Oil Market (including Vehicle Fuels, Mass Transit, and Transportation Markets)

- Dysfunctional Oil Market Costs Customers and Stakeholders
- Misallocation of Capital Investments
- Cost Savings from a Functional Oil Market could fund enough Incentives to Substantially Decarbonize United States energy markets
- Change resisted and sabotaged by industry corporate executives

Of the energy markets, the oil market performs worst. The dysfunctional oil market operates far short of meeting every critically important customer need, and dumps huge costs on customers and some stakeholders. Oil producers, refiners, and foreign oil companies benefit greatly, at customer expense, by the status quo of “free market” ideological driven energy policies in the United States.

A program of rapid substitution for oil products would save customers several hundred billion dollars annually. Half of the cost savings would fund enough incentives to reduce carbon emissions in the US by 80%. And a effective substitution program would end the misallocation of about $400B of capital investments annually into crude oil exploration, production, and refining.

Industry corporate executives have opposed and stymied change by attempting to block government actions and policies intended to drive substitution, reduce crude oil demand, and reduce customer long-term costs. These policies would increase substitution causing lower oil prices, and reduce the incentives to invest in frontier and unconventional oil resources, oil refining, high cost oil products technology, and instead shift huge capital investment flows to vehicle manufacturing, biofuel, and general manufacturing sectors. Some of the energy industry sabotaging actions includes funding political disinformation campaigns to mislead customers and the American public. Corporate managers in both the oil industry and vehicle manufacturing have failed to develop a comprehensive plan to ramp deployment of green vehicles and biofuels, expand use of alternative transportation options, and failed to provide the leadership needed to drive change in this important economic sector.

Vehicle Fuels Market Analysis Overview

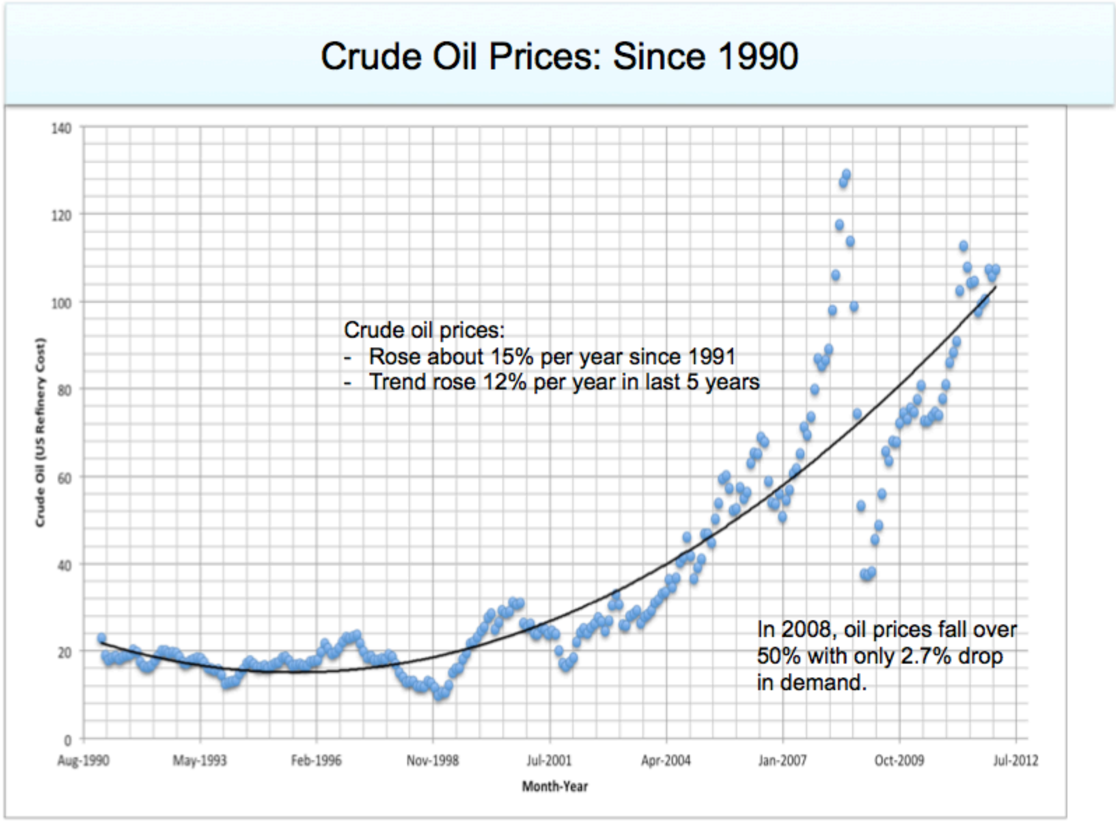
The next slide “Vehicle Fuels Market: Analysis Overview”, summarizes the key problem with the oil market, and recommends a solution. The dysfunctional oil market provides the highest fully loaded annual costs to customers and stakeholders of any energy market. The oil price greatly exceeds the cost of producing most crude oil; couple this with subsidies for fossil fuel projects and investments, plus lack of cost for externalities, resulted in a huge misallocation of capital to oil and natural gas producers instead of substitute fuels or substitute vehicles.

If substitutes were used to reduce global crude oil demand about 5%, the oil price would decline substantially. The cost savings to oil products customers would greatly exceed the cost of the substitute products capturing five percent of the oil market.

Vehicle Fuels Market: Analysis Overview

- Dysfunctional Crude Oil Market
  - Oil price greatly exceeds crude oil cost (= finding cost + lift cost)
  - Subsidies for fossil fuel projects and investments, plus lack of cost for externalities has resulted in a huge misallocation of capital
- Substitute Fuels or Substitute Vehicles Reduce Demand for Crude Oil
  - Oil price volatility and impact from 5+% substitution in the global markets drives down oil prices.
  - Cost savings to customers greatly exceeds cost of substitute products capturing 5% of the oil products market.
- Setup a Green Vehicle Group (GVG) to invest in substitutes
  - Levy a crude oil tax (based on falling oil prices) to capture a fraction of the customer cost savings.
  - Use the tax proceeds to fund GVG investments in substitutes

The best solution to fix the oil market problems involves setting up a regulated private sector entity, a Green Vehicle Group to invest in substitutes. After the oil price begins declining, the government should levy a crude oil tax (based on falling oil prices below the forecast trend) to capture a fraction of the customer cost savings. The tax proceeds would fund the Group investments in substitutes, thus creating a positive feedback loop to reduce oil demand and prices. If America invested half the cost savings (due to a rapid reduction of global oil demand) in subsidizing green energy sources, the cash flow would fund enough green energy supply to reduce US carbon emissions by over 80% by 2040. This option represents the quickest and easiest method to decarbonize the energy markets.



Oil Market Pricing History

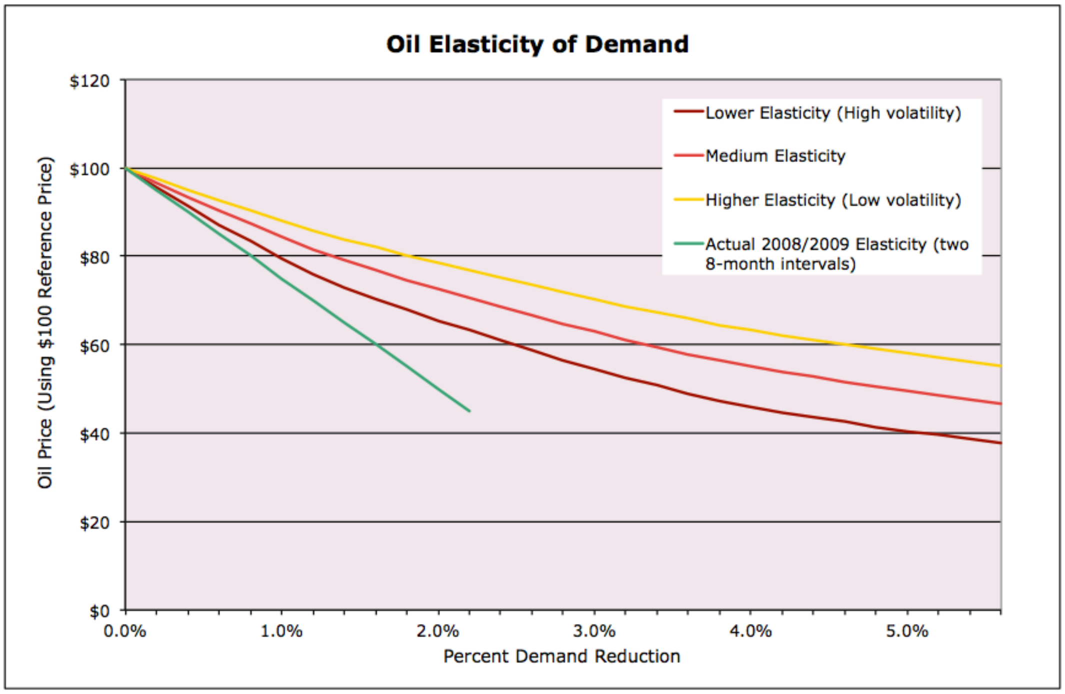
This slide shows the crude oil prices since 1990 until mid-2012 (from EIA data). Since then, the trend price rise has slowed a bit to just over 10% annually, measured over the last 7-8 years; but this rise is still roughly 5x the inflation rate. The rise in global oil prices, and the acquisition cost of US refineries, has caused higher prices for refined products for American customers.

Oil prices peaked at almost $140 per barrel for 4-8 months in the summer of 2008, but by March of 2009, the price fell below $40 per barrel, caused by reduced demand of about 2.5 million barrels daily.

The next slide shows an estimate of the price volatility due to reduced demand. The curve showing some estimates of oil market price volatility (inverse of oil price elasticity of demand) as the demand declines up to 5.5% from the reference point. The actual price decline, from a demand drop from an 8-month period in 2008 to an 8-month period in 2009, exceeded the estimate from even the lowest estimate of oil market elasticity. The curves, and actual market performance, clearly show that the global oil price during the current period of $80-140 oil prices highly sensitive (volatile) to small declines in demand.

If substitutes penetrate the markets to reduce oil demand 5%, oil prices collapse to less than half the recent prices. The resulting decline in oil costs would be sufficient to pay for not only for the substitution, but also essentially decarbonize American/Canadian energy markets. Clearly we need to understand the impact of substitution on the oil markets. The next section discusses the impact in more detail.

Oil Market Price Volatility



<u>Estimating Cost of Incremental Oil Demand in the Red Zone</u>

"Largest Engineering Economics Mistake Ever Made?" (review in Nov 2012)

- Review Supply Demand curve for global oil market
- Discuss Red Zone
- Oil Price Elasticity of Demand: Short-Term versus Long-Term (20 years)
- Crude oil price history: Since 1990
- Oil Company Expenditures
- Oil Industry Blowing Past Climate Limits
- Define Oil Price Monopsony
- Calculating Oil Price Sensitivity to Demand
- Calculate various measures of oil price monopsony
- Examples Calculating Monopsony Estimates from Supply (Production) Curve
    - Supply Curve "hockey stick handle" monopsony estimate
    - Supply Curve "hockey stick blade" monopsony estimate
- Accuracy Problems with Michalek et.al. (2011) Use of Monopsony Oil Premiums
    - Errors Analyzing Crude Oil Market Pricing, and Production Rates/Production Costs
- Various Estimates of Oil Premiums Paid by Oil Products Customers Due to Rationing Premium in the Market Oil Price since 2006
- Evaluation of CV costs versus HEV, PHEV, and BEV Substitution
- Conclusion: A Decline in Oil Demand would Reduce the Oil Production Rate below the Production Limit and Cause a Large Oil Price Drop
- Important Questions: "Who is Responsible?" and "Who is in Charge?"

The attached set of presentation slides in pdf format file named “The largest engineering economics mistake ever made? Ignoring green vehicle and biofuel impacts on crude oil prices.” covers the key problem in the crude oil market from our study done in late 2012.

The largest engineering economics mistake ever made?

Ignoring green vehicle and biofuel impacts on crude oil prices.

Paul Klemencic
Skibo Systems LLC
Seattle, Washington

The next slide discusses oil price sensitivity to demand level. In order to understand why global oil prices are volatile and extremely sensitive to demand, begin by reviewing oil exploration and production costs. Most oil production costs less than $30 per barrel, and most of this cost represent recovery of “sunk capital”, not current operating costs. Since the investment to discover and develop the oil fields represents “sunk capital”, this investment doesn’t enter into decisions to shut in production due to low oil prices. Only countries in the OPEC cartel, or cooperating with OPEC, would choose to curtail production levels to maintain unsustainable high prices.

Capital investment recovery comprises most of the production cost, and most oil projects in production today, have either already recovered the capital invested, or don’t need large annual investment expenditures to continue producing. This means that global oil prices could fall substantially from the current level over $100 per barrel, before oil production would shut in. The next slide shows the cost components of oil production costs, showing that most of the cost is a “tax” levied by oil producing countries and a cash profit margin. The “tax” really represents the ability of the producers to receive a price for a limited resource significantly higher than production cost. The higher price includes a rationing premium to allocate a limited resource among competing customers.

Rapidly reducing global oil demand by 20% (if possible) would collapse oil prices to about $20 per barrel, which really isn’t a good outcome for either customers or suppliers; but it does show the huge incentive to rapidly reduce demand to please customers.

