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BLUE SKIES FOR DOCKSIDE GREEN:

BIOMASS GASIFICATION HEATS HARBORFRONT COMMUNITY

Dejan Sparica, Vice President and Chief Engineer, Nexterra Systems Corp.

Cyclists crossing the Johnson Street Bridge heading out of downtown Victoria, British Columbia, quickly find themselves riding along a piece of the city's historic waterfront known as the Galloping Goose Trail. Named for a gawky, noisy gas rail car that carried passengers there in the 1920s, the trail passes directly in mentally friendly materials and sustainable design. Each building to be constructed at Dockside Green will in fact be designed to achieve the LEED[®] (Leadership in Energy and Environmental Design) Platinum rating.

This innovative green project is anchored by a unique district

front of a development that many believe to be the future of sustainable urban living.

Dockside Green, as the community is known, is hailed as one of the most ambitious developments in North America adhering to a strict building code based on environmental, social and economic responsibility. Built on 15 acres reclaimed from a former brownfield site, it is the largest development of city land in Victoria's history and a showcase of environ-



The first two residential phases of Victoria's Dockside Green are now occupied. The first phase, encompassing four buildings, earned LEED Platinum with a world-record-setting 63 out of 70 possible points.

energy system based on advanced biomass gasification technology. Commissioned in July 2009, the system enables Dockside Green to self-generate clean, low-cost heat using locally sourced wood fuel to help achieve the developer's goal of carbon neutrality. The biomass gasification plant has been instrumental in bringing a great deal of national and international recognition to Dockside Green, including selection by the Clinton Climate



Figure 1. A Rendering of Dockside Green's Master Plan.

Initiative as a founding member community in its Climate Positive Development Program.

From Concept to Renewable Reality

The concept of building an eco-friendly, sustainable community on Victoria's harborfront emerged in the early 2000s when the city was looking for a 'triple bottom line' development - one whose success is measured in social and environmental as well as economic terms. After the city issued a request for proposals in 2004, Joe Van Belleghem, the visionary behind Dockside and a partner with development company Windmill West, responded to the call with a complete conceptual design - one that mirrored the actual design of the community today. A master development agreement was signed in May 2005 between the city and Dockside Green Ltd., formed by Windmill West and Vancity Capital, which is an investment subsidiary of Vancity, Canada's largest credit union.

THE BIOMASS GASIFICATION PLANT HAS BEEN INSTRUMENTAL IN BRINGING A GREAT DEAL OF NATIONAL AND INTERNATIONAL RECOGNITION TO DOCKSIDE GREEN.

Site remediation work started shortly thereafter. This involved taking soil off the site, thermally treating it and mixing it with biosolids, then using it to reclaim an old copper mine; some of the soil was also capped. These remediation efforts were incorporated into the project's financials by designing the master plan around the areas where the soil could be capped.

Dockside Green's master plan encompasses 26 buildings totaling 1.3 million sq ft of mixed residential, office, retail and light industrial space (fig. 1). By 2015, the community will be home to approximately 2,500 residents in three neighborhoods. Project construction began in early 2006.

Van Belleghem was so committed to making the project a model for green living that he had promised to pay the city CA\$1 million (about \$919,000) if he didn't achieve LEED Platinum status on each of the eligible buildings within the master-planned com-

munity. The first construction phase of Dockside Green, called Synergy, has already made good on that promise, earning LEED Platinum with the highest rating ever achieved for that level of certification. Completed in March 2008, this phase comprises two mid-rise residential towers with commercial units on the ground floor plus two townhome complexes.

Phase 2, called Balance, was completed in May 2009 and comprises two towers with 171 suites. Seven additional residential phases are planned that include mid-rise buildings with one- and two-bedroom suites and penthouses, plus luxury and affordable townhomes.

In addition to the biomass gasification plant, Dockside Green features such other eco-friendly components as its own wastewater treatment and reclamation system; green roofs on many buildings; solar-powered street lights and garbage compactors; and a carsharing program and bike racks to encourage less use of car transportation.

