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Thank you, Chairman Bingaman, Ranking Member Domenici and distinguished members of this Committee, for the privilege of contributing to your discussion concerning clean energy investment and economic stimulus programs.

As a macro-level energy analyst for an investment bank, I interpret domestic and global economic and policy trends for institutional investors, including crude oil prices, alternative energy economics, climate mitigation costs and the energy policy decisions taken by governments. My testimony reflects lessons learned in this capacity as well as observations I have drawn from ongoing discussions with industry contacts and financial investors. The views I will present today, however, are my own, and do not necessarily represent those of my employer.

A GREEN RESPONSE TO A NATION IN THE RED

Dramatic job losses, collapsing commodity prices and a slowdown in the pace of clean energy investment are symptoms of an economic crisis that is neither typical nor trivial. This is the time for a well-considered policy response. Measures that restore economic vitality at the same time that they diminish energy-related environmental impacts could satisfy immediate cash flow needs while setting the stage for long-term strategic gains. After all, this nation's tremendous natural resource wealth and historically abundant and low-cost energy sources have been essential components of past economic expansions. Investment in energy production capacity and energy efficiency gains will support recovery and ongoing growth.

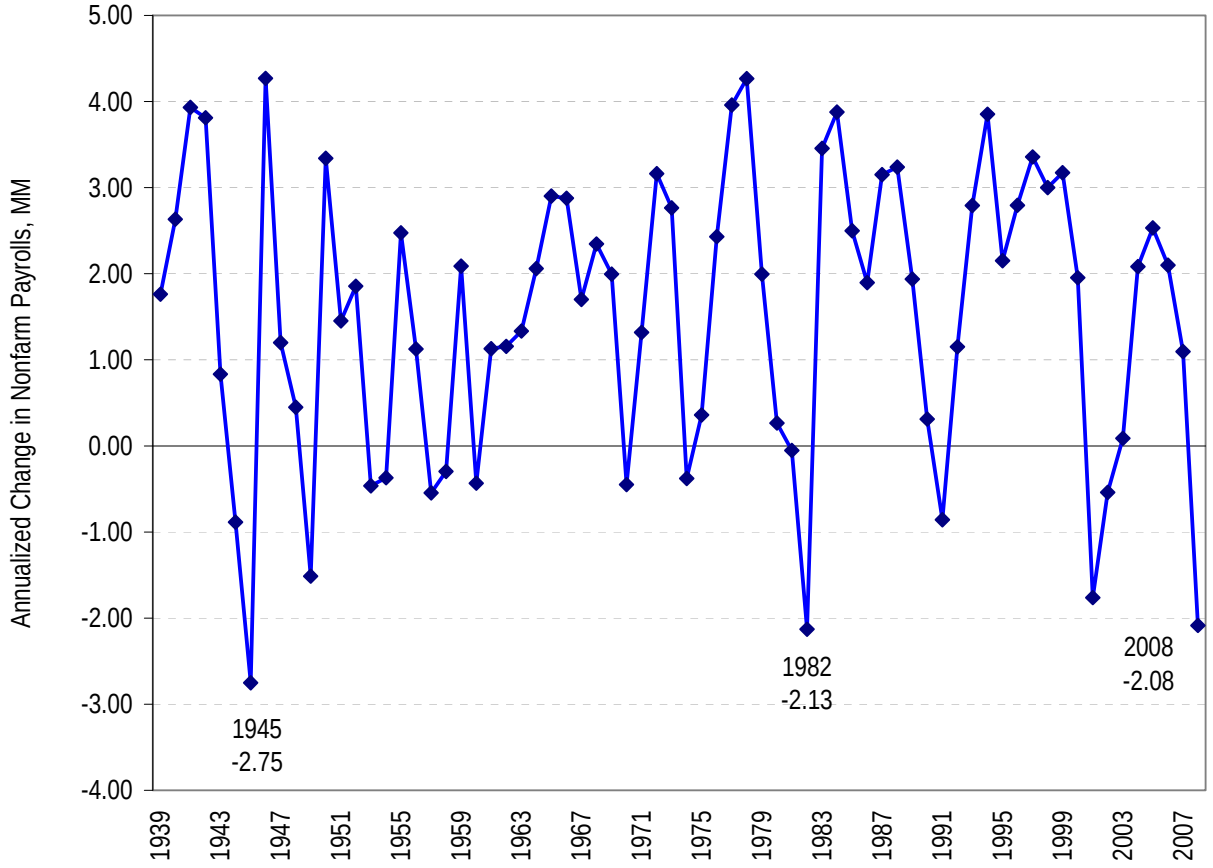
However, the solution cannot start and end with government alone. Fiscal, monetary and labor policy actions may provide short-term relief, but complete economic recovery will require private investors to commit capital on a long-term basis to new, innovative and productive uses. These clean energy investments must ultimately prove economically viable relative to competing sources. Technologies that cannot survive on a long-term basis without ongoing government support can lead to inefficient energy use and investment decisions, potentially saddling governments with high, rising and inflexible cost burdens and diminishing international competitiveness.