Oil Production Rate Limits Causes Oil Price Sensitivity to Demand Part 1

- Almost all oil production costs less than $30 per barrel to produce
  - Following chart shows production costs of about $30 per barrel; the "tax" shown in the chart goes to the country or company that owns the oil resource.
  - Exploration finding costs, plus the capital portion of lift costs comprise over $20 per barrel.
  - Almost all fields in production in the world today, have already recovered these expenditures (exploration costs and capital cost portion of lift costs).
  - Operating costs generally run less than $10 per barrel, although stripper wells, and high cost production such as tar sands, have op costs comprising a higher portion of the lift costs.
  - Dropping the oil price to $40 from current levels (48-month moving average is in the $85-90 range) by reducing demand, wouldn't shut-in much production due to price declining below lift costs.
  - Only when the price falls below $30, would significant production shut-in due to costs.
  - Reducing demand levels by 20%, would likely drive oil prices below $20 per barrel, without serious OPEC contravention to keep prices higher (OPEC controls 40% of the oil supply).
  - If global demand declined enough (20-30%), the price of oil could collapse to the level of the op cost portion of lift costs, approximately $10 per barrel.

Side notes:

- A collapse to $10-20 per barrel, doesn't work to the best interests of most stakeholders, but would stall the tar sands production ramp.
- A large drop in oil price, creates an opportunity to add a tax on petroleum, that could fund green vehicles, biofuels, energy efficiency investments, even green power subsidies, and still lower customer costs.

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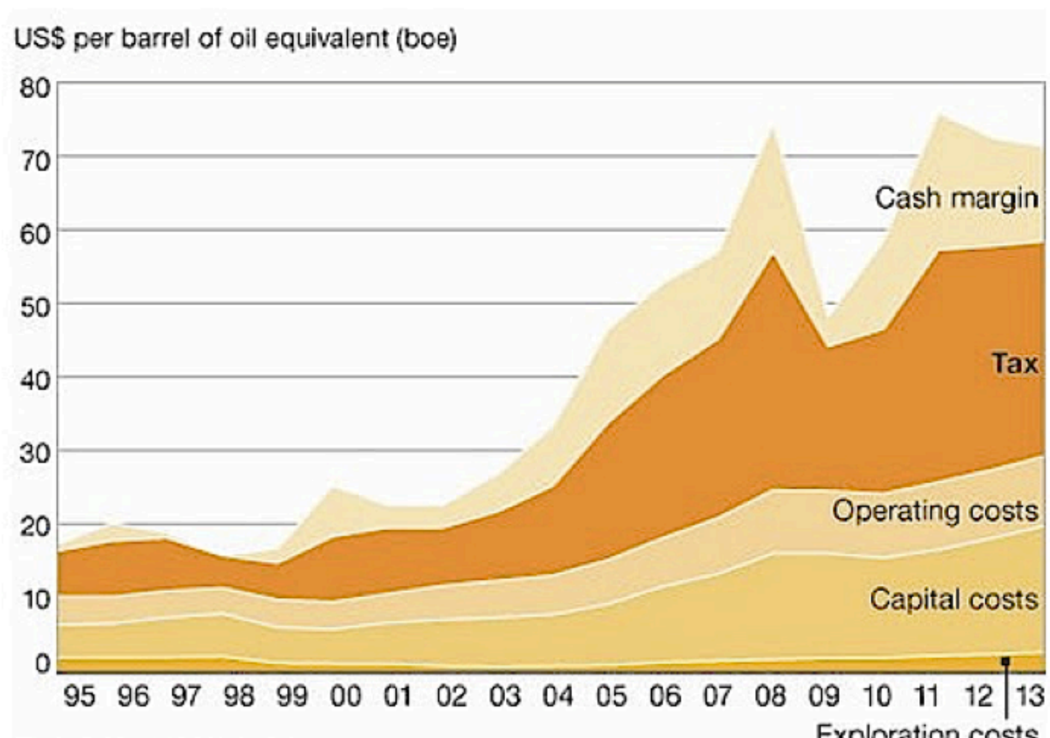
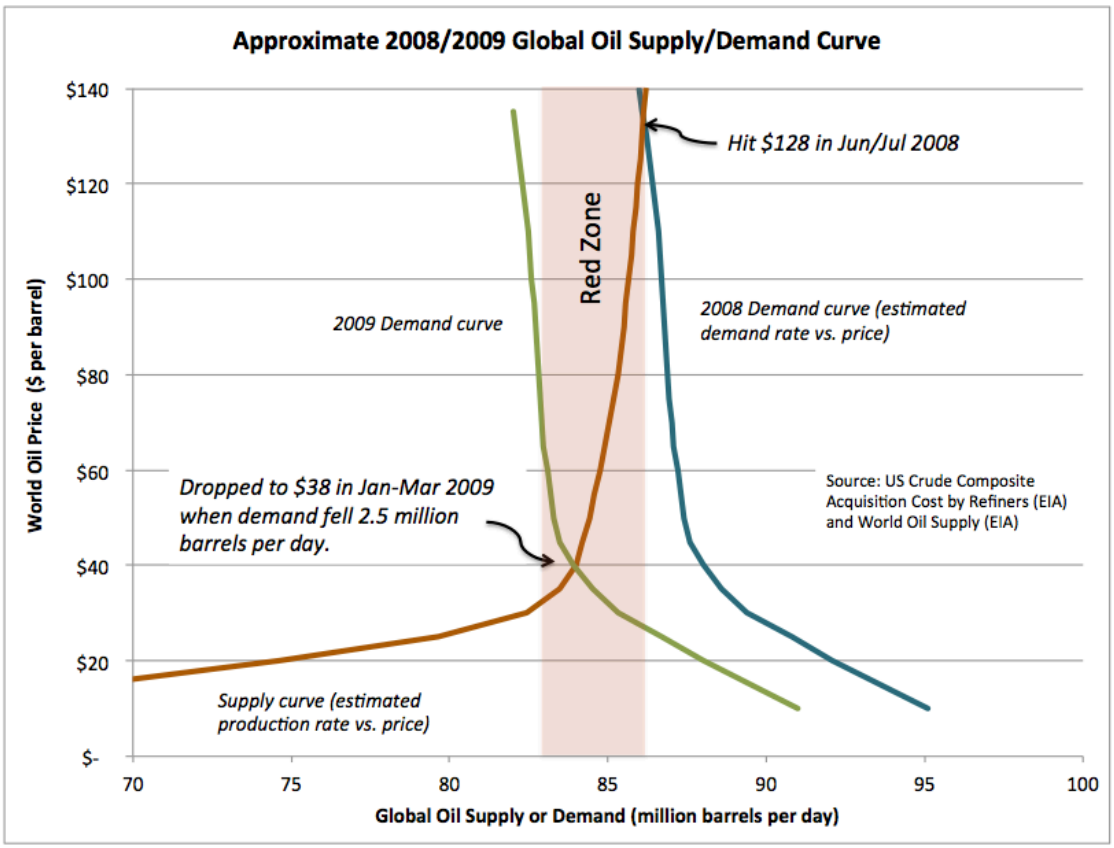


Source: Wood Mackenzie

The problem with the oil market can best be explained by considering the rational actions of a monopsony buyer. A monopsony customer would be a hypothetical single buyer of the entire global output of crude oil, similar but opposite to a monopoly (single supplier). A monopsony buyer would not buy the current global oil daily production volume of 90 million barrels at $100, but rather buy a reduced volume of 85 million barrels at $40; then purchase substitute fuels or use substitute vehicles to replace the last five million barrels of production. The substitutes cost far less than the cost savings on the 85 million barrels of oil purchased, so this buying strategy saves the monopsony buyer from overpaying for the supply of crude oil.

Without a rational buying strategy, individuals compete for the oil supply, pushing demanded volume up against a limited production capacity and driving prices for all the oil supply higher and higher until some buyers are priced out of the market.



An historical example illustrates this issue. Examining the supply curve in this diagram, maximum global supply in 2008 was 87 million barrels daily. As rising demand in Asia and elsewhere pushed up against this real constraint, the price rose to over $120 per barrel, and some customers were finally priced out of the market. As just discussed above, the oil price greatly exceeded production costs, so the higher price essentially included a rationing premium caused by over-competition for limited supply. Some economists call this rationing premium, the “monopsony premium”.

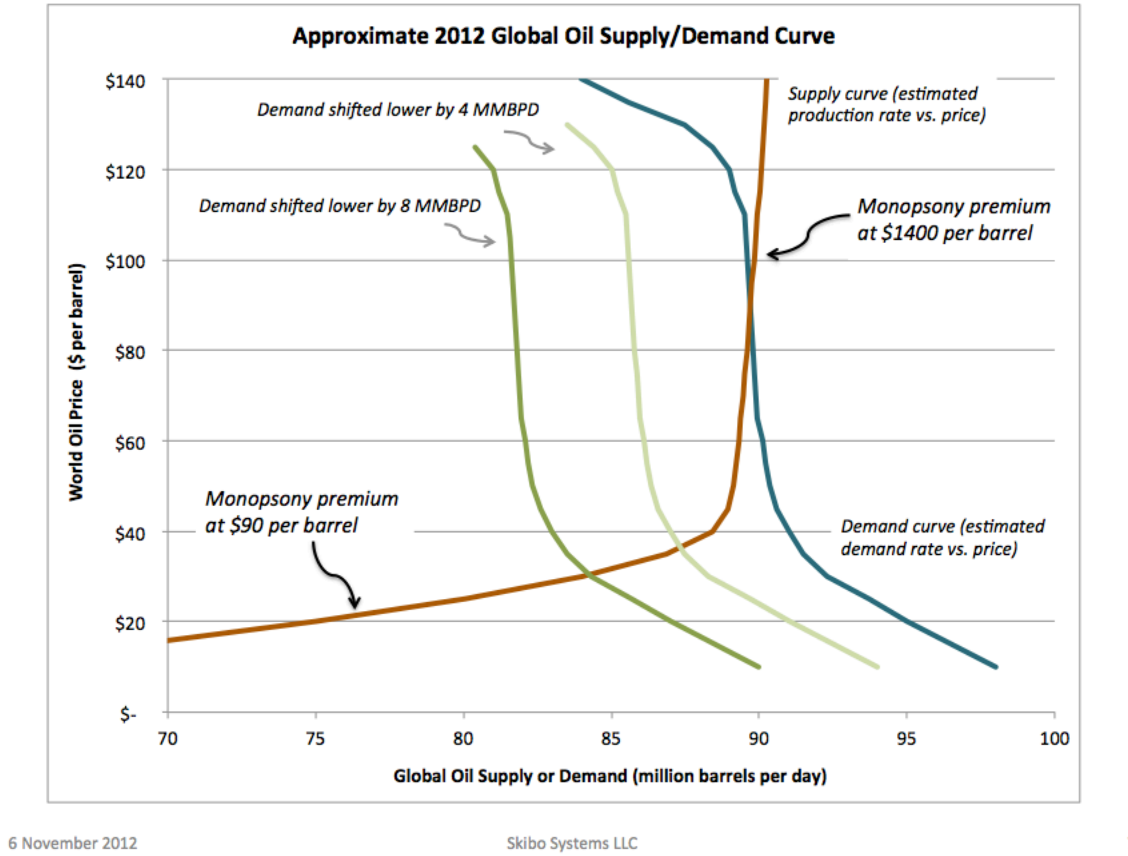
Oil Production Rate Limits Causes Oil Price Sensitivity to Demand Part 2

- **Increasing demand has pushed production rates into the vertical price climbing interval of the supply curve, in spite of increased production capacity.**
  - Global oil production is limited by the capability of the oilfields to produce; if the wells are drawn too hard, eventual recovered reserves decline due to saltwater incursion, or damage to the formation
  - Production rate can be increased in the short-term by drilling infill wells, or working over wells; but the last five years of high prices have likely depleted the potential to increase production rate by these methods.
  - As increasing demand pushed the price up, OPEC decreased their production curtailment, but mostly since late 2006, OPEC has produced at capacity (although new fields developed, increasing OPEC production rate from 32 million to 36 million BPD)
  - OPEC + US + Russian + W. African production increases drove global oil production higher from 78 million in 2002 to over a rate over 90 million BPD by mid-2013.
  - Although the production rate increased due to new field development, demand increased faster, eating up surplus OPEC (Saudi) production capacity.
  - This pushed the production rate into the "red zone" just below maximum global production rate (within 4 million BPD), and eventually pushed prices much higher (up the hockey stick blade).
- **Connecting the two sectional intervals of the supply curve, between the horizontal handle section (flat due to the low prices needed to shut-in production), and the vertical blade section (vertical due to inability to increase production beyond capability), is the shoulder section where the slope depends on decisions by OPEC to curtail production.**

The slide shows the Approximate 2008/2009 Global Oil Supply/Demand Curve, with an explanation of how the curve was constructed on the next slide. By 2005/2006 rising oil demand had eliminated OPEC's (most Saudi Arabia) curtailed production capability, and by 2008 the rising demand through the Red Zone caused oil prices to push up against the global daily production capacity of 87 million barrels. The red supply curve shows that rising demand pushed oil prices higher, averaging $128 per barrel in June and July of 2008 (the intersection of the supply curve and the blue 2008 demand curve). When the global financial crisis occurred in fall of 2008, daily demand fell about 2.5 million barrels by January through March 2009, which shifted the demand curve to the left by this amount. The next supply-demand equilibrium was at $38 per barrel in the first three months of 2009.

