REVIEW OF ATOMIC ENERGY CANADA LIMITED

Summary Report by Natural Resources Canada

Presented to the Honourable Lisa Raitt
Minister of Natural Resources

May 2009

AECL REVIEW SUMMARY REPORT

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EXECUTIVE SUMMARY

The past 60 years have seen Canada's emergence as a leading nation in the development and civilian use of nuclear energy. Canada's nuclear industry spans uranium production, fuel processing, the design, construction, servicing and decommissioning of reactors, the production of medical isotopes and the management of waste material. Its scope and the skills of those employed in the industry are truly impressive.

Canada is the world's largest producer of uranium. Canada's processing facilities compete globally. Canadian CANDU technology represents almost 10 percent of installed reactor capacity around the globe. Domestically, nuclear energy supplies 15 percent of the country's electricity needs and represents one of the few base load solutions to reducing greenhouse gas emissions. In Ontario, nuclear energy accounts for over 50 percent of electricity supply. The industry boasts established power operators in Ontario, New Brunswick and Quebec, and a robust supply chain that covers a range of high technology and high precision goods and services. In addition, world-class research is conducted at the Chalk River Laboratories (CRL), the private sector and at Canadian universities. In total, Canada's nuclear industry provides over 30,000 well-paying jobs.

The strength of Canada's nuclear industry is mirrored by strong and independent regulation. In Canada, nuclear activities, including the production and use of nuclear materials are regulated to the highest international guidelines by the Canadian Nuclear Safety Commission, an independent, quasi-judicial body.

At the centre of Canada's nuclear industry is AECL, an agent Crown Corporation, created in 1952. While its origins lay in research and development, AECL now fills a more complex dual role - at once a commercial enterprise competing for multibillion dollar nuclear reactor projects and at the same time meeting a mandate to carry out essential public policy functions. AECL relies on funding from the federal government which also serves as the ultimate backstop for the financial risks associated with AECL's activities.

Few would doubt that there are significant and growing global opportunities available to AECL in both the refurbishment of existing reactors and the construction of new reactors. After decades of stagnation, the nuclear industry is expanding as countries seek secure sources of energy to meet growing demand. Fossil fuels still dominate the energy mix, but with concerns growing over their environmental impact, nuclear energy is finding growing acceptance. While estimates of new reactor construction vary, conservative projections place the number at over 100 between now and 2030.

In Canada there is a similar desire to find energy sources that are economical and produce lower greenhouse gas emissions. There are currently 18 nuclear

reactors in operation or undergoing refurbishment, all of which use CANDU technology. Ontario has launched a competitive process to construct two new reactors. New Brunswick, Alberta and Saskatchewan are also assessing prospects for new reactor construction. What is new is that for the first time, AECL is facing competition in Canada from global competitors. The participation of AREVA and Westinghouse/Toshiba in the Ontario bid process brings home the evolution that has taken place in the nuclear industry. Restructurings, mergers and consolidations have led to the emergence of a small number of companies that are integrated, well-capitalized and global in their reach.

The Review of AECL

It is against the backdrop of a revitalized global nuclear industry that the review of AECL's structure was announced in November 2007 by the Minister of Natural Resources. Its purpose was to determine whether AECL's current structure is appropriate and best equips AECL and ultimately the Canadian nuclear industry to participate in the resurgent global nuclear industry. The Review was led by Natural Resources Canada, with the participation of the Departments of Finance and Justice and the full collaboration of AECL. National Bank Financial was hired to provide independent financial advice.

Three key policy objectives provide a framework for the Review: first, Canada requires safe, reliable and economic options to address its energy and environmental needs. Second, the costs of the Government's support of the industry need to be controlled and the return from its investment in the industry maximized. And third, the final outcome and structure of AECL should position Canada's nuclear industry to seize domestic and global opportunities.

The following is a summary by Natural Resources Canada of the findings and conclusions of the AECL Review.

The Review found that AECL's current mandate and structure hampers its success and development and does not maximize benefits for Canada. The two halves of the Corporation, the CANDU Reactor Division, and the Research and Technology Division, have distinct mandates, resource and management needs. Over the medium term, the status quo will place the execution of key projects under pressure, expose the Government as shareholder to undue financial risk, and potentially limit Canada's participation in the global supply chain.

The Review concluded that the CANDU Reactor Division is too small to establish a strong presence in the high growth markets that are a key to its success. The activities of the Research and Technology Division, while meeting essential public policy requirements, can be managed in a more focussed manner and still provide for innovative approaches.

At the same time, the Review highlighted AECL's strong industry credentials, its valued intellectual property and highly trained labour force. AECL employs some of the best and brightest engineers and scientists in the nuclear business. Its workforce is a tremendous value to the Corporation, and to Canada.

National Bank Financial found significant private sector interest in investing in AECL's commercial operations and thereby expanding opportunities for Canada's nuclear industry. It also found private sector interest in participating in the management of CRL, through alternative approaches such as a government-owned/company-operated arrangement.

Conclusions

The Review concludes that AECL should be restructured. The business model for AECL must be changed to allow Canada's nuclear industry to fully participate in the nuclear industry's global expansion. Successful participation in the commercial reactor business depends on partnering with corporations that have global scale to leverage AECL's technology, skills, experience and capabilities. A potential partner could bring new opportunities to the restructured business and the Canadian nuclear industry writ large.

CRL similarly would benefit from a strong partner to drive innovation and renewal, while ensuring safe and reliable operations. A government-owned/company-operated approach in which ownership of the existing facilities and the policy mandate and funding would rest with the Government, with the operation of those facilities contracted to one or more third parties through a competitive process, should be considered.

In general, a restructuring of AECL could inject strength in the nuclear industry in Canada, creating a culture of growth, a culture of innovation and a culture of leadership. The Government would continue to play a key role in the nuclear industry including its regulatory responsibilities and its ownership of CRL.

Given the wide-ranging impact a restructuring of AECL could have on the Canadian nuclear industry and others, it would need to be accompanied by a broad engagement strategy with AECL's many stakeholders. An important consideration would be the impact of any restructuring on AECL's employees, who are the Corporation's most valuable asset. Their interests, therefore, should be at the forefront throughout this process.

REPORT

Introduction

Through over 60 years of development, Canada has built an integrated nuclear industry covering virtually the entire nuclear fuel cycle. The Canadian industry comprises uranium exploration and mining, conversion and fuel fabrication, the design, manufacturing, servicing and refurbishment of nuclear reactors, their operation by public and private utilities, and the management of radioactive waste. Canada is the world's largest producer of uranium, supplying approximately one-quarter of global demand. The industry generates $6.6 billion per year in economic activity, over 30,000 jobs, and $1.2 billion in exports. AECL has been a driving force of Canada's nuclear industry, as the designer and vendor of CANDU reactors and the focus of nuclear research.

The strength of Canada's nuclear industry is mirrored by strong and independent regulation. In Canada, nuclear activities, including the production and use of nuclear materials are regulated to the highest international guidelines by the Canadian Nuclear Safety Commission, an independent, quasi-judicial body.

Both globally and domestically, interest in nuclear energy is on the rise as public perceptions change and the economics of nuclear generation become more favourable. Nuclear generation is viewed as one of the few base load options that can help address growing concerns over greenhouse gas emissions and energy security. Improvements in operability and economics make nuclear generation an attractive power supply source. In Canada, nuclear energy accounts for 15 percent of the country's electricity supply, and fully 50 percent in Ontario, where much of Canada's nuclear industry is located. In view of the Government's target to generate 90 percent of power from non-greenhouse gas emitting sources by 2020, nuclear energy will remain a key part of Canada's energy mix in the future.

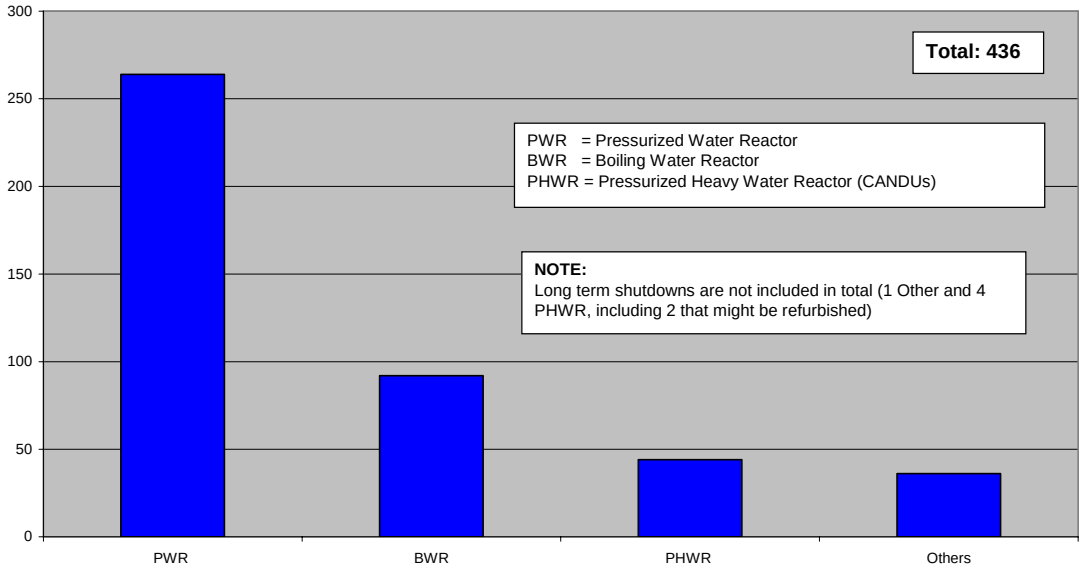
The nuclear industry has been rapidly evolving to respond to current and expected new demand. Recent years have seen a number of consolidations and mergers in the industry, leading to the emergence of well-capitalized global companies, such as Westinghouse/Toshiba and GE/Hitachi. They are joined by France's state-owned AREVA, the only company active in all areas of the nuclear fuel cycle.

