GLOBAL RESOURCE RISKS AND OPPORTUNITIES

A Perspective on Stranded Assets and Portfolio Rebalancing

The following is the result of a two year conversation between the principals of ***resourcient*** *(a resource-focused capital, advisory and networking firm), and senior asset managers in several of the world's largest pension funds, several professors at the Steyer-Taylor Institute at Stanford University, executives of The Carbon Tracker organization in London, senior staffers at The Rocky Mountain Institute in Colorado and a number of senior investment professionals across leading firms in the alternative energy sector. The views expressed here are those of the* ***resourcient*** *team.*

Energy stocks, particularly holdings in oil, gas and coal, have traditionally represented as much as seven percent or more of institutional investor holdings and, until very recently, an even larger share of profits and distributions. From 2005-2009, returns on oil and natural gas assets in the top two state funds in 17 states, which include almost half of all the people covered by state and local pension plans in the U.S., averaged 42 cents for each dollar invested compared to just 6 cents for other assets in these funds. Investments in the oil and gas industry accounted for 4.6 percent of the average fund's total assets while producing 15.7 percent of total returns during that period.

However, we are beginning to see some very significant changes in the expectations that investors have about the forward performance of their energy holdings. Though very little action has, as yet, been taken to actually constrain carbon emissions from fossil fuels and penetration levels of renewable energy remain low, environmental sustainability is no longer a fringe consideration.

Today, increased volatility in oil prices is threatening to put at least some oil holdings under the same pressure already seen in the coal industry and in the European power utilities industry. The tougher question is whether these are momentary blips or harbingers of longer term trends and changes that should affect how investments in energy as an asset class, and perhaps a broader range of commodities whose prices are heavily correlated to energy costs, are viewed and handled.

An additional factor is the possibility of fossil fuels becoming "stranded assets" – assets that are highly valued today, particularly in the form of reserves, but will be far more difficult to monetize in a carbon constrained world. Commonly, this risk of "stranding" is thought of as the result of governmental action to limit the use or burning of fossils; however, a more sophisticated view acknowledges that a case of peaking and then declining demand (especially in the face of ever increasing costs) may be the critical driver.

As investors contemplate these risks and changes, they are also encountering a broader issue – whether a much larger percentage of their overall portfolio is correlated to these risks, not just with respect to fossil fuels, but with respect to commodities whose availability and pricing is likely to be much more volatile in the future than has historically been the case. Early indications are that examining the typical portfolio for risk correlations of this type will lead to a conclusion of much higher than expected risk correlation and much lower than expected diversification vis-à-vis resource risk. If and when and broader range of investors comes to the realization that a substantial portion of today's fossil reserves are unusable and the associated E&P business models become constrained, there may be a much more rapid rush for the exit than the market today acknowledges.

There are no easy or certain answers to most of these questions. But investors who aren't at least asking themselves the questions are likely to be left behind as the history of these changes implies

that prices drop far faster than laggards can escape the no longer favored asset classes. The bigger an institution you are the harder it is to effectively move once the shift has started, but it is equally clear that our biggest institutions find it hardest to be leaders in making shifts of this magnitude. Fundamentally, we believe that all asset managers should be asking themselves which of the following courses of action they are and should be pursuing:

How Are You Playing It?

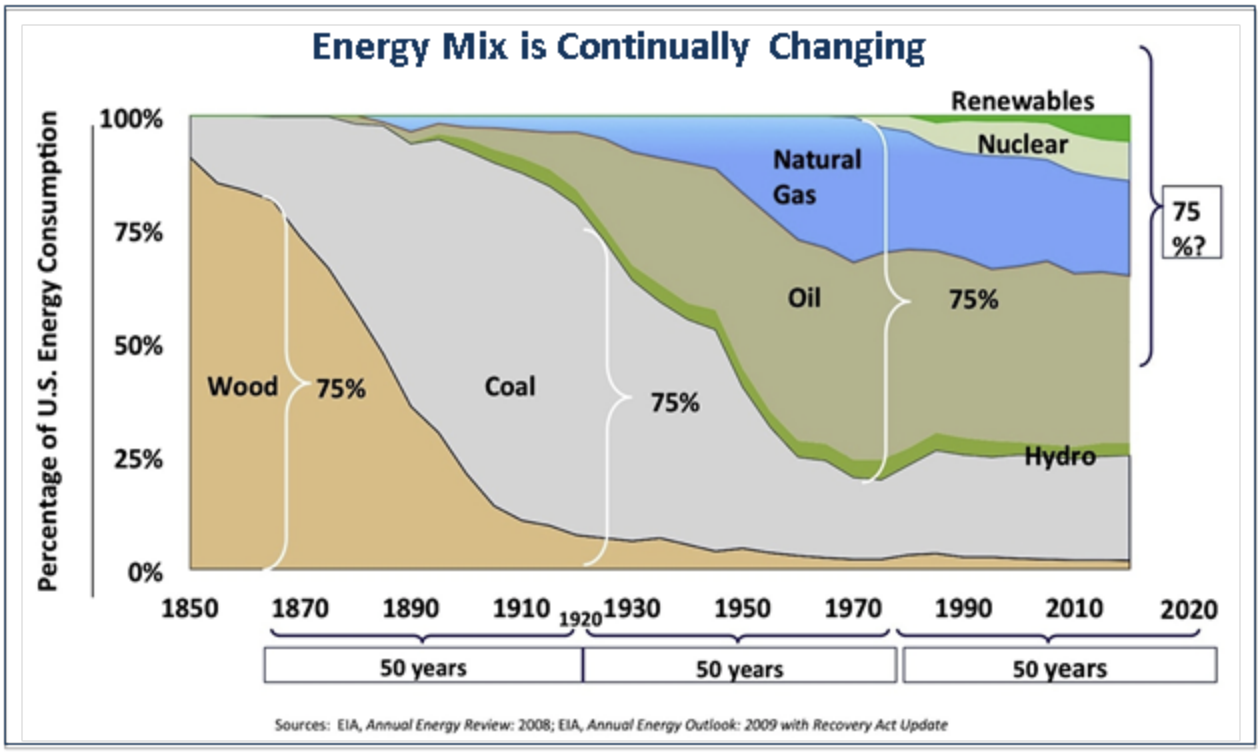
1 "Stay the Course"	▪ Business as usual – the world can't or won't face environmental issues, new energy technologies will remain niche and population and GDP growth will drive up conventional energy values
2 Decrease Direct Exposure to Stranded Assets	▪ Follow the lead of a growing number of funds, in starting with coal and gradually divesting fossil fuel positions ▪ Invest in new publicly traded indices that avoid direct carbon exposure (i.e. Blackrock/NRDC/FTSE ex-Fossil Fuels Index)
3 Decrease Correlated Risk of Primary and Secondary Exposure	▪ Recognize that much more than just fossil fuel companies face significant exposure and start limiting positions with direct as well as indirect risk ▪ Shareholder activism – encourage portfolio companies to themselves take necessary steps to mitigate carbon and resource risks.
4 Invest in New Energy Infrastructure	▪ Follow Buffet, KKR and others in owning wind farms, solar parks and YieldCo's
5 Actively Hedge Risky Assets	▪ Design the "appropriate" short position to cover a deflating carbon bubble ▪ Note: Hank Paulsen and the Bank of England have both recently described the analogy to the sub-prime risk/opportunity
6 Intelligently Invest in the Upside – Avoid Portfolio Correlation	▪ Increasingly own and hold positions in companies that are creating and/or benefiting from the new energy paradigm ▪ Focus portfolio on low holding costs and on positions that gain most from a rapid shift to lower carbon energy

In our view, the traditional and newer views can be summarized as follows:

The Conventional Wisdom:
"We have developed business models to assure diversification – such as currency risk, inflation risk, and other economic factors, but future environmental or resource factors are not risks that we can or should include in our portfolio allocation strategies except under general ESG notions."

