# Climate Change: The Standard Fixes Don't Work

World leaders seem to have their minds made up regarding what will fix world CO2 emissions problems. Their list includes taxes on gasoline consumption, more general carbon taxes, cap and trade programs, increased efficiency in automobiles, greater focus on renewables, and more natural gas usage.

Unfortunately, we live in a world economy with constrained oil supply. Because of this, the chosen approaches have a tendency to backfire if some countries adopt them, and others do not. But even if everyone adopts them, it is not at all clear that they will provide the promised benefits.

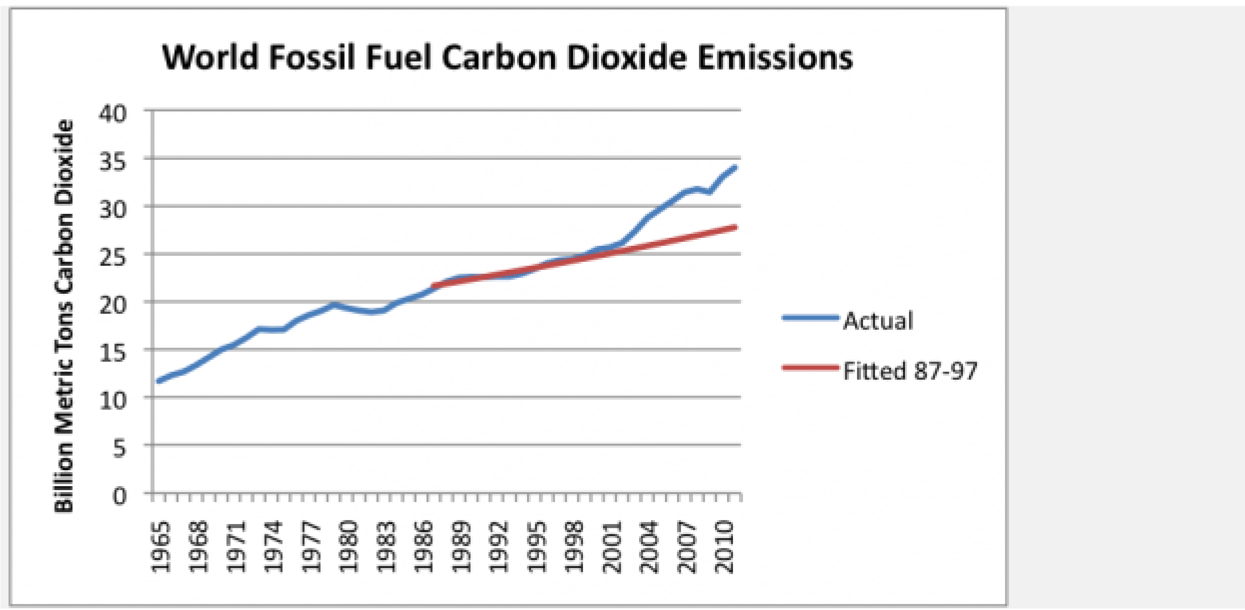


Figure 1. Actual world carbon dioxide emissions from fossil fuels, as shown in BP's 2012 Statistical Review of World Energy. Fitted line is expected trend in emissions, based on actual trend in emissions from 1987-1997, equal to about 1.0% per year.

The Kyoto Protocol was adopted in 1997. If emissions had risen at the average rate that they did during the 1987 to 1997 period (about 1% per year), emissions in 2011 would be 18% lower than they actually were. While there were many other things going on at the same time, the much higher rise in emissions in recent years is not an encouraging sign.

The standard fixes don't work for several reasons:

1. In an oil-supply constrained world, if a few countries reduce their oil consumption, the big impact is to leave more oil for the countries that don't. Oil price may drop a tiny amount, but on a world-wide basis, pretty much the same amount of oil will be extracted, and nearly all of it will be consumed.

2. Unless there is a high tax on imported products made with fossil fuels, the big impact of a carbon tax is to send manufacturing to countries without a carbon tax, such as China and India. These countries are likely to use a far higher proportion of coal in their manufacturing than OECD countries would, and this change will tend to increase world $CO_2$ emissions. Such a change will also tend to raise the standard of living of citizens in the countries adding manufacturing, further raising emissions. This change will also tend to reduce the number of jobs available in OECD countries.