The summary figures presented on the next several pages frame these opportunities and challenges.

ECONOMIC GROWTH, ENERGY DEMAND AND ENVIRONMENTAL IMPACT

Figure 1 presents annualized changes in nonfarm payrolls since February 1939. 2008 is on pace to be the third-worst year from a job-loss perspective during this 70-year period. Only the 1982 recession and structural changes to the U.S. economy in 1945 at the end of World War II exceeded this year's likely declines in employment rolls. This is the most poignant, human element of the current economic crisis.

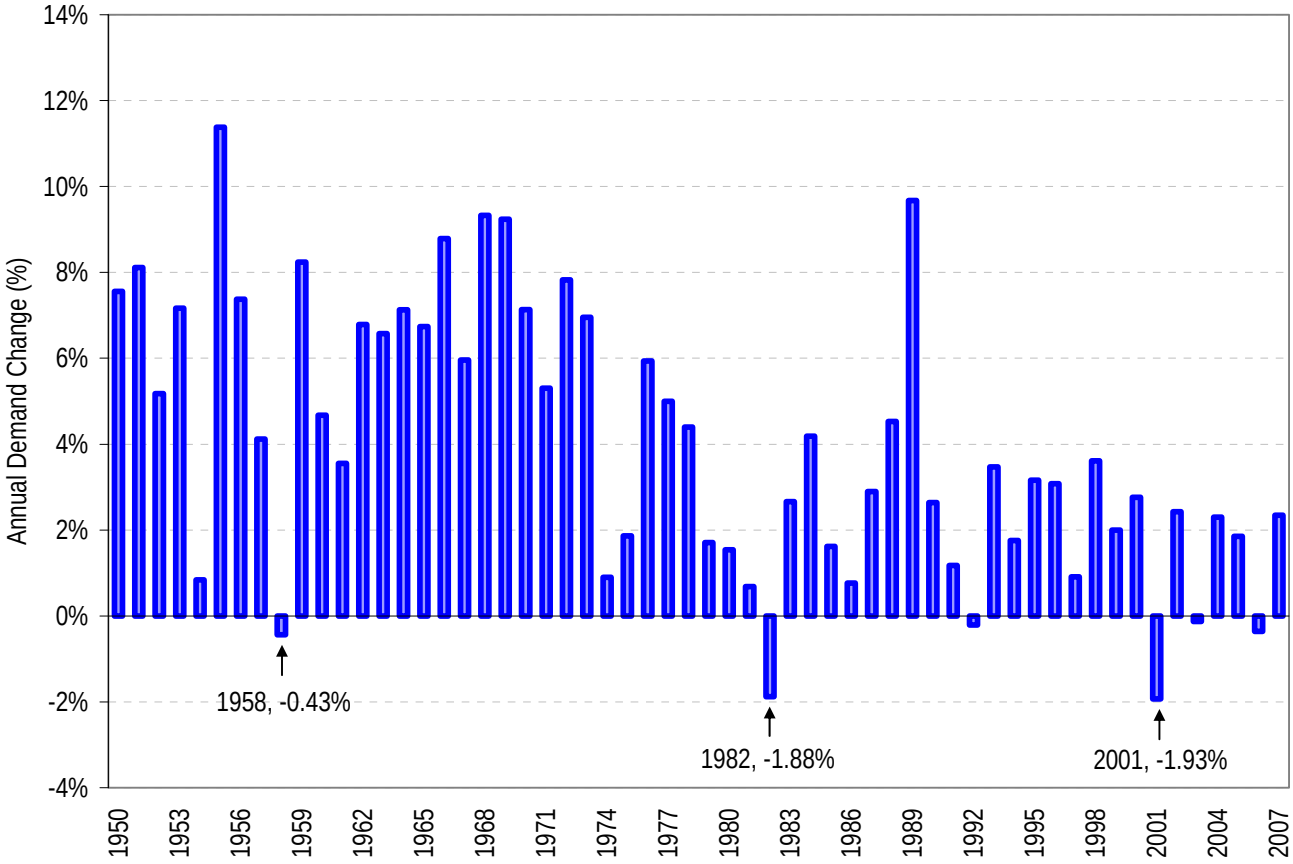
Figure 1 – Annualized Change in Nonfarm Payrolls, February 1939 – November 2008