"Dockside has been such an important project for the city," said Mayor Dean Fortin."We inherited the site from the province, and it needed extensive remediation. Now we have a wonderful combination of market and social housing, bike paths and water features in a community that the world is coming to see."



Dockside Green's biomass gasification system showing fuel feed (far left) to gasifier (background); oxidizer and hot water heater are in foreground.

THE PRINCIPLES OF GASIFICATION HAVE BEEN WELL-KNOWN FOR MORE THAN 200 YEARS, BUT BIOMASS GASIFICATION HAS NOT SEEN COMMERCIAL SUCCESS UNTIL RECENTLY.

Existing Technology, Scaled for Future

The biomass gasification system serving Dockside Green was developed and built by Vancouver-based Nexterra Systems Corp. The plant itself is owned by Dockside Green Energy LLP, a 'micro energy utility' created by Terasen Energy Services, Vancity Capital, Windmill Developments and Corix Utilities, with additional financial support from BC Hydro, the provincial government and the city of Victoria.

The system takes urban wood fuel and converts it to lowemission synthetic gas, or 'syngas.'The syngas is directed through an oxidizer and then a boiler, which in turn provides hot water that is piped to Dockside's various buildings and used for space heating and domestic hot water (90 degrees F). The solution provides a cleaner, quieter alternative to traditional combustion with lower emissions, greater fuel flexibility and higher turndown.

Gasification differs from conventional combustion because it uses just 20 percent to 30 percent of the oxygen needed for complete fuel combustion. The process consists of heating wood in an oxygen-starved environment until volatile gases (carbon dioxide and hydrogen) are released from the wood. The gases are mixed with air in a secondary combustion chamber, the oxidizer, where they are burned to complete the combustion process. Hot flue gas leaving the oxidizer can then be directed into energy recovery equipment or fired directly into boilers to produce hot water, steam and/or electricity.

The gasifier at Dockside is based on a fixed-bed, updraft design. Biomass fuel, sized to 3 inches in diameter, is bottom-fed into the center of a cylindrical, refractory-lined gasifier. Combustion air, steam and/or oxygen are introduced into the base of the fuel pile. Partial oxidation, pyrolysis and gasification occur at 1,500-1,800 F, and the fuel is converted into syngas and noncombustible ash.

The fuel-bed temperature is tightly controlled to prevent the bed from exceeding the fuel's ash melting point. This prevents the ash from forming 'clinker,' which is a challenge for conven-



The Dockside Green biomass plant is housed in an architecturally designed building that blends in with the neighborhood.

Leaving Nothing to Waste

Dockside's biomass gasification plant is undoubtedly an anchor for the development's sustainable pedigree. Another unique component of the community that sets it apart is its on-site sewage/wastewater treatment plant. One hundred percent of the treated effluent and reclaimed water at Dockside is used in toilets, rooftops gardens and irrigation systems for the entire site. The minimal amount of sludge left over from the sewage treatment process is compacted and can be used as fuel in the biomass gasification plant.

Nexterra recently began testing biosolids (wastewater residuals) supplied by Metro Vancouver as a new fuel source at its Product Development Centre in Kamloops, B.C. This new fuel has the potential to provide a renewable energy source for drying, heat or power generation at wastewater treatment facilities.

According to the U.S. EPA, there are more than 16,000 wastewater treatment facilities in the U.S., with many owned and operated by municipalities. Traditional methods for the disposal of biosolids involve trucking to landfills or using as land spread. However many municipalities would like to discontinue these practices due to rising fuel and disposal costs, greenhouse gas emissions and concerns about landfill capacity.

tional combustion systems. Instead, the ash remains granular, freeflowing and is discharged intermittently through the gasifier base into a single ash bin. The mineral-rich ash generated at the Dockside facility is actually collected by the fuel supplier and recycled as compost.

The principles of gasification have been well-known for more than 200 years, but biomass gasification has not seen commercial success until recently. Scaling the technology to handle larger-capacity loads is an area that has shown great promise. While Dockside's system generates 7 MMBtu/hr of net usable heat, a 72 MMBtu/hr system using the same gasification technology is operating on University of South Carolina's (USC) Columbia campus.