3. The only time when increasing natural gas usage will actually reduce carbon dioxide emissions is if it replaces coal consumption. Otherwise it adds to carbon emissions, but at a lower rate than other fossil fuels, relative to the energy provided.

4. Substitutes for oil, including renewable fuels, are ways of increasing consumption of coal and natural gas over what they would be in the absence of renewable fuels, because they act as **add-ons to** world oil supply, rather than as true substitutes for oil. Even in cases where they are theoretically more efficient, they still tend to raise carbon emissions in absolute terms, by raising the production of coal and natural gas needed to produce them.

5. Even using more biomass as fuel does not appear to be a solution. Recent work by noted scientists suggests that ramping up the use of biomass runs the risk of pushing the world past a climate change tipping point.

It is really unfortunate that the standard fixes work the way they do, because many of the proposed fixes do have good points. For example, if oil supply is limited, available oil can be shared far more equitably if people drive small fuel-efficient vehicles. The balance sheet of an oil importing nation looks better if citizens of that nation conserve oil. But we are kidding ourselves if we think these fixes will actually do much to solve the world's $CO_2$ emissions problem.

If we really want to reduce world $CO_2$ emissions, we need to look at reducing world population, reducing world trade, and making more "essential" goods and services locally. It is doubtful that many countries will volunteer to use these approaches, however. It seems likely that Nature will ultimately provide its own solution, perhaps working through high oil prices and weaknesses in the world financial system.

**Elastic Versus Inelastic Supply**

It seems to me that many bad decisions have been made because many economists have missed the point that **crude oil supply tends to be very inelastic**, while other fuels are fairly elastic. Let me explain.

**Elastic supply** is the usual situation for most goods. Plenty of the product is available, if the price is high enough. If there is a shortage, prices rise, and in not too long a time, the market is well-supplied again. If supply is elastic, if you or I use less of it, ultimately less of the product is produced.

Coal and natural gas usually are considered to be elastic in their supply. To some extent, they are still "extract it as you need it" products. Supply of natural gas liquids (often grouped with crude oil, but acting more like a gas, so it is less suitable as a transportation fuel) is also fairly elastic.

Crude oil is the one product that is in quite short supply, on a world-wide basis. Its supply doesn't seem to increase by more than a tiny percentage, no matter how high the price rises. This is a situation of **inelastic supply**.