Source: FBR Research using BLS data

Figure 2 presents the annual change in U.S. electric power demand between 1950 and 2007. The U.S. economy today produces goods and services that differ markedly from economic output a half-century ago. In this context, it is striking that only three years within the survey period show significant (approximately 0.5% or more) annual decreases in electric power demand. This is a very flattering statistic: inexpensive, reliable and readily-available electricity enables widespread diffusion of labor-saving and productivity-enhancing technologies. By the same token, early data suggest that 2008 will probably bring the fourth significant contraction of electric power demand on record; in the absence of observed efficiency improvements, the implications for quality of life are nothing to celebrate.

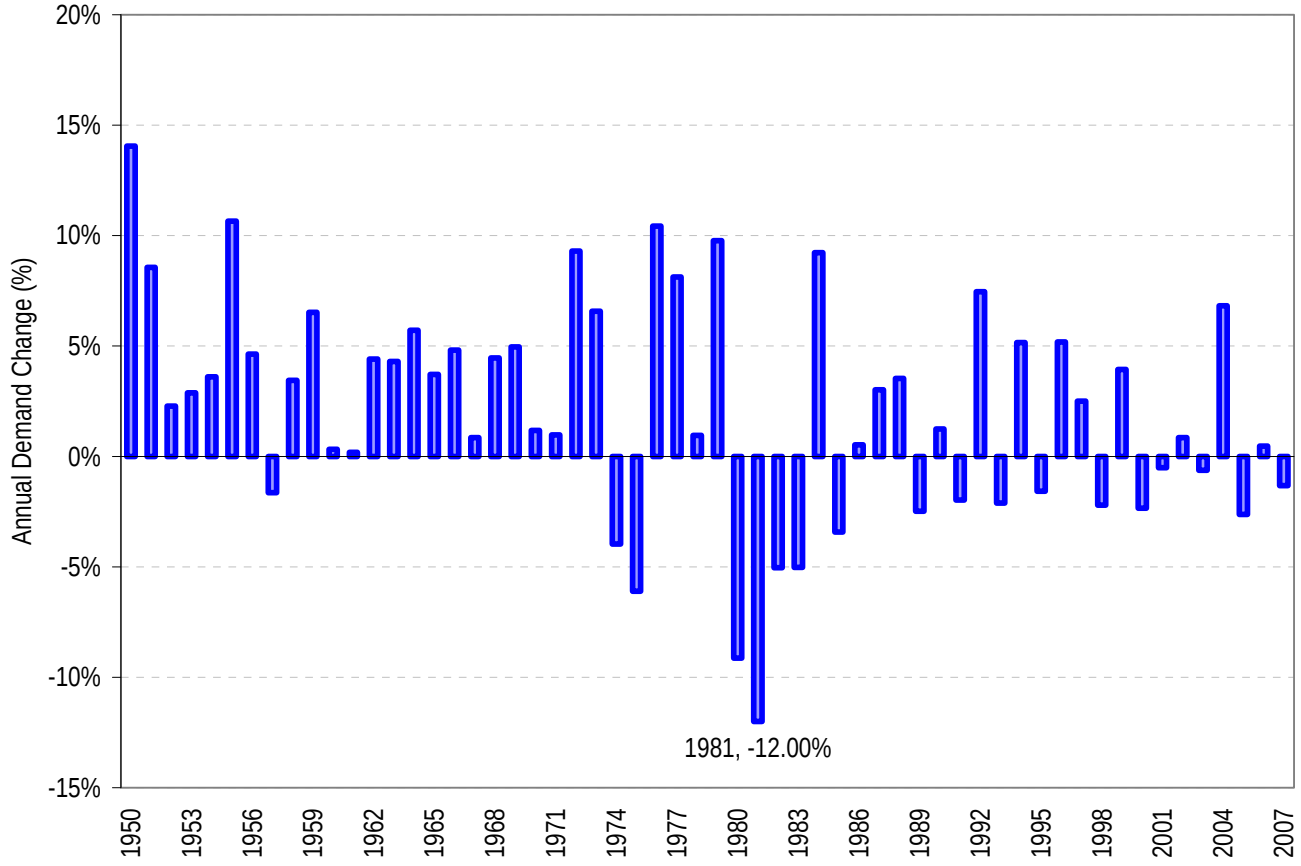
Figure 2 – Annual Change in U.S. Electric Power Demand, 1950 – 2007