The USC biomass gasification cogeneration facility converts wood residue supplied by local sawmills into clean renewable energy and significantly reduces campus greenhouse gas emissions. At peak capacity the plant generates 60,000 lb/hr of steam to heat the campus, as well as 1.38 MW of electricity sold to the grid. On-site power generation is also planned for Dockside Green in the future, using syngas produced at the biomass gasification plant and conveying it into a high-efficiency internal combustion engine (see sidebar).

Gasification also offers flexibility both in terms of the fuel used – Dockside's system can handle anywhere between 10 percent and 55 percent moisture content – and the reduced need for complex after-treatment systems, due to the technology's inherent cleanliness.

When operating at peak capacity, the Dockside plant requires delivery of approximately one truckload of wood fuel every two days. (The system also has a natural gas boiler to provide backup service during scheduled maintenance intervals.) This fuel is material that would otherwise be destined for a landfill: wood waste derived from land-clearing activities, municipal tree trimmings, the remains of construction two-by-fours and used pallets. There is more than an ample supply of this locally sourced wood, provided by waste management company Alpine Group, to meet ongoing plant requirements.

Why Biomass Gasification?

Van Belleghem and his team chose biomass gasification technology for its promise to deliver a combination of superior performance and operational benefits over those of conventional combustion – including design simplicity, fuel versatility, low emissions and cost.

Cyclists cruising past the biomass plant would certainly have a hard time distinguishing the facility as an industrial operation. The plant is housed in an architecturally designed building that blends in with the surrounding neighborhood, and the plant's operation is imperceptible from a noise, dust and emissions perspective.

The emissions profile of biomass gasification systems as it pertains to particulate matter has been shown to be comparable to that of natural gas, using a carbon-neutral, renewable fuel source. In addition, emissions of both carbon dioxide and volatile organic compounds are significantly lower than the guidelines set by the U.S. Environmental Protection Agency as compared to levels resulting from the burning of natural gas. Biomass is considered carbon-neutral by key monitoring agencies, which distinguish renewable energy sources like wood – which recirculates CO_2 already in the biosphere's carbon cycle – from the fossil fuels that add more CO_2 to that in active circulation.

PRIMARILY DUE TO ITS RENEWABLE ENERGY USE, DOCKSIDE GREEN IS ON TRACK TO BE CARBON-NEUTRAL.

The choice of biomass gasification for the central heating plant has enabled the project to take concrete action toward reducing greenhouse gas emissions. Once the development is completed, heating with syngas produced from biomass instead of burning natural gas will cut CO_2 emissions by 3,460 tonnes per year at Dockside Green – the equivalent of taking 850 cars off the road.

These benefits are not lost on Dockside residents, who state that the on-site creation and use of green energy is an appealing aspect that makes them feel good about where they live. "I am really excited that the developers of Dockside Green are being so proactive about energy and environmental issues," says resident Taylor Kennedy. "The fact that we have excess capacity for others in our community is an added bonus. It's great knowing that our heating system will help keep carbon out of the atmosphere, while also reducing my heating bills."

Dockside Green is, in fact, on track to be carbon-neutral, primarily due to its renewable energy use. By generating surplus renewable energy in the form of heat that can be sold off site, the development will be able to compensate for the greenhouse gases generated on site through electricity and the delivery of the waste wood biomass to the plant. The community also began to earn carbon credits this fall when the biomass plant was connected to serve a nearby hotel.

Certainly the project's renewable energy system seems tailormade for British Columbia, where greenhouse gas emissions reduction strategies and targets are required in all official community plans and regional growth strategies. The province has estabSince 2003, Nexterra Energy Corp. has been developing a fixed-bed, updraft gasification technology that converts wood residuals such as bark, sawdust and shavings into syngas. The first generation of this technology has been successfully commercially deployed for heat and steam applications at Dockside Green; Tolko Industries in Kamloops, B.C.; and the University of South Carolina in Columbia.

The second stage of technology development involves conveying and directly firing the syngas into rotary kiln and boiler burners. The company has performed successful trials of this application at pilot scale and is currently working to commercialize this solution. The first installation will startup later this year at the Kruger Products tissue mill in New Westminster, B.C.