AECL has a small but well-established place in the global nuclear industry. Its CANDU technology accounts for roughly 10 percent of the installed base of operating reactors and 100 percent of the installed nuclear capacity in Canada. AECL's monopoly in the Canadian marketplace and its prospects elsewhere are being put to the test in the competitive process now under way in Ontario to construct two new nuclear reactors. AECL's bid is based on its Generation III

reactor, the Advanced CANDU reactor (ACR) which is currently completing development. Whether the ACR is able to succeed against competitors and expand AECL's global reach - and by extension that of the Canadian nuclear industry - depends not only on the technical merits of the ACR, but on critical decisions regarding AECL's future.

Figure 1

Nuclear Power Plants
Operational Reactors by Type



Source: © 2009 International Atomic Energy Agency, *Power Reactor Information System*

Against the backdrop of an evolving and expanding nuclear industry, the Minister of Natural Resources launched a review of the structure of AECL in November 2007 to determine whether the Corporation's current structure is appropriate and best equips AECL and the Canadian nuclear industry to participate in the growing demand for nuclear energy. The Review was led by Natural Resources Canada with the participation of the Departments of Finance and Justice and the full collaboration of AECL. National Bank Financial was hired to provide independent financial advice to the Review Team. The following is a summary by Natural Resources Canada of the findings and conclusions of the AECL Review.

The Global Marketplace

While the desire for good governance and fiscal prudence provide ample reason for undertaking a review of AECL's structure, equally compelling is the fact that opportunities for companies in the nuclear reactor business are expected to remain strong for decades to come. AECL's reactor business, and by extension

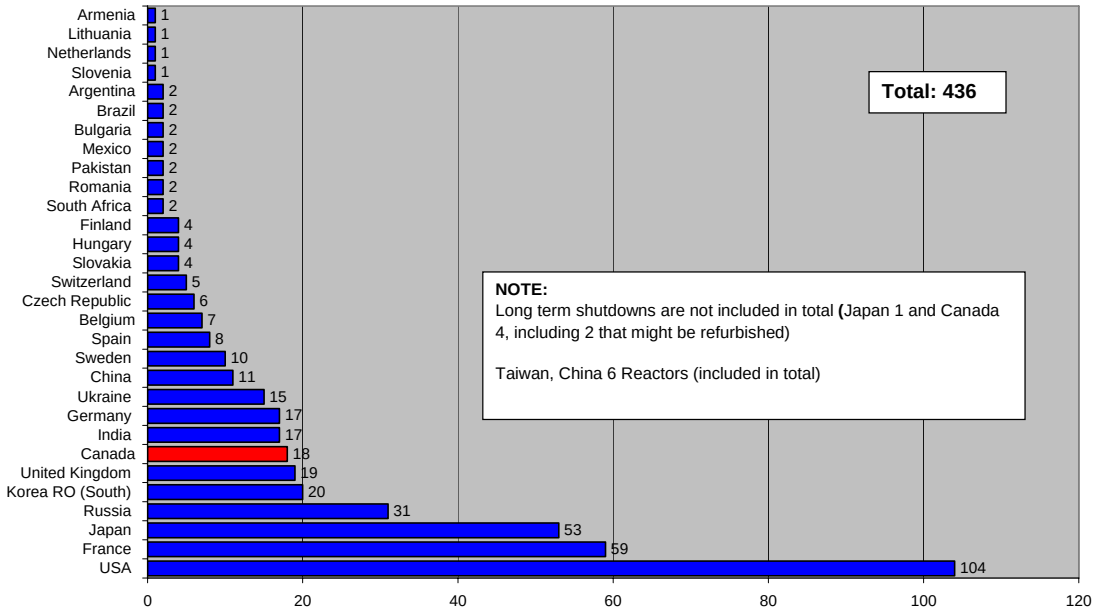
the Canadian nuclear industry, can be an important part of this resurgence if it is positioned to succeed.

A number of factors lie behind the re-emergence of nuclear energy in recent years. First is continued growth in energy demand. The most recent projections from the International Energy Agency point to a 45 percent increase in demand for energy between 2006 and 2030 in response to economic and population growth. Much of this growth comes from developing countries, China and India in particular. The two countries account for fully half of the increase in energy demand over the period. The increase in energy demand is driven in large measure by growing demand for electricity. The International Energy Agency projects electricity demand to rise by some 80 percent between 2006 and 2030, with growth rates again strongest in Asia.

The growth in demand for electricity in countries such as China and India provides considerable optimism that the demand for nuclear energy will also grow. Adding to this optimism is the fact that much of the current nuclear capacity dates to 1970s and 1980s and requires either refurbishment or replacement. More than 75 percent of the world's current fleet of 441 nuclear reactors (five of which are not operational) are 20 years or older and 25 percent are over 30 years old. This is particularly the case in the United States where more than 80 percent of the country's 104 reactors have received licences for extension or refurbishment.

Figure 2

Nuclear Power Plants
Operational Reactors by Country



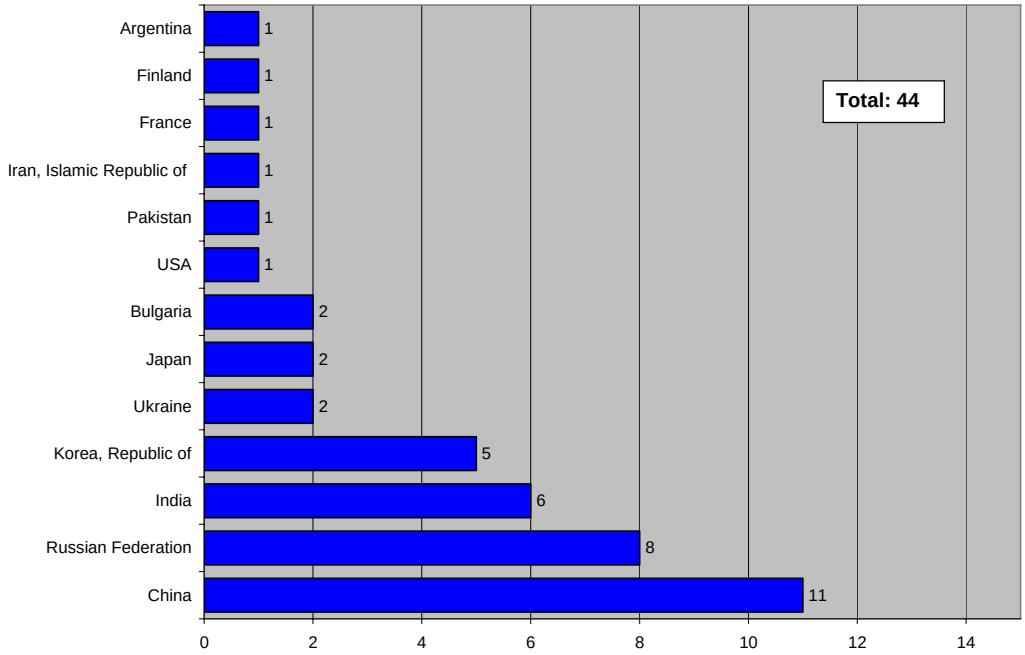
Source: © 2009 International Atomic Energy Agency, *Power Reactor Information System*

Nuclear energy is of course not the only option available to countries looking to either replace existing nuclear capacity or meet future energy demand. Fossil fuels will continue to be the primary source of energy for decades to come, but price volatility, concerns over the security of supply, the desire to reduce greenhouse gas emissions, and shifting public perceptions towards nuclear energy are leading more countries to consider nuclear energy as a cost effective and environmentally viable alternative to fossil fuels.

Relative economic costs are also contributing to the attractiveness of nuclear energy. Shorter construction times and higher operating efficiencies have strengthened nuclear energy's competitive position vis-à-vis fossil fuel generation, even in the absence of regulatory or other measures to control greenhouse gas emissions.

In sum, these factors have combined to foster a resurgence in the nuclear industry. Globally, 44 reactors are currently under construction.

