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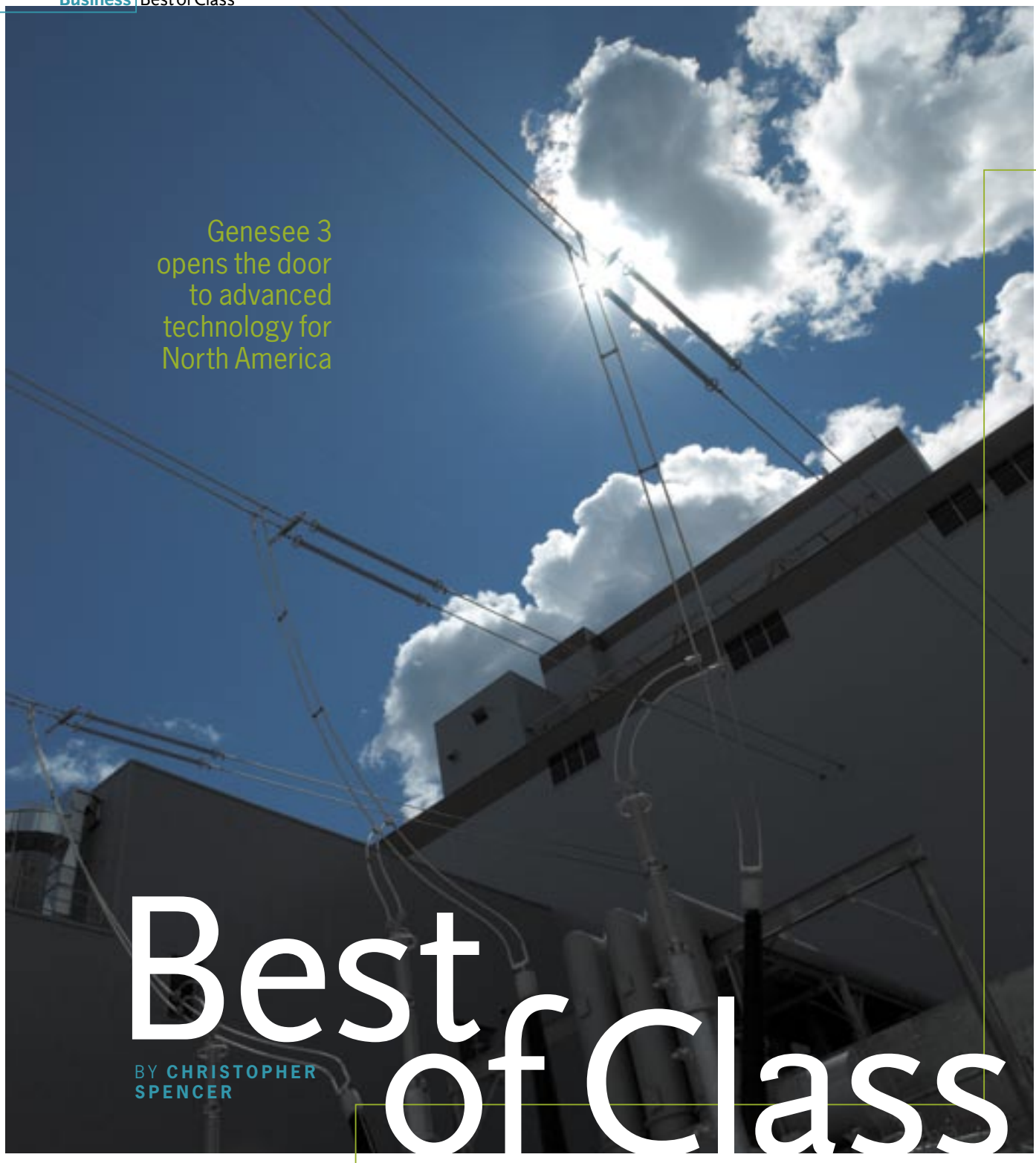


Genesee 3 opens the door to advanced technology for North America

Best of Class

BY **CHRISTOPHER SPENCER**

Thermal generating plants are shrouded in mystery, with most of the technology tucked behind thick, almost windowless walls. At Genesee 3, those walls also house a more intangible asset – the bright minds and enthusiastic attitudes that have made the facility the most technologically advanced in Canada.

Coal's reputation as an old-fashioned, labour-intensive fuel may create certain expectations, but most employees at the plant spend their shifts exercising their brains more than their muscles.

Tim Kennedy has worked at Genesee Generating Station since 1988, and is now the plant manager for the new unit. The technol-

PHOTOGRAPH BY JOHN GAUCHER

PHOTOGRAPH BY JOHN GAUCHER

Genesee 3 is currently operating more efficiently than the designers hoped.

ogy is impressive; I've never seen it in operation in any other similar-sized units," he says. "It's exciting to see the things we tried to get to work 15 years ago and couldn't. The technology wasn't there. The computer systems weren't there. But today, that level of technology exists."

Hitachi's supercritical boiler is the centrepiece of G3. Inside, temperatures reach 1,400 degrees Celsius. The extreme heat and high pressures support an extremely efficient burning process that uses less coal per megawatt hour than conventional thermal generating plants. Interestingly, the boiler does not draw heat from burning chunks of coal. To boost efficiency, the fuel is crushed, then pulverised into a fine powder. A high powered fan blows up to 210 tonnes of coal powder per hour into the boiler flame.

Steam from the boiler is 570 degrees Celsius and generates energy by driving a turbine that weighs in at 296 tonnes.

A $90-million investment in environmental technologies, and a unique commitment

Genesee History

Late 1950s The City of Edmonton purchases mineral licenses on 18,000 acres of land in Leduc County near the North Saskatchewan River

1976 A preliminary plan is presented to build a power plant at Genesee, 70 kilometres southwest of Edmonton

1982 Construction begins on the first unit, employing 800 temporary workers

July 1989 A heat wave hits Alberta, driving up power usage and forcing Genesee to begin operating at close to capacity ahead of schedule

April 1989 After two deferrals, power begins flowing from the Genesee plant

October 1989 Edmonton mayor Terry Cavanaugh officially opens Genesee adding 400 MW to the Alberta grid

June 1991 Public hearings are initiated on building another unit at Genesee

May 1992 Approval is received from the provincial government to begin work on the additional Genesee unit

September 1994 The new unit is officially plugged into the power grid, producing 400 MW of power.

