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## **China's Coal Bubble ...and how it will deflate U.S. efforts to develop "clean coal"**

The conventional wisdom in energy-and-environment circles is that China's economy, which is growing at a rate of eight percent or more per year, is mostly coal powered today and will continue to be so for decades to come. Coal is cheap and abundant, and China uses far more of it than any other nation. The country is trying to develop other energy sources fast—including nuclear, solar, and wind—but these won't be sufficient to reduce its reliance on coal. That's one of the reasons it is important for the U.S. to develop "clean coal" technology, which China can then begin to adopt so as to reduce the horrific climate impacts of its coal-heavy energy mix.

Most of this conventional wisdom is correct, but some of it is plain wrong—so wrong, in fact, that environment-, economic-, and energy-policy wonks are constructing scenarios for the future of U.S. and world energy, and for the global economy, that bear little or no resemblance to the reality that is unfolding.

Let's see if we can sort what's right from what's not, and see also if doing so can help us paint a more accurate picture of where China, and the rest of the world, are actually headed.

### **Runaway Train**

It is true of course that China's coal consumption is enormous and growing, and that coal is the basis of the Chinese economy, fueling over 80 percent of electricity generation. China's coal output grew an astonishing 28.1 percent from first quarter 2009 to first quarter 2010, to over 750 million metric tons consumed in just the past three months. But this is a situation that is patently unsustainable—not just because of the carbon emissions it entails, but because China simply doesn't have enough coal to continue growing its consumption much longer.

Start with the stats and do some simple math. China is now mining and burning over three billion tons of coal per year. If the nation's coal consumption grows at, say, seven percent per year, that means consumption will double in ten years (its annual growth rate was actually over nine percent in one or two of the last several years,

implying a doubling every eight years—but let's be conservative and assume seven percent growth). In that case, by 2020 China would be using about six billion tons per annum.

It takes some reflection to come to terms with the enormity of these figures. In 2000, China's coal consumption was only marginally higher than that of the U.S. Today, a decade later, it is *three times* U.S. consumption. (It is worth noting that the U.S. has double China's coal reserves.)

Combine unprecedented consumption levels with furious growth rates and you quickly arrive at absurdities and impossibilities. As in, it *won't happen*. The wheels will fall off the wagon first.

### **There Are Limits**

It takes infrastructure to mine and use coal. Rails and rail wagons, plus trucks and roads, are needed to move coal from mines to power plants. Then there are the mines themselves, as well as the boilers and turbines that actually produce electricity. (In this essay we will not further consider the vital importance of coal to China's steel industry, and the necessity of steel for manufacturing and economic growth in general.)

China is building all of these at a frenetic pace—but the relentless math of exponential growth is starting to hit home. Doubling small levels of production and consumption is relatively easy in practical terms, but, as quantities expand, the task balloons. China accomplished an amazing feat by adding almost two billion tons per year of coal production and consumption capacity and transport infrastructure during the past decade. Adding another three billion tons per year of capacity during the next decade would be—well, nearly twice as big a feat. Imagine building mining and transport infrastructure *three times* the size of the entire U.S. coal and rail industries in just ten years. That's what it will take for China to maintain seven percent growth rates.

It takes other resources to consume coal; crucially, water is needed to run coal power plants. A typical 500-megawatt coal-fired power plant uses about 2.2 billion gallons of water each year to create steam for turning its turbines—enough water to support a city of 250,000 people. In recent months droughts have wracked huge sections of China, idling hydroelectric dams and stoking demand for coal. If the droughts recur and worsen (as climate-change scenarios suggest), at some point nuclear and coal power plants will be forced to shut down as well, leading to the kinds of electricity supply problems that are already plaguing Pakistan and dozens of other nations, where the lights are off for hours each day even in the largest cities.

And so, partly due to these factors, but primarily because most of the highways, shopping malls, and appliances that the Chinese people are likely to need for a while have by now already been built, China is entering a period characterized by what are called "saturation effects," which will result in significant slowdowns in key industrial energy consuming sectors of the economy. China's infrastructure boom that has driven so much of energy demand growth in the past decade has probably peaked, so that growth in cement and steel

demand will soon taper off. While the nation's stimulus package, representing 40 percent of GDP, has extended the party, it will play out over the next year or so and probably can't be repeated.

But that still leaves a smoldering question: can China's coal industry continue to supply domestic demand with even modest rates of growth going forward, declining perhaps to something more on the order of two percent per year?

