nexterra Backgrounder

Nexterra's Oak Ridge National Laboratory Biomass Gasification System

Site:	US Department of Energy's Oak Ridge National Laboratory
Customer:	Johnson Controls Inc.
Location:	Oak Ridge, Tennessee
Annual Fossil Fuel Savings:	$3 - $4 million/yr
Natural Gas Displacement:	75 MMBtu/hr
CO2 Emissions Reduction:	23,000 tonnes/year
Nexterra Scope of Supply:	Supply only of turnkey energy-from-renewable-waste system

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Project Background:

In 2007, the Department of Energy (DOE) selected Johnson Controls, Inc. (JCI) to develop an energy savings performance contract (ESPC) project for its Oak Ridge National Laboratory (ORNL) campus. The final proposal, approved for contract in July 2008, was the culmination of an engineering study and analysis of the infrastructure at the installation.

Eight Energy Conservation Measures (ECMs) were selected based on both their individual and collective merit in supporting the mission of the DOE. The ORNL ESPC is a $94 million project that is offset by an estimated $8.5 million in annual energy savings. ECMs are guaranteed to provide electric, natural gas, water and operational savings totaling an estimated $263 million over the 21 year performance period. The biomass gasification system is the cornerstone of the performance contract.

This project was initiated under the US DOE's Transformational Energy Action Management (TEAM) Initiative. TEAM aims to reduce energy waste and greenhouse gases at DOE facilities nationwide by 30 per cent.

Biomass Steam Plant Project Overview:

In 2008, JCI and ORNL selected Nexterra Systems Corp. to build a complete biomass gasification system that would enable ORNL to displace natural gas used for heating all campus buildings.

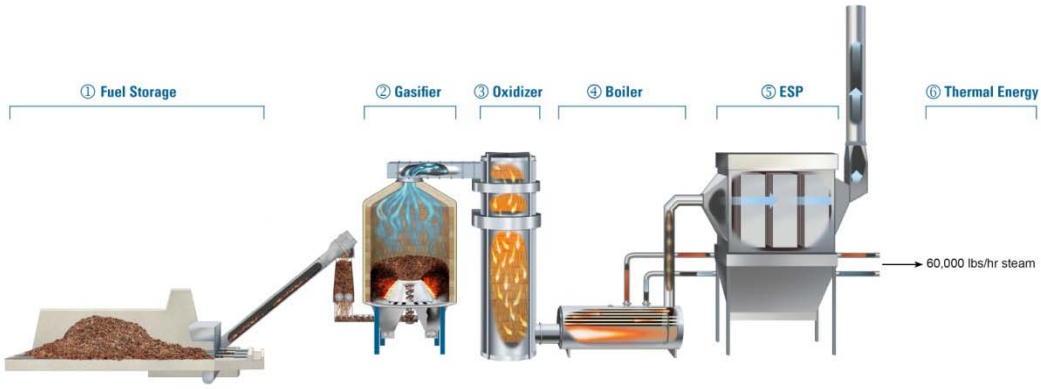
Nexterra's system provides 60,000 lbs/hr of steam and has allowed ORNL to eliminate four aging and inefficient fossil fuel boilers. Nexterra supplied the complete gasification system from fuel handling and storage through to the exhaust stack. The system is expected to save the lab $3 – 4 million per year in fossil fuel costs and reduce greenhouse gas emissions by 23,000 tonnes per year. The system completed testing for capacity, emissions and endurance in early 2012.

The Nexterra system was selected for this project because it would produce significantly lower levels of air emissions than conventional combustion and because it could complement other ORNL Biomass and Syngas research initiatives.

How the Nexterra System Works at ORNL:

- Sawmill and forestry waste from within 50 miles of the site is delivered to the fuel storage area which can hold up to 60 tonnes of material. In a typical year, the ORNL Biomass Steam Plant will consume about 40,000 dry tonnes of fuel, equivalent to about 1600 truck loads per year (4-5 trucks per day).

- Fuel enters the gasifier and goes through several stages including drying, pyrolysis (chemical change brought about by heat) and gasification. The wood waste is converted into a synthetic gas called “syngas” which can be used like natural gas.
- The syngas is conveyed into the oxidizer where it is fully combusted. The resulting hot flue gas is directed through a boiler to produce steam at 187 psi.
- Steam from the boiler is conveyed via an underground piping system and distributed to heat campus buildings. Cool water is circulated back to the boiler where it is re-heated.
- After exiting the boiler the flue gas is cleaned in an electrostatic precipitator that filters out the particulate matter before being released to the atmosphere. The particulate emissions from the ORNL gasification plant are equivalent to those from heating systems that burn natural gas.



How long did the project take to construct?
A typical Nexterra system will take 14 – 16 months to construct. The ORNL project took almost 4 years due to a number of site-related constraints that delayed the actual start of construction.

Plant construction began in the fall of 2009 with concrete foundations being formed for the fuel receiving area. Nexterra began installing its equipment in 2010. The plant began operation in October 2011. Emissions performance testing in January 2012 confirmed ultra-low air emissions. Commissioning continued until June, followed by full DOE approval of the project, which was officially opened July 19, 2012.

Where does the fuel come from?

The system uses locally sourced renewable waste wood and forestry residue that is sourced from within 50 miles of the site.

What are the local benefits of the system?

- Ultra-low air emissions equivalent to natural gas
- Enables shut down of four fossil fuel-fired boilers
- 23,000 tonnes/yr GHG reduction
- Long-term fuel cost savings
- Supports local business by using locally sourced wood waste

Why is biomass considered carbon neutral?

