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Chairman Bingaman, Ranking Member Domenici and distinguished Members of this Committee, thank you for the privilege of appearing before you today. The views I will present this morning are my own and do not necessarily represent those of my employer.

I would like to begin by offering my admiration for the comity and caution this Committee has demonstrated in addressing the energy and environmental security challenges facing the nation. Your efforts have already engaged corporations and private citizens alike in a necessary national discussion regarding the sources and uses of our natural resources. All around the globe, emerging nations are entering into their energy-hungry adolescence and the dislocations wrought by this paradigm shift will require public and private sector leaders to keep their heads. If history is any guide, it won't be easy.

During the last five years, the world's top energy economists have offered a disarmingly variable sequence of explanations for the run in crude oil prices. At the beginning of the decade, market watchers counted days of demand cover, a measure of whether working inventories contained sufficient oil to meet expected demand. Subsequently, many of the same experts linked escalating prices to refining capacity constraints, the growth of wealth in China, geopolitical risks in the Middle East and Nigeria, cost inflation and, most recently, the depreciation of the dollar relative to other currencies. Each of these phenomena has correlated to, and sometimes predicted, oil prices. But none of these explanations has proven consistently useful throughout the decade or when back-tested against earlier data.

The same might be said for the notion that non-commercial buyers of forward and futures contracts are driving up oil prices. This may be partially true today, and it may even be somewhat price-predictive to assess the flow of investor wealth into commodities, particularly if one believes that institutional investors may be seeking a value-retentive refuge from the falling U.S. dollar. But this phenomenon certainly won't be true forever. It may not even be true for long. My comments regarding investor motivations, market dynamics and oil production are intended to suggest that an optimal policy response should not ignore the historical tendency of the law of supply and demand to govern long-term oil market outcomes.

AN OVERVIEW OF INSTITUTIONAL INVESTORS' INCENTIVES

Generally speaking, an "institutional" investor manages other people's money professionally. One or several layers of management expertise can lie between primary investors and markets. Institutional investors themselves compete in the market for asset management services. Widely variable charters constrain the asset classes that different investment funds may hold and the strategies that institutional investors may employ, but all asset managers share a common trait: they are paid to retain, and ideally to augment, their clients' wealth. Simply put, investors fire managers who lose their money.

On February 28, 2008, CalPERS, the California pension fund, announced plans to invest as much as $7.2 billion through calendar year 2010 in commodities. At the upper bound, this could represent a little less than 3% of the portfolio, a meaningful commitment to commodities as an asset class. This was neither unexpected nor unheralded. The first exchange-traded fund (ETF) created to track crude oil contract prices began trading on the London Stock Exchange in July 2005. The first U.S. oil ETF began trading on the American Mercantile Exchange in April 2006. Oil ETFs typically buy and sell oil futures to enable investors who might not buy commodities to replicate the performance of oil markets. Oil ETFs largely resemble an earlier vintage of ETF, S&P 500 "index funds" that buy and sell S&P component equities.

At the time of the CalPERS announcement, several market commentators extrapolated its implications, reasoning that, if institutions as conservative as pension funds were buying oil, then everyone else must be, too. I would respectfully submit an alternative thesis. Investors of all stripes may be diversifying into commodities markets, but they are not all buying. Some are likely to be selling, and many of the investors who are buying today might well be selling tomorrow, depending on their risk tolerances.

Hedge fund managers typically earn fixed management fees but the bulk of their compensation usually derives from percentages of earned profits. Because hedge funds may hold heavily concentrated positions or illiquid investments, it can take fund managers days, weeks or months to gracefully unravel their positions without destroying fund value. As a result, most hedge fund charters limit the opportunities for investors to "redeem" invested capital to narrow, periodic windows. This can encourage hedge fund managers to pursue higher-risk strategies, including investments that may result in short-term losses. But the wealthy individuals and institutions who buy into hedge funds pay premiums in return for high performance. These clients can grow impatient and vote with their wallets if managers deliver sustained losses. Managers of funds with smaller cash holdings could conceivably exert downward pressure on oil prices by closing long positions in a hurry to service a spate of redemptions.

Sovereign funds exist to diversify national wealth away from its source. This is a matter of particular concern for oil-producing nations and Asian export economies. Sovereign fund managers usually have a single client, eliminating the competitive pressures for performance that can force quick sales of securities or, for that matter, discourage risky bets. Historic wealth transfers from largely Western, consumer nations to the largely Eastern producer nations that supply them have provoked timely calls for best practices and transparency by the IMF and OECD. Transparency is warranted, but protectionism is not. If fund managers are "diversifying" producer nations' sovereign wealth into oil futures, this might suggest similar economic circumstances to those that often motivate corporate stock repurchases: managers may

not see any better way to safely invest the money. If this is true, new barriers – including bills like the "No Oil Producing and Exporting Cartels" (NOPEC) Act – to U.S. investment might further encourage dollar flight to commodity futures.

