Solar Thermal Power Plant- Beryl
Mudgee District Environment Group

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Project Overview
– notes to accompany slides (see Beryl Solar Thermal_2011_9_22. pdf)

MDEG thought of the idea about building a solar thermal power station at Beryl about 3 years ago. We were looking for something positive to set a goal for, instead of the usual negatives that go with opposing coal mines and land degradation. Beryl was chosen after a search for a suitable site.

Before I talk about Beryl I want to take you through the reasons and costs of building a power station.

Why Renewable Energy?
This is an image of the satellite readings of global temperature created from the NASA website. It does not include any land based or sea based temperature readings, only satellite measurements. It compares the mean temperature taken over the period between 1951 and 1980 against the mean temperature for 2011.

Note the poles. Check the temperature scale.

Note Australia. Very little change has occurred. Ask yourself why some politicians in Australia don't believe in global warming. It's because they can't physically see any evidence for it.

The Poles are Warming
The next slide shows the mean temperature rise taken from this satellite data for 2011 based on latitude. The large peak is Antarctica.

Ice Loss in the Arctic
This shows the loss of summer sea ice in the Arctic. It has even become worse than this since 2007. Commercial shipping went across the top of Russia in 2009 and is doing so again this year. The loss of sea ice has a positive feedback effect. The ice reflects the sun's heat normally, but as it disappears, it allows the heat of the sun to warm the waters of the Arctic Ocean which reduces the ice coverage in the later year.

Future Warming
The map here shows one IPCC model – the HadCM3 – of global temperature rise if we don't take steps to curb global emissions. This model predicts a temperature rise of 3°C by 2100. The highest prediction in this model is 9.2°C in the Arctic Ocean. This model is the lower end of the IPCC prediction scale. All of the various IPCC models show an average prediction range of 1.4 – 5.8°C.

Note the hot spot over South America. This is due to the predicted changes in the El Nino/La Nina cycles and the collapse of the Amazon rainforest. We are talking serious outcomes here.

Just a comment. At temperatures of 36°C and above with near maximum humidity, it becomes impossible for larger massed animals, including humans, to survive without an external means of cooling the body. This is likely to become the case in the Amazon valley.

So you see the need for renewable energy to become the dominant source of electricity in the near future. Unfortunately renewable energy is perceived as expensive and unwarranted in Australia up to now, despite the urging of scientists to reduce our carbon emissions.

Electricity Costs in NSW
This graph shows the electricity demand and the costs to the electricity distributors for a typical winter's day. The green line is the electricity demand, which has the same basic shape for each day; and the red line shows how much the distributors paid for the electricity. The peaks are due to the fact that the electricity generators had to start up extra generating equipment to accommodate the increased demand. The electricity grid can only cope with about a 4% oversupply.

The reason I wanted to show you this is the cost. Note that the average cost is about $30 - $35 per MWH, or 3-3.5c/kWH. The distributors charge the extra that you pay for their maintenance and profits. Remember those figures.

Energy Generation Installation Costs
I included this to show you the relative costs of installing new power stations. These figures are a guide only, several factors can affect the actual cost. Note that coal and gas are relatively cheap compared to other options. There are extras in these 2 though.

Operating a coal fired power station is expensive and ongoing. Burning one tonne of coal generates about 2000kWH of electricity. A typical 1000MW coal fired power station burns around 500 tonnes of coal per hour. The current global price for coal is around $140 per tonne, so the coal cost should be $70000 per hour. Current high grade coking coal prices are even higher, at something like $300 per tonne. If you do the maths with coal at this price, the cost of coal to generate one kWH of electricity works out at 7c. Remember the 3-3.5c? The NSW government is buying coal at a very cheap price. This is why the Cobbora mine is so important. They want the cheap coal to keep the cost of electricity artificially low. This restricts the rollout of renewable energy because the cost of generating electricity by these means is inevitably higher.

Once a renewable energy electricity generation facility is built, the input operating costs are nil or near zero. The main cost is maintenance, and maintenance is required in all forms of electricity generation.

Renewable Energy Options
Renewable energy must be developed in all its forms, not just one. It is inherent that renewable energy generation in a particular form will not be constant, because each form relies on nature in some fashion. Therefore a range of solutions will complement each other to produce a constant outcome.

Wind energy is rolling out fast because it is the cheapest to install. It's not the total solution though, because wind is variable.

Solar panels on houses also help, but they don't generate electricity during the peak demand period.

Geothermal is one form that can provide a continuous source of energy, but it does affect the deep rock strata.

Why Solar Thermal?
Solar thermal electricity generation is not new technology. USA had a plant operating back in 1941. MDEG has decided to push for a solar thermal power station to be built at Beryl. Why solar thermal?

There are some disadvantages. It is expensive to install. It requires water.

Photovoltaics or solar panels are also becoming cheaper, which is making that form of generation viable. Solar cells coming out of China are now going for close to $1 per watt..

They are big advantages though.

They main advantages are that this form of renewable electricity generation can generate base load power, it can utilise biomass in times of poor solar radiation, and that maximum power occurs near the maximum demand.