November 2000 EPCOR announces plans to build a third generating unit at Genesee

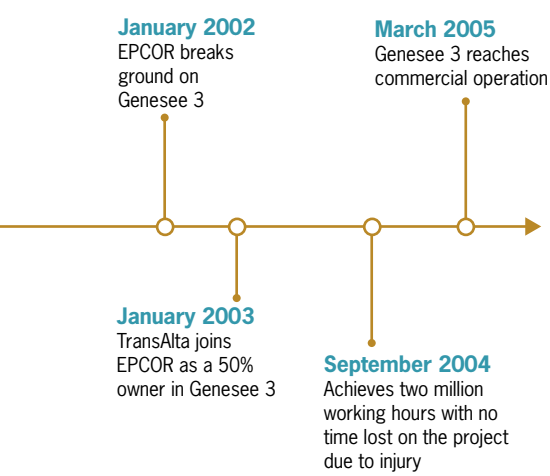
December 2001 Regulators approve the Genesee 3 expansion

to further offset greenhouse gas emissions, make G3 one of the most environmentally responsible coal-fired power plants on the continent. Two months into commercial operation, and Kennedy reports that G3 is operating more efficiently than the designers hoped.

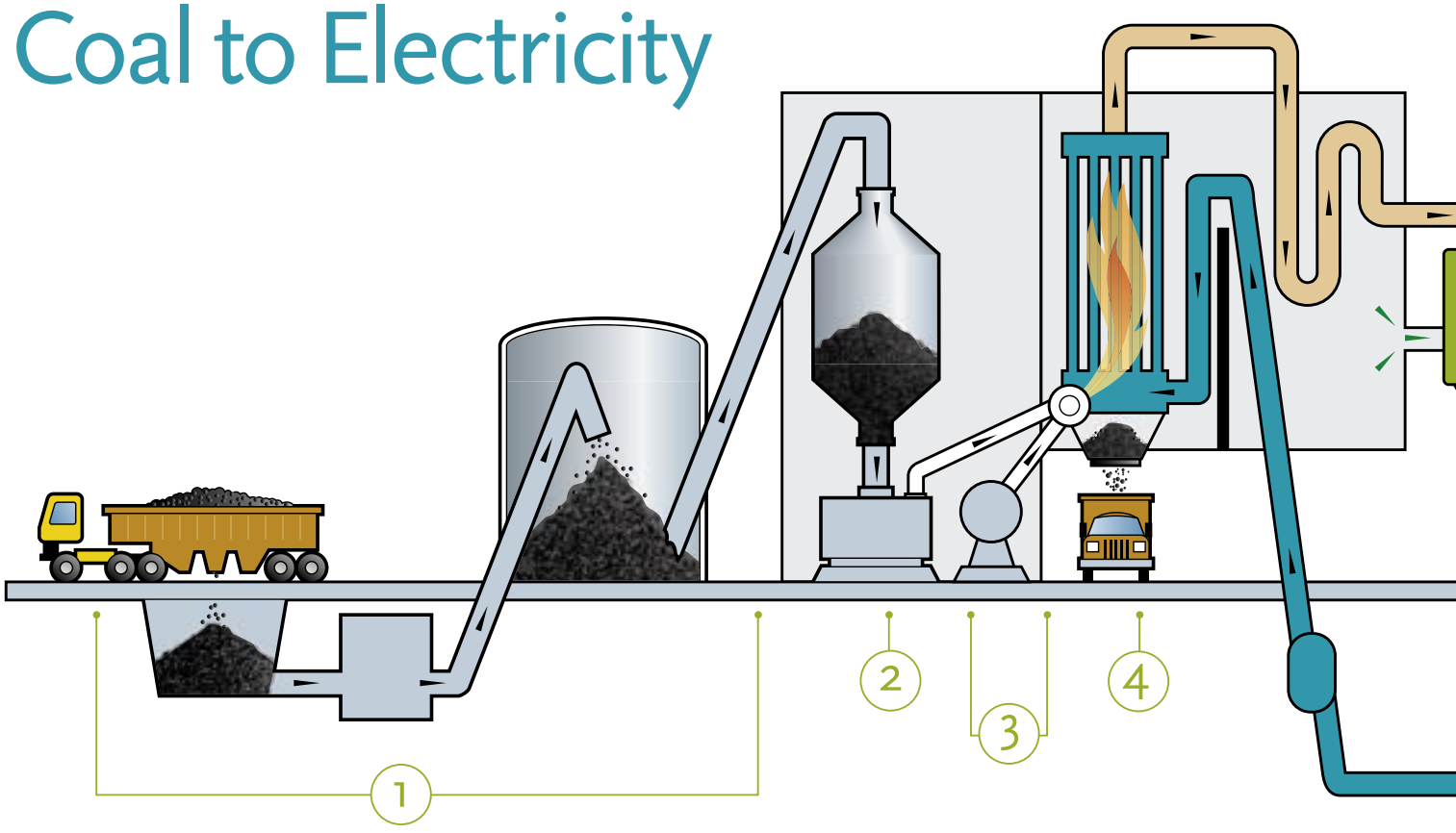
Leadership is what got G3 out of the ground. It is also a source of pride for the G3 crew. "The leadership we get, not just from the directors but also from the middle management, is outstanding," Kennedy says.

"The work that the project team and the suppliers of the major equipment did was really incredible, being able to pull it together so well, on schedule and on budget," says Ken Warren, EPCOR Generation's director of management services, and former Genesee 1 and 2 plant manager. "There were no environmental incidents at all during construction and the safety record was much better than the industry average. That's about as good as it can be."

