Uranium

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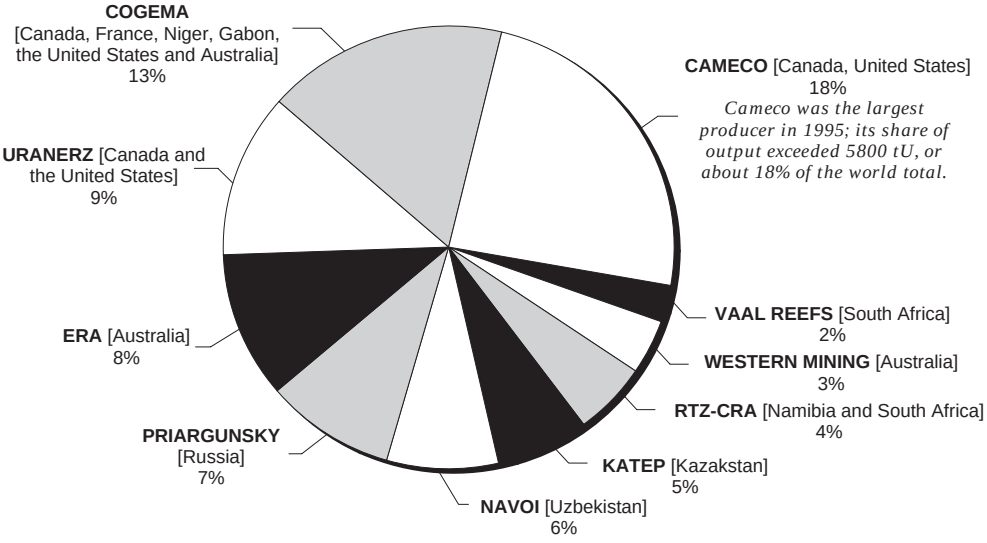
OVERVIEW

The outlook for Canada's uranium industry improved somewhat in 1996. In the early part of the year, uranium supplies continued to be limited. Spot prices began to rise as uranium consumers turned to primary producers for increasingly larger amounts of uranium. However, despite the continued drawdown of Western inventories, the rise in world uranium spot prices stalled late in 1996. Some believe that primary uranium output has reached dangerously low levels and that prices are insufficient to warrant the significant levels of new exploration deemed necessary to replenish resources as primary production increases in the West. Others dismiss such concerns, pointing to offsetting factors such as the development of new uranium production centres around the world, and the increasing availability of uranium from the former Soviet Union (FSU) and from surplus military material in both the FSU and the United States. Any constraint on increasing global uranium production will be related to an inability of primary producers to augment supply. Mine expansions and new production capacity are more likely to be hampered by non-market forces such as regulatory and environmental constraints. Supply shortfalls will have to be filled from non-traditional sources, including FSU material, military or otherwise.

Nonetheless, Canada's uranium industry continues to prosper. Primary production increased to an estimated 11 700 tonnes of uranium (tU), its highest level in eight years. As shown in Figure 1, Canada

Figure 1
World's Top Ten Uranium Mining Companies in 1995



These 10 companies accounted for about 75% of 1995 world production, which totalled some 33 275 tU.

Source: Uranium Institute Pocket Guide, November 1996 [revised] .
Note: Ranking reflects equity interest in production facilities, not market share.

hosts three of the world's top ten uranium-producing companies. Development work is proceeding on schedule at the McClean Lake project, which will become Canada's first new uranium-producing operation since the Key Lake mine began production in 1982. If approved, the Cigar Lake and Midwest projects will send ore to the McClean Lake mill, where combined annual uranium production could exceed 9000 tU, and the McArthur River project will provide ore for the Key Lake operation, greatly extending its useful life and allowing an increase in output to 6900 tU/y.

While well below the near-record volume of some 20 500 tU in 1995, the level of new export contracts signed by Canada's uranium marketers in 1996 reached 10 850 tU. The decrease reflects the fact that new business was well below normal in 1992 and 1993, and was catching up in 1994 and 1995.

As of January 1, 1996, known uranium resources in Canada were increased to an estimated 490 000 tU, due largely to the exploration successes at the McArthur River project in Saskatchewan. Follow-up exploration at McArthur River has significantly upgraded resources from 100 000 tU averaging 4.2% uranium to 160 000 tU averaging 12.7% uranium. Mineable reserves now total 73 000 tU averaging 16% uranium. As less than 20% of the mineralized structure at McArthur River has been drilled in detail from underground, the potential for expanding total resources is considered to be excellent.

DOMESTIC PRODUCTION AND DEVELOPMENTS

Estimated primary output from Canada's four uranium-producing operations in 1996 is 11 700 tU, up about 11% from 1995 production despite the closure of Rio Algom Limited's Stanleigh mine at Elliot Lake, Ontario, at the end of June (see Table 1). Overall employment at these operations fell to 1100 due to the Stanleigh closure. As indicated in Table 2, preliminary estimates of 1996 mine shipments, under all domestic and export contracts, increased in tonnage and value compared with the revised 1995 estimates. Uranium continues to rank sixth among Canada's top ten metal commodities in terms of output value. Table 3 highlights the main operational characteristics of the existing uranium production centres in 1995, the most recent year for which complete data are available. Table 4 updates the status of new projects that represent Canada's future production capability. Figure 2 locates Canada's producing uranium mines and major deposits, and Figure 3 shows domestic production by project and owner for 1995.

Elliot Lake, Ontario

On June 30, 1996, Rio Algom Limited closed its Stanleigh operation as planned, winding up 40 years of uranium production at Elliot Lake. In the first half of 1996, Rio Algom shipped an estimated 400 tU from the Stanleigh operation to Ontario Hydro. Ontario Hydro had originally contracted to buy some 29 000 tU and 48 000 tU from Rio Algom and Denison Mines Limited, respectively, but ended these contracts in 1991.

Also in June, the Elliot Lake Environmental Assessment Panel submitted its recommendations to the federal government concerning plans by Rio Algom and Denison to decommission their mill tailings sites in the Elliot Lake area. The Panel agreed with the decommissioning proposals set out by Rio Algom and Denison, and its recommendations are not expected to change the estimated costs for closing and reclaiming the Quirke, Panel, Denison and Stanrock tailings facilities. The federal response to the Panel's recommendations was expected to be released in the first quarter of 1997.

In the United States, Rio Algom announced plans in January 1996 to spend US$43 million to develop its Smith Ranch *in-situ* leach[2] uranium property near Casper, Wyoming. The new mine could produce 230 tU in 1997, increasing to 770 tU annually from 1998, from resources of some 23 000 tU. Contracts have reportedly been signed for about half of the first two years' production.

Athabasca Basin, Saskatchewan

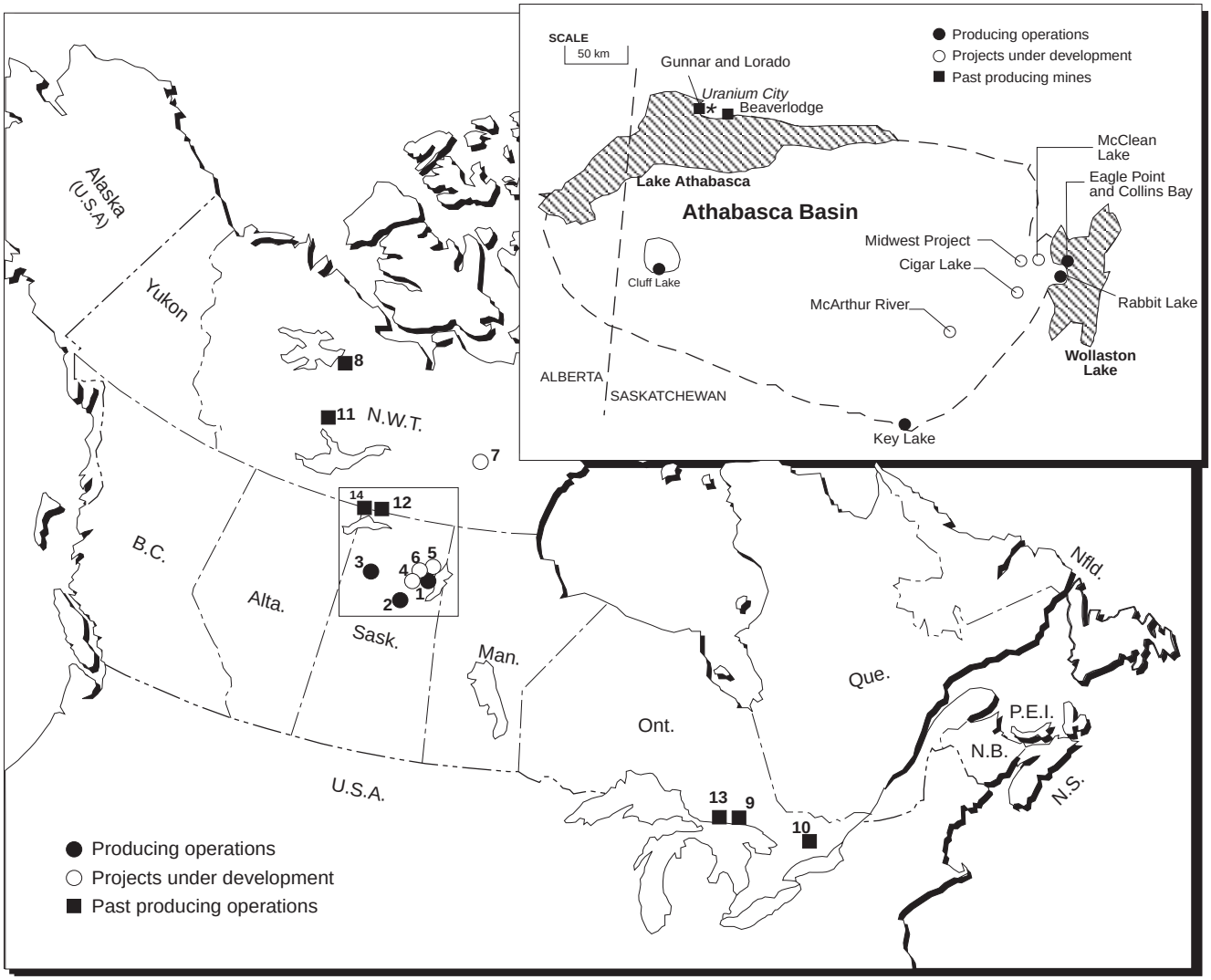
The Rabbit Lake uranium production facility is operated by Cameco Corporation in partnership with Uranerz Exploration and Mining Limited. Despite operating on an alternate-week schedule, the Rabbit Lake mill increased its annual output again in 1996 to an estimated 3900 tU, a record level of production. Source ore was almost all from the Eagle Point underground mine as the Collins Bay "D" Zone was mined out by mid-year. Construction of the Collins Bay "A" Zone dike was completed in preparation for mining during the winter of 1996/97; Collins Bay "A" is expected to be mined out by mid-1997. Ore from the Collins Bay "A" and "D" deposits is sufficient to provide feed to the mill for about two years and, together with Eagle Point ore, the mill can operate beyond the year 2000. Surface and underground exploration programs continue in the hope of adding to current resources. On October 24, 1996, the Atomic Energy Control Board (AECB) announced the renewal of the Rabbit Lake operating licence for a two-year period ending October 31, 1998. The new licence permits an increase in the annual mine production limit from 5400 to 6500 tU should market conditions warrant bringing output well beyond current levels later in the decade.

