CHAPTER 7 CASE STUDIES

Saskatchewan Penitentiary, Heating Plant Retrofit

Saskatchewan Penitentiary, located in Prince Albert, Saskatchewan, is one of the oldest prisons in Canada. It is a big facility with stone walls and reliable heating is an important operational concern and a big expense. In 1995, the heating plant was upgraded with new equipment.

The heating plant consisted of three boilers dating back to 1954. They were originally designed to burn coal and No. 6 fuel oil and had been upgraded to natural gas, with No. 2 oil as backup. The boilers were sized for 20,000 lb/h and 25,000 lb/h of 125 psig steam. The heating load ranged from 2,000 lb/h in the summer to 24,000 lb/h on the coldest winter days. After completion of the project, the heating plant operated more reliably, cost less to operate and produced fewer emissions.

The Problem

1. Low efficiency – Three old boilers, operation at minimum fire most of the year.
2. Low efficiency – During the winter, 2 boilers running at low loads.
3. Low efficiency – Antiquated controls did not allow good air/fuel combustion control.
4. High emissions – NO_x emissions 87 ppm to 136 ppm (3% O_2), firing natural gas.
5. Questionable reliability – Old equipment meant poor spare parts availability.
6. Questionable reliability – Tests showed thinning tube walls on two boilers.

The Solution

1. Replace two old boilers with two 14,000 lb/h new boilers – One meets load from spring to fall, both operate during the winter: higher efficiency at higher firing rates.
2. Low-NO_x burner with each new boiler – 3% to 5% O_2: higher efficiency, and 40 ppm NO_x (3% O_2), firing natural gas: meets NO_x guidelines.
3. Economizers on each new boiler - Efficiency gain of 3% to 4%.
4. New controls for all boilers – Reliable operation.

The Results

1. Gas savings – 3.6 million cubic meters the year before retrofit, 3.1 million cubic meters the year after; 500,000 cubic meter of natural gas savings.
2. Gas savings – Approximately 17% reduction in natural gas for building heating, relative to heated floor space.
3. Emissions reduction – 7340 kg NO_x produced year before retrofit, 2230 kg after; approximately 5000 kg/y less NO_x "up the stack."
4. Emissions reduction – 7.3 million kg CO_2 produced year before retrofit, 6.3 million kg after; a savings of 1 million kg.
5. Efficient, reliable operation – New controls and properly sized equipment.

Poster 7-1 Saskatchewan Penitentiary Heating Plant Retrofit

Sacré-Coeur Hospital, Direct Contact Heaters

Sacré-Coeur Hospital, in Montreal, Quebec, has been in operation since 1925. The heating plant supplies steam and hot water heating for the hospital (800,000 ft^2), a residence (540,000 ft^2), fresh air heating, sanitary hot water, and hot water for laundry, cooking and sterilization. In the early 1990's, the heating plant was completely upgraded. Efficiencies were significantly increased with the use of a condensing economizer and a direct contact water heater from Sofame-Tech of Montreal.

The heating plant consisted of five boilers, three dating back to 1925 and two installed in 1960. They were originally designed to burn coal or No. 6 fuel oil and had been upgraded to natural gas in 1976. The project focused on reducing fuel costs and emissions and simplifying the plant operation.