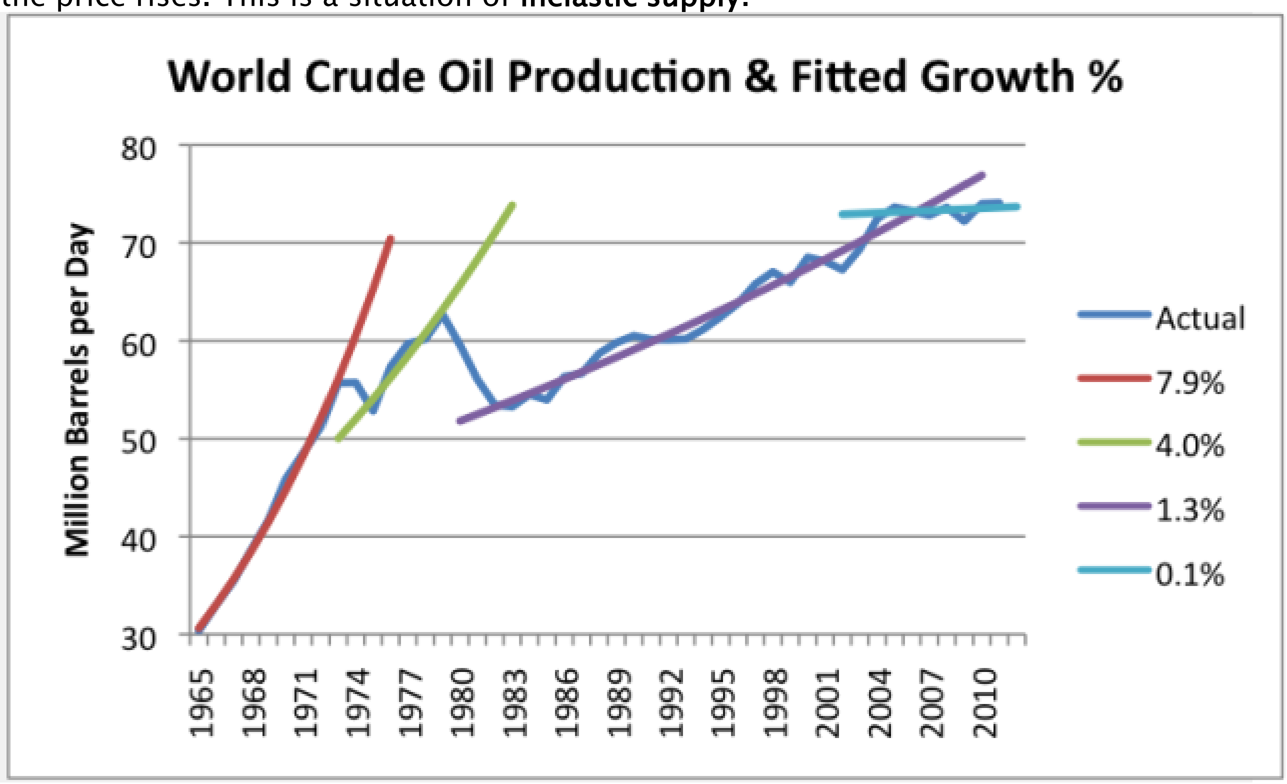


Figure 2. World crude oil production (including condensate) based primarily on US Energy Information Administration data, with trend lines fitted by the author.

Even though oil prices have been very high since 2005 (shown in Figure 3, below), the amount of crude oil has increased by only 0.1% per year (Figure 2, above).

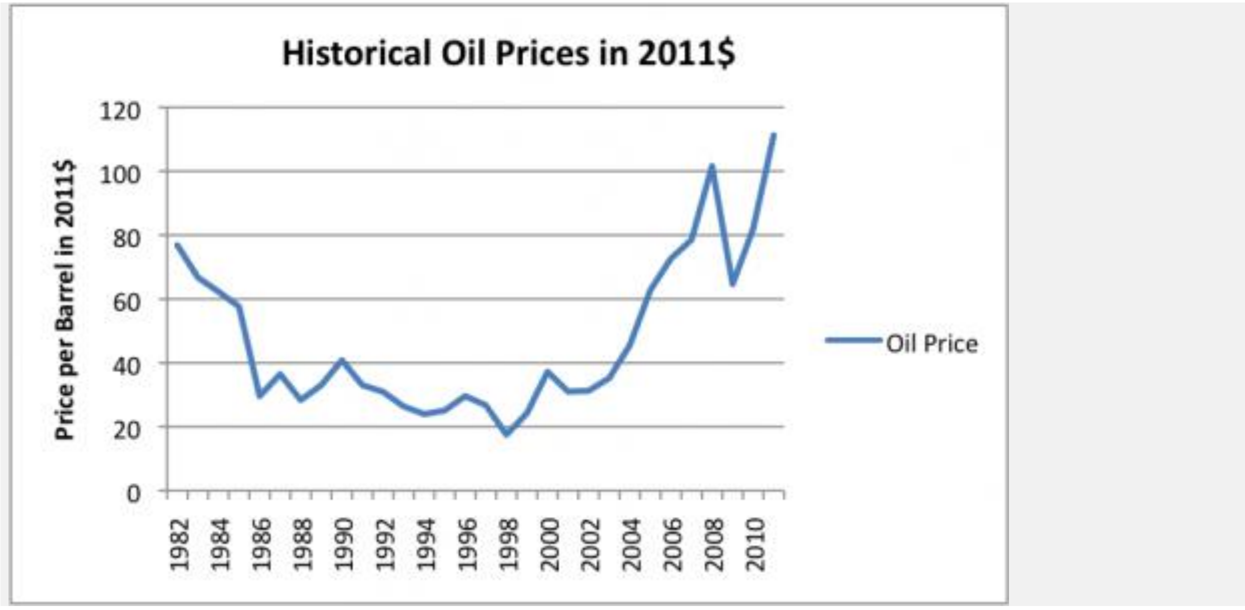


Figure 3. Historical average annual oil prices, ("Brent" or equivalent) in 2011$, from BP's 2012 Statistical Review of World Energy.