For Warren, bringing on the third phase is indicative of a capacity for innovation. "I'm really proud of what EPCOR is doing and glad to be part of this organization because we are leaders in the field," Warren says. "This Genesee 3 unit is the first of its kind in Canada. That's been the history of our company since 1902; we have been leaders in our industry and we plan to stay in front." fp



How it Works:
Coal to Electricity



The fuel source is the Genesee Mine, owned by EPCOR and Luscar, which provides fuel for all three generating units at Genesee. Geologists estimate that 180 million tonnes of coal are recoverable from the mine, enough feedstock to generate power for another 40 years. Luscar operates the Genesee Mine.

1. Processing

- Coal is trucked to the processing area, where it is broken up into smaller pieces by secondary crushers. Conveyors transport the fuel on a steep journey to the top of bunkers inside the power plant building.
- The bunkers serve as storage facilities, accumulating fuel to keep the plant functioning and generating power if there is a disruption in the coal supply. Genesee 3 uses about 210 tonnes of fuel every hour.

2. Preparation

- From the bunkers, coal is pounded by pulverizing machines into a fine powder.

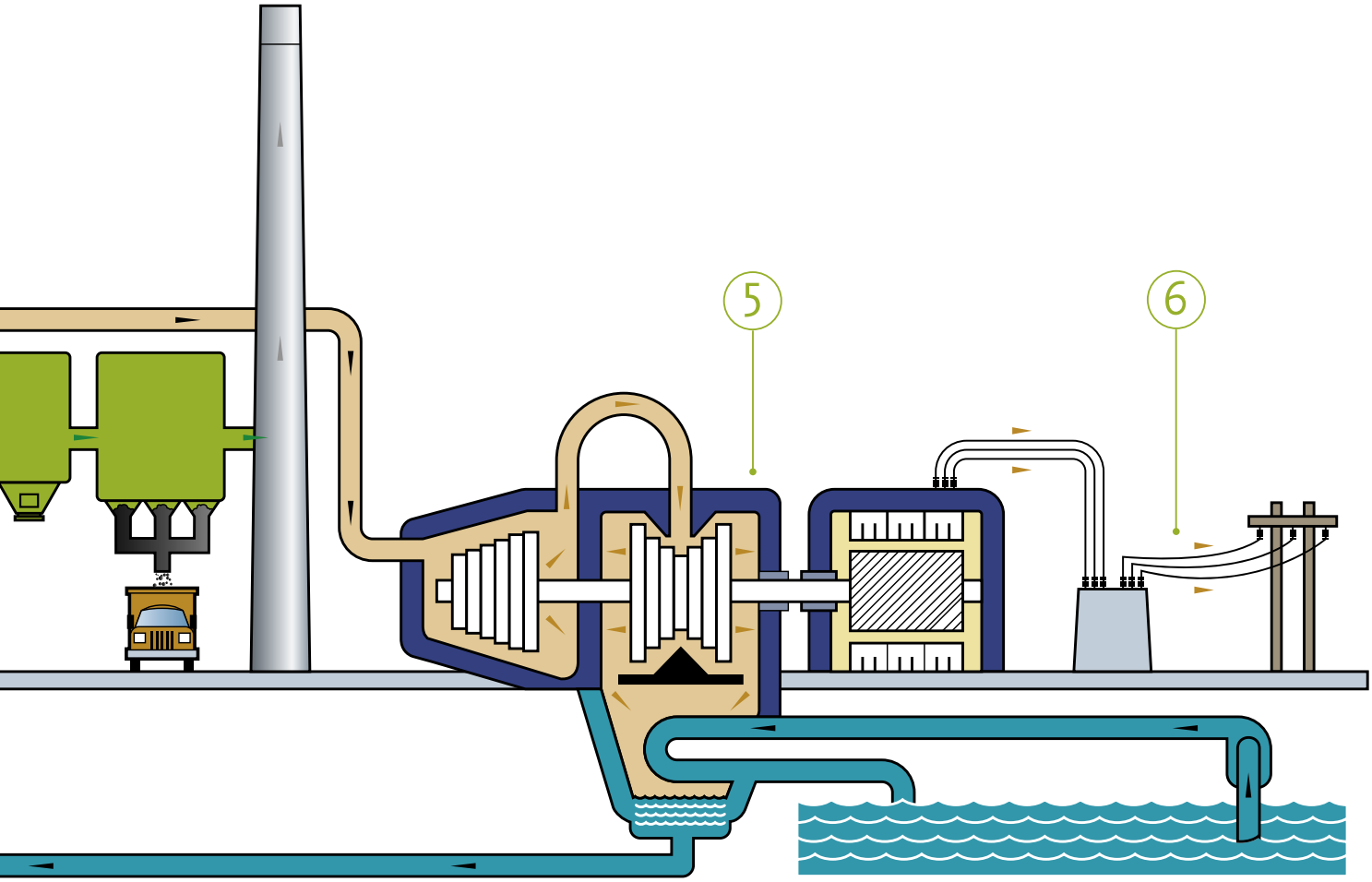
3. Injection

- The powder is forced into the furnace along a high velocity air stream generated by a large fan.

4. The Boiler

- The centrepiece of Genesee 3 is the most sophisticated boiler ever installed in a Canadian power plant. It features supercritical technology, where high temperatures and steam pressures efficiently convert thermal energy into electricity. In other words, the boiler uses less coal to generate more power, reducing emissions and improving environmental performance.
- The primary air fan blows coal dust from the pulverizing machines into the furnace, which can reach temperatures as high as 1,400 degrees Celsius. A secondary fan provides additional oxygen to ensure that combustion occurs in optimal conditions.
- Because of the extreme heat, water flowing through adjacent furnace tubes turns into steam so quickly that it doesn't even boil. Before reaching the turbine, the steam absorbs even more energy by passing through four additional super-heaters.
- At the peak of the heating process, the temperature of the steam is nearly 570 degrees Celsius. It is kept at a pressure of more than 26 megapascals, which is 50% greater than most thermal power plants and roughly 125 times the air pressure in an automobile tire.
- The cycle creates up to 1,450 tonnes of steam an hour.