Figure 3
Nuclear Power Plants
Reactors Under Construction by Country

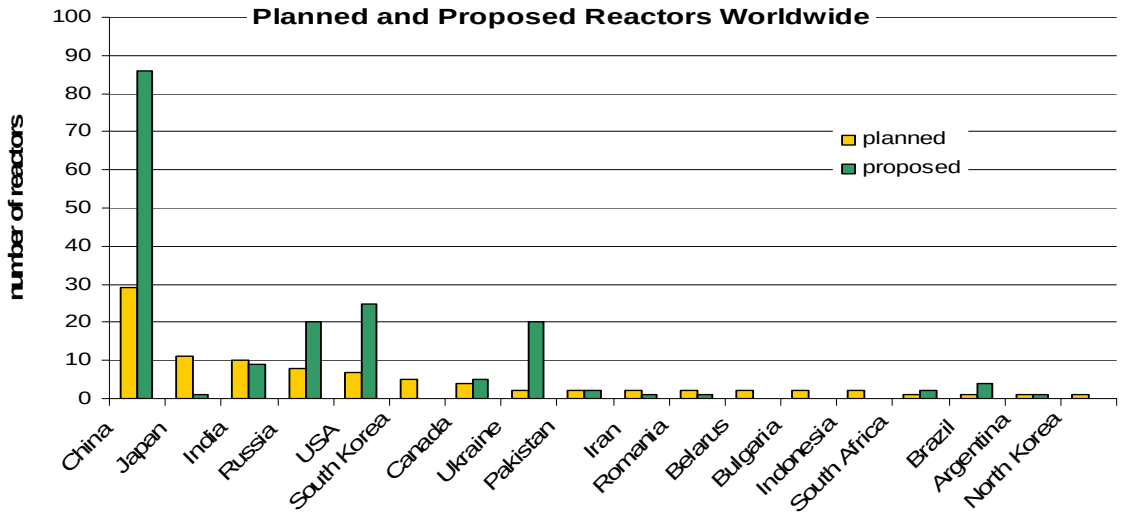


Source: © 2009 International Atomic Energy Agency, *Power Reactor Information System*

The International Energy Agency estimates that up to 100 new reactors could be built by 2030 to respond to energy needs. In the United States alone, applications for 26 new reactors are under review by the country's regulatory commission. Other estimates of future reactor builds are much higher. For example, the World Nuclear Association reported in March 2008 that at least 228 nuclear reactors are planned or proposed over the next 15 years with the strongest demand expected in China, India, the United States and Russia. This

represents opportunities of as much as $400 billion in markets open to competitive processes.

Figure 4



Source: World Nuclear Association
Note: Planned and proposed are defined as;
1) Planned – approvals, funding or major commitment is in place, mostly expected in operation within eight years
2) Proposed – clear intention or proposal but still without firm commitment to proceed.

Part of this global demand for nuclear energy will come from Canada, either in the form of refurbishments or the construction of new reactors. Refurbishment projects are ongoing in Ontario, New Brunswick and Quebec. In addition to Ontario's plan to construct two new reactors, New Brunswick is also considering building a new reactor at Point Lepreau. Alberta may follow suit as well and Saskatchewan has expressed strong interest in further developing its nuclear value chain.

The National Energy Board projects energy demand in Canada to grow by 1.4 percent annually to 2030. The choice of nuclear energy in Canada's overall energy mix will be driven by the desire for cleaner forms of power production and the improving economics of nuclear energy production.

AECL and the Canadian Nuclear Industry

AECL stands at the centre of the Canadian nuclear industry. Annex A provides a detailed description of AECL's governance, structure and funding. Over the decades, its prospects and those of the industry have become inextricably linked. AECL employs over 5,000 employees primarily at its headquarters in Mississauga, Ontario and nuclear laboratory in Chalk River, Ontario. A further 25,000 jobs are linked to the nuclear sector, many high skilled and high paying. The Canadian nuclear industry consists of over 120 companies, located largely in Ontario. These companies constitute AECL's supply chain, with their processes and prospects linked to AECL's commercial operations and the CANDU

technology. Annex B identifies some of the major players in the Canadian industry.

AECL's contributions to the nuclear industry have been based on its development of heavy-water CANDU nuclear reactor technology. The CANDU design, although significantly different in engineering concept from the light-water designs used in the majority of installed world power reactors, has a number of significant advantages. In particular, it is fuel-flexible; it is capable of utilizing thorium, rather than uranium, as fuel. Thorium is more abundant than uranium and the thorium cycle is of particular interest for countries with significant thorium resources but little or no uranium, such as India and China. In addition, CANDU can use spent fuel from light-water reactors as fuel, both maximizing the energy content of the fuel while, at the same time, "burning" the highly-radioactive materials that make long-term storage of spent fuel difficult. Finally, fuel flexibility allows CANDU to assist with nuclear disarmament through its ability to efficiently use mixed-oxide fuel, where weapons-grade plutonium from decommissioned nuclear weapons is mixed with depleted uranium to fuel the reactor.

In addition to the CANDU's fuel flexibility, it has design and operational advantages that increase its efficiency and heighten safety. Advantages such as online refueling have led to some of the highest operating efficiencies for reactors on record. The design itself enhances safety in two ways: it reduces the risk of a loss-of-coolant accident and its heavy water moderator acts as a heat sink, carrying away excess heat in the event of a pressure tube overheating.

Finally, pressure tubes are relatively simple to manufacture, and so the CANDU design is not reliant on access to the few remaining manufacturers with industrial facilities capable of producing the large forgings required for pressure vessels.

The design features of the CANDU reactor also serve as barriers to possible use of the reactor to produce nuclear weapons. While the risk of proliferation from a nuclear power reactor exists in theory, in reality proliferation is a remote possibility for any type of power reactor. In the case of the CANDU reactor, the risk is further reduced by the fundamental physics of heavy-water reactors.

The CANDU reactor produces roughly half the plutonium of a light water reactor. To acquire a weapons-usable quantity of fissile material, between 100 and 200 highly radio-active fuel bundles, weighing three to four tonnes each, would need to be diverted and subsequently reprocessed, without detection. CANDU's online fuelling feature provides a further safeguard as fueling is a highly controlled and automated process that is easily tracked and verified. Finally, CANDU reactors use natural or, in the case of the ACR, slightly enriched uranium. This means that countries with CANDU reactors have no need to develop an indigenous enrichment capacity, which could subsequently be used for weapons purposes.

There are currently 18 CANDU reactors in operation or being refurbished in Canada, with all but two - Gentilly in Quebec and Point Lepreau in New Brunswick - located in Ontario. Beyond Canada's borders, AECL has successfully exported its CANDU technology to China, Korea, Romania and Argentina. Significantly, in an industry characterised by delivery delays and cost overruns, AECL delivered these projects on-time and on-budget. This record reflects the capabilities of AECL's highly trained workforce.

AECL Organization and Mandate

AECL is an agent Crown Corporation whose shares are wholly owned by the Crown. Created in 1952, AECL reports to Parliament through the Minister of Natural Resources and is subject to the Financial Administration Act. Notably, its status prevents AECL from accessing capital markets and from making equity investments. AECL manages its operations through its Corporate Plan which is approved annually by the Government. Funding is similarly provided to AECL on an annual basis through the Budget process. Expenditures are then strictly pegged to activities that were profiled and estimated in the Corporate Plan. This contrasts with both the multi-year approach to planning and investment that a commercial enterprise involved in long-term, capital-intensive projects would pursue as well as the flexibility of re-profiling approved budgets to meet opportunities and challenges as they arise.

While much of AECL's activities are tied in one way or another to the development, sales and servicing of CANDU reactor products, the Corporation has a broader mandate. It must manage its commercial activities while carrying out a public policy role that spans nuclear research and technology, waste management and medical isotope production.

AECL's organizational structure reflects these dual roles. Two operational Divisions currently exist. The CANDU Reactor Division is responsible for the Corporation's commercial activities and includes two main activities, the refurbishment and servicing of existing reactors and the development and marketing on new reactors. Most of AECL's commercial reactor business and engineering work takes place in Mississauga.

The Research and Technology Division manages AECL's public policy business activities. These include the development of new reactor technologies and medical isotope production, as well as managing nuclear waste, decommissioning and legacy liabilities. Much of this work takes place at the Chalk River Laboratories (CRL) and is primarily conducted on a non-commercial basis.

Notwithstanding this organizational structure, the reality is that the two Divisions have inter-related business operations and considerable overlap and multitasking by personnel occurs between different units. At times AECL has had to use earnings from its commercial business to fund necessary public policy expenditures at Chalk River, as opposed to strengthening its commercial operations. This blurring of mandates and accountabilities ill serves both the Corporation's interests and broader public policy interests.

The Policy Context

A number of key policy considerations have served as the basis for examining possible options. First and foremost is the premise that Canada is as a matter of principle committed to remaining a leading civilian nuclear energy country and will thus continue to support its domestic nuclear industry. Financial support is the most concrete demonstration of this commitment. The Government has allocated $1.74 billion to AECL since 2006/07 to maintain safe and reliable operations at CRL and for the continued development of the ACR reactor. This commitment also finds expression in actions such as the Government's adoption of a plan for the long-term disposal and management of nuclear waste and in the introduction of legislation to modernize Canada's nuclear liability regime.

Beyond this basic premise, three policy objectives anchored the examination of options in the Review. First, Canada requires safe, reliable and economic options to address its energy and environmental needs. Second, the costs of the Government's support of the industry need to be controlled and the return on its investment in the industry maximized. And third, the final outcome and structure of AECL should position Canada's nuclear industry to seize domestic and global opportunities. In sum, these policy considerations speak to an outcome that will help Canada maximize opportunities in the global marketplace, manage more effectively the federal investment in AECL and reduce the Government's exposure to financial risk.

