



Northern Border Pipeline

5.5 MW Waste Heat to Power CHP System

Site Description

In August 2006, the Northern Border Pipeline (NBP) installed a waste heat to power (WHP) system at their Compressor Station #7 (CS #7), located in St Anthony, North Dakota. The 5.5 megawatt system converts waste heat given off by the compressor station into electricity using an Organic Rankine Cycle (ORC)-based power plant. ORMAT Technologies, Inc. installed, owns, and operates the plant, purchasing the waste heat from NBP and selling the generated electricity to the Basin Electric Power Cooperative under a power purchase agreement. Following the success of the WHP system at CS #7, many of the 16 compressor stations along the pipeline have adopted similar WHP systems for their compressors. The WHP system runs continuously as long as the compressor station is running. The electricity produced by these stations is bought by surrounding electric companies, most notably, Basin Electric Power Cooperative in North Dakota and East River Electric Power Cooperative in South Dakota. The Northern Border Pipeline profits off of the otherwise wasted heat produced by their compressors while at the same time helping electric companies provide reliable, high quality power to the nearby communities.

Quick Facts

LOCATION: St. Anthony, North Dakota
MARKET SECTOR: Natural Gas Pipeline
ELECTRICAL GENERATING CAPACITY: 5.5 MW
DESIGN LOAD FACTOR: ~ 90%
EQUIPMENT: ORMAT organic rankine cycle
FUEL: Recovered Waste Heat
ESTIMATED ENERGY OUTPUT: 27,600 MWh per year
USE OF ELECTRICAL ENERGY: Sold back to MorGranSou Electric
TOTAL PROJECT COST: \$13.75 Million
ESTIMATED YEARLY SAVINGS: Over \$600,000
ESTIMATED 20-YEAR SAVINGS: Over \$10 million
INTERNAL RATE OF RETURN: 5% to 15%
ENVIRONMENTAL BENEFITS: 27,600 tons of CO₂, 34,500 kg of NO_x, and 124,200 kg of SO₂ saved each year
PROJECT PARTNERS: ORMAT, Basin Electric Power Cooperative, and MorGranSou Electric Cooperative
BEGAN OPERATION: August 2006

Reasons for Waste Heat Recovery

Installing WHP at compressor stations takes advantage of the unused exhaust heat, generating electricity from a previously wasted resource. By partnering with a third party developer and operator, NBP was able to create revenue from waste with very little capital risk. Primary benefits of recovered energy at compressor stations include:

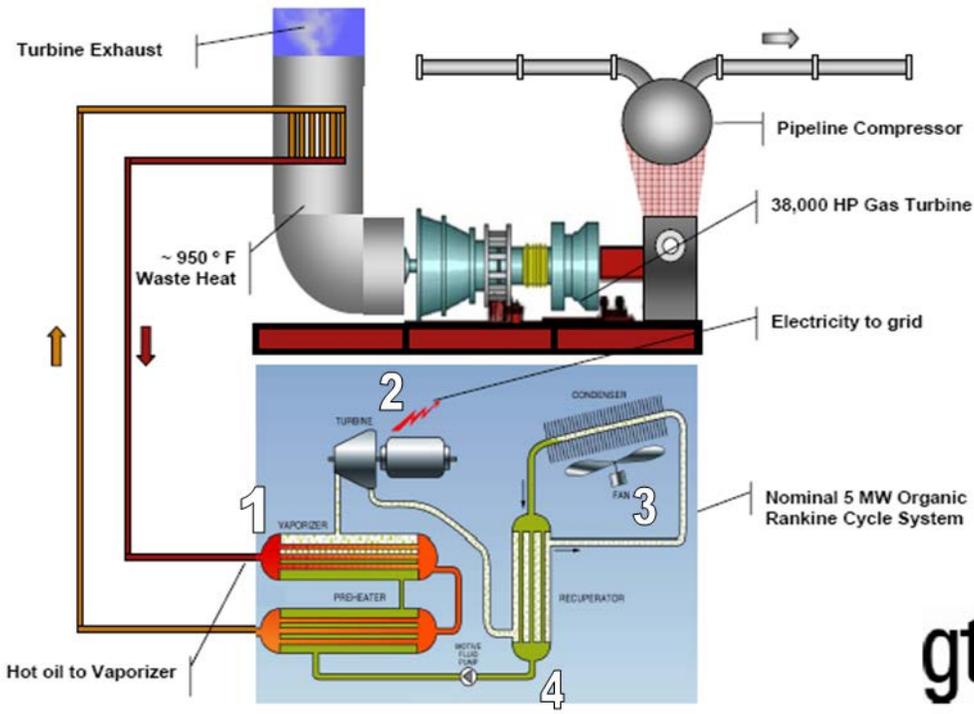
- Fuel-free system - recovered heat is used directly to generate electricity
- Pollution-free electrical generation
- Reliable, high quality power in remote areas



Compressor Station #7 in St. Anthony, North Dakota

The Organic Rankine Cycle

The Organic Rankine Cycle-based WHP system used at NBP's CS #7 converts excess heat directly into electricity. The figure to the right illustrates how CHP may be tied into a natural gas pipeline compressor system. In a natural gas pipeline compressor station, a large gas turbine acts as a mechanical drive for the compressor. Pipeline compressor stations are typically located in remote, rural areas, and have no heating loads, thus the high-temperature turbine exhaust is generally wasted. This waste heat may instead be recovered for use in an ORC-based power plant. The heat recovered from the compressor and turbine exhaust superheats a working fluid in a vaporizer (1) and it is expanded in a turbine (2). The expanding fluid drives the turbine and creates electric power. The fluid is then condensed (3), and fed back into the vaporizer (4). The whole process produces electric power with minimal emissions and no added fuel.



Collaborative Business Partnership

This project was a result of a successful collaboration among several organizations. Northern Border Pipeline supplies the land and waste heat to ORMAT in exchange for a royalty on electric sales. ORMAT built, owns and operates the ORC plant, using its Power Purchase Agreement (PPA) with Basin Electric to finance the project. Basin Electric executes a 25-year PPA with ORMAT for all electricity, which is produced at a very competitive price as there are no fuel costs excepting the waste heat royalties owed to NBP. The MorGranSou Electric Cooperative built distribution wires for the Basin interconnection to CS #7 and agreed to buy all electricity supplied. This power provides critical voltage to support their grid.

Other Locations

The WHP system was installed at CS #7 in conjunction with three other stations located in South Dakota near Wetonka, Clark, and Estelline. Following the success of these projects, NBP continued to work with ORMAT to install similar systems at six other stations along their pipeline near Culbertson, Montana, Manning and Zeeland, North Dakota, and Garvin, Minnesota. These plants became operational in 2009 and 2010. The North Dakota WHP systems help supply energy to Basin Electric Power Cooperative while the South Dakota systems provide electricity for East River Electric Power Cooperative. All the WHP systems have a 5.5 megawatt capacity and are owned by ORMAT. The Garvin site will provide energy to both East River and Basin electric companies, interconnecting the two power grids.

For More Information

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The Midwest CHP TAP is a U.S. DOE sponsored program managed by the Energy Resources Center located at the University of Illinois of Chicago.