

## Jousting with James Hansen: China building a renewables powerhouse ジェームス・ハンセンとの論戦 中国は再生可能なエネルギー大国になりつつある

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**Between 2012 and 2014 we posted a number of articles on contemporary affairs without giving them volume and issue numbers or dates. Often the date can be determined from internal evidence in the article, but sometimes not. We have decided retrospectively to list all of them as Volume 10, Issue 54 with a date of 2012 with the understanding that all were published between 2012 and 2014.**

### John Mathews and Hao Tan

We have the dubious distinction of being misrepresented by Dr James Hansen, surely the most famous climate scientist in the world. It's not often that two social scientists find themselves dealt with in this way by such a deservedly respected public figure. Not to respond would be to declare defeat or even to agree with Dr Hansen's assertions, and we are inclined to do neither.

In this article, we begin our rebuttal by affirming our unbounded admiration for Dr Hansen. He is not only the world's top climate scientist but also a fearless, and deliberately activist, exponent of the view that the age of fossil fuels is - and must be - drawing to an end. Dr Hansen's research and activism are a major reason we are having this debate about climate and energy.

So we have no disagreement that it is imperative to end the age of fossil fuels. Where we part company, however, is on the policy implications. We have been caught in Dr Hansen's wider trawl for what he calls "Renewables can do all" greenies, or what might better be called "Nothing but renewables" greenies (NBRGs). He accuses NBRGs of mistakenly promoting renewables at the expense of nuclear power and thereby opening the way towards the rise and conquest of the gas industry. In the US, where fracking of coal seam gas and exploitation of tar sands is reaching fever pitch, this is an understandable concern.

Our concern however is with China and the representation of its efforts to build a sustainable energy system to underpin its awesome and dangerously polluting industrial machine. In this regard, Dr Hansen discusses our findings on China and its rapid build-up of an energy system based largely on coal, and where there are also substantial investments being made in both nuclear and renewables, particularly hydro, wind and solar. In Dr Hansen's posting "Renewable energy, nuclear power and Galileo: Do scientists have a duty to expose popular misconceptions?" ([http://www.columbia.edu/~jeh1/mailings/2014/20140221\\_DraftOpinion.pdf](http://www.columbia.edu/~jeh1/mailings/2014/20140221_DraftOpinion.pdf)) we read the quite correct assertion that "China is now leading the world in installation of new hydropower, wind, solar and nuclear electricity generation."

We certainly concur with Dr Hansen about that. But he didn't leave it there. He went on to insist that "the energy development situation in China is often reported, in the West, in very misleading ways. For example, a 2014 article 'China roars ahead with renewables' in *Ecologist* magazine reprinted from *The Conversation* [that is, our own article, unattributed], stated 'Reports of China opening a huge new coal-fired power station every week belie the reality - China is the new global powerhouse for renewable modernization and industrialization of the country - is now [sic] being powered more by renewables than by fossil fuels.'"

Whether deliberate or not, this extract (which does not use our own words but is compiled from the editors' introduction in *The Ecologist*) obscures a pertinent fact: we were making a very clear distinction (and continue to make the distinction) between China's total electric power system, which is still largely coal-driven, and the leading edge of change, where new capacity additions are being installed and where renewables are coming to occupy an ever greater part of China's expansive energy profile.

Our objective was to highlight the significance of the new capacity additions to China's power system for that nation's future trajectory. It is in this crucial area that renewables capacity is coming to outrank thermal capacity. We could not have been clearer, when we stated that "the **growth** of its [China's] electric power system - that underpins the entire modernisation and industrialisation of the country - is now being powered more by renewables than by fossil fuels." The distinction between what happens at the level of the total system, and what is happening at its leading

edge, is critically important.

We think it is of great significance - as Dr Hansen obviously does as well - that China is building renewables and nuclear industries so fast. China's energy transformation means that it is now "leading the world in installation of new hydropower, wind, solar and nuclear electricity generation." What we have sought to do is to put flesh on these statistical bones. Is new capacity in renewables actually outranking thermal power, and where does nuclear stand? We draw on three sources of data to answer these questions in our latest article published in the *Asia-Pacific Journal* [http://japanfocus.org/-John\\_A\\_-Mathews/4098](http://japanfocus.org/-John_A_-Mathews/4098). There are data that measure installed capacity (measured in gigawatts of power); there are data that record changes in electricity generation itself, which allocate the different sources according to different capacity factors; and there are investment data.