Source: FBR Research using EIA data

Figure 3 presents the annual change in U.S. petroleum demand between 1950 and 2007. During the first two decades of the data set, demand increased each year with only one exception. During the decades following the 1973 Arab oil embargo, petroleum demand oscillated between annual increases and decreases. In my view, this illustrates how a combination of government-imposed efficiency standards and an economic "reality check" can change the nature of energy consumption. Although U.S. energy use patterns shifted markedly in the wake of the 1979 Iranian Revolution, I would suggest that the demand trough in 1981 reflects more than power generators switching away from oil-fired boilers or consumers adaptively responding to sustained high prices. A component of the demand retracement throughout the early 1980s resulted from U.S. drivers' rapid shifts out of old, large, low-efficiency cars and into new, small, higher-efficiency vehicles. Adaptive responses come and go, but changes in capital stock can enduringly shape energy use behaviors.

Figure 3 – Annual Change in U.S. Petroleum Demand, 1950 – 2007



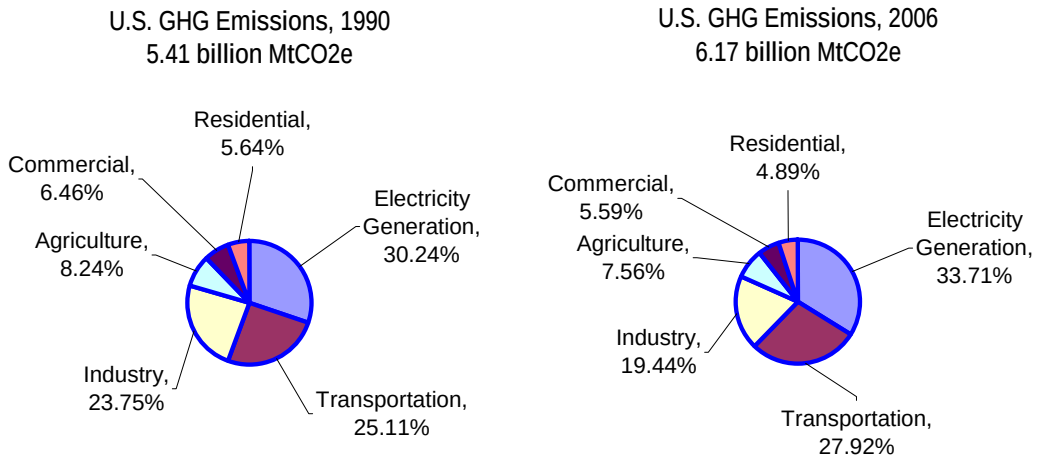
Source: FBR Research using EIA data

There is a strong positive correlation between economic security, energy security and environmental security. Generally speaking, energy demand increases with economic activity because growing economies require more fuels of all kinds, and virtually all industrial activities have environmental consequences. Prosperous economies use more energy, but they can also afford to invest in high-efficiency capital stock. As a result, they tend to use energy more cleanly and efficiently on a marginal basis than less-developed nations. The opposite is also true. Slower economic growth, or economic contraction, demands less energy, but lower economic output during lean years leaves less money for higher-efficiency infrastructure. As a result, the poorest nations resort to the lowest-cost sources of electric power and transportation fuels. Put another way, efficient growth is cleaner and more valuable than inefficient growth, but it also tends to be more expensive.