At the Key Lake uranium production facility, also operated by Cameco in partnership with Uranerz, 1996 production from Deilmann ore was expected to exceed 5400 tU. Although Deilmann reserves will be depleted early in 1997, the Key Lake mill could process stockpiled ore until mid-1999 at the present rate of output. Given the necessary approvals to proceed, the McArthur River project will begin feeding

the Key Lake mill in 1999, doubling its useful life. In late 1995, Cameco announced that mill output would be increased in stages to a rate of 6900 tU annually to handle ore from McArthur River. In 1996, Cameco conducted a pilot study to determine the feasibility of recovering nickel and cobalt from the Key Lake tailings. A C$45 million extraction plant, handling over 800 t of tailings daily, could produce 3175 t of nickel and 227 t of cobalt annually for a decade or more, with the tailings residues re-deposited in the new Deilmann pit sub-surface tailings facility. While extraction proved to be technically feasible, the market outlook for cobalt and nickel by early 1997 led to a postponement of the commercial development plan.

Figure 2

Uranium Mining in Canada, 1996



Numbers refer to locations on map above.

PRODUCING OPERATIONS

1. Rabbit Lake (incl. Eagle Point and Collins Bay)
2. Key Lake
3. Cluff Lake

PROJECTS UNDER DEVELOPMENT

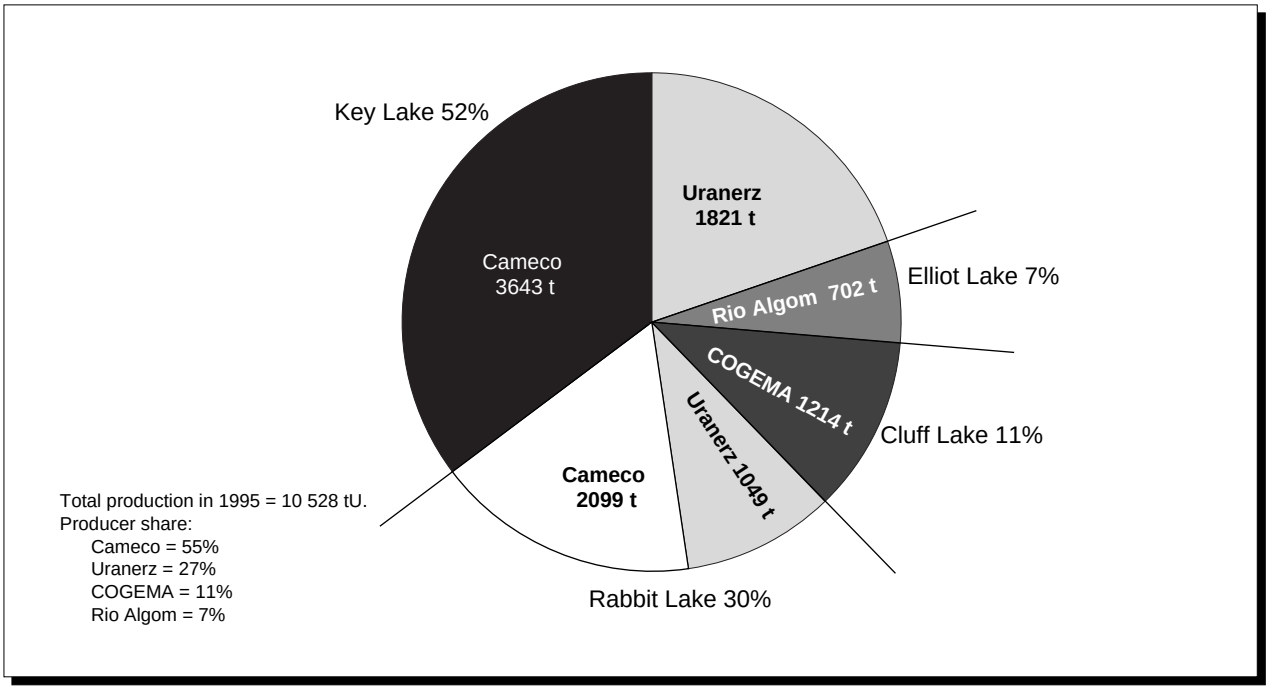
4. McArthur River
5. Midwest/McClean
6. Cigar Lake
7. Kiggavik

PAST PRODUCING DEVELOPMENT

8. Port Radium
9. Agnew Lake
10. Madawaska et al (Bancroft)
11. Rayrock (Marian River)
12. Beaverlodge et al
13. Quirke/Panel/Denison and Stanleigh et al (Elliot Lake)
14. Gunnar and Lorado et al

Source: Uranium and Nuclear Energy Branch, Natural Resources Canada.

Figure 3
Canadian Uranium Production and Ownership, 1995



Source: Uranium and Nuclear Energy Branch, Natural Resources Canada.

The Cluff Lake uranium production facility, owned by COGEMA Resources Inc., is located in the western Athabasca Basin. Late in 1995, the mill began operating at full capacity, having previously alternated operations on a weekly basis. On March 8, 1996, the AECB renewed the Cluff Lake operating licence, authorizing an increase in the annual production limit from 1500 to 2020 tU. Output in 1996 from all producing deposits was expected to exceed 1900 tU. The Dominique-Janine (DJ) Extension open pit reached a depth of 50 m in September 1996, and is scheduled to be mined out in 1997. While known reserves at the Dominique-Peter (DP) underground mine could be depleted in the 1990s, overall resources in other parts of the mineralized structure, including the DJ underground mine and the newly established areas at West DJ, will permit operations to continue until around the year 2005.

The McClean Lake uranium production facility being developed on the eastern margin of the Athabasca Basin is majority-owned and operated by COGEMA Resources Inc. Since financing was finalized in March 1995, site construction at the C$250 million project has proceeded rapidly toward a scheduled production start-up on July 1, 1997. By late 1996, project construction was half completed with the on-site power system, permanent camp, mill office and warehouse, water treatment plant and dewatering wells at the JEB deposit in place. By year-end, the mill building, ore receiving and grinding facilities, and the remainder of the processing plant were either in place or well advanced. Mining out of the JEB open pit was scheduled for the first quarter of 1997 in preparation for its use as a tailings management facility. When the last ore from the JEB and Sue deposits is processed through the McClean mill around 2003, milling of ore from the Midwest project (see below) will begin, followed by ore from the McClean underground mine around 2009. Throughput capacity at the McClean mill will be expanded to handle ore from the Cigar Lake project (see below) beginning late this decade. Its annual production capability will be increased fourfold from 2300 to 9200 tU.

Additional Production Possibilities

Beyond these existing and committed centres of uranium production, there are a number of new projects that could be brought on stream in the next few years if environmental and regulatory approvals are received. Table 4 updates, as of December 1996, recent developments at those mining projects that will form the basis of Canada's uranium production capability well into the future, and indicates the current status of the environmental review process for each of them.

Saskatchewan Environmental Assessment and Review Panels

Background

In 1991, six uranium mining projects in Saskatchewan were referred pursuant to the federal Environmental Assessment and Review Process (EARP) Guidelines Order. In October 1993, a Joint Federal-Provincial Environmental Assessment Panel on Uranium Mining Developments in Northern Saskatchewan reported on three projects, namely the Dominique-Janine Extension at Cluff Lake, the McClean Lake project, and the Midwest Joint Venture project.

Federal and provincial governments responded to the recommendations of this panel in December 1993. Essentially, both governments stated that the Cluff Lake and McClean Lake projects should proceed, subject to the phased AECB licensing process, but that the Midwest project should not be approved as then designed. A second panel, representing only the federal government, reported on the Eagle Point/ Collins Bay Expansion at Rabbit Lake in December 1993. The federal government responded to the recommendations of this panel in March 1994, stating that the Rabbit Lake Expansion should also proceed subject to AECB licensing.