The Problem

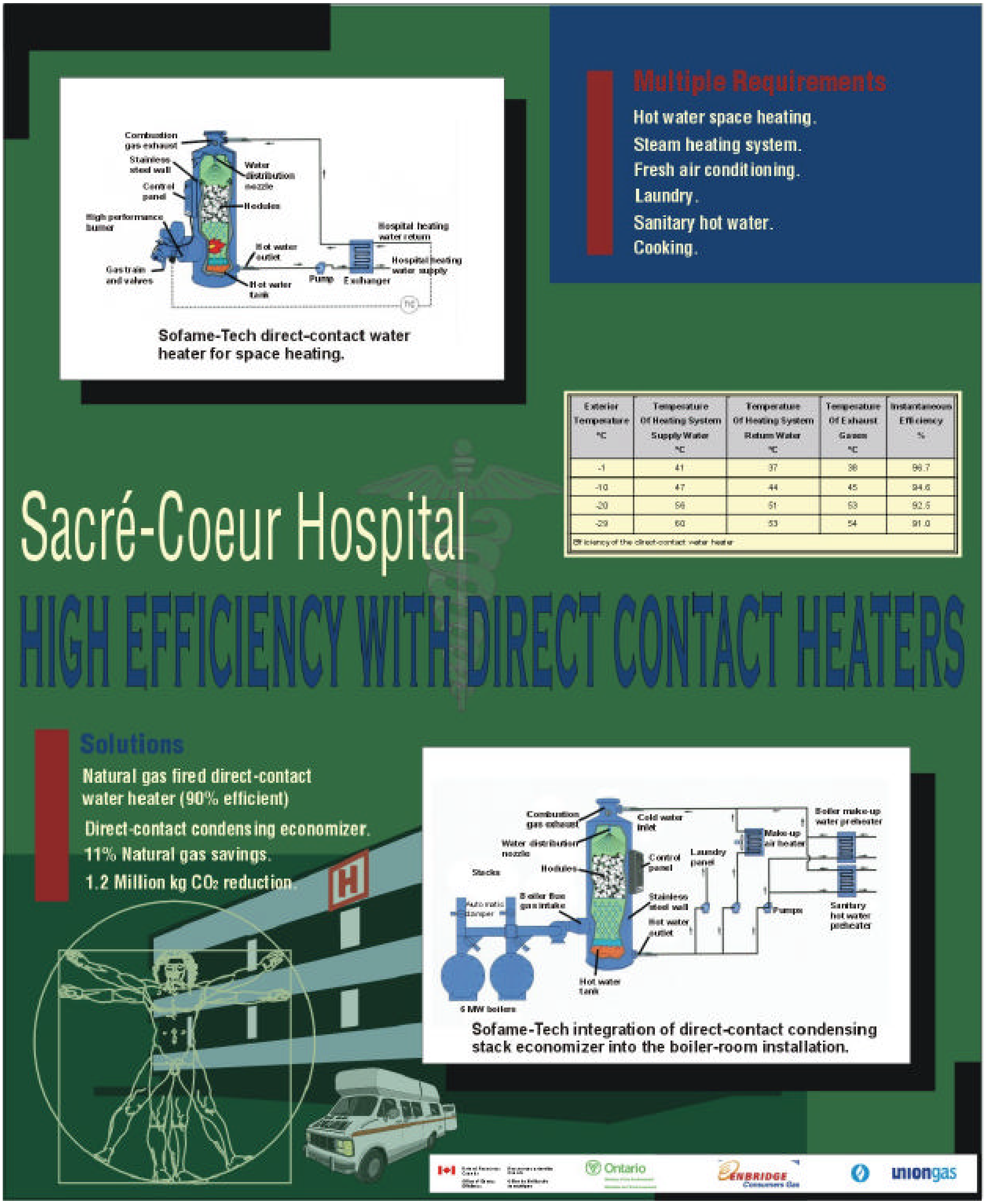
1. Low efficiency – Old boilers operating at low loads.
2. Low efficiency – Large boilers designed for coal, large radiant losses, high flue gas temperatures.
3. High emissions – Old burner designs.
4. Questionable reliability – Old equipment meant poor spare parts availability.
5. High maintenance costs – Continuous repairs to old equipment.

The Solution

Existing heating plant equipment replaced with:
1. Two new steam boilers – 20,000 lb/h (125 psig) each.
2. Direct contact economizer – Flue gas temperature reduced from 232 ^oC (450 ^oF) to 5.6 ^oC (10 ^oF) above water injection temperature.
3. System flexibility – 22,700 L water storage in economizer, heat storage for varying demands.
4. Direct contact water heater- 6 MWt high efficiency heat source for space heating system.

The Results

1. Gas savings – Annual natural gas consumption reduced by 600,000 cubic meters.
2. Gas savings – 11% reduction over 6 years since retrofit.
3. High efficiency – Operational data confirm efficiencies above 90% from direct contact water heater.
4. Emissions reduction – Fewer than 40 ppm of NO_x.
5. Emissions reduction – 1.2 million kg CO_2 reduction.
6. Reliable operation – Simple systems.
7. Fast response – Instantaneous production of hot water.



Poster 7-2 Sacré-Coeur Hospital Heating Plant Retrofit

Vineland Research Farm, Cogeneration Installation

Until 1994, Agiculture and Agri-Food Canada's Research Farm in Vineland, Ontario purchased their steam for heating from a nearby heating plant. In 1994, they received word this heat source would be cut off. The site needed 15 psig steam to heat its seven greenhouses and single administration building. Consideration was given to an electricity-and-heat cogeneration system powered by a gas-fired engine to meet the site's electrical load with the heat recovered from the engine cooling and flue gas generating the 15 psig steam.

The heating load ranged from a peak of 150 boiler horsepower (Bhp) to no heating during the summer. To balance the seasonal load, a 90 tonne absorption chiller to meet the facility cooling load was included which would provide an approximately 50 Bhp load during the summer. With the absorption chiller eliminating the electrical load from the existing electric chiller, a 260 kWe ebullient cooled generator matched the electrical base load while generating 50 Bhp of 15 psig steam. This cogeneration alone would meet the summer steam load and with an additional 100 Bhp boiler would meet the peak winter load. A second 150 Bhp boiler was installed for standby purposes. The boiler/ cogeneration plant operates at a 74% seasonal efficiency, and costs less to operate than the previously purchased steam.

