Bioenergy Q&A

Q: What is Bioenergy?

A: Bioenergy is renewable energy obtained from materials derived from biological sources, known as Biomass

Q: What is Biomass?

A: Biomass consists of living and recently dead biological material that can be used for energy or industrial production

Q: Where does the energy in Biomass come from?

A: Bioenergy is actually another form of solar energy, in that the biomass used for bioenergy production gets its energy from the sun via the process of photosynthesis. Plants, including trees, use energy from the sun, carbon dioxide from the atmosphere and water and nutrients from the ground to build their fibrous structure, In doing so, they store energy and carbon in the plant, oxygen which is released to the atmosphere, and water vapour which is transpired back to the atmosphere. Bioenergy production then converts the energy in the biomass into other forms of energy (thermal, kinetic, electrical).

Q: What biomass feedstocks can be used for Bioenergy?

A: Almost any form of biomass can be used as a feedstock. Common feedstocks include trees, grasses, algae, animal dung, municipal waste, landfill emissions, vegetable oils and other materials such as sugarcane bagasse.

Q: What is the difference between BioFuels and Bioenergy?

A: BioFuels are a sub-set of Bioenergy, and refer to those bioenergy products that are in liquid form, and hence suitable for mobile fuel uses (such as petrol replacements). Examples of biofuels are ethanol and bio-diesel. Bioenergy usually refers to non-liquid energy outputs such as electricity and heating.

Q: What is the difference between first-generation and second-generation Bioenergy?

A: First-generation biofuels (and bioenergy) are made from feedstocks that could also be used for food or feed production. Examples of first-generation feedstocks are various cereals (such as corn), oil-producing plants (such as soybean and sunflowers) and various forms of sugars and starches (such as sugarcane). Because of the alternative use of these feedstocks for food production, first-generation biofuels have often been connected with the so-called "food vs fuel" debates. Second-generation bioenergy most commonly uses inedible cellulosic feedstocks such as grasses and trees, or waste from the production of foods such as sugarcane bagasse and wheat stubble. Because they are inedible, second-generation feedstocks do not get directly embroiled in the "food vs fuel" debate, although they can be indirectly involved if the feedstock production uses land that could otherwise be used for food production.

Q: What are the outputs from Bioenergy production?

A: "Outputs" are defined as the intended outcomes from Bioenergy production. The main outputs are electricity, heat, liquid fuels, gaseous fuels, biological (non-fuel) chemicals for a wide variety of uses (such as lubricants, foodstuffs and dyes) and biochar (charcoal).

Q: What are the by-products from Bioenergy production?

A: "By-products" are defined as the unintended outcomes from Bioenergy production. The main by-products are atmospheric emissions (CO2 and particulates), charcoal, ash and water.

Q: Is Bioenergy production carbon-neutral?

A: Unlike fossil fuel energy production, bioenergy production is essentially carbon neutral over a short timespan, because the CO2 produced when the biomass is burned is balanced by the same amount of CO2 absorbed from the atmosphere in the recent past when the biomass was grown. There is a small amount of CO2 emitted during the bioenergy production process, such as in the harvesting of the biomass, but Life-Cycle Analyses (LCA) have shown this to be in the order of 5% of the total CO2 absorbed during the growing of the trees.

Q: Is coal-fired electricity production carbon-neutral?

A: Theoretically, coal-fired electricity production is also carbon neutral (over a huge timespan) because the coal contains carbon that was also absorbed from the atmosphere, but this absorption was done millions of years ago (rather than 1-20 years ago as with biomass).

Q: What is the Bioenergy "substitution effect"?

A: While the production of bioenergy from biomass is, in itself, essentially carbon neutral, the real advantage of bioenergy (compared to fossil fuel energy) lies in the "substitution effect", whereby biomass is used to create a megawatt of electricity rather than using fossil fuels (e.g coal). If the coal is not used to create this electricity, then the coal (along with its embedded carbon) can remain in the ground and hence the CO2 from this coal combustion is not emitted to the atmosphere. So, bioenergy produces no net emissions in itself, and also prevents CO2 from coal combustion from entering the atmosphere. The Clean Energy Council of Australia has estimated that one megawatt of bioenergy-derived electricity has an overall net reduction of one tonne of CO2 emissions (including the substitution effect) when the bioenergy replaces electricity from coal-fired power stations (as it is in most of Australia). Thus, bioenergy is not just carbon-neutral, it is carbon-negative (in that it reduces CO2 emissions compared to the coal-fired alternatives).

Q: What emissions are created from the production of Bioenergy?

A: While bioenergy production results in a net decrease in CO2 emissions, there are some local air emissions (apart from the local CO2 emissions). These include particulates, carbon monoxide and nitrous oxides. Modern bioenergy power plants include various types of filters and scrubbers such that the emissions are minute. The European standards, from where most bioenergy technology is sourced, are ten times more stringent than comparable Australian standards. Typically, it would be impossible to tell from the stack emissions whether the plant is operating or not. A typical home wood heater would have more emissions than a megawatt bioenergy power plant.

