commission to make that clear to them.

In general, we cannot be aware of all future risks and costs, but as the party most able to discover possible future risks, PSCo should bear those risks.

Q. You are asking the Commission to shift considerably more risk to Xcel shareholders and PSCo bondholders than is envisioned by the Settlement Agreement. Is that fair?

A. Given the excessive 10.5% Return on Equity and low debt to equity ratio envisioned in the Settlement, I believe it is fair.

Q. Why do you consider a 10.5% return on equity (ROE) excessive?

A. As testified by CEC witness Gorman in his Answer Testimony, The general standards for setting the authorized return on equity should: (1) be sufficient to maintain financial integrity; (2) attract capital under reasonable terms; and (3) be commensurate with returns investors could earn by investing in other enterprises of comparable risk.

On the first point (1), PSCo is not at risk for their financial integrity.

On point (2) a 10.5% ROE is higher than what is currently required to induce Shareholders to own Xcel stock because the equity market are currently demanding historically low risk premiums.

On point (3), Xcel is not demonstrating the initiative in investing in modern technology and anticipation of future market conditions that an unregulated company would have to demonstrate in order to maintain a high ROE, so it should not be rewarded the opportunity to earn an ROE comparable to companies that do take such risks.

Q. Addressing each of these points in turn, why do you say PSCo's financial integrity is not at risk?

A. As testified by witness Davis of Commission Staff in his Answer Testimony, given PSCo's high S&P bond rating, they should not be considered at risk. Also, given the recent increase in Xcel's share price, from around $18 a year ago to near $22 today (a 22% gain, compared to a 14% gain for the S&P 500), the financial markets have decreasing fears for the company's integrity.

Q. Why do you say that a 10.5% ROE is higher than what is required to induce shareholders to own Xcel stock?

A. The equity market is currently demanding historically very low risk premiums. Appendix B (attached) is a chart of the Chicago Board of Trade Options Exchange Volatility Index (VIX), used by technical market analysts as a measure of risk aversion. Given that it closed on 10/30/06 at 11.4, and that it has been holding roughly this historically low level since January 2005, it is fair to say that risk aversion among investors is much lower than it has been in recent years.

In August 26 of 2005, Alan Greenspan delivered his valedictory address in Jackson Hole Wyoming. In that speech he remarked "[The] vast increase in the market value of asset claims is in part the indirect result of investors accepting lower compensation for risk." Given that the broad S&P 500 market index has risen approximately 14% since then, and Xcel's stock price has risen even more during the same period, we can conclude that investors in general, and Xcel investors in particular, continue to accept lower compensation for risk than they have historically.

Q. How is investors' acceptance of lower compensation for risk related to the Return on Equity that they are willing to accept?

A. There are three methodologies which various witnesses in this case have used in their testimony when recommending particular values for a fair return on equity. They are Discounted Cash Flow (DCF), Market Risk Premium, and Capital Asset Pricing Model (CAPM). Of these three models, both the risk premium model, and the CAPM require the analyst to estimate a market risk premium for Xcel stock. This estimate is based on historical market data, and so all the estimates of risk premiums were based on data from periods when investors were demanding more return in exchange for the risk they were taking on than they are today. Because a higher risk premium has the effect of increasing the calculated ROE in both the risk premium methodology and CAPM, the estimates using these methodologies produced ROE's higher than what is currently necessary to induce investors to hold Xcel stock.

The estimates of fair ROE using these methodologies all fell in the range from 10.4% to 12.7%, near or above the proposed 10.5% ROE in the settlement agreement.

Q. Is the remaining methodology, the DCF, also biased by historical risk premiums.

A. I believe that the DCF is also biased upwards by historical risk premiums, but not nearly to the same extent of the CAPM and risk premium models.

Q. What causes the bias in the DCF?

A. The DCF has as its most critical estimate of expected future growth rate of various metrics, which are assumed to grow at the same rate. A higher predicted growth rate will lead to a calculated ROE. Analysts are typically less excitable than investors, and since they base their estimates on the expected growth of earnings and dividends, which are not tied to market prices, they are less likely to be swayed by market moves.