### 1) *Installed capacity*

In terms of installed capacity, China now has the largest electric power system in the world, rated at 1.25 trillion watts (TW). This massive number, for comparison, exceeds the US power system's capacity, which is rated at 1.16 TW. Renewables now account for 30% of China's capacity, while coal still accounts for 69%. The latter number shows that China's power is still a very black system. But the fact remains that China's power system's leading edge is getting greener: in 2013 China added 94 GW of new capacity, of which 55.3 GW came from renewable (hydro, wind, solar PV) sources and just 36.5 GW from thermal (mostly coal) sources. As to nuclear, China added just 2.2 GW of nuclear capacity in 2013.

## 2) *Electrical generation*

Installed capacity is one thing; actual electrical energy generated is quite another. By 2013 China was generating a total of 5,322 billion kWh (or TWh), including nearly 4,000 TWh from thermal power stations and just over 1 trillion kWh [1,000 TWh] – or 20% -- from renewable sources. The official target from the NDRC in China is for this 20% level to rise to 30% of electric energy generated by 2020. Again, the leading edge of the power system is going greener. In the year 2013, new generation added was (depending on the method of calculation) either 1) putative generation of 180 TWh from thermal sources and 140 TWh from water, wind and solar – plus just under 20 TWh from nuclear; or 2) actual added generation was 148 TWh from thermal sources, and 82 TWh from renewables, plus 14 TWh from nuclear. The first method uses capacity factors for each source, while the second uses year-on-year differences in actual generation. Either way, the latest year indicates that the proportion of green electricity from water, wind and solar has probably risen to around 40% of new electrical generation – a clear indication of the direction of change.

## 3) *Investment*

The China Electricity Council has also released investment data for 2013. The data indicate that China is now spending more on grid upgrades than on new generating capacity. This expenditure on transmission infrastructure is very important because it enables the grid to handle higher levels of fluctuating renewable-power inputs. Moreover, as to volume of

investment in generating capacity, water, wind and solar sources accounted for 40% of total investment in new generating capacity while investment in new coal-burning facilities fell to 25% of expenditures.

Why do we stress these data? Our aim is to show that China is building a vast energy “engine” that powers its entire industrial economy in a way that is moving demonstrably away from dependence on fossil fuels, and coal in particular, towards a broader base for its energy systems. We show that China is building the world’s largest renewables and nuclear system (i.e. non fossil fuelled system), one overwhelmingly centred in renewables. Based on the evidence, we propose that China is making this renewable-centred transformation at a pace that will, if it is sustained, enable it to replace its fossil-fuelled system in a reasonable time frame.

And by “reasonable” we mean such that China’s carbon emissions, which are still rising, will peak and then start falling – possibly as early as 2020, and certainly in the 2020s. Our findings show that, year by year, thermal (coal-fired) power stations are becoming less important to China’s power generation system. This argument flies in the face of much of the conventional wisdom. But we base it on a clear distinction between the state of the total system (with its historic legacy of high coal dependence) and the proportions of coal-fired power in the new additions to the system recorded each year.

We urge Dr Hansen to join us in this endeavour, rather than misrepresent us. We were certainly not claiming that China’s total system is already less dependent on fossil fuels than on renewables. It would be of great benefit to the energy and climate debate if Dr Hansen were to recognize this and add his

voice to the growing scholarly recognition that China is doing something extraordinary through its renewable energy revolution. As he says, “China is our friend. We are all in the same boat. We must try to help them deal with their pollution.” Yes indeed. And equally true is the fact that there is much that we can learn from China. Of course there remains great concern as China’s rapid development results in large-scale production of greenhouse gases – obviously Dr Hansen’s primary concern. But it is also clear that China’s massive build-up of renewables represents an optimal means of mitigating carbon emissions, and moving towards their rapid phasing out by the early 2020s.

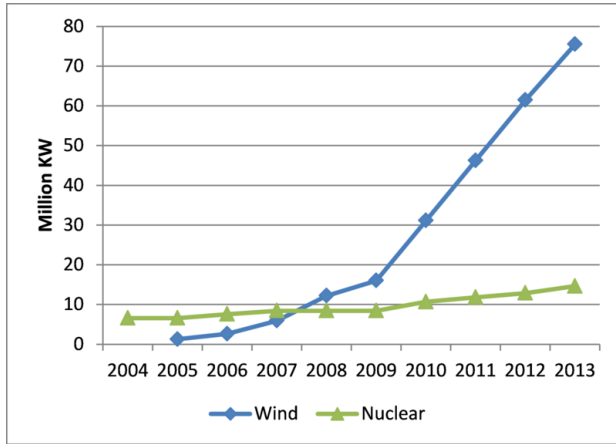
China is building the largest renewable energy system in the world. As noted earlier, by 2013 green power accounted 1 trillion kWh, or more than 20% of China’s electric power generation – a figure likely to rise to 30% by 2020. This in turn reduces China’s energy insecurity, and makes its dependence on oil, natural gas and coal imports from unstable parts of the world less likely to trigger violent conflicts. To acknowledge these facts is difficult because it goes against the common view that everything in China is “black” – that there are no green shoots of hope in the murky gloom of its industrialization. That is dire enough. But it also goes against the commonly represented ‘green’ view in the US that the Americans should be building renewables at the expense of both nuclear and coal – so that what actually intensifies is the dependence on natural gas (in particular, coal seam gas derived from hydraulic fracture, or fracking). We are taking neither a pro nor contra view on nuclear power in the US. When Dr Hansen resorts to polemic by disparagingly implying that people who support renewables are part of the brigade who drink the Kool-Aid – quite literally, people who follow someone else’s lead because brainwashed and incapable of making