Update

Environmental impact statements (EIS) for the Cigar Lake, McArthur River and revised Midwest projects were submitted in 1995, and additional information was provided in early 1996 in response to further Joint Panel requests for data. In April 1996, the Panel reconvened, and on May 27 began its review of the redesigned Midwest project. Technical sessions were held in four northern communities, with final hearings in Regina and Saskatoon in mid-June. In mid-July, the Joint Panel announced the schedule for public hearings for the McArthur River and Cigar Lake uranium projects. Government and general sessions began in Regina on September 4, with technical sessions held in Saskatoon and several northern communities ending October 7. The Panel's review of these proposals determines their acceptability in terms of environmental, health, safety and socio-economic impacts. The hearings provide an opportunity for review participants to present their views and opinions on the acceptability of the proposals by focussing on EIS data prepared by Cameco (McArthur River), COGEMA (Midwest) and Cigar Lake Mining Corporation. In the two months of public hearings scheduled for these three projects, the Joint Panel heard from some 75 groups, agencies and government representatives.

Related Developments

On August 23, 1996, Dr. Donald Lee, Joint Panel Chairman, announced the resignation of Dr. Annalee Yassi, who cited difficulties in accommodating the Panel's schedule and external time constraints as reasons for resigning. A Panel member since it was formed in 1991, Dr. Yassi provided expertise in the areas of radiological and community health issues. In recognizing her contributions, Dr. Lee indicated that the resignation would not affect plans for holding public hearings.

On August 26, 1996, COGEMA Resources Inc., operator of the McClean Lake project, informed the Joint Panel that it would change its tailings disposal plan for the JEB pit. The "pervious surround" disposal method had been approved for McClean Lake in 1993. However, use of the improved technologies of paste tailings and sub-aqueous deposition for the disposal of all tailings from the McClean Lake, Midwest and Cigar Lake projects would be better, provided the new technologies were approved. The time required to get approval for these new technologies led COGEMA to put forward its new proposal. The McClean Lake tailings would be deposited using the approved pervious surround technology, followed by sub-aqueous deposition of paste tailings, if approved, from the Cigar Lake and Midwest projects.

The Joint Panel considered this change as a new disposal scheme for which it had limited information. COGEMA was asked to submit complete data describing the combination of these technologies, including data relevant for Midwest. Until such data were received, released for public review and comment, and discussed at public hearings, the Joint Panel declared that its review of the Midwest project could not be completed. As the Cigar Lake tailings would be deposited in the JEB pit as well, the Panel decided to schedule supplementary hearings to discuss the disposal of both the Midwest and Cigar Lake tailings.

On October 1, 1996, Mr. John Dantouze, Vice-Chief of the Prince Albert Grand Council, and an original member of the Joint Panel, unexpectedly resigned. He protested the lack of progress in securing considerations for the Native people derived from the development of the new multi-billion-dollar uranium mining projects. In thanking Mr. Dantouze for his contribution over the years, Dr. Lee expressed his confidence that the Panel's work would be completed in a timely fashion.

Final Panel Reports

On October 31, the proponents of the Cigar Lake and Midwest projects submitted documentation on the new tailings disposal plan, which the Panel released for a 30-day public review. However, after reviewing these data, the Panel announced that insufficient information had been provided to proceed with supplementary hearings and that additional data were needed. If the proponents supplied this information so that hearings could be concluded early in 1997, the Joint Panel should be able to submit its recommendations to

governments on these two project reports in sufficient time to permit government responses to the Panel reports during 1997 (refer to Table 4). By year-end 1996, the Joint Panel had completed its review of the McArthur River project and had begun preparation of its recommendations to governments. It was expected that if the Joint Panel's report on McArthur River was submitted to governments early in 1997, a government response could be released in the second quarter of the year.

Cameco Privatization

On February 26, 1996, Cameco announced that its major shareholder, Crown Investments Corporation of Saskatchewan (CICS), would offer 9.5 million common shares of Cameco in Canada, the United States and internationally, with an option to purchase up to one million "over-allotment" shares. These were purchased at C$75.50 each, netting the Saskatchewan government some C$580 million. By April 24, some 620 500 "over-allotment" shares had been sold. With the total divestiture of 10 120 500 shares by CICS, the public holds 89.7% of Cameco, while the provincial government holds the remaining 10.3% through CICS.

Also in late February, Cameco announced the formation of Cameco Gold Inc., a wholly owned subsidiary, to oversee its global gold operations. The new company opened its Toronto headquarters on May 6, 1996, with a reported annual budget of C$10 million for exploration and operations. Its objective is to produce 500 000 oz of gold annually by 2005, largely from its one-third share in production from the Kumtor deposit in Kyrgyzstan, which is one of the world's largest orebodies. Mining began in July 1996 at the US$450 million Kumtor project and, by year-end, Cameco reported that mill commissioning was well under way, site construction was virtually complete, and production was expected to begin on schedule and to reach 400 000 oz in 1997.

EXPLORATION

Natural Resources Canada (NRCan) completed its twenty-second annual assessment of Canada's uranium supply capabilities and an associated survey of uranium exploration activity, and reported[3] the results in June 1996. Uranium exploration activity remains concentrated in areas favourable for the occurrence of deposits associated with Proterozoic unconformities, notably in the Athabasca Basin of Saskatchewan and the Thelon Basin in the Northwest Territories. In the 1995/96 field season, uranium exploration expenditures reached C$44 million, exceeding the C$36 million spent in 1994/95, while uranium exploration and surface development drilling reached 75 000 m, a significant increase from the 67 000 m reported for 1994/95. It should be noted that in recent years most of the reported increase in expenditures can be attributed to advanced underground exploration and deposit-appraisal activities associated with the Cigar Lake, McArthur River, McClean Lake and Eagle Point deposits, all in northeastern Saskatchewan. In comparison, the Saskatchewan government estimated that grass-roots uranium exploration reached C$15 million in 1996, an increase from the revised estimate of C$12.5 million reported for 1995. A summary of uranium exploration activity in Canada from 1976 to 1995 is provided in Table 5.

The number of companies actively exploring for uranium in Canada has fallen to fewer than 15. Of the more than 60 exploration projects that remained in good standing in the 1995/96 field season, half were actively explored. The top five active operators[4] were responsible for spending virtually the entire C$44 million committed in the 1995/96 field season. In alphabetical order they were: Cameco Corporation, Cigar Lake Mining Corporation, COGEMA Resources Inc., PNC Exploration (Canada) Co. Ltd., and Uranerz Exploration and Mining Limited.

RESOURCES

NRCan's annual assessment of domestic uranium supply capability provides a compilation of Canada's "known" uranium resources, based on the results of an evaluation of company data. Uranium supply from Canada in the next decade will come from known resources, estimates of which are divided into three major categories, *measured*, *indicated* and *inferred*, that reflect different levels of confidence in the reported quantities. Most of these resources are associated with deposits identified in Figure 2.

Recent NRCan assessments of Canada's uranium resources have been restricted to those recoverable from mineable ore at prices of C$150/kgU or less. Estimates are not made for uranium resources recoverable at prices between C$150 and C$300/kgU, i.e., those not of current economic interest. Table 6 provides a breakdown of the latest resource estimates compared with those of the previous year. As of January 1, 1996, total recoverable known uranium resources were estimated at 490 000 tU, a sizeable increase from the 454 000 tU reported as of January 1, 1995. Since 1990, total uranium resources have increased steadily due to continued exploration successes in Saskatchewan and the Northwest Territories.

SUPPLY CAPABILITY

In 1996, Canada's uranium supply capability declined when Rio Algom closed its Stanleigh operation. However, other producers were able to maintain or increase output levels, which more than compensated for the mine closure in Ontario. In the short term, timely environmental approvals and higher uranium prices will be required to allow

Canada's production capability to expand to its full potential of 20 000 tU or more annually early in the next century.

Developments in the international uranium market, the rate at which projects clear environmental reviews, and uncertainty regarding the costs associated with certain of the planned new projects preclude projecting future production capability levels with much certainty. Table 7 ranks Canada among the world's major producers, showing actual uranium production from 1989 to 1995 inclusive. Figure 4 illustrates Canada's share of world output in 1995 compared to other major producers.