When measuring carbon emissions (also called greenhouse gas emissions), it is important to note that it is measured on a life cycle basis as opposed to what is emitted from the stack. Using biomass to produce energy is considered carbon neutral by the UN Intergovernmental Panel on Climate Change (IPCC) and the US Environmental Protection Agency. The rationale is that plants and trees absorb carbon dioxide as they grow, and then naturally release it into the atmosphere when they die and decay or burn. The carbon emissions from burning biomass are offset by new plant growth. Therefore, when biomass or syngas derived from biomass is used to displace fossil fuels (which are not naturally replaced once used), it is deemed to reduce greenhouse gas emissions.

For example, the Kruger Products Paper Mill in New Westminster, BC converted from natural gas to a Nexterra biomass gasification system in 2009. The mill has been able to reduce greenhouse gas emissions by over 20,000 tonnes per year. These emissions were certified by a third party and Kruger sold the reductions as carbon credits.

Is gasification a new technology?

The principles of gasification have been well understood for over 200 years. Coal gasification was widespread during the late 1800s, providing fuel for urban lighting and power generation. The abundance of inexpensive oil and gas resulted in a decline in gasification after World War II.

In recent years, gasification has experienced a resurgence due to escalating fossil fuel and electricity costs coupled with the need to reduce greenhouse gas emissions and increase energy security. Today, gasification is recognized as one of the most versatile, efficient and cleanest ways to convert low cost wood residuals and other biomass fuels into thermal energy or electricity.

Since its founding in 2003, Nexterra has focused on making its gasification technology more reliable, simpler to operate and more versatile. Nexterra has also invested heavily into product development to commercialize new products that maximize the value of the gasification process.

Nexterra now has seven commercial projects in Canada and the United States either operational or under construction. Nexterra also operates a commercial scale product development centre in Kamloops BC.

Why is turning wood into syngas or natural gas more advantageous than burning it outright?

There are a number of advantages to gasifying biomass wood residuals into syngas rather than burning it outright.

First of all, emissions are dramatically reduced compared to conventional biomass combustion technologies. For instance, because the fuel enters the gasification chamber from underneath and is quiescent – as opposed to combustion systems where the fuel is dropped from above which agitates the surface – the particulate (PM) emissions are much lower.

Secondly, Nexterra's gasification technology produces a clean burning gas – "syngas" – which can be fired directly into boilers and kilns. Nexterra is also cleaning and conditioning the syngas so it can be fired directly into an internal combustion engine to increase the efficiency of electricity generation. This is not possible with conventional combustion technologies which can only provide heat.

And thirdly, syngas can potentially be converted into high value fuels and chemicals which, again, is not possible with conventional combustion technology.

Can this technology be adapted in other places where there are fewer trees and thus less access to waste wood products?

Nexterra gasification systems can run on a variety of biomass materials in addition to what is commonly called "wood waste" such as bark, hog fuel, sawdust, etc. Some of Nexterra's biomass systems use tree trimmings (from municipal, Hydro and other utility operations) and clean construction debris from construction and demolition sites.

Another important feedstock is biosolids from municipal water and sewage treatment plants. This fuel is one of the most promising biomass feedstocks, especially if one considers the potential savings from using biosolids to fuel Nexterra's gasifiers which in turn produce heat that is used to dry the continuous stream of biosolids coming out of these facilities. Use of this fuel could potentially be a closed loop system.

Nexterra is also evaluating running its technology on other forms of biomass including various local renewable feedstocks such as refuse derived fuels (RDF), bagasse (sugar cane waste), eucalyptus, oat hulls and spent grains.

About Nexterra Systems Corp.
Nexterra is a leading provider of plant-scale, energy-from-renewable-waste systems that generate energy and fuels for a range of customers, including District Energy providers, Industrial process plant operators and Independent Power Producers. Nexterra systems integrate seamlessly with customer operations, providing both environmental and operational advantages, including high reliability and class-leading emissions performance. Nexterra has successfully supplied commercial gasification systems for projects at the US Department of Energy, Dockside Green, Kruger Products, the University of Northern BC and Tolko Industries.
More information is available at: www.nexterra.ca

About Oak Ridge National Laboratory (ORNL)

ORNL is a multi-program science and technology laboratory managed for the U.S. Department of Energy by UT-Battelle, LLC. Scientists and engineers at ORNL conduct basic and applied research and development to create scientific knowledge and technological solutions that strengthen the nation's leadership in key areas of science; increase the availability of clean, abundant energy; restore and protect the environment; and contribute to national security. With 4,200 staff, 3,000 guest researchers, 20 user facilities, and a budget of approximately $1.2 billion, ORNL supports the Department of Energy's mission through six major scientific competencies in energy, neutron science, high-performance computing, complex biological systems, materials research, and national security.
More information is available at: www.ornl.gov

About Johnson Controls, Inc.

Johnson Controls (NYSE: JCI) is the global leader that brings ingenuity to the places where people live, work and travel. By integrating technologies, products and services, we create smart environments that redefine the relationships between people and their surroundings. Our team of 140,000 employees creates a more comfortable, safe and sustainable world through our products and services for more than 200 million vehicles, 12 million homes and one million commercial buildings. Our commitment to sustainability drives our environmental stewardship, good corporate citizenship in our workplaces and communities, and the products and services we provide to customers.
For additional information, please visit: www.johnsoncontrols.com