The Case for Restructuring

The distinct functions and objectives of AECL's two operational Divisions represent a point of departure for the analysis undertaken by the Review. A basic question is whether AECL can compete effectively with global reactor companies with its current governance, mandate and structure. Can AECL's commercial operations develop sufficient scale, can they be sufficiently focussed and aggressively pursued, while the Corporation is simultaneously charged with carrying out public policy responsibilities?

The Review's analysis revealed a Corporation trying to manage two Divisions with very different objectives and subsequently different measures of success and different needs. One Division is profit-oriented. To succeed it requires a market savvy management approach and access to risk capital. The business of

the other is research and technology development and while it has commercial opportunities, these have not been a primary motivator for its work. Its success has been defined in terms of its ability to respond to public policy imperatives.

In trying to fulfil both its commercial and public policy mandates, AECL has not been able to bring the necessary focus each Division requires. Moreover, pursing both mandates has blurred accountability. Finally, from a financial position, CRL has represented a draw on the limited commercial revenues available to AECL to expand its reactor business. AECL has not been profitable for the last five years as a consolidated entity, a situation that persists despite the commercial revenue it has generated and the infusion of significant government funding. This underscores the structural nature of the problem facing AECL.

Given these factors, the Review found that the optimal outcome for the Corporation and the broader interests of the Government lies in restructuring AECL. The desired outcomes of such a restructuring, based on the policy framework described previously include:

- improving access to key growth markets and maximizing Canadian participation in these markets;
- providing access to capital;
- risk sharing with private partners;
- contributing enhanced project planning and management resources; and
- maximizing employment in Canada.

Annex C illustrates the link between the policy drivers for the Review and the desired outcomes of a restructuring.

Building a Successful Commercial Nuclear Company

In the past decade, the nuclear industry has evolved through acquisitions, mergers and restructurings. These changes have been motivated in part by clients' expectations for on-time and on-budget delivery of nuclear projects and in part by a need to acquire sufficient scale to accommodate risk and manage cash flow when project revenues are uneven. They are also a reflection of the industry's unique character – the fact that the nuclear reactor business is capital intensive; it requires large and ongoing investments in research and innovation; and it places a premium on marketing skills to develop and expand markets. A small number of large, well-capitalized and integrated companies have emerged in recent years in response to these needs, most notably AREVA, Westinghouse/Toshiba and GE/Hitachi. In general, the focus of these companies is threefold: ensuring access to major markets; securing highly specialized and scarce resources; and, acquiring sufficient scale to win multiple contracts and deliver on multi-billion dollar projects. An overview of the key global nuclear companies is presented in Annex D.

Unlike its main competitors, AECL is not part of an integrated alliance. AECL has attempted to overcome this limitation by forming Team CANDU with SNC-Lavalin Nuclear, GE-Hitachi Nuclear Energy Canada, Hitachi Canada Ltd, and Babcock and Wilcox. This partnership has helped AECL to operate in Canada and enabled it to penetrate some international markets in emerging economies. It has not furthered however its ability to penetrate mature Western markets or to expand its operations beyond the supply of nuclear power generating stations.

Figure 5
Operations of Key Global Nuclear Companies

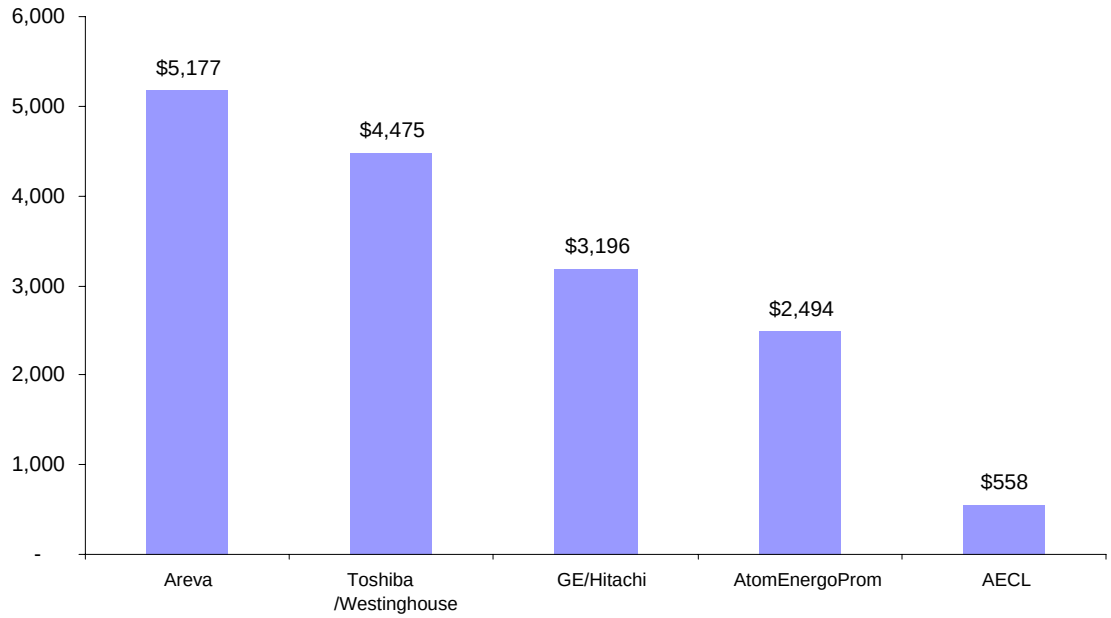
	Reactor Tech.	Functions						
		Mining / Uranium	Conv. / Chemistry	Enrich-ment	Uranium fuel	Reactors & Services	Treatment	Recycling (MOX fuel)
AREVA	~ European Pressurized Reactor (EPR) ~ 1,600 MW-class PWR	✓	✓	✓	✓	✓	✓	✓
Westinghouse / Toshiba	~ AP1000 (a form of PWR)	✓	✓	✓	✓	✓	✓	
GE-Hitachi	~ Advanced Boiling Water Reactor (ABWR) ~ ESBWR, a Gen III+ BWR reactor			✓	✓	✓	✓	✓
Mitsubishi	~ Advanced Pressurized Water Reactor (APWR)	✓	✓	✓	✓	✓	✓	✓
AECL	~ Enhanced CANDU 6 (EC-6) ~ Advanced CANDU Reactor (ACR-1000)					✓	✓	

Source: National Bank Financial

In contrast, many of its competitors have vertically integrated operations with capabilities that span the nuclear fuel cycle (mining, enrichment, power generation, reprocessing and waste management), as illustrated in Figure 5 above. Whether it is born out by evidence, there is widespread expectation that such integrated companies will be the primary beneficiaries of the global nuclear resurgence.

Further impeding AECL's ability to compete is its size (see Figure 6 below). In the nuclear industry size matters - large integrated companies are better able to access capital, absorb risk and manage cash flow.

Figure 6
Reactors, Services and Fuel Revenues, 2008 (C$2008)



Source: Natural Resources Canada, AECL Annual Report, 2008, AREVA Annual Report 2008

Simply put, AECL does not have the critical mass or financial strength to establish a strong presence into the key markets that will ensure its success. Moreover, its reliance on government funding and approval processes in managing commercial projects valued in the billions of dollars places it at a further disadvantage. Remaining a niche player, however, will not generate sufficient demand for new reactor construction to make the CANDU Reactor Division a viable business. The likely result would be a withering of the commercial division, which would in turn put in jeopardy the broader nuclear industry in Canada. The status quo is thus not a viable option.

Opportunities for the Research and Technology Division

AECL has its roots as a research and development engineering organization and in the decades since its founding, the quality of work at CRL has been widely recognized. CRL performs critical public policy functions – it ensures the safe and efficient operation of Canada's nuclear platform, carries out applied research for the development of new reactor designs, produces medical isotopes, undertakes advanced materials research, accepts and manages nuclear waste generated at universities and hospitals and manages the Government's legacy liabilities dating from the inception and development of nuclear energy in Canada. Its activities cover the entire spectrum of peaceful and safe nuclear energy use.

CRL represents Canada's largest scientific research establishment, has a well-established international reputation, and solid partnerships with universities and research organizations in Canada and abroad. Over 2,000 people work at CRL on a full-time basis and 200 scientists visit CRL each year as part of the National Research Council's program of advanced materials research at the Canadian Neutron Beam Centre.

Like all national nuclear laboratories, CRL is supported by significant public funding. The financial costs facing CRL are increasing for several reasons. First, the support provided from the CANDU Owners Group (see Annex B) for CANDU-related CRL activities has declined significantly over the last fifteen years and is less than a fifth of the levels experienced in the early 1990's. Second, AECL is now managing a major 80-year program dealing with Canada's nuclear legacy liabilities, largely associated with the Cold War activities at CRL, the production of medical isotopes, and the early development of CANDU technology. The total liability is estimated at $2.7 billion and an initial $500 million, five-year program is now underway, with Natural Resources Canada performing an oversight role.