Q: What methods are available for creating Bioenergy from wood?

A: There are essentially three ways to convert wood into electricity. The simplest and oldest method is Combustion, where the wood is burnt in copious air to produce heat which heats a fluid (such as water or an organic fluid) which drives a turbine, which runs a generator to produce electricity. The second method is Gasification, which heats the wood in very limited air. This drives gases out of the wood that are then captured and used to run an internal combustion engine or a turbine, which turns a generator to produce electricity. The third method is Pyrolysis, which heats the wood in no air to produce a liquid fuel (bio-oil) and other products (notably bio-char). The bio-oil can then converted into useful energy in various ways, including running an engine to turn a generator to create electricity.

Q: How efficient is Bioenergy production?

A: Bioenergy power plants typically only convert about 20-25% of the energy content of the biomass into usable electricity. This compares with large-scale coal-fired generators, which have an electrical efficiency of about 30% but lose up to 10% in transmission to the final consumer. Being smaller and closer to the end consumer, bioenergy power plants have much smaller transmission losses.

Q: What is Co-Generation?

A: Co-generation power plants generate electricity (with 25% efficiency) and also capture the waste heat from the process and use it as a lower-grade form of energy (which often substitutes for the use of some other fossil fuel to create the heat). By capturing and utilising the waste heat, co-generation power plants can operate at overall efficiencies greater than 70%.

Q: What is Tri-Generation?

A: Tri-generation takes the concept of co-generation one step further, by using an absorption chiller to convert some of the waste heat into cooling. This enables the waste energy to be used for cooling and refrigeration, where there is a greater need for this than for heating.

Q: What is District Heating (and Cooling)?

A: The heating and cooling produced from a bioenergy power plant can be used in one of two ways (or together). The heating or cooling could be used by a centralised facility close to the power plant. Examples of centralised usage could be a greenhouse vegetable garden or a heated swimming pool (for heating) or a cold-store for food storage or an ice-rink (for cooling). Alternatively, the heating and cooling could be used in a decentralised manner in a District Heating and Cooling network, whereby hot and/or cold water is reticulated through a pipe network to homes and businesses in the area to provide heating and cooling instead of using other forms of energy (e.g. electricity or gas) to produce the same effects. Each home or business would have a heat exchanger to take heating or cooling from the closed reticulation network. District Heating systems are very common in Europe.

Q: How is the Bioenergy electricity transported to end users?

A: The electricity outputs can be conveyed to end users either directly or indirectly. If there is a single on-site user of the electricity, then the electricity can be fed directly from the power plant to the end user. However, the more conventional system is to feed the electricity into the electrical grid and then let users at any grid-connected location draw power from the grid in the conventional manner. There are major difficulties in attempting to feed power directly to a number of off-site users, since the power generator would then need to register also as a power distributor, which carries many more administrative and technical responsibilities.

Q: Does Bioenergy production create much employment?

A: Bioenergy power plants are designed, for economic reasons, to run in a very automated fashion with as little direct employment as possible. Thus apart from the construction phase, when there would be significant local employment involved, the ongoing operations would generate relatively little employment. However, if the existence of the power plant can encourage other businesses requiring power, heating or cooling to co-locate, then significant indirect employment opportunities are possible.

Q: At what scale can Bioenergy be produced?

A: Bioenergy systems based on wood can operate from the very tiny scale to the very large scale. Striking a match is probably the smallest common bioenergy system! Home wood-heating is a very common small bioenergy system. On-farm gasification systems can be in the range of 15-75 kW. Medium size systems can be from 200-1000kW, while large-scale systems can go up to hundreds of megawatts.

Q: What steps are involved in the creation of Bioenergy from wood?

A: The production of bioenergy from wood is a good example of a Supply Chain, with many different processes involved along the way. These steps include:

- Growing (sourcing) of the feedstock
- Transport of the feedstock to the power plant
- Storage of feedstock on site
- Preparation of the feedstock
- Feeding of the feedstock to the furnace
- Converting the wood to energy
- Capturing and using the waste heat
- Distribution of the outputs to the end-users

Q: Where does the wood come from for the creation of Bioenergy?

A: The wood that can be used for the creation of bioenergy can come from a number of sources, including:

- Woody wastes from weeding operations (e.g. willow removals along waterways)
- Wood residue from thinning and pruning operations from farm forestry

- Wood residues from thinning and pruning operations from commercial plantations
- Waste wood at the end of its recycling lifetime from construction
- Woody wastes from municipal waste streams
- Wood residues from sustainable harvesting and fuel reduction operations in forests.

Q: Are native forest wood residues used in the creation of Bioenergy?

A: As listed above, wood residues from native forest maintenance operations can be used to create bioenergy (where this is legal in the State). The use of such wood waste to create bioenergy is better than burning it in the field (as is common practice) or simply leaving it to rot on the forest floor (which also creates methane, one of the worst greenhouse gases).

Q: Should native forests be harvested for the purpose of creating Bioenergy?