The Emergent Wisdom:
"Resource risks (including, but certainly not limited to climate) are likely to have a broader and increasing influence on portfolio outcomes over the next decade. Our current business models largely fail to account for these risks as financial risks, our securities disclosures inadequately address them and insurance is unlikely to cover us for our shortcomings."

Our Energy Mix is Constantly Changing. Although we tend to view our energy mix as a fairly stable and slow moving resource, history indicates otherwise and indicates that we may already be on our way into the next great transformation. See chart below:



History suggests we are on track for yet another 75% change in fuel mix by 2020. This seems unlikely today, but it is clear that a much broader mix of energy sources is in our nearer-term future.

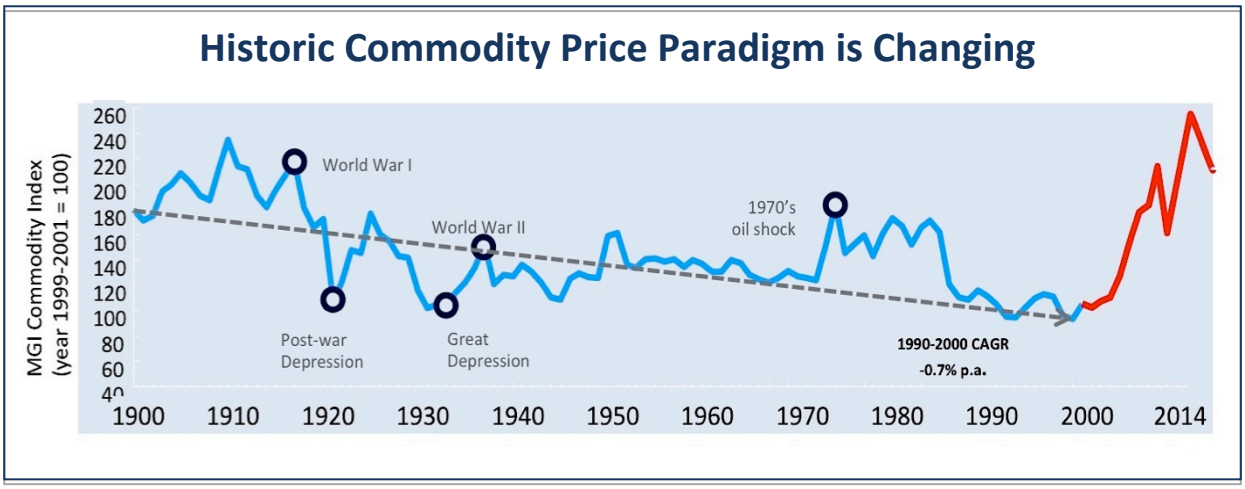
The **resourcient** team has for a decade or more actively developed considerable expertise in the global transition from what we refer to as "conventional energy assets" (carbon-heavy fuels, combustion engines, monolithic utility and grid systems, incandescent lighting, etc.) toward "advanced energy assets" (renewable and distributed energy generation, power storage, bio chemicals and fuels, electric vehicles, LED lighting, and Smart Grid). We have worked closely with some of the biggest oil, chemical, automotive, and consumer products companies in the world, as well as the largest power utilities in North America and Europe, as they themselves have explored these issues and looked to learn from and acquire new technologies.

During the period that we engaged in this sector, the world (i) experienced a severe global recession, (ii) developed a greater understanding of the risks of global climate change, (iii) gradually increased its understanding of much broader finite resource challenges and a consequent shift in the use and pricing of energy, water and other scarce resources, (iv) embraced a significant euphoria over the technology driven potential of fracking/horizontal drilling and its implications for additional oil/gas discoveries, (v) saw the beginning of significant shift away from coal as a power generating asset, and (vi) saw rapidly declining oil prices run squarely up against a fifteen-year trend of ever-increasing capital costs of exploration and discovery. We refer to this combination of risks and opportunities as "Global Resource Risk and Opportunity."

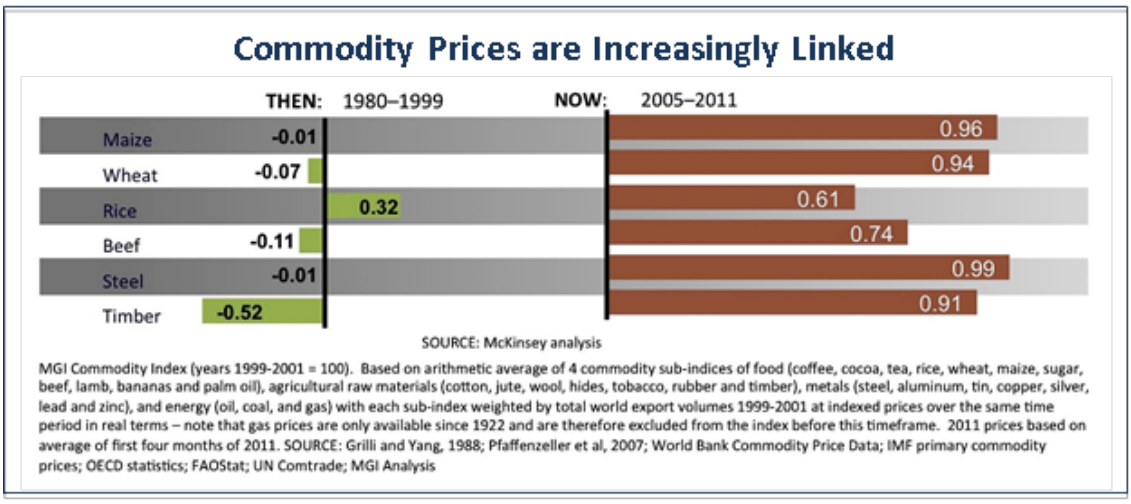
Through the efforts of, among others, Ceres and the Investor Network on Climate Risk ("INCR"), a growing number of financial asset managers, public pension funds, university endowments and private foundations are reassessing their holdings in conventional energy assets. A more select group is now looking for a lower risk and meaningful way to increase their exposure to advanced energy assets. That increased exposure has proven challenging so far when applied to the technologies with the greatest potential (but also highest risk) of addressing or mitigating Global Resource Risk and has raised doubt as to the "Opportunity" part of the equation. It is a challenge that each of us deals with on a daily basis and have sought to engage others in for most of the last decade.