independent decisions – he does himself a disservice.

Yes, there are furious debates in the US over the choice between nuclear and renewables, and there is grave danger that coal seam gas and new “alternative” fossil fuels like tar sands will expand in the interim – making fortunes for those who have invested hugely in the fracking revolution. Yes, we understand the concern when, for example, California’s plan to replace the 2.2 GW San Onofre nuclear power plant with alternative procurement procedures opens the way to expansion of renewable sources but also to expansion of gas-fired power. But we are not discussing California’s options – we are discussing China’s. China is clearly building renewables and nuclear as fast as it can – indeed, it seems to be one country that can actually power ahead on both trajectories. As one of us said in a Letter to the *Financial Times* in 2011:

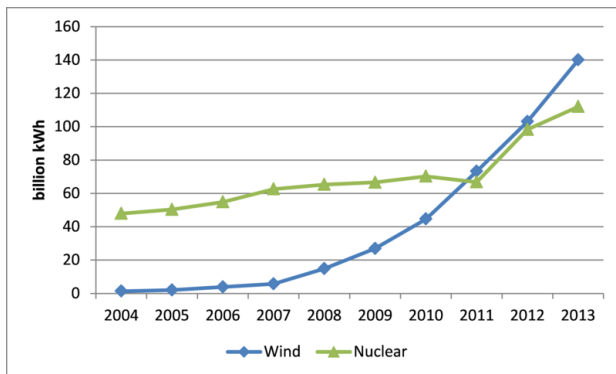
“It seems to be only the Chinese who can back nuclear and renewables at the same time, as twin alternatives to fossil fuels. Europe and the US remain locked in a Manichean mindset that it has to be either/or – to their manifest disadvantage.”

We are taking neither a pro-nuclear nor anti-nuclear stand in our writings. We observe that decisions taken in China on the question whether to develop wind power or nuclear power carry a clear message (Figs 1 and 2). The expansion of renewables in the last few years greatly exceeds expansion of nuclear power. Our role is simply to point out these trends.



**Fig. 1. Installed electric capacity in China: Wind vs. Nuclear**

Source of primary data: data up to 2011 available from the US EIA, data for 2012 and 2013 available from the China Electricity Council



**Fig. 2. Electric generation: Wind vs. nuclear in China**

Source of primary data: data up to 2011 available from the US EIA, data for 2012 and

2013 available from the China Electricity Council.

The problem is that Dr Hansen has gone so far in his promotion of nuclear at the expense of renewables that he too has become an exponent of this ‘either/or’ mindset. In his most recent testimony to Congress “Climate and Energy: Fundamental facts, responsibilities and opportunities” Dr Hansen goes to the extreme of asserting:

“Non-hydro renewables provide only a tiny fraction of global energy and do not appear capable of satisfying the large energy requirements of developing nations such as China and India.”

It is not difficult to demonstrate why this is contradicted by the evidence, particularly in terms of the leading edge data that we utilized above. Rather than look at the macro-level evidence, Dr Hansen provides a comparison between one specific example of current renewables and one of nuclear power stations. He contrasts the recently completed Ivanpah Concentrated Solar Power (CSP) plant built in Nevada with one of the AP-1000 nuclear reactors being built by Westinghouse in China. The point of the comparison is presumably to suggest that the CSP plants provide only intermittent power at the cost of much land that China can ill-afford.

