

On Coal-Fired & Other Power Electricity Generation.

This article began as a 'Letter to the Editor' of the Rockhampton Morning Bulletin newspaper on 22nd December 2009. It was written as a response to a radical well-known local 'greenie' who said in a letter to the editor that we were the laughing stock of the world, power stations were terrible polluters, 70% of the boiler heat went 'up the chimney', and everyone else was changing to renewable energy.

Although frustrated at the nonsense being put forth by 'Global Warming/Climate Change' alarmists about carbon dioxide (CO₂) emissions and the supposed 'pollution' from thermal coal-fired power stations, I sat idly by for a number of years. Then as the promotion of pie-in-the-sky 'green' renewable energy increased (with associated hysteria), coupled with the attempted Government foisting upon us of the ridiculous "Carbon Pollution Reduction Scheme" (Emissions Trading Scheme), I decided it was time to speak out especially because with my many years of practical experience in the power generation industry I knew that all of the claims of 'pollution' from thermal coal-fired power stations are based on untruths.

I suffered still more frustration at the lies being told (particularly during the last Federal election) about 'global pollution', and the stupidity of using pictures of power station cooling towers in the Media as an example of supposed 'pollution'. (The condensation coming from those cooling towers is *water vapour* as pure as that which comes out of any kettle!)

There has been yet more frustration in hearing about the so-called (and incorrectly-named) 'man-made carbon emissions' (which are in reality *carbon dioxide* emissions) and of the 'damage' extra CO₂ supposedly is doing to our planet. Everything I see and hear about this ignores the reality that *CO₂ increases follow warming* (and not the other way around), and that increased CO₂ in the atmosphere has a *logarithmic warming effect* in relation to any increase in this gas.

And then there has been the frustration of hearing the lies being told about renewable energy, and the deliberate distortions about the capabilities of renewable energy generators and of their supposed ability to replace fossil fuel energy generation.

On top of this there has been further frustration at the flawed and ridiculous 'carbon credit' program, a concept which is beyond any logic, let alone any real comprehensibility. This is particularly so in the light of the increasingly revealed scientific truth about our planet's climate *which is that mankind's effect on it is negligible* (as as been demonstrated by recent *real* scientific observations about cloud feedback).

And, as if this wasn't enough, there has been even further frustration in *hearing the opinions of members of the public who clearly do not have the slightest clue* about either thermal power stations or existing renewable energy technologies.

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And so there is the continuing spectacle of misinformed people quoting ridiculous figures about which it is clear they have little or no knowledge. And then these ill-informed opinions are 'parroted' on our media thereby compounding the overall misinformation.

Perhaps now we can look at some facts to offset the fiction that has been portrayed about coal-fired power stations!

Let me say firstly that coal-fired power stations DO NOT send between 60% and 70% of the energy in the coal 'up the chimney'. The reality is that boilers in modern power stations are 96% efficient, with the exhaust heat being captured by economisers and re-heaters, so that new air and water are preheated *before* entering the boilers. (This is very efficient!) The very small amount of exhaust that exits the smokestack is moist air due to condensation, and includes mostly CO₂. There is virtually no *fly ash* because this is removed by 'precipitators' or 'bagging plants' that are 99.98% efficient! There is only a trivial 4% energy loss in heat because of convection through the boiler walls.

In a black (bituminous) coal-fired power station the full efficiency figures are: boiler 96%, alternator 99%, and turbine 46%, giving an overall efficiency of 44%, depending on the quality of the coal.

The efficiency loss is due to condenser water cooling the turbine, exhaust low pressure wet steam to condensate so it can be returned to the boiler via the low pressure and high pressure heaters.

In a 350MW unit there is 1,000,000 hp in the boiler and 440,000hp at the alternator shaft equal to 350MWs.

Coal-fired power stations are *highly efficient*, with very little heat loss, and they can generate massive amounts of energy for our needs. They can generate power at an efficiency level of less than 10,000btu per kilowatt, and from a cost perspective that is very low.

The percentage cost of mining and freight is likewise very low, with the total cost of fuel being only 8% of total generation cost. So you can see this *does not* constitute a major production cost.

As for being '*laughing stock of the world*', China is building 450 coal-fired power stations simply because they are the most efficient method of bulk *base-load* power generation.

Like the USA, we have coal-fired power stations because *we have the raw materials in Australia, and are very fortunate to have them!* Believe me, no one is laughing at Australia - exactly the reverse; people are very envious of our massive deposits of raw materials, and of our resulting independence!

