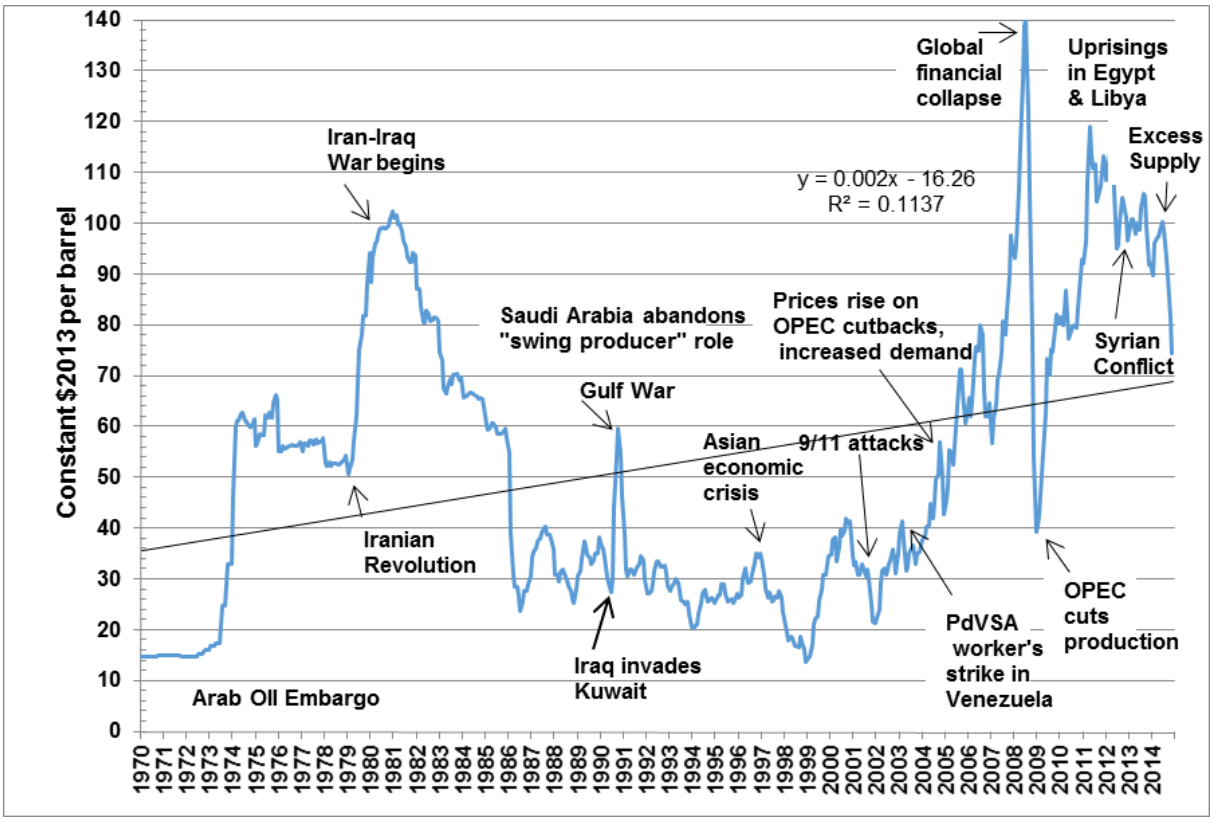
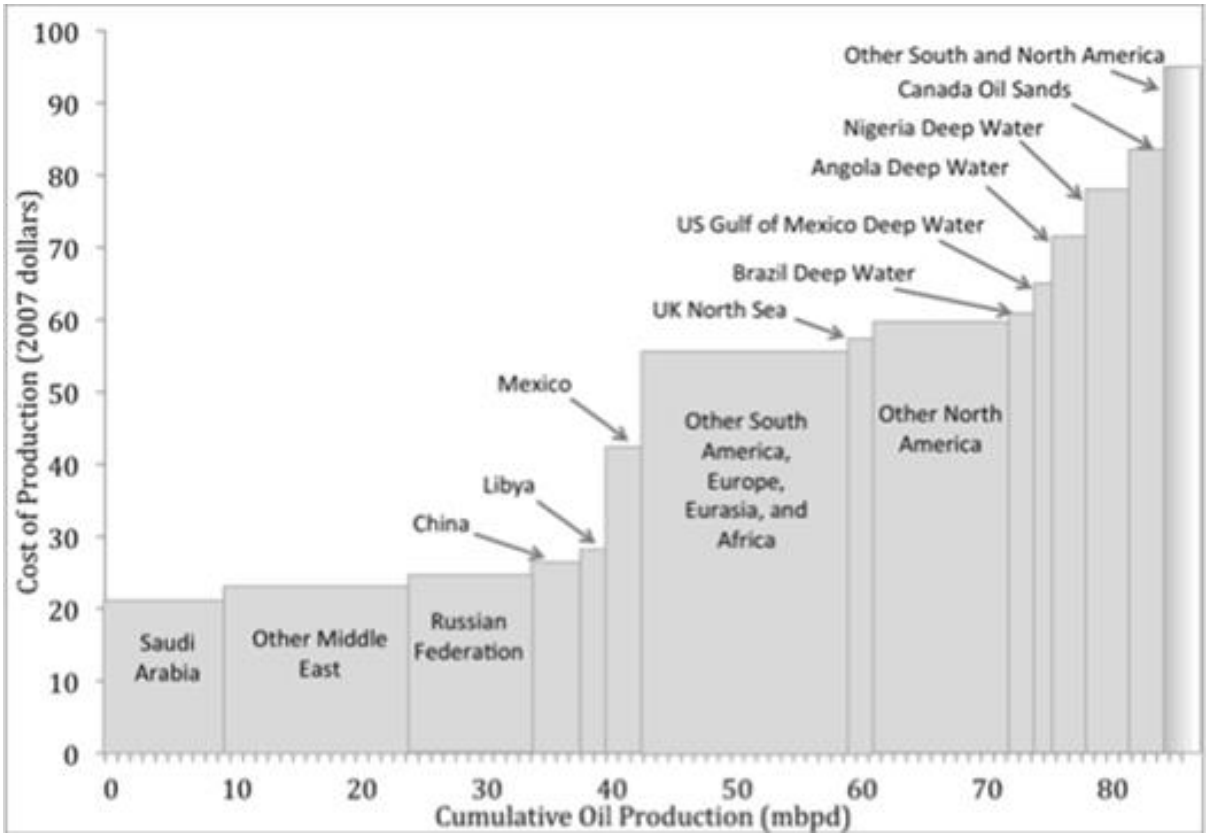
Energy and declining economic growth