We believe that we are collectively standing before one of the biggest challenges in human history and the start of the biggest investment opportunity in a century. Just as during prior industrial revolutions, this can be a time of extraordinary wealth creation, as dominant new positions and new business models are established. But this is also likely to be a time of creative destruction, as companies that can't compete in a changed and changing world struggle to survive. As investors, we see it as critical to understand the drivers of change, the pace of change and the implications of those factors on the valuations of the winners and losers in this changing landscape.

A Growing Correlation between Energy and Commodities Prices. Over the last century, the developed world and the world's leading companies got used to commodity prices that remained relatively stable or even benefitted from real declines. As a result, labor productivity and capital productivity grew at more than 3% per year. On the other hand, gains in resource productivity have languished at less than 1% per year for the last twenty years. Meeting the needs of the new urban 2.5 billion will require improvements in resource productivity at closer to 3% per year for the next twenty years. Since 2000, commodity prices have surged – a 225% increase for energy, 275% for metals, and 125% for agricultural products. See the following chart.



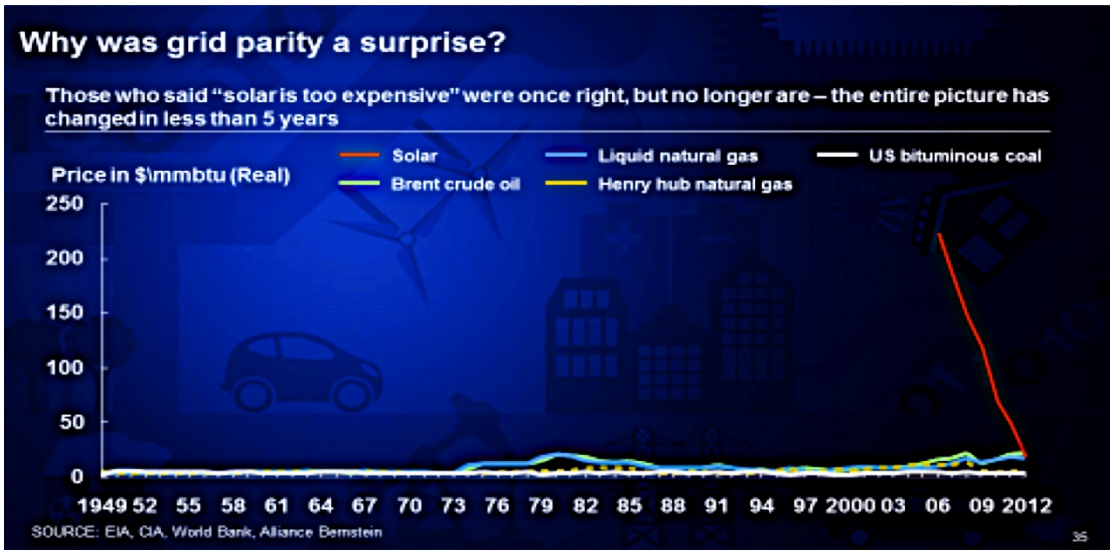
Clearly, the relationship between commodity price trends, GDP growth and energy prices has changed and remains in a far more volatile state than has been true over the last 100 years. In addition, all commodities are more linked to each other, and to the price of oil, than ever before. Thus the role of cheap energy in global GDP growth has broad and lasting ramifications. See chart next page:



The recent volatility in oil prices may have briefly opened the door for falling commodity prices. But the price movements should also have raised a series of questions about the forward profitability of fossil fuel holdings as the price drop clearly seems far more related to short-term excess supply and potential political desires than to any change in the cost curves for oil production.

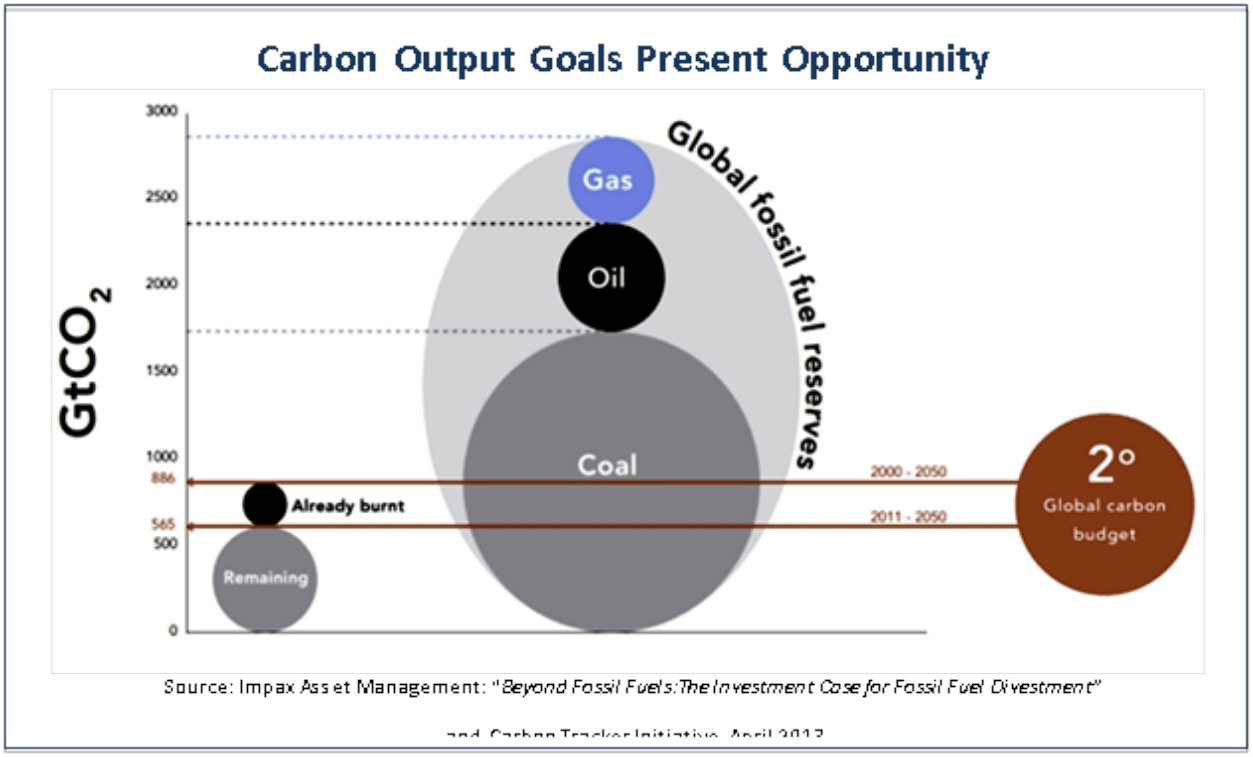
Large resource transitions typically combine commodity price volatility, creative destruction of incumbent companies and the growth of new technologies and business models interacting to both destroy and create wealth. We know how much shareholder value has been created by information technologies in the enterprise, consumer devices and communications/entertainment realms. These industries are still small compared with the global energy, materials, transportation, infrastructure and industrial sectors, where the same IT technologies are now unleashing significant productivity gains. We believe this is fertile ground for savvy investors looking for alpha growth but unstable ground for those investors looking to stay the course they have taken over the last decade or longer.