In the case of oil, both supply and demand are quite inelastic. No matter how high the price, demand for oil doesn't drop back by much. No matter how high the price of oil, world supply doesn't rise very much, either.[1]

In a situation of inelastic supply, the usual actions a person might take *appear* to work when viewed on a local basis, but backfire on a world basis, if not everyone participates. When one country tries to conserve crude oil (whether through a carbon tax, gasoline tax, or higher automobile mileage requirement), it may reduce its own consumption, but there are still plenty of other buyers in the market for the oil that was saved. So the oil gets used by someone else, perhaps at a slightly lower price. World oil production remains virtually unchanged. Thus, a reduction in oil usage by an OECD country can translate to more oil consumption by China or India, and ultimately more development of all types by those countries.

**Adding Substitutes <u>Adds to</u> Carbon Emissions**

If we don't have enough crude oil, one approach is to create substitutes. Because crude oil supply is inelastic, though, these substitutes aren't really substitutes, though. They are "**add ons**" to world oil supply, and this is one source of our problem with increasing world emissions.

What do we use to make the substitutes? Basically, natural gas and coal, and to a limited extent oil (because we can't avoid using oil). The catch is, that to make the substitutes, we need to burn natural gas and coal more quickly than we would, if we didn't make the oil substitutes. Since the supply of coal and natural gas is elastic, it is possible to pull them out of the ground more quickly. Thus, making the substitutes tends to increase carbon dioxide emissions over what they would have been, if we had never come up with the idea of substitutes.

The increased use of coal and natural gas is pretty clear, if a person thinks about coal-to-liquids or gas-to-liquids. Here, we need to first build the plants used in production, and then with each barrel of substitute made, we need to use more natural gas or coal. So it is very clear that we are extracting a lot of additional coal and natural gas, to make a relatively smaller amount of oil substitute. There is often a substantial need for water to make the process work as well, adding another stress on the system.

But the same issue comes up with biofuels, and with other renewables. These too, are add-ons to the world oil supply, not substitutes. While theoretically they might produce energy with less $CO_2$ per unit than fossil fuel systems, in absolute terms they lead to natural gas and coal being pulled out of the ground more quickly to be used in making fertilizer, electricity, concrete, and other inputs to renewables.[2]

**Carbon Taxes and Competitiveness**

Each country competes with others in the world market place. Adding a carbon tax makes products made by the local company less competitive in the world marketplace. It also signals to potential coal users that the countries adopting the carbon taxes are willing to a leave a greater proportion of world coal exports to those who are *not* adopting the tax, thus helping to keep the cost of imported coal down.

Asian countries already have a competitive edge over OECD countries in terms of lower wages and lower fuel costs (because of their heavy coal mix), when it comes to manufacturing. Adding a carbon tax tends to **add to the Asian competitive edge**. This tends to shift production offshore, and with it, jobs.

