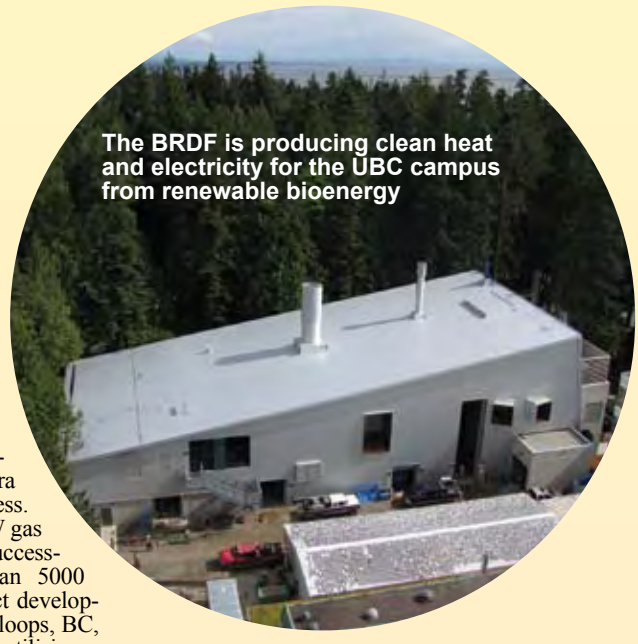
Turning up the heat on biomass gasification

A new facility to demonstrate combined heat and power production from biomass gasification in a commercial setting, recently began operation in Vancouver, Canada. **Junior Isles** looks at this pioneering project.



The BRDF is producing clean heat and electricity for the UBC campus from renewable bioenergy

Much of British Columbia is characterised by its extensive forests. Forests cover about two-thirds (60 million hectares) of the province's total land mass and, since 95 per cent of BC's land base is publicly owned, the management of the forest resource rests largely with the provincial government. Subsequently, there is no shortage of sources of biomass. This combined with a desire to push clean technology has led the University of British Columbia (UBC) in Vancouver to open a new clean energy facility that also fits into its educational programme.

The $27-million Bioenergy Research & Demonstration Facility (BRDF), which opened in September, received financial support from UBC, the Province of British Columbia, and the Canadian Federal Government. It is claimed to be the first demonstration of its kind in the world of a community-scale heat and power system fuelled by biomass.

Certainly UBC is Canada's first university – and one of a few institutions worldwide – to produce both clean heat and electricity for its campus from renewable bioenergy. UBC researchers, students and partners will use the first-of-its-kind facility to research, develop and evaluate bioenergy and other clean energies, processes and technologies.

Commenting on the project, Brent Sauder, Director, of UBC's Strategic Partnerships Office said: "UBC is an independent municipality occupying a site of 400 hectares. It is a community of over 50 000 persons made up of students, staff, faculty and market housing residents. The UBC owned and managed electrical and heating grids serve over 400 buildings in the university's academic core

"All the heat and power generated by the cogen facility will be consumed on campus, offsetting the amount of energy normally supplied by the electricity and gas utilities."

Sauder noted that as a "small city", UBC is perfectly placed to try out new technologies. "Under the Living Laboratory Initiative, we have the ability to try out technologies such as cogen and hot-water district heating. We also have a project based on distributed batteries. We are doing a number of things with different partners to try to demonstrate the economic value of these new technologies."

The BRDF is a partnership between UBC, Vancouver-based Nexterra Systems Corporation and GE Energy. Notably, it is the first commercial demonstration of a new application that combines Nexterra's gasification and syngas cleaning technologies with GE Energy's Jenbacher engines.

The system creates synthesis (syn) gas that is then burned in raw form to produce steam, or conditioned to create ultra clean syngas that is injected into an internal combustion engine used to generate electricity and additional heat (recovered engine heat) for the UBC campus.

Although the use of biomass gasification to generate electricity can be seen as a somewhat exotic solution, Roger George, General Manager, North America, Gas Engines, GE Jenbacher points out that it has advantages over other conventional technologies.

"Compared to straightforward incineration, there's a significant efficiency gain. The BRDF will have an electrical efficiency of about 25-26 per cent compared to about 18-20 per cent for a conventional [boiler and steam turbine] solution. In addition, in CHP mode additional thermal energy capacity is available to increase overall system efficiency to up to 60 per cent. The gasifier also has advantages in terms of emissions at the back-end of the system. Gasification is a much more elegant solution. In terms of scale, it is also much more targeted [to this particular installation]. Gasification of biomass peaks at about 10 MWe in terms of scale. Steam turbine-based plants scale after above 10 MWe."