The Impact of Technology on Energy Prices. It is important not to confuse the misfortunes of individual clean energy technology companies with the change in the prices of clean energy that they collectively have caused. In particular, the price of solar, is not one the markets have fully absorbed:



As an increasing number of commentators have noted, we are not really at risk of peak oil from a supply standpoint, but we may be at risk of peak demand; which could cause prices to soften even as costs of recovery increase. We therefore view the greatest risk of stranded assets not as an environmental risk, but as a financial risk of substitution toward better, cheaper alternatives.

The Risk of a Carbon Bubble. The stranded asset notion relating to carbon arises from the connection between fossil fuels, the carbon dioxide produced by burning them and the amount of global warming produced by that carbon dioxide, with the scientific consensus being that we should not allow the global temperature to increase by more than 2 degrees Celsius. More specifically, it is believed that 2 degrees is the maximum temperature rise we should allow if we want to avoid amplifying carbon-cycle feedbacks. More recent research even suggests that 2 degrees may be too high a limit. Nonetheless, a 2 degree limit means we can burn roughly 565 more gigatons of CO2 by 2050. As of 2014, the amount we "plan" to burn – the amount that is represented by the proven coal and oil and gas reserves of the fossil-fuel companies (the asset value on their books), and the countries that act like fossil-fuel companies – is roughly 2,795 gigatons. In dollars, this asset value is roughly $27 trillion, and the amount that would need to be written off between now and 2050, if we hold ourselves to the 2 degree limit, is $20 trillion.



Even the International Energy Agency says global CO2 emissions from energy need to peak by 2017. "The contradiction between global carbon budgets and fossil fuel reserves is gaining increasing attention," it says. Nonetheless oil majors including Shell and Exxon have recently released statements to their shareholders saying that our global desires for economic growth imply an insatiable appetite for fossil fuels, or at least one we won't be willing to curb for the period necessary to achieve financial returns from their "reserves."

The increased media coverage being dedicated to the Stranded Asset discussion has recently caused the oil industry to respond through two of its most reliable spokesmen – IHS and IPIECA. IHS provides information, expertise and analysis to support the decision-making process of businesses and governments in key capital-intensive industries (particularly in energy through its recent acquisition of Cambridge Energy Research Associates (CERA)). IPIECA is the global oil and gas industry's own association for environmental and social issues. The reports published by these groups conclude that action on carbon emissions, although necessary, is unlikely to lead to much change in demand over the next 10-15 years. In particular, they assume that proven oil and gas reserves are at little risk from near-term policy changes. What they seem to ignore is the degree to which downward oil prices changes are likely to impact the cash flows coming from proven reserves. History has proven that even small shifts in the supply/demand balance can cause large and quick moves in oil prices, moves that oil majors have no hope of reacting to given their current business models. The inherent assumptions that both HIS and IPIECA make is that the downturn in prices will be short-lived, that behavioral changes will not affect global demand for these commodities, that there will be no regulatory changes affecting their burning and therefore that in a world of continuously increasing capital costs we will happily continue to spend increasing dollars on our supply of oil and gas. No doubt those assumptions were pretty safe over the last fifty years; but how certain are you, as an asset manager, that they really hold as true today?

Far less reported and commented on is that limitations on burning carbon may not be the only path to stranding significant oil, coal and gas assets. There are, in fact, three separate potential paths to stranding:

1. Laws, regulations and taxes, including indirect regulation through increased pollution controls, constraints on water usage, or policies targeting environmental or health concerns; as well as mandates on increased use of renewable energy adoption and efficiency standards;
2. Simple market economics, whether in the form of a) increasing costs of fossil fuels destroying demand levels or b) declining costs of renewable energy technologies to the point where they are economically competitive with fossil fuels and substitution results, both shifting capital allocation way from fossil fuels; and
3. Sociopolitical pressures being applied on institutional and other investors (such as fossil fuel divestment campaigns, environmental advocacy, grassroots protests and changing public opinion) similar to what we are now seeing from universities such as Stanford.

The movement of capital away from coal, oil and gas may prove both a more potent and a faster-acting force than simple regulation. Generally, once financial markets realize there's an arbitrage opportunity, they relentlessly chip away at it until it is eliminated. And the stranded fossil asset arbitrage opportunity is one that's worth many trillions of dollars. As public pressure continues to build, companies will have to respond with increased risk disclosures. A few recent cases even suggest that oil company executives and directors may not be protected by D&O insurance if they fail to or incompletely acknowledge risks to their business relating to climate change and potential asset stranding.

"The inevitable transition to a low-carbon economy will revolutionize financial markets at an unprecedented magnitude. Although we cannot, and should not, abandon the world's current energy infrastructure overnight, investors who equate the transition with drawn-out, incremental change do so at their own peril as the stranding of carbon assets may occur at unforeseen rates and at an unpredictable scale." - Generation Foundation 2013

Recently, the Chief Investment Officer of the giant California Pension Fund, CalSTRS, Jack Ehnes added his voice to the debate: "CalSTRS strongly believes the issues presented in Carbon Tracker's Unburnable Carbon 2013: Wasted Capital and Stranded Assets report call for action. Of the top 200 global fossil fuel companies listed on the Carbon Tracker website, CalSTRS has engaged 44 U.S. companies held in our portfolio requesting disclosure. Engagement through educated dialogue will be far more productive in accomplishing our goal that these companies publicly price the risk posed by unburnable fossil fuels."

A rapidly collapsing bubble would obviously have significant disruptive potential and raises some important parallels to the subprime crisis of 2008. The root of the subprime crisis can be traced to an underlying assumption that the historical performance of mortgage assets, which were characterized as providing stable returns and lower risk while offering higher returns than other comparable lower risk securities, would continue in perpetuity. Investors typically weren't looking at the underlying market dynamics, but relying instead on historical performance figures and rating agency evaluations. The resulting dramatic and non-linear decline in value, which resulted in losses in the trillions of dollars, can be attributed to investors not including a key risk assumption in their investment framework and models.