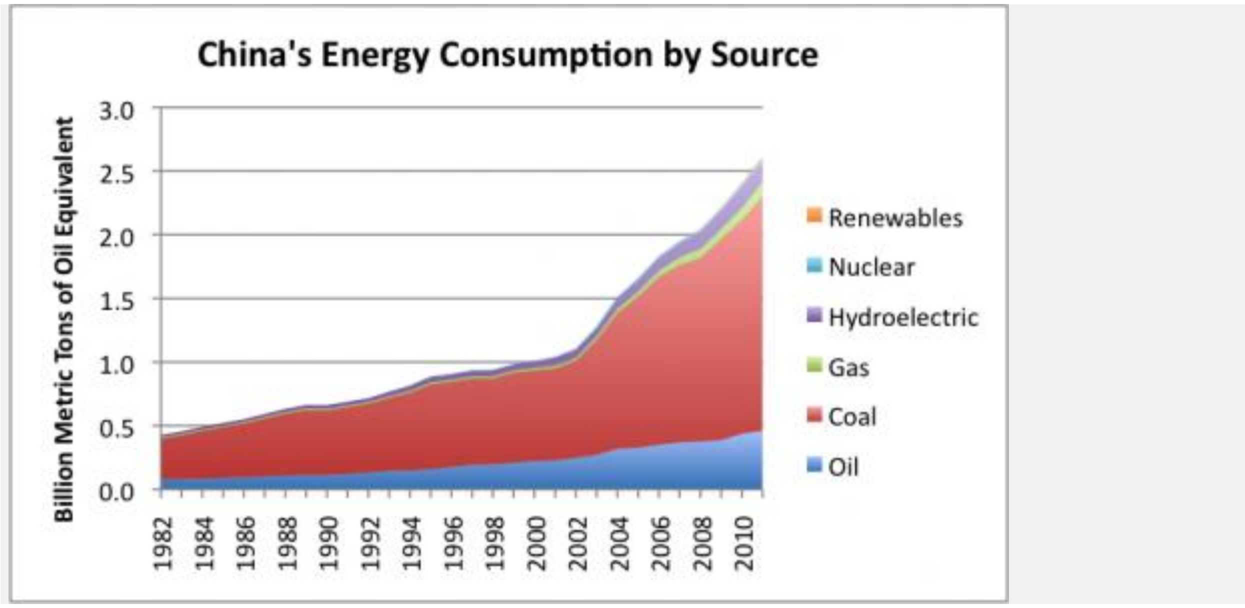


Figure 4. China's energy consumption by source, based on BP's Statistical Review of World Energy data.

China joined the World Trade Organization in 2001. Figure 4 shows clearly that its fuel consumption ramped up rapidly thereafter. It seems likely that the number of Chinese manufacturing jobs and spending on Chinese infrastructure increased at the same time.

Economists seem to have missed the serious worldwide deterioration in CO2 emissions in recent years by looking primarily at individual country indications, including CO2 emissions per unit of GDP. Unfortunately, this narrow view misses the big picture–that total CO2 emissions are rising, and that CO2 emissions relative to world GDP have stopped falling. (See my posts Is it really possible to decouple GDP growth from energy growth andThoughts on why energy use and CO2 emissions are rising as fast as GDP. See also Figure 1 at the top of the post.)

**The Employment Connection**

I have shown that in the US there is a close correlation between energy consumption and number of jobs. (For more information, including a look at older periods, see my post, The close tie between energy consumption, employment, and recession.)