Building on Dr Hansen’s approach, let us provide an alternative and more apposite comparison. Another CSP plant just recently completed and coming on stream in the US this year is **Crescent Dunes**, in Arizona. Unlike Ivanpah, this CSP plant features heat storage

for up to 12 hours with molten salts technology – the current best practice for CSP plants, enabling them to provide dispatchable power 24/7 (and whose absence from Ivanpah is a serious flaw in that plant’s design). The Crescent Dunes plant is rated at 110 MW, with a capacity factor of 52% (very high, indeed higher than many coal-fired power plants), meaning that it can produce 440 GWh of electric energy in a year. Its capital cost is less than \$1 billion, and it occupies 600 hectares, or 6 km<sup>2</sup>. This is a large area, and for a better indication of land area that might be required in China we can look to the **Shams1 CSP plant** recently constructed in the desert, this time in the Gulf where countries like the UAE are frantically seeking a future where they are not dependent on oil. The Shams1 CSP plant that came on line in 2013 is rated at 100 MW with a land area of 2.5 km<sup>2</sup> – or 2.5 hectare needed for each MW of generating capacity. That’s 25 km<sup>2</sup> for each GW, and 25,000 km<sup>2</sup> for a TW of power – capable of generating half of China’s current electricity needs at a capacity rating of 52%.

A space of 25,000 km<sup>2</sup> would fit in the Gobi desert straddling Mongolia and China’s Inner Mongolia without anybody even noticing. It is the connection to the grid that is important – and here China’s herculean efforts to upgrade its grid, and build new east-west HVDC transmission lines, are the key factors in allowing the country to scale up benign sources of power like CSP with molten salts to give dispatchable 24/7 power.

At the same time China is allowing the construction of four AP-1000 nuclear reactors by Westinghouse, with the first of them due to come on-line in 2014 and all four to be operational by 2016. According to the CEO of Westinghouse, China wants to have 100 units

of the AP-1000 reactors under construction or operational by 2020. Rated at just over 1000 MW each, this would mean a contribution of 100 GW, or one tenth of 1 TW, with electric energy generation of 880 TWh.

Then there is wind power, where China has built 80 GW capacity in just the past eight years, generating 140 TWh of extra electricity. By 2020 China’s NDRC expects China to have built 300 GW of capacity in wind power. Let us take the recently completed **Salkhit wind farm** in Mongolia as best practice example (50 MW, construction cost \$120 million, output 168.5 GWh or capacity factor of 40%). On this basis the 300 GW by 2020 should be adding 1000 TWh of electricity in a year – around a fifth of China’s current needs.

The point we are making is that by 2020, at the rate that China is going, renewables could be adding 1 TW with CSP, 300 GW with wind power and 100 GW with nuclear – adding up to a system generating more electricity than China currently needs. That is what we would call a real energy revolution – with all the issues raised by it including energy security, industrial development through building new green industries, the further build-up of greenhouse gases and their mitigation, and the management of the biggest energy transformation the world has ever seen. We trust that Dr Hansen will join us in representing it fairly and with due regard to its immense future possibilities.

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We say “probably” because there is still a degree of uncertainty over the 2013 generation estimates - but our characterization of 40% renewables generation in 2013 is no doubt close to the mark. We discuss this issue in our companion article in *APJ:JF*.

See ‘California’s plan to replace San Onofre nuclear: green success or natural gas giveaway?’, by Jeff St. John, March 14, 2014, *GreenTechMedia*, at: <http://www.greentechmedia.com/articles/read/cpucs-songs-decision-green-breakthrough-or-natural-gas-giveaway>

See John Mathews, ‘Locked into an either/or mindset’, Letters, Financial Times, Oct 29 2011, at: <http://www.ft.com/intl/cms/s/0/d02e2b18-ffc7-11e0-8441-00144feabdc0.html?siteedition=intl#axzz2mRQqJ01l>

See James Hansen, Testimony to the United States Senate Committee on Foreign Relations, 13 March 2014, at: [http://www.foreign.senate.gov/imo/media/doc/Hansen\\_Testimony.pdf](http://www.foreign.senate.gov/imo/media/doc/Hansen_Testimony.pdf)

The Salkhit wind farm was supported financially by the European Bank for Reconstruction and Development. See news report at: <http://www.ebrd.com/pages/news/press/2013/130620.shtml>

Our calculation proceeds as follows. 1 TW of CSP generating at capacity factor of 50% would generate 4,400 TWh in a year; 300 GW of wind power would generate 1,000 TWh in a year (at the capacity factor demonstrated in Mongolia); and 100 GW of nuclear (100 AP-1000 reactors) would generate 880 TWh. That is 6,380 TWh in a year - more than China is producing/consuming currently. And it excludes rooftop solar PV and other applications of solar PV; geothermal; wave power and bioenergy, so it is a highly conservative estimate. It demonstrates that fossil-fuelled thermal power would not be needed at all by the year 2020 - without making any assumptions as growth in coal seam gas or tar sands.