SCURA PALEY
AND COMPANY

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Scura Paley and Company
Market Intelligence

Peter Wright
1-617-454-1030
pwright@scurapartners.com

Disclosure: Please refer to the last page of this report for important disclosures.

New Energy

Our Expectations for New Capital Allocations in 2012

- **Scura Paley believes that "Peak Energy" is a myth and continued investment in "New Energy" technologies will maintain an abundance of energy.** The three drivers of energy demand– population growth, urbanization and industrialization – are resulting in energy demand growth of ~2% Y/Y. Despite an acceleration of these trends in emerging markets, this growth rate is roughly half levels experienced prior to 1970 and we expect this manageable growth rate to persist. Moreover, we expect the energy supply to boom in coming years due to 1) enhanced capture rates of fossil fuels in exploration, drilling and refining; 2) improved focus on efficiencies across all four energy consumption sectors; and 3) a steady investment in alternative renewable energy sources.

- **Energy (oil) prices are high due to speculation, not fundamentals, and we expect sentiment to moderate in coming years as the supply-side of the equation is better understood.** Over the last 10 years the price influencers of oil have shifted from physical users to investors and speculators with >$9 of every $10 being controlled by a party interested in paper ownership rather than taking physical delivery. Investment in oil is being used as a hedge against inflation and political instability in the Middle East, as well as a great way to invest in volatility. Oil is inelastic in the short-term, but highly elastic in the long-term and we expect factors that attract speculators today to reverse in the coming years.

- **Almost 60% of energy produced is rejected and we believe that efficiencies and elimination of energy waste is the Holy Grail.** Although we believe that energy is in complete abundance, we recognize that this position is debated. As a result we expect more investment and protective policies to be geared towards supporting technologies and companies that focus on efficiencies to win. Moreover, as energy demand shifts more towards electricity there is a greater opportunity to eliminate waste.

- **We recommend energy investors focus on either building capacity that attracts healthy incremental margins or new technologies that deliver a lower cost of energy.** We believe there are two high level strategies that energy investors should follow. First, only provide capital to players that are building capacity that can achieve attractive incremental margins. Second, invest capital in companies that are deploying technologies that offer attractive ROI to end users – cheaper energy. As for more emerging development stage opportunities, we are specifically interested in technologies that can replicate aspects of Mother Nature (i.e. photosynthetic fuels).

- **Politics and energy policies of different regions will continue to have a profound impact at shaping the investment landscape.** There is one important caveat to analyzing the energy sector on a fundamental basis – be aware of politics and policies that could manipulate the market and consumption in the short-term. For example, if it were not for favorable Germany subsidies for the solar market or Chinese LED manufacturing subsidies there never would have been as much capital dedicated to either of these industries as there has been over the past 5 years. Fundamentals tell all in the long-term, but policy, and policy changes, can be the biggest factor of influence in the short-term.

Energy Demand: Increasingly Manageable

Secular Drivers Increasing Demand for Energy, Albeit at a Reduced Pace

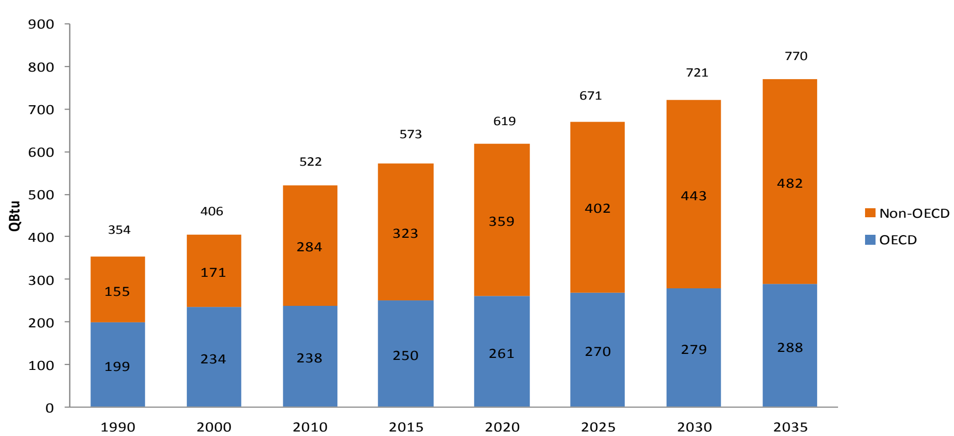
There are three drivers causing global energy consumption to grow; however, experts agree that energy demand is likely to grow at a decelerating rate. Over the past six decades (1950–2011), demand for energy has grown at a steady cumulative annual growth rate (CAGR) of ~2.5%. According to the EIA, over the next two decades (2010–2030), energy demand is expected to grow from 522QBtu to 721QBtu, a ~1.63% CAGR. However, without energy productivity and demand abatement measures in place, energy demand will more likely remain constant at a ~2.5% CAGR and reach 839 QBtu by 2030 with a relatively high correlation to global GDP growth. It is important to understand the secular growth drivers of energy demand: population growth, urbanization & motorization, and industrialization – all drivers alive and well.

- **Population Growth:** The population explosion in Europe and then in the Americas led to an increased demand for energy at the beginning of the twentieth century. These countries led the global energy demand at 5.4% during 1950–1970 with the aid of cheap Middle-East fuel. Population growth in China over the past 40 years has averaged >1% per year (>50% over the full time period) causing the demand for oil to grow at 6-7% per year. During the decade from 1995–2005, India's oil consumption increased >60% tied largely to population growth. The Indian population is expected to grow from 1.1 billion in 2011 to 1.8 billion by 2050.

- **Urbanization and Motorization:** Urbanization refers to a transfer of workforce from agriculture to industry and services, and within an industry, from low-energy processing of primary products to energy-intensive metals and chemical products, among others. Urbanization leads to rapid growth in motorized transport as much more transport of goods and people are needed and there is significant scope of further urbanization in the developing countries. Rapid urbanization and motorization go hand-in-hand during economic development and further increase demand for energy.

- **Industrialization:** Industrialization refers to the conversion of the socioeconomic fabric of a society from an agricultural one to a manufacturing one. Manual labor is replaced by mechanized mass production, and craftsmen are replaced by assembly lines based on fossil fuels as energy input. Traditional energy (biomass) is quickly replaced by fossil fuels (initially coal, and then oil and gas). After Europe, the U.S., and East Asia, it is now the turn of China, India, and Brazil to industrialize.

Chart 1. Global Energy Consumption



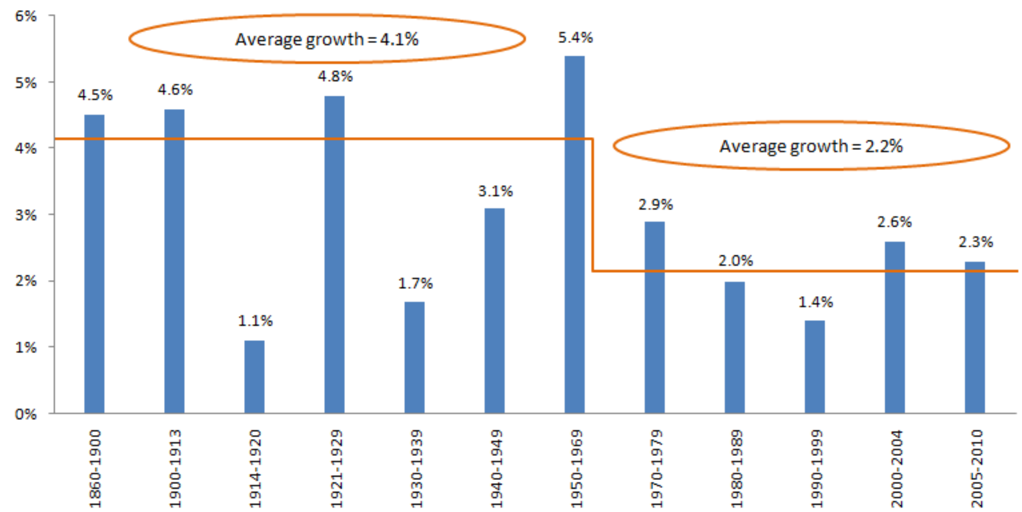
Sources: Scura Paley, IEA

In the short-term, cyclical demand drivers cause volatility in energy demand growth. Over the past 150 years of the advent of commercial energy, there have been periods of high global growth coupled with periods of stagnation or reduced growth. Growth in commercial energy demand has been related to high economic growth periods, supported previously by industrialization of the west with the availability of cheap and abundant fossil fuels and now by demand created by developing nations. Low growth has been associated with less prosperous periods of economic activity amid conditions such as recession, depression, wars, and oil shocks. The correlation between energy and economic growth has gone down over time and, broadly, energy expenditure is expected to remain at ~10% of GDP.