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On the other hand a large percentage of new power generation in Europe and in the U.K. is nuclear because they don't have the coal supply for the future.

Yes! It would be very nice to have clean, quiet, cheap sources of 'green' energy in bulk supply. Everyone agrees that it would be ideal. You don't have to be a genius to work that out. But there is only one problem---it doesn't exist!

Yes! There are wind and solar generators being built all over the world, but they add only a small percentage to the overall power supply.

So let's look at the 'renewable energy' situation as it exists at the moment.

Firstly: wind power. The maximum-size wind generator is 3 Megawatts, although there are 5MW units being tested. But this output can only rarely be attained on a continuous basis simply because it requires substantial forces of wind to achieve this output. And for the same reason, they can generate power only when there is sufficient wind to drive them. Of course this depends on where wind-driven generators are located, but usually they only run for between 45%-65% of the time; mostly well below maximum capacity. For this reason they cannot be relied upon to provide 'base load' power because they are too variable. *And they certainly could not be used for load control!*

The peak load demand for electricity in Australia is approximately 50,000 Megawatts, and only small part of this comes from the *Snowy Hydro Electric System* (the ultimate power generation!) because it is only available when water is there from snow-melt or rain. And yes! The water can be pumped back, but it costs to do that. (This is a long story!)

Tasmanians are very fortunate in that they have mostly hydro-electric generation made possible due to their high amounts of snow and rainfall. They also have wind generators (located in the 'Roaring Forties') but these are only a small amount of total power generated.

To meet the present power needs of Australia, and based on an average generating output of 1.5 megawatts (*of unreliable power*) per wind generator would require over 33,300 wind generators – an almost impossible number of units!

Secondly: solar power. There has been much research for decades on how to harness solar energy, with the result that two principal types of electricity generating systems have evolved. These are *solar thermal generation* and *solar electric generation*, but in each case they are incapable of generating large amounts of electricity with presently available technology.

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Of course it is obvious that any clean, cheap energy could only be welcomed, but the present technology simply does not have the capability of replacing thermal power generation.

So, if you believe that the day of efficient renewable energy has arrived then you need to get your head '*out of the clouds*', do some basic mathematics, and look at the facts! Going '*off with the fairies*' (or some would say with extreme '*greenies*') flies in the face of cold, hard facts. Romance does not replace physical reality!

Even if it was possible (*and I repeat that it is not*) the influence from unreliable wind or solar generators would cause *instability* in the power grid system as they continually change without any warning. Also there would have to be a spinning reserve in the grid system in excess of 20%, plus a normal spinning reserve to cover the largest unit (in N.S.W. 660MWs), plus spare.

That reserve would be covered by thermal power station units backed off sufficiently in load to immediately pick up if required. This affects their generation efficiency as they are at maximum efficiency at full load, thus increasing generation cost.

And no! You cannot just 'turn them on and off' like light switches! To bring a coal-fired thermal unit to at least mid-load or better operating level can take up to twelve hours or more from a cold start.

Hot starts are quicker but are not good for the unit on a continuous basis. Generators are designed to stay on line and operating continuously and they normally do that for months on end - usually more than a year - requiring only normal service shutdowns.

The power grid system in any country is a very closely-controlled, finely-tuned, and highly-sensitive network that must maintain the system voltage and frequency within very fine limits. To subject it to major (i.e. 20%) *unregulated* continual variations in power input can create control problems and instability.

More gas turbines are being installed, but these only have a relatively small output and are used for peak loads; not load control.

I read an article recently by a Melbourne University lecturer where he stated that coal-fired thermal power generation units *were slow and could not respond to load changes*. It is this type of completely erroneous statement from someone who should know better that deliberately mislead the community.

Coal-fired thermal power generators can respond rapidly to system load changes, and can cover the instant loss of the largest unit (660 megawatts) without instability being created in the system. It is this type of response that

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would be required to compensate for the erratic output from wind and solar generators if they were to have a 20% input to the grid. Now, we are all 'greenies' in one form or another, and most of us care very much about our planet. The difference is that most of us are realistic and practical! The result is that most do not believe in some idyllic Utopia of wishful thinking where everything can be made perfect by standing around holding a banner, and being a general pain in the backside.

Now, let's do some simple maths!

Here are some facts that will show how ridiculous is this proposed financial madness being promoted by the present Government. The calculations are simple; you don't have to be mathematical genius to see for yourself.