Nevertheless, analysts are human, and rising prices have a tendency to lead them to predict continuing price rises. The fact that most analysts were caught up in the dot-com bubble of the late 1990's led to that bubble being more pronounced and prolonged than it would otherwise have been.

So, I expect that most of the analyst estimates used DCF calculations by witnesses in this case also contain an upward bias, which will in turn bias the calculated ROEs upward as well. However, I expect that the DCF estimates of fair ROE are better than the ones derived by the other two methodologies.

Q. Do you have a recommendation for ROE?

A. Yes. ROE should be set at the lower end of the range of estimates made using the DCF methodology, in recognition of the probability of upward bias in even these estimates.

Q. What was the range of estimates using the DCF methodology?

A. Witness Gorman calculated an 9.4% ROE using the DCF methodology, witness Baudino came up with a range of estimates from 8.4% to 10.55%, while witness

Trogonoski came up with a range of estimates from 9.09% to 9.4%. Averaging the low end of these ranges, I recommend a ROE of 8.9%.

Q. Please elaborate further on your third point, that ROE be commensurate with returns investors could earn by investing in other enterprises of comparable risk.

A. Xcel is not demonstrating the initiative in investing in modern technology and anticipation of future market conditions that an unregulated company would have to demonstrate in order to maintain a high ROE, so it should not be rewarded the opportunity to earn an ROE comparable to companies that do take such risks.

Q. What technologies might they be investing in that would be commensurate with a high return on equity?

A. In general, technologies that protect ratepayers from risks to the electrical system, as well as price and environmental risks. As a financial advisor, I constantly tell clients that they need to diversify their portfolio as much as possible to reduce systematic risk. PSCo needs not only to diversify its generation more by technology, but to reduce exposure to those technologies which have known regulatory and fuel price risks. The cover article from the September/October issue of EnergyBiz magazine titled "Massive Build Ahead" in which Xcel's CEO Richard Kelly was interviewed along with other industry CEOs about the massive investments needed in new generation and transmission. I quote the first few lines "While consumers are largely oblivious, the utility industry is about to embark on a massive building campaign to address a looming power shortage. Concurrently, politics — if not science— will force utility executives to pay close attention to addressing global warming."

There is also the risk of declining water supplies for electricity generation which can be addressed with new technologies.

It is also well known in the industry that the nation's transmission system is in need of massive investment in transmission infrastructure, and part of the reason for that is that utilities have not been historically well compensated for investing in transmission infrastructure. Given the massive needs, PSCo should be able to earn a high rate or return on investments in needed transmission and reliability infrastructure.

PSCo should also be well rewarded for reducing the vulnerability of the electrical grid to terrorist attack. Our electrical grid is one of our nation's greatest vulnerabilities to terrorists, and this vulnerability should be addressed as soon as possible, and PSCo should be well rewarded for its efforts to do so. Considering that the Great Northeast Power Outage of 2003 happened without outside intervention, it is terrifying to consider what a terrorist could do intentionally, and we need to be prepared for that eventuality.

Q. Does pulverized coal generation protect the ratepayer from environmental, price, or reliability risks due to terrorism or other factors?

A. No. The environmental risks of coal are well known. It is one of the dirtiest forms of electrical generation currently in use, not only in terms of greenhouse gasses, but also in terms of Mercury, NOx, SOx, particulate and other emissions. Typical conventional coal plants evaporate 1.5 gallons of water for every kilowatt hour generated, and need about 25 gallons of water for cooling.

New coal generation simply substitutes coal price risk for natural gas price risk, both of which have become increasingly volatile in recent years. Also, since coal plants are larger and longer lasting investments than most other forms of generation,

investments in coal fired plants expose ratepayers to these risks for a longer period and a greater degree than would a mix of energy efficiency measures and smaller, more diverse types of generation.

The massive, localized nature of coal power plants makes them particularly vulnerable to terrorist attack.

Q. What types of investments protect the ratepayer from environmental risks?

A. Most forms of renewable generation have fewer environmental risks than the existing infrastructure. In particular, Wind, Solar PV, Concentrating Solar Thermal, Geothermal, and biogas have little or no net emissions. Wind and solar photovoltaic use no water for cooling.

