"CURRENT" EVENTS

How can nuclear technology be applied to generate more electricity for Ontario … and the world?

J. M. Cuttler

A change in our current course is appropriate in light of the projected shortage of electricity generating capacity in Ontario. The August 14, 2003 blackout revealed that "nothing works without electricity." Rapidly escalating energy costs are clear evidence of this, as oil supply and demand move out of balance. This leads to an increased demand for natural gas (which is also being used to generate increasing amounts of electricity in the U.S.) and to the extraction of increasing amounts of oil from the Alberta tar sands.

Ontario is also turning to gas-fired power generation, which escalates in cost as we bid against the Americans for limited supplies of gas. Increasing electricity prices damage the Ontario economy. Businesses are forced to close or move to other provinces. Increased use of nuclear energy could be part of the solution to these problems.

Most Ontarians have supported nuclear energy use for the last 30 years. That support has declined recently due to the negative images being disseminated about nuclear technology. There are relatively few positive messages—especially about nuclear power. As a result, the Ontario government seems reluctant to urge the refurbishment of old nuclear plants (such as Pickering NGS) and the construction of new ones.

Generally, the negative images are not factual. They have been designed to shift public opinion away from support of nuclear energy. Such a shift would result in decisions that would lead to phasing out nuclear generation in favour of wind and gas-fired generation. Windmills operate irregularly—only about 20 percent of the time. They require a back-up—typically more gas-fired generation. This article provides factual information about nuclear energy as it relates to clean

The Pickering nuclear generating station is focusing on plant life maintenance and life extension.

Emissions of radioactivity are typically more than a hundred times *below* the regulatory limits

environment, affordable electricity, sustainability, and social acceptance.

Clean environment

The mining and processing of uranium ore into nuclear fuel are, of course, carried out in accordance with Canadian regulations. Nuclear power plants, under strict regulations, provide more than half of the electricity used in Ontario. The environment around these plants is very clean, *especially* the air. Emissions of radioactivity are typically more than a hundred times below the regulatory limits.

Those who advocate nuclear phase-out have created an issue about the management of the small volume of used fuel from 30 years of electricity supply. They raise concerns about the potential release of radioactivity far into the future. The used fuel is stored at our nuclear sites in robust, sealed containers, made from steel and reinforced concrete, which will remain leak tight for thousands of years. Long before then, future generations of Canadians will recycle the used fuel in advanced nuclear reactors to release the vast amount of energy that still remains in this fuel. In these breeder reactors, the long-lived radioactivity will be transformed into much shorter-lived radioactivity, which will also be managed safely. The amount of this material is small compared with the amount of naturally radioactive material already in the soil we cultivate, the water we drink, and the air we breathe.

Affordable electricity

The cost of electricity from nuclear plants, which includes allowance for plant decommissioning and managing the used fuel, is comparable with the cost of electricity from coal-fired plants. The cost is much lower than the cost electricity from gas-fired plants. With the restoration of capacity factors to levels in excess of 80 percent, Ontario Power Generation (OPG)'s partial unit electricity cost for nuclear power has improved to about 4 cents/kWh (with a target of 3.5 cents/kWh in 2006). OPG receives about 5 cents/kWh. Without these nuclear plants, the average cost of electricity in Ontario would be comparable to the average cost in the State of New York or Michigan—about twice as high as the 5 to 5.8 cents/kWh we currently pay.

Anti-nuclear activists focus on the high capital cost of nuclear power. Current plants cost about $2,000 per kilowatt of capacity and they last more than 25 years before refurbishment is needed. Since the average home uses approximately a kilowatt of power, a homeowner's share of the capital cost of our nuclear plants is about $2,000. This is roughly the same cost as a home gas furnace or a central air conditioner. The capital cost of a nuclear plant would appear affordable if it were presented in this manner. A way has to be found to pay for nuclear plants in the same period of time that homeowners pay for their gas furnaces and air conditioners.

If stable conditions were assured, the potential for significant profit would induce businesses to invest in nuclear plant construction. Advances in technology over the past 30 years enable the capital cost of future plant to be reduced. Because of low fuel costs, the operating cost of nuclear plants will remain below the operating cost of gas-fired plants. Ongoing improvements in nuclear plant management are reducing operating costs.