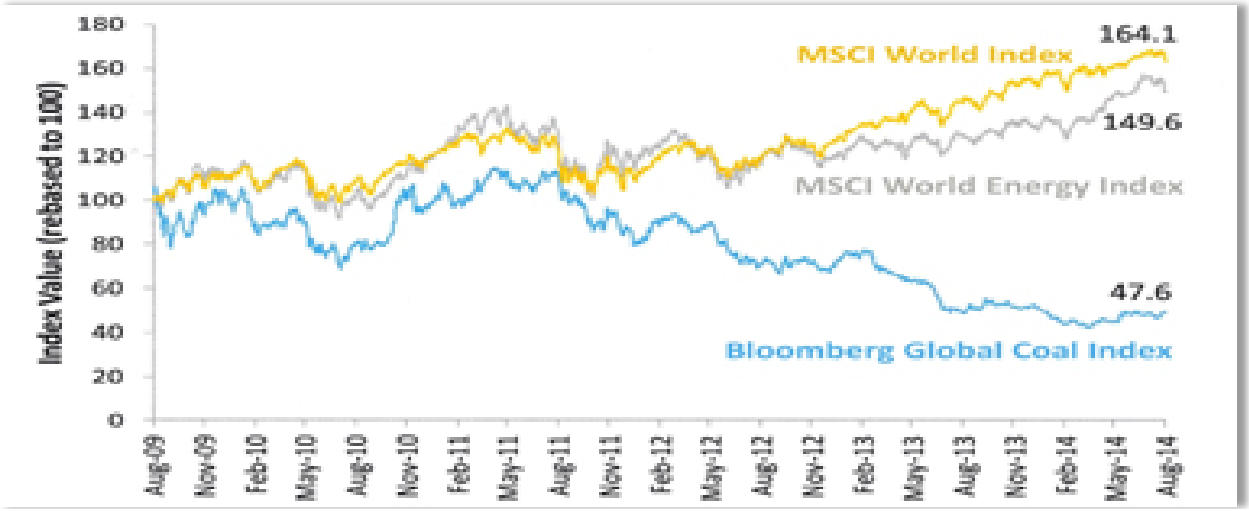
The potential for such a story to repeat itself with organizations having high exposure to potentially unburnable carbon assets is worth consideration. Analysis by McKinsey and the Carbon Trust indicate that more than 50% of oil and gas company valuations can be attributed to cash flows generated more than 11 years in the future. Therefore the believability of claims reserves will be fully utilizable is a critical assumption in valuing fossil stocks and could greatly challenge the underlying assumption that carbon-intensive stocks provide stable returns and high dividend yield with a relatively low risk profile.

In the United States, we have an additional question in that we have developed a healthy dose of confidence in the ability of shale gas and tight oil to address many issues; chiefly economic, but one that could easily lead to an overstated belief in these fuels and just how much of a "solution" they really pose. Natural gas is increasingly being referred to as a "bridging fuel" to take us toward a much lower carbon world. However, a false reliance on the length and strength of that bridge further increases the stranded asset risk.

C**oal: Already Down, Unlikely to Recover**. Since early 2013, there has been a growing call for city, state and other pension funds to divest from their fossil fuel holdings, and particularly, their coal holdings. However, a closer look suggests that the divestment movement (13 universities, 31 cities, 41 religious institutions and 28 foundations and growing) that started in April 2012, effectively came too late, the crash had already occurred and it has had little effect on coal stock prices since. As a result, divestment may simply have been an elegant way out of an asset class that was already on the ropes. With aging plant infrastructure, economics that worsen as usage declines, large CAPEX for new construction and much less flexibility than gas peakers, it is unclear whether coal could make a comeback even if natural gas prices rose.

U.S. Coal - Commodity and ETF Valuations

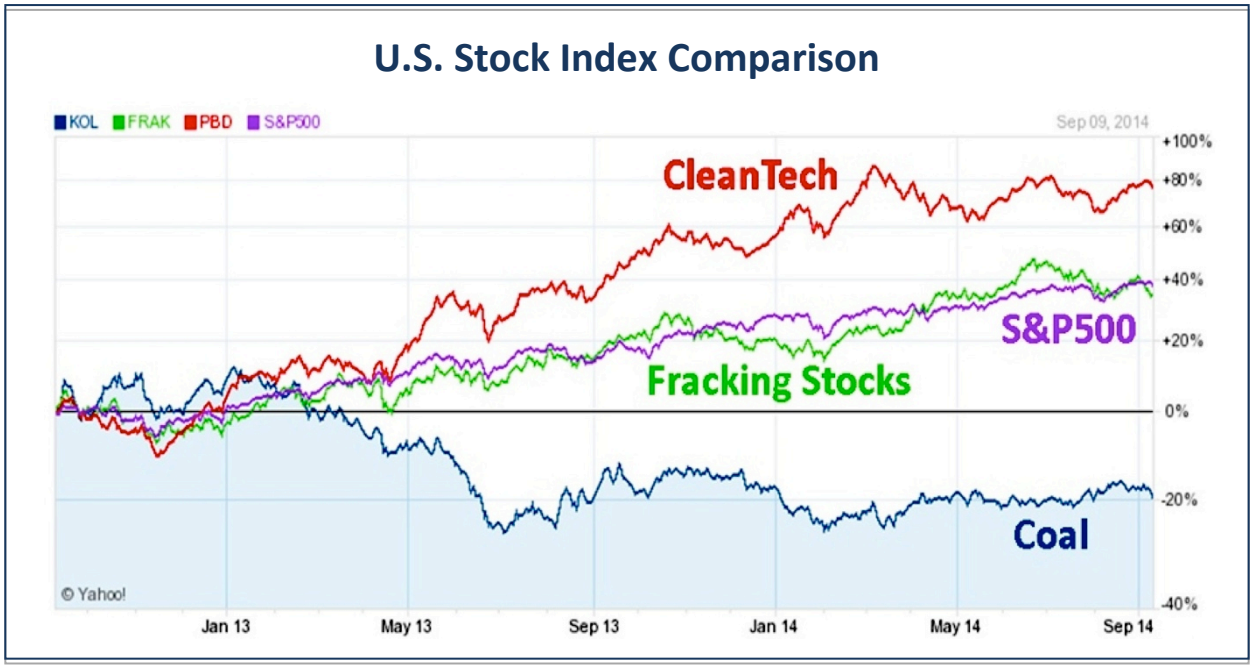
Since 2011, a portfolio of U.S. coal stocks, including the nation's leading companies – Peabody Energy, Alpha Natural Resources, Cloud Peak Energy and Arch Coal – has lost 61% of its value. During that same period, Peabody Energy, the world's largest pure-play private sector coal company, lost 74% of its value. Most of the declining fortunes of the coal industry in the United States can be ascribed to the gains of the natural gas industry due to the significant increase in gas supplies from U.S. fracking activities. In the course of a single year (2008-2009), Henry Hub gas prices declined from almost $15/mmbtu to roughly $4/mmbtu and have remained in the $4-$5 range since then. This uptick in cheap gas supplies may turn out to be relatively short-lived; however, the likelihood that coal can stage an effective recovery is questionable at best.