Energy

Increasing costs of energy are already causing an economic growth problem and this will have more serious economic consequences as the cost increases and the problem worsens going forward. The following is an attempt to quantify this effect based on the negative impact on GDP growth rate of the increasing cost of energy since around 1970.



Energy price, particularly oil price is very volatile. This makes it hard to see any underlying trend hidden in the noise. As the graph above shows, during the period from 1970 to 2014 oil prices followed a very volatile trajectory, starting high, bottoming in 1998, and generally rising until the recent fall. When we add the overall price trend line shown in the graph above we see that the price of oil has been increasing steadily over this 45 year period. The price has about about doubled from $35/b to $70/b on top of a big initial $20/b step up due to the OPEC cartel imposing monopoly pricing.



If instead of price, we look at the cost of production the situation is easier to understand. This graph from a few years back captures the **cost** of oil production in about 2010. This graph only covers variable O&M and fixed O&M financial costs. The oil **price** paid is the sum of these costs, the investment in developing new supply and profit (or loss).

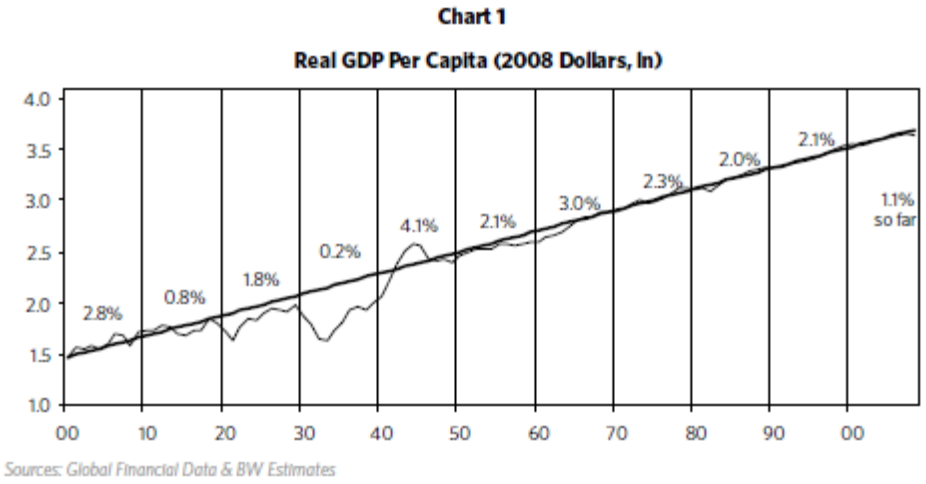
Up to about 1980, most oil cost around what Saudi oil costs to produce ($15/b to $20/b). By 2010, more than half of oil production was more expensive due to the expense of enhanced oil recovery technologies, deep water wells, and oil sands, with production cost averaging around $50/b. US fracking appears to have production costs between $50/b and $80/b and its volume growth since 2010 has slowed the rate of increase of average cost somewhat.