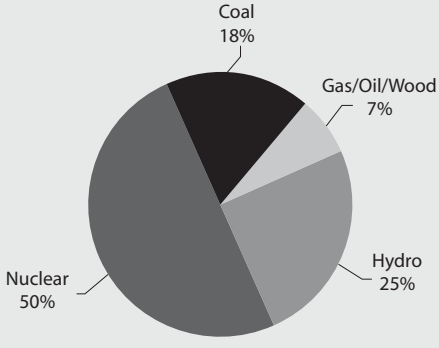
Sustainability

Just one CANDU fuel bundle, 10 cm in diameter and 50 cm long, provides the electricity consumed by an average household for about 100 years. Because current reactors fission only one percent of the nuclear fuel, an enormous amount of energy remains in the used bundles. Within a century, it will likely be economical to build advanced reactors and recycle our used fuel.

How long can nuclear energy sustain us? Bernard Cohen has pointed out that the usual assessment of the world's uranium resources, lasting a few thousand years, is based on the quantities available at the current market price.[1] Using breeder reactors, it will be economical to extract uranium from the oceans and still keep the fuel cost below one percent of the cost of electricity. This fuel supply is sustainable because new uranium is being carried into the seas by rivers, allowing at least 6,500 tonnes of uranium to be withdrawn each year. This amount is adequate to generate approximately ten times the world's present electricity usage. Fission of uranium is consistent with the definition of a "renewable" energy source in the sense in which that term is generally used.

Nuclear power is generally regarded as a low-cost source of "base load" electricity with hydro and fossil plants employed for "peaking." But naval reactors are designed to "load-follow," and nuclear plants can be built to do the job of the coal-fired plants.

ELECTRICITY GENERATION IN ONTARIO (2004)



Source: Independent Electricity System Operator (Ontario)

Social acceptance

For more than 30 years, Ontarians have accepted nuclear power to supply a large fraction of their electricity. It supplied two-thirds in the early 1990s. The rise of environmentalism brought prominent, ongoing efforts to discredit this technology. Provincial government actions impaired Ontario Hydro's capability to manage its nuclear plants. This was compounded by employee culture and management problems, which impacted negatively on plant construction and plant life management. Such problems are common in many large organizations and damage their performance. Strong corrective measures have been taken that are restoring excellence and public confidence in our power utility.