Some of the cyclical drivers of energy that cause fluctuations of demand include:

- **During the years preceding and following the First World War, commercial energy use increased significantly.** This was abetted by the population explosion in Europe and the Americas, the growth of rail and sea transport, and the industrial and trade revolution. The average annual growth rate in energy demand, during the industrialization of the West, from 1860 to 1913 was 4.5% CAGR. During this time, the use of commercial oil products grew from nothing to 1 mb/d (million barrels/day). Demand for energy was mainly met by coal until the end of the 1950s. After the First World War, demand for energy grew even faster, and in the 1920s, it was increasing by nearly a 5% CAGR. During the 1930s, demand for energy declined due to depression and growth averaged <2% CAGR.
- **Between 1950s and 1960s, the use of commercial energy grew rapidly demonstrating the elasticity of energy when new supply emerges.** The amount of energy used almost tripled, growing at 5.4% and industrialized economies grew at ~5%. This growth was boosted by the availability of cheap Middle East oil supplies – a new source of energy that was incremental to the dominance of coal prior to that time. Oil demand grew at 8% per year over the same period. Coal use also continued to grow globally. During this era, massive inter-fuel substitution occurred, specifically by more efficient oil products. Oil was preferred as its price was low and stable (energy growth rates would have been higher if the substitution had not taken place to reach 7–8% instead of ~5%). Apart from low oil prices, other drivers were continued including the mechanization and expansion of heavy industry in major countries and industrialization began in many developing countries. Some of these factors are still relevant in the current context to the rate of energy growth in developing countries. The number of transport vehicles quadrupled in OECD countries. Personal disposable incomes rose at an unprecedented rate, providing a boost to living standards and the requirement for heating and cooling. All these factors contributed to increased commercial energy use.
- **There is marked difference in the energy growth during 1860-1970s (4.1% CAGR) relative to the period during 1970-2011 (2.2% CAGR).** One of the most noteworthy take-aways that we found when analyzing long-term energy supply and demand trends, was the sudden and prolonged change in energy demand growth that occurred after the oil shocks of the 1970s. This change can be attributed to factors such as — political situation changes and oil shocks of the 1970s; decoupling between energy growth and economic growth in 1980s; energy efficiency and productivity measures of 1990s and 2000s. We believe one of the most important questions going forward relates to demand elasticity of energy, specifically as new sources of energy proliferate– natural gas, as well as a host of renewable energies can a lower price for energy result in increased demand . . . could energy demand once again return to growth levels experienced prior to 1970?

Chart 2. Energy Demand Growth For Different Periods – Step Function Down in 1970s



Sources: Scura Paley, Oxford Institute for Energy Studies (OIES), EIA, Enerdata, World Energy Production 1800 – 1895

- **The energy market started to mature in the early 1970s.** The broader economic and political situation changed dramatically in the 1970s and had a cascading effect on perceptions about future growth in demand and in prices. Oil price shocks in 1970s, 1973, and 1979 reduced annual growth in global demand for energy to just under 3% per year through the 1970s and the first half of the 1980s. Energy prices were weak in the 1980s, particularly during the oil price collapse of 1986, which encouraged growth in demand. However, energy growth was only 2% during the 1980s. For the first time in decades, growth in energy demand was substantially lower than that of GDP as a result of increased focus on efficiencies in the western industrialized countries -- the correlation between energy and economic growth was challenged.

- **Since 1990, the developing nations have been the major driver of energy growth.** The major growth in energy demand and economic activity came from developing nations, mainly China, India, and Brazil. Global GDP grew at an average of 2.7% in the 1990s and at an average of 4.2% from 2000 to 2011. China achieved an aggregate growth in GDP of >10% from 1990 to 2010. Economic reforms in India beginning in the early 1990s opened the economy and over the next two decades (from 1990 to 2010) saw significant GDP growth averaging 6.4%. This growth has continued despite the slower growth in the more developed nations, which has more recently been punctuated by the Great Recession starting in late 2008 and lasting through the first quarter of 2010; followed by the deleveraging of the financial markets, which is still plaguing Europe today, the oil shocks of 2004 and 2008 when oil reached $140/barrel; sociopolitical unrest; and wars in oil-rich geographies, all this amid continued talk of oil reaching peak production. Over the same period (1990–2009), the European Union and US's GDP grew at an annual average rate of ~2.0%. Global energy growth over this same period was 1.8%. This suggests that the developing nations are taking the learnings from the Western developed nations, and are industrializing more efficiently.

Energy Supply: Three Drivers Secure Energy Abundance

Debunking the Myth of "Peak Energy"

There is increased discussion surrounding the energy industry that oil extraction and therefore its supply has peaked. Aggregate energy growth has long past overtaken new finds of oil reservoir, and with oil production declining and R/P increasing from 40.3 in 2010 to 46.2 in 2010, it doesn't take an expert to diagnose that, assuming the status quo, at some point in the near future we will reach peak oil production. Before even considering other "new" energy sources, it is worth examining if there are possibilities that this conclusion ignores.

1. Will we develop technologies that help us find new undiscovered reservoirs?
2. Will we develop technologies for more efficient oil extraction?
3. Will known, but less economical, reservoirs become economical to develop?

<u>We believe advances in technology could result in oil production remaining at or above current levels for decades to come. The more important question is will that be the most economical solution, or will other sources of more competitively priced energy emerge?</u>

- **The fear that the world is running out of energy sells newspapers, but it is an exaggeration of the truth**. The fear of Peak Oil has been expressed for long, however the past developments and trend do not indicate the peak oil situation in near future. The new found discovery of oil reserves, improvement in technology used for extraction of oil and gas and additional extraction from existing oil wells will ensure that there is sufficient oil supply to meet the market demands. During the period 2007-09 for every barrel of oil produced 1.6 barrels of new reserves were added in 2011. Significant oil discoveries in South America, as well as other parts of the world in 2011 will contribute to maintaining global oil supply-demand equilibrium. Continuous development of technologies aimed at discovering new oil fields and increases the output from the existing oil fields further increase the oil production. Improved technologies can unlock an additional 125 billion barrels of oil, which is close to the estimated oil reserve of Iraq. Peak oil advocated would argue this is merely an incremental 3.5 years as global oil and liquid fuel production capacity is expect to increase from 92 million barrels per day to >110 million barrels per day. However, this is merely the new found reserves in 2011 -- we expect technology to make these types of finds perpetual.