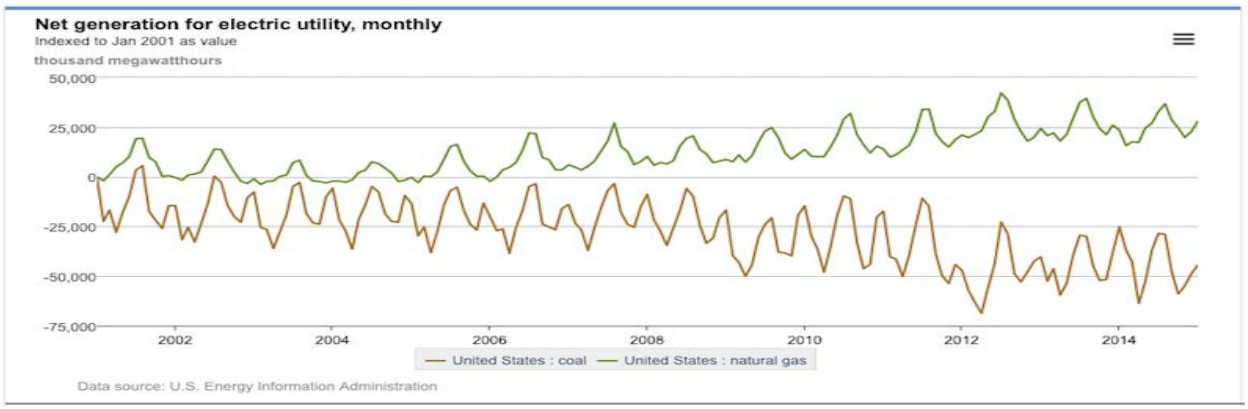
As the foregoing chart illustrates vis-à-vis the United States and the following chart indicates globally, even fairly small decreases in coal prices can have dramatic effects on the prices of coal stocks and indices.

Throughout the 1990's and as recently as 2003, coal still supplied 50% of the nation's electricity. 1990's. By April 2012 the transition was largely complete, with coal's market share dropping to a historic low of 33%. Wise investors would have unloaded their coal positions starting in 2009 and could have gotten out long before the popular divestment calls began.

The net result is that even since 2012 (when coal stocks had already dropped by more than half), not only have both the S&P 500 and fracking indices covering U.S. oil & gas considerably outperformed coal, but a leading CleanTech index has outperformed them all.



The effect on coal was not immediate in that electric producers began to shift production from coal to gas in a process that took almost 5 years to unseat coal from its dominant position (see chart below).

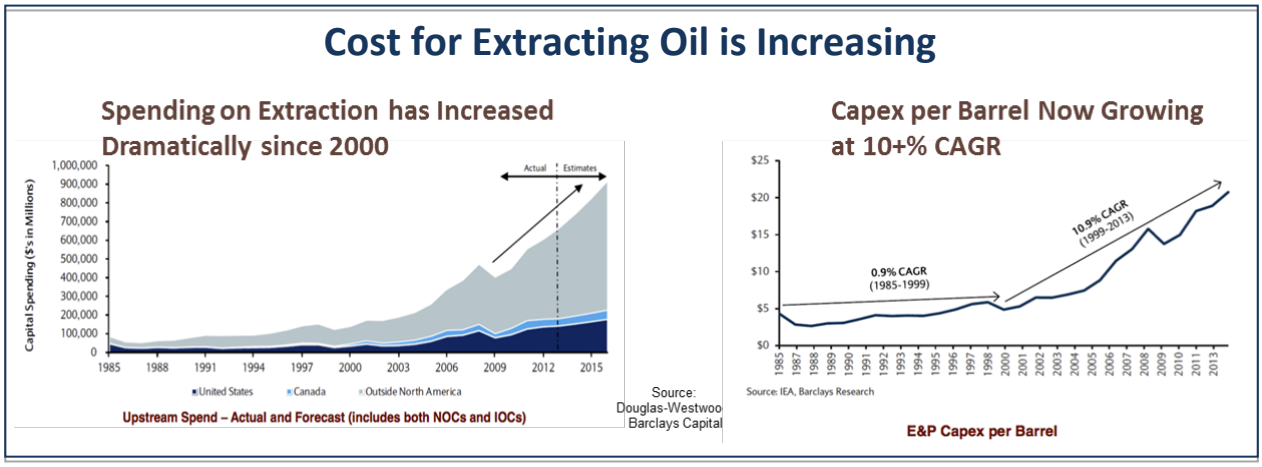


More importantly, there are some patterns of coal's decline that bear close watch with regard to other fossil fuels. For example, in the ten years from 2004 to 2014, coal industry borrowing rose from $3 billion to $20 billion. Secondly, the nation's fleet of coal plants is aging rapidly. By 2020, more than 70% of the existing coal-fired power plants will be over 40 years old, and 36% will be more than 50 years old. Obtaining the public will to build new plants under current market circumstances will be difficult. Black and Veatch has projected that coal's market share in the United States power market would drop to 21% by 2038. Given a move to smaller and more nimble gas turbines, which can flex much more easily in concert with renewable energy sources, it is difficult to

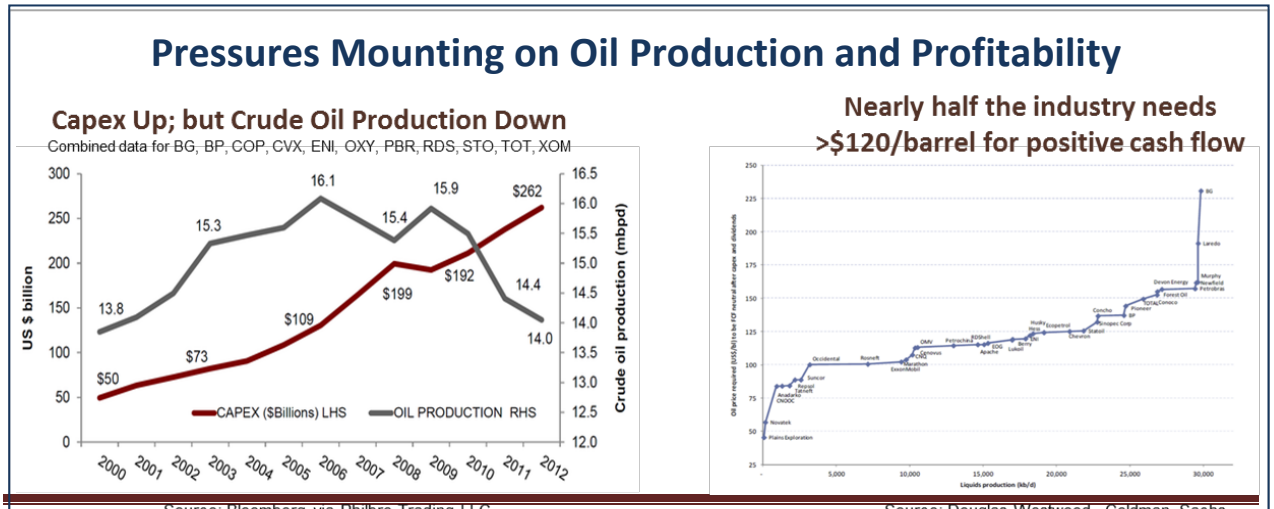
see how coal can make a comeback in the United States, even if natural gas prices were to rise to a level that might make coal competitive as a fuel source.