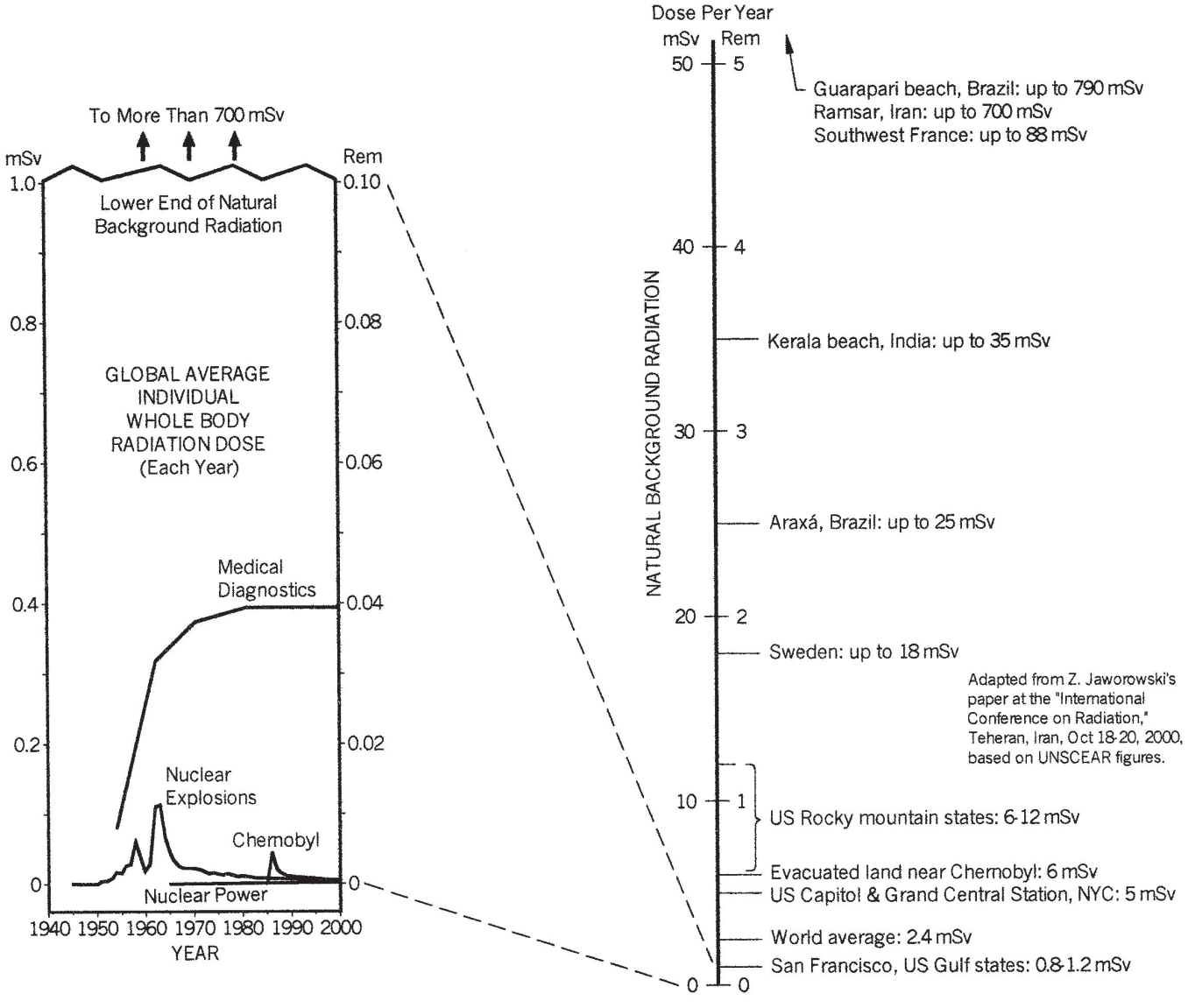


Figure 1. Comparing human-made radiation with natural radiation[6]

There are many examples of well-managed nuclear projects, including Canadian ones. Nuclear stations worldwide are generally very well managed, but this good news does not attract media attention. Technical problems have been identified over the past 30 years, in this relatively new technology, and solutions to all of these problems have been found. The operating lives of many nuclear plants have been and are being extended. This positive message needs to be shared with the public for continued social acceptance.

An unwarranted scare has been created about the safety of our nuclear plants. Analysis of plant design and operation over more than 30 years has demonstrated that nuclear power is a very safe method of generating electricity. Concerns have been raised from time to time about potential exposures to ionizing radiation from the reactors. Plant workers receive radiation exposures that are well below harmful levels, and any radiation received by nearby residents is a tiny fraction of the natural radiation they receive. Figure 1 compares natural with human-made radiation.

An enormous amount of research has been carried out on the effects of radiation on health for more than a century, and radiation is used extensively in medicine. The radiation level below which *no* adverse health effects have been observed is well known[2,3], and employee exposures are maintained below this level. Biologists know that the greatest cause of cell damage (many orders of magnitude greater than other natural causes) is the oxygen we breathe. All living organisms have a damage-control biosystem that prevents, repairs, and removes cell damage, or they would not survive very long. Radiation biologists know that a *low* dose of radiation (less than about 0.30 Gy)* increases the activity of this biosystem (resulting in *less* cancer incidence), while a high dose of radiation decreases the activity of this biosystem (more cancer). There is extensive evidence of beneficial health effects (radiation hormesis) following

* 1 Gray = 1 joule of radiation energy per kilogram of living tissue

exposures to low doses and low dose rates of radiation in every living organism.[4]

Theodore Rockwell[6] points out that the nuclear community agonizes over its inability to communicate its message to the public, but it cannot overcome a basic problem. "Our credibility is continually undermined by ostensibly authoritative statements that no amount of radiation is small enough to be harmless and that a nuclear casualty could kill as many as hundreds of thousands of people. *That* message we *have* communicated, and therefore the public and the media are not wholly to blame for the resulting public fear of radiation and all things nuclear. We cannot expect people to believe our assurances of safety so long as we acquiesce in terrifying messages to the contrary. … Although the case is persuasive that the worst realistic nuclear casualty is less harmful than that of nuclear power's serious competitors, the evidence has not yet been assembled into an overall documented statement and evaluation. … The action urgently needed now is to prepare the case, and then discuss it within our own ranks. … Until that happens, the status quo will prevail.[5]"