At the same time, there may be two offsetting forces influencing sovereign investment in oil futures. Sovereign fund managers must answer to their clients, after all, and leaders of Gulf Cooperation Council nations have made known their concerns that the declining dollar has eroded their largely dollar-linked national wealth. Since oil trades in U.S. dollars, fund managers have an obvious motivation to hedge. On the other hand, these same clients are also best positioned to know when oil demand may be slowing, and they might well advise their fund managers to lighten up on commodities ahead of a slowdown, even if it means downward pressure on oil prices. This could conceivably occur if EU-27 economic growth began to slow as a United States slowdown continues, as oil could sell off at the same time that the U.S. dollar appreciated relative to the Euro.

If funds flowing into commodities are indeed elevating oil futures, then accumulating evidence of a slowdown within the world's biggest oil-consuming economies could provoke an equal and opposite reaction as conservative investors close their positions and aggressive investors sell short.

The question remains unclear, in my mind, whether the oil markets are vulnerable to manipulation by speculators, or whether speculators are vulnerable to manipulation by the oil markets.

There is a lot of difference between a market and a mob. Markets are driven by the value of a good or service; mobs are driven by human emotions. Markets reflect disagreement over price; mobs typically reflect uniformity of opinion. Retrospective analyses of market bubbles often reveal how many otherwise rational actors caught up in the mob ignored readily available data that might have discouraged their behaviors, had they not been blinded by fear, greed or what 19th Century author Charles Mackay termed "extraordinary popular delusions and the madness of crowds".

Markets set prices for buyers and sellers, but market prices also inform those buyers and sellers by summarizing the collective decisions of market participants into a number and a direction. Numbers and directions are objective truths, but their interpretation can be very subjective. For example, the market could be suggesting that this – and other – nations lack the willpower to adhere to conservation plans, the flexibility to rebalance energy needs with environmental stewardship or the technological wherewithal to produce economically-viable alternative fuels.

Many market participants appear to believe with great certainty that high prices signify peak oil production. This seems particularly surprising now that, twice during the last six months, oil companies have identified possible "super-giant" oil fields off the Brazilian coast, underneath the salt layer and well within the reach of modern technology. It might seem safer to assume that the moment when mankind will have exhausted 50% of the oil molecules in the Earth's crust is still a long way off, but that's not what the futures market may have been thinking in March. A March 16, 2008 *Financial Times* story entitled, "Investors bet on $100 a barrel until 2016" was the first of many media reports I read that attributed the close of long-dated crude futures as a shift in sentiment towards enduring scarcity. Indeed there were bets out to 2016 on $100 oil, but not a lot of them. In fact, only 108 December 2016 WTI contracts traded on March 14, 2008 (the date referenced by the article) as compared to 293,217 front-month contracts.

The oil market isn't the only place for speculative money to go, nor are oil markets obviously oversaturated. Crude oil is the most widely traded commodity in the world. Daily oil consumption of about 86 million barrels has an aggregate value of approximately $7.5 billion, discounting for quality. Commodities exchanges trade contracts for physical deliveries eight years in the future. In theory, if every barrel for the next eight years of future delivery were contracted at today's price and volume assumptions, those contracts could absorb about $20-25 trillion. Open interest in light sweet crude oil contracts is approximately 2.5 million contracts. Each contract represents 1,000 barrels, making open interest worth $250 billion at $100 per barrel. $250 billion is a staggering sum in its own right, but only about 1% of the theoretical maximum market size, and a rounding error in contrast to the global notional value of derivative instruments of all kinds, which the Bank of International Settlements estimated in June 2007 to be worth more than $500 trillion.

Capital markets and commodities markets play different roles in wealth creation. The value of equity securities derives from investor expectations that today's investments will deliver tomorrow's cash flows. When equity values appreciate, corporations can sell treasury stock or issue a follow-on stock offering to capitalize investment or retire expensive debts. The value of commodities usually derives from scarcity, at least in the short-term. The short-term effects of a growing volume of dollars chasing a currently fixed number of barrels can be inflationary in cases where new investment grows meaningfully relative to the market size. For the intermediate term, however, dollars spent by non-commercial bidders provide working capital that doesn't have to come from either producers or commercial users, lowering the transactional and financial costs of ensuring adequate future supply. In the long run, dollars that rush into the oil markets will play a very important role. The premiums above production cost visible in today's oil market will ultimately have the effect of encouraging future production by signaling producers that even higher-priced projects like tar sands, tertiary oil recovery and alternative fuels may be rewarded.