The start-up of the system at UBC represents the culmination of more than four years of product development work and collaboration between Nexterra and GE's Jenbacher business. Prior to installing the 2 MW gas engine at UBC, Nexterra successfully completed more than 5000 hours of trials at its product development centre (PDC) in Kamloops, BC, including over 3000 hours utilising a 250 kWe Jenbacher engine.

Explaining the partnership with Nexterra, George noted: "Jenbacher has more than 12 years of experience of burning syngas in its engines… We wanted to find a [gasifier] technology company that could execute on a commercial solution. We did a lot of testing with Nexterra on a pilot project and then standardised the gasifier for a Jenbacher 620 engine platform. This is our largest engine capable of running on syngas."

> "The operation of this unit will provide solid data for projects in other parts of the world. GE believes there are significant opportunities in the Europe, India and Southeast Asia"

The pilot served to examine two main areas: the consistency and stability of the syngas from the gasifier and the cleanliness of the fuel.

"In addition to the syngas stability, tars can be a big problem. They can cool and solidify in areas of ducting just before the engine, which causes a serious maintenance issue. So a critical issue was how to clean those tars before they get to the engine. We had to make sure these two issues were solved before we moved to a bigger engine," said George.

With the pilot demonstrated successfully, the next step was to scale it up. UBC is the first commercial customer to demonstrate the technology. George commented: "As a demonstration project they have given us the leeway to improve the system. For example, the engine is rated at 1.5 MW electrical but during commissioning we were able to tune the engine along with the gasifier to increase the capacity to 2 MWe."

The BRDF will gasify 12 500 dry tonnes/year of woody biomass, some of which was previously destined for local landfills. The feedstock is an area that requires careful consideration.

Sauder explained: "You have to be very clear about the characterisation of your fuel stock. We have a student working on characterising the fuel coming into the plant. UBC is building towards defining a 'blend of biomass' specially mixed by our fuel aggregator to suit our needs."

The quality of the fuel has a direct correlation to the ability to produce good syngas and also affects the performance and maintenance costs of the facility. As Sauder pointed out: "Some people think biomass is biomass but that is definitely not the case. I can see the day when biomass will be graded, just like other fuels.

There will be different classes of biomass so you know what you are buying."

The BRDF has two main operating modes. The first is 'thermal-only mode', where the syngas from the gasifier replaces natural gas used to produce steam and hot water to meet the campus' heating needs.

The second is called 'demonstration mode', as it is the first site to use the technology for combined heat and power in a commercial setting. Here the syngas is conditioned to remove impurities and fed into GE's Jenbacher gas engine to produce electricity. In addition, heat from the engine is recovered and directed to the district heating system. The combined heat and power system has a maximum output of 2 MW of power and 4365 kg/hr (9600 lb/hr) of steam.

According to UBC, the engine has been running well since start up. Performance tests will be carried out during the first three months of operation. Once in full commercial operation, the BRDF is expected to produce up to 15 million kWh/yr of electricity.

Sauder noted: "In thermal mode it has been working well, as we would expect. The cogen part of the project is the part where the technical risk is. At the moment we are running in cogen for increasing periods of time and taking measurements on things such as emissions and noise, which have been fine. We will start to get 'commercial hours' out of it after about a year's operation. Our aim is to run it 24/7 at its full capacity."

The operation of this unit will provide solid data for projects in other parts of the world. GE believes there are significant opportunities in Europe, India and Southeast Asia.

George explained: "Biomass availability is the first criteria. There also has to be a certain level of price for power. There are opportunities in areas where natural gas is not widely available and people have to depend on diesel. The industrial sector also has possibilities. In Southeast Asia for example, there is big potential for rice husk gasification."

UBC's BRDF will not only demonstrate the feasibility of such projects but also the commercial viability. In addition to supplying up to 12 per cent of UBC's heat requirements, it will reduce UBC's campus greenhouse gas emissions by 9 per cent (5000 tonnes). Although UBC is a jurisdiction of very low natural gas and electricity prices, at today's gas prices, UBC estimates the BRDF will pay for itself in about 15 years.

Simplified illustration of the advanced biomass heat and power system