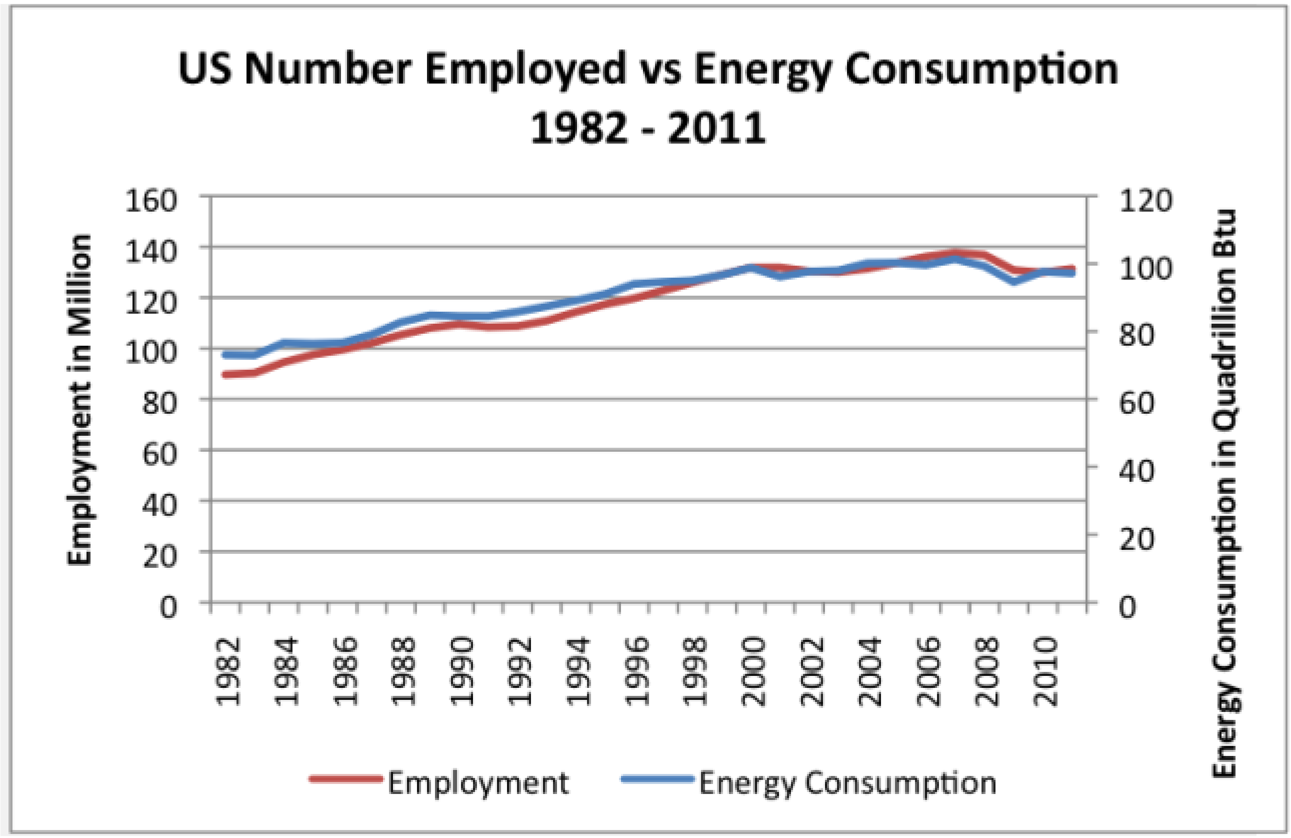


Figure 5. Employment is the total number employed at non-farm labor as reported by the US Census Bureau. Energy consumption is the total amount of energy of all types consumed (oil, coal, natural gas, nuclear, wind, etc.), in British Thermal Units (Btu), as reported by the US Energy Information Administration.

There are several reasons why a connection between energy consumption and the number of jobs is to be expected:

(1) The job itself in almost every situation requires energy, even if it is only electricity to operate computers, and fuel to heat and light buildings.

(2) Equally importantly, the salaries that employees earn allow them to buy goods that require the use of energy, such as a car or house. ("Energy demand" is what people can**afford**; jobs allow "demand" to rise.)

(3) The lowest salaried people can be expected to spend the highest proportion of their salaries on energy-related services (such as food and gasoline for commuting). The wealthy spend their money on high priced goods and services, such as financial planning services and designer clothing that require much less energy per dollar of expenditure.

The thing I find concerning is the close timing between the ramp-up of Asian coal use and thus jobs using coal, and the drop-off of US employment as a percentage of US population, as illustrated in Figure 6 below. Arguably, the ramp up in world trade is just as important, but some aspects of programs that are intended to save CO2 emissions also seem to encourage world trade.

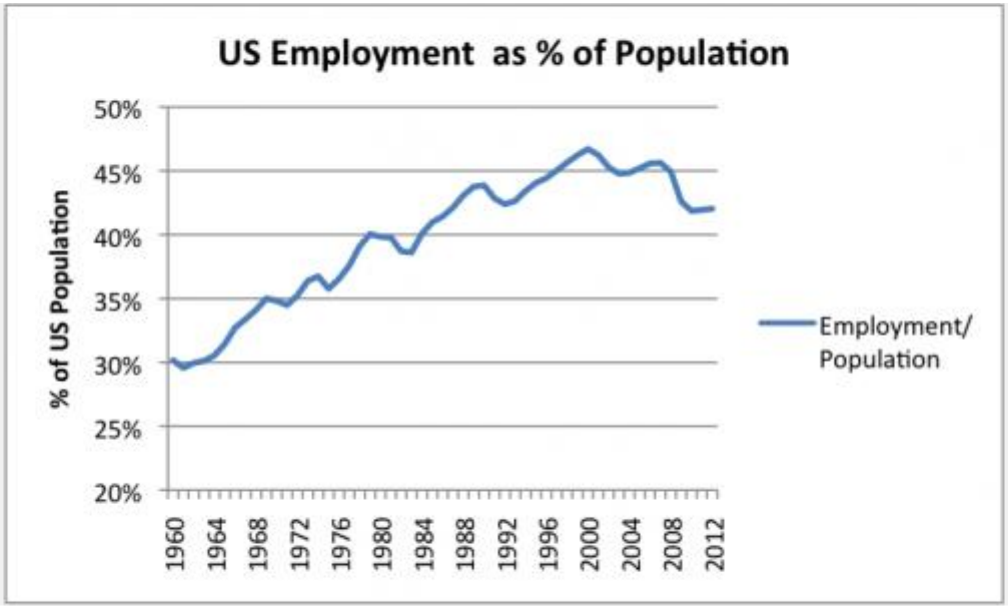


Figure 6. US Number Employed / Population, where US Number Employed is Total Non_Farm Workers from Current Employment Statistics of the Bureau of Labor Statistics and Population is US Resident Population from the US Census. 2012 is partial year estimate.