A fundamental issue for the US economy is that as time is passing an increasing percentage of oil is more expensive to produce and the average cost of production is rising steadily. Despite the volatility of the oil market, this rising cost of production also shows through clearly in the rising price trend shown in the first graph. This increasing cost of production also applies to natural gas, the price of which is just as volatile as oil. Electricity also faces an increasing cost of production as high cost wind and solar alternative energy are taking an increasing share of electricity generation investment.

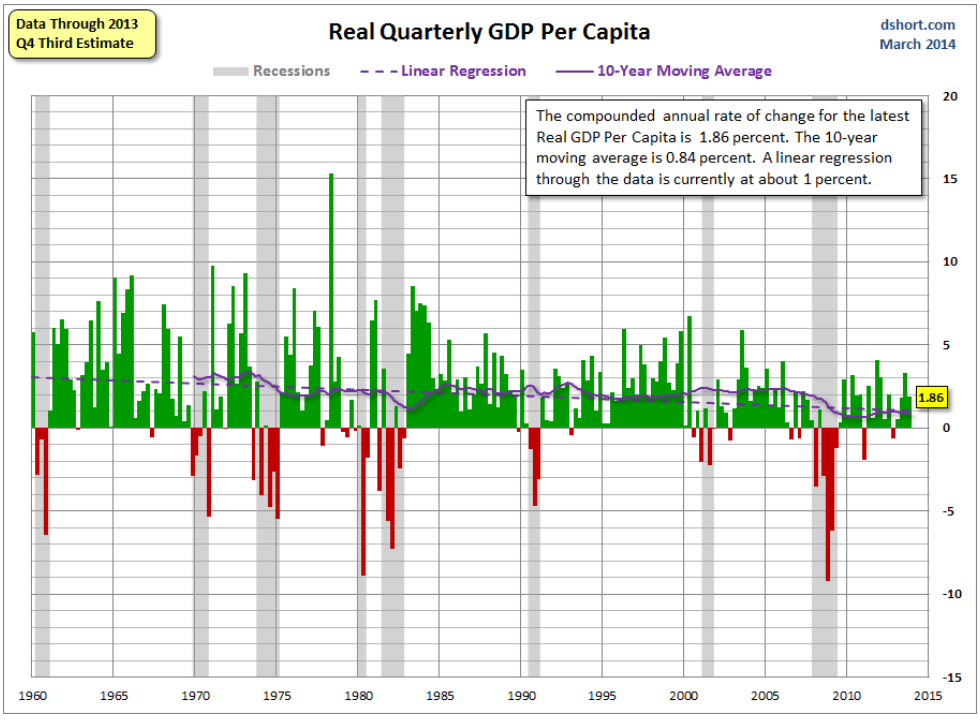
This means the energy sector of the US economy is getting less productive. The economy as a whole is still productive, so logically the combination of oil and the rest of the economy must be less productive than the rest of the economy alone. This should help with estimating the relative size of the productive and non productive sectors of the US economy using the available statistics for economic growth.

Economic growth

The fundamental economic issue is the increasing cost of oil and other energy production. Energy is a very large part of the economy and fundamentally linked to economic growth. If energy costs more resources to produce, the rest of the economy has fewer resources.



As the graph of real US GDP per capita from 1900 to 2015 above shows, over the last 115 years, US real GDP per capita has grown with a very stable long term trend of 2%/y.



However, this graph of real quarterly change in US GDP per capita from the shorter period of 1960 to the present (54 years) shows a steadily declining growth rate trend line that started at 3% and is currently at 1%. This implies that we may no longer be at the 2% longer term 115-year trend in

economic growth seen in the first graph. Visually there is clearly a lot less green on the right hand side of the graph.