Even better, investments in energy efficiency reduce environmental risks while avoiding the cost of new generation and transmission infrastructure.

Q. What types of investments protect the ratepayer from price risks?

A. Investments in energy storage in the form of pumped hydro can partially displace the cost of spinning energy reserves (*see* "Utility Scale Energy Storage for Colorado Integrating Wind & Pumped Hydro," Abstract from CU Energy Initiative/NREL Symposium, attached as Appendix C), as well as reducing price risks by shaving peak load and reducing the use of electricity generation. Intermittent renewable resources with no price risk can be firmed up to be used as base load power with energy storage systems such as Compressed Air Energy Storage (*see* "Creating Baseload Wind Power Plants Using Advanced Compressed Air Energy Storage Concepts," Abstract from CU Energy Initiative/NREL Symposium, attached as Appendix D, attached).

Investments in electricity transmission allow the purchase of power form locations where it can be generated cheaply and transmitted to locations where it costs more.

Investments in Energy Efficiency not only reduce ratepayer bills up front, but they also protect ratepayers from rising and volatile prices by allowing them to cut their use.

Investments in price signaling mechanisms such as Time of Use Pricing and Demand Side Management allow customers to shift their demand from times when power is expensive to times when power is relatively cheap.

New generation with zero fuel cost technologies such as wind, solar, geothermal, and landfill gas all protect the ratepayer from price changes because the fuel is free.

Q. What types of investments protect the ratepayer from risks to reliability and terrorism?

Energy efficiency investments reduce the load on the grid, and thereby improve its reliability. Investments in small, distributed forms of generation such as wind, solar, biomass, small hydropower, and geothermal generation all deny terrorists big targets that they can take out with a single attack. Investments in distribution and power management all make the grid more robust and less prone to outage.

Q. So you are suggesting that greater investments in technologies that protect the ratepayer from risk should be allowed to earn higher returns on the equity invested than those which do not protect or expose the ratepayer to risks?

A. Yes.

Q. Moving to the specifics of the settlement agreement, do you feel that it does a good job incentivizing PSCo to reduce risks to the ratepayer where PSCo has the ability to do so, and to incentivize the ratepayer to reduce the risks that ratepayers have the ability to reduce?

A. No. The settlement agreement makes some small steps to *incentivizing certain* ratepayers to reduce short term price fluctuations through the Time of Use (TOU) pricing mechanism incorporated in the ECA, but most of the other incentives will actually lead PSCo to increase risks that it has the ability to reduce, and which are primarily borne by the ratepayer.

Q. Tell us about these perverse incentives in the settlement.

A. The perverse incentive is the Baseload Energy Benefit, or BLEB. The BLEB's explicit purpose is to reward Xcel for burning as much coal as possible. This has the effect of increasing ratepayers' environmental risks as elaborated earlier, and the risk of insufficient water supplies for coal generation. Rewarding PSCo for increasing our risk is precisely the opposite of what we should be doing.

Q. Are there other perverse incentives contained in the BLEB, as outlined in the settlement agreement?

A. Yes. By using an annual average of monthly natural gas prices in the formula, PSCo is incentivized to use coal equally as much during months when the gas price is relatively low as when the gas price is high. Given that the stated purpose of the BLEB is to reduce prices for the ratepayer by substituting coal fired generation for natural gas fired generation, it would make more sense to give PSCo more incentive to burn coal when the natural gas price is relatively high.

Further, one possible reason for temporarily high natural gas prices would be at times when it is relatively difficult to obtain coal, and many utilities are being forced to switch to gas fired generation. Once again, the stated purpose of the BLEB is to incentivize PSCo to take advance actions to protect themselves from coal shortages. To do that, the BLEB would give PSCo a greater incentive to use coal when the gas price is relatively high.

Finally, by only including two possible fuels in the BLEB formula, those fuels are implicitly favored over all other technologies, and this perpetuates the mindset that there are only two alternatives for new generation.