Figure 4 contrasts the absolute and proportional levels of greenhouse gas (GHG) emissions from key sectors of the U.S. economy in 2006, the most recent year for which robust data are available, with 1990, the baseline year established by the Kyoto Protocol. Although energy intensity and emissions intensity of U.S. GDP declined between 1990 and 2006, and GHG emissions from industrial, agricultural, commercial and residential sources *decreased* on an absolute and proportional basis, emissions from electric power and transportation *increased*. In short, throughout the greatest period of wealth creation in U.S. history, Americans consumed more, drove more and manufactured less. It may be challenging for the nation to consume less, drive less and manufacture more during a severe downturn.

Figure 4 – U.S. GHG Emissions, by Sector, 1990 – 2006, Proportional and Absolute Levels

Sector/Source	1990	1995	2000	2005	2006
Electricity Generation	1,859.1	1,989.7	2,328.9	2,430.0	2,377.8
Transportation	1,544.1	1,685.8	1,917.5	1,987.2	1,969.5
Industry	1,460.3	1,478.0	1,432.9	1,354.3	1,371.5
Agriculture	506.8	524.1	528.0	521.3	533.6
Commercial	396.9	404.5	390.3	400.4	394.6
Residential	346.9	370.9	387.7	376.0	344.8
Total Emissions	6,148.3	6,494.0	7,032.6	7,129.9	7,054.2
Sinks	-737.7	-775.3	-673.6	-878.6	-883.7
Net Emissions (Sources and Sinks)	5,410.6	5,718.7	6,359.0	6,251.3	6,170.5



Source: FBR Research using EPA data

UN-STICKING CLEAN ENERGY INVESTMENT

Three primary forces appear to be depressing clean energy investment today, all of them a function of the economic downturn. First and most obviously, low commodity prices tend to widen the spread between low-cost conventional sources and higher-cost alternatives, rendering many newer technologies uneconomic (or more uneconomic) on a relative basis. Second, limited access to, and higher costs of, credit can make it difficult for project sponsors to source funding for new initiatives. Third, unlike nations that provide explicit surplus payments to encourage clean energy investment, the U.S. structures its investment incentives as tax credits that can have little or no value to project sponsors who do not need to shield taxable income.

Low fossil energy prices. The "problem" of low fossil energy prices is likely to disappear with renewed economic growth. Fundamental scarcity has not gone away, and likely underinvestment in energy infrastructure due to today's economic challenges increases the odds that tomorrow's price spikes will be steeper, swifter and more devastating than this year's peaks. Nor, by any objective measure, is new energy infrastructure cheap in any case. Although short-run price weakness may dampen recent land, labor and materials price inflation, the next barrel of oil and the next megawatt-

hour of power will still cost substantially more than the installed capacity, if only because incumbent producers have already paid for the existing infrastructure.