Lastly, CRL is facing substantial costs to restore its aging infrastructure, some of which dates from the early 1950s, to meet modern and more stringent regulatory requirements for health, safety, security and environmental protection.

In contrast to the commercial division, the primary issue surrounding CRL's future is not whether it can become a profitable, commercially viable enterprise, but whether its activities are focussed, driven by innovation and managed optimally. That being said, some CRL activities could be developed on a more commercially-oriented footing, including the research and development services performed for the CANDU Reactor Division. These services may also be of interest to other reactor manufacturers. Similarly, there may be opportunities to market CRL's waste management services both domestically and internationally.

The Options for AECL

The Review examined a number of alternative structures for AECL. These options, described briefly below, were assessed in relation to AECL as a whole and for each of the Divisions separately. The findings are presented in summary form, given their commercially sensitive nature.

Public-Private partnership: this option entails a partnership between the Government and a private partner(s) in which ownership is maintained by the Government. The private partner assumes or shares the risks associated with economic performance and provides capital to develop and support business activities.

Government-owned/company-operated: under such an arrangement, the Government maintains ownership, with an outside partner responsible for

managing operations. This partner would share operating risks but would not provide capital.

Strategic alliance: a strategic alliance with one or more partners could take many forms, including project specific joint ventures, mergers or the sale of an equity position in which the Government retains either a majority or minority ownership position.

Divestiture: under this option, the Government would sell 100 percent of its equity interest in all or part of the Corporation to a private partner(s).

National Bank Financial found significant private sector interest in AECL's commercial operations, a testament to the CANDU brand and the skills and expertise of the AECL work force. By contrast, there was little private sector interest in an ownership position in the Research and Technology Division – this is not surprising as one would not expect a private sector company to be interested in funding public policy driven activities or sharing liabilities with the government. National Bank Financial did, however, find private sector interest in participating in the management of CRL; indeed several observations were made by the private sector on opportunities for investment and improvements that could be made in operations at Chalk River.

With respect to the CANDU Reactor Division, the Review found that the formation of a strategic alliance has the potential to further all of Canada's key policy objectives. The specific form of such a restructuring requires further consideration. What is essential is that through new partnerships or alliances, the commercial reactor business acquires sufficient reach and capacity for it and the Canadian nuclear industry to participate in those markets where growth is strongest, while also contributing to meeting energy needs in this country. The involvement of private partners would moreover enable the Government to share the significant upfront capital costs of reactor development, as well as both the financial risks associated with the commercial nuclear business and the benefits from future revenue streams.

The Review found that management of CRL's operations through a new model, such as a government–owned/company-operated arrangement, would best serve the Government's policy objectives. Continued public ownership would enable the Government to maintain control and direction of the programs and policy work at CRL, while private sector involvement could sharpen focus and drive innovation.

This option provides the possibility of diversifying funding sources from the private sector, for example from waste management and decommissioning activities, thereby helping to manage costs for the Government. It is a model that has worked well in other jurisdiction, most notably in the United States and the United Kingdom.

A decision to restructure AECL would need to take into account external developments since the launch of the Review. Chief among these is the conduct of the competitive process for reactor new builds in Ontario in which AECL is participating. Clearly, any restructuring of AECL must respect the terms of the Ontario process. The restructuring plan will also need to reflect on the impact of the global economic and financial crisis that, without affecting fundamental trends, may alter some elements of the commercial landscape for the nuclear industry in the short to medium term.

The success of any restructuring scenario depends on leveraging the expertise that Canada's has created over the last sixty years. One of the key findings of the Review is the widespread recognition of the quality of AECL's highly-specialized labour force and the strength of the whole Canadian nuclear value-chain. AECL employs some of the best and brightest engineers and scientists in the nuclear business, and serves as a training platform for the entire Canadian industry. This workforce represents tremendous value to Canada.

Conclusions

The Review finds that as organized and governed, AECL is not positioned for success. With its current structure and mandate, the Corporation is not able to fully achieve Canada's nuclear policy objectives. Moreover, AECL is limited in its ability to establish a strong presence in today's global nuclear industry. With the industry on a path toward continued expansion, the time to act is now.

Success in the nuclear industry today requires scale, financial strength and access to growing markets. Compared to its competitors, AECL is undersized and undercapitalized. These factors constrain AECL from realizing its full market potential. A restructured company in partnership with a strong commercial player(s) would better position the company for success nationally and internationally and increase opportunities for the Canadian nuclear industry, while mitigating the Government's exposure to commercial risk.

The activities carried out at CRL cannot be viewed through the same lens as the CANDU Reactor Division but CRL would similarly benefit from the contribution of a strong partner to drive innovation and renewal. With a focus on CRL's core responsibilities and competencies, the Government could seek a operating and management partner with the capacity to contribute risk capital, build new alliances with the private sector and academia, and develop new commercial opportunities in the domestic and export markets, while sharing in the benefits of any gains.

Based on the information available to it during the period of the Review, the Review Team concludes that:

1) AECL should be restructured to separate its commercial business activities (CANDU Reactor Division) from its research and technology activities;

2) The commercial activities of the CANDU Reactor Division can be best served by a strategic alliance with one or more partners with global scale that can leverage the technology, skills and experience of AECL in Canada and internationally.

3) A new approach, such as a government-owned/company-operated management model, should be pursued for CRL, along the lines practiced successfully in the United States and the United Kingdom. Ownership of the existing facilities and the policy mandate would stay with the public sector.

The Government would continue to play a key role in the nuclear industry including its regulatory responsibilities and its ownership of CRL.

The Review Team concludes that a detailed restructuring plan and negotiating mandates should now be developed. Given the wide-ranging impact a restructuring of AECL could have on the Canadian nuclear industry and others, it would need to be accompanied by a broad engagement strategy with AECL's many stakeholders. Another important consideration as this process moves forward is the impact of any restructuring on AECL's employees, who are one of the Corporation's most valuable assets. Their interests, therefore, should be at the forefront throughout this process.

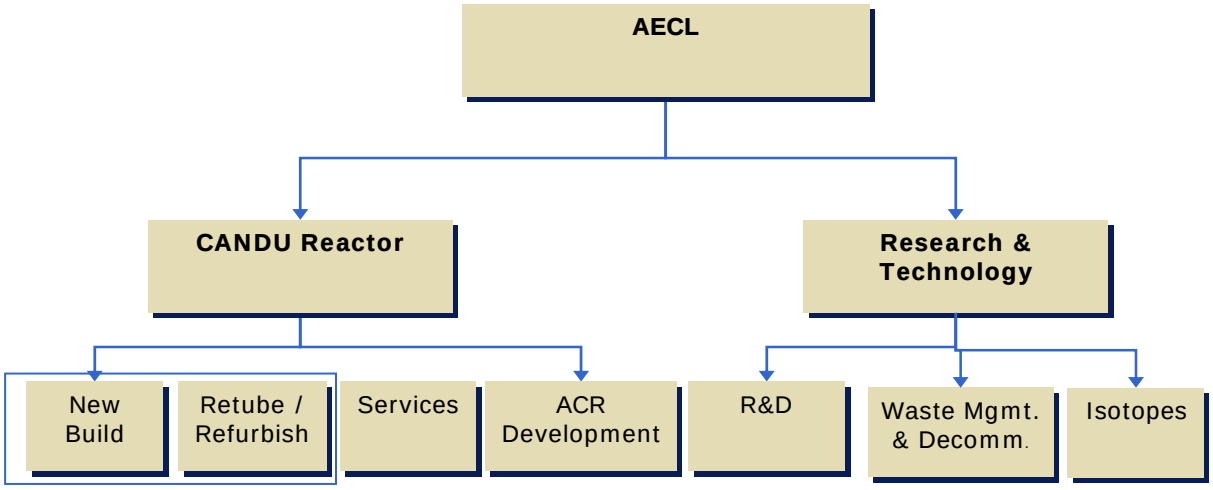
ANNEX A - Atomic Energy of Canada Limited (AECL)

Governance and Legislation

AECL was established in 1952. It operates as an agent of Her Majesty the Queen in Right of Canada under the authority of the *Nuclear Energy Act* to carry out and perform certain powers of the Minister of Natural Resources. In this capacity, AECL essentially undertakes research in, and prepares for the utilization of, nuclear energy.

AECL is a parent Crown Corporation under the *Financial Administration Act.*. It is wholly owned by the Crown, and it reports to Parliament through the Minister of Natural Resources. The relevant *Financial Administration Act* provisions set out financial management and control procedures. These provisions notably prevent AECL from borrowing money from any other source than the Crown and from making equity investments. As a result, AECL relies upon government funding, and government approvals for certain key decisions. Most importantly, it manages its operations through its Corporate Plan, which is approved annually by the government

Structurally, AECL is currently composed of two Divisions: the CANDU Reactor Division (CRD) and the Research and Technology Division (RTD), as seen below.



AECL is headquartered in Mississauga, Ontario where its design and engineering offices are located. AECL's research and development (R&D) facilities at CRL, Ontario provide R&D capabilities and expertise for AECL's commercial design activities, CANDU owners both domestically and abroad, and materials research for the National Research Council. AECL also produces medical isotopes using the National Research Universal reactor and other

facilities at CRL. Total employment at AECL is over 5,000, with 4891 employed on a full-time basis.