### **If It's Not There, You Can't Burn It**

According to the World Coal Institute, China has reserves totaling a little over 110 billion tons. That's almost 37 years' worth of coal at current rates of consumption (i.e., three billion tons per year). But to assume that China won't have coal supply problems until 37 years have passed is also to assume two absurdities: that Chinese demand, production, and consumption of coal will remain constant; and that after maintaining this steady rate of extraction and consumption for 37 years, China will one day suddenly discover that its coal has run out.

In the real world, China's demand for coal is expected to grow. Adding ten percent annual consumption growth to the forecast would yield a reserves lifetime of only 16 years. While a sustained rate of growth this high is extremely unlikely, the principle is worth keeping in mind.

Also in the real world, production profiles plotted over time assume the shape of a distorted bell curve that starts at zero and ends at zero, with a peak somewhere in between. We know this is true for coal extraction because several regions in the world have already seen a peak and substantial decline of extraction rates, while no region has so far managed to maintain a high, steady rate of production (or a growing rate of production) until reserves suddenly reached exhaustion. This means that China's coal production will peak and begin to decline significantly sooner than reserves-to-production ratios (37 at steady rates, or 16 with ten percent annual growth) would suggest.

Could China increase its coal reserves? In principle, yes. Reserves are defined as the portion of the total coal resource base that geologists believe can be mined economically. New mining technology and higher coal prices could impact those estimates. However, the overwhelming trend globally is for reserves to be downgraded to mere resources as geologists take into account more restrictions on the amount of coal that is practically recoverable—restrictions like location, depth, seam thickness, and coal quality. It is this general trend that causes some analysts to doubt China's official reserves figure of 187 billion tons (which is notably higher than estimates published by World Energy Council, World Coal Institute, and others): the coal is certainly there, but—like the great majority of coal elsewhere in the world—most of it is probably destined to stay right where it is.

In my 2009 book [\*Blackout: Coal, Climate and the Last Energy Crisis\*](#), I surveyed four studies forecasting the timing of the peak of China's coal production. At one extreme, a 2006 study by Energy Watch

Group of Germany used a reserves figure of 62.2 billion tons to forecast a peak of production for 2015, with a rapid production decline commencing in 2020. At the other extreme was a 2007 study by Chinese academics Tao and Li published in *Energy Policy*, which used the Chinese government's official coal reserves figure of 187 billion tons to arrive at a peaking date between 2025 and 2032.

None of these forecasts envisioned the rapid growth in Chinese coal production that has actually occurred over the past few years. This predictive failure could be interpreted in one of two ways: it suggests either that China's coal reserves are larger than previously estimated, thus permitting a higher sustained rate of extraction; or that Chinese officials have forced extraction rates to the absolute maximum level sooner rather than later in order to support economic growth, thus hastening the production peak—which could therefore possibly occur even before the earliest forecast date (2015).

### **No Alternatives**

Economic growth requires energy, and China needs economic growth to maintain domestic political stability and international competitiveness. If there's not enough coal to support the nation's energy growth, then other options must be considered.

China is developing alternative energy sources; can these be brought on line fast enough to make a difference? Let's do some numbers. China aims to have 100 gigawatts (GW) of wind power capacity by 2020, and the nation's leaders plan to expand installed solar capacity to 20 GW during the same period. These are truly astonishing goals, and, if China even comes close to accomplishing them, it will become the world's renewable energy leader. But there is a problem: total Chinese electricity generation capacity is 900 GW currently; with seven percent growth, that means the nation's electricity demand in 2020 will be something like 1800 GW. Wind and solar together would supply less than seven percent of that. The only thing likely to boost that percentage much would be a dramatic reduction in growth of energy demand to, say, two percent annually.

The situation with nuclear power is similar: China has 11 atomic power plants now and is in the process of building 20 more, with a target of 60 GW of generating capacity, or possibly more, by 2020. But this will supply only between three and five percent of total electricity demand, depending on energy demand growth rates.

The conclusion is unsettling but inescapable: China's reliance on coal cannot be significantly reduced as long as its demand for electrical power continues to grow at anything like current rates. And even if energy demand growth tapers off and alternative energy sources come on line quickly, the country's ability to supply enough coal domestically will still be challenged.

### **Imports Can't Make Up the Difference**

China has been self-sufficient in coal until recently (importing some coal but exporting just as much or more), but supply problems over the last couple of years have led to burgeoning imports and shrinking exports. If Chinese coal mines can no longer cover the nation's

demand, why not just expand imports still further to make up the difference?