ILLUSTRATION BY TREVOR JOHNSTON



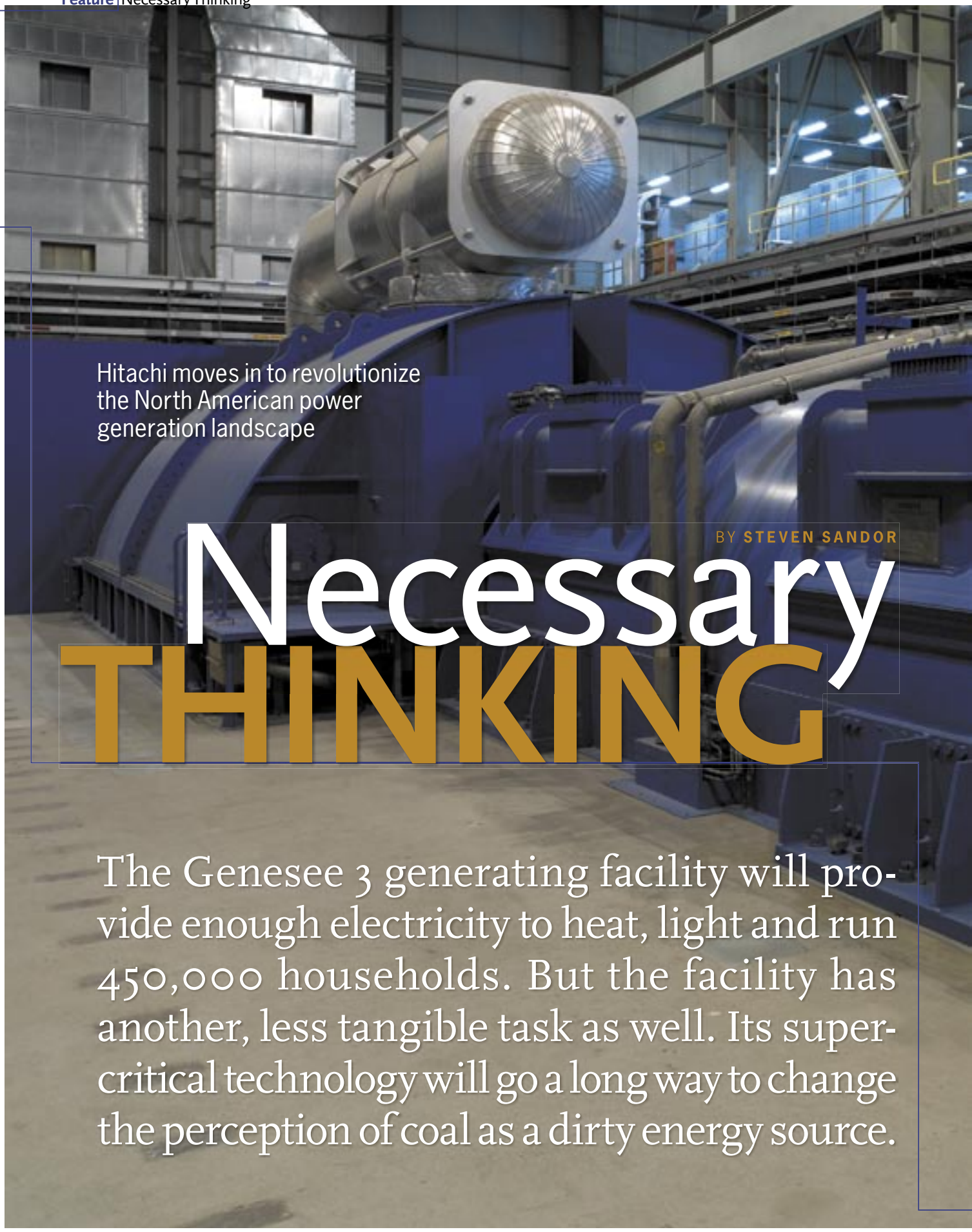
- The boiler is suspended from an "I" beam frame by a series of spring-loaded hangers. The bottom of the boiler is submerged in a trough of water, which maintains an air-tight seal and prevents flue gases from escaping into the power house.
- The water trough allows the boiler to expand as much as 30 centimetres at full temperature.

5. Generation

- Energy from the steam drives the high pressure turbine. Additional efficiency is achieved by capturing the steam and reheating it using hot gases which exhaust from the furnace. The reheated steam is then piped through an intermediate pressure turbine, where it gives up its remaining useful energy
- The turbines are essentially large rotary motors that turn the generator converting mechanical energy into electrical power.
- The generator exemplifies the relationship between magnetism and electricity. When a magnet rotates, it induces a series of electrical currents in wires. Together, all these small currents add up to millions of watts of energy.

6. Transmission

- To transmit the electricity, transformers convert the electricity to a higher voltage, which travels more efficiently over long distances. The current can then be sent out over transmissions line throughout Alberta via the electrical grid.
- Adding power to the grid is sometimes compared to a car merging in high traffic on a highway. The new electricity has to flow at the same speed as the rest of the current on the grid to avoid accidents. In North America, the speed limit for electricity is 240 kilovolts with a generator frequency of 60 cycles per second. This is the standard to which all power plants must be synchronized.
- At substations, the electricity is converted back to a lower voltage.
- The Genesee 3 unit generates about 490 MW of electricity, equivalent to 65,000 horsepower. Up to 40 MW are used by the facility itself, so the plant provides a net of 450 MW – enough power to keep the lights on in nearly 450,000 households.