References

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2. Health Physics Society, "Radiation Risk in Perspective," Position Statement January 1996, and reaffirmed March 2001, www.hps.org/documents/radiationrisk.pdf.
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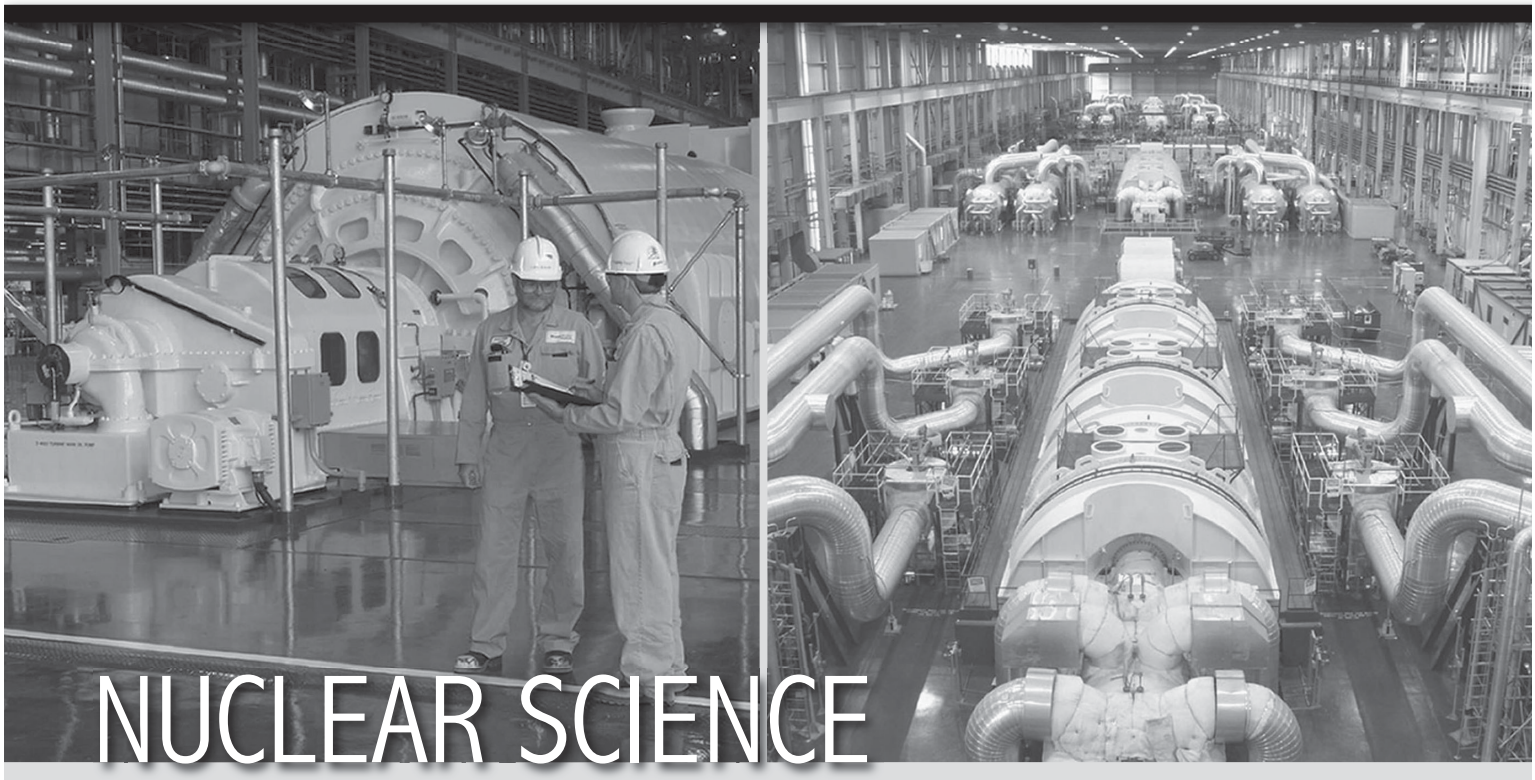
5. Rockwell T., "The Realism Project: It's Time to Get Real," American Nuclear Society, *Nuclear News* December 2004, pp 10–12.
6. Rockwell T., "Creating the New World: Stories and Images from the Dawn of the Atomic Age," (Bloomington, Indiana: 1st Books Library, 2003), Figure 7.1, p. 150.

Jerry Cuttler, DSc, PEng, FCNS, led a team that designed the reactor control, safety system, and radiation instrumentation for the CANDU 6, Pickering B, and Bruce B electricity generating stations for Atomic Energy of Canada Limited (AECL). He is a longstanding member of the Canadian Nuclear Society Council and was president from 1995 to 1996. For the past ten years, Cuttler has assessed the effects of ionizing radiation on health and has drawn widespread attention to the beneficial effects of low doses. He retired from AECL in July 2000 to form Cuttler & Associates Inc. and provides consulting services.



NUCLEAR SCIENCE

Nuclear science has contributed to the development of technologies that benefit Canadians and people around the world every day. Apart from electricity production, nuclear science has applications in medicine, scientific research and biotechnology, agriculture, and industry. Some of the most common consumer products rely on nuclear technology for their efficiency and reliability, such as calculators, computers discs, smoke detectors, and even cosmetics!

Learn about this and much more at www.aecl.ca.

Photos courtesy of Bruce Power