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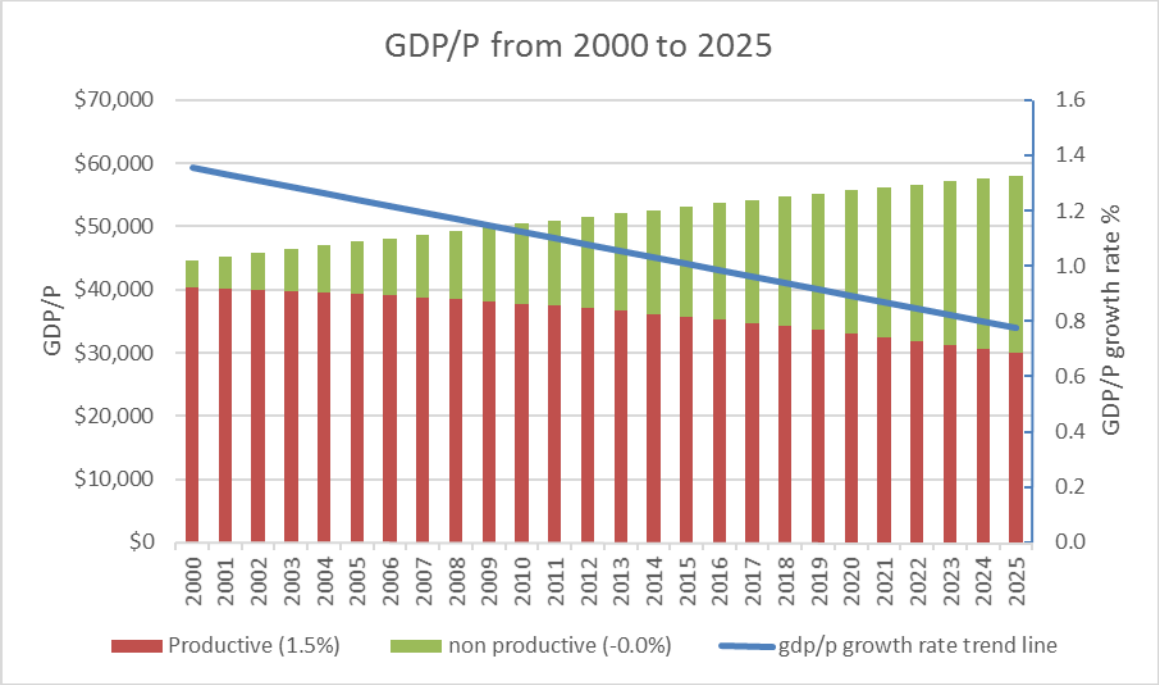


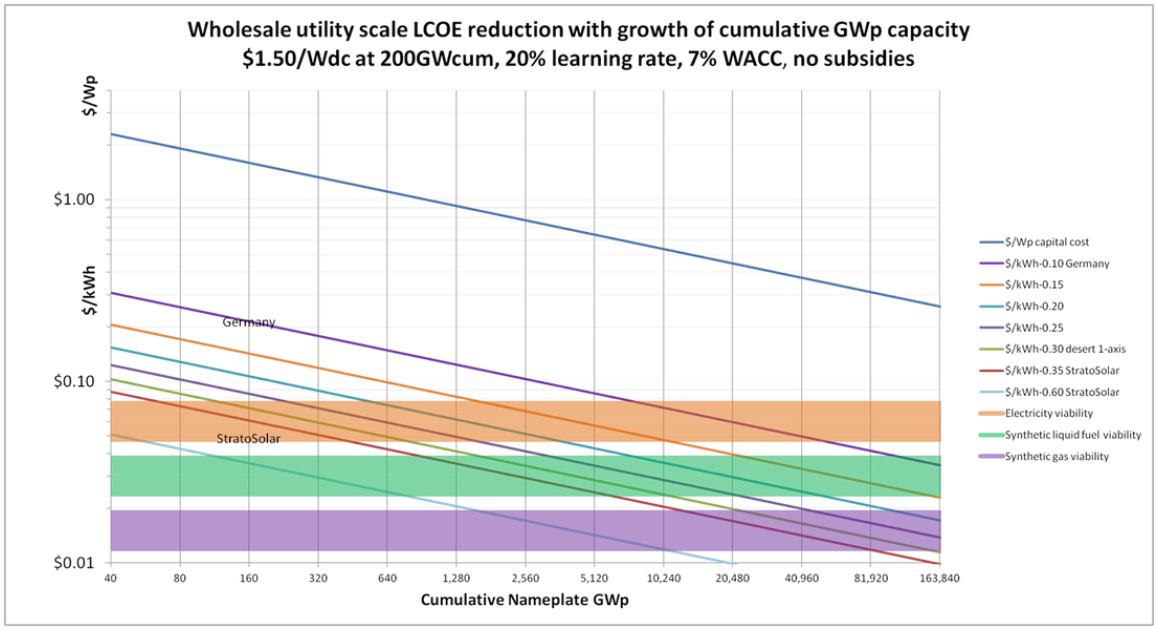
The straight line in the graph above (axis on the right) is based on the downward trend in GDP growth from 1960 to 2015 shown in the previous graph. It shows the trend for the period 2000 to 2015 extended to 2025. The stacked colored bars representing GDP per capita (axis on the left) illustrate a simple model that assumes the economy has two sectors P (productive) and NP (non productive) where GDP = P + NP. The model assumes that the decline in overall growth rate is caused by the growth of a non productive sector that is offsetting the gains of the productive sector.