GOVERNMENT INITIATIVES

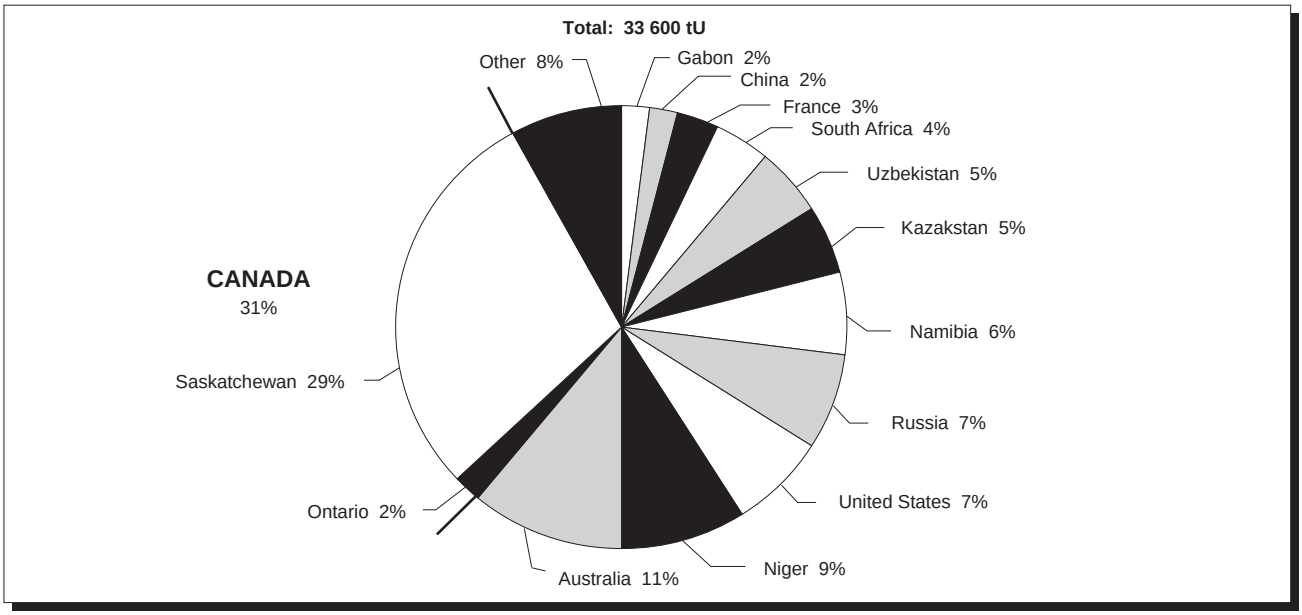
On March 21, 1996, Bill C-23, *The Nuclear Safety and Control Act* (NSCA), was introduced in the House of Commons. While the existing *Atomic Energy Control Act* (AECA) encompasses both the regulatory and developmental aspects of nuclear activities, the new legislation will repeal portions of the AECA that established and governed the operation of the Atomic Energy Control Board, and will establish in its place the Canadian Nuclear Safety Commission (CNSC).

The new legislation will change the remaining portions of the AECA to the *Nuclear Energy Act*, which continues to govern the developmental aspects of nuclear power, including the operation of Atomic Energy of Canada Limited (AECL), the federal nuclear research, development and marketing organization. In disconnecting the two functions, the new act will provide a distinct identity to the new CNSC, while underlining its separate role from that of AECL. This should provide for more explicit and effective regulation of nuclear energy in Canada. At year-end, the NSCA was at the report stage following Second Reading; the Third Reading, final vote and passage were expected during the first quarter of 1997.

In early 1995, the federal Cabinet approved the development of a Policy Framework for radioactive waste having recognized the need for policies on financial responsibility for decommissioning and long-term care and maintenance of uranium mine facilities and mill tailings. NRCan officials sought the views of industry representatives and provincial government officials, including all of the uranium producers. The need for action resulted in an announcement by Anne McLellan, Minister of Natural Resources Canada, on July 10, 1996. The Minister noted that the Policy Framework will guide Canada's approach for radioactive waste disposal by laying out the ground rules and defining the role of government and waste producers and owners.

The Policy Framework recommends that long-term management and disposal of nuclear fuel waste, low-level radioactive waste, and uranium mine wastes and mill tailings proceed in a safe, environmentally sound, comprehensive, cost-effective and integrated manner. It recognizes the federal role to develop policy and to ensure waste producers and owners comply with legal requirements and meet their operational

Figure 4
World Uranium Production, 1995



Source: Uranium and Nuclear Energy Branch, Natural Resources Canada.

and funding responsibilities in accordance with approved waste disposal plans, as well as the role of the federal AECB to regulate waste disposal activities. Under the Policy Framework, the waste producers and owners are responsible, in accordance with the "polluter pays" principle, for the funding, organization, management and operation of disposal and other facilities required for their wastes. This principle recognizes that arrangements may be different for nuclear fuel waste, low-level radioactive waste, and uranium mine wastes and mill tailings.

INTERNATIONAL DEVELOPMENTS

United States

On July 29, 1996, Cameco announced that it had entered into an agreement with the United States Enrichment Corporation (USEC) to develop the technology for, and demonstrate the feasibility of, converting uranium into feedstock for the Atomic Vapour Laser Isotope Separation (AVLIS) process. Cameco's Blind River refinery will provide high-purity UO_3 as the intermediate product, while its Port Hope conversion facilities will conduct other tests during the two-year feedstock demonstration project. If the project is successful and the USEC proceeds with AVLIS, the feasibility of full-scale commercial operations would be evaluated.

On October 14, 1996, Cameco sought to diversify its resource base by agreeing to acquire the North American assets of British government-owned Magnox Electric plc, subject to regulatory approval. Cameco was successful and, on January 13, 1997, announced the US$106 million acquisition of a 100% interest in Power Resources Inc. (PRI) of Colorado. PRI holds 74% of the Highland *in-situ* leach (ISL) uranium project in Wyoming (26% held by COGEMA), which annually produces about 500 tU. Cameco also acquired PRI's 100% interest in the potentially larger Gas Hills project in Wyoming, and 100% of CEGBE (Canada) Ltd., which holds uranium properties in Saskatchewan and a 20% interest in the Kiggavik uranium project in the Northwest Territories. The purchase increases Cameco's uranium production by 385 tU yearly (about 6%), boosts reserve levels by 10%, and enhances its expertise in ISL technology.

During the year, studies progressed on the disposition of military plutonium declared "excess" to defence needs in the United States and the Russian Federation. On October 1, the U.S. Department of Energy's (DOE) Office of Arms Control & Nonproliferation released a report entitled *Draft Nonproliferation and Arms Control Assessment of Weapons-Usable Fissile Material and Plutonium Disposition Alternatives*, which considered a variety of approaches. This was followed on December 9 by a programmatic EIS and, on January 14, 1997, by a formal Record of Decision that set the DOE on a dual-path approach to plutonium disposition.

"Burning" the plutonium in mixed oxide (MOX) fuels in light-water reactors or CANDU reactors and vitrification in glass or other immobilizing medium will both be pursued to ensure an early start to the program and as insurance against possible difficulties with the implementation of either option. At least some of the U.S. plutonium will be immobilized because it is unsuitable for MOX fuel.

Meanwhile, a group of experts from the G7, Russia, Belgium, Switzerland, the European Union and the International Atomic Energy Agency, mandated in January 1994 by Presidents Clinton and Yeltsin to debate military plutonium disposition options, concluded at a meeting held in Paris October 28-31, 1996, that no option should be definitively eliminated, and that the major options, namely, use in reactors and immobilization, should be pursued in parallel. Russia and the United States each have approximately 50 t of such material. Use of MOX fuel would displace some uranium demand, but the effect on uranium markets should be inconsequential since proposals under review would involve a very small number of reactors over an extended number of years.

Australia

Outside Canada, the most important developments affecting new primary uranium supply relate to Australia, where a major expansion in uranium mining could occur as a result of the removal of the restrictive "Three Mines Policy" on uranium. On March 2, 1996, a coalition of the Liberal and National Parties dislodged the Australian Labour Party (ALP) government after 13 years in power. The new government acted quickly to abolish the ALP uranium policy to take advantage of improving market opportunities.

In April 1996, Energy Resources of Australia Ltd. (ERA) applied to the government to develop its Ranger II – formerly Jabiluka – deposit, which contains 77 000 tU. In October, it released a draft EIS for public comment. The EIS examines development options for Ranger II, highlighting ERA's preference to begin small-scale underground mining. Subject to approval, construction of the access decline is scheduled to begin in May 1997, with ore production to begin in 1999 at an annual rate of 100 000 t, rising in stages to 900 000 t/y after 14 years. Ore would be trucked 20 km to the Ranger mill, while tailings would be placed in the Ranger I pit, which was mined out in late 1994, and prepared as a repository. Stockpiled Ranger I ore is sufficient to feed the mill to 1999. In May 1996, ERA received approval to develop its Ranger III orebody, estimated to contain 48 000 tU. First production from Ranger III is scheduled for July 1997 when the A$38 million expansion in milling capacity to 4200 tU/y is expected to be completed. ERA indicated that annual production at the Ranger operation might eventually exceed 5000 tU.

Also in May 1996, RTZ-CRA reported that its Kintyre deposit would proceed pending government and company approvals. In September, the Australian government announced that a full EIS was required with major public participation. Subject to settling Native Title claims, the project owners expected approval by late 1997, construction over the next 18 to 24 months, and start up of open-pit mining in 1999. Production from the A$120 million project could begin at 1000 tU/y and increase to 1300 tU/y. Based on estimated resources of 30 000 tU, a mine life of 20 years is expected.

In June 1996, Western Mining Corporation (WMC) announced the proposed expansion of its Olympic Dam project in South Australia to more than double its production by 2001. Based on an incremental increase in ore throughput to 8.5 Mt/y over four years, output would rise to about 3100 tU/y. The A$1.3 billion expansion of Olympic Dam represents WMC's largest capital investment in 63 years and brings total investment in the project to A$2.3 billion. WMC must first submit an EIS to the government and participate in extensive public consultations regarding the expansion. In October 1996, it was reported that WMC planned to raise US$800 million with a public offering in the United States devoted principally to the expansion of the Olympic Dam mine, with $400 million expected to be raised by the end of July 1997.

Notwithstanding these announcements, a Senate Select Committee on Uranium Mining and Milling began hearings on August 23, 1996, to examine the environmental impact, health and safety, and other implications and effectiveness of security agreements in relation to the mining, milling and export of Australian uranium. The committee received submissions from many interested parties and will likely report its findings in early 1997. It is uncertain what impact these hearings may have on new Australian uranium developments since the committee's findings have no force in law.