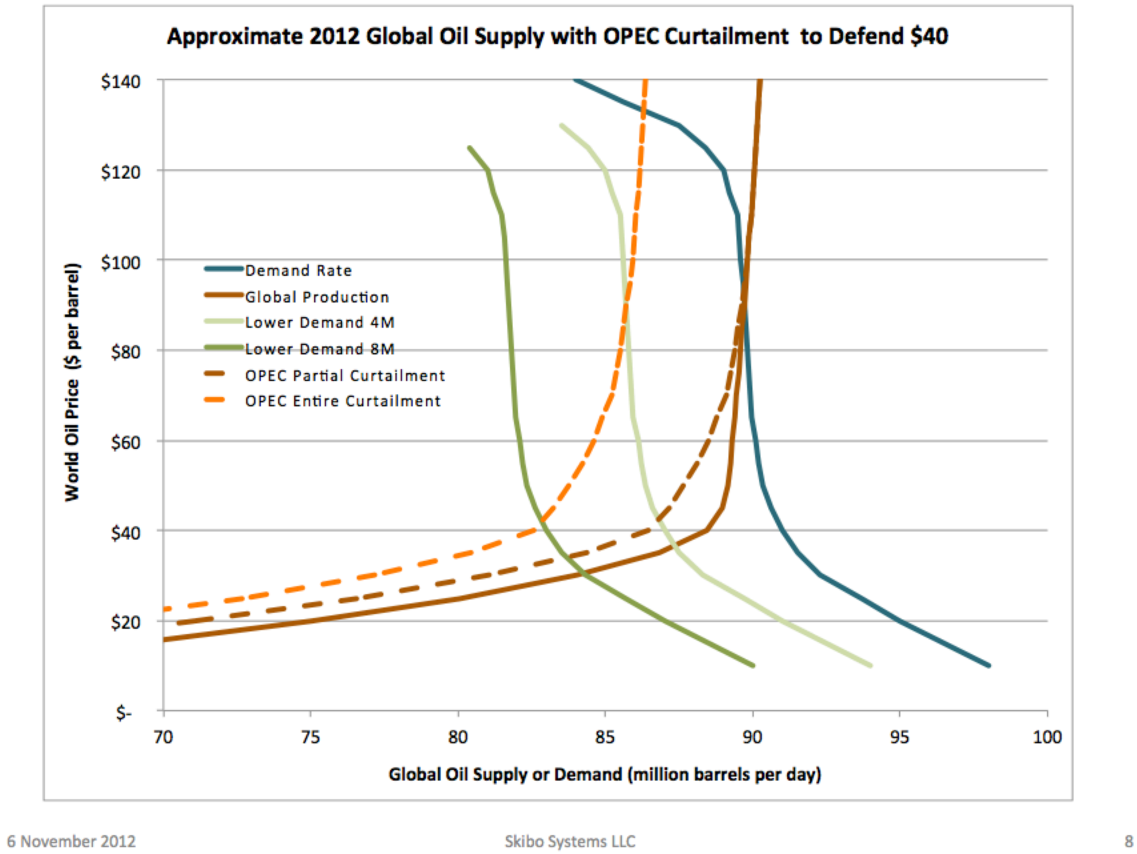
So in 2008/2009, a small decline in demand of less than three percent caused oil prices to fall 70%. Then after the financial collapse, recovering economies steadily increased oil demand up again into the Red Zone, and pushed oil prices higher.

The next slide summarizes the major problem with oil market pricing. Increasing demand since 2000 first used up remaining OPEC curtailed capacity by about 2005, then pushed demand up through the red zone until prices soared due the rationing premium in 2008. Although daily supply increased from 78 million barrels in 2002 to 90 million barrels by 2013, the increase could not keep up with rising demand. This was true in spite of massive investments in exploration and development of conventional, unconventional, and frontier oil sources.



Slide 7 shows the estimated supply and demand curves for 2012 (when this analysis was done). The slide shows possible shifts in the demand curve lower by 4 million and 8 million barrels daily that would result in much lower equilibrium prices.

The supply curve (red curve) shows a typical “hockey stick” with the blade section due to demand pushing up against production constraints. The estimated global monopsony premium based on the shape of the supply curve, calculates to about $1400 per barrel based on the first 3% of demand drop, in the hockey stick blade section of the supply curve (in the Red Zone). Once daily demand declines over 8 million barrels, the demand curve (green curve) crosses the supply curve on the hockey stick handle section. The global monopsony premium in this section of the curve calculates to about $90 per barrel.



Slide 8 shows that with a drop in demand of 4 million barrels, OPEC could defend $40 per barrel with only a 3 million barrel curtailment (with a corresponding shift in the supply curve), but to defend the $40 price with a demand drop of 8 million barrels, requires OPEC curtailment of about 7 million barrels (about 20% of OPEC capacity).

This market response demonstrates that a sustained program of subsidies for crude oil substitutes would cause oil prices to collapse, even if OPEC elected to stop falling prices by curtailing production. By sustaining substitution, the ability of OPEC to keep oil prices at high levels is overwhelmed. The increasing penetration of green vehicles into the vehicle fleet essentially ensures a drop in oil demand over the lifetime of the vehicles deployed (12-15 years for EVs). OPEC gets caught in a dilemma, because keeping oil prices high drives the increasing deployment of green vehicles.

The oil market doesn't offer a good strategy for OPEC to slow substitution, after governments establish substantial major substitution programs in countries with major vehicle fleets. OPEC could wait until substitution starts causing dropping global oil demand, then curtail production and attempt to defend at a given oil price (likely in the range of $60-$80 per barrel). At this price point, OPEC can hope that substitution begins to slow and level off; but this strategy probably won't succeed. In the end, the only realistic option for OPEC involves efforts to invest in corporations providing substitutes, to hedge their overexposure to crude oil prices. Once major substitution programs pick up steam and cause declining oil demand, there really isn't any foreseeable reason why oil prices would stay above $40 per barrel; supply won't substantially decline until oil prices fall below that level.

Oil Price Elasticity of Demand: Short-Term versus Long-Term (20 years)

Table 3.1. Oil Demand Price and Income Elasticities
(Subsample, 1990–2009)

	Short-Term Elasticity		Long-Term Elasticity	
	Price	Income	Price	Income
Combined OECD[1] and Non-OECD	−0.019 [−0.028, −0.009]	0.685 [0.562, 0.808]	−0.072 [−0.113, −0.032]	0.294 [0.128, 0.452]
OECD	−0.025 [−0.035, −0.015]	0.671 [0.548, 0.793]	−0.093 [−0.128, −0.057]	0.243 [0.092, 0.383]
Non-OECD	−0.007 [−0.016, 0.002]	0.711 [0.586, 0.836]	−0.035 [−0.087, 0.013]	0.385 [0.193, 0.577]

Source: IMF staff calculations.

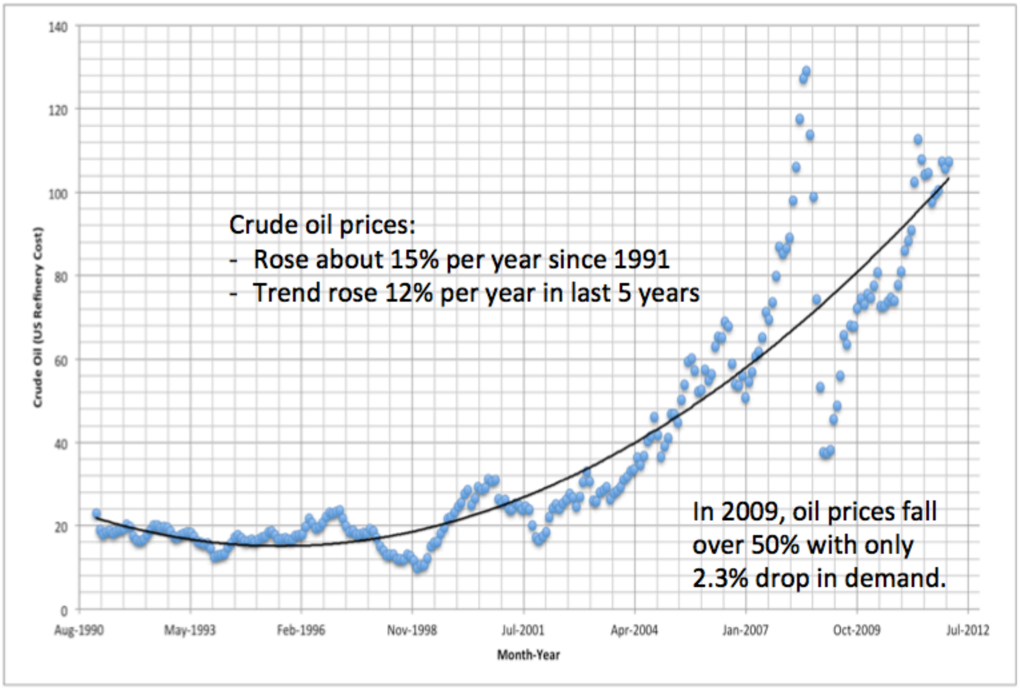
Note: Median elasticities and confidence intervals showing 10th and 90th percentile of the distribution in brackets are estimated by Monte Carlo simulations. Long-term elasticities are calculated using a 20-year horizon.

The next set of slides, show IMF estimates for oil price elasticity of demand. The short-term elasticity of demand at -0.019 corresponds with a 50% drop in oil price for the first one percent of demand decline, and the long-term elasticity of -0.072 corresponds with a long term 14% drop in oil price caused by a permanent one percent demand decline; the price drop remains even after twenty years. The IMF estimates translate (invert) into higher sensitivity to declining demand, than the sensitivity estimated from the supply/demand curves. The corresponding savings from permanent reductions in demand using IMF estimates exceed the estimated savings used throughout this review.

Slide 10 shows the rapid run up of oil prices after OPEC lost all significant curtailed production capacity in 2005. The loss of any OPEC curtailed production clearly shows up on the Global Oil Demand curve in early 2005 shown in slide 11. Since then, the only period that OPEC had any significant curtailed production capacity was in the first half of 2009.

In order for oil markets to work effectively, some entity must maintain curtailed production to draw on when oil demand increases. OPEC has generally served this role in the past, but this requirement for a swing producer isn't being filled currently. No one has any surplus production capacity, and it doesn't appear that excess capacity will develop from current projections. The only way to build significant curtailed production capacity involves reducing global demand by introducing substitutes, and working with some oil producers to compensate them by some means to hold surplus capacity. If necessary, extensive substitution can force OPEC back into the role of swing producer.

Crude Oil Prices: Since 1990



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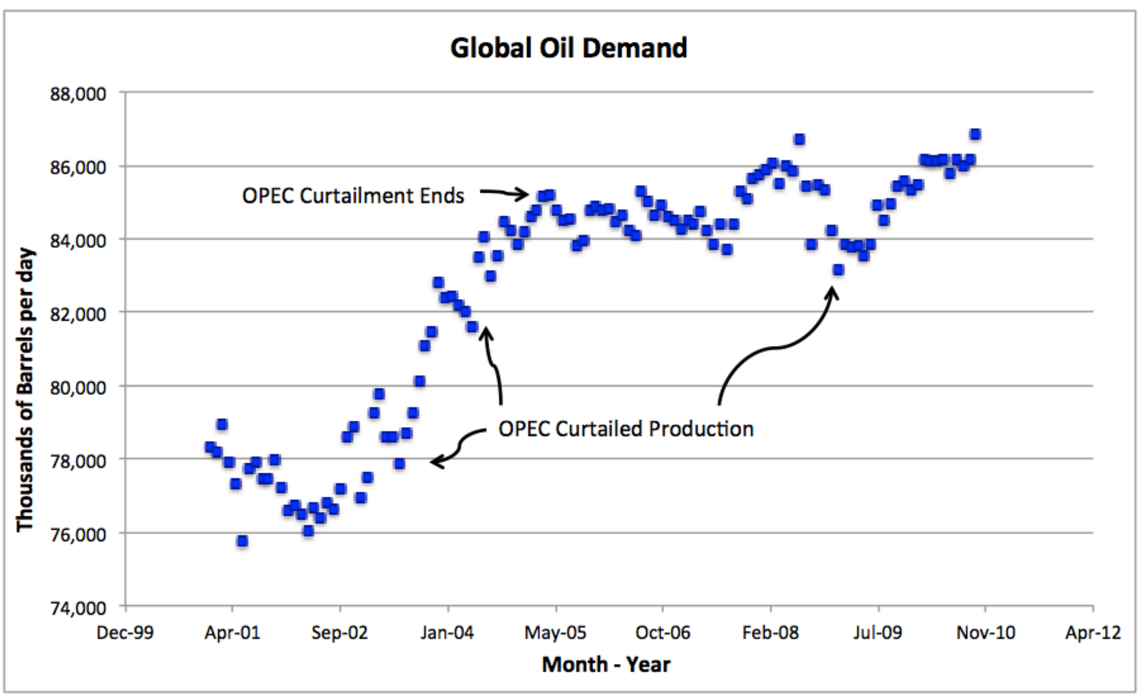