China will import 150 million tons (Mt) of coal this year, twice what it imported last year. That's not much, if we think of it as a percentage of the nation's total coal consumption. But that 150 Mt represents over 60 percent of the total exports of Australia, the world's top coal exporter. This means if Chinese imports double again next year—not an unrealistic scenario—China will need to import more coal than Australia can currently provide. One more doubling of import demand and China will be wanting to import 600 million tons per year, about the total amount of coal exported by all exporting nations last year.

Can Australia expand its coal production? Yes, it can and no doubt will. Likewise Indonesia and South Africa. But will any or all of these countries be able to grow exports fast enough to keep up with Chinese demand? Again, expansion will be limited by infrastructure requirements—ships, ports, trains, and rails. It takes time to build all of these. By the latter decades of the 21st century, Australia could be the world's biggest coal producer, even though that nation's coal reserves are smaller than those of the U.S., China, or India. (How can this be? It would simply occur as a result of the latter high-consuming nations gobbling up their own reserves so quickly and so soon; Australia has been a fairly minor producer up to this point.) But that will do China little good over the next decade or so, if its domestic coal production peaks and goes into steep decline.

China's increasing reliance on coal imports is not good news for India, Europe, and other coal importers. India burns 500 Mt of coal per year and is facing growing problems with its domestic mining industry. The solution appears to be, unsurprisingly, to import more coal. India wants to grow its economy at seven percent annually, just as the Chinese are doing, and India's economy is just as coal-dependent as China's.

Until recently, coal has been a resource used mostly in the country of origin. Internationally traded coal was a fairly small percentage of the total amount consumed globally—a situation quite different from that with oil, over half of which is exported from the country of origin. However, there is an increasing trend toward the development of an integrated global coal market—and it appears that trend is about to go into overdrive.

This means that if Chinese and Indian demand for coal imports pushes up the price for export coal (as it almost certainly will, and probably quite dramatically), the result will be higher coal prices everywhere—even within nations that are self-sufficient in the resource. After all, if a coal mining company in the U.S. can get twice the price for its product by selling it abroad as opposed to selling it domestically, won't it opt to export? Unless governments implement export curbs or domestic price caps, the international export price of coal will end up being the domestic price for countries everywhere.

Yet if coal prices go too high, that will cause demand to fall, as potential coal buyers choose other energy sources or simply do without. The result will be the same kind of volatility in coal prices as we have seen in oil prices over the past few years. That price

volatility will undermine energy markets in general, and poorer nations that use coal will consistently be outbid.

## **Implication for the U.S.: Forget "Clean Coal"**

Now: what does any of this have to do with "clean coal" technology?

Also known as Carbon Capture and Sequestration (CCS), "clean coal" is touted as the solution to one of the biggest conundrums facing industrial civilization in the 21st century: how to reduce greenhouse gas emissions and thus prevent catastrophic climate change, while maintaining growth in energy supplies and therefore in economic activity. Since nobody in a position of authority can seemingly figure out how to maintain economic growth while cutting coal out of the energy equation globally, and since nearly everyone assumes coal will remain cheap and abundant far into the foreseeable future, the obvious answer to the dilemma is to find a way to continue burning increasing amounts of coal while keeping the resulting CO<sub>2</sub> from going into the atmosphere.

We know this can be done—on a small scale. All of the elements of the technology are already working in various pilot projects. Oil companies already inject carbon dioxide into oil wells to increase production. Pipelines, compressors, pumps—none of these requires quantum physics.

There are two hitches: the difficulty of scaling up such an enterprise, and its impact on electricity prices. As many analysts have pointed out, the sheer size of the proposed operation—if deployed nationally in the U.S. alone, let alone the entire world—will be mind-boggling. And the costs of all those pipelines, pumps, compressors, and new coal gasification power plants (these are needed because it's really difficult and expensive to add CCS onto existing pulverized coal burning power plants) add up quickly and steeply. Every energy analyst agrees that this will boost the cost of electricity.

Still, the scheme might just barely work—as long as coal prices remain constant.

However, add much higher coal prices to the equation and the result is electricity costs that will significantly dampen economic growth, make other energy sources comparatively more economically viable—or both. Conclusion: "clean coal" is an idea whose time will never come.