THE URANIUM MARKET

Overview

In 1996, world uranium production provided just over half of the world's requirements with the balance coming largely from inventory. Increasingly, as inventories decline, supply will come from new or expanded uranium production centres and non-traditional sources such as surplus military material in the FSU and the United States. Canadian uranium marketers signed new export contracts for the delivery of 10 850 tU in 1996, well below the level in 1995. Table 8 indicates the cumulative amount of uranium under Canadian export contracts since 1974, and illustrates Canada's diverse export base. As of January 1, 1997, forward commitments under all export contracts exceeded 50 000 tU.

Developments Involving Surplus Uranium from the Former Soviet Union and the United States

On April 26, 1996, the United States Enrichment Corporation (USEC) privatization legislation was signed into law as part of the budget bill. The language was consistent with the version passed by Congress at the end of 1995, and did not include a waiver of U.S. trade law with respect to the sale of enrichment feed delivered to the USEC by utilities in conjunction with the purchase of enriched uranium derived from Russian "highly enriched uranium" (HEU), i.e., "displaced feed."

The legislation provides that the displaced feed corresponding to deliveries in 1995 and 1996 under the HEU Agreement is to be transferred to the DOE free of charge prior to the end of 1996. The DOE is then to sell and receive payment for this displaced feed within seven years of enactment of the legislation.

It may be sold: (a) at any time for overfeeding the enrichment plants or for end use outside the United States; (b) in 1995 and 1996 to Minatom (the Russian executive agent under the HEU Agreement) at the purchase price for use in matched sales under the Suspension Agreement; or (c) in 2001 for consumption by end users in the United States after 2001 in volumes not exceeding 3 million lb U_3O_8 equivalent per annum. All such displaced feed is deemed under U.S. law to be of Russian origin. Prior to the end of 1996, Minatom blended down 18 t of HEU and delivered the corresponding "low enriched uranium" (LEU) to the USEC. The equivalent amount of displaced feed was 14.2 million lb U_3O_8 equivalent.

With respect to displaced feed corresponding to deliveries after January 1, 1997, under the HEU Agreement, the legislation provides Minatom with the option of taking title to this in North America concurrently with the delivery of LEU to the USEC. Alternatively, the material is to be auctioned by an independent entity in such a way as to maximize proceeds, and Minatom is to receive the net proceeds. In either case, this material may be sold as Russian-origin uranium in a matched sale under the Suspension Agreement, or it may be sold at any time for overfeeding or for end use outside the United States. However, it may not be delivered for consumption by end users in the United States, either directly or indirectly, prior to January 1, 1998, and it may be delivered thereafter only in accordance with a schedule that rises in annual increments from 2 million lb U_3O_8 equivalent in 1998 to 20 million lb U_3O_8 equivalent in 2009 and subsequent years. The legislation places no restrictions on the sale of the conversion component.

The legislation also provides that the DOE is to transfer to the USEC free of charge up to 50 t of surplus U.S. HEU and up to 7000 tU of natural uranium from the DOE stockpile. This may not be delivered

for commercial end use in the United States prior to January 1, 1998, and after that date it is subject to a limit of 10% or 4 million lb U_3O_8 equivalent, whichever is less, in any calendar year.

The DOE may sell other natural or enriched uranium from its stockpile at a price not less than fair market value if the President determines that it is not necessary for national security, and the Secretary of Energy determines that the sale will not have a material adverse impact on the domestic mining, conversion or enrichment industries, taking into account sales under the HEU Agreement and the Suspension Agreement.

Finally, the USEC privatization legislation calls for the President to monitor the USEC's actions under the HEU Agreement and report annually to Congress on the effect of this uranium on the domestic mining, conversion and enrichment industries and on the steps taken to prevent or mitigate adverse material impacts on these industries. The Secretary of Commerce is to administer and enforce the uranium delivery limitations, although the legislation is silent on the procedures for doing so.

To date, 174.3 t of HEU have been declared excess to U.S. national security needs. Additional quantities may become excess as a result of future arms reduction agreements. Most of the 174.3 t of HEU is also surplus to DOE program needs. It includes 13 t transferred to the USEC in 1994 under the provisions of the *Energy Policy Act* of 1992, and 10 t under IAEA safeguards that are tentatively reserved for use in DOE non-weapons programs by 2001. Also included is the 50 t mentioned above, which will become available for blending during 1997-2001. The disposition of this material is governed by the USEC privatization legislation. Another 40 t will become available for blending during the following 10-year period. This may ultimately become available for commercial disposition, although up to 5 t may be required for DOE programs and 27 t are "off-specification" and may have limited commercial suitability. The ensuing five-year period may see a further 36 t of "difficult-to-recover" material become available for blending and ultimate commercial disposition, although 13 t of this is also "off-specification." The remaining 25 t are likely to be disposed of as waste.

The year 1996 also saw further developments under the anti-dumping suspension agreements. In August, the rules were finalized for closing off the "enrichment bypass" under the Kazak and Uzbek suspension agreements, and the Russian agreement was amended to accomplish the same objective and to bring it into conformity with the USEC privatization legislation. Enrichment bypass contracts signed prior to March 27, 1995, were grandfathered and the total quantity was crystallized at 444 tU under the Kazak and Uzbek agreements, of which 25% became available for matching with newly produced U.S. production.

Finally, on November 14, 1996, the USEC and TENEX reached a five-year agreement on HEU quantities and Separative Work Unit prices under the HEU agreement. Quantities are to be 18 t HEU in 1997, 24 t in 1998, and 24 t in each of the ensuing years. Russia is to retain title to the approximate 40 000 tU of resulting displaced feed, which can only be marketed in the United States within the constraints of the USEC privatization legislation. There are indications that Russia may require some of this material for its own domestic feeds, including continued downblending of the HEU.

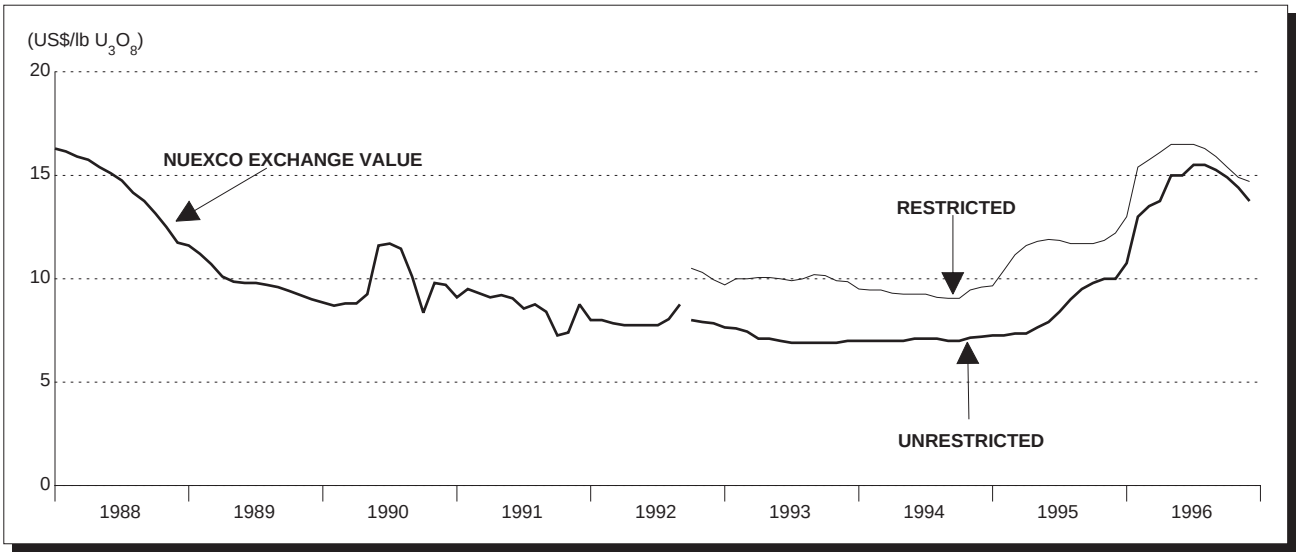
These developments bode reasonably well for the Canadian uranium industry. It is unlikely that any significant new quantities of government uranium originating from disarmament initiatives will become available to the market over the next 10 years. A legislated schedule applies to the release in the U.S. market of those quantities that will become available during the next 10 years. Given the restrictions that apply in other important markets, and the certainty brought about by the disclosure of quantities and scheduling, those companies considering investment in new uranium production facilities will be able to make decisions in a rather stable environment.

Uranium Prices

A two-tiered spot market price developed in 1992 when import restrictions were placed on FSU uranium in the United States and the European Union. By late 1995, the "restricted" market price was US$12.20/lb U_3O_8, while the "unrestricted" price reached US$10.00/lb U_3O_8. The rapid price increase continued into 1996, with TradeTech, a successor of NUEXCO,[5] indicating a "restricted" price of US$16.10/lb U_3O_8 by May. It peaked at US$16.60/lb in mid-June, but had fallen to below US$16.00/lb by September. The "restricted" and "unrestricted" spot prices differed at one point by only US50¢/lb, but this increased to US95¢/lb U_3O_8 at year-end, at which time the "restricted" price was US$14.70/lb versus an "unrestricted" price of US$13.75/lb U_3O_8. Figure 5 shows the development of uranium spot prices from 1988, the last time they were above US$15.00/lb U_3O_8.