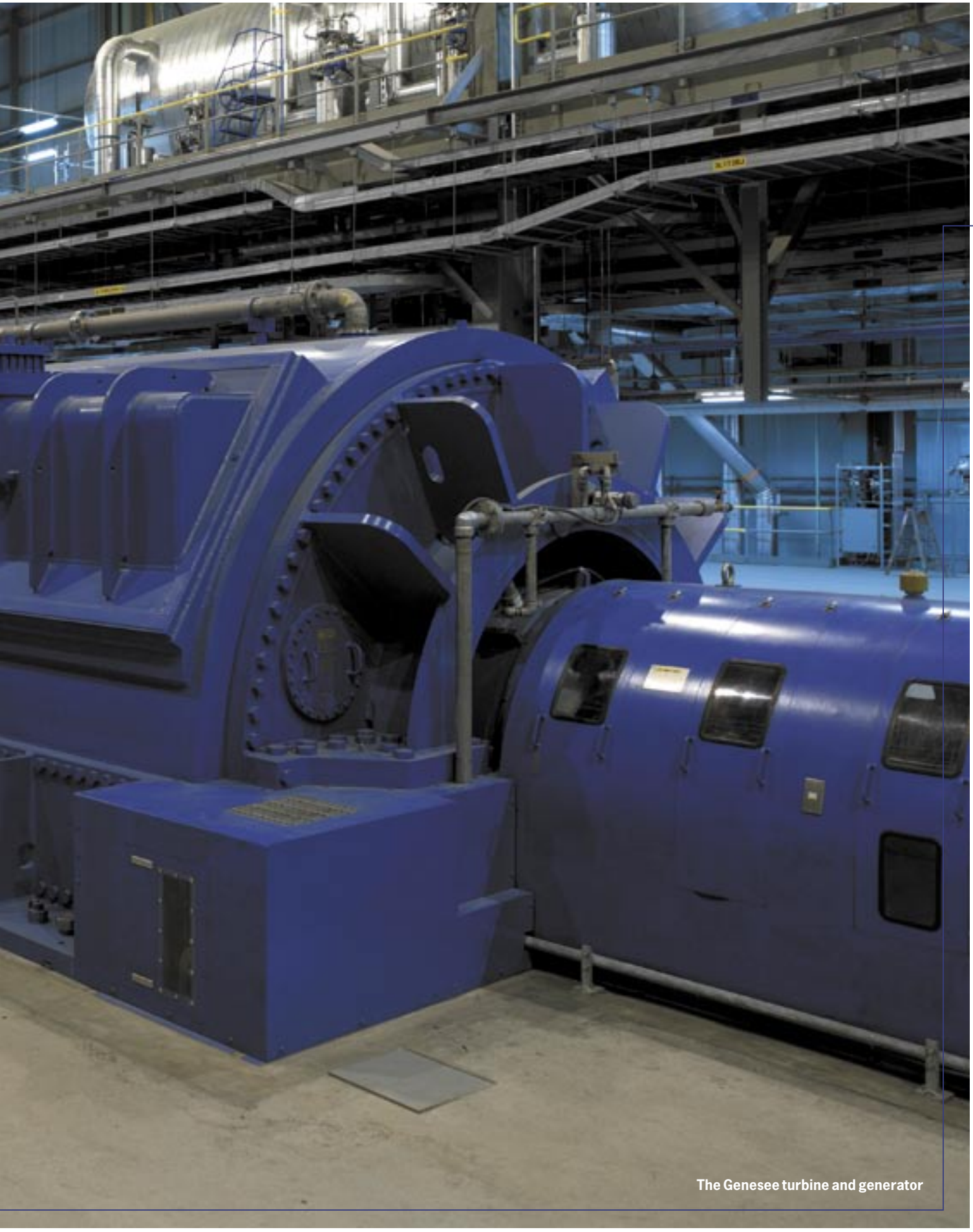


Hitachi moves in to revolutionize the North American power generation landscape

Necessary THINKING

BY STEVEN SANDOR

The Genesee 3 generating facility will provide enough electricity to heat, light and run 450,000 households. But the facility has another, less tangible task as well. Its supercritical technology will go a long way to change the perception of coal as a dirty energy source.



The Genesee turbine and generator

PHOTOGRAPH BY JOHN GAUCHER

> "What G3 has allowed us to do is to introduce best-in-class technology to this market."
>
> *Hitachi Canada president and CEO, Howard Shearer*

According to a report penned by Dave Conlin, EPCOR's project manager for the G3 power island: "Genesee 3 will emit CO_2 at a level 14.8% lower than the Alberta average for coal-fired plants. Sulphur emissions will be 57% below the Alberta standard and nitrogen emissions will be 54% lower than the existing Genesee units." Since writing that report, Conlin has found that G3 is actually exceeding those standards. "Can coal emissions be reduced to the same levels of natural gas? Not yet," says Conlin. "But coal is a more abundant resource than gas. And, compared to the old coal-fired plants, this one knocks their socks off when it comes to emissions."

But while this technology is on the cutting edge for North America, it's now the standard in Japan, the home nation of Hitachi – the industrial giant that supplied key components through its Canadian subsidiary for the 450 megawatt(MW) joint-venture between EPCOR and TransAlta. "It's the first plant of its kind in Canada, but it's not groundbreaking on a worldwide scale," says Jody Acton, Hitachi Canada Inc.'s project manager for G3. Hitachi provided the turbine, generator and boiler, incorporating the company's supercritical generating technology. So why is something that is so new to North Americans so old hat to the Japanese? While power-generating technology has moved forward at a steady clip in North America, it has been aggressively pursued in Japan. Acton explains after the power crunches of the '70s and '80s, there was a lull in demand for electricity, so there wasn't the urgency for new power generating technology in North America. Meanwhile, Japan – because it does not have natural resources to draw on like Canada but does have a large population thirsting for energy – needed to find more efficient ways to generate power. "Japan has to import all of its fuel. As a result, the need to maximize efficiency of power generation is paramount," Acton says. And that imperative has made Hitachi the world leader when it comes to providing critical components for electric utilities.

"In roundabout figures, when it comes to comparing this (G3) to the average coal-fired plant, it is 18% per cent more efficient," says Acton. "And it's 10% more efficient than the next highest efficient plant in Alberta, which is one of the other Genesee units."