Of course, the US did not sign the Kyoto Protocol or enact a carbon tax, and it is its jobs that I show falling as a percentage of population. It is more that the CO2 solutions act as yet another way to encourage more international trade, and with it more "growth", and more CO2.

**Using More Biomass is Not a Fix Either**

Burning more wood for fuel and creating "second generation" biofuels from biomass seems like a fix, until a person realizes that we are reaching limits there, as well.

In June 2012, twenty noted scientist published a paper in the journal Nature calledApproaching a State Shift in the Earth's Biosphere. This report indicates that humans have already converted as much as 43% of Earth's land to urban or agricultural uses. In total, 20% to 40% of Earth's primary productivity has been taken over by humans. The authors are concerned that we may now be reaching a tipping point leading to a state shift, because of loss of ecosystem services as use of biological products increases. With this state change would come a change in climate. Simulations indicate that this tipping point may occur when as little as 50% of land use is disturbed. This tipping point may be even lower, if world-wide synergies take place.

**On Our Current Path – Lacking Good Solutions**

While this list of problems relating to current proposed solutions is not complete, it gives a hint of the problems with reducing CO2 emissions using approaches suggested to date. There are many issues I have not covered.

One issue of note is the fact the cost of integrating intermittent renewables (such as wind and solar PV) increases rapidly, as we add increasing amounts to the grid. This occurs because there is more need to transport the electricity long distances and to mitigate its variability through electricity storage or fossil fuel balancing. (See for example, Low Carbon Projects Demand a New Transmission and Distribution Model, Grid Instability Has Industry Scrambling for Solutions, and Hawaii's Solar Power Flare-Up.)

While the problems noted in these articles are probably solvable, the cost of these solutions has not been built into energy balance analyses. Energy balances (or EROEI estimates) as currently reported do not vary with the proportion of intermittent renewables added to the grid. If energy balance analyses were adjusted to reflect the high cost of adding an increasing proportion of wind or solar PV to the grid, they would likely show a rapidly declining energy balance, above a certain threshold. This would indicate that while adding a little intermittent renewables (as we have done to date) can be a partial solution, adding a lot is likely to have serious cost and energy balance issues.

Another issue that is difficult to deal with is the fact that we are not dealing with a temporary problem with CO2 emissions. The idea is not to slow down the burning of fossil fuels, and burn more later; what we really need to do is to leave unburned fossil fuels in the ground for all time. This is a problem, because there is no way that we can impose our will on people living 10 or 50 years from now. The Maximum Power Principle of H. T. Odum would seem to indicate that any species will make use of whatever energy sources are available to it, to the extent that it can. Even if we temporarily defeat this tendency with respect to humans' use of fossil fuels, I don't see any way that we can defeat this tendency for the long term.

Considering all of these issues, it does not appear that most of the "standard" solutions will really work.[3] What other options do we have?

**Nature's Solution**

The Earth has been handling the problem of shifting conditions for over 4 billion years. The earth is a finite system. Nature provides that finite systems, such as the Earth, will cycle to new states of equilibrium over time, as conditions change. While we would like to defeat Earth's tendency in this regard, it is not at all clear that we can. Part of this cycling to a new state is likely to be a change in climate.

A state change is a cause for concern to humans, but not necessarily to the Earth itself. The Earth has moved from state to state many times in its existence, and will continue to do so in the future. The changes will bring the Earth back into a new equilibrium. For example, if CO2 levels are high, species that can make use of higher CO2 levels (such as plants) are likely to become dominant, rather than humans.

Exactly how this state change might occur is subject to different views. One view is that changing CO2 levels will be a primary driver. The Nature article referenced previously suggested that increased disturbance of natural ecosystems (as with greater use of biomass) might force a state change. My personal view is that a financial collapse related to high oil price may be part of Nature's approach to moving to a new state. It could bring about a reduction in world trade, a scale back in CO2 emissions, and a general contraction of human systems.[4]

However the change takes place, it could be abrupt. It will not be to many people's liking, since most will not be prepared for it.