Now, there are other reasons for assuming that U.S. coal prices will be higher in a decade or so than they are now. Official estimates of U.S. coal reserves are probably inflated, and domestic supply problems could start to appear sooner than most energy analysts are willing to admit. Moreover, America's coal transport infrastructure could be hobbled by higher diesel prices if world oil production goes into decline soon (as increasing numbers of analysts foresee), since transport costs often account for the lion's share of the delivered price of coal. But even if we ignore those looming systemic limits and consider only the implications of China's growing demand for coal imports, it's clear that U.S. coal prices can go nowhere but up. The only thing likely to keep them from doing so would be a collapse of

the Chinese—and the global—economy.

### **China: Leading the Global Economy...Into the Ditch**

Some commentators are concerned about China's economy for reasons that have nothing to do with coal. The prime example: it would appear that Beijing has a problem with over-reliance on property development as an engine of domestic economic growth. One of those sounding the alarm on this score is hedge fund manager James Chanos, founder of Kynikos Associates Ltd.; he says China is "on a treadmill to hell," and that the nation is "Dubai times a thousand." He has also been [quoted as saying](#), "They can't afford to get off this heroin of property development. It is the only thing keeping the economic . . . numbers growing."

A bursting of China's property bubble could collapse the nation's economy quickly and soon. But it is essentially a problem of money, and money is a creation of the human mind. Currencies can be reformed; banking systems can be reorganized. Such things are painful and take time, but they are certainly possible—and historic examples are numerous.

Energy is different. Without energy, nothing happens. Transport systems stall; building construction and manufacturing cease. The lights go out. You can't make energy out of nothing and you can't call it into existence with computer keystrokes, as bankers can do with money. Generating electrical power requires physical resources, infrastructure, and labor. And so there are natural limits to how much energy we can summon for our human purposes at any given time.

China has become a great manufacturing powerhouse largely because it was able to grow its energy supply quickly and cheaply. And so China's contribution to the world economy is to this extent a function of China's contribution to world energy. One significant gauge of this link is the fact that Chinese coal production represents more than double the amount of energy contributed to the world economy as compared to Saudi Arabia's oil production (1,100 million tons of oil equivalent vs. 540 Mtoe.)

If China faces hard energy limits, that means its economy is living on borrowed time. That also means the world as a whole confronts energy and economic constraints that are harsher, and closer, than we are being told.

### **Forever Blowing Bubbles?**

High coal prices and "clean coal" don't mix. China's insatiable hunger for more coal will drive up coal prices everywhere. China can't keep up coal-powered industrial expansion for much longer, nor can the global economy accelerate without the engine of China. The evidence on these scores couldn't be clearer: the numbers we have discussed are fairly uncontroversial, and the math of compounded steady growth is easy. Still, none of these realities has entered our public discourse. This fact in itself is really peculiar and disturbing. We are participating in a slow-motion train wreck, yet all we can manage to discuss is the quality of the food in the dining car.

Maybe this is because acknowledging the train wreck would require us to confront a slew of contradictions at the core of the entire modern industrial project. Without clean coal, there is no solution to the climate crisis—unless we are willing to contemplate giving up economic growth. But further growth may be unattainable anyway, as the world approaches fundamental resource limits. Nobody wants to think about these things, much less talk about them. Not China's leaders, nor economists elsewhere, nor many environmentalists, nor politicians, nor journalists.

But we can't wish these limits away. Impossible things (like unending economic growth) won't happen just because people want them to. And awful things (like the wreck of the China train) won't be averted just because acknowledging them makes us uncomfortable.

There are of course steps that Chinese officials—everyone, in fact—could take to make the situation better. We should be developing and deploying renewable energy as fast as possible, with a wartime mentality in terms of priority and commitment. And we should be planning for the end of growth, indeed for economic contraction. These things will be difficult, there's no getting around it. Still, they are possible in principle. But we will fail for sure if we remain sunk in denial and do not even make the effort.

China's economic bubble in some ways represents a microcosm of the entire industrial period—itsself a relatively brief era of urbanization, fossil-fueled expansion, technological innovation, and unprecedented explosion of consumption. China has taken only two or three decades to accomplish what some other nations did over the course of a couple of centuries. This suggests that, for that country, implosion may come just as quickly.

It is all a remarkable spectacle. Sit back, watch, and marvel if you wish. But know one thing: unless we collectively wake up, engage the brakes on this runaway train (and here I am speaking not just of China), and start discussing how we will adjust to the end of economic growth as we have known and defined it, none of this will end well.