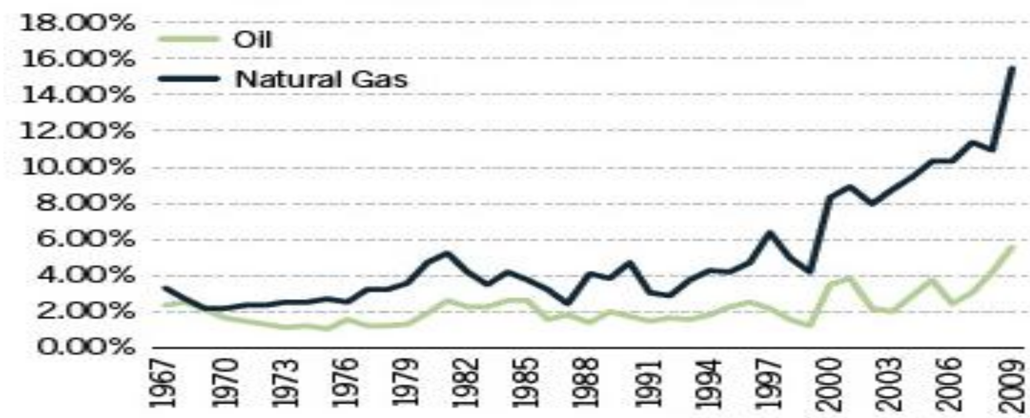
Chart 3. 10 Largest Oil and Gas Discoveries in 2011

Sl No	Company	Region	Capacity
1	Repsol YPF	Argentina	927 MMbbl
2	Apache	Western Australian coast	-
3	Total EP Norge AS	Norway	10 and 50 B standard cubic meters
4	ExxonMobil	Gulf of Mexico	700 MMboe
6	Heritage Oil	Iraq	6.8-9.1 trillion cubic feet (Tcf) with 42-71 MMbbl of condensate and 53-75 MMbbl of oil
7	Petronas	Malaysia	227 MMboe
8	Eni	Northern Mozambique	7.5 Tcf
9	Anadarko	Northern Mozambique	-
10	Anadarko	Colorado	500 MMbbl to 1.5 Bboe

Source: Scura Paley, Petroleum Insights

- **Drilling capacity of existing reservoirs has increased as compared to the previous years.** With the technological advancements and increase in demand for energy the recovery rates have consistently increased over the last 10 years. As the conventional oil reserves are fast depleting the oil majors are trying to explore ways of increasing the extraction of oil from existing reserves. Deepwater drilling and ultra-deepwater drilling are some of the major discoveries which have enabled the oil companies to explore the possibility of oil extraction from greater depths from the offshore oil fields. According to Haver Analytics, oil companies have been successful in increasing the output of the reservoirs as much as 10-12% over the last 10 years. New capital funding technologies that help oil companies improve recovery rates is going to be major focus area in the coming years.

Chart 4. Impact Of New Drilling Technologies On Improving The Output Of Reservoirs



Source: Scura Paley, Haver Analytics, US DOE

- **Deepwater drilling have redefined the energy equation.** With the technological developments such as emergence of 3D and 4D seismic technologies, more-sophisticated drilling techniques, and deepwater rigs, industry has been able to tap the oil trapped in greater depths of oceans through deepwater drilling. Global deepwater oil production has grown seven-fold since 2000 production level of 1.5 million barrels from 20 wells to ~10 million barrels in 2011 from >200 wells. Oil exploration has shifted to deeper depths of 15,000 feet. Ongoing technological developments will enable oil companies to explore oil trapped upto 30,000 feet.

- **Oil sand has emerged as another alternative source as a result of increasing oil prices.** Huge oil sand reserves with proven reserves of 170 billion barrels in Canada, have become commercial viable for extraction with oil prices remaining above $60-70 per barrel. Oil sand production in Canada has increased from 0.6mbpd in 2000 to >1.5mbpd in 2011, and with increasing oil prices this will increase further as the total oil sand reserves (including non-proven) are estimated to be 1Tn barrels. Oil sand will emerge as key source to meet the energy requirements of America, even as countries like China show significant interest in these reserves.

- **Discovery of shale gas from the rocky terrains of Pennsylvania, Texas, Louisiana and other states has emerged as another significant source of energy.** The discovery and extraction of shale gas has been a major factor driving down the price of natural gas over the last few years. We expect that with government initiatives focused at reducing its energy dependence on Russia, Poland will emerge as another dominant player in extraction of shale gas.

- As different countries explore various means of oil extraction, Arctic region which are estimated to have ~25% of the world's undiscovered oil supply might be the next opportunity for oil players to maintain their leadership position. Companies such as Shell have already spent ~5 years to try and drill in Alaska's Chukchi and Beaufort Seas and have already invested about $4 billion on 10-year leases.

The supply of energy has continuously outstripped the demand for energy and we expect this will continue due to three primary drivers. The supply of energy has been enough to accommodate the rising demand for energy and with a regulated oligopoly (OPEC) managing supply (and price), it should be intuitive why the world is led to believe that supply is tighter than it is in reality. We believe that fear of "peak energy" is likely to persist in the near-term as the world's governments increasingly focus on increasing their individual energy security equations through a combination of 1) developing technologies that promote efficient exploration, extraction and refining of domestic energy sources; 2) promoting user efficiencies including smart grid and energy storage technologies; and 3) investing in a richer mix of renewable energy. The energy equation is changing, but we expect supply demand to remain in equilibrium; however, new capital will be directed to new areas of focus across the New Energy landscape and this piece is dedicated to finding the best opportunities for new investment.

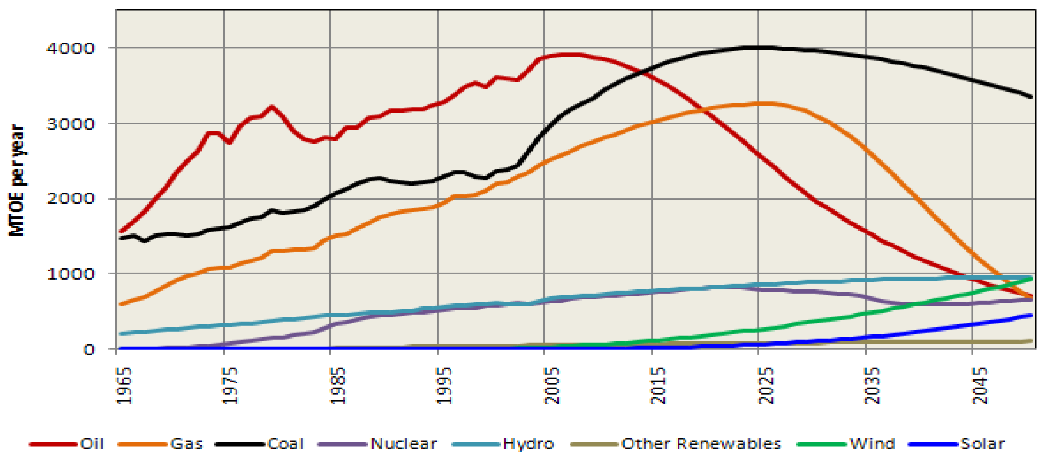
- **Developing new sources of fossil fuel.** This involves investments in new 1) exploration technologies -- seismic and non-seismic; 2) drilling technologies -- deepwater and enhanced fuel recovery (examples include drilling deeper into the Earth's surface at depths that were once thought to be unfeasible, new techniques such as fracking for shale gas, as well as more robust extraction from tar sands; and 3) refining technologies which fall into five primary categories: 1) topping and separation; 2) thermal and catalytic cracking; 3) combination/rearrangement; 4) treating and blending of products; and 5) specialty product manufacture. We cover each of these topics in greater detail in the Technology section of this report; however, here are the market opportunities that we are most excited about for new capital opportunities.

- **Promoting energy efficiency.** This will involve investing in energy efficient technologies such as 1) new energy conversion technologies (i.e. natural gas combine cycle—NGCC turbines) that improve energy efficiency of energy plants; 2) improved distribution and storage technologies (i.e. advanced cables, smart grid and energy storage); and 3) end user efficiencies (i.e. vehicle efficiencies, building efficiencies like LED lighting and smart meters, and new HVAC systems). We are especially excited about energy efficiencies technologies due to the fact that ~60% of energy generated gets wasted through the supply chain and most technologies offer attractive ROIs. We cover each of these topics in greater detail in the Waste Energy and Technology section of this report; however, here are the market opportunities that we are most excited about for new capital opportunities.