How Solar Thermal Works
Solar thermal power generation is based on heat, in exactly the same way as a coal fired power station is based. It's just the source of heat that is different.

Heat is collected from the sun's radiation by reflecting it to a focal point, which raises the temperature of that focal point to between 400 and 700°C. This high temperature is used to heat water or oil, which in turn is used to create steam to drive a turbine. The turbine spins a generator to create the electricity.

Excess heat can be stored for later use. It is most commonly stored in large molten salt tanks or in huge blocks of graphite. This heat storage can be used to create steam at a later time.

A biomass burner can be simply added to the plant, and the heat generated from burning biomass can be fed into the heat storage bank for use when required. Supplying heat from the storage bank to the turbine rather than directly from the biomass burner ensures a constant, stable heat source, which makes it easier to control the turbine.

Water is required to operate the plant, as it's based on steam. Air cooling can be implemented which save a large amount of water.

This form of energy generation must be medium to large scale to make it viable. Anything less than about 3MW would be too small to make itself pay. Most solar thermal power stations around the world are 10 – 50MW.

There are several methods of concentrating the sun's heat for power generation, 4 of them will be shown.

Solar Trough Technology
Solar trough technology has been around for many years. It is a proven technology, is fairly simply to control, and uses a heat transfer medium such as oil or stem to take the heat to where it's required. Large scale solar trough farms have been around since about 1980. USA and Spain have several solar thermal power stations that use solar trough technology.

Linear Fresnel Technology
This is a relatively recent technology that is being implemented. It works in a similar fashion to the solar trough technology, with the reflectors working on a slightly different principle. This method is used in a trial plant at Liddel power station near Muswellbrook to complement the coal burner. A proposed large scale solar thermal power station at Chinchilla, Queensland, will also implement this technology.

Parabolic Dish Technology
This technology can create very high temperatures, in the order of 2000 degrees if required. It's not so common in operating power stations because it is quite expensive to install. There are a couple of examples of its use in Australia, the one at White Cliffs provides the town with electricity. This picture is the largest solar power dish in the world in Israel.

Solar Tower Technology
This technology is most likely the one to prevail of the 4 mentioned. It uses numerous heliostats, or mirrors, to concentrate the sun's energy to a single point. Very high temperatures can be generated, and there is only one point to extract the heat from, making it more efficient in terms of heat loss. Solar trough technology requires that the heat be extracted from many hectares of troughs. This picture is one example in USA.

Lifetime Input Cost Comparison
This next slide gives a comparison of the cost per kWH over a 50 year lifetime between a coal fired power station and a solar thermal power station. The costs ignore maintenance costs,

interest on loans, labour, etc, but give you an idea of the significance of having to manually supply an energy source to a power station. The construction cost of a coal fired power station pales into insignificance compared to is lifetime running cost, whereas there is nothing to supply in a renewable power station, unless of course if a biomass supplement is required.

The cost of electricity from a solar thermal power station would be very competitive with coal fired power stations if the NSW government didn't buy the coal at artificially low prices.

Base Load Power
What is base load power? This is the electricity that must be available 24 hours a day, 365 days a year.

A solar thermal power station is capable of providing this continuous power. To do this it will require a heat storage bank and probably a biomass burner to prevent the heat storage bank becoming excessively large.

Wind is not capable of providing base load power because it cannot be relied on 100% to provide the power. At best it is only 40% reliable at any time.

Why Beryl?
Why Beryl for a solar thermal power station? It has all the prerequisites for such a power station. The Beryl 132kV electricity substation is there, it is within 1km of the Cudgegong River, there is flat land, and it's not too far from Gulgong and Mudgee. Electricity is distributed from Beryl to Dunedoo, Coolah, and villages in between.

Epuron, a renewable energy facility construction company, have evaluated the site and determined that a 50MW power station can be situated there. Significantly, this is the size of many solar thermal power stations around the world, so the technology is readily available. The cost of this project has been estimated at somewhere around $250 - $300 million.

With due respect to the previous speaker and Beyond Zero Emissions, I believe that many solar thermal power station of this size dotted all over the country will provide more reliable power than a few large scale solar thermal power stations concentrated in a few locations. The reason for this is the weather. Localised cloud cover over a large facility will create a large loss in electricity availability, whereas there is much more of a chance of continuous power if the power stations are de-centralised. Local cloud cover will have much less of an impact if there are many smaller power stations.

Current Status
This project is in limbo at the moment. It basically requires money and commitment by a government to guarantee the purchase of electricity from the facility.

It missed out on qualifying for the solar flagships fund because it was too small. The federal government stipulated that a power station must be 250MW to qualify, which is larger that any single solar thermal power station in the world. There are some areas with multiple power stations that are larger, but not a single power station.

We are hoping that the revenue coming from the proposed carbon tax might provide a source of funds, and there may be another company somewhere that might be interested in building it, but at this stage it is not progressing.

If anyone knows of a company or person that may be interested in developing this idea we would welcome their suggestion. MDEG is not interested in gaining anything from the project, we only want to see it built. We just want to do our part in reducing global carbon emissions.