AECL, as the operator of nuclear facilities, is regulated by the Canadian Nuclear Safety Commission under the *Nuclear Safety and Control Act* and is also subject to regulations under the *Canadian Environmental Protection Act* and *Canadian Environmental Assessment Act*.

AECL Reactor Designs

AECL's flagship products are the Enhanced CANDU-6 (EC-6) 750 MWe reactor and the Advanced CANDU Reactor (ACR) 1200MWe. The EC-6 is essentially an upgrade of the original CANDU-6 first built at Point Lepreau, New Brunswick, and subsequently at Gentilly-2 in Quebec, Argentina, South Korea, Romania and China. The ACR, currently under development, is the technology proposed to Ontario in the ongoing competitive process.

The CANDU-6 design is a heavy water moderated and cooled reactor, with the moderator contained in a calandria incorporating horizontal pressure tubes containing the fuel bundles. It is fuelled by natural uranium, but can accommodate alternative fuel cycles, such as slightly enriched uranium, mixed-oxide (MOX) fuel, as well as light-water reactor spent fuel, and thorium.[1]

Aside from its flexible fuel cycle capability, the CANDU design has a number of operational advantages: it can be refueled while under power, thus allowing the operator to refuel and also optimize fuel burning without a fuelling outage. The large amount of cool heavy water in the calandria acts as an inherent passive safety system, by ensuring adequate cooling of the horizontal fuel channels in the event of a fuel bundle failure. In addition, the horizontal design minimizes potential exposure of the core in the event of a loss-of-coolant accident.

The ACR is an evolution of the original CANDU-6 design. It is also a heavy water-moderated, horizontal pressure tube design, but uses light water as a coolant and slightly enriched uranium as fuel. It incorporates more passive safety systems than the CANDU-6, and uses modular construction techniques (developed in the construction of the CANDU-6 units in China) to shorten construction time and mitigate costs.

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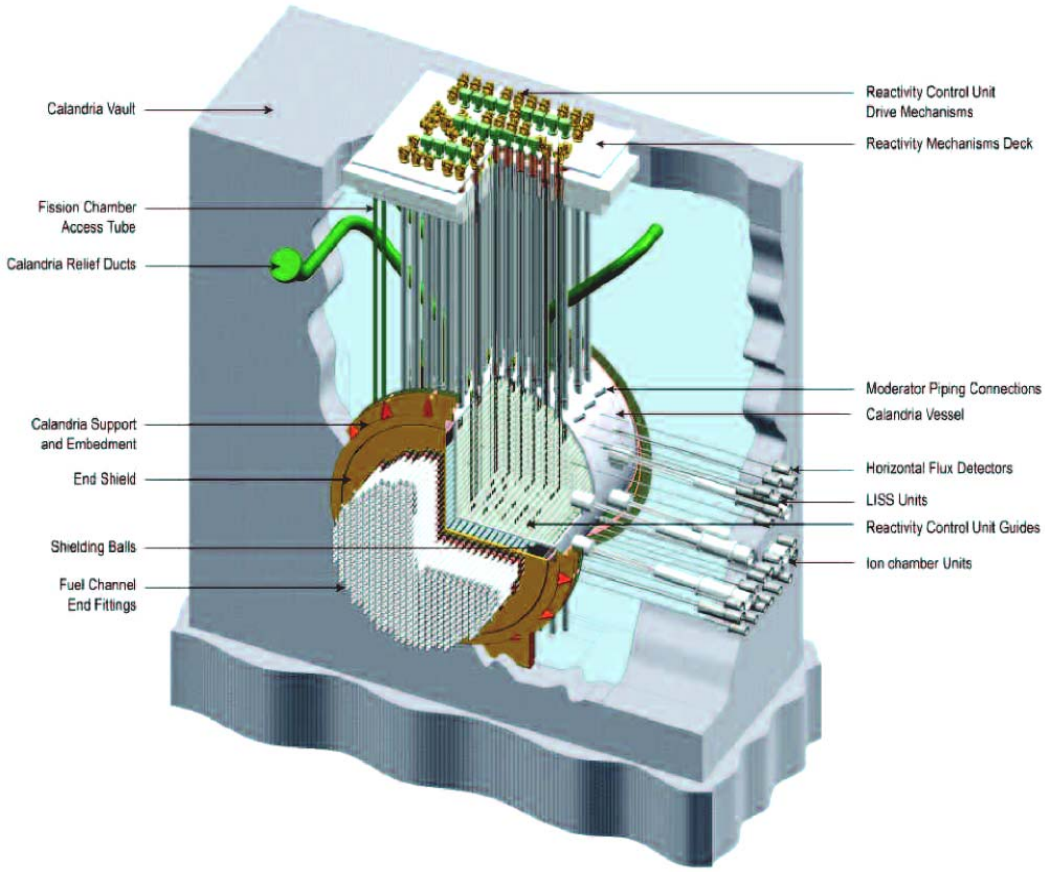
[1] The CANDU design, although significantly different in engineering concept from the light-water moderated designs used in the majority of installed world power reactors, has a number of significant advantages. In particular, it is fuel-flexible; it is capable of utilizing thorium, rather than uranium, as fuel. Thorium is more abundant than uranium and the thorium cycle is of particular interest for countries with significant thorium resources but little or no uranium, such as India and China. In addition, CANDU, through the DUPIC fuel cycle, can use spent fuel from light-water reactors as fuel, both maximizing the energy content of the fuel while, at the same time, "burning" the highly-radioactive actinides that make long-term storage of spent fuel difficult. Finally, fuel flexibility also allows CANDU to assist with nuclear disarmament by its ability to efficiently use mixed-oxide (MOX) fuel, where weapons-grade plutonium from decommissioned nuclear weapons is mixed with depleted uranium to fuel the reactor.

Figure A-1: Schematic of the ACR



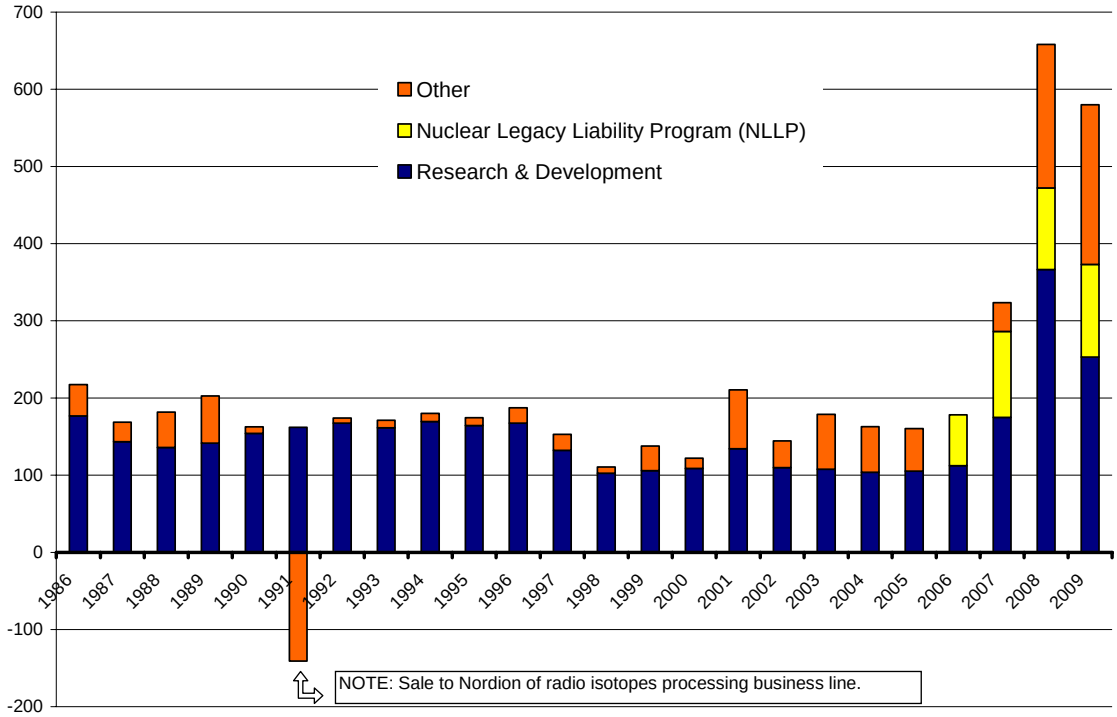
Government Funding of AECL

As an agent Crown Corporation subject to appropriations, AECL is funded through an on-going annual appropriation of $103 million, supplemented as necessary by single-year appropriations, including funds for the development of the ACR. Other income is derived from its commercial activities: new reactor design and construction, refurbishments, services, and medical isotope production.

In 2006, the federal government provided AECL with $510 million over five years to begin to address the legacy wastes that had accumulated at CRL as a result of the Laboratories' research since the 1940s. These funds are not provided to AECL directly, but are disbursed to the Corporation by Natural Resource Canada as AECL completes projects under the legacy waste liability program.

The following table outlines AECL appropriations since the 1986/87 fiscal year.

