BALANCING NEEDS

GLOBAL TRENDS IN URANIUM PRODUCTION AND DEMAND

BY JEAN-PAUL NICOLET AND DOUGLAS UNDERHILL

In many countries, uranium is a major energy resource, fueling nuclear power plants that collectively generate about 17% of the world's electricity. With global demand for energy, especially electricity, projected to grow rapidly over the coming decades, the price and availability of all energy sources, including uranium, are key components in the process of energy planning and decision-making. Over the past decade, changing political and economic conditions left their marks on the civilian uranium market, as they did throughout the energy industry.

Particularly affecting the uranium market were changing projections about nuclear power's growth and the consequent demand for nuclear fuel; the emergence of a more integrated free market system including former centrally planned economies; and the emergence into the civilian market of uranium released from dismantled nuclear weapons. All these factors contributed to uncertainties in the commercial uranium market that raised questions about future fuel supplies for nuclear power plants.

Signs today indicate that the situation is changing. The world uranium market is moving towards a more balanced relationship between supply and demand. After falling nearly 50% from 1988-94, world uranium production increased in 1995, 1996 and 1997. The estimated 1997 production was up about 20% over 1994. While the uranium spot market price has followed an erratic trend since recovering from its all time low in mid-1994, prices in early 1998 were up by more than 30%.

Important production-related developments have been taking place in some countries, including Australia, Canada, Kazakhstan, Mongolia, the United States, and Uzbekistan. Additional progress was made in 1997 regarding the market introduction of low-enriched uranium (LEU) derived from blending down of 500 tonnes of high-enriched uranium (HEU) purchased by the United States from Russia. The first deliveries under this agreement were made by Russia to the United States in 1996 and 1997.

World uranium production has been below uranium requirements since 1990. Only about 60% of total world requirements for nuclear reactors – about 63,800 tonnes-uranium (tU) — was met by production in 1997. This under-supply situation has caused a cumulative drawdown of world inventories of about 160,000 tU since 1990. *(See graphs next page.)* The drawdown is expected to continue at more than 20,000 tU in 1998. The rapid drawdown has depleted the civilian uranium stockpile to a level where some market analysts concluded that there are only limited amounts of excess material available for sale. Although inventories remain substantial, the increase in spot uranium prices during 1995-96 was a sign that inventories are getting much closer to desired levels.

SUPPLY & DEMAND PROJECTIONS

Analysis of the availability of supplemental uranium supplies to meet reactor demand leads to the conclusion that uranium production will continue as the predominant source of nuclear fuel. Therefore, the question arises as to the adequacy of both uranium resources and production capacity to meet demand on a timely basis. To address these questions, the IAEA invited specialists to analyze the available information and prepare a report of projections through the year 2020. This article highlights the principle findings of this report and describes selected IAEA activities related to uranium exploration and production activities. *(See box, page 20.)*

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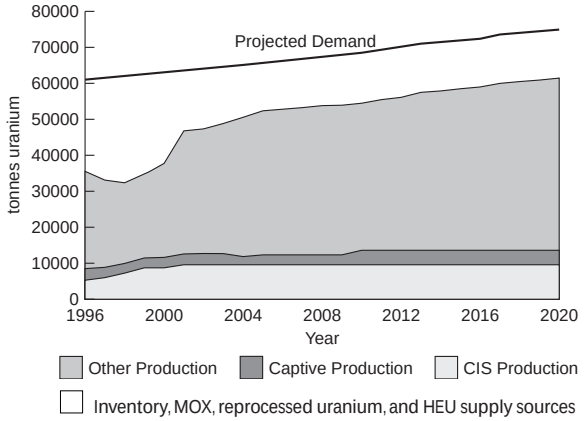