- **Investing in alternative energy sources. Some of these sources include solar energy, wind energy, geothermal energy, etc. From an investment perspective, these new (alternative) sources of energy generation have stolen the lime-light. Although we see the opportunity for many of these technologies to play an increasing role in the world's energy portfolio, we are cautious near-term and believe there are more economical way to secure the required energy supply growth.** We cover each of these topics in greater detail in the Technology section of this report; however, here are the market opportunities that we are most excited about for new capital opportunities.

Alternatives Sources of Energy Generation: The Long Term Solution

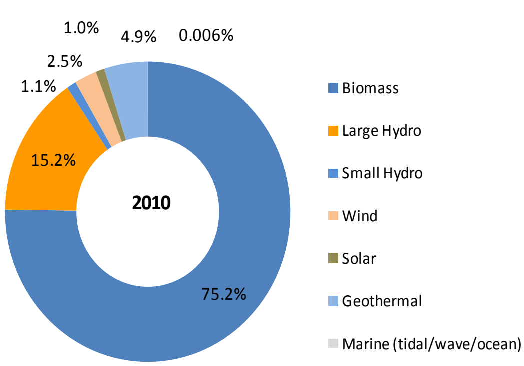
Chart 5. Potential Impact of Efficiency on Global Energy Demand



Source: Scura Paley, Paul Chefurka

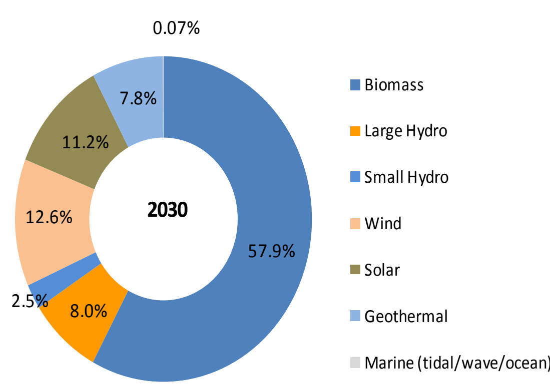
Renewable energy sources are expected to supply ~25% of global energy by 2030. Currently, renewable energy sources contribute ~14% to the global primary energy consumption market — the figure is expected to reach 25% by the end of 2030. As per the European Renewable Energy Council (EREC)**,** the share of renewables in global energy consumption will increase from ~70 QBtu in 2010 to ~171.6 QBtu by 2030. Rising concerns about global warming and the depletion of non-renewable sources of energy will drive the use of renewables over the next decades. **In certain regions of the world, we believe that wind, hydro, and other renewables can account for 50%, if not 100%, of electricity generation.** For this to happen, certain fundamental changes will be required in the way electric grids operate today. A network of energy storage plants will have to be added to the existing transmission systems to store renewable generation from wind and other sources when it is available and supply that power at night or when the wind stops blowing**.** We expect to see an increased focus on grid development and energy storage that will help integrate variable energy sources.

Chart 6. Global Renewable Energy (2010)



Total Renewable Energy Sources Share: 69.8 QBtu

Chart 7. Global Renewable Energy (2030)



Total Renewable Energy Sources Share: 171.6 QBtu

Sources: Scura Paley, European Renewable Energy Council (EREC), Scura Paley

We expect wind and hydro power to fuel much of the global increase in renewable electricity supply. According to US EIA's International Energy Outlook 2010, there will be an increase of nearly 4.5 trillion kilowatt hours in renewable electricity generation through 2035. Out of this, 2.4 trillion kilowatt hours (54%) are expected to come from hydroelectric power and 1.2 trillion kilowatt hours (26%) from wind. Other than these two sources, most renewable generation technologies are not cost competitive with fossil fuels, outside a few niche markets. Although renewables other than hydroelectricity and wind—including solar, geothermal, biomass, waste, and tidal/wave/oceanic energy, constitute a small portion of the total renewable electricity generation—they do increase at a rapid rate through 2035.

The growth in renewable energy production will depend on the growth of fuel cells, wind, biofuels, nuclear and clean fossil fuels market. All these renewable energy sources are expected to register a double digit CAGR growth over the coming years. We expect fuel cells market to increase tremendously once the LCOE comes down to $0.12/kWh. While China and the US will continue to drive the wind energy growth at a CAGR of 12%, clean fossil fuels will get a boost from the rising global warming concerns. Biofuels will grow at a 10% CAGR increasing to >$100 billion by 2015. On the other hand, nuclear, though will increase at a CAGR of 3% through 2015, it will reach a substantial market size of $120 billion and being a baseload generation source already accounts for 14% of overall global electricity generation. We believe as it relates to the comeback in nuclear energy, most sovereign nations will be making a decision in the coming years to go with a cleaner but more capital intensive (upfront) nuclear option vs. a dirtier less capital intensive coal based solution.

Chart 8. Global Net Electricity by Fuel

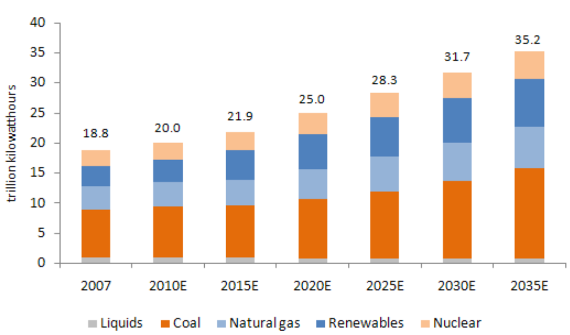
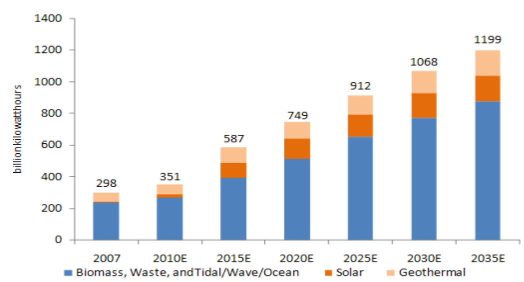


Chart 9. Renewable Electricity by Source*



Source: Scura Paley, US Energy Information Administration (EIA), *- Excluding Wind and Hydro Power

Different low carbon energy generation alternatives and their opportunity areas:

- **Fuel cells –** Fuel cells offer a tremendous growth opportunity once LCOE hits $0.12/kWh, which we expect by 2012. Global fuel cell spending is forecast to grow at a CAGR of 10.9% to reach $10.3Bn by 2015 and then reach >$19Bn by in 2020, as per the Freedonia Group. One of the most exciting aspects of fuel cells vs. other alternative energy technologies is its breadth of applicability, with technology solutions that can address the vast majority of the $6 trillion energy market. It all comes down to cost -- the unsubsidized levelized cost of electricity (LCOE) generated by fuel cells is currently ~$0.15/kWh (assuming volume), and we expect it to reach $0.12 by 2012. This will make fuel cells competitive with peak-level grid pricing in a large number of geographies.

- **Solar energy –** Solar PV and CSP are two widely used technologies for generating electricity from solar energy. We estimate that the global solar market will more than double from 28GW in 2011 to 60GW ($70Bn) by 2015, while CSP will account for $24Bn market size. Though we expect CSP market to grow at a rapid pace, PV will continue to maintain its lead in the solar market. Crystalline silicon panels, which are being manufactured at a larger scale than thin-film and CSP technologies, will dominate the global market in the near term. However, of all the thin-film technologies, we believe that the CIGS market presents the fastest growth opportunity. According to Lux Research, the CIGS market is expected to grow ~100% from 1.2GW in 2011 to 2.3GW in 2015, and be worth $2.4Bn.