The success of G3, the first power generating facility built in North America designed by an offshore firm, has spurred interest from utilities across North America. Hitachi has already entered agreements to build four out of the next five supercritical generating plants in North America. This list includes a facility currently under construction in Iowa for MidAmerican Energy Company. The plant will have an 880 MW capacity, almost twice that of G3.

"What G3 has allowed us to do is to introduce best-in-class technology to this market," says Howard Shearer, president and CEO of Hitachi Canada. Genesee 3 was not only a hallmark for North American power generation technology, but for how the project was managed. After a three-month period of pre-engineering that wrapped up in 2001, the project was put out for tender. In December, 2001, Hitachi was awarded the contract and construction began in earnest in January 2002. "Hitachi won based on their performance and their ability to be able to complete the project on schedule," says Conlin. "EPCOR went about searching for the best commercial technology available," says Shearer. "A lot of companies claim that their technologies are the best, so they certainly didn't take our word for it."

That presented a series of unique challenges for the Japanese contractor. Because the plans were drawn up overseas, Hitachi needed an Alberta engineer to certify that the work would comply with Alberta regulations. While this might not seem all that unusual to anyone inside the province, it provided for a cultural barrier for Hitachi to overcome. In Japan, the company has two-thirds of the supercritical generation business – when it designs a plant for the domestic Japanese market, very few obstacles are presented in approvals. Having to go through a rigorous approval process was new for a company that's considered the world leader in building machinery for power generation. "In Japan, the Hitachi name is enough," says Acton.

The sheer size of the project presented another challenge. "It's one thing to have a good product," says Shearer. "It's another to execute, to deliver a plant." With 2,100 workers

on the jobsite, 42 different contractors and 16 unions to work with, Hitachi's project managers also had to deal with scheduling and manpower issues. While Hitachi used components shipped from all over the world, including from plants in Saskatoon and Guelph, Shearer says that 95% of tradespeople employed on the jobsite were local. "This was the quickest construction of a plant this size in North American history," Acton adds. "One year ahead of schedule of any plant this size," he says. "We had workers on top of each other, different contractors working on different levels. And that presented many logistical and safety challenges."

Now that Genesee 3 is complete, it will begin to change the opinion of cynics that don't believe coal can be an environmentally responsible fuel for power generation. The breakthroughs Hitachi has made in burning coal more efficiently and cleanly are just the first steps in a renaissance for the resource.

"We hope it impacts the opinion shapers, who are the general public," Shearer says. "While G3 meets and exceeds current industry standards, we know that future generations will require even cleaner coal plants." In an era of spiraling increases in the price of oil and gas, coal is a more cost-effective alternative. Thanks to technological leaps forward, there is a future for coal not only as a cheaper energy solution, but one that looks to redeem its environmental reputation.

Genesee 3 is the North American proving ground for the resource. For the moment, G3 stands as the lone coal plant of its kind on this continent. But, with more supercritical plants on the way, it's not a title that is going to last very long. fp

It's one of the most abundant minerals on the planet – coal supports our way of life

The WHOLE Story

BY **K-M. TRATT**

The core of your battery, the lead in your pencil – these are derived from one of the most abundant elements known in the universe: carbon. Nearly 20% of the human body is made up of carbon, enough by some estimates to make 9,000 pencils.

Unique among the elements, carbon is in everything from graphite, one of the softest materials known, to diamonds, the hardest. Your body is made up of large parts carbon, oxygen and hydrogen – the same as an average lump of coal. The similarity could be organic: coal is formed from the original, leafy vegetation that appeared on our planet during the Carboniferous Period.

In the ensuing 300 million years there were several ice ages, droughts and mass extinctions. The Earth exerted intense heat and extreme pressure on the rotted vegetation, resulting in vast reserves of coal, which today exceed one trillion tonnes worldwide, enough to last 220 years at the current rate of global consumption. In comparison, proven oil and gas reserves could be depleted in less than half that time.

Our ancestors started taking advantage of coal 4,000 years ago. Abundant and accessible, coal is the stuff of the Industrial Revolution. Coal fueled the railroad and the expansion of Canada. Oil and gas often come to mind when you think of Alberta, but coal is the largest egg in Alberta's energy basket. Vast reserves of bituminous and sub-bituminous coal, some of the hardest and best available, have played a major role in the province's history, ever since the opening of the No. 1 Mine in the valley of Canmore Creek in 1886.

By the 1920s, there were hundreds of mines in the province, now there are fewer than 10. Nearly all of Alberta's mining activity is conducted above ground in open-pit and strip mines. Massive equipment and modern technology have changed the nature of the work,