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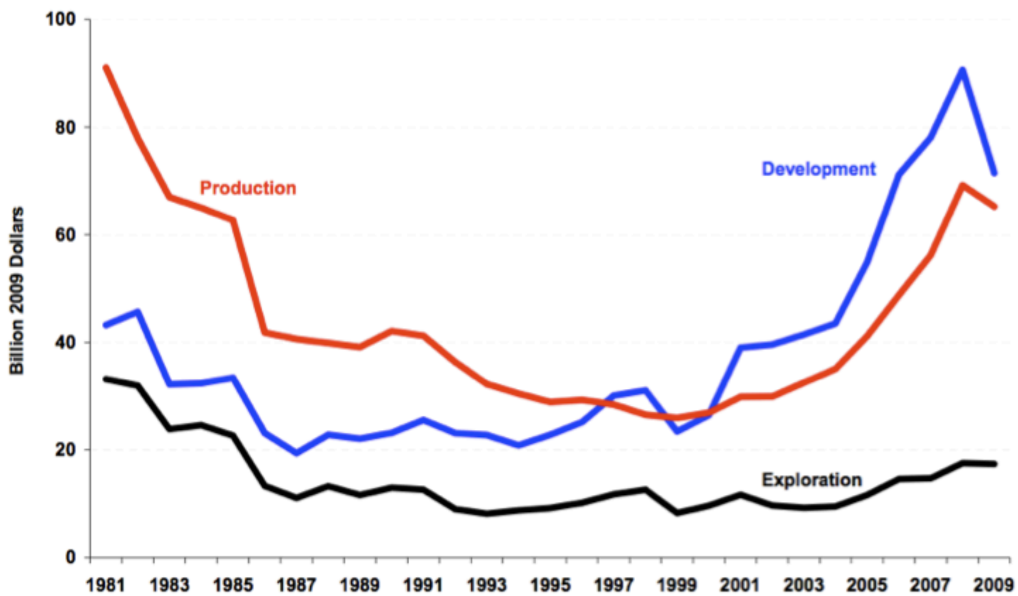
Oil Company Expenditures
(from EIA report, "Performance Measures of Major Energy Producers 2009)

Figure 11. FRS Worldwide Expenditures for Exploration, Development, and Production, 1981-2009



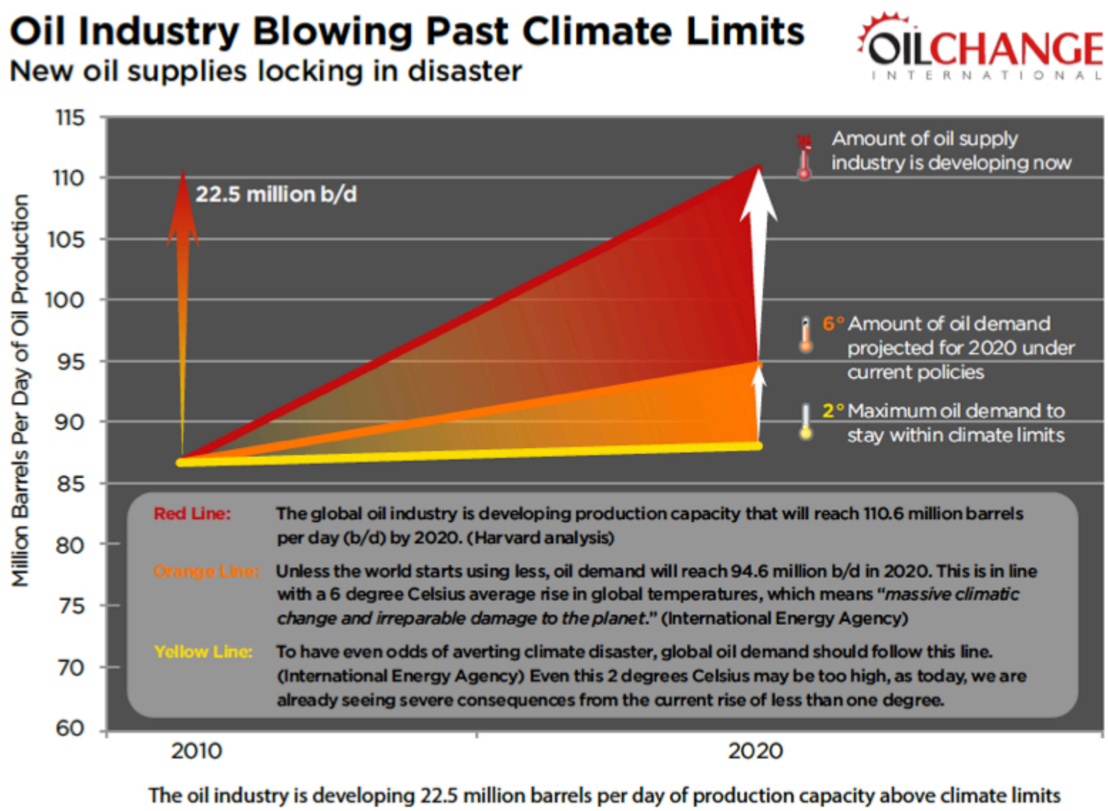
Source: U.S. Energy Information Administration, Form EIA-28 (Financial Reporting System).

Slide 12 shows the trend for major oil company expenditures from the last period of unrealistic high oil prices in the period 1981-1985; followed by unrealistic low oil prices from 1986 until the late 1990s; then ending with the massive increase in annual expenditures for exploration, development, and production in the ten years 2000-2009, a trend that has continued up to the present. This large increase in expenditures represents a misallocation of capital into oil and natural gas development, instead of vehicle manufacturing and biofuel production. This increase in capital spending shown doesn't include much of the increased capital spent by national oil companies. The global capital spending on oil exploration, development, and production more than doubles expenditures shown in this graph.

The recent EIA 2013 Upstream Financial Review puts major global companies oil exploration and development expenditures at over $350B, and production expenditures at $250B, for a total exceeding $600B. Misallocated capital spent on oil exploration and development likely has reached $200B-300B annually. Investing this excess capital in substitutes to permanently reduce oil demand would more effectively optimize the oil and related markets and satisfy customers.

In addition to this misallocation of capital flows, misallocated additional investments in expanding refining and marketing, developing new gasoline and diesel vehicles and technology, and investment in new petroleum based fuels likely adds another $200B of misallocated annual investments worldwide.

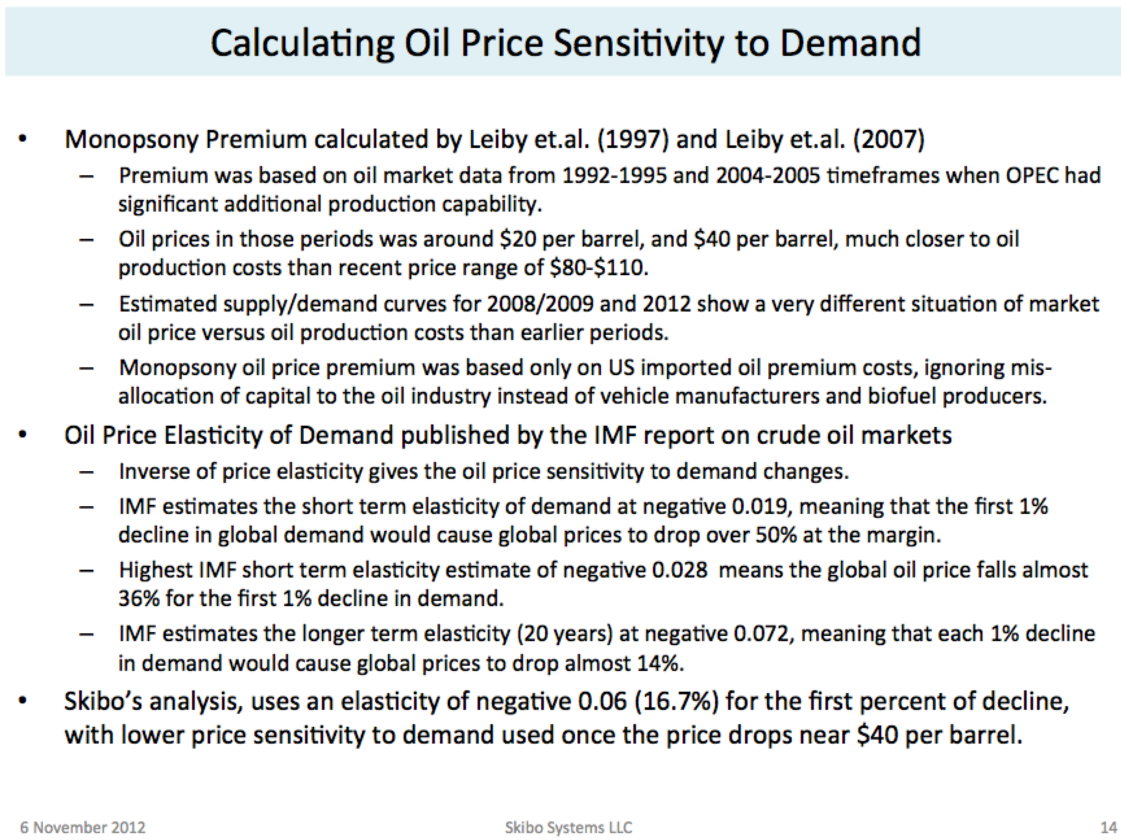
Slide 13 shows the ultimate stupidity of the current approach, as it shows oil industry production levels blowing past climate limits. The mispricing in the oil markets has led to huge misallocation of societal resources into fossil fuel development, with a corresponding increase in carbon dioxide emissions. America's biggest source of carbon emissions comes from crude oil products, with emissions significantly higher than coal carbon emissions.



This study estimates that global oil production will reach 110 million barrels daily by 2020. This rapid expansion of unconventional and new petroleum resource would doom efforts to control global warming to less than 2 degree C, according to this study.

The expensive cost of these additional barrels of daily production drives customer costs up, depletes reserves, and funds an ever-increasing spiral of spending, production, and consumption levels. The exploitation of unconventional oil reserves, tar sands, deep-water, frontier, and potentially oil shale deposits eventually drives carbon emissions to levels that blow past carbon levels in the atmosphere. But eventually this upward spiral must slow down and eventually halt. The increasing expenditure of society resources on increasing oil production levels represents an enormous misallocation of investment.

The fact that oil markets prices most global production at the marginal cost that includes the rationing premium (monopsony premium) drives this exploration/production spiral. This makes understanding the monopsony premium a key factor in making oil markets functional, along with the related natural gas market that in turn impacts the electricity and coal markets. And of course the very high cost of the last increment of oil demand impacts markets for green vehicles, biofuels, and expenditures to improve the transportation sector. In order to achieve effective energy markets, the DOE should place a high priority on developing a critical understanding of the monopsony oil premium on this last increment of demand.



Previous studies of oil price confirm the oil price sensitivity to demand variations. Paul Leiby estimated the monopsony premium on imported oil in studies in 1997 and 2007 done for the Oak Ridge NL (administrators of the Strategic Petroleum Reserve). Global oil prices in the time periods for those two studies averaged about $20 and $40 per barrel; Leiby estimated a median oil import monopsony premium of $10 per barrel ($8 per barrel in 2004 dollars escalated to $10-11 in 2012 dollars) in the latter study. At that time, America imported about 10 million barrels daily, about 12% of global production, so an extrapolated estimate of the global monopsony premium of $90 per barrel is consistent with Leiby study. This estimate falls in the same range as the global monopsony estimate calculated from the handle section of the hockey stick supply curve in slide 7. Because the blade section of the supply curve is much steeper, the global monopsony premium climbs much higher during periods when OPEC has no significant remaining production capacity. The DOE should review and update the calculations from the Leiby study, and extend the analysis to global markets.

Slide 14 also summarized the IMF data on oil price elasticity of demand. The short-term elasticity translates into short-term price drop of 50% for a one percent drop in oil demand, and the long-term elasticity translates to about 14% long-term price drop (20 years) after a permanent one percent drop in demand. The Skibo Systems LLC analysis presented later in these comments uses a 16-17% price drop for the first percent of

demand decline, with lower price sensitivity once the global oil price drops near $40 per barrel. This is quite conservative compared to the IMF estimates, since the important portion of the Skibo analysis occurs only 5-15 years after a major substitution program begins. The IMF elasticity estimates extend over 20 years.
Slide 15 gives some examples of how to calculate the global monopsony premium from the estimated supply curve. The US imported oil monopsony premiums is much lower, since only the price drop in imported oil volumes is considered when calculating the customer cost savings due to lower oil prices.