As companies begin to position themselves to respond to price signals, investment flows may shift. This year, WTI futures prices have risen about 10%, while the share prices of the three largest U.S. integrated oil companies, ChevronTexaco, ConocoPhillips and ExxonMobil have *fallen* about 9% on a market-cap-weighted average basis during the comparable period. This suggests at a very cursory level that investors would rather hold oil itself than the companies that produce it (it is cursory to say this because the same investors don't always play equities and commodities markets). A shift in investment flows into oil companies and away from commodities may have predictive value as well as a technical effect. Historical oil prices have normalized in response to demand abatement, but also as a result of technology improvements and the economic decisions made by nations that control access to resources.

Investors have limited visibility into the true state of global oil production. Divining the state of affairs requires constant attention to the reserves and production data reported publicly by governments, investor-owned companies and some state-owned firms as well as the refiners who ultimately purchase oil for commercial use. Investors may also consider proxies for consumption, like economic growth, and value chain constraints, like freight and shipping indices, as well as a range of third-party, proprietary sources that investigate everything from the comings and goings of tankers to orders for specialized capital equipment used for oil production. Some investors may be overwhelmed by the sheer volume of data to the point where the marginal benefit of incremental analysis exceeds the marginal benefit (or cost) of making a bad investment. Ironically, other investors may rely in the absence of empirical evidence on the signals generated by financial markets for futures contracts, in which case the endless trumpeting of rising WTI contract prices may create a "feedback loop" that seems to suggest enduring scarcity.

Futures contracts cannot trade ahead of extraction cost forever. If the price of oil is, as OPEC suggests, being driven by speculation, then at least one of two things might happen to dispel the mob: either oil will fill up storage facilities and buyers will be physically unable to take delivery, or new capacity (or alternatives) will show up on the market to take advantage of price premiums.

PEAK OIL, PEAK ACCESS OR PEAK APPETITE?

The price of oil goes up – and down – but it doesn't always move smoothly. Commodities markets can be "sticky" – that is, supply may not immediately respond to price. The following, very brief description of the exploration, production and refining sectors may help illustrate some of the reasons.

First, let's be clear about what we mean by "oil". Geological petroleum deposits take many forms. The word "oil" can apply to a wide range of compounds of differing densities, viscosities and purities. The petroleum industry classifies oils that contain more natural gasoline and lower-density molecules as "light" and oils that contain lower levels of sulfur and other impurities as "sweet". Ultimately, the value of oil depends on the processing capabilities of the refiners – the commercial customers – who buy it. Refiners consider oils that are light and sweet to be "high quality" because they can be distilled into transportation fuels, chemicals and industrial products at lower fixed and variable costs than oils that are "heavy" and "sour". As global demand grows, oil companies are drilling deeper for oil and producing, on average, barrels that are heavier and sourer. Refiners' corresponding investment in new and higher-complexity refineries generates new market opportunities for exploration and production companies (or divisions) to look again at resources they once ignored.

Oils of similar composition tend to be interchangeable in the short-term. In the intermediate term, refiners of higher-quality oils who want to use lower-quality oils must invest in new refining equipment capable of processing impurities. Operating these higher-complexity refineries requires more energy, resulting in increased per-unit costs. However, the finished products that refiners make from oil – gasoline, diesel and jet fuel – are also commodities. Refiners must accept the market price offered for the products they produce, because any attempts to recapture additional costs by charging a higher price are likely to be undercut by competitors who produce fuel at lower marginal cost. As a result, the global refining industry as a whole typically prefers to pay less for lower-quality grades. Price relationships between oil grades tend to normalize over time because refiners will eventually invest in higher-complexity equipment to take advantage of sustained discounts for heavier or sourer oils. Similarly, greater demand for low-quality oils can bid them up relative to high-quality oils and diminish or stabilize demand for high-quality oils.

Thanks to high prices, oil companies are willing to consider new technologies. Incremental technology improvements are expensive to deploy. Oil companies will be most willing to put capital at risk when they believe robust demand will reward their investments. Incremental deployments of new technologies often bring rewards in the form of process improvements as employees climb their "learning curves". In subsequent deployments, oil companies can also take advantage of scale economies by standardizing operations around new technologies. On the other hand, oil production doesn't easily switch on and off, for a variety of practical and economic reasons. Petroleum production takes time; seven to ten years typically lie between the corporate decision to proceed and delivery of oil to the market. Because executives at investor-owned companies are accountable to shareholders, even if the price of oil falls between the time company management puts money into a project and the time production begins, oil companies may need to operate at loss in order to generate enough cash to pay back their up-front investments and fund future efforts.