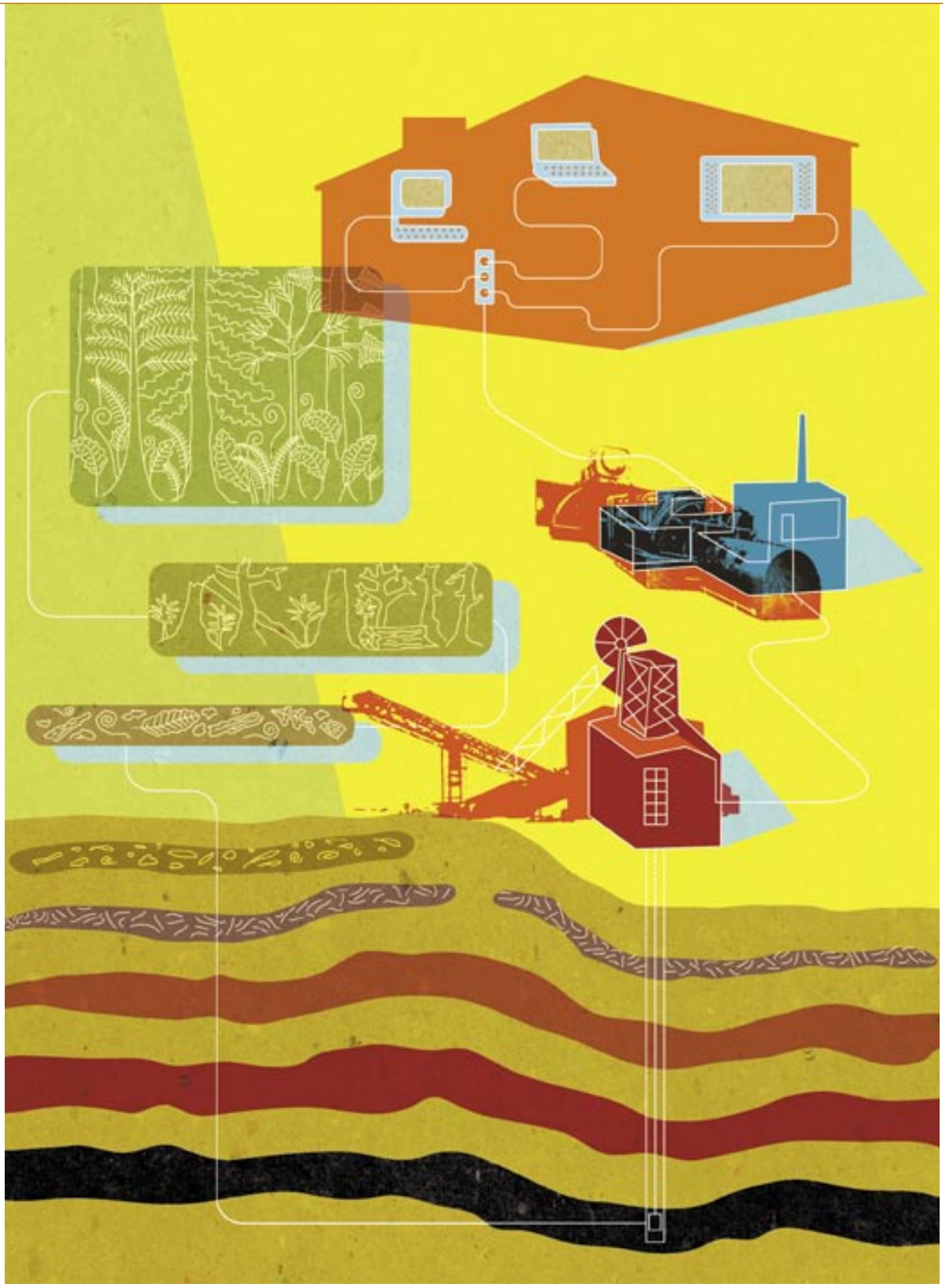


ILLUSTRATION BY OTTO STEININGER

> "With clean coal technology, there has been a kind of coal renaissance."
>
> *Executive director of the Alberta Chamber of Resources, Brad Anderson*

and the image of red-eyed miners covered in black soot is as outdated as the chimney sweep in *Mary Poppins*.

Coal is second only to oil as the world's energy source. Approximately 70% of the world's coal production is thermal coal, used to generate 40% of the world's electricity; 12% is made into metallurgical coal, also known as 'coke', to produce 70% of the world's steel. Coal is also involved in a variety of other industries, such as cement production. Alberta's coal deposits are some of the most extensive in Canada, and account for 45% of the coal produced in the country. The coal mines of Nova Scotia are also vast, spreading miles under the ocean.

Alberta used 42% of the coal consumed in Canada and is followed by Ontario, at 32%. In Alberta and Saskatchewan, the majority of electricity is generated from coal, where it is an affordable, reliable, long-term fuel source.

Early in the new millennium, 3.1 billion tonnes of coal are produced worldwide, the largest producers being the United States, China and India. Canada produced 66.6 million tonnes of coal, 40% of which was metallurgical coal destined for 20 different countries. Most of the thermal coal produced here is used domestically. Exports of Canadian coal bring in $2 billion annually to federal coffers, and the coal industry overall enriches our economy by $5 billion a year.

"The U.S. depends on coal more and more for their power generation," says Allen Wright, executive director of the Canadian Coal Association. "Fifty-two per cent of their power is generated by coal, compared to Canada, where it's 18% to 19%," he says. "If you look at the production and consumption of coal in North America, it's about even. Oil and gas, however, are way out of whack. The U.S. consumes a lot more than they produce."

As the hunger for energy grows, so does the appetite for coal, which leads to advances in technology, such as EPCOR and TransAlta's Genesee 3 generating facility, which began commercial operation in Alberta in March of 2005. Its supercritical burner uses less coal per megawatt hour of electrical energy, meaning we get more electricity but burn less fuel.

"The actual mining side produces a relatively small amount of greenhouse gases, maybe 3%," Wright says. "In the coal chain, from mining to consumption, the problem arises during the burning of coal for electrical purposes."

Greenhouse gases result when coal is burned to create the steam to power a turbine for power generation. But leading edge technology reduces emissions.

"With clean coal technology, there has been a kind of coal renaissance," says Brad Anderson, executive director of the Alberta Chamber of Resources. "In Alberta it never stopped. I grew up in Edmonton, and I didn't connect the dots that every time I used a light switch, the power comes from coal," he says. "It's a simple matter of Albertans not being educated about coal and where our power comes from. They don't make the connection either, but coal is why our standard of living is where it's at." fp

Environmental nightmare turns into a clean dream on the west coast

Disaster RELIEF

BY **ROBIN BRUNET**

Jutting like a metal and glass fortress from a hillside near Squamish, British Columbia, the abandoned Britannia Mine facilities were reduced to being a film and television location for Hollywood, most notably as a hideout for aliens in *The X-Files*. The complex is otherwise a pit stop for tourists driving from Vancouver to Whistler, and for locals it's a painful reminder of how harmful old mining operations can be to the environment.

Exactly how harmful? Environment Canada calls Britannia "the single worst source of pollution in North America." And before EPCOR Utilities was retained to treat acid water runoff from the site, reclamation of the mine was thought to be too expensive to be feasible.