Supplies in the "unrestricted" segment of the market were apparently quite limited for about a year. Controls on using this uranium in Europe and the United States are now well established and appear to be having the designed effect on trade. The most difficult part of the adjustment to market economy principles for the non-market economy countries now appears to be behind them, and future development is likely to be based on economic considerations. While spot prices tailed off in the second half of the year due to limited near-term demand, it is unlikely that they will decline again to the levels seen in the late 1980s and early 1990s. These prices may be strong enough to encourage the necessary new production facilities to proceed, while not jumping to unsustainable levels that would encourage the advancement of economically questionable new projects.

Figure 5
Trend in Uranium Spot Prices, 1988-96



Source: TradeTech.

In comparison with spot market prices, the average price of Canadian export deliveries increased sharply from C$47/kgU (US$13/lb U_3O_8) in 1995 to C$54/kgU (US$15/lb U_3O_8) in 1996. This reflects strengthened spot prices and an increasing proportion of deliveries under higher-priced contracts. Table 9 shows the export price trend from 1974 to 1996, while Table 10 indicates actual exports of Canadian-origin uranium to principal customers from 1989 to 1995. The destination of Canada's exports of uranium in concentrate on a cumulative basis (1991-95 inclusive) is illustrated in Figure 6, which highlights the importance of the United States as a major customer.

REFINING AND CONVERSION

Cameco operates Canada's only uranium refining and conversion facilities located at Blind River and Port Hope, Ontario, respectively. At the Blind River refinery – the world's largest – uranium mine concentrates from Canada and abroad are refined to uranium trioxide (UO_3), an intermediate product. The UO_3 is then trucked to the Port Hope facilities, which have about one quarter of the Western World's annual uranium hexafluoride (UF_6) conversion capacity and provide the only commercial supply of fuel-grade natural uranium dioxide (UO_2). UF_6 is enriched outside Canada for use in foreign light-water reactors, while natural UO_2 is used to fabricate fuel bundles for CANDU reactors in Canada and abroad. About 80% of the UO_3 from Blind River is converted to UF_6, while the remaining 20% is converted to UO_2.

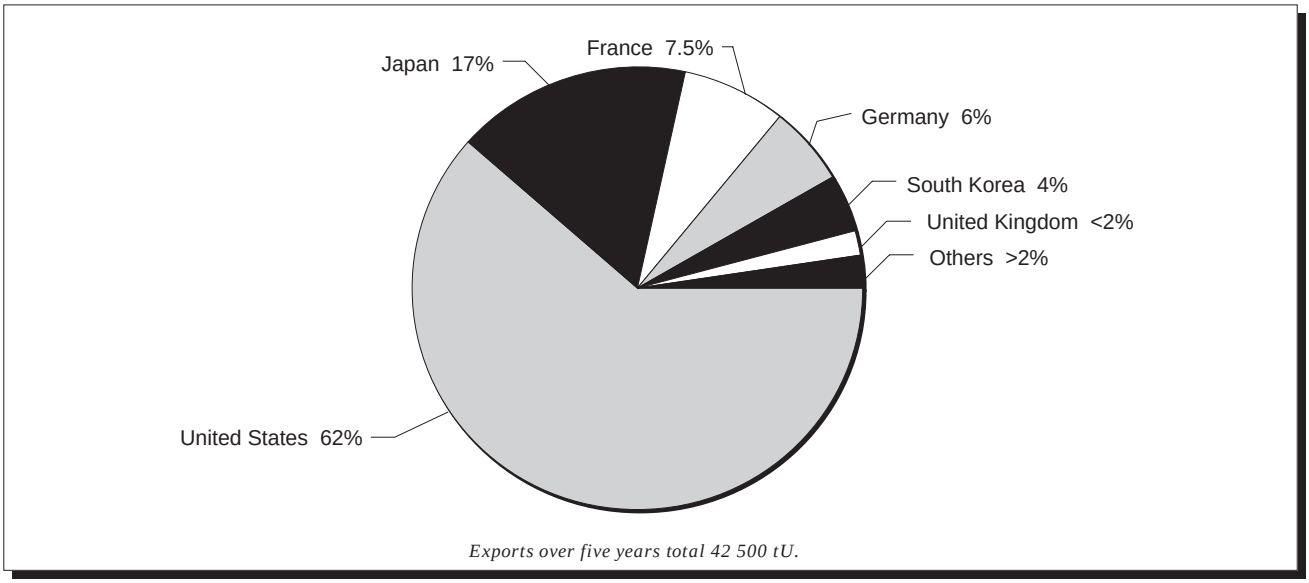
In August 1996, Cameco completed a C$9 million improvement program at Port Hope with the relocation of 14 fluorine cells used in the production of UF_6. The combined new facility now houses 46 fluorine cells, with room for 8 more. Table 11 tabulates Canada's production of refined and converted uranium, and notes the associated work force from 1993 to 1995.

Commissioning of Cameco's new C$10 million Blind River recycling facility proceeded in 1996. An innovative process to convert by-product liquid raffinates into a dry powder form will reduce product volumes by 75%. The solids will be stored on site before shipment to a facility to recover the remaining uranium. Cameco developed this process anticipating the closure of the Stanleigh operation, north of Blind River, where by-product uranium was recovered until mid-1996.

NUCLEAR POWER DEVELOPMENTS

The relevant statistics for Canada's nuclear energy program are provided in Tables 12 and 13. At the Bruce "A" Nuclear Generating Station (NGS), Unit 2 was taken out of service on October 8, 1995, but remains in Ontario Hydro's generation plans as an option to meet electricity demand beyond the year 2000. At the Pickering NGS, Ontario Hydro tested valves in the fuel cooling system and suspended fuelling operations on five operating reactors until further checks could be done. Five units were shut down in mid-April 1996, but by year-end all had been returned to service.

Figure 6
Canadian Uranium Exports, by Country of Final Destination, 1991-95



Source: Atomic Energy Control Board (AECB), Canada.

Internationally, the first CANDU unit at Cernavoda, Romania, achieved criticality on April 16, 1996. In Turkey, bids were requested for the first nuclear power station at the Akkuyu site, and AECL is one of the four bidders expressing interest in building the station. In the Republic of Korea, construction of three CANDU 6 units at the Wolsong site is on schedule; in-service dates for Wolsong 2, 3 and 4 are June of 1997, 1998 and 1999, respectively. Two more CANDU units (Bongil 1 and 2) may also be purchased, and AECL is developing a larger CANDU design, with a capacity of 950 MWe, for the Korean market. In China, AECL and the China National Nuclear Corporation signed a contract for the sale of two CANDU reactors on November 26, 1996. The contract took effect in January 1997; in-service dates for the two 700-MWe CANDU reactors to be built at Qinshan are scheduled for January and October 2003.

In 1996, the Government of Canada examined a proposal to burn reprocessed plutonium from dismantled nuclear weapons in refitted CANDU reactors in Canada. The plan could give Canada a direct opportunity to help reduce the world's stockpiles of weapons-grade plutonium through a process of recycling it as fuel. Under the scheme, imported mixed-oxide fuel (MOX), made in the United States from weapons-grade plutonium, could be burned in Canadian CANDU reactors to generate electricity. The proportion of plutonium in the MOX fuel would be less than 2%. The use of Canada's reactors is one of several options under consideration by the United States for plutonium disposal, but small-scale testing will first have to be conducted in Canada.

OUTLOOK

In 1996, increases in uranium spot market prices helped to reassure domestic producers as they guided their new mining proposals through the environmental review process. The start-up of these world-class projects in Saskatchewan will form the basis of continued Canadian production well into the next decade. With significant potential for discovering additional uranium resources, Canada will be able to maintain its role as a reliable and competitive supplier to its trading partners. A sizeable baseload of long-term supply contracts with customers in the United States, Western Europe and the Far East positions Canada's uranium producers very well to compete with the world's major uranium suppliers. Given adequate market incentives, Canada's uranium industry is capable of maintaining its position as the world's leading supplier of uranium for many years to come.

REFERENCES

1 John French, an advisor on uranium markets (tel.: 613-995-7474), has made a significant contribution to the text in those sections dealing with international uranium market developments and uranium prices.

2 *In-situ* leaching involves extracting uranium from ore in place in the deposit; acidic or basic solutions dissolve uranium as they are circulated through holes drilled into the orebody from surface.

3 *Canada's Uranium Industry – The World Leader Poised to Expand* – NRCan mailing, June 18, 1996.

4 In certain cases, the identified operator has reported the total expenditures of a joint-venture effort. Therefore, contributions by other parties not responding to the NRCan survey are accounted for in the C$44 million total.

5 NUEXCO, an international uranium brokerage firm, was originally called the Nuclear Exchange Corporation. Several companies in the NUEXCO organization, which were associated with uranium trading, declared bankruptcy in early 1995. Certain of these have been reorganized and continue to provide brokerage services. NUEXCO's publication activities are carried on by TradeTech.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 70. (2) Information in this review was current as of February 1, 1997.

TABLE 1. URANIUM PRODUCTION AND ASSOCIATED WORK FORCE IN CANADA, 1993-95

Province and Producer	Company Work Force[1] (Dec. 31)			Annual Output[2] (tU)		
	1993	1994	1995	1993	1994	1995
ATHABASCA BASIN, SASKATCHEWAN						
Cluff Mining (COGEMA Resources Inc., 100%)	114	188	208	867	1 065	1 214
Key Lake JV (Cameco, 66 2/3%; Uranerz, 33 1/3%)	397	399	397	5 315	5 074	5 464
Rabbit Lake JV (Cameco, 66 2/3%; Uranerz, 33 1/3%)	245	234	249	2 313	2 868	3 148
Subtotal	756	821	854	8 495	9 007	9 826
ELLIOT LAKE, ONTARIO						
Rio Algom Limited Stanleigh	558	550	488	660	640	647
Total	1 320	1 371	1 342	9 155	9 647	10 473

Sources: Company annual reports; Atomic Energy Control Board open files.
1 Figures (rounded) are for company-payroll employees only; on-site contractors (mining, construction, services, etc.) are not included. **2** Primary output only. In 1995, an additional 55 tU was recovered by the remaining Elliot Lake producer from Cameco's refinery/conversion facility by-products, compared with about 53 tU in 1994 and 30 tU in 1993. While these amounts are NOT included in the Canadian totals of primary uranium production noted above, they are included in the shipments and value of shipments figures provided in Table 2.