According to the believers in 'anthropogenic global warming', CO₂ in the atmosphere has risen from 0.034% to 0.038% of air over the last 50 years, an 'alarming' increase of 0.004%. To give you a clear idea of what this means, consider the following:

Suppose you have a room measuring 3.7 metres x 3.7 metres x 2.1 metres (or 12 feet x 12 feet x 7 feet) then the volume that CO₂ would occupy in that room would be a mere 0.25metres x 0.25metres x 0.17metres - approximately the size of a large packet of breakfast cereal.

Australia emits about 1% of the World's total CO₂, and the Government wants to reduce this by 20% (i.e., 0.2% of the world's total CO₂ emissions).

So what effect will this have on existing CO₂ levels?

That increase in CO₂ over 50 years amounts to 0.00008% per year (i.e., 0.004% ÷ 50). And of that Australia contributes only 1%.

Thus, our emissions would have caused CO₂ to rise .00008 divided by 100 = 0.0000008%.

Of that 1% we supposedly emit, the Government wants to reduce this by 20%, which is 1/5th of 0.0000008%. The result is a 'massive' 0.00000016% effect per year on the World's CO₂ emissions.

Looking now at the area in our 'room', *this equates to a volume in that room the size of a small pin!*

To achieve this *pin-sized* reduction the Government has gone crazy in proposing a ridiculous trading scheme, inefficient 'wind-farms', widespread and expensive solar and roofing installations, the failed 'clean coal' technology, futile renewable energy targets, etc, etc.

How ridiculous is that?

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The cost to the general public and industry will be enormous. This will certainly cripple, and in many cases is likely to force some smaller enterprises to go out of business.

The cost to install, to operate, and maintain these is very high. As an aside I should say that environmentalists concerned about wildlife need to note that wind generators have killed and injured large numbers of birds because of collisions with the turbine blades. Here's [an example](#) (video link).

Now here are some of those 'screaming facts' I've mentioned above:

Firstly, wind turbine generators

California in the early 1980s was seduced by the mirage of 'renewable' energy, and proceeded to offer subsidies to anyone wanting to erect a wind generator. This subsidy ceased in the late 1990s as the State ran out of money due to bankruptcy.

By 2008 there were over 18,000 wind generators scattered across California – *14,000 of them no longer operate!* Some have been 'cannibalised' to keep the others running.

The cost of power in California now has doubled! Its thermal power generation has increased continually to compensate for this disaster, and the input from the wind generators after 30 years of development, produces [only 2.3%](#) of California's electricity. This is an extremely small percentage, and an erratic output.

And a special note for the conservationist: *there are also over 15,000 birds killed per year by bird strikes from wind generators.*

Spain also embraced renewable energy with wind generators and solar array farms. A recent detailed analysis found that for every job created by state-funded support of 'renewable' energy, particularly wind energy, 2.2 jobs were lost! *Each wind industry job created cost almost \$2-million in subsidies.*

There is now an unemployment rate of 19%. The cost of power has gone up 100%, and Spain is forced to import power from other countries.

Germany has over 7,000 wind generators with over 2,500 wind generator failures last year alone. The German experience is no different. *'Der Spiegel'* reports that "Germany's CO₂ emissions haven't been reduced by even a single gram" and that additional coal- and gas-fired plants have had to be constructed to ensure reliable supply.

Sweden has 5,000 wind generators and 2,000 wind generator failures.

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During the cold weather in Europe last December a large number of wind generators froze up and did not work at all. When finally they did work again *they generated only 4% of their capacity.*

Denmark, the world's most wind-intensive nation, with more than 6,000 turbines generating 19% of its electricity, has yet to close a single fossil-fuel plant. It requires 50% more coal-generated electricity to cover wind power's unpredictability, and pollution and carbon dioxide emissions have risen by 36% in 2006 alone, and continues to rise. *Its electricity generation costs are the highest in Europe.*

Niels Gram of the *Danish Federation of Industries* says: "Windmills are a mistake and economically make no sense" whilst Aase Madsen, the *Chair of Energy Policy* in the Danish Parliament, calls it "a terribly expensive disaster."

Wind generators only generate an average of 30% of their capacity averaged over a month and are completely inconsistent, varying in output between zero and 70% and rarely reaching their maximum capacity.