Thanks to technology, it's easier to find oil. The days when a lone wildcatter with a dowsing rod and big dreams could uncover a gusher of Texas Tea with a hand drill ended decades ago. That's because most of the readily accessible large oilfields discoverable through yesterday's technologies are already in production. But this doesn't mean that the world's oil supply has peaked. The Earth is a big place, and oil deposits reside at varying depths throughout the Earth's crust all the world over. New seismic and electromagnetic technologies and advanced computer modeling make it possible for oil companies to identify significant new petroleum deposits in places where it had never been possible to look in the past, like underneath thousands of feet of rock or seawater. Drilling technologies are becoming superficially similar to endoscopic surgical techniques. In the not-too-distant future, producers may be able to access underground reservoirs by creating minimally intrusive surface holes and threading their drill-bits between rock formations. Oil companies are getting more out of every well, too. Enhanced oil recovery technologies using water and carbon dioxide are enabling North American production volumes that exceed original estimates by as much as 30% to 45%.

Are we on the other side of "peak access" to oil reserves? Investor-owned companies face increasing barriers to drilling overseas as oil-rich sovereigns renegotiate, expropriate and nationalize their petroleum sectors to capture greater value from high prices. High prices may also have made OPEC a more effective cartel. At $100 per barrel, OPEC nations collectively generate about $3 billion each day. When prices were $10 to $15 per barrel, the poorest oil exporters sometimes exceeded their assigned quotas to keep national treasuries solvent. Today, even weaker producer economies can afford to hold the line on supply. Greater wealth means that the state-owned oil companies that control more than 80% of global reserves can afford their own advanced oilfield technologies and have fewer incentives to grant favorable concessions to investor-owned oil companies. A telling sign that the game is changing arrived last month, when oil companies bid a record $3.7 billion for offshore drilling rights in the Gulf of Mexico. In this context, restricting drilling where the U.S. has oil – including the Arctic National Wildlife Refuge and the Eastern Gulf of Mexico – will only transfer wealth and market power to OPEC.

Once again, protectionism is the wrong answer. Petroleum refining is a tough business for the U.S. oil companies that must pay top dollar for raw materials on the global market but end up selling a commodity. The prospect of punitive taxation and escalating environmental expenditures may make investor-owned companies understandably leery of committing multiple billions of dollars towards the building and expansion of their refineries. Not every oil company may regard investment in U.S. energy infrastructure as a bad deal. For state-owned oil companies, a new or bigger U.S. refinery could improve the profits associated with production of lower-quality crudes by turning them into gasoline to capture what has typically (but not always) been at a premium to their unrefined value.

It may be that we are merely reaching our "peak appetite" for oil. Energy crises provoke transformational efficiency gains, even though they are expensive and take a long time to play out. Assessing oil production limits requires an examination of the vehicles that use petroleum-derived fuels, too. Today's cars, trucks and things that go are already quite flexible and will become more so. Forecasts made by the EIA, IEA and industry groups leave little doubt that many of the vehicles on the road today are taking growing advantage of fuels from non-oil sources that are similar in composition and

performance to petroleum distillates. Likewise, tomorrow's transportation fleet is likely to employ liquid fuels of any origin much more efficiently than today's fleet. Technologies like hybrid petroleum-electric propulsion systems are now maturing. High prices are already provoking commercial aviation companies to look for low-cost, high-yield design changes that minimize energy lost to friction, like the wing "tips" frequently installed on commercial airlines. It seems likely that a conservation response is already underway and I believe the U.S. government is right to encourage it.

New taxes could have self-defeating implications in the meantime. Replacing the 230 million passenger vehicles on U.S. roads will take 15 to 20 years if we start today. Electric cars may require, among other things, investment towards a more reliable power grid. Likewise, diffusion of flexible fuel vehicles and E85 dispensers could require more than $50 billion in incremental spending and will rely on economic, large-scale production of cellulosic biofuels. A "flexible" vehicle implies a choice, and policies that encourage petroleum investment will keep that choice open, even as policies this Committee has enacted pave the road to future fuels. Corporate leaders of for-profit companies must balance expected returns from 30-year projects against the risks that federal budgets can change annually, congressional polarities can reverse biennially and new regulators might reinterpret existing law every four or eight years. Dramatic policy shifts and tax hikes could make it harder, not easier, for oil companies to transition to future fuels.

AN AFTERTHOUGHT REGARDING THE U.S. RELATIONSHIP WITH PETROLEUM

Addiction is the wrong metaphor. We didn't start refining oil by accident. Oil continues to fuel 97% of the world's vehicles because generations of engineers, corporate leaders and policy planners selected it on the basis of its suitability. Oil is energy-dense, readily transportable and plentiful relative to alternatives, even despite the high prices of the moment. Allow me to suggest a different metaphor. For the foreseeable future, petroleum will continue to fuel industrialized societies the same way oxygen nourishes the body. Two obvious conclusions emerge.

- First, increasingly prosperous, growing populations will require more oil, not less.
- Second, a man who is short of breath is not addicted to oxygen; he may just need to get in shape. We will need to use oil more efficiently.

This concludes my prepared testimony. I will look forward to responding to any questions the Committee might have at the appropriate time.