The Problem

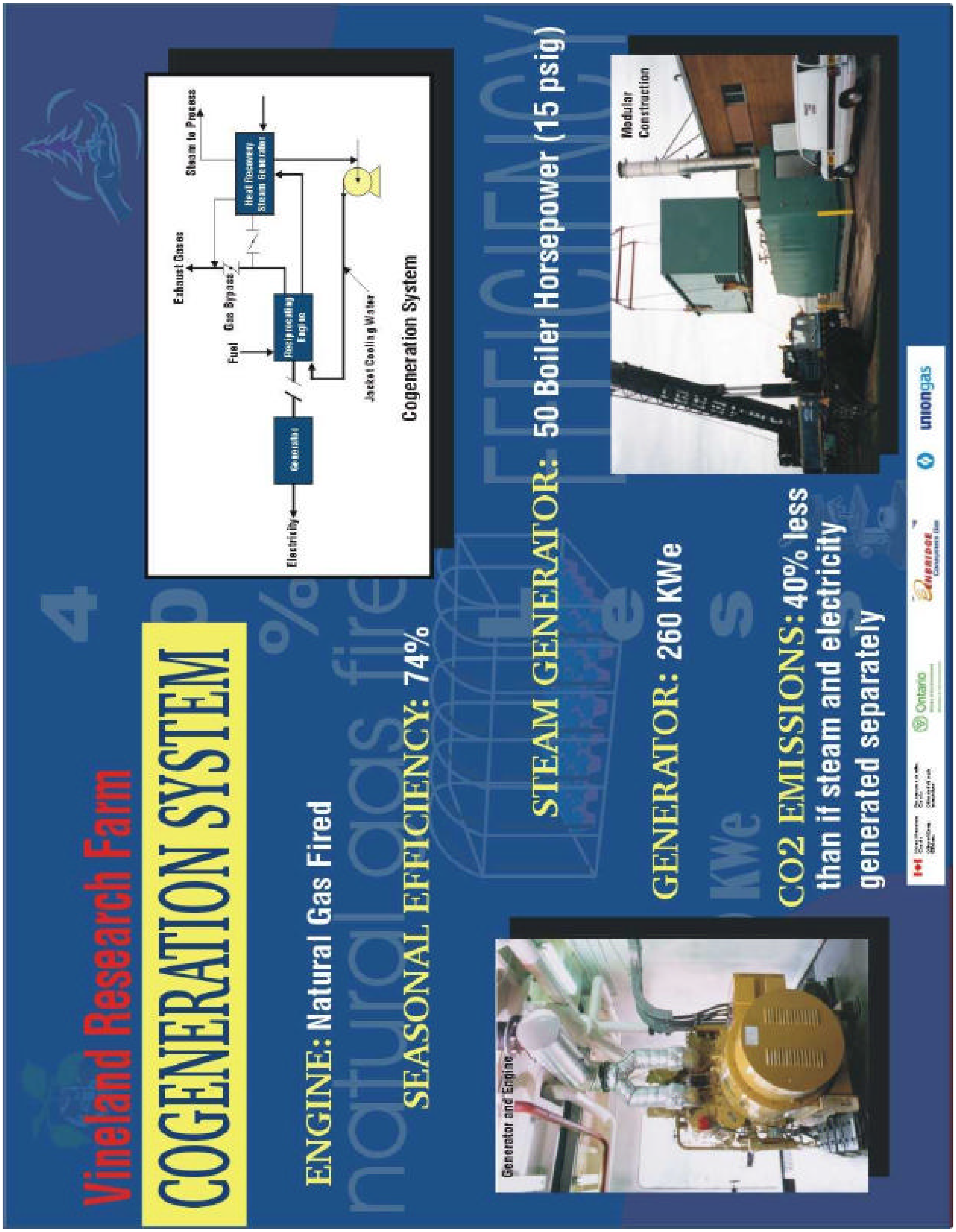
1. Heating source – Existing steam supply to be eliminated.
2. Environmentally friendly – Concern about increased local emissions affecting greenhouse atmospheres.
3. Limited space – No space in existing buildings.

The Solution

1. Cogeneration set – Natural gas fired, ebullient cooled 260 kWe generator, 50 Bhp steam generator capacity.
2. Unique containerized construction – Containers stacked, engine/generator on bottom, heat recovery boiler on top.
3. Two new boilers – One 100 Bhp, to meet load while cogenerator running, one 150 Bhp standby.
4. Standby boiler equipped with low-NO_x burners – 3% to 5% O_2: higher efficiency, and 40 ppm NO_x (3% O_2), firing natural gas: meets NO_x guidelines.

The Results

1. High efficiency – Cogeneration system overall efficiency: 74%.
2. High efficiency – Seasonal efficiency of 74% over 4 year operating record.
3. Low emissions – 2.2 million kg CO_2 per year, 40% less than if heat and electricity were generated separately.



Poster 7-3 Vineland Research Farm Cogeneration Installation