Oil: Increasing Extraction Costs in Face of Declining Sales Prices. The cost of producing the world's needs for fossil fuels have been steadily growing, with the cost of oil extraction rising at a 10.9% CAGR since 1999. In addition, we note a gradual but ongoing decrease in the energy return on energy invested (ERoEI) of coal, oil and gas, and a commensurate growth in the ERoEI of solar and wind energy. Much of the global economic growth over the last century has been fueled by access to "cheap" energy. More recently, however, a continuing increase in the costs of extracting or producing fossil fuels places us at significantly greater risk of slowing economic growth, while an ongoing improvement in the cost and productivity of wind and solar technologies (as well as power storage) provides the opportunity to improve or retain current economic growth expectations/requirements.

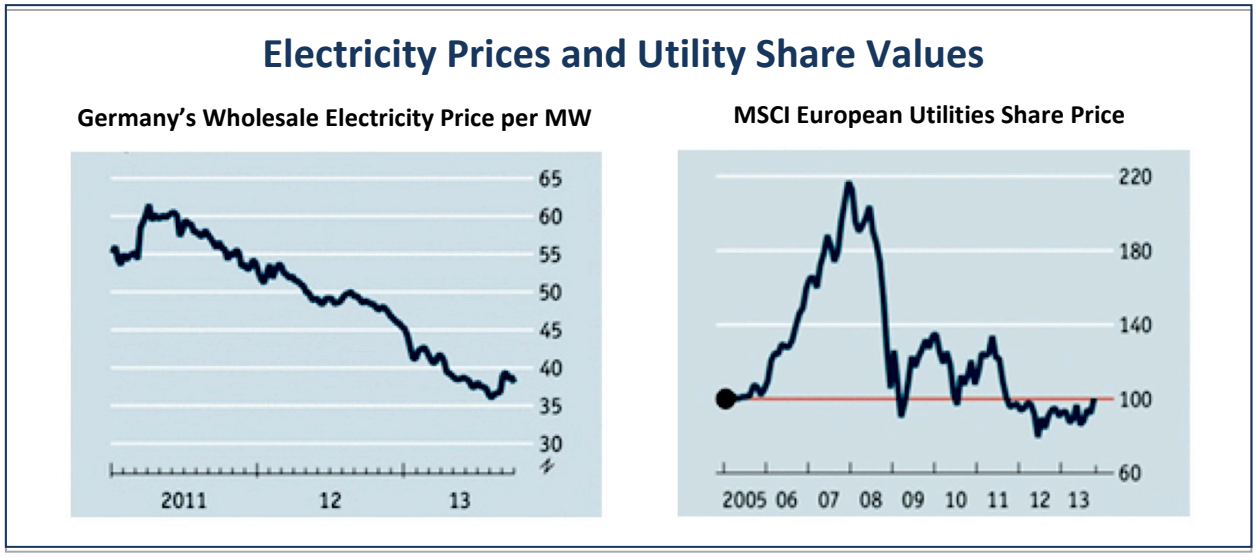
Despite its understanding of the carbon bubble, the oil industry spent $350 billion in 2013 to find more oil.



Notwithstanding these increasing capital expenditures, actual oil production for the majors is down (see chart on left below). Further, for an increasing number of producers, prices nearer to $120/barrel are needed to produce positive cash flow (see chart on right below).



The Utility Death Spiral. The increasing penetration of wind and solar are starting to have a very meaningful impact on global utilities – particularly in Europe, where the penetration of renewables is high. Since 2008 the top 20 European utilities (then worth $1.3 trillion) have lost half their value. The chief reason for these losses is that conventional fossil fuel plants were typically built to cover a baseload energy profile – in other words they operated 365 days a year on a 24 by 7 basis. As the penetration of wind and solar increased, generation from these assets was prioritized, turning coal and gas fired baseload plants into "peakers." Using these plants on an "as-needed" basis and ramping them up and down effectively destroyed their economics. In addition, all of the additional energy produced brought wholesale electric prices in Europe down considerably, further hurting conventional plant economics. The following two charts illustrate the result:



Similar effects are starting to be observed elsewhere around the world with the result being that utilities have been the worst-performing sector in the Morgan Stanley index of global share prices. In Europe, in 2008 the top ten European utilities all had credit ratings of A or better; now only five do. As wind and solar penetration start to increase in the U.S., U.S. utilities very much started to feel the same pressures in 2013, with U.S. stock analysts already downgrading the sector.

U.S. Shale Gas and Tight Oil Production. The sole bright spot on the global fossil fuel horizon over the last several years has been the phenomenal growth in the U.S. shale industry. Is that period over?

The perfection of horizontal drilling and hydraulic fracturing for shale oil and shale gas has jumpstarted U.S. oil and gas production. It has been said that we have access to as much as 2,600 trillion cubic feet (tcf) of natural gas domestically in the United States. The U.S. currently uses approximately 22 tcf per year. Quick math says that could mean another 100 years or more of cheap electricity. As stated above, these finds have already accelerated the retirement of coal power plants. They have also reduced our dependence on foreign oil and our foreign exchange imbalance. Further, these developments represent the U.S. oil and gas industry's use of innovative technologies to take a giant leap forward at a time when the industry risked a significant decline in domestic production.

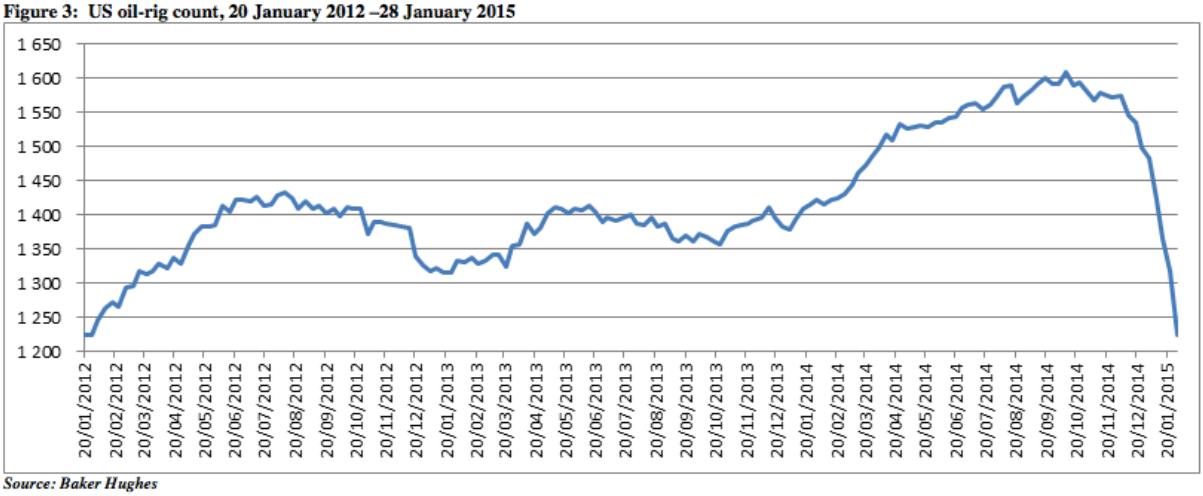
The story of shale gas production is fairly complex. It took a while to really learn the fracking process, but as that was going on a new land rush developed to secure valuable leases to sites that