AECL Appropriated Funding since 1987 (millions)



ANNEX B - Major Participants in the Canadian Nuclear Industry

Uranium Sector	
Cameco	- Uranium producer, accounting for 15 percent of world production from its mines in Canada and the US; - Provider of processing services required to produce fuel for nuclear power plants; - Partner in Bruce Power, operator of the Bruce nuclear generating station in Ontario; - Publically-traded Corporation.
AREVA Resources Canada Inc (formerly COGEMA Resources Inc)	- Saskatchewan uranium producer - Wholly owned subsidiary of AREVA

Team CANDU	
AECL	- Reactor designer and vendor
Babcock & Wilcox Canada	- Manufacturer of steam generation products and services; - Supplier of over 297 CANDU and PWR steam generators worldwide, as well as other major plant components; - Experience in over 90 countries; - Dominates North American steam generator market; - Other capabilities include: engineering, project management, quality assurance, supply management; - Subsidiary of Babcock & Wilcox Power Generation Group, Inc.
GE-Hitachi Nuclear Canada	- Manufacturer of CANDU fuel bundles; - Wholly-owned subsidiary of GE-Hitachi Nuclear USA.
SNC-Lavalin Nuclear	- Wholly owned subsidiary of SNC-Lavalin, a leading engineering and construction company; - Global leader in the ownership of infrastructure, and in operations and maintenance services; - SNC-Lavalin has offices across Canada and in 30 other countries around the world, and are currently working in some 100 countries.
Hitachi Canada	- Manufacturer of turbine generators; - Subsidiary of Hitachi America, Ltd. (55 percent) and Hitachi, Ltd., Japan (45 percent).

Nuclear Power Generation	
Ontario Power Generation	- One of the largest producers of electricity in North America; - Operator of 3,500 MWe Darlington and 3,100 MWe Pickering nuclear power plants.
Bruce Power	- Canada's first private nuclear generator; - Partnership between Cameco Corporation, TransCanada Corporation, Ontario Municipal Employees Retirement System, the Power Workers' Union and The Society of Energy Professionals; - Leases Bruce A and B generating stations (eight CANDU reactors, six units currently operational); - Refurbishment of remaining two units at Bruce A under way.
Hydro Quebec	- Operates Gentilly-2 CANDU-6 power station; - Refurbishment of Gentilly-2 announced.
NB Power	- Operates Point Lepreau CANDU-6 power station; - Refurbishment of Lepreau currently under way; - Would operate second reactor if New Brunswick Government approves construction.

Industry Organizations	
Canadian Nuclear Association	- Non-profit organization established in 1960 to represent the nuclear industry in Canada by: - creating and fostering a political environment and reasonable regulatory framework for advancing the nuclear industry in Canada - encouraging co-operation between various industries utilities, educational institutions, government departments and agencies, and other authoritative bodies which have a common interest in the development of economic uses for nuclear power and radioisotopes; - providing a forum for the discussion and resolution of problems of concern to members, to industry, or to the Canadian public; and - encouraging co-operation with other associations with similar objectives and purposes - Currently has approximately 90 members

Organization of CANDU Industries (OCI)	- Membership of 122 companies in the Canadian nuclear industry; - Represent its membership in support of domestic and international equipment supply to the nuclear industry; - Provides a forum for exchange of information related to technical and quality issues with particular regard to the potential impact of such issues on the supply base for its members' products and services.
CANDU Owners Group (COG)	- Affiliation of CANDU Nuclear Power Plant Operators; - Provides a framework for co-operation, mutual assistance and exchange of information for the successful support, development, operation, maintenance and economics of CANDU technology; - Initiates and manages jointly funded research and development and updating of standard use computer codes to ensure safe and economic operation of CANDU stations.

Source: Canadian Nuclear Association

Detailed information on the companies in the Canadian nuclear supply chain can be found in the Industry Canada publication *The Canadian Nuclear Industry Capabilities Guide, 2008.*

ANNEX C - Policy Objectives and Evaluation of a Successful Restructuring

Policy Objectives	Evaluative Criteria for Successful Restructuring	Desired Outcomes in Successful Transaction(s)
1. Safe, reliable and economic options to address Canada's energy and environmental needs	Ability to efficiently deliver projects on time and on budget	- Bring in commercially-driven project planning and management, increased execution capacity
	Ability to ensure long-term reliability / regulatory oversight of nuclear fleet	- Regulatory and industry resources available to meet requirements and assure safety, security under new structure on predictable timeline and at reasonable cost
2. Control costs to the government while maximizing return on investment	Reduced reliance on government funding and fiscal exposure to commercial risk	- Maximize risk sharing with private partner - Provide access to private capital, debt
	Improved competitiveness and efficiency (addressing dual mandate)	- Improve operational and financial management - Provide access to key growing markets
	Maximize return on Canada's investment in nuclear energy	-Obtain best value for participation in AECL or sale/licensing of intellectual property
3. Position Canada's nuclear industry to seize domestic / global opportunities	Optimize contribution of CRL to a globally competitive nuclear industry	- Management contract to optimize efficiencies / services - Secure commercial business for CRL from restructured reactor entity (e.g., CANDU Inc)
	Maximize and expand use of Canadian supply-chain domestically/internationally	- Maximize Canadian content / participation in domestic and global opportunities
	Maintain/grow expertise and highly-qualified professionals	- Maintain/grow level of jobs / design and engineering activities in Canada

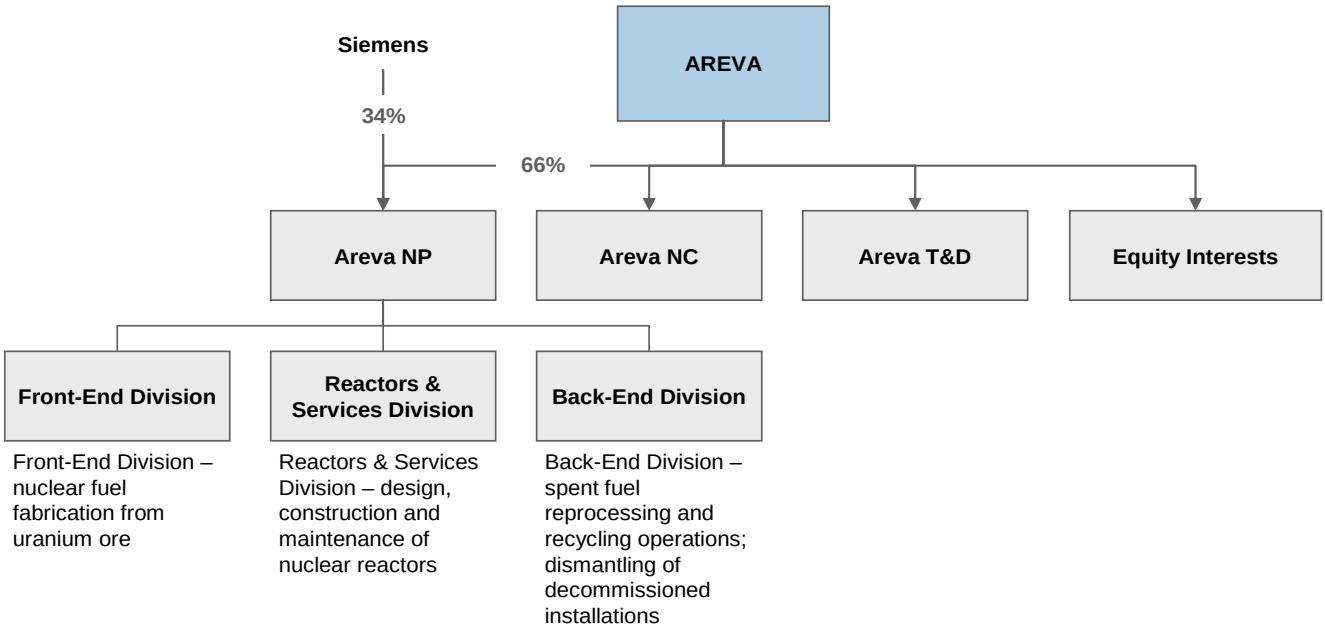
Annex D – Global Integrated Nuclear Companies

AREVA

AREVA covers all industrial activities in the nuclear power field. It has manufacturing operations in 43 countries, a sales network spanning more than 100 countries and over 75,000 employees worldwide. In 2008, AREVA generated sales of €13,160 million, approximately Cdn$20,800 million at current exchange rates.

Corporate Structure and Governance The French state owns 87 percent of this integrated nuclear conglomerate directly and a further seven percent through other state-owned institutions. (See Figure D-1 – AREVA Corporate Structure). A subsidiary, AREVA NP (formerly Framatome), is in charge of building the Evolutionary Power Reactor (EPR), a third-generation nuclear reactor. AREVA complements its reactor business with a second subsidiary, AREVA NC (formerly Cogema), controlling the whole nuclear fuel cycle, from mining to waste disposal. A third subsidiary, AREVA T&D, deals with power transmission and distribution.

Figure D-1 – AREVA Corporate Structure



Technology The EPR is a 1,600 MW-class Pressurize Water Reactor (PWR) that uses light water as both moderator and coolant. PWR technology represents 56 percent of the world's operational nuclear capacity. AREVA is currently building its first EPR in Finland, and a second one in France, and a third is planned for construction in France beginning 2012. Outside Europe, AREVA

secured a contract in China to build two units. In the United States, at least five proposed nuclear plants will adopt the EPR technology.