Limited access to credit. The second problem may persist even after recovery begins. Credit challenges are unlikely to abate once seized-up credit markets resume operation because lending is not likely to resume until lenders can command higher interest rates. Higher interest rates mean higher marginal costs for clean energy producers. Even before the downturn, commercial lenders and debt underwriters were unlikely to offer project sponsors low-cost debt without explicit guarantees from the federal government. If coming reforms include tighter scrutiny of borrowers' creditworthiness and greater regulatory capital requirements for lenders, debt costs for risky projects could be higher and approvals could be fewer and further between. It's easy to see why: with "overnight" capital costs of between $4,500 and $7,000 per kilowatt for some renewable sources and nuclear power technologies, a single 1,000 megawatt installation would cost between $4.5 and $7 billion – more than the market value of the common equity, and a significant portion of the enterprise value, of many investor-owned utilities.

For this reason, loan guarantees under Title XVII of the Energy Policy Act of 2005 provide a powerful mechanism for improving the financial return profile of clean energy projects at little or no cost to taxpayers, provided, of course, that commercial lenders and federal government guarantors sufficiently vet candidate projects for financial viability. It may be possible to improve upon the Title XVII program, which must be funded through Congressional appropriations, with legislative proposals for a perpetually-funded "Clean Energy Bank of the United States" chartered to provide project sponsors with low-cost debt. By itself, low-cost debt may not be sufficient to provoke clean energy infrastructure investment during periods of tangible energy demand contraction, but few projects are likely without it. Moreover, cheap credit improves the relative cost profile of clean energy, improving odds that a risky project will succeed.

Diminished appetite for "tax equity". Giving companies tax credits for clean energy investment provides development incentives at minimum explicit cost to the federal government while simultaneously encouraging investment in profitable, and therefore taxable, enterprises. But not every investor who might sponsor projects needs to offset taxable income (especially not this year). This has led to complex financing structures that shift project ownership to third-party financial investors until the tax credits are exhausted, at which point ownership reverts back to the project's sponsor, developer or a designated third party. Fewer taxable profits within the U.S. economy mean fewer dollars theoretically available for clean energy investment in this fashion.

Legislative changes that make tax credits *tradable* (discrete, transferable units of value that project sponsors can sell on a per-unit basis to taxable entities, rather than transferring producing assets as a whole) or *refundable* (credits that become explicit payment streams for recipients without tax liabilities) might awaken some investor enthusiasm for clean energy, but only if low-cost financing is available. Long-term, declining surplus payments for clean energy that offer a premium to market prices on a per-unit basis (like European "feed-in-tariffs" for electric power) have successfully encouraged investment in high-cost, clean energy technologies by project sponsors eager to capture a guaranteed rate of return in excess of capital costs. However, this approach has two drawbacks. First, unless governments limit the amount they are willing to spend, a "free money plan" tends to have many takers, and costs add up fast. Second, surplus payments do nothing to encourage developers and

providers of clean energy technologies to aggressively compete for price parity with conventional sources and this can potentially *preserve* entrenched disadvantages, particularly in the event that governments facing financial strictures withdraw all or part of these surplus payment streams.

RECOMMENDATIONS

There are many ways to address energy infrastructure needs with programs explicitly directed at alleviating economic malaise. Stimulus spending can offer a band-aid by giving cash-strapped consumers and local governments necessary working capital. To extend the metaphor, policies that promote efficiency gains offer strong medicine for an intermediate-term cure, but the inevitable growth of energy demand above and beyond conservation-induced or recession-diminished levels means that this medicine can eventually lose its efficacy. Last, incentives to build economically viable new infrastructure are tantamount to transplant surgery, but surgeries can be last-resort, high-cost, high-risk interventions.

President-elect Barack Obama has called for a new works program to transform U.S. industrial and energy infrastructure. At minimum, a "green jobs" campaign may be a necessarily hopeful vision that inspires small and large businesses to renew their investments in the faltering economy. At best, a workforce of government-sponsored green jobs could implement a strategic roadmap to 21st century municipal infrastructure, including high-performance schools and low-loss, "smart" electrical transmission infrastructure capable of interconnecting with, and balancing, a growing number of renewable, intermittent power sources. But transformations can also have long lead times and many potential pitfalls. As a result, it may be prudent to consider opportunities for incremental gains, particularly if these incremental changes can get dollars into the U.S. economy on a short-term basis.