## Steps That Might Work to Slow CO2 Emissions

It would be convenient if we could slow CO2 emissions by working to produce energy with less CO2. This option does not seem to be working well though, so I would argue that we need to work in a different direction: toward reducing humans' need for external energy. In order to do this, I would suggest two major steps:

(1) Reduce the world's population, through one-child policies and universal access to family planning services. This step is necessary because rising population adds to demand. If we are to reduce demand, lower population needs to play a role.

(2) Change our emphasis to producing essential goods locally, rather than outsourcing them to parts of the world that are likely use coal to produce them. I would suggest starting with food, water, and clothing, and the supply chains necessary to produce these items.

Changing our emphasis to producing essential goods locally will have a multiple benefits. It will (a) add local jobs, and (b) lead to less worldwide growth in coal usage, (c) save on transport fuel, and (d) add protection against the adverse impact of declining world oil supply, if this should happen in the not too distant future. It should also help reduce CO2 emissions. The costs of goods will likely be higher using this approach, leading to less "stuff" per person, but this, too, is part of reaching reduced CO2 emissions.

It is hard to see that the steps outlined above would be acceptable to world leaders or to the majority of world population. Thus, I am afraid we will end up falling back on Nature's plan, discussed above.

**Notes**:

[1] Michael Kumhof and Dirk Muir recently prepared a model of oil supply and demand (IMF working paper: Oil and the World Economy: Some Possible Futures). In it, they assume a long run price-elasticity of oil supply of 0.03, and remark that a paper by Benes and others indicates a range of 0.005 to 0.02 for this variable. The long term price elasticity of oil demand is assumed to be .08 in the Kumhof and Muir analysis.

[2] I would argue that standard EROEI measurements are defined too narrowly to give a true measure of the amount of energy used in making a particular substitute. For example, EROEI measures do not consider the energy costs associated with labor (even though workers spend their salaries on clothing, and commuting costs, and many other good and services that use fossil fuels), or with financing costs, or of indirect impacts like wear and tear on the roads by transporting corn for biofuel.

Other types of analysis have ways of dealing with this known shortfall. For example, when the number of jobs that a new employer can be expected to add to a community is evaluated, the usual approach seems to be to take the number of jobs that can be directly counted and multiply by three, to estimate the full impact. I would argue that with substitutes, some similar adjustment is needed. This adjustment which would act to increase the energy use associated with renewables, and reduce the EROEI. For example, the adjustment might divide directly calculated EROEI by three.

A calculation of the true net benefit of renewables also needs to recognize that nearly the full energy cost is paid up front, and only over time is recovered in energy production. When renewable production is growing rapidly, society tends to be in a long-term deficit position. Typically, it is only as growth slows that society reaches as net-positive energy position.

[3] I obviously have not covered all potential solutions. Nuclear power is sometimes mentioned, as is space solar power. There are new solutions being proposed regularly. Even if these solutions would work, ramping them up would take time and require use of fossil fuels, so it is wise to consider other options as well.

[4] The way that limited oil supply could interfere with world trade is as follows: High oil prices cause consumers to cut back on discretionary goods. This leads to layoffs in discretionary sectors of the economy, such as vacation travel. It also leads to secondary effects, such as debt defaults and lower housing prices. The financial effects "concentrate up" to governments of oil importing nations, because they receive less tax revenue from laid-off workers at the same time that they pay out more in unemployment benefits, stimulus, and bank bailouts. (We are already at this point.)

Eventually, countries will find that deficit spending is spiraling out of control. If countries raise taxes and cut benefits, this is likely to lead to more lay offs and debt defaults. One possible outcome is that citizens will become increasingly unhappy, and replace governments with new governments that repudiate old debt. The new governments may have difficulty establishing financial relationships with other governments, given that most are major debt defaulters. Such issues could reduce world trade substantially. With the drop of world trade would come much more limited ability to maintain our current systems, such as electricity and long distance transport.

Source: http://ourfiniteworld.com/2012/11/20/climate-change-the-standard-fixes-dont-work/