appeared likely to produce the greatest volumes of gas. Early on, the land rush got ahead of itself, forcing many drillers to move forward so rapidly with drilling operations that they produced a flood of gas and tanked the market, resulting in rapidly plummeting prices. That, in turn, led to a pull-back in drilling operations and a reallocation of drilling rigs away from dry gas sites toward tight oil sites (many of which also happen to produce gas). The overproduction caused a number of companies to take significant write-downs and levels of new investment in gas dipped sharply. Since then, things appear to have stabilized somewhat and it appears that at least for 2015 and 2016 investment will reappear and shale gas production will ramp up, so long as prices remain above today's sub-$4.00/mcf levels.

Increases in gas prices will obviously spur greater investment – a reason why U.S. gas drillers are so eager to see significant export growth in the form of LNG. With foreign prices being higher, greater exports should raise U.S. prices to a level that will enable more investment, more drilling and, at those prices, positive cash flow and profit.

Both the EIA and IEA agree that U.S. tight oil production will likely peak in 2020 and decline thereafter. Until very recently, high global oil prices have continued to support very active U.S. tight oil drilling; on the other hand, the much lower than elsewhere prices for U.S. natural gas have left much of dry gas (wells that produce only gas) stranded. Almost all rigs had moved to oil and gas liquids production, which is more profitable at current prices. Most recently, however, declining oil prices have had a dramatic effect on oil rig counts (see graph below).

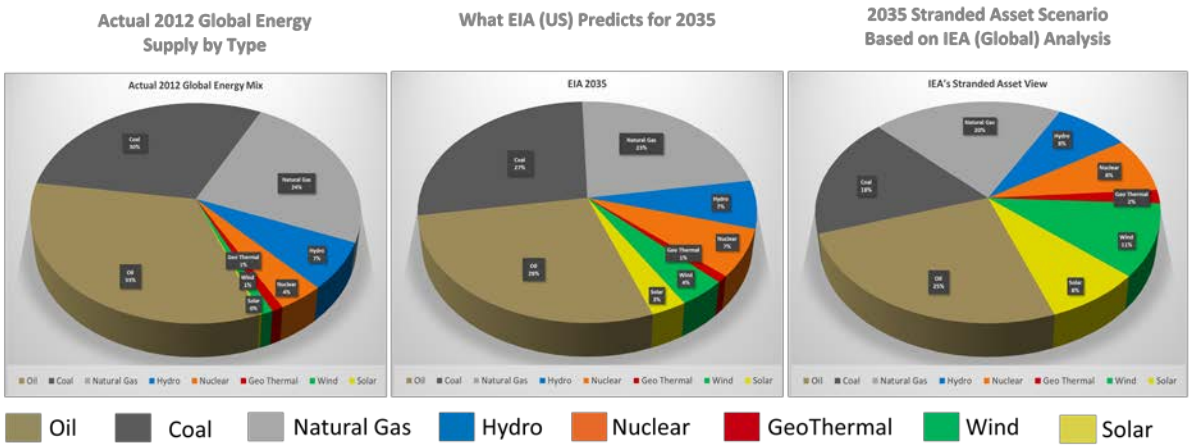
Figure 3: US oil-rig count, 20 January 2012 –28 January 2015



Source: Baker Hughes

Overall shale gas and tight oil remains a work in process. One of the biggest questions is what is referred to as the "Red Queen" problem – do drillers have to drill ever more wells more quickly just to keep production levels up? Currently, about 7,200 new wells a year are needed to keep up existing production levels, necessitating $42 billion in CAPEX but producing only $32 billion in revenues in 2012. The result is that since 2010 shale debt has doubled while revenues have grown by only 5.6%. The biggest unknown is what will long-term depletion rates look like. Typically, fracked wells decline by 79-95% in the first three years (compared to 4.5% per year for conventional wells). Although learning curve improvements led to increased output per well in the early years, production levels per well in Bakken have flattened since 2008. As a result, theoretical "reserve" numbers of 100 years supply are now more commonly thought to be 20+ years of supply and some suggest supplies will start dropping after only another 7 years.

Growth Impacts of Changing Energy Mix:



- U.S. Energy Information Administration – wind +960%; solar +1,600% in next 20 years.
- Global International Energy Agency, in addressing the "Stranded Asset" problem and projecting the needed cutbacks in coal, oil and gas, implies growth rates of approximately 4,000% in wind and 4,500% in solar over same 15 years to produce necessary global energy output.
- Even the more aggressive IEA numbers only require a 30% compounded growth rate, solar has averaged 45% (2007 to 2015).

resourcient

The Case for Portfolio Risk and Rebalancing. Getting investing right over the next few decades will not be easy. More than half the value of most natural-resource companies (oil, mining, etc.) is in their proven reserves, not in operating cash flows. As demand grows and the marginal producer has to extract lower grade resources in tougher conditions, costs will rise steeply. Pension funds and other long-term investors are typically overweight in their allocation to energy and infrastructure companies; the majority of them centered on current technologies. As the market becomes increasingly aware of the ability to shift to newer energy technologies, market caps will reset to reflect the new expectations. Smart investors such as Harvard's endowment and Singapore's sovereign wealth funds have made long-term bets on rising resource prices and on shifts between asset types. The revolutionary part of their thinking is the additional alpha from a long-term secular trend, driven by urbanization, and the rise of the middle class in emerging markets, but manifested in very specific additional option value above market expectations – pure alpha.

resourcient's discussions have focused on lessons learned, but more importantly on how a new approach to portfolio investments in "advanced energy asset" enterprises will produce a significantly more positive investment return than CleanTech fund investments from 2000-2013. We share the belief that the transition from conventional energy to advanced energy assets and technologies continues to be a critical tenet of achieving a more sustainable global economy, and that as much as this transition will involve a gradual reduction in the holdings of old world assets by major institutional investors, it will also require a concomitant building of holdings in new world assets.