For wind generators to provide 20% renewable energy in Australia there would have to be over 7,000 of them, assuming each is a 5MW unit and allowing for the usual generation capability of only 30% of each generator's rating. Every Megawatt they might generate would have to be backed up by a 'spinning reserve' in the power grid system ready to compensate for their inconsistency. Of course, *this neutralises any advantage these wind turbines might offer.*

Wind generators are ideal for boats or isolated areas where they can charge a bank of wet-cell batteries providing a continuous power supply. However, unlike the imaged Utopian ideals of their environmentalist advocates they are extremely expensive to operate and maintain, *and are therefore of absolutely no advantage to the power grid system.*

Secondly, solar power generation, of which there are two forms:

Solar thermal generation is where there are solar reflectors that concentrate the Sun's light onto a central receiver which then heats a liquid such as sodium which, in turn, heats water to generate steam that drives a turbine coupled to a generator.

The problem is that the heat is available only in strong sunlight, and therefore increases throughout the day and then falls off to nothing in the evening when there is insufficient sunlight to heat and drive the turbine. Naturally it then stops generating! This inactivity occurs for 14 to 16 hours of the day and, once again, this continual heating and cooling is not good for steam turbine operation.

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These units, even though they cover a large land area, only generate small amounts of power and add little to power demands.

Solar electric generation ‘farms’ of solar array panels is more common where the panels generate power from sunlight stimulation. They are very expensive to install per kilowatt generated, and require high maintenance to keep them clean. They are also highly susceptible to damage from storms and falling objects.

Now let's consider some reality! As an understandable benchmark: the total peak power presently generated in Australia is approximately 50,000MWs. The World's largest (currently) operating solar power generation plant is the *Olmedilla Photovoltaic Park* in Spain, and this needs an area of 250 hectares to generate 60MWs in bright sunlight. So let's put this into perspective.

There are 100 hectares to the square kilometre, and using *Olmedilla* as a guide, one square kilometre will generate 24MWs. Theoretically therefore, at maximum generation on a bright sunny day the generation of 10,000MWs to power 20% of Australia's needs (in terms of the fantasy that Australia must generate 20% of its energy using ‘renewable’ & ‘green’ sources) would require a solar array covering an area of 420 square kilometres – a massive area.

However because such a plant would only generate at approximately 20%-30% of its capacity measured over a year, the full size area needed would have to be *five times larger*, i.e. 2,100 square kilometres.

And then there is the minor (?) problem: *these plants do not generate at night – the very time that electric lighting is needed!* So here are some hard facts about solar generation:

1. Supply is more consistent in continually sunny areas e.g. Saudi Arabia, Queensland, Africa, etc., therefore solar generation would not be very effective in areas such as U.K., Europe, Russia, etc. where it is far more overcast. Solar power requires bright sunlight for maximum performance. The output varies dependent on how overcast it is.
2. Solar generation is only possible during daylight hours where there is sufficient sunlight, approximately eight to ten hours per day; therefore it does not generate anything for between 14 and 16 hours per day.
3. Output cannot be controlled except for changing angles of arrays where fitted with moving solar panels.
4. The supply is unreliable, although more consistent than wind generation which is notoriously unreliable. Thermal, nuclear, or hydro power (if available) is required to carry sufficient reserve in the grid

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system to compensate for any changes in solar plant output due to any changes in sunlight during the day, e.g. where there is a cloudy period.

5. Installation is very expensive per kilowatt, and is expensive per kilowatt to operate and maintain. The solar panel receivers have to be continuously kept clean of bird droppings, dust, and rubbish; and they can be damaged in severe weather (for example in the recent severe hailstorm in Melbourne).

As a power 'add on', solar 'farms' are useful but could never play anything more than a small part of the grid system because of their inflexible and unreliable nature. The same applies even more so to wind generators.

And now a note about solar power generation for your home:

The solar program which has been subsidised by the Federal Government has an output of 1 to 1.5 kilowatts per hour. That power can be produced *provided only that the Sun shines brightly, and there is no cloud cover.*

The power usage of the average Australian family (i.e. 2 adults + 2 children) is approximately 3 to 4 kilowatts per hour during the day, and the additional power required would need to be drawn from the grid system. Even at night while you are asleep some 0.8 to 1.5 kilowatts per hour is still required to keep things going, such as a refrigerator. If you start to run things such as air-conditioning then inevitably your power demand must increase, and all power must be drawn from the power grid.