Examples of how to calculate monopsony estimates from the Supply(production) curve using the slope of the curve over an incremental production curve interval.	
Supply Curve "hockey stick handle" section:	
Estimate the change in price for a given incremental change in demand.	Calculate $11 drop in price for 10 million BPD change from 82 to 72 million BPD. This is $1.10/bbl for each million BPD change.
Apply the price change to the amount of oil used to calculate the relevant monopsony premium.	Use $1.10/bbl for one million BPD decline in demand, applied to the global oil demand of (82-1) million BPD = $89M per day. **Global Monopsony Premium = $89 per barrel**
For US imported oil, use the change in global oil price and apply only to remaining US imported oil volume to estimate total decreased oil costs, then divide by the reduction in import volumes.	Use $1.10/bbl for one million BPD decline in demand, applied to the imported oil demand of (10-1) million BPD = $10M per day. **US Import Monopsony Premium = $10 per barrel**
Supply Curve "hockey stick blade" section	
Estimate the change in price for an incremental change in demand on the blade.	Calculate a $50 per barrel price drop for a 2 million BPD change from 86 million BPD to 84 million BPD. This is $25/bbl for each million BPD change.
Apply the price change to the amount of oil used to calculate the relevant monopsony premium.	Use $25/bbl applied to (89-1) million BPD to get $2200M per day. **Global Monopsony Premium = $2200 per barrel**
For US imported oil, use the change in global oil price and apply only to remaining US imported oil volume to estimate total decreased oil costs, then divide by the reduction in import volumes.	Use $25/bbl for one million BPD decline in demand, applied to the imported oil demand of (9-1) million BPD = $200M per day. **US Import Monopsony Premium = $200 per barrel**

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The "handle" section of the supply curve "hockey stick" has only a slight upward slope, due to the low price needed to shut-in existing oil production. This slope essentially sets the monopsony premium when demand falls to levels well below global capacity. But when demand pushes into the red zone and prices rise up into the hockey stick blade section, the steeper slope calculates to a much higher monopsony premium.

Analyzing green vehicle or biofuel substitution impacts on the oil market depends on an accurate estimate of the monopsony oil premium. An exemplary study by Michalek et.al. 2011 used the monopsony oil premium from Leiby 2007 to analyze the cost of electrical vehicle alternatives such as hybrids (HEV), plug-in hybrids (PHEV), and all-electric battery vehicles (BEV). Unfortunately, the Leiby 2007 data was completely out of date by 2011, leading to an erroneous analysis in Michalek 2011. The problem with outdated data was compounded by several other problems. The paper assumed no foreign PHEV/BEV substitution because Leiby only considered US unilateral action to push substitution. A coordinated global substitution effort would result in a bigger drop in oil demand and prices. The Leiby analysis focused only on imported oil premiums, and ignores the windfall profits received by US domestic oil producers. These domestic producers get much higher revenues than in a rational oil market due to higher global prices. This causes a misallocation of capital to the oil industry instead of green vehicle manufacturers and biofuel producers. The monopsony premium used to analyze green vehicle substitution should consider all US demand; and in the case where global coordination of substitution occurs, the oil premium should include all the demand from all the large vehicle fleet countries.

Interestingly, Paul Leiby seems to recognize the cost of high cost oil on the US economy exceeds the calculated cost of the incremental oil demand using his estimate of the oil price premium. In a presentation (2) at the International Association of Energy Economists conference in June 2009, Leiby shows a slide depicting the oil dependence cost on the US economy. The estimated oil dependence cost on his slide exceeds $350B for 2008. This greatly exceeds the estimated cost of incremental oil demand calculated using his lowball oil premium cost. The biggest component of the oil dependence cost arises from Wealth Transfer (about $200B annually), although the Macroeconomic Adjustment and Potential GDP Loss together kick in another $150B in costs.

Accuracy Problems with Michalek et.al. (2011) Use of Monopsony Oil Premiums (Errors Analyzing Crude Oil Market Pricing, and Production Rates/ Production Costs).

1. Analysis in MI11 ignores change in crude oil market between 2004/2005 period, and the period starting in mid-2006 to the present.
   a) In 2004/2005 OPEC had significant additional production capacity (4+ million BPD).
   b) Since late 2006, OPEC has produced at or near capacity.
   c) Crude oil price at the equilibrium point (S=D) has increased to 3x-4x production costs, and caused a rationing premium.
   d) Leiby estimated **$10/bbl** ($2010) US imported oil monopsony premium; now would get **$200/bbl (20X)**.
   e) Skibo uses a price sensitivity to demand equivalent to $126/barrel (12.6X) monopsony premium for first 5% of decline.
2. Analysis in MI11 assumes no foreign PHEV/BEV substitution; Leiby only considered unilateral action.
   a) If foreign countries substitute one EV for every EV US substitutes (1:1), then the monopsony premium estimates for US imported oil doubles(20X MI11 estimate) to **$400/bbl**.
   b) If foreign countries substitutes two EVs for every EV US substitutes (2:1) increases the monopsony premium for US imported oil increases to 60X MI11 estimate to **$600/bbl**; and 3: 1 increases 80X to $800/bbl.
   c) Reaching agreements on substitution with other oil importers substantially leverages our collective monopsony power.
3. Analysis in MI11 ignores windfall profits accruing to US domestic production => Causes misallocation of capital to oil industry instead of green vehicle and biofuel industries.
   a) Currently imports comprise 8 million BPD of 19 million BPD demand, so the additional premium paid on domestic oil increases the total monopsony premium on US oil demand by another 2.4X to **$950 to $1420** per barrel.
   b) This causes an additional $200B annually collected by domestic oil producers, that could go to vehicle manufacturers or biofuel producers instead, if global demand fell 10% due to substitution.
4. Analysis in MI11 ignores the variable value of the monopsony oil premium due to substitution as green vehicles penetrate into the vehicle fleet.
   a) The Supply curve isn't a straight line over the interval of 5-10% reduced demand by 2020 advocated by Skibo.
   b) US import monopsony premium starts in the range **$200 to $380** per barrel, then falls below **$100** after a 5-10% decline.

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The analysis in Michalek also ignores the variable value of the monopsony oil premium as oil demand falls further and further below global capacity levels creating curtailed production capacity. In the event of a rapid program of substitution the demand level falls below the Red Zone shown in the supply curve. As substitution creates surplus capacity capability the next increment of demand reduction has a lower monopsony oil premium. The most important substitution reduces oil demand the first 5%, but substitution decreasing oil demand a second 5% also has a very large oil monopsony premium.

Slide 17 estimates the oil premiums paid by oil products customers due to the rationing premium present in the oil market since 2006. The US Import Monopsony premium has been in the range of $200-$380 per barrel. If we include the premium paid on US domestic production, the range for the monopsony premium increases to almost $500, and likely peaked at over $700 in 2008. If we consider the approximate 46 million barrels consumed by all OECD countries, the premium increases to almost $1000 per barrel, and peaked over $1700 in 2008. The cost premium for gasoline refined from this last four million barrels of daily demand is at least $25 per gallon for OECD oil customers.

Various Estimates of Oil Premiums Paid by Oil Products Customers Due to Rationing Premium In the Market Oil Price Since 2006 ($/barrel)

Time Period	2004 through 2005	2008 / 2009	2012 Estimate	5 yr. Forecast
US Import Monopsony Premium	$10	$380	$200	$126
With foreign substitution				
➢ Match US 1:1	$20	$760	$400	$252
➢ Match US 2:1	$30	$1140	$600	$378
➢ Match US 3:1	$40	$1520	$800	$504
Based on these import levels =>	*10 million BPD*	*9 million BPD*	*8 million BPD*	*8 million BPD*
US Domestic + Import Oil Cost Premium	$19-21	$720	$475	$300
With foreign substitution				
➢ Match US 1:1	$40	$1520	**$950**	$600
➢ Match US 2:1	$60	$2280	**$1425**	$900
➢ Match US 3:1	$80	$3040	$1900	$1200
Based on US demand of 19 million BPD.				
OECD Oil Cost Premium				
With foreign substitution				
➢ Match US 1:1	$49	$1760	**$980**	**$620**
➢ Match US 2:1	$48	$1730	$960	$605
Based on OECD demand of 46 million BPD.				
Hypothetical Global Oil Cost Premium	$80	$3150	$2250	$1420
Based on these global demand levels =>	83	86	90	Varies

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The hypothetical global oil cost premium is about $2200 per barrel. Some producing nations consume a significant amount of global oil production and set prices below world oil prices, so this estimate represents a hypothetical oil premium. The costs to oil products customers worldwide doesn't reach this level. But most customers in the OECD countries buy oil products refined from oil, priced near global prices. Therefore, the estimated monopsony oil premium currently exceeds $1000 per barrel, but less than $2200 per barrel. The last increment of global demand (4-5 million barrels daily) has an extraordinarily high cost.

Foreign substitution impacts the analysis, because if foreign countries match US substitution efforts, it takes less US substitution to reduce global oil prices. Since other countries in the OECD consume oil at over 140% of US consumption, these countries should match US substitution at 1.4X US substitution. Other countries not include in the OECD should also push substitutes, such that foreign substitution should exceed 2X US substitution.

The facts that much of the world's oil is priced below the market equilibrium price, and that global oil prices are affected by the OPEC cartel, demonstrates that applying free unregulated market models to the energy markets is unrealistic and leads to incorrect forecasts and predictions of market behavior. Oil market performance needs evaluation and it takes governmental initiatives to drive action to correct deficiencies and optimize the market performance to please customers and other stakeholders.

The biggest problem is the irrational global oil market pricing method. Essentially, the oil market treats customers like rats fighting for food. The global oil price is driven higher by a rationing premium, as customers fight over a limited production volume of crude oil. Suppliers of substitutes, and customers who purchase green vehicles, biofuels, or use more energy efficient transportation alternatives, don't receive benefits commensurate with the value delivered to customers in the global energy markets. The biggest benefits from a decision to buy a green vehicle accrue to remaining oil products customers, not to the green vehicle owner.

Slides 18 and 19 take the key analysis from Michalek 2011 and corrects the critical table calculations to arrive at a more accurate estimate of the net cost savings due to introducing different EV options. The top part of slide 18 shows a portion of Table S26 from Michalek 2011 showing lifetime ownership costs for each option.

Michalek 2011 used an oil premium of 22 cents per gallon ($9-$10 per barrel); this represents the US imported oil premium reported by Leiby 2007 based on the period 2000-2004 when oil prices were only $20-$40 per barrel, and OPEC had substantial curtailed production. Using 22 cents per gallon, the lifetime oil premium for an average CV was estimated at only $829 in Table S26. This amount represents Michalek's estimate of the indirect oil cost savings (due to lower oil market prices) from deploying a BEV substituting for a CV.

The CV owner would pay about $16700 for fuel and maintenance in the Michalek table, while the owner of the BEV would pay $7500 for electricity and maintenance. The owner of the BEV would save about $9000 compared to a CV over a 12-year lifetime due to direct oil cost savings and lower maintenance costs. However, the BEV costs substantially more to deploy than a CV making the unsubsidized total lifetime Net Cost higher than a CV.

The indirect cost savings using the outdated and incorrect oil premium estimate of $10 per barrel resulting in the indirect oil premium savings of $829 doesn't agree with the analysis of observed oil market price sensitivity to demand over the last ten years. This low estimate also doesn't agree with the IMF oil price elasticity of demand data, nor does this estimate agree with the supply/demand curve analysis, and this low estimate doesn't explain the market pricing observed in 2008/2009, and over the last six years.

Global Participation Matches 1:1 US/Canadian Fleet PHEV/EV Substitution

Adapted from Michalek et.al. 2011

Table S26. Lifetime ownership costs (*$2010 per vehicle lifetime*)

	CV	HEV	PHEV20	PHEV60	BEV
Base Vehicle Cost	23019	24800	25666	25729	20497
Initial Battery Cost	0	2068	2632	8730	31953
Battery Replacement Cost	0	0	0	0	0
Gasoline Cost	12386	8847	7189	6226	0
Electricity Cost	0	0	788	2314	5282
Scheduled Maintenance	4380	3962	3235	3235	2232
Charger/installation	0	0	1200	2400	2400
Net Cost	39786	39677	40709	48635	62364
Lifetime Oil Premium @22¢/gal.	829	592	481	417	0

Fleet Penetration Case	**Base**	(to achieve 22 cents/gallon gasoline price drop)			
Single Vehicle Lifetime Oil Premium	829	592	481	417	0
US/Can. Fleet Penetration Needed		4.4%	3.0%	2.5%	**1.25%**
Ratio of CV/EV		22	33	39	79
CV Fleet Oil Cost Savings per EV deployed		17539	26530	31714	65491
Total Savings by Other US/Can. Oil Customers per EV		7517	11370	13592	28068
Adjusted Net Cost	39786	14621	2809	3329	(31195)
Net Cost (Savings) for Foreign Oil Customers per foreign EV		(38913)	(77611)	(92585)	(228027)
Net Cost (Savings) of Global Consumers per EV Deployed	39786	(12146)	(37401)	(44628)	(129611)

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The current analysis in these comments extends and corrects the Michalek method to consider the recent global oil market observations, resulting in the revised estimates shown in slide 18. The analysis considers the US/Canadian fleet substitution by various EV alternatives, such as hybrids (HEV), plugin hybrids (PHEV), and battery driven vehicles (BEV). In order to get a reasonable estimate of US substitution net cost, the rate of foreign substitution needs to be considered. Slide 18 shows a case where foreign substitution deploys one EV for each EV deployed in the US/Canadian fleet; this case substitutes a much smaller fraction of the foreign fleet. Slide 19 shows a case where foreign substitution deploys two EVs for each EV deployed in US/Canada; this case roughly represents a case where the substitution rate in the OECD countries matches US/Canadian substitution.

Using a conservative estimate of price sensitivity to demand of a 16-18% drop in oil price for the first one percent decline in global demand, plus US/Canada EV deployment matched 1:1 by foreign EV deployment, with the US/Canada deployment causing the fleet penetration levels shown in slide 18, and then adding a small decline in refining margin, results in a price drop of 22 cents per gallon.