Q. Do you have a proposed alternative for the BLEB?

A. No. The BLEB is flawed in both intent and execution. While PSCo should have an incentive to reduce the cost of energy to consumers, the best way to do this without creating perverse incentives is to simply have them bear some portion of that cost, including long term costs due to regulation and environmental damage.

If the commission chooses to approve an incentive which explicitly gives incentives to coal and no other fuel, you will be condoning the use of coal to the greatest extent possible, and perpetuate a moral hazard by implying that ratepayers are willing to accept the long term adverse consequences of coal use in return for cheap power today.

The BLEB is a nice, tidy formula, and it is easy to be seduced by its apparent precision. However, as Warren Buffett, the greatest living investor has said, "It is better to be approximately right than precisely wrong."

Q. Do you see other perverse incentives in the settlement agreement?

A. Time of Use pricing, as I explained earlier, should be mandatory for all rate classes where the monitoring equipment is available, and the prices adjusted to reflect the marginal cost of meeting demand during the shortest possible time period. The voluntary TOU tariff rewards ratepayers whose behavior currently benefits the system without giving ratepayers whose current usage puts strain on the system any incentive to change, forcing all ratepayers to bear the cost of their actions.

TOU pricing should be expanded to all classes immediately on a voluntary basis, provided that the ratepayer buys the necessary equipment. Following that, it should be expanded on a mandatory basis to each rate class as soon as the benefits to the system justify the costs of the necessary equipment.

TOU rates should reflect not only system usage, but the availability of intermittent renewable resources. For example, one benefit of extending TOU pricing to all rate classes would be to give ratepayers with solar PV on their roof an incentive to point the panels to the west or south-west, where they would be of more benefit to the system as a whole, despite the fact that they produce less electricity overall.

Q. Does that conclude your testimony?

A. Yes, it does. Thank you.

Respectfully submitted, this 31st day of October, 2006

Appendix A

TOM KONRAD

STATEMENT OF QUALIFICATIONS

1. Ph.D. in Math, specializing in Chaos Theory. This is relevant because financial markets display chaotic behavior. Purdue University, Indiana.
2. During my studies, I took graduate level courses in probability, stochastic integration (a course in which we derived the Black-Scholes formula for option pricing. This is relevant because options are financial instruments used in the financial markets to transfer risk.) , and game theory, a modern mathematical theory which describes how multiple economic players act in competition.
3. I first studied Economics as an undergraduate in 1988. My undergraduate concentration was in economics and I have read extensively in the field since then.
4. After completing my graduate degree, I began to manage financial portfolios. My investment strategy is based on a combination of global macro economic analysis, combined with behavioral finance, and risk management using exchange traded options strategies.
5. I am now a Registered Investment Advisor, managing money for retail clients, as well as doing due diligence on private equity investments in energy companies.
6. During my career of investment management, I have several calls which challenge the conventional wisdom, but have turned out to be correct. In particular,

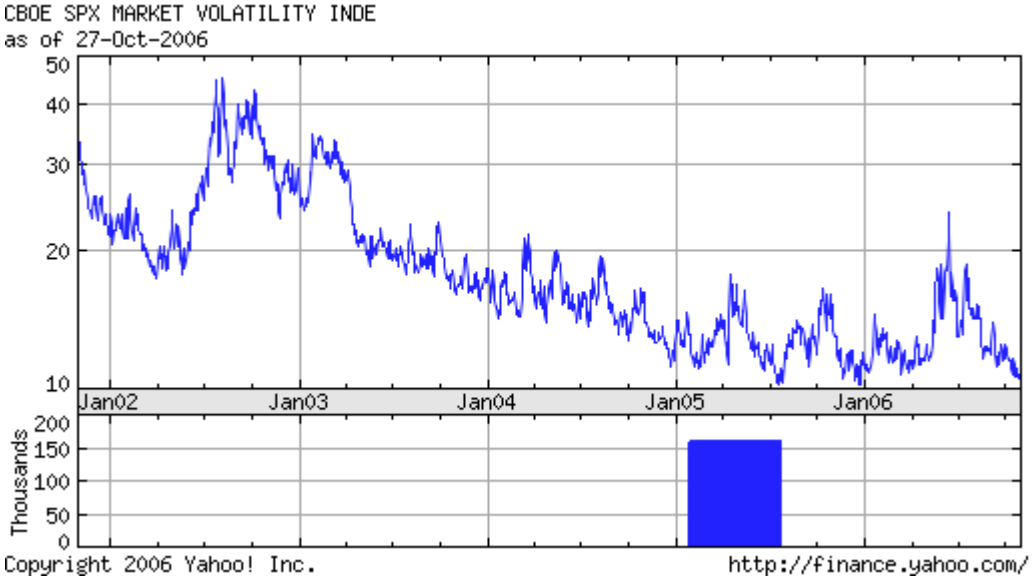
a. I anticipated the downturn of the dot-com bubble. During 1999 and 2000, I moved completely out of the technology sector, while buying real estate investment trusts, which subsequently performed very well in the years since.

