NEAR TO ZERO EMISSION BIOMASS POWER GENERATION TECHNOLOGIES

Introduction

Near to zero emission power generation (ZEPG) is defined as the production of electricity with minimal emissions to all elements of the environment (the atmosphere, water and land). However, what makes these technologies strategically important is that they produce near to zero emissions of CO2; the principal gas responsible for climate change. Of the three classes of technology capable of being developed worldwide as ZEPG plant, renewable energy sources and nuclear power are inherently low in CO2 emissions (the main emissions are those associated with their manufacture, fuel processing/transportation and final decommissioning). In contrast, technologies using fossil fuels require engineered systems to separate, capture and dispose of the carbon in the fuels either before or after combustion (e.g. during gasification of coal, or by taking CO2 out of flue gases).

Each of the above technology classes draws on a range of devices and processes, together with enabling technologies (e.g. materials, control systems, structural integrity analysis, etc.). In some cases, the same devices are common to more than one class of technology. Important examples are gas turbines, boilers and steam turbines, which are used in fossil and biomass plant as well as in a range of nuclear reactor designs. Another is fuel cells, which are likely to be crucial to achieving high conversion efficiencies with both fossil, with CO2 capture, and biomass power generation. Storage of energy is recognised as an important enabling technology for the efficient operation of future energy networks.

Fossil fuel systems involve the oxidation of carboniferous material and conversion of the energy released to electrical power through high efficiency devices such as gas turbines, fuel cells, gasifiers, boilers and steam turbines. Technologies are already supplied by Clearwater Technology Group to give considerable reductions in the emissions of pollutants such as NOX and SOX, and the power generation industry is constantly striving to maximise fuel efficiency through technical advances and greater deployment of combined heat and power systems. However, whilst these represent important intermediate steps towards near to zero emissions, such developments are not the complete answer. Capture and disposal of CO2 is an important element of fossil plant that is designed for near

to zero greenhouse gas emissions. This introduces the need for developments and expertise (e.g. CO2 separation methods, geological disposal of CO2) lying well beyond the traditional capabilities used in the manufacture of thermal power plant.

Renewable Energy based on biomass crops (such as arundo donax or bamboo) utilises a range of devices that capture different sources of energy present in nature and converts them mainly to electricity. It includes sources of biomass for combustion including; energy crops, waste and landfill gas. These technologies already have near to zero emission characteristics, but their sustained commercial deployment has depended on further reductions in cost and increased capture efficiencies being achieved. Biomass gasification benefits from many of the recent developments and efficiency gains with fossil fuel systems.

The key feature of near to zero emissions power plant is that it offers an approach for achieving major cuts in CO2 emissions from power generation, at an extremely attractive generating cost:

- Near to zero emission power plant can be derived from nuclear power and renewable energy sources.
- Nuclear power and renewable energy are inherently low in CO2 emissions, but fossil fuel systems require CO2 sequestration and disposal.
- Each near to zero emissions power system consists of a chain of devices, processes and enabling technologies, which need to be developed in an integrated manner to achieve commercial deployment.
- Several of the devices are common to more than one type of near to zero emission system (e.g. gas turbines, gasifiers, fuels cells, boilers, steam turbines, storage) and therefore their development will have broader benefits.

CTG has harnessed and developed the technologies required to implement biomass-based near Zero Emissions Power Generating plant. The core of our approach is the efficient conversion of dry biomass material into a syn-gas fuel stream using modern gasification technologies. The syn-gas is used to fire an integrated combined cycle power generation process. The whole system can be described by the acronym: ZEBIGCC – Zero Emission Biogas Integrated Gasification Combined Cycle Power Generation

Example

The table shown below is an abstract from an in-depth study conducted by Department of Science, Technology and Society, Utrecht University in The Netherlands during 2001. It serves to summarise that [in 2001] it could be concluded that large scale electricity generation by Nicaraguan biomass based on the use of bagasse (spent sugar cane) during the sugarcane season, and eucalyptus outside this season, was competitive with electricity from fuel oil under the conditions currently prevailing in Nicaragua, and countries with similar tropical or semi-tropical climates. Furthermore, this form of biomass energy has significant macro-economic and environmental advantages. Since 2001, of course, fossil fuel prices have leapt ahead and the gap between biomass and fossil fuels ahs widened much further.

	Unit	Fuel oil	Electricity from biomass at sugar mill		
			Whole year average	Off-season-eucalyptus	Season-bagasse
		Cost results			
Fuel cost	($/GJ$_{LHV}$)	3,2	0,94	1,7	—
Cost of electricity[a]	(c/kWh)	5,8	5,0	6,2	3,2
		Macro-economic results			
Value added	(%)	17	64	68	36
Import	(%)	83	36	32	44
Employment creation	(person yr/MW yr)	15	32	50	9
		Environmental results			
Fossil fuel use	(MJ/kWh)	9,7	0,15	0,26	0,020
Greenhouse emissions	(g/kWh)	778	12	20	1,6
Acidifying emissions	(g/kWh)	25	1,4	2,5	0,0
Dust emissions	(g/kWh)	0,59	4,4	7,8	—

Using Arundo as feedstock allows CTG to create power at a much lower cost than from fossil fuels.

Table I. Comparative feedstock cost analysis

Feedstock	Comparative cost factor
Arundo	14.29
Oil (Light)	58.61
Oil (Heavy)	58.44
Natural Gas (Firm)	36.77
LPG	17.76
Pet-Coke (V.High S)	9.26
Coal	17.81

The table describes the cost of feedstock to generate an equivalent amount of electricity. This analysis does not include any additional tax benefits that are usually offered to producers of clean energy.

A 120 MW output plant requires circa 15,000 acres of Arundo to support it.

CLEARWATER POWER TECHNOLOGY - CPT

Clearwater Power Technology – CPT is an internationally-focussed energy consulting firm formed to develop and exploit many fuels and technologies, including biomass. Production of biomass raw materials on a commercial agro-industrial scale using unique patented technologies is one of CPT's accomplishments. CPT also has the in-house expertise to utilise biomass energy in association with wind energy.

Biomass is recognised as the fastest growing sector of the alternative energy market. CPT can offer the technology to produce power cheaper than most conventional gas or oil powered plants AND we can guarantee the prices to the consumer at a flat rate for 15 to 20 years.