- **Wind energy –** We believe that the global wind industry, which had an installed base of 238GW at the end of 2011, has the potential to be worth ~100GW/Year by 2015. According to the Global Wind Energy Council (GWEC), the global installed wind capacity increased by 41GW last year, with market leader China accounting for 44% of the new capacity, followed by the U.S. and India, with a 17% and 7% share. We believe that non-OECD nations, led by countries from Asia Pacific and LatAm, will drive the future growth of the wind market. We believe that the rise in the wind energy installed base will drive the growth of the wind turbine market, which is expected to be worth ~$93Bn by 2015, according to Transparency Market Research. We believe that the offshore wind market will be the fastest growing segment of the industry over the next 5-10 years. The offshore market, which was worth 3GW/$0.7Bn in 2010, has the potential to grow to >100GW/$20Bn by 2020, according to MEC Intelligence.
- **Geothermal energy –** Geothermal and hydro-energy companies are more mature and thus receive less attention than other renewable markets, but we expect strong growth in both markets. The global geothermal energy market is ~$9Bn market (13% CAGR) with growth drivers including: clean, cost-competitive, and base-load ready. We expect these factors, coupled with the industry's favorable economic characteristics such as long life assets, predictable cash flow, and low levelized costs (LCOE) at $0.05 will help it grow into a $13Bn market by 2015; the global geothermal capacity is estimated to grow from 11.9GW in 2011 to ~20GW by 2015.
- **Hydro energy –** The hydro-energy market is ~$290 billion market (5% CAGR) with the primary growth driver being the lowest LCOE of any energy source at $0.03/kWh. We view most of the tidal and marine driven projects in northern Europe to be slightly ahead of the science project stage and we believe we are still too far away from making a compelling economic case for most of these technologies.
- **Clean Fossil Fuels –** We expect clean fossil fuel (CFF) technology to be fundamental in reducing CO2 emissions and allowing coal and natural gas to meet the world's growing electricity demand. CFF technology can be further subcategorized into carbon capture and storage technology, combined cycles power plants and industrial cogeneration. According to IEA estimate, CCS could account for almost 20% of emission reduction by 2050. Existing commercialized CCS technologies have an efficiency range of 30-45%, sub-critical pulverized coal combustion with efficiency of 35%, super-critical pulverized coal combustion with efficiency of ~40% and fluidized-bed combustion (FBC) with efficiency of 30-40%. Upcoming CCS technologies are currently under R&D and demonstration phases and can be categorized into three forms—pre-combustion carbon capture technology with carbon reduction potential of ~95%, post-combustion capture (PCC) technology with 80–90% and oxy combustion capture technology with ~90%. There is a need for successful large-scale demonstration of the technical, economic and environmental performance of CCS system components namely—capture, transportation and storage.
- **Biofuels –** We believe that the global biofuels market stood at $82Bn in 2011 and is expected to increase to $185Bn by 2021, representing a CAGR of 9%. We believe that with the transportation sector growing rapidly and the oil prices recently crossing $120/barrel mark, the demand for biofuels will receive a boost. According to IEA, the global share of biofuel in total transport fuel will grow from 2% today to 27% in 2050. The global biofuels

demand is expected to grow by an impressive 133% through 2020, primarily due to government policies and market mandates.

- **Nuclear –** We expect the global nuclear energy market to grow from $217Bn in 2010 to $272Bn by 2015. Nuclear energy represents ~15% of global electricity generation and is the most economical and longest living source of electricity in much of the developed world. As of 2011, 30 countries were operating 437 nuclear reactors and generating 371GW of electricity. According to the Nuclear Energy Institute, 63 new nuclear plants are currently under construction, that are expected add another ~63GW, with an average unit size of ~980MW. Nuclear energy is a base-load technology and is thus stable and predictable with an 86% efficiency factor. Thus, from a generation perspective this is equivalent to 250GW of installed solar power (assuming 20% efficiency) and the solar industry would have to grow at >30% CAGR to reach an equivalent incremental energy contribution vs. nuclear in 5 years.

Table 1: Comparison of Different Energy Generation Technologies

	DIFFERENT GENERATION TECHNOLOGIES							
	Solar	Wind	Nuclear	Geothermal	Hydro	Clean Fossil Fuels	Fuel cells	Biofuels (Transportation)
COST ($/kWh)	0.19	0.08	0.04	0.05	0.03	Clean coal: 0.08-0.09 NGCC: 0.086	0.15	Biodiesel - $2.87/gallon Bioethanol - $2.20/gallon
ENERGY EFFICIENCY*	Crystalline: 12–20% Thin-film: 8–13.5% Parabolic Troughs: 14%	Generator efficiency is usually 75-85% now	30-40%	10-23%	85-95%	40-50%	60-65%	N/A
CAPACITY FACTOR**	PV: 15-20% Parabolic Troughs: 56% Power Towers: 73%	30-40%	86%	90%	50%	90-95%	95%	N/A
CAPITAL INTENSITY***	70-80%	75%	63%	51%	48%	Clean Coal: 28% NGCC: 12%	38%	- First gen: Low - Second gen: High
ABUNDANCE/SUPPLY	Abundant, but intermittent	Abundant, but intermittent	Uranium (fuel) is abundant	Highly abundant	Relatively abundant	Limited availability	Available in sufficient quantities	- First gen: Limited - Second gen: Relatively abundant
KEY GEOGRAPHIES	Germany, Spain, Japan, US	China, US, Germany, Spain	US, France, Japan, Russia, Canada (Emerging nations: China, S. Korea & India)	US, Philippines, Indonesia, Mexico, Italy	China, Canada Brazil, US, Russia	US, Canada, Norway, China, Russia	US, Canada, Germany Japan, UK	US, Brazil, France
PROS	- Fuel is freely available and costs are coming down - Inexhaustible energy source - Long-term reliability; lifetime of solar plants 25–40 years	- Fuel is freely available - Inexhaustible energy source	- Fuel is inexpensive - No acid rain or greenhouse effects	- Fuel is freely available - Inexhaustible resource - Highest capacity factors among renewables	- Very inexpensive once the dam is built - Can supply large amounts of electricity quite consistently	- Stable price - Less GHG emissions as compared with conventional fossil fuels	- Fuel (hydrogen) combines easily with oxygen to produce water and energy	- The only viable large-scale renewable transportation fuel alternate.
CONS	- Intermittent energy source - Most expensive renewable energy sources - Large land area requirements	- Limited to windy areas - Might impact endangered birds	- Involves high capital cost due to containment, radioactive waste and storage systems - Potential nuclear proliferation issues	- High upfront costs, specifically, exploration and plant construction costs - Subject to geological risks and uncertainties	- Highly capital intensive Negatively impacts the geographical landscape - Affects marine life	- Non-renewable resource - High Carbon Capture and Sequesteration (CCS) costs	- Very costly to produce - Takes more energy to produce hydrogen then energy that could be recovered.	- Consumer fears related to "food vs. fuel debate" - High prices of second-generation biofuels

Source: Scura Paley, *Energy efficiency refers to the percentage of total energy input that is consumed in useful work and not wasted as useless heat. **Capacity factor of a plant refers to the ratio of actual output of the power plant over a period of time and the output in case it had operated at full nameplate capacity the entire time. ***Capital intensity has been calculated by dividing the capital costs by the total cost of the respective technologies.

Energy "The Commodity"

Energy, and access to it, powers both economies and politics. Energy prices are extremely volatile due to the ability for politics to drive sentiment cycles over the underlying economics of energy. The price of energy affects not only industries, but nations as well. The market dynamics of energy have lead to concerns which are, indeed, complex. They can result in confusion and even mistrust, much of which got resolved by having a clear commercial perspective and that's why energy commodity markets have evolved.

The primary function of any futures market, including energy commodities, is to provide a centralized marketplace for those who have an interest in buying/selling physical commodities at some time in the future. The energy futures market helps hedgers reduce the risk associated with adverse price movements. There are a number of hedgers in the energy markets because almost every industrial sector uses energy in some form.