So for example, if BEVs deployed into the US/Canadian fleet of 240 million vehicles until they reached a 1.25% fleet penetration, and if other countries with 760 million vehicles matched the BEV deployment 1:1, then gasoline/diesel fuel prices would fall about 22 cents per gallon.

After 1.25% substitution, the vehicle fleet would have 79 CVs in the fleet for every BEV. Each owner of these CVs would save 22 cents per gallon on fuel energy cost, totaling over $800 in fuel cost savings for each CV over the vehicle lifetime. The indirect oil cost savings means that each BEV deployed to reach the 1.25% fleet penetration in the US/Canadian market saves the corresponding pool of 79 CV owners $65,000 over the 12-year period used in the vehicle lifetime analysis. Other oil products customers (e.g. jet fuel customers) save $28,000, bringing the indirect oil cost savings to over $93,000 per BEV deployed.

The indirect oil cost savings overwhelms the increased cost of the BEV. In the case shown in slide 18, the net cost of the BEV falls from $62,000 to a net savings of $31,000. The net cost $40,000 for a CV, turns into a net savings of $31,000 for each BEV deployed, a cost reduction of $70,000 for US and Canadian oil products customers for each BEV replacing a CV. The gasoline vehicle costs over $70,000 more than a comparable electric vehicle over the vehicle lifetime. Foreign customers save more on crude oil per BEV, getting a net savings to $130,000 for global oil customers, resulting in indirect cost savings of $170,000 for every BEV deployed globally to replace a CV.

Compare these results with the estimate of oil price change and economic impact from the original analysis using the outdated Leiby oil monopsony premium. In this case the 1.25% fleet penetration of BEVs, or a combination of PHEV/BEV reaching 2-3% fleet penetration, with the number of EVs deployed matched by the numbers of foreign vehicles deployed in the much larger global fleet, results in approximately 0.5% decline in global oil demand (about 600,000 BPD).

In this case, the global substitution would result in a decline in global oil prices. Using an oil monopsony premium of $10 per barrel used in Michalek 2011, applied to the decline of approximately 600,000 BPD, only results in global indirect oil cost savings of $6M daily. This represents a global oil price drop of less than seven cents per barrel. This doesn't agree with oil market observations. Oil price drops much further when daily oil demand declines by over half a million barrels.

This substitution case used in this analysis begins a rapid deployment scenario that reduces global oil demand 5% (about 4-5 million BPD). Using the oil monopsony premium of $10 per barrel, the results in global indirect oil cost savings of $40M-$50M daily; again only a drop of 44-55 cents per barrel. This estimate is ridiculously low. If daily oil demand fell by five million barrels, the oil price would drop over 50 dollars per barrel. The estimate of only $10 per barrel for the oil premium is inaccurate; a more accurate estimate would increase this oil premium by 100X.

This inaccurate estimate of oil monopsony premium has resulted in one of the largest engineering economics errors in history. The actual impact of green vehicle substitution on global oil prices is over 100X the estimate used in these studies. Not adjusting energy policy to account for an accurate estimate of the impact of green vehicle and biofuel deployment on oil prices represents one of the biggest economic mistakes by government and the private sector in the last decade. (Only the financial market collapse and the subsidized housing boom in the US, exceeds this mistake.) The mistaken estimate of oil market response to substitution was compounded by decisions to undertake military operations in the Middle East, possibly driven by the need to secure oil supply, and by decisions to continue government subsidies for fossil fuel producers and refiners.

Slide 19 shows the same calculations for a case with higher global participation deploying substitutes, where foreign countries deploy two green vehicles in their fleet, for every green vehicle deployed in the US/Canadian fleet. This should be a more realistic case, because many large vehicle fleet countries, in Europe, Japan, China, Korea, India, Brazil, have even bigger motivations and self-interest to deploy green vehicles and increase biofuel supplies than the United States. The net savings for each BEV deployed in US/Canada increases to $77,000, resulting in a cost reduction of $117,000 per BEV deployed to replace a CV.

Global Participation Matches 2:1 US/Canadian Fleet PHEV/EV Substitution

Adapted from Michalek et.al. 2011 — Table S26. Lifetime ownership costs (*$2010 per vehicle lifetime)*

	CV	HEV	PHEV20	PHEV60	BEV
Base Vehicle Cost	23019	24800	25666	25729	20497
Initial Battery Cost	0	2068	2632	8730	31953
Battery Replacement Cost	0	0	0	0	0
Gasoline Cost	12386	8847	7189	6226	0
Electricity Cost	0	0	788	2314	5282
Scheduled Maintenance	4380	3962	3235	3235	2232
Charger/installation	0	0	1200	2400	2400
Net Cost	39786	39677	40709	48635	62364
Lifetime Oil Premium @22¢/gal.	829	592	481	417	0
Fleet Penetration Case	**Base**	(based on 22 cents/gallon gasoline price drop)			
Single Vehicle Lifetime Oil Premium	829	592	481	417	0
US/Can. Fleet Penetration Needed		2.9%	2.0%	1.7%	**0.84%**
Ratio of CV/EV		33	49	58	118
CV Fleet Oil Cost Savings per EV deployed		26793	40119	47802	97861
Total Savings by Other US/Can. Oil Customers per EV		11483	17194	20486	41941
Adjusted Net Cost	39786	1401	(16603)	(19653)	(77438)
Net Cost (Savings) for Foreign Oil Customers per foreign EV		(20659)	(49062)	(58104)	(154911)
Net Cost to Global Consumers per Global EV Deployed	39786	(13306)	(38242)	(45287)	(129086)

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If the global participation matched US/Canadian deployment 3:1, a ratio similar to the relative size of existing vehicle fleets resulting in a more uniform global deployment, then the cost savings for US/Canadian fleets rises further, to a cost reduction of $170,000 for every BEV deployed to replace a CV.

Slide 20 draws the conclusions. Increasing demand has pushed production rates into a “Red Zone” where the oil price climbed to levels 3x-4x production costs. The incremental cost of oil to US customers in the Red Zone exceeds $600 per barrel, and could be as high as $1500 per barrel because demand drives the price for all crude oil higher. The current oil price is driven higher as the market exacts a rationing premium to price some customers out of the market. The incremental demand costs at least $14 per gallon, and likely in the range $25-$35 per gallon for vehicle fuels from petroleum, and this just includes the energy cost (not including refining and retailing margins and taxes). The incremental demand cost, including the monopsony premium, actually costs 5X to over 10X the market energy price.

Conclusion: A Decline in Oil Demand would Reduce the Oil Production Rate Significantly Below the Production Limit and Cause a Large Oil Price Drop

- Increasing demand has pushed production rates into a "Red Zone" where the oil price climbed to levels 3x-4x production costs.
- Incremental cost of oil to customers exceeds $600 per barrel, and could be as high as $1500 per barrel, due to the increased price on existing purchases caused by the extra demand.
- The higher price gives US domestic oil producers an additional $200B annually, with some of these windfall profits invested to push to higher levels of high cost oil production.
- Alternatively, a significant portion of customer payments for oil products, could be directed into green vehicles, biofuels, or energy efficiency investments, to reduce oil demand.
- Re-allocating the capital flow would result in lower oil prices, and the resulting savings could fund the investments to reduce oil demand.
- Each time a conventional vehicle is purchased instead of a green vehicle, the sum of the misallocated purchase cost plus the oil cost premium incurred is approximately $120k.
- Not deploying 8 million green or biofuel vehicles per year is a suboptimal investment decision causing $1 trillion of misdirected cash flow during these vehicle lifetimes.
- Reaching this level of green vehicle sales as rapidly as possible, reduces the $1 trillion annual opportunity cost of delaying the deployment.

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The higher oil price gives US domestic oil producers an additional $200 billion annually, with most windfall profits invested to increase high cost oil production. Alternatively, a significant portion of the customer payments for oil products could be redirected into purchases of green vehicles or biofuels, and or into investments to improve energy efficiency or conservation to reduce oil demand.

Each time a conventional vehicle is purchased instead of a green vehicle, the sum of the misallocated purchase cost plus the oil cost premium incurred over the vehicle lifetime adds to approximately $120,000 to $160,000. The high cost incremental demand (high oil monopsony premium) makes the green vehicle the preferred economic choice.

This high cost of incremental demand should cause a rapid deployment of green vehicles into the vehicle fleet to use substitute energy sources or fuels. The US fleet needs to deploy about 50 million vehicles into the fleet quickly, and this means a reasonable target should deploy 8 million green vehicles annually as soon as possible. Not reaching this target results in a suboptimal investment decision causing $1 trillion in of misdirected cash flow over the lifetime of the 8 million conventional vehicles deployed annually instead. Increasing green vehicle sales rapidly reduces the $1 trillion annual opportunity cost due to the delay of green vehicle deployments.

The last slide in this presentation, lists some important questions: Why didn't the oil industry propose action to address dysfunctional oil markets? Why did "Drill baby, drill!" become the only acceptable industry solution to rising oil prices? Why didn't the green vehicle manufacturers or biofuel industry propose action based on dysfunctional vehicle fuels markets? Is the huge oil industry financial support of politicians tied to blocking green energy policies, an attempt to avoid the financial consequences of substitution on oil producers, refiners, and marketers?

And what is the best way to ramp green vehicles into the vehicle fleet, and increase the production and use of biofuels?

We suggest the best way involve the use of a regulated private sector group (Green Vehicle Group) that can identify and evaluate methods to reduce oil demand, then invest in incentives to deploy substitutes and reduce oil demand. The next section of these comments reviews this proposal, by developing a green vehicle deployment program example. The rapid green vehicle deployment program performs well, decisively defeating the current 'drill, baby, drill' approach, and performs better than the slow deployment plan currently sponsored by governments.

Important Questions:

Why didn't the oil industry engineers and economists discover this and propose action?

Why didn't the green vehicle industry, or the biofuel industry, discover this and propose action?

What is the best way to ramp green vehicles into the vehicle fleet and increase the production and use of biofuels?

Why did "Drill baby, drill!" become the only acceptable answer to addressing rising oil prices in a dysfunctional oil market?

Is oil industry financial support of Republican politicians (especially Tea Party), tied to blocking green energy policies and reducing financial impacts on their industry that would be caused by green vehicle substitution?

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Vehicle Fuels and Oil Market: "Customers First" Approach

- Vehicle Fuels Market: Analysis Overview
- Crude oil price history: Since 1990
- Green Vehicle Group (GVG) Strategy
- Examples that Reduce Crude Oil Demand
- Increase Green Vehicle Incentives
- Analysis of Fleet Penetration and Tax Credits
- Incentivized Green Vehicle Penetration Into the American Vehicle Fleet
- Impact of fleet change on American Oil Demand and Global Oil Market
- Faster American Green Vehicle substitution increases cost of existing tax credits, but results in much higher Direct Cost Savings by GV customers
- Cost of extra incentives to ramp GV fleet results in much higher Indirect Cost Savings to CV customers
- Extra GV Incentives Cost/Benefit Analysis (based on recovering 30% of CV customers cost savings)

Due to the high oil premium cost on incremental oil demand, rapid deployment of green vehicle substitution serves customers better than the status quo. Currently the government subsidizes green vehicles and biofuels, but not even close to the incentive level needed to capture a significant portion of the vehicle fleet. The existing US federal tax credit of $7500 for a BEV is less than 6% of the indirect oil cost savings of $120,000 to $140,000. The savings can justify much higher incentives.

An effective target would reduce global oil demand by 5% (due to substitution) as soon as possible. If substitutes penetrate 22% of the US + Canada fleet of 250 million vehicles, then global demand for crude oil would decline approximately 3.5%, and foreign substitution should kick in another 2-3% decline. This target requires substitution of 55-60 million green vehicles (or a larger number of PHEV and biofuel flex vehicles) in American and Canadian fleet. America should reach an annual deployment of 8 million green vehicles as rapidly as possible. This ambitious plan deploys substitute vehicles and biofuels much faster than anyone in the DOE or private sector currently envision.

But thousands of opportunities exist to reduce oil demand and deploy substitutes. Governments are not the best organizations to select and fund opportunities, or decide on the most effective deployment plan, let alone manage deployment. Private sector organizations, possibly with some government partners, should get this responsibility. And governments should set up funding mechanisms to keep these privately run organizations operating to improve energy market performance.

Although not currently considered by decision makers, methods and plans to deploy substitutes to reduce oil demand and drive down oil prices exist; wherein some portion of the oil cost savings, funds incentives driving the substitution. Although the government could pay for incentives for substitution, then collect some of the cost savings from a crude oil tax; this would involve a very unwieldy and bureaucratic system. The economic benefits from this aggressive substitution plan result from a speedy ramp in substitution, and the private sector can move more quickly than government driven programs.

The best solution uses a regulated private sector Green Energy Coalition that invests to ramp green energy, improve effective use of energy, and increase carbon sinks. The business Coalition would receive compensation from the government, from a pass-through tax on fossil fuels. In particular, a Green Vehicle Group subsidiary of the Coalition would invest in substitutes for crude oil and other methods and systems to reduce oil demand, then evaluate and monitor progress and oil market behavior. After the oil price begins declining, the government should levy a crude oil tax (based on the drop in oil prices below the forecast trend) to capture a sizable fraction (30% to 50%) of the customer cost savings, and arrange pass-through of this cash flow to the Green Vehicle Group. This enables the Group to continue investing in incentives to reduce oil demand, ramp green vehicle use, and increase biofuel sales. The result: increasing investment in green energy systems; investment shifted from the fossil fuel sector.