A: While wood waste from native forests could be used to create bioenergy, such forests should not be harvested purely for the purpose of creating bioenergy. These forests have many other biodiversity benefits that should be maintained. In addition, there are other cheaper and more environmentally sound sources of wood for the creation of bioenergy.

Q: What happens to harvest residues if they are not used to create Bioenergy?

A: If harvest residues (from plantations or forest) are not used to create bioenergy, then they normally have two other alternative endpoints. Firstly, it is common practice to windrow (pile up) the residues and then burn them in the field. While this practice in itself is carbon neutral (as explained above), it misses the opportunity for reductions in greenhouse gases due to the "substitution effect" when that wood is used to create bioenergy. Secondly, wood residues can be left on the forest floor to decay. This has the advantage of returning some nutrients to the soil but, particularly in moist conditions, can also result in the production of methane during the delaying process. Since methane is such a strong greenhouse gas (21 times the Global Warming Potential of carbon dioxide), this eventuality is to be avoided where possible.

Q: What is the cost of producing Bioenergy from wood?

A: The cost of producing bioenergy electricity from wood will depend on many factors, such as the scale of the power plant, the cost of the feedstock, and the transport and preparation costs involved. While this can result in a wide variation in production costs, a cost in the range of 7-10 cents/kWhr could be expected.

Q: Is Bioenergy cost-competitive with coal-fired electricity generation?

A: The cost of producing wood-based bioenergy can be compared with the current costs of 3-5 cents/kWhr for coal-based electricity. Coal-based electricity is currently cheaper because it does not face its true environmental costs. Wood-based bioenergy is only competitive when the value of Renewable Energy Certificates and Carbon Credits are taken into account. Local bioenergy production can also be cost-competitive if the waste heat from the process can be captured and used.

Q: What incentives are available for the production of Bioenergy?

A: Two major incentives for bioenergy, which go some way to redress the imbalance with the cost of coal-based electricity, are the payments for Renewable Energy Certificates (RECs) and Carbon Credits (or Offsets). RECs are issued for the production of every megawatt of renewable energy by an accredited producer. These RECs can then be sold, especially to large electricity producers who need to meet the Mandated Renewable Energy Target (proposed to be 20% of energy production). The current price of RECs is approximately 5 cents/kWhr, but is expected to rise in the future. Carbon Credits will need to be surrendered within the Carbon Pollution Reduction Scheme (CPRS) for every tonne of CO2 produced. Bioenergy production has a "zero rating" but coal-based electricity will need to add the cost of the Carbon Credit onto the current cost, thus making bioenergy more cost competitive. The current price of voluntary Carbon Offsets is about $20/tonne CO2, which translates to about 2 cents/kWhr.

Q: Are there any certification standards for Bioenergy?

A: Unlike forestry, where a number of Certification Standards already exist, there are currently no Certification Standards for bioenergy. However, attempts are currently being made to develop such standards by organisations such as the World Wildlife Federation (WWF) and the World Bioenergy Association (WBA). In addition, in Australia, any Bioenergy power plant must conform to all the regulatory requirements of the Office of the Renewable Energy Regulator (ORER) in order to be eligible for RECs

Q: How much does a Bioenergy power plant cost to build?

A: The cost of a bioenergy power plant will depend on the technology involved, the scale of the plant and on what additional extras are included (e.g. land, buildings and supporting infrastructure). Larger plants cost less per megawatt than smaller plants. The cost per kilowatt of rated capacity for the power plant (including infrastructure costs) ranges from $5000-$15000 per kilowatt of rated capacity.

Q: How much does a Bioenergy power plant cost to operate?

A: The ongoing costs to operate and maintain the power plant will again depend on the technology involved, the degree of automation and the scale of the power plant. The annual cost of operation and maintenance should be in the range of $500-$1500 per kilowatt of rated capacity.

Q: What is the operating life-time of a Bioenergy power plant?

A: Most of the components of a bioenergy power plant have guaranteed lives of 20 years. However, many such plants have been operating in Europe for more than 20 years with little of no major problems. A period of 20 years is often used for the economic evaluation of the capital cost investment.

Q: Can Bioenergy produce baseload electricity?

A: Unlike an isolated solar or wind power generation facility, bioenergy plants can be run for 24 hours per day in any weather. They will, however, need to be shut down periodically for routine maintenance (approx 4 weeks per year). Therefore, like solar and wind systems, most bioenergy power plants feed into the electricity grid so that end-users can draw power from the grid when it is not being produced by the bioenergy plant.

Q: How does Bioenergy from wood compare with the production of renewable energy by other means (e.g. solar, wind, hydro)?

A: The future Renewable Energy scene in Australia will require contributions from all forms of renewable energy, as and when they are appropriate. Despite bioenergy being largely overlooked by the media and politicians in favour of more high-profile technologies such as wind, hydro and solar (Clean Energy Council, 2007), it compares very favourably to those alternatives, both environmentally and economically.

Q: Can Bioenergy make a significant contribution to national Renewable Energy Targets?

A: The Clean Energy Council estimates that by 2040, 26% of Australia's electricity could be supplied from biomass with negligible additional land required.

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