But earlier this year, the B.C. government chose EPCOR to design, build, finance and operate an acid water treatment facility at the site. In addition to treating contaminated runoff flowing into Howe Sound, the facility dovetails an extensive rehabilitation plan for Britannia Beach, which boasts a population of 300 people. The plant is expected to be operational by November 2005, none too soon for a community and a government that has received unwanted media exposure for the on-going damage the mine is causing to the ecosystem.

Located 48 kilometres north of Vancouver, Britannia was once the largest copper mine in the British Empire. It was discovered in the late 1800s and operated from 1902 to 1974 by the Britannia Mining and Smelting Company. It was subsequently run by the Anaconda Mining Company. In its heyday, the mine consisted of 160 kilometres of tunnels and five open pits.

The process of excavating ore and waste rock exposed pyrite and iron sulphide miner-

MINE AND RECLAIM: *Britannia Mine in operation. Below: Rendering of EPCOR's water treatment facility.*

TOP: COURTESY OF BC MUSEUM OF MINING; BOTTOM: COURTESY OF EPCOR

als to water and air, creating sulphuric acid. It resulted in a runoff, known as acid mine damage (AMD) and triggered a domino-style series of problems. It dissolved many metals found in surrounding rocks and soil, such as copper, zinc and cadmium. These water-laden metals in turn flowed into nearby creeks, streams and eventually the ocean, where the high toxicity proved to be devastating to aquatic organisms. This is of special concern to the Department of Fisheries and Oceans, since the shorelines of Howe Sound are important habitats for Chinook and Chum salmon, rockfish, sole, crab, mussels and prawns. When Chinook smolts were held in cages near Britannia Creek, they all died in less than 48 hours.

"We're mostly worried about the presence of copper, which is a powerful biocide," Dave Rector, director of operations for EPCOR Water, says. "So powerful, that the old sailing ships used to be coated with the metal because it killed barnacle growth."

As recently as 2000, the Environmental Mining Council of British Columbia lamented the prevention of AMD at the mine site as impossible. The only other option to treating the runoff before it comes in contact with fish would be exorbitantly expensive, it says. The mine's owners, Copper Beach Estates Ltd. (CBEL), proposed to turn the site into a gigantic landfill that would plug the open pits at the top of the mine workings and pipe the contaminated waters away from Britannia Creek.

EPCOR's involvement is a partnership between the company and the Ministry of Sustainable Resource Management (MSRM). The company was selected for the clean-up task earlier via a competitive process among six different teams, and it has been assisted in the design and construction phase of the project by Lockerbie Stanley Inc, Stantec Consulting Ltd. and BioteQ Environmental Technologies Inc. Ground officially broke on the project in March.

Rector outlines how the treatment facility will work. "Simply put, we'll channel the water into tanks and treat it with lime, which will raise its pH level and precipitate lime sludge," he says. "The sludge will enter a filter press and be de-watered. Meanwhile, the treated water will be re-routed into Howe Sound."

The Britannia project is especially noteworthy because of EPCOR's commitment to green building design. "The effluent is located substantially higher up the hill than our plant, so we decided to install a turbine that will – depending on water flow rate – produce 20% to 40% of the plant's electrical requirements," Rector outlines. "We're also embarking on pilot programs to recover metals in the lime sludge and sell them on the market, as well as

> "Partnerships like the one at Britannia Mine are a great way for governments to provide the best value for the project and for the public."
>
> *B.C.'s small business and economic development minister, John Les*

make lime blocks from the sludge," he adds. "Our goal is to uphold the three Rs of environmental philosophy: reduce, recycle and reuse." EPCOR is also exploring the feasibility of using geothermal energy imparted by the polluted water in order to heat and cool the treatment facility. And with an eye towards public appeal, a 1,200-square foot visitor's centre will also be constructed on-site.

EPCOR is financing the design and construction and will operate the water treatment plant for 21 years, while the B.C. government will contribute performance-based payments to the company. The life cycle cost of the project is $10 million less than the estimated cost of completing the plant through traditional methods.

There are other benefits to the partnership approach. Life cycle savings are achieved thanks to the experience brought to bear by EPCOR. Process innovation reduces costs by minimizing the amount of chemicals needed to treat the water and reduces electricity costs thanks to the on-site hydro generation plant. The partnership also ensures regulatory compliance by transferring the risk of financial penalties for non-compliance to EPCOR. "Partnerships like the one at Britannia Mine are a great way for governments to provide the best value for the project and for the public," says small business and economic development minister John Les. "It builds on private sector creativity and innovation and delivers results."

Les is particularly enthusiastic about the fact that the advent of water treatment at Britannia has helped inspire a community-wide revitalization. As Squamish/Lillooet regional district chair and Britannia Beach area director John Turner puts it, "The building of this plant has opened up new opportunities and ensures the future of Britannia Beach. Sustainability and sustainable communities are key objectives in the development of our regional growth strategy."

Redevelopment in Britannia Beach has already begun, with Britannia Bay Properties renovating existing homes and historic buildings, building new roads, adding services and, last summer, selling 90 new lots for development. The developer and the province have a remediation agreement and the developer will contribute to a clean-up fund through the sale of new lots.

Although EPCOR's team of professionals are committed to creating the best possible success scenario for Britannia Mine, Rector points out that the company is heavily involved in a wide variety of projects throughout the Pacific Northwest. "We operate a waste water treatment plant in Port Hardy and are presiding over the construction of a waste water collection system in Sooke," he says. "We're also involved in the purchase of the Breakwater water system in Parksville/Qualicum Beach as well as the water system in White Rock."

EPCOR provides the Greater Vancouver Regional District (GVRD) its expertise in advanced water treatment systems to ensure that the GVRD's Seymour-Capilano filtration plant operates efficiently and produces exceptional levels of water quality. South of the border in Washington state, EPCOR purchased the Frederickson Power facility in 2002, making this the first such power plant to come on-line in that state following the 2001 energy crisis. fp