The company is now embarked on the third generation of biomass gasification technology in collaboration with GE Energy and its gas engine division, GE Jenbacher. It is developing an advanced combined heat and power system, ranging from 2 to 10 MWe, that involves direct-firing syngas into GE's Ecomaginationcertified Jenbacher internal combustion engines. Pilot testing of the technology is being conducted at the company's Product Development Centre, where a 250 kWe Jenbacher is being installed. This next-phase gasification system has also been proposed for installation at Dockside Green when it becomes commercially available.

In late August, the company announced that it had received CA\$7.7 million (\$7.08 million) in funding to support the commercialization of the new biomass power system. Funding sources include the BC Bionenergy Network, Sustainable Development Technology Canada, the National Research Council Canada Industrial Research Assistance Program and Ethanol BC.

lished legally binding greenhouse gas reduction targets of 33 percent from 2007 levels by 2020 and 80 percent by 2050. But the cornerstone of British Columbia's climate action plan is a revenue-neutral carbon tax starting at CA\$10 (\$9.19) per tonne in 2008 rising to CA\$30 (\$27.57) per tonne in 2012. It has also established Pacific Carbon Trust to sell carbon offsets at CA\$25 (\$22.98) per tonne.

B.C. Premier Gordon Campbell announced that municipalities will be given the power to waive development cost charges as a way to encourage green developments such as Dockside Green. All public institutions in the province must be carbon-neutral by 2010, and any new government buildings or facilities shall be built to a minimum LEED Gold or equivalent certification.

A Climate Positive Community

Dockside's on-site biomass heat generation plant was a key factor in the community's selection by the Clinton Climate

Initiative (CCI), a project of the William J. Clinton Foundation, as one of 16 founding member communities from around the world in its Climate Positive Development Program. The program was created in collaboration with the U.S. Green Building Council to set a new global benchmark for large-scale urban developments, to demonstrate that communities and cities can grow in ways that are 'climate positive.'

Elee Muslin, CCI director, said real estate developments like Dockside will strive to reduce the amount of net on-site CO_2 emissions to below zero. Muslin said the goal can be achieved through the implementation of economically viable innovations including clean energy generation, integrated waste management and energy-efficient strategies. "The biomass heat generation plant at Dockside Green is a strong example of the kind of innovation that communities around the world need to adopt as we forge a new path towards the creation of climate positive communities," Muslin said.

THE BIOMASS PLANT PLAYED A KEY ROLE IN HELPING DOCKSIDE GREEN GARNER NEARLY TWO DOZEN HONORS.

The biomass plant also played a key role in helping Dockside Green garner nearly two dozen national and international honors, including a BC Green Cities Partnership Award from LiveSmart BC, a Ministry of Environment Arbor Vitae Award and an Excellence in Urban Sustainability Award from the Globe Foundation's Awards for Environmental Excellence.

The wide recognition that Dockside Green has received may help spur the demand for similar sustainable developments. "It has been a pleasure working with the Dockside Green team on a project that is establishing a new standard of urban living, design and sustainability," says Belleghem.

Jonathan Rhone, Nexterra's president and chief executive officer, notes that the company is seeing "a tremendous amount of interest from energy providers, customers and all levels of govern-

ment to consider projects like Dockside Green." Indeed, as Belleghem observes, Dockside Green is proof that the challenges associated with global warming can be converted into powerful economic opportunities through the adoption of clean energy solutions that meet both

economic and envi-

ronmental objectives.

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Dejan Sparica is vice president and chief engineer of Vancouverbased Nexterra Systems Corp., which supplied the gasification system as well as heat recovery and hot water circulation system

for Dockside Green. An engineer for more than 25 years, Sparica has more than 15 years' experience designing and implementing industrial-scale combustion systems. He previously served as contract department manager at Salton Fabrication Ltd., where he was responsible for design and project management of large-scale energy system projects for numerous major manufacturers of pulp and paper and other forest products. Sparica can be reached at dsparica@nexterra.ca.

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