Commodity markets are regarded as one of the most efficient markets, but some claim that increased speculation has made the market less efficient. Commodity futures are traded openly and the values are estimated by the traders and analysts in a 24/7 environment. However energy markets are characterized by problems arising out of the imperfections in the market like excessive speculation. Over the past decade, speculative buyers (i.e. hedge funds) seeking leverage have driven the price of energy artificially higher punishing the physical delivery market.

Drivers Behind the Traders of Energy Commodities

An energy futures contract is a legally binding agreement for delivery of crude, unleaded gas, heating oil or natural gas in the future at an agreed upon price. The contracts are standardized in terms of quantity, quality, time and place of delivery by commodity exchanges like New York Mercantile Exchange (NYMEX) and Intercontinental Exchange (ICE). Price is the only variable.

Trading in energy commodities offers the following benefits:

- **Hedging** – Energy commodity future offers a hedging mechanism from highly volatile oil and gas prices. This helps both consumers and producers to plan their inventory levels.
- **Futures contracts offer speculators a higher risk/return investment vehicle because of the amount of leverage involved with commodities –** Energy contracts in particular are highly leveraged products. Exchange margin rules, gives investors the ability to leverage $1 to control roughly $15.
- **Ability to go short –** Energy futures contracts can be sold as easily as they are bought enabling a speculator to profit from falling markets as well as rising ones.

However it encompasses a few problems as well:

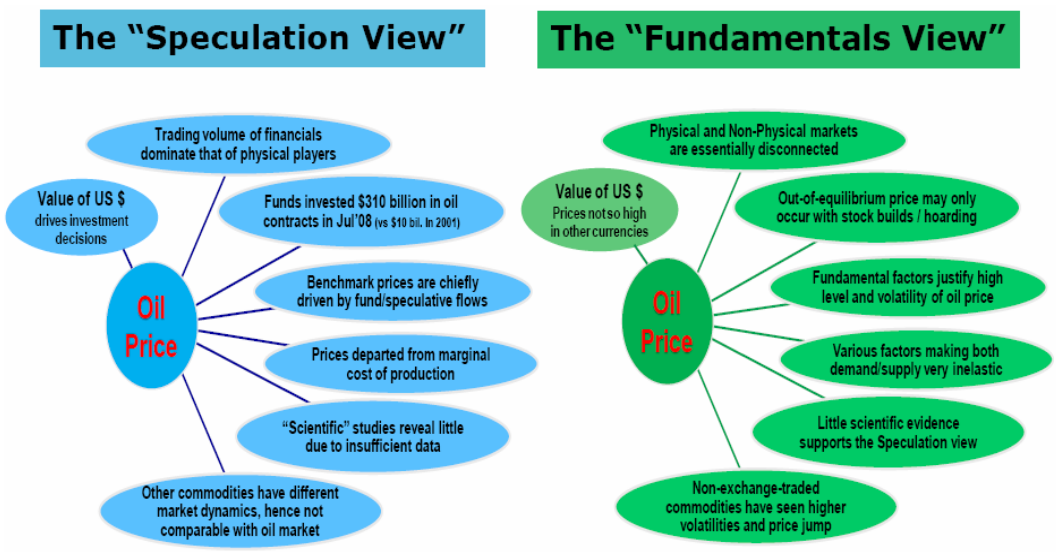
- **The commodity markets are very volatile and inexperienced investors can suffer significant losses** – Unlike many other commodities, the dynamics of the oil markets around the world can be subject to permanent physical changes over time, some quite dramatic. The users of the energy commodity markets must be well educated in the real fundamental factors driving those changes and the resultant influences on relationships among the petroleum benchmarks.
- **Excessive Speculation –** Speculation in energy commodity sometimes increases the energy prices to unjustified levels which results into a bubble. Such levels of energy prices cannot be explained using demand and supply model. So the very purpose of commodity market helping in price discovery gets defeated.

Dynamics of Oil Prices

Understanding oil price behavior is important in the current environment of large swings and volatility. Oil prices have a prominent impact on global economics. Increasing oil prices can slow economic growth, cause inflationary pressures, create global imbalances, discourage the much-needed investment in the oil sector, and arguably most importantly raise fears about oil scarcity and concerns about energy security – volatility, not supply is the true economic concern.

Is oil so inelastic that a 5% increase in demand results in a 75% increase in price? Multiple views exist on the dynamics of oil prices. Fundamental and speculation are two such views that explore the economics of oil prices. As per the fundamental view, the normal laws of supply and demand are the basis for determination of prices of commodities like oil. In addition, the oil supply can be influenced by the weather conditions (storms can lead to production halts), OPEC output reductions, geo-political issues and other factors — all these are referred to as the fundamental factors driving oil prices. This holds true in certain cases; but when we look at speculative part of the picture, it becomes more complicated. When speculators take control of the commodities market, laws of demand and supply takes a back seat and commodity prices largely reflect the traders' sentiments.

Chart 10. Speculation Vs. Fundamental – 2008 Oil Spike



Source: Scura Paley, IEA 2009

Structural transformation in oil prices - Exhaustibility of oil and its non-replaceable nature in the short term makes oil command a scarcity rent, which reflects the opportunity cost of using the resource today rather than keeping it for future. With this awareness being of a global nature, oil prices are expected to go up as available reserve of oil decreases. But, in the recent few years, the surging of oil price resulting from tight and inelastic supply/demand amid high investor influence points towards some structural transformation in oil prices.

- Erosion of spare capacity in oil supply chain
- Shift in oil pricing regime towards the futures market and growing importance of financial investors and traders
- Emergence of new large consumers – Wall street banks
- New geopolitical uncertainties in the Middle East and elsewhere

Shift in Oil Pricing Regime towards Futures Market

As much as 60% of the current crude oil price is pure speculation. The price of WTI crude oil saw its highest ever growth in one day, when it increased by $16.37/bbl on September 22, 2008, rising from $104.55/bbl to $120.92/bbl. The established theory of demand and supply failed to explain what could possibly happen overnight to increase crude price by >15%. China and India demand for oil cannot have this kind of an effect on dynamics of oil prices in a single day. Given the unchanged equilibrium in global oil supply and demand and the explosive rise in oil futures prices traded on Nymex and ICE exchanges in New York and London, as much as 60% of the current oil price is likely to be pure speculation.

Control of oil prices has shifted from OPEC to Wall Street with excessive speculation. The development of unregulated international derivatives trading in oil futures is largely responsible for the present speculation around oil prices. Two biggest oil exchanges, Nymex in New York and ICE Futures in London, now control global benchmark oil prices via futures contracts on two grades of crude oil—West Texas Intermediate and North Sea Brent. The CFTC, a financial futures regulator, ensures that prices on the futures market reflect the laws of supply and demand rather than manipulative practices or excessive speculation. But, in the current unregulated oil future market, the process is so opaque that it is difficult to determine the buyer and seller of oil futures or derivative contracts. Majority of these future contracts are entered into not for physical delivery, but only to gain from the rise in price of "paper oil", and >90% of these contracts are rolled over to the next period. The loophole in government regulation of oil derivatives trading resulted in speculation, which in turn forced oil prices to shoot up to $145.63/bbl from $70/bbl and then fall down to $40/bbl , all of this within 12 months in 2007–2008.