TABLE 2. VALUE[1] OF URANIUM SHIPMENTS[2] BY PROVINCE, 1990-96

	Unit	1990	1991	1992	1993	1994	1995	1996[p]
Ontario producer shipments	tU	4 597	1 288	1 027	ND	ND	ND	ND
Value of shipments	C$ millions	627	271	173	ND	ND	ND	ND
Saskatchewan producer shipments	tU	5 123	6 911	8 125	ND	ND	ND	ND
Value of shipments	C$ millions	261	333	400	ND	ND	ND	ND
Total producer shipments	tU	9 720	8 199	9 152	8 727	11 253	10 293	11 448[p]
Total value of shipments	C$ millions	888	604	573	497	625	534	645[p]

Source: Natural Resources Canada.
ND: No disclosure provincially, as only one producer in Ontario (closed June 1996).
[p] Preliminary.
[1] Value of shipments includes the value of uranium recovered from the refinery/conversion facility by-products noted in Table 1, which are not included in primary production. [2] Shipments in tonnes of uranium (tU), contained in concentrate, from ore-processing plants.

TABLE 3. OPERATIONAL CHARACTERISTICS OF EXISTING CANADIAN URANIUM PRODUCTION CENTRES, 1995

Operating Entity/ Operator and Location	Ore-Processing Plant[1]			
	Capacity	Recovery	Annual Throughput	
	Nameplate	Overall	Total Ore	Ore Grade
	(t/d)	(%)	(t)	(%)
Cluff Mining (COGEMA Resources Inc.) Cluff Lake, Saskatchewan	>900	98	194 300	0.64
Rabbit Lake JV (Cameco Corporation) Rabbit Lake, Saskatchewan	>2 500	98	205 000	1.61
Key Lake JV (Cameco Corporation) Key Lake, Saskatchewan	>800	97	300 000	1.87
Stanleigh Mine (Rio Algom Limited) Elliot Lake, Ontario	>4 500	96	860 000	0.086

Sources: Corporate annual reports; Atomic Energy Control Board open files.
[1] Figures are rounded.

TABLE 4. SUMMARY, CANADIAN URANIUM MINING PROJECTS, AS OF DECEMBER 31, 1996

Project, Province/Operator	Owners Percentage Share (%)	Deposit Type/ Discoverer and Discovery Date	Resources (Company Estimates)	Ore Grade and Notes on Deposits	Mining Method, Milling Rate and Capacity	Project Particulars and Status	Location of Project/ Notes of Interest
NEW PROJECTS PLANNED FOR PRODUCTION							
Cigar Lake, Sask./ Cigar Lake Mining Corporation	Cameco (48.75), COGEMA (36.375), Idemitsu (12.875), KEPCO (2 non-vote)	Unconformity-related/ COGEMA 1981	Overall property 136 000 tU, *mineable*	Overall property grade of 21% U; grades vary from 5% to 70% U; orebody at depth of 450 m	"Non-entry" underground; "jet-boring" mining method; milling at McClean Lake contributing from 2300 to 6900 tU/y	C$555 million project; test mining completed in 1992; EIS submitted in October 1995; public hearings in 1996/97	670 km N of Saskatoon; 500-m-deep shaft sunk; brine freezing of ground is required to mine the ore; project to start up by 1999
McClean Lake, Sask./COGEMA Resources Inc.	COGEMA (70), Denison (22.5), OURD (7.5)	Unconformity-related/ original McClean by CanOxy/Inco 1979-80; JEB & Sue *et al* - 1982 to 1990 by Minatco	Overall property 17 300 tU, *mineable*	2.7% U average overall; open-pit depths from 20 to 145 m; McClean underground ore to 4% U at depth of 170 m	75% by open pit at JEB, Sue A, B & C; underground at McClean; mill capacity may be expanded to 9200 tU/y (see Cigar Lake)	C$200 million project (alone); public hearings in 1993; approved subject to AECB licensing process; construction well under way	350 km N of La Ronge; JEB open-pit mining starts in 1996 with milling set for July 1997; mine life of the co-enterprise >2010
Midwest Project, Sask./COGEMA Resources Inc.	COGEMA (56), Denison (19.5), Uranerz (20), OURD (4.5)	Unconformity-related/ Esso Minerals 1977 (interests of Bow Valley, Numac Oil & Gas, *et al* bought out by partners)	Overall property 13 200 tU, *mineable*	Overall property grade of 4% U; grades vary from 2% to 30% U; orebody at depth of 200 m	"Non-entry" underground; "jet-boring" mining method; milling at McClean Lake; contributing 2300 tU/y	$80 million co-venture with McClean; in 1993, Panel rejects proposal; EIS submitted August 1995; public hearings in 1996/97	710 km N of Saskatoon; 185-m-deep shaft sunk and ore test mined; new operator, COGEMA, submits revised EIS
McArthur River, Sask./Cameco Corporation	Cameco (55.844), Uranerz (27.922), COGEMA (16.234)	Unconformity-related/ Cameco 1988	Overall property 73 000 tU (at least), *mineable*	Overall property grade varies from 2% to 70% U; averages 15% U; orebody at depth of 550 m; silicified alteration zone missing Ni and As	"Non-entry" underground mining method with milling at Key Lake; licensed mill capacity 6150 tU/y but expandable to 6900 tU/y	C$400 million project; UEP proceeded in 1993; EIS submitted in December 1995; public hearings in late 1996; Panel to report early 1997	80 km NE of Key Lake; start-up mid- to late-1999; will extend operations at Key Lake mill beyond 2015
Kiggavik, N.W.T./ Urangesellschaft Canada Limited	Urangesellschaft (79), CEGB Expl'n (20), Daewoo Corp. (1)	Unconformity-related/ Urangesellschaft 1977	Overall property 15 000 tU, *mineable*; (more incl. Andrew Lake *et al*)	0.41% U average overall; depth Centre pit 100 m, Main pit 200 m	Open-pit mining methods; 1200 t/d mill feed; output rate of 1200 tU/y originally expected	EIS submitted but project deemed deficient by Panel; COGEMA expected to review project and submit new EIS	75 km W of Baker Lake; start-up not likely before 2000; >11-year mine life with tributary ore included
RECENTLY APPROVED EXTENSIONS OR EXPANSIONS TO EXISTING OPERATIONS							
Dominique-Janine Extension (DJX) at Cluff Lake, Sask./ (COGEMA Resources Inc.)	COGEMA Resources Inc. (100)	Unconformity-related/ "D" pit by Mokta 1969 (depleted 1981); Claude *et al* by Amok 1970-76 (Claude depleted 1989); D-J & Dominique-Peter 1980-86	Overall property 16 000 tU *mineable*, D-J Extension 5250 tU, *mineable*	Mill-feed grade for 1995 was 0.64% U; DJX to mine >680 000 t of ore grading 0.73% U to yield in excess of 5000 tU	Open pit at DJX before underground; re-licensed mill capacity to 2020 tU/y; milling rate being increased over time from half-capacity operation	C$10 million Cluff Lake extension; hearings in 1993; approval to proceed subject to AECB licensing; mining well under way in 1995	720 km N of Saskatoon; revised three-phase mine plan offers mining flexibility; mine life beyond 2000 with DJX
Eagle Point & Collins Bay at Rabbit Lake, Sask./Cameco Corporation	Cameco (66.67), Uranerz (33.33)	Unconformity-related/Gulf Minerals 1968; Rabbit Lake (depleted 1984); 1971-79 for Collins Bay ("B" pit depleted 1991); 1980 for Eagle Point	Eagle Point *et al*, 20 000 tU *mineable,* overall property 37 100 tU (incl. stockpiles)	Mill-feed grade for 1995 was 1.61% U; mineable grade 1.16% U for Eagle Point and 3.45% U for Collins "A&D"; Eagle Pit depth 120-335 m	"Non-entry" underground methods at Eagle Point, open pit for others; milling rate below 5400 tU/y licensed capacity but increased in 1995	Eagle Point test mining 1992; Panel reviewed and federal government approved in 1993; Eagle Point in production, Collins A&D being mined	805 km N of Saskatoon; mining Eagle Point ore since late June 1994; expansion will extend mine life beyond 2000

Notes: OURD (Canada) Co., Ltd. is a subsidiary of the Overseas Uranium Resources Development Corporation (OURD) of Japan. Urangesellschaft Canada Limited, operated by COGEMA Resources Inc., is a subsidiary of COGEMA of France. Idemitsu Uranium Exploration Canada Ltd. is a wholly owned subsidiary of Idemitsu Kosan Co., Ltd. of Japan. Korea Electric Power Corporation (KEPCO) is the Republic of Korea's only nuclear-electric utility. CEGB Exploration (Canada) Ltd. was acquired by Cameco Corporation in early 1997 from a subsidiary of Magnox Electric plc, a company based in the United Kingdom.