The cost of a 1.7kW system is somewhere between \$7,000 & \$8,000 after allowing for the present Australian Government subsidy. The cost before the subsidy is somewhere between \$13,000 & \$14,000.

The good news is that it seems that far more efficient solar photovoltaic panels have been invented in Israel, and these are reported to be some 400% more efficient than present panels. However this new technology is still under development and testing and is not yet ready for general use.

Thirdly, other forms of electricity generation

Hydro Electric is the perfect power generation, but Australia is using all its available water resources and so there is no more available for increased capacity. Hydro generation accounts for 4.6% of total generation, and in any event can run only when there is sufficient water from spring snow melt and natural rainfall.

Geothermal is good if you are in New Zealand, but there is none in Australia except for the *Hot Rocks'* experiments which so far have met only with expensive failure.

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Tidal and wave generation is being developed, but would only have a very minor possible power generation capability for the foreseeable future. In the distant future (50 years) I believe it may be developed substantially.

Nuclear Power generation is proving throughout the world to be the ideal power generation system, especially with new systems that reduce the life of the uranium fuel. *This is especially so with the new and revolutionary fourth-generation liquid fluoride thorium reactor system (LFTR) that solves all the problems previously associated with nuclear power.* [LFTR systems](#) consume 100% of the thorium fed to them, and can be started with 'spent' fuel rods or old nuclear warheads; so it is almost certain that LFTR systems will be used to [clean up](#) old nuclear waste. *This is a very exciting new concept for power generation and is the solution for the previous problems associated with nuclear power stations, such as what to do with the waste and how to prevent terrorists gaining access to such waste!* ([Video lecture viewable here!](#))

Australia, with its massive mineral wealth is surely well placed to take the fullest advantage of this new technology. The old objections to nuclear power must now surely disappear as being totally irrelevant with LFTR systems.

Now let's just check what has happened in the past three years. The Rudd government has squandered billions of dollars on:

- A. Clean coal technology: a complete failure.
- B. Hot rocks programs: still struggling to get any form of result.
- C. Power stations with CO₂ deep storage: massive cost for a teaspoon of power. And basically [this is pointless nonsense](#) in any event.
- D. Renewable energy projects: as discussed, these could never achieve a viable usage or cost.
- E. Home Insulation programs: a total waste of money and a well – publicised disaster.
- F. Solar Panels on homes: will have negligible effect on power generation.

All have been either a failure or worse - a disaster as in the case of the home insulation program. **And for what?**

Oh yes! That's right! *To reduce our 'carbon footprint'!* What a ridiculous term! One imagines a big black boot covered in graphite leaving a mess on the carpet. The current eruption of Iceland's *Eyjafjallajökull* that is emitting millions of tons of sulphur dioxide, ash, and carbon dioxide daily make man's efforts extremely puny and ridiculous by comparison.

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CO₂ is discussed in great detail elsewhere in the slide show from which you accessed this paper, and you can glean more than enough information from it to show that concern about 'anthropogenic' CO₂ causing 'global warming' is as pointless as the Arcadian fantasy of using wind and solar power generation as a means of replacing base-load power generation from coal-fired and/or nuclear energy sources.

It would be remiss of me not to mention some basic chemistry involved in the process of burning coal to produce heat. People find it amazing that the tonnage of gases produced by coal fired power stations is far greater than the tonnage of coal burnt in that station. Is this the same sort of magic multiplication that has been used to justify the 'greenhouse' hypothesis? No, it's just chemistry!

[Read this excellent paper](#) that describes the chemistry in such simplistic terms that even the most devout follower of 'coal is evil' Green philosophy might begin to understand it. Or possibly not ...

Perhaps the most important assertion that I can make in conclusion to this paper is to point out that all of the 'green' measures taken by our Australian Government to reduce *thermal* power generation have been a dismal failure, and there are many other governments internationally following the same 'reduce carbon pollution to save the planet' line. All of these measures have achieved not one iota of reduction in the demand for *thermal* power generation but rather have achieved a major squandering of vast amounts of taxpayer's money. Overall demand for power has continued to rise in the order of 4% per year despite all of the 'green' measures enumerated already, and continues to do so – with *no reduction* in *thermal* power generated!

Finally, read [this article](#) on 'Capacity Factor' – it puts things into perspective!

Could it be that the greatest achievement from all of this government expenditure has been [to increase the number of public servants](#) employed to do nothing in particular at the *Department of Climate Change* in Canberra?

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