Chart 11. Oil Market - Investors vs. Consumers

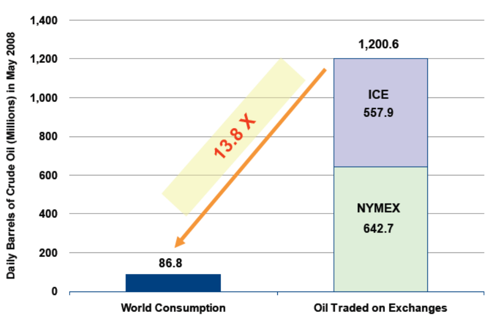
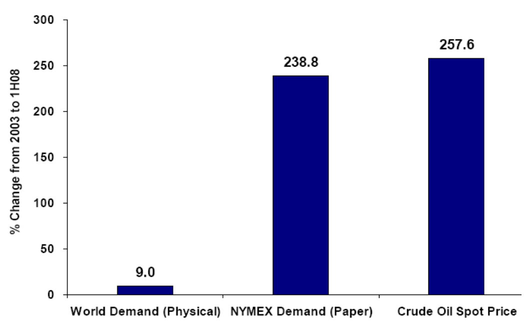


Chart 12. Oil Demand – Physical vs. Paper

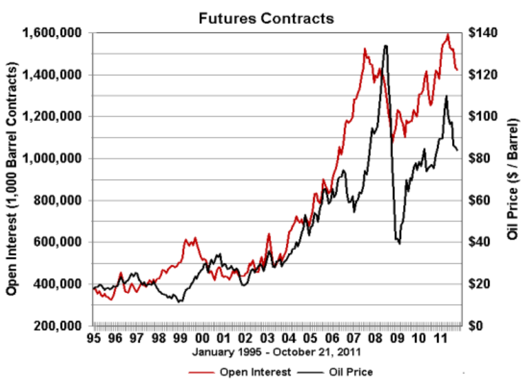


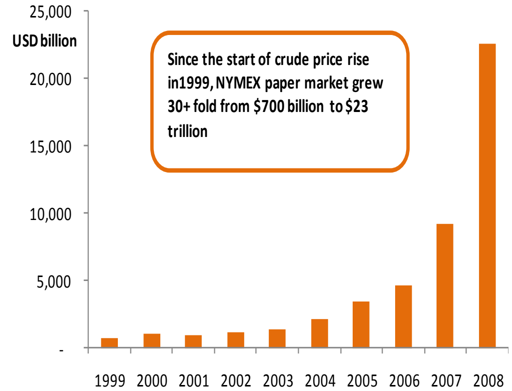
Sources: Scura Paley, IEA

High supplies of crude oil and high crude oil prices: Speculators have provided a financial incentive for oil companies to buy more oil and place it in storage. A refiner will purchase oil beyond its capacity today, even if it costs >$100 per barrel, if it expects futures price to be higher in future. As a result, in the past few years US crude oil inventories have been increasing at a high rate to reach their zenith. Oil prices kept increasing in mid-2008 in spite of the EIA's announcement of global supplies exceeding demand and a situation of surplus capacity with all-time high inventories.

The uptrend in crude oil prices over the past five years suggests that the buyers have been the price makers, while the more passive scale-up sellers can be considered the price takers. In the same period, it is noted that the ~425% rise in open interest over this period has greatly exceeded the corresponding growth in the physical market of ~8.5%.

Chart 13. NYMEX Crude Open Interest **Chart 14. Open Interest - Physical vs. Paper**





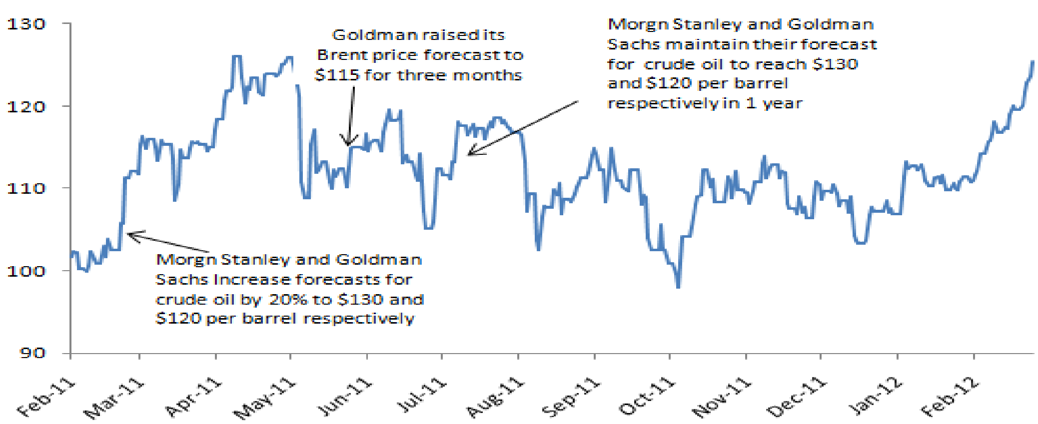
Sources: Scura Paley, CFTC

Emergence of New Large Consumers – Wall Street Banks

Who Controls Oil Prices In US — Exxon, Chevron, BP, or Big Wall Street Banks? Banks cannot be classified as traditional oil companies because they do not own or control oil wells, refineries, or gas stations. But, a closer look at documents filed with the Securities and Exchange Commission reveal the significant role played by these banks in the wholesale market through various entities controlled by them. For example:

- Morgan Stanley not only buys and sells physical oil through subsidiaries and companies that it controls, but also has the capacity to store and hold 20 million barrels of oil. Morgan Stanley controls ~15% of the home heating oil market in New England and stores its oil in New Haven, CT.
- Wall Street bank Goldman Sachs also holds huge stakes in companies that own refineries in Coffeyville, KS, and control 43,000 miles of pipeline and >150 storage terminals.

Chart 15. Bullish Reports Preceded Price Spikes



Sources: Scura Paley, Bloomberg, Reuters

Increasing popularity of oil commodity index fund: Amid higher speculation, Wall Street started featuring oil commodity index as an investment class with high growth, and the popularity of these indices grew manifold. A top ranking analyst further strengthened this popularity by giving higher estimates for oil prices. In mid-2008, Goldman Sachs and Morgan Stanley gave an oil price target of $200/bbl and $150/bbl, respectively. With more money chasing these indices, future price of oil kept on shooting up and resulted in a bubble.

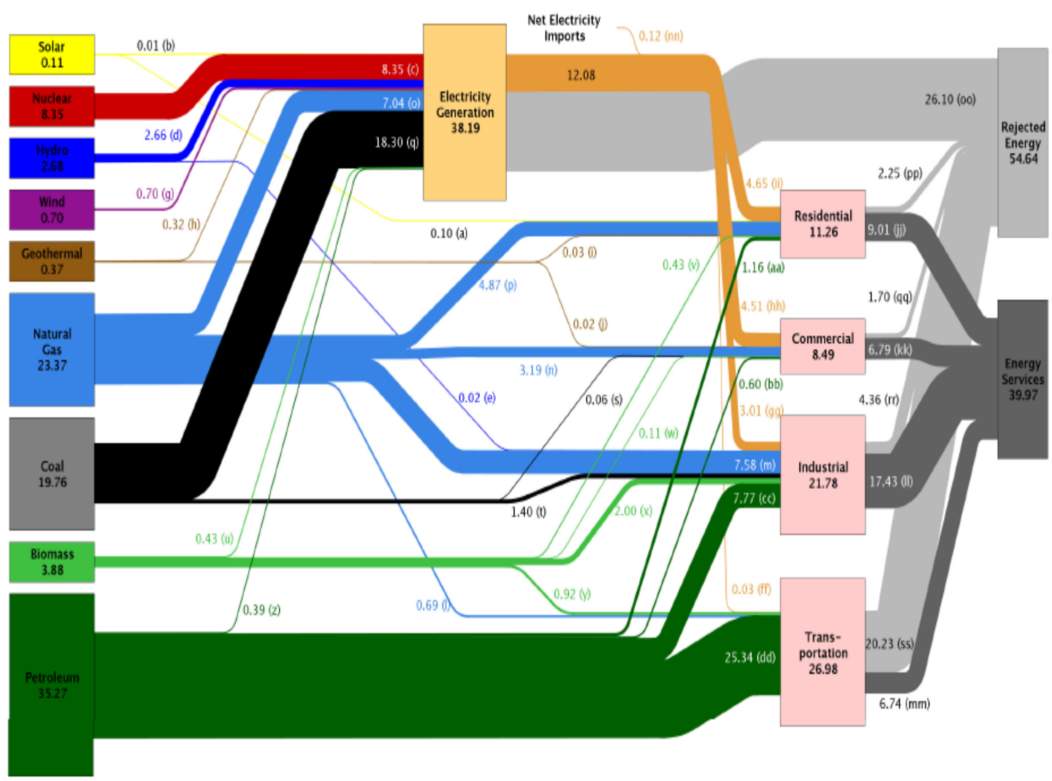
Waste Energy: Efficiency Could Be the Holy Grail