The next section of this comment report, examines the possible operation of a Green Vehicle Group, dedicated to driving substitution and reducing crude oil consumption.

Vehicle Fuels Market: Analysis Overview

- Dysfunctional Crude Oil Market
  - Oil price greatly exceeds crude oil cost (= finding cost + lift cost)
  - Subsidies for fossil fuel projects and investments, plus lack of cost for externalities has resulted in a huge misallocation of capital
- Substitute Fuels or Substitute Vehicles Reduce Demand for Crude Oil
  - Oil price volatility and impact from 5+% substitution in the global markets drives down oil prices.
  - Cost savings to customers greatly exceeds cost of substitute products capturing 5% of the oil products market.
- Setup a Green Vehicle Group (GVG) to invest in substitutes
  - Levy a crude oil tax (based on falling oil prices) to capture a fraction of the customer cost savings.
  - Use the tax proceeds to fund GVG investments in substitutes

Returning to the ‘Customers First’ Energy Market Approach pdf deck, the slides present a recommended method to ramp green vehicles deployment. Slide 7 gives an overview of the vehicle fuel market analysis that culminates in the recommendation to set up a regulated private sector entity, a Green Vehicle Group to invest in substitutes. After the oil price begins declining, the government should levy a crude oil (based on falling oil prices below the forecast trend) to capture a fraction of the customer cost savings. Then use the tax proceeds to fund the Group investments in substitutes, thus creating a positive feedback loop to reduce oil demand and prices.

Slide 8 shows the oil price history, already discussed in these comments. Slide 9 shows oil market price volatility, also already discussed above. The graph shows the expected oil price (based on a reference price of $100 per barrel with the world producing at full capacity), with the decline in price caused by permanent declines in demand. The expected oil price response shows oil price falling almost to $40 with a demand reduction of 5-6%.

A Green Vehicle Group could target a large number of initiatives to reduce crude oil demand, ranging from vehicle and fuel substitution, alternative transportation alternatives, energy efficiency, urban development, city planning, better quality transportation alternatives, and distributed work centers.

Green Vehicle Group (GVG) Strategy

- Form a jointly owned, independent company to promote initiatives and subsidies that will encourage growth in the green vehicle market .
- Propose and enact policies to incentivize public and private companies to reduce crude oil consumption
- Use the crude oil cost savings to reimburse the Green Vehicle Group's investments and subsidies.
- Fuel substitution decreases the fossil energy cost per mile driven by over 80%, although, investments in green vehicle manufacturing, battery storage, biofuels, and power distribution increase substantially as investments shift to these sectors.
- Possible Green Vehicle Group members:
  - Vehicle manufactures
  - Battery manufacturers
  - Power generators and distributors
  - Cities and States
  - Major oil companies

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Slide 10 describes the Green Vehicle Group strategies for providing incentives to green vehicle manufacturers and biofuel producers, possibly augmented by incentives for customers to buy these substitute products and reduce crude oil demand. Green Vehicle Group investors could include vehicle manufacturers, battery manufacturers, biofuel producers, power companies, city and state governments, and even some major oil companies.

Many companies should consider investing in a Green Vehicle Group because the Group incentives would increase demand for existing products and business units. If the Group operates as part of a Green Energy Coalition also investing in green power, natural gas, and coal power plant replacement, the pool of potential investors increases. The current review cover the option of establishing a Green Vehicle Group as part of a larger Coalition, after discussing and recommending actions required in these other energy markets. Part 5 of the review comments recommends forming the Coalition.

Examples that Reduce Crude Oil Demand

- Provide increased incentives to green vehicle manufacturers and marketers, reducing green vehicle costs to customers:
  - Increase green vehicle incentive to over $15,000 for PHEVs or EVs
  - Increased incentives substantially increase fleet penetration
- Provide incentives to biofuel producers
  - Increase biofuel compensation 20-50% (received by biofuel producers)
  - Reduces biofuel prices to customers to less than gasoline or diesel
- Invest to deploy more fuel efficient vehicles, or alternate vehicles
  - Incentives to deploy electric motorcycles or scooters, or even bicycles
- Expand and improve mass transit in key areas of the county
- Expand and improve high speed rail both short and long distances
- Provide incentives for homeowners to switch from heating oil to heat pumps

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Slide 11 shows some examples of methods that could be used to reduce crude oil demand.

Deciding on levels of incentives, infrastructure investment, and manufacturer and producer support (including direct investment), involves a complicated set of analyses that requires constant update and revision. Government agencies would have difficulty executing these tasks; whereas private sector entity could execute and improve investments in green energy much better than governments.

Although in the example estimating the impact of reduced oil demand in the next section uses primarily vehicle substitution as the primary Green Vehicle Group activity, possible actions includes many more options to reduce oil demand. For the purposes of this review, vehicle substitution provides a transparent and easily understood set of actions to reduce global crude oil demand. So even if the substitution schedule seems overly ambitious, the actual plan implemented by the Group would likely rely on more options to reduce oil demand, and less on vehicle substitution. Please consider this example as a preliminary plan, and that the Group would use existing expertise of their members to substantially improve this plan. Considering the number of EV alternatives currently under development and scheduled for deployment by existing vehicle manufacturers, the most understandable action to reduce oil demand, simply uses added incentives to manufacturers or customers to purchase EVs.

Increase Green Vehicle Incentive

Provide increased incentives to green vehicle manufacturers and marketers, reducing green vehicle costs to customers:

- Current green vehicle incentive not attractive to many customers
  - Currently US tax credit maximum = $7500 (California adds $2500 to max $10,000)
  - Current cost premium for green vehicles exceeds $20,000
  - Current incentive reduces cost premium to customer to $12,500 (CA = $10,000)
  - Average customer saves $1200-$1800 per year in fuel costs (6-10 year payout)
- Increase green vehicle incentive to over $15,000
  - Higher incentive reduces cost premium to less than $5000
  - Results in 3-4 year payout for customers

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One of the important Green Vehicle Group leverage investments includes increased green vehicle incentives, particularly incentives for battery-electric vehicles. Slide 12 shows a brief summary of a proposal to add $7500 to the existing US tax credit maximum of $7500, for a total incentive exceeding $15,000. This lowers the BEV cost premium to as little as $5000 from over $20,000 (pays most of the battery pack, and results in a four year payback for customers of BEVs).

A larger battery pack could cost more. In Michalek 2011, the battery pack was estimated to cost $32,000, so a total incentive of $15,000 would cut the pack cost roughly in half, and leave a $17,000 net cost resulting in over a ten-year payout for BEV customers. But as production of BEVs and other EV alternative increases, efforts to optimize the supply chain should reduce the battery cost substantially, and the remaining cost of the EV. The battery cost has already fallen about 25-30% since the data used in the 2011 study. The Michalek 2011 study neglected declining battery and EV costs, and then compared with mature product costs for CVs; yet another key mistake that led to incorrect conclusions.

In the analysis that follows, the Green Vehicle Group initially adds incentives at $14,000 per BEV to the Federal tax credit, to pay for $21,500 of the BEV cost. The Group's added incentive would decline over time, anticipating improved costs for batteries and EVs. Given the anticipated cost of battery packs, the combined incentives would initially pay for most of the battery pack cost.

Analysis of Fleet Penetration and Tax Credits

Incentivized Green Vehicle Penetration into the American Vehicle Fleet

Adding extremely generous incentives to existing tax credit should capture 40-50% of new vehicle market by 2020, with fleet penetration over 20%.

Annual Vehicle Additions/Replacements

	Annual Growth	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Vehicle Fleet Additions	0.2%	24	24	24	24	24	25	25	25	25	25	25	25	25	26	26
Biofuel	30%	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.8	1.0	1.3	1.7	2.2	2.9	3.8
PHEV & EV	S-curve	1.6	2.5	4.5	6.0	7.5	9.0	10.4	11.5	12.1	12.1	12.1	12.1	12.1	12.1	12.1
CNG	25% / 20%	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8
Mogas & Diesel	0.20%	22	21.4	19.5	18.1	16.6	15.1	13.7	12.5	11.9	11.7	11.5	11.1	10.6	10.0	9.1
Green Vehcile Market Penetration		7.1%	10.9%	19.2%	25.5%	31.8%	38.0%	44.1%	48.6%	51.4%	52.1%	53.0%	54.3%	56.1%	58.4%	61.5%
Extra Incentive per vehicle	*Thousand $*	*14.0*	*12.0*	*11.0*	*10.0*	9.0	8.1	7.3	6.6	5.9	5.3	4.8	4.3	3.9	3.5	3.1
Cost of Incentives	*Billion $*	22	30	50	60	68	73	76	75	71	64	58	52	47	42	38
Accumulative Cost	*Billion $*	22	52	102	162	229	302	378	**454**	525	589	647	699	745	787	**825**

Adding incentives to existing tax credit could cost over $800B in fifteen years, but could replace 50% of the fleet

American Vehicle Fleet Composition

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Vehicle Fleet	230	230	231	232	233	235	236	237	238	239	241	242	243	244	245	247
Biofuel	0.4	0.5	0.6	0.8	1.0	1.2	1.6	2.1	2.7	3.4	4.5	5.8	7.5	9.7	12.6	16.4
PHEV & EV	0.0	1.6	4.1	8.6	14.6	22.1	31.1	41.6	53.1	65.1	75.6	85.1	92.7	98.7	103.3	106.4
CNG	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.8	1.0	1.3	1.6	2.0	2.5	3.1	3.7	4.6
Mogas & Diesel	230	228	226	223	218	211	202	193	181	170	159	149	140	133	126	119
Green Vehicle Fleet Penetration	0.2%	0.9%	2.0%	4.0%	6.7%	10.0%	13.9%	18.4%	**23.4%**	28.6%	33.3%	37.6%	41.2%	44.4%	47.2%	**49.8%**

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Slide 13 shows a preliminary Analysis of Fleet Penetration and Tax Credits (done in August 2012) that shows an example of an extremely rapid green vehicle deployment.

The slides cut the entire spreadsheet analysis into five parts. The dates (years) in the spreadsheet simply represent the first years following the analysis date, and not a forecast. Since the Green Vehicle Group hasn't yet been established, all the dates shown should slip 2-3 years. This analysis and spreadsheet presents an example and a preliminary estimate, and not a comprehensive study. In all likelihood, the ramp in biofuels such as ethanol could happen faster than shown, and ramp shown for EVs seems too fast. Nevertheless, the analysis allows policy makers and business leaders to draw critical conclusions, and justifies a more comprehensive analysis.

In the first year of the analysis, 1.6 million large battery PHEVs and EVs are deployed, and ramped as rapidly as possible in an S-curve deployment to over 8 million units; eventually reaching 12 million units annually in fifteen years. Biofuel vehicles and CNG vehicles total another 4-5 million units by the end of this period.

In the first year of green vehicle deployment, the extra incentive paid by the GVG would add $14,000 (to the $7500 federal tax credit), paid to the customer or manufacturer. The total of $21,500 would pay 60%-80% of the cost of the battery pack for EVs; or alternatively pay a significant portion of biofuel costs. Using the aggressive deployment schedule show, the annual cost of the GVG incentives starts around $20B then increases to $70B five years into the program; with funding increases, even as the extra incentive per vehicle declines from $14k per green vehicle to $9K per vehicle.

The ramp of green vehicles in the spreadsheet is very aggressive, attempting to exceed 20% of the US/Canadian fleet within eight years, and approach 50% within fifteen years. The estimated cost of the incentives exceeds $800B, to penetrate the fleet to this degree. Many could argue this deployment unrealistic; however this deployment would be highly profitable, saving customer far more than the cost of the tax credit + extra GV incentives, so can we be sure the private sector can't achieve this transformative change in the vehicle fleet?

Give the private sector the profit motivation to accomplish the transformation, and let them figure the best way to do it. The Green Vehicle Group business coalition would actively solicit methods to reduce oil demand, and eagerly fund efforts to ramp green vehicle use; as well as other methods to reduce oil demand.

- ✧ An American Green Vehicle ramp could reduce world oil demand by 3-4% by 2020 due to 20+% fleet penetration…
  - … and within 15 years, America's green vehicle could reduce world oil demand by 9%.
- ✧ If other countries ramped green vehicles at half this rate, demand could fall almost 10% by 2020 ...
  - … and within 15 years, world oil demand could fall over 20%.