b. In 2000 and 2001 I was also buying bonds denominated in a wide variety of foreign currencies, particularly the Euro, which I still own. At the time, one Euro cost about 90 cents. On 10/26/2006, one Euro cost approximately $1.27. I also benefited from the interest on those bonds, as well as capital appreciation.

c. In 2003, I began buying gold mining companies in the anticipation of a run up in the gold price. At the time gold was trading between $300 and $400 an ounce. It is currently trading at $600 an ounce.

Appendix B

Chicago Board of Trade VIX



Appendix C

Abstract from CU Energy Initiative/NREL Symposium

Utility Scale Energy Storage for Colorado Integrating Wind & Pumped Hydro Electricity

Jonah Levine, Master's Candidate - Advisement: Dr. Frank Barnes
University of Colorado at Boulder

Wind generation is intermittent by nature: sometimes it blows, and sometimes it does not. Due to intermittences that are off set with spinning reserves of fossil fuel, wind generation without storage is challenging to incorporate into our electrical grid at high penetration rates. That challenge stems from both economic and carbon constraints incurred by the spinning reserves of fossil fuel [1]. The following poster shows: an example of a utility scale Pumped Hydroelectric storage solution that attempts to decrease the need for spinning reserves. This solution marries the advantageous natural resources of wind, water, and steep changing topography and enables the storage of reliable, clean power. This stored power can be used to address peak power, a critical component in regards to both revenue generation as well as greenhouse gas emissions reduction. Moreover, this case leverages current infrastructure, retrofitting pumped hydro storage components to fit Colorado's Big Thompson Project. A fundamental difference between this hydroelectric storage example and past hydroelectric generation is that by utilizing wind power to send water up-hill hydroelectricity can be used to generate power multiple times per year, as opposed to the constraints of the annual precipitation cycle. This case also minimizes impact and costs through use of infrastructure already in place. Expanding pumped hydroelectric storage in Colorado along side the development of more wind power merits further investigation.

Appendix D

Abstract from CU Energy Initiative/NREL Symposium

Creating Baseload Wind Power Plants Using Advanced Compressed Air Energy Storage Concepts

Paul Denholm - NREL

Electricity generation from wind is now among the lowest cost energy resource in much of the Midwestern and Western U.S. Development of very large-scale wind energy resources may require many large, long-distance transmission lines connecting remote wind energy resources to major load centers. At very large penetration, this type of development may also require utilityscale energy storage to increase the capacity factor of wind energy systems, improve the economics of long-distance transmission, and increase overall system reliability. Among the more promising sources of very large (GW scale) storage in the U.S. is compressed air energy storage (CAES). A number of studies have examined the concept of creating “baseload” wind power plants, which are functionally equivalent to a baseload fossil or nuclear plant. These baseload wind plants combine wind energy generation with a CAES system to create a power plant with a reliable capacity factor of up to 90%. The use of CAES requires both a relatively large underground storage vessel, and source of combustible fuel, typically natural gas. NREL is interested in examining the technical, economic and environmental aspects of combining wind energy with a variety of CAES concepts, including advanced fuel pathways using synfuels derived from coal or biomass, as well as non-combustion CAES technologies. Additional understanding of geologic constraints of CAES is also required