The Real Cost of Energy

Global energy consumption represents less than half of what is generated due to significant energy waste throughout the supply chain. In 2012, energy demand is estimated to be 546 QBtu, and of this amount only 40–50% will be put to use (depending on region and technology), while the remaining will go waste. Before we go on to elaborate where all this energy is going waste, it is important to note that >254 QBtu of energy is rejected globally on an annual basis. In other words, energy generation is more than double the amount of energy that we actually need. A case in point would be the representation by the Lawrence Livermore National Laboratory's energy use chart, which shows the breakdown of energy generation, consumption and waste in the US – 58% of the energy generated in the US got wasted.

There is a need to use this energy more efficiently and curtail energy demand growth in an economically feasible way, along with containing carbon dioxide (CO_2) emissions. Such opportunities already exist in the market, and simply need to be taped. It is not enough to generate more energy from newer sources to meet growing energy demand, expected to be 653 QBtu by 2020. We need to step up efforts for using energy already being generated more efficiently and productively, which could bring down the energy demand to 596 QBtu in 2020. There are technologies and opportunities in the market to boost energy productivity by 57 QBtu by 2020, which is equivalent to ~9% of energy expected to be generated in 2020 without these measures. In addition, CO_2 emissions will be significantly reduced due to efficiency gains and lesser energy generation.

Chart 16. Estimated US Energy Use Breakdown (2009): ~94.6 QBtu



Source: Scura Paley, Lawrence Livermore National Laboratory

Energy Efficiency: The Potential to Prevent Energy from being a Growth Market

Energy efficiency technologies score on all three parameters—supply, cost and emissions. The charts below compare the different electricity generation sources—the first one measures availability and costs, while the second chart measures costs and emissions for different technologies. While photovoltaics generate the least emissions, they are comparatively high on costs. Also, wind though low on emissions is the most intermittent energy source. Most of the technologies have the potential to act as a base load energy source, for instance, hydro, Concentrated Solar Power (CSP), nuclear, IGCC, etc.

Chart 17. Electricity Supply Availability and Costs

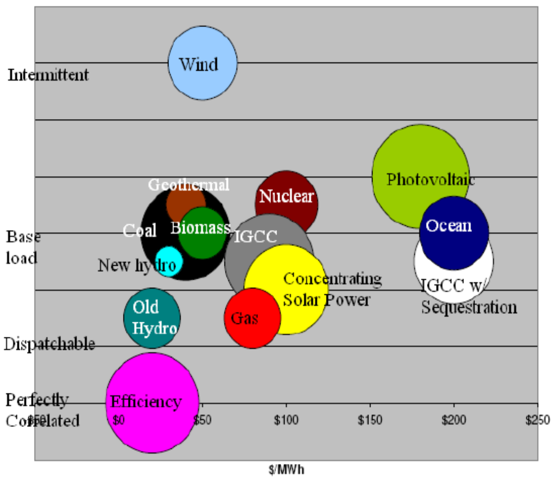
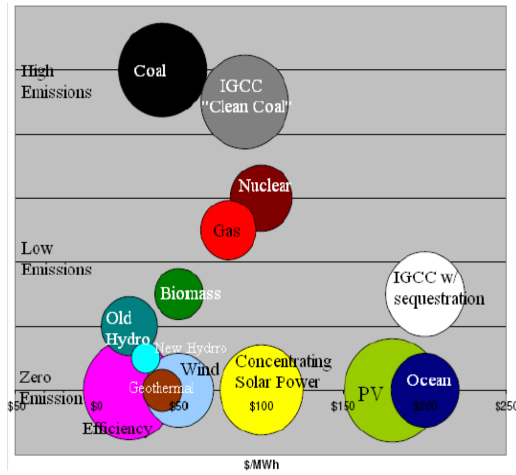


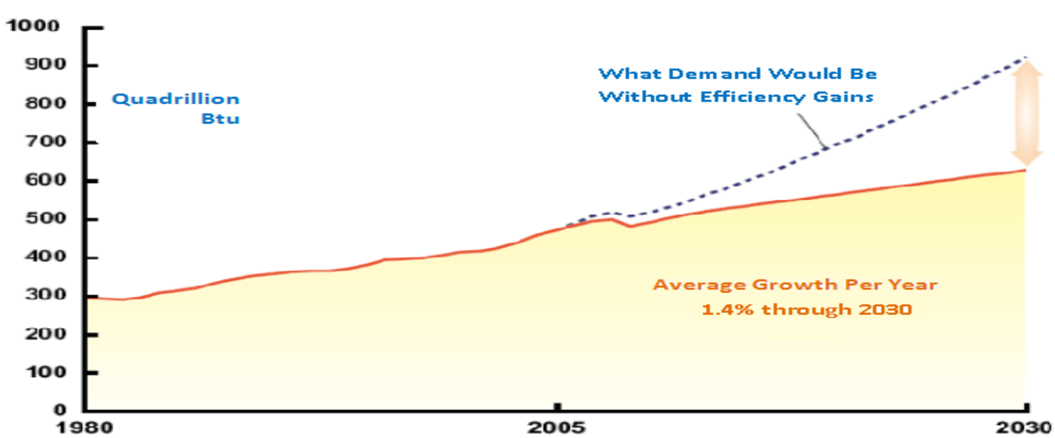
Chart 18. Electricity Supply Costs & Emissions



Source: Scura Paley, EIA

Besides renewable energy sources, new technologies are changing the energy supply equation. These technologies are being promoted to enable extraction sources of energy that were previously thought unfeasible or uneconomical. This is another smart way of meeting the rising energy demand levels. As can be seen from our reference case scenario in Chart 1, demand can be reduced by ~161 QBtu through 2030 with energy efficiency and productivity measures. Some of the technologies that have created new energy supplies are shale gas extraction, deepwater drilling and Enhanced Oil Recovery techniques.

Chart 19. Potential Impact of Efficiency on Global Energy Demand



Source: Scura Paley, WEF/CERA Energy Efficiency Report

Technology: Unlocking the New Energy Equation

NOTE: The full report includes a three page new capital analysis for each of the 29 market segments listed below. Following please find a sample write-up on the smart grid market.

Fossil Fuels	**Efficiencies**	**Alternative**
Exploration:	**Conversion:**	**Alternative to Fossil Fuels:**
1. Seismic & Non-Seismic	1. Natural Gas (Gas to Liquid)	1. Nuclear
	2. Oil (Heavy Oil Upgrade)	2. Hydro
Drilling:	3. Coal (Clean Coal)	3. BioMass
1. Deepwater Drilling (oil)		4. BioFuels
2. Hydraulic Fracking	**Storage & Distribution:**	
3. Tar Sand	1. Smart Grid	**Alternative & Renewable Fuels:**
4. EOR	2. Storage Technology	1. Wind
	3. Efficient Distribution	2. Geothermal
Refining:		3. Solar (CS)
1. Topping & Separation	**User Efficiency:**	4. Solar (PV)
2. Thermal & Catalytic Cracking	1. Smart Industrialization	5. Marine (Tidal, Wave, Ocean)
3. Combination/Rearrangement	2. Smart Buildings	6. Fuel Cells
4. Treating and Blending	3. Smart Transportation	
5. Specialty Manufacturing		

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