TABLE 5. URANIUM EXPLORATION ACTIVITY IN CANADA, 1976-95

Year	Expenditures[1]	Drilling[2]	Million-Dollar Projects[3]
	(C$ millions)	(km)	(number)
1976	44	155	4
1978	90	334	7
1980	128	503	24
1982	71	247	13
1984	35	197	12
1986	33	162	11
1987	37	164	12
1988	59	201	11
1989	58	158	11
1990	45	66	6
1991	44	67	4
1992	46	79	4
1993	40	62	5
1994	36	67	8
1995	44	75	10

Source: Natural Resources Canada.
1 Direct exploration and drilling expenditures in current dollars; from late 1980s, includes advanced underground exploration and deposit appraisal expenditures. **2** Exploration and surface development drilling; excludes development drilling on producing properties. **3** Number of projects where direct exploration and drilling expenditures exceeded C$1 million in current dollars.

TABLE 6. ESTIMATES OF CANADA'S URANIUM RESOURCES RECOVERABLE FROM MINEABLE ORE,[1] JANUARY 1, 1996, AND JANUARY 1, 1995

Price Ranges Within Which Mineable Ore is Assessed[2]	Measured		Indicated		Inferred	
	1/1/96	1/1/95	1/1/96	1/1/95	1/1/96	1/1/95
			(000 tU)			
Up to C$100/kgU	165	68	201	202	118	30
C$100 to $150/kgU	<1	<1	3	111	3	43
Total	165	68	204	313	121	73

Source: Natural Resources Canada.
1 Actual or expected losses in mining recovery and ore processing have been accounted for; these factors were individually applied to resources tributary to existing or prospective production centres. In underground operations, mineable ore is generally 75% to 85% of the ore-in-place; higher mining recoveries are achievable in open-pit operations. Ore-processing recoveries in Canada normally range from 90% to 99%; Canada's weighted average mill recovery for existing conventional uranium operations was 97% over the 1994/95 period. **2** The Canadian dollar figures reflect the price of a quantity of uranium concentrate containing 1 kg of elemental uranium. The prices were used in determining the cut-off grade at each deposit assessed, taking into account the mining method used and the processing losses expected. The price of C$100/kgU was used by Natural Resources Canada to illustrate those resources that were of economic interest to Canada during this period.
Note: $1/lb U_3O_8 = $2.6/kgU.

TABLE 7. PRODUCTION OF URANIUM IN CONCENTRATES BY SELECTED MAJOR PRODUCING COUNTRIES, 1989-95

	1989	1990	1991	1992	1993	1994	1995
				(tonnes U)			
Canada[1]	11 350	8 780	8 200	9 340	9 190	9 700	10 530
Russia	. .	. .	. .	(in Other)	2 700	2 350	2 200
Kazakstan	. .	. .	. .	(in Other)	2 700	2 240	1 580
Uzbekistan	. .	. .	. .	(in Other)	2 700	2 120	1 700
China	. .	. .	. .	(in Other)	950	480	780
United States	5 320	3 420	3 060	1 860	1 290	1 290	2 324
South Africa	2 950	2 530	1 710	1 670	1 710	1 670	1 420
Namibia	3 100	3 210	2 450	1 680	1 670	1 900	2 010
Australia	3 660	3 530	3 780	2 330	2 270	2 210	3 710
Niger	2 990	2 830	2 960	2 970	2 910	2 980	2 980
France	3 240	2 830	2 480	2 150	1 710	1 050	1 020
Gabon	850	710	690	540	550	650	630
Other[2]	940	3 800	2 250	12 600	2 770	2 370	2 730
Total[3]	34 400	31 640	27 580	35 140	33 120	31 010	33 610

Sources: *Uranium: Resources, Production and Demand*, a biennial report published jointly by the Nuclear Energy Agency of the OECD and the International Atomic Energy Agency; miscellaneous corporate, national and international reports.
. . Not available.
1 Figures include refinery/conversion facility by-product uranium, and differ from primary production figures shown elsewhere. **2** Includes Argentina, Belgium, Brazil, Germany (West), India, Israel, Japan, Portugal, Spain and Yugoslavia; from 1990, *Other* also includes Germany (East), Hungary and Pakistan; in 1992, *Other* also includes Bulgaria, China, the Czech Republic, Kazakstan, Mongolia, Romania, Russia, Ukraine and Uzbekistan; from 1993, *Other* includes all of the above, except China, Kazakstan, Russia and Uzbekistan. **3** Totals are of the listed figures only; *world* totals represented from 1992 onward.
Note: Country figures are rounded to the nearest 10 tU.

TABLE 8. CANADIAN URANIUM UNDER EXPORT CONTRACTS[1]

Country of Buyer[2]	Tonnes U
Argentina[3]	69
Belgium	3 175
Finland	3 075
France	26 986
Germany	16 580
Italy	1 115
Japan	26 581
South Africa	385
South Korea	8 042
Spain	4 068
Sweden	9 440
Switzerland	154
United Kingdom	8 755
United States	92 340
Total	200 765

Source: Natural Resources Canada.
1 The nominal quantity of uranium in all contracts reviewed and accepted under Canadian uranium export policy since September 5, 1974. Country totals are adjusted to reflect new and amended contracts, and the exercising of quantity-flexibility options, as of December 31, 1996. **2** In most cases, indicates country of end-user. **3** Initially as manufactured fuel bundles for Argentina's CANDU reactor.

TABLE 9. CANADIAN URANIUM EXPORT PRICE,[1] 1974-96

Year	Average Export Prices		Spot Sale Portion of Deliveries
	Current Dollars	Constant 1996 Dollars	
	(C$kg/U)[2]		(%)
1974	39	113	n.r.
1975	52	137	n.r.
1976	104	253	n.r.
1977	110	252	n.r.
1978	125	270	n.r.
1979	130	255	n.r.
1980	135	240	n.r.
1981	110	176	1
1982	113	166	1.5
1983	98	138	10
1984	90	122	26
1985	91	121	20
1986	89	115	21
1987	79	98	35
1988	79	93	13
1989	74	83	<1
1990	71	78	<1
1991	61	65	<2
1992	59	62	<1
1993	50	52	<1
1994	51	53	<1
1995	47	48	2
1996	54	54	1

Source: Natural Resources Canada.
n.r. Not reported.
[1] NRCan derives the Export Price figure annually. It is based on the average price under all export contracts made by Canadian producers for deliveries in the given year. [2] $/kgU x 0.38465 = $/lb U_3O_8.
Notes: Prices are rounded. Constant dollar values are derived using the Implicit Price Index for Gross Domestic Product.

TABLE 10. EXPORTS OF URANIUM OF CANADIAN ORIGIN, 1990-95

Country of Final Destination	1990	1991	1992	1993	1994	1995
	(tonnes of contained uranium[1])					
Argentina	–	19	20	29	–	–
Belgium	–	–	–	–	115	3
Finland	83	–	–	–	–	–
France	799	822	111	461	766	1 016
Germany	220	459	534	665	465	348
Indonesia	–	–	–	–	–	–
Italy	–	–	–	–	–	–
Japan	2 005	399	2 328	523	3 443	363
Netherlands	–	–	–	–	–	–
South Korea	339	215	104	715	455	290
Spain	–	–	–	–	274	186
Sweden	285	91	170	–	–	84
United Kingdom	882	498	19	–	50	198
United States	4 035	5 307	4 032	6 291	4 938	5 702
Total	8 648	7 810	7 318	8 684	10 507	8 180

Source: Atomic Energy Control Board.
– Nil.
[1] Some of this uranium was first exported to an intermediate country for conversion and/or enrichment prior to transfer to the country of final destination.

TABLE 11. URANIUM PROCESSING PRODUCTION AND ASSOCIATED WORK FORCE IN CANADA, 1993-95

Process and Location (Nameplate Capacity)	Production			Site Work Force		
	1993	1994	1995	1993	1994	1995
	(tU)			(number)		
Refining at Blind River (18 000 tU as UO_3)	6 833	9 445	10 729	81	81	86
Conversion at Port Hope (10 500 tU as UF_6 and 2500 tU as UO_2)	7 853	9 490	10 552	198	198	231

Source: Cameco Corporation.

TABLE 12. NUCLEAR POWER PLANTS IN CANADA AS OF DECEMBER 31, 1996

Reactors	Owner	Net Capacity	In-Service Dates
		(MWe)	
Pickering 1 to 4	Ontario Hydro	2 060	1971-73
Bruce 1 to 4[a]	Ontario Hydro	2 307	1977-79
Point Lepreau	NB Power[1]	635	1983
Gentilly 2	Hydro-Québec	638	1983
Pickering 5 to 8	Ontario Hydro	2 064	1983-86
Bruce 5 to 8	Ontario Hydro	3 440	1984-87
Darlington 1 to 4	Ontario Hydro	3 524	1990-93
Total net capacity (MWe)		14 668	

Source: Natural Resources Canada.
[a] Bruce Unit 2 out of service on October 8, 1995, and being mothballed.
[1] New Brunswick Power Corporation.

TABLE 13. NUCLEAR POWER DATA IN CANADA AS OF DECEMBER 31, 1996

	Unit	Canada	Ontario	New Brunswick	Quebec
Electricity demand growth	%/y	1.1	–1.0	1.0	1.0
Nuclear share of electric utility generation	%	16.0	54.1	29.9	3.1
Reactors in service	no.	21	19	1	1
Capacity in service	Net MWe	14 668	13 395	635	638

Source: Natural Resources Canada.
Note: Unit 2 of the Bruce Nuclear Generating Station was taken out of service on October 8, 1995.