AREVA supports activities across the nuclear fuel cycle value chain with research primarily done in-house and by the *Commissariat à l'énergie atomique*. AREVA's organic R&D capabilities, however, are also supplemented by partnerships with French and German universities and research centres.

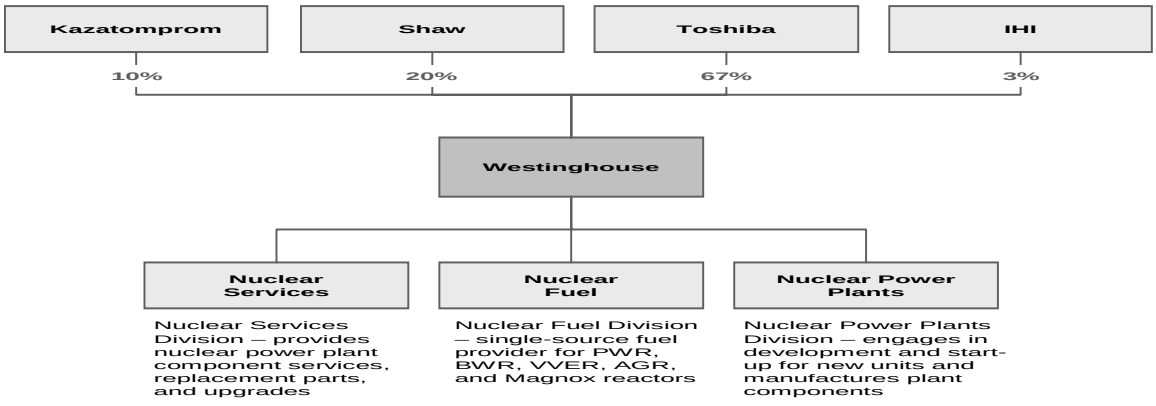
Germany-based electronics and engineering company Siemens holds a 34 percent interest in AREVA NP. On January 26, 2009, Siemens announced that it will withdraw its equity share from AREVA under the terms of a put agreement effective no later than January 30, 2012. AREVA and Siemens are currently discussing share valuation and timing in accordance with the agreement.

Westinghouse

Westinghouse, based in Pittsburgh, Pennsylvania, is a group company of Toshiba Corporation, which provides fuel, services, technology, plant design and equipment for the commercial nuclear electric power industry. Nearly 50 percent of existing nuclear power plants worldwide, and close to 60 percent in the United States, are based on Westinghouse technology. The company has nearly 8,500 employees worldwide.

Corporate Structure In 2006, Toshiba Group purchased Westinghouse from the British company BNFL for US$ 5.4 billion. Westinghouse Electric Company provides fuel, services, technology, plant design, and equipment to utility and industrial customers in the worldwide commercial nuclear electric power industry. Toshiba subsequently sold 20 percent of Westinghouse to the American Shaw Group, and 10 percent to Kazatomprom, a nuclear fuel supplier in Kazakhstan. This deal allows Toshiba to expand overseas, with Kazatomprom providing a potential fuel supply source for reactor purchasers.

Figure D-2 – Westinghouse ownership and corporate structure



Technology Westinghouse designs the AP1000, an advanced 1,117 to 1,154 MW PWR power technology that is an extension of its AP600 plant. In January 2006, the United States Nuclear Regulatory Commission approved the final design certification for the AP1000. Westinghouse has its own in-house R&D capabilities but also utilizes the laboratories of the United States Department of Energy. As of early 2009, the AP1000 technology has been identified for 9 nuclear plants that could be built in the United States.

In addition Westinghouse and the Shaw Group signed contracts in 2007 to provide 4 AP1000 nuclear power plants in China where initial construction is underway. Westinghouse also submitted a bid in 2008 for three nuclear plants in South Africa to be built by 2016.

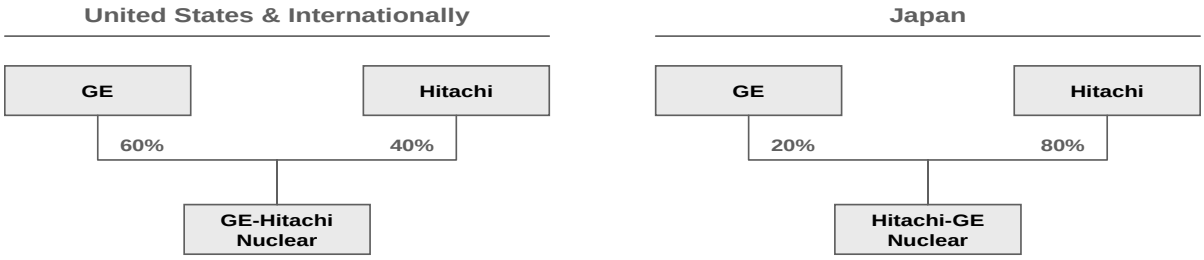
GE-Hitachi

Based in Wilmington, North Carolina, GE-Hitatchi is a leading provider of advance nuclear reactors and services.

Corporate Structure In June 2007, Hitachi and GE formed GE-Hitachi Nuclear Energy Inc. Cross-sharing companies were then created: Hitachi-GE Japan to operate exclusively in Japan, and GE-Hitachi Nuclear Energy Inc. USA to operate worldwide, with GE-Hitachi Nuclear Energy Canada as a subsidiary. The operating arrangement between GE and Hitachi with respect to the joint venture is diagrammed below in Figure D-3.

The deal combines their nuclear power divisions into two jointly-owned companies, creating one of the world's most comprehensive nuclear power plant and services operations that will compete for new reactor projects around the world. The new venture will also offer key equipment and services for pressurized water reactors. GE-Hitachi, along with Toshiba, operates Global Nuclear Fuels, a fuel supply joint venture. In addition to these activities, a significant portion of GE-Hitachi Canada’s business is related to the manufacturing of CANDU fuel. The research and development that supports GE’s North American business includes in-house research conducted at a small research reactor in California and is supplemented by access to United States Department of Energy research facilities.

Figure D-3 – GE-Hitachi partnership structure



Technology The Advanced Boiling Water Reactor (ABWR) is the foundation of GE's nuclear reactor portfolio. GE's Generation III ABWR technology is used in four operating units in Japan. Another three units are under construction in Taiwan and Japan, and nine more units are planned in Japan. The ESBWR, the latest GE-designed Gen III+ BWR reactor is currently in the United States design certification process, with a commercial target for 2015. At least four companies have adopted this design for their proposed nuclear projects in the United States.

AREVA, Westinghouse and GE-Hitachi are the three most referred-to nuclear vendors. Mitsubishi and Rosatom are also significant industry players.

Mitsubishi Heavy Industries

Mitsubishi Heavy Industries is a Japanese conglomerate and leading global producer of heavy equipment. It has traditionally focused its nuclear activities on its home market, with twenty-three built reactors. It established a subsidiary, Mitsubishi Nuclear Energy Systems, to help expand the company's nuclear power efforts beyond Japan. In January 2008, the company submitted an application for standard design certification for its latest Advanced Pressurized Water Reactor (APWR) technology to the United States Nuclear Regulatory Commission. Luminant Power, located in Dallas, Texas, has selected the Mitsubishi APWR design for its planned new nuclear power plant at Comanchi Peak. In February 2009, it formed a joint venture with Mitsubishi to build and operate the two proposed units. In addition to its commercial activities, the company has five laboratories concentrating on R&D closely tied to specific technologies, and one Advanced Technology Research Center focusing on leading-edge research into technologies of the future.

Rosatom (AtomEnergoProm)

AtomEnergoProm is 100 percent controlled by state-owned holding company Rosatom. Created in 2007 to unite the Russian civil nuclear industry, Rosatom is an amalgamation of previously independently operated nuclear companies which cover the full nuclear power engineering cycle from uranium mining to nuclear energy generation. The company acts as a general supplier of equipment and

materials and/or as a general contractor for construction of nuclear power plants and other nuclear projects abroad. Subsidiaries include Concern Enrgoatom (largest nuclear electricity generation company in Russia), TVEL (17 percent of global nuclear fuel supplier) and TENEX (40 percent of global uranium enrichment services market). Amalgamation is expected to be completed by the end of 2009.

Rosatom's primary nuclear technology is the water-moderated VVER power reactor (analogous to Western PWRs) found in many former Soviet-bloc countries, as well as Russia and Kazakhstan. Advanced versions of the VVER-1000MW with western instrumentation and control systems have been built in China and are being built in India. AtomEnergoProm recently signed an agreement with Toshiba regarding future cooperation on all aspects of the nuclear cycle.

Siemens signed a memorandum of understanding to create a joint venture with Rosatom to further develop and construct the Russian Pressurized Water Reactor in March 2009. Rosatom will hold 50 percent plus one share of the new joint venture and the remainder will be held by Siemens.

Since 1990, Siemens has partnered with Rosatom on several nuclear projects including providing safety and operational controls for two power plants in Slovakia, and is partnering with Atomstroyexport, Rosatom's subdiary, to build a nuclear plant in Bulgaria.