The graph shows a case where the red sector P has a real productivity growth rate of 1.5% and the green sector NP is stalled out with 0% productivity growth rate. These numbers set the non productive green sector at 10% of GDP in 2000. This produces a breakdown like that shown, with the non productive sector continually increasing as the overall growth rate declines. By 2025 if the current trend persists, the non productive sector is 50% of the economy. If we assume the productive sector has a higher productivity than 1.5%, then the productive share of the economy is smaller and the non productive bigger. This simple model implies that growth rate of the productive sector has declined since 1960 when it has to have been around 3%. Trying to fit cases with higher productive sector growth rates into this simple model would indicate that most of the current economy is non productive. This may actually be the case but that is a subject for future research.

These numbers imply that a larger sector of the economy than just energy is contributing to the recent decline in economic growth rate, as the energy fraction of GDP in 2015 is about 8% to 10% but the non productive sector is at least 25% of GDP. This means that increased energy costs seem likely to account for about a third of the decline in growth rate by 2015. The other likely contributors to decreasing growth rate are substantial and growing parts of the financial sector, health care and education.

This reduced rate of overall economic growth is already causing severe economic problems, contributing to income inequality and stagnant wages as the limited gains accrue to a powerful few. These problems will only get worse if the growth rate continues on its current downward trend. This illustrates that economic growth is a sensitive thing that cannot survive a large and growing part of the economy becoming less productive. This simple model shows that fixing the problem of lower growth means reducing the relative size of the non productive sectors. For the service sector problem areas, like finance and healthcare, the solutions are mainly political, but for energy the solution has to be mainly technological.

Energy solution



The last section showed that the current rising cost of fossil fuel energy is already contributing to reducing US economic growth. CO2 emissions and climate change largely drive the US energy political agenda without any regard for the impact of high costs on economic growth. There is no broad understanding that fossil fuels are already a significant and increasing economic growth problem that high cost alternative energy only exacerbates. Awareness of this economic growth problem would make it clear that a competitive, lower cost source of clean energy is already the most important thing to enable an energy transition that restores US economic growth. In fact, to maintain US economic growth, an energy solution should not only be low cost but should also become more productive and cost less to produce over time.

The graph above shows that PV generation meets the need for cost reduction with increased capacity over time. The historical trend over forty years is a 20% reduction in cost for each doubling in cumulative

capacity. However, the upper trend lines for ground based PV for various geographical locations at the current 200GW installed nameplate capacity, show that ground based PV solar electricity is currently significantly above the needed lower cost (shown by the orange band) and is reducing in cost at too low a rate to be an affordable solution for a long time. At these high costs, increasing solar PV capacity to any meaningful amount would make energy production an increasing part of GDP and reduce or destroy economic growth.

The graph trend lines for StratoSolar show a cost of electricity (LCOE) with current PV technology that is already lower than fossil fuel generation ($0.05/kWh), with continuing cost reduction as more capacity is deployed over time. StratoSolar also solves daytime intermittency, nighttime generation with gravity energy storage and geographical location problems that plague current ground PV. As a lower cost than fossil fuel, complete, dispatchable, electricity solution, StratoSolar provides the only energy solution that can reduce the increasing GDP fraction of the energy sector, restore economic growth and reduce CO2 emissions.

Conclusion

Awareness of the degree to which rising energy costs are already reducing economic growth should highlight the need for a lower cost energy solution. Politicians can ignore climate change, but not economic growth. Sustained economic growth is at the heart of modern prosperity and if its decline were understood, it could not be ignored. Clearly, this awareness of the need for a low cost energy solution is lacking as evidenced by current investment in wind and solar that are only making the economic growth problem worse.