Figure 5 compares theoretical ten-year discounted returns on plug-in hybrid electric vehicles (PHEV, via retrofit) with first-generation (unmodified) hybrids and typical, light-duty passenger vehicles (LDV) at two different long-term oil prices. At $115/bbl, the first-generation hybrid has a 4% rate of return relative to the LDV and the PHEV barely breaks even, and this assumes the driver never exceeds the 35-mile useful range of the on-board battery. At $80/bbl, the conventional hybrid does 2% worse than the conventional LDV – close enough to break even in another year's time – while the PHEV does 5% worse. In theory, a new car purchaser should be willing to buy a hybrid (the incremental change) with a government subsidy of as little as $400, but it would take as much as $3,000 to encourage the same buyer to consider a PHEV via retrofit (the transformational change). Notably, neither theoretical scenario counts the costs associated with generation, transmission and distribution capacity to support PHEVs. The outcome of this analysis would be different if ready-made PHEVs existed today at price points at, or below, the prices of first-generation hybrids and conventional LDVs but, today, dollars spent on incrementalism may go seven times further than dollars devoted to transformation.

In a similar fashion, it may be possible to encourage "hybrid" investments that pair new coal-fired generating capacity with wind or solar installations in order to incrementally improve GHG emissions on a combined, per-megawatt-hour basis while minimizing increases in blended average capital costs. This pairing could also potentially take advantage of the complementary relationship between coal-fired base-load generation and the use of alternative power to satisfy peak demand.

Figure 5 – Visionary vs. Incremental Changes

	Low Price Case	High Price Case
10-Year Average Nominal Oil Price ($/bbl)	$80.00	$115.00
10-Year Average Nominal Cost of Transportation to Refinery ($/bbl)	$4.00	$4.00
10-Year Average Refiner's Margin	7.5%	7.5%
Implied Gasoline Price ($/gal)	$2.56	$3.45
10-Year Average Power Price ($/kWh)	$0.125	$0.125
Hours to Charge Plug-In	6	6
Fuel Economy, Conventional LDV (mpg)	27.5	27.5
Fuel Economy, Hybrid LDV (mpg)	45	45
Fuel Economy Benefit, Plug-In Retrofit Kit (miles per chg)	35	35
Purchase Price, Conventional LDV	$18,000	$18,000
Purchase Price, Hybrid LDV	$22,000	$22,000
Cost of Installed Plug-In Retrofit Kit	$7,500	$7,500
VMT (miles/year)	13,500	13,500
Business-As-Usual Gasoline consumption (gal/d)	1.34	1.34
Business-As-Usual Gasoline consumption (gal/Y)	490.91	490.91
Gallon savings of Plug-In - Within Battery Range (gal/d)	1.27	1.27
Annual Cost of Gasoline, Conventional LDV	$1,256	$1,696
Annual Savings from Hybrid LDV	$488	$659
Annual Savings from Plug-In Hybrid LDV	$698	$986
Annual Savings from Plug-In Hybrid LDV - Driving Never Exceeds Daily Avg	$1,165	$1,573
Cost of Capital	6%	6%

	IRR	NPV	IRR	NPV
Benefits of Hybrid vs. Conventional Car, net of Tax Benefits	-2%	($406)	4%	$853
Benefits of Plug-In Hybrid vs. Conventional Car	-13%	($6,366)	-8%	($4,242)
Benefits of Plug-In Hybrid vs. Conventional Car (Never Exceeds Daily Avg)	-5%	($2,925)	0%	$78

Source: FBR Research

Last, there are ample opportunities for incremental (and enduring) efficiency gains within homes and commercial buildings that can be obtained through relatively low-cost, low-technology envelope improvements, furnace upgrades and electric appliance or lighting retrofits. This work is, in the words of the President-elect, "shovel-ready" in that it can begin almost immediately, even as broader strategic plans are developed to address longer-dated infrastructure strategies.

Mr. Chairman, this concludes my prepared testimony. I will look forward to any questions at the appropriate time.