Impact of fleet change on American oil demand, plus lower substitution globally, on Global Oil Market

Demand In million barrels per day	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Mogas/ Diesel	13.0	12.9	12.8	12.6	12.3	11.9	11.5	10.9	10.3	9.6	9.0	8.4	7.9	7.5	7.1	6.8
Oil for Mogas/ Diesel	14.3	14.2	14.1	13.9	13.6	13.1	12.6	12.0	11.3	10.6	9.9	9.3	8.7	8.3	7.8	7.4
Total Oil consumption	16.9	16.8	16.7	16.5	16.2	15.7	15.2	14.6	13.9	13.2	12.5	11.9	11.3	10.9	10.4	10.0
Reduction: Oil Demand	0.0	0.1	0.2	0.4	0.7	1.2	1.7	2.3	3.0	3.7	4.4	5.0	5.6	6.0	6.5	6.9
World Oil Demand	89.0	89.0	89.0	89.0	89.0	89.0	88.1	87.2	85.5	83.8	82.1	80.5	78.8	77.3	75.7	74.2
% Reduction in Gobal Demand (due to lower American demand)		0.1%	0.2%	0.5%	0.8%	1.3%	1.9%	2.6%	**3.5%**	4.5%	5.4%	6.2%	7.0%	7.8%	8.5%	**9.3%**
% Reduction in Gobal Demand (due to lower foreign demand)		0.1%	0.1%	0.2%	0.4%	0.7%	1.0%	1.3%	1.8%	2.2%	2.7%	3.1%	3.5%	3.9%	4.3%	4.6%
% Reduction in Gobal Oil Demand		0.2%	0.3%	0.7%	1.3%	2.0%	2.9%	4.0%	**5.3%**	6.7%	8.0%	9.4%	10.6%	11.7%	12.8%	**13.9%**
Forecast Oil Price	$84	$88	$93	$94	$91	$85	$72	$53	**$41**	$39	$39	$40	$44	$46	$51	$56
Trend Oil Price 8% / year	84	91	98	106	114	123	133	144	155	168	181	196	212	228	247	266
Foreign fleet growth	1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.29	1.32	1.35
% Reduction Gobal Demand (if GV penetration of foreign fleet is half US)		0.4%	0.7%	1.4%	2.4%	3.7%	5.3%	7.2%	**9.5%**	11.9%	14.1%	16.3%	18.2%	19.9%	21.5%	**23.0%**

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The spreadsheet continues in slide 14, estimating the impact on world oil demand of substitution in the American market, then adding foreign substitution assumed at half the penetration rate of the green vehicle units deployed in the American market. Global oil demand would decline five percent in eight years; due to rapid substitution in the American market augmented by foreign substitution assumed at only half the green vehicles deployed in the US/Canada market.

In a second case of added foreign substitution where GV penetration matches the US/Canadian fleet, the global demand declines almost ten percent in eight years. In fifteen years under this case, global demand for crude oil would decline about 23%. This second case represents a more likely outcome, but the two cases probably bracket the outcome.

Faster American Green Vehicle substitution increases the costs of existing tax credits:

- Over 15 years, the tax credits cost over $1 trillion, **but…**

  … **direct customer cost savings** due to lower volumes of crude oil purchased **exceed $3.5 trillion**.
- Could we recover a portion of the cost savings to cover the cost of the tax credits?

  Direct customer cost savings cover the annual cost of tax credits in the 7th year, so some kind of tax could be levied to recover increased cost of existing tax credits due to faster substitution without imposing higher costs on customers (more on this later in this report).

Cost of Existing Tax Credits would Rise with Faster Green Vehicle Deployment, but Customer Direct Cost Savings Rise More

8% Oil Inflation Case: Reference Oil Price based on 8% annual price increase (48 month rolling average), versus 10.7% annual increase over last 15 years

		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Reference Oil Price		$84	$91	$98	$106	$114	$123	$133	$144	$155	$168	$181	$196	$212	$228	$247	$266
Direct Oil Cost Savings (reduced oil demand)	*Billion $*		4	7	16	31	53	82	121	170	229	291	359	429	503	582	668
Cumulative Direct Oil Cost Savings	*Billion $*		4	11	27	59	111	193	314	484	713	1004	1363	1793	2296	2878	**3546**
Cost of Tax Credits (with large GV fleet)	*Billion $*		12	19	34	45	56	68	78	86	90	90	90	90	90	90	90
Cumulative Cost of Tax Credits	*Billion $*		12	31	65	110	166	233	312	398	488	579	669	759	850	940	**1031**
Direct Oil Cost Savings less Cost of Tax Credits	*Billion $*		-8	-20	-37	-51	-55	-40	**2**	86	225	426	694	1033	1446	1938	**2515**

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In slides 15 and 16, the spreadsheet continues and estimates oil cost savings. The reference oil price forecast is shown, escalating at a lower rate than the escalation over the last fifteen years (when this analysis was done in late 2012). Please note the current average global oil price in 2014 matches/exceeds the reference price of $98 per barrel forecasted more than two years ago. The oil price forecast for the green vehicle substitution case was shown in slide 14, showing a reduced oil price declining to about $40 per barrel in eight years.

The direct oil cost savings result from the reduced oil demand multiplied by the cost per barrel of reduced demand. Direct oil cost savings would hit $170B annually within eight years, and the cumulative savings in the first fifteen years of the aggressive GV ramp would reach $3.5 trillion. The cumulative cost of existing federal tax credits over the same fifteen years would reach $1.0 trillion, for a net savings due to direct oil cost savings of $2.5 trillion.

Costs of extra incentives to ramp American Green Vehicle fleet:

- ✧ Over 15 years, the extra incentives cost over $800 billion, but…

  … indirect customer cost savings due to lower prices for crude oil exceeds $6.6 trillion.
- ✧ Could we recover a portion of the indirect cost savings to cover the cost of the extra incentives?
- ✧ Customers' indirect savings cover the cost of the extra incentives within three years.
- ✧ Option to recover costs of both the tax credits, and additional incentives:

  Use a variable crude oil tax based on the decline in oil price below a reference oil price trend.

Reference Oil Price		$84	$91	$98	$106	$114	$123	$133	$144	$155	$168	$181	$196	$212	$228	$247	$266
Forecast Oil Price (48-month moving average)		$84	$88	$93	$94	$91	$85	$75	$65	$59	$54	$47	$44	$40	$40	$40	$40
Indirect Oil Cost Savings (reduced oil prices)	*Billion $*		16	33	73	136	223	323	419	492	547	614	659	710	747	787	829
Cumulative Indirect Oil Cost Savings	*Billion $*		16	49	122	258	481	804	1223	1714	2262	2876	3535	4245	4992	5780	**6609**
Cost of Extra Incentives	*Billion $*		22	30	50	60	68	73	76	75	71	64	58	52	47	42	38
Indirect Oil Cost Savings less Incentive Costs	*Billion $*		-6	3	24	76	155	250	343	416	476	550	601	658	701	745	791
Cumulative Cost of Extra Incentives	*Billion $*		22	52	102	162	229	302	378	454	525	589	647	699	745	787	**825**
Cumulative Indirect Savings less Incentives Costs	*Billion $*		-6	-3	**20**	96	252	502	845	1261	1737	2287	2888	3546	4247	4992	**5784**

Note: Forecast oil price based on world oil demand elasticity of 0.06 for the first 3 percent of demand drop.

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Slide 16 shows the reference oil price forecast versus the substitution oil price forecast; using the difference in oil price multiplied by the remaining oil demand forecast (shown in slide 14) calculates the indirect oil cost savings. After eight years of aggressive GV substitution, the indirect oil cost savings reach $490B annually, with cumulative indirect oil cost savings over the first fifteen years reaching $6.6 trillion in fifteen years. The cumulative cost of the extra GVG incentives are only $0.8 trillion, resulting in net indirect oil cost savings of $5.8 trillion in fifteen years.

The indirect oil cost savings exceeds the cost of GVG extra incentives within 3-4 years of beginning an aggressive ramp of green vehicle deployment.

Recovering costs of extra incentives using a crude oil tax based on 30% of customer crude oil purchase cost savings:

- ✧ Cumulative cash flow over 15 years exceeds $1.1 trillion.
- ✧ Highest cumulative net investment is approximately $85 billion in year 4 and year 5.
- ✧ Before-tax IRR equals 37%, and could be higher if crude oil prices fall due to reduced demand, as much as occurred in 2008.
- ✧ Forecast of crude oil price forecast assumes low to moderate levels of similar policies enacted by large oil consuming countries.

Green Vehicle Incentives Cost/Benefit Analysis

Incentive using Inflating Reference Price: Cost Savings Share: **30%**

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	
GV Incentive Oil Tax	0	1	2	4	7	12	17	24	29	34	40	46	51	57	62	68	
GV Incentive Proceeds	0	5	10	22	41	67	97	126	147	164	184	198	213	224	236	249	
Accumulative Proceeds *Billion $*		5	15	37	77	144	241	367	514	679	863	1060	1273	1498	1734	1983	
Oil Price + Incentive Tax	84	89	94	97	98	96	93	89	88	88	87	89	91	97	102	108	
delta Effective Oil Price	0	-2	-4	-9	-16	-27	-41	-55	-68	-80	-94	-106	-120	-132	-145	-159	
GV Group Economic Analysis																	
Incentive Costs		22	30	50	60	68	73	76	75	71	64	58	52	47	42	38	
Savings Share Income		5	10	22	41	67	97	126	147	164	184	198	213	224	236	249	BT IRR
Net B4-Tax Cash Flow		-18	-20	-28	-19	-1	24	49	72	93	120	140	161	177	194	211	***37%***
Cumulative Cash Flow			*-38*	*-65*	*-84*	***-85***	*-61*	*-12*	*61*	*154*	*274*	*414*	*575*	*752*	*946*	***1157***	

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Slide 17 then continues the spreadsheet analysis by adding a crude oil tax based on 30% of oil customer cost savings. The savings share income to the Green Vehicle Group from a pass-through tax based on oil price falling below the reference price trend forecast, increases to the $60B-$70B range within five years; a level expected to match outgoing GVG investment in GV incentives, thus reaching breakeven cash flow.

The GVG would have a positive cumulative cash flow of over $1.1 trillion over a 15-year period, and discounting the cash flow results in a before-tax internal rate of return (IRR) of over 35%. This excellent return is garnered by capturing only 30% of the anticipated decline in oil costs due to the dropping demand and prices for crude oil in America. Global oil customers also benefit from declining oil prices, a fact that should prompt substitution, and perhaps Green Vehicle Group programs, in Europe and Asia.

The preliminary analysis presented by the spreadsheet (covered in slides 13-17) shows that only a fraction (30%) of the indirect oil cost savings, sufficiently funds an extremely rapid GV substitution program in the US/Canadian vehicle fleet. Although preliminary, the analysis is robust enough to hold up through a more comprehensive final review. This result should shift attention to planning and executing a rapid green vehicle deployment program. Skibo Systems LLC suggests that America should use a regulated private sector entity, a Green Vehicle Group, to plan and execute this GV deployment program.

Extrapolation of Rapid Green Vehicle / Biofuel Substitution Program

The example used in the spreadsheet underestimates the impact of substitution on crude oil prices for a number of reasons:

1. The additional incentives awarded by the Green Vehicle Group can target the highest gasoline and diesel consuming vehicles in the fleet. A significant portion of the vehicle fleet use 2x-4x the average vehicle fuel. The incentives should get at least twice “the bang for buck” by targeting the big users. The spreadsheet doesn’t reflect this distribution. By targeting the big users for substitution, the drop in global oil demand should be almost twice the estimates in the spreadsheet.

2. The spreadsheet likely underestimates foreign substitution programs. Fuel costs significantly more in most other countries with large fleets, so additional green vehicle initiatives in those countries should push fleet penetration to levels higher than the US. In slide 14, the global decline in oil demand due to US substitution in year eight is estimated at 3.5%, with foreign substitution increasing the decline to over 5% resulting in a $40 oil price. If the foreign substitution matches US fleet penetration, then oil demand could decline 5% before year five. The oil price could reach $40 per barrel price within 4-5 years of a rapid green vehicle ramp globally.

3. Practices and methods to provide transportation alternative to vehicles can take market share, particularly mass transit, small alternative vehicles, and vehicle share programs. Adding incentives payments to these programs could reduce oil demand more per dollar expended, than green vehicles.

4. Incentives can be offered to improve energy efficiency for liquid fuel vehicles. For example, some advance fuel injection technology can cost $500-1000 per vehicle to retrofit, which limits current deployment. But if these advanced systems can improve mileage by 10%, incentives could pay for the retrofit. Although improving gasoline and diesel fuel efficiency technology seems to run counter to green vehicle initiatives, some of the new tech should also apply to biofuel vehicles resulting in energy efficiency benefits.

5. Establishing a Green Vehicle Group should result in an explosion of new and innovative technologies set off by providing a funding source to bridge Valley of Death for energy tech developers. The new innovative tech should drive substitution, and speed up supply chain improvements lowering the cost of substitution.

Based on these factors, the actual program rollout should easily beat the financial projections made in the spreadsheet. A Green Vehicle Group should achieve much better results than shown, more quickly than forecast, and deliver bigger cost savings to customers due to faster positive impacts, and recover and redeploy foreign oil development funds.

Crude Oil Market and Related Markets – Summary and Conclusions

The "substitution for oil" example and preliminary analysis of green vehicle substitution leads to some extremely important conclusions:

1. The crude oil market, and the related transportation fuels market don't serve customers and other stakeholders well.

2. Rapid deployment of green energy substitutes for oil results in much lower customer costs for crude oil purchases, addresses key national security concerns, improves the economy, and addresses environmental objectives and goals.

3. Existing crude oil producers and refiners exhibit predatory behavior and use a TTMAR business model; they engaged in efforts to restrict and stop substitution and stymie regulations to improve effective use of energy.

4. Vehicle manufacturers have used business plans that didn't include the value created by the impact of green vehicles on crude oil prices.

5. Government regulations and subsidies won't drive substitution and reduce oil demand quickly enough to provide the best outcome for customers. A better approach uses a regulated private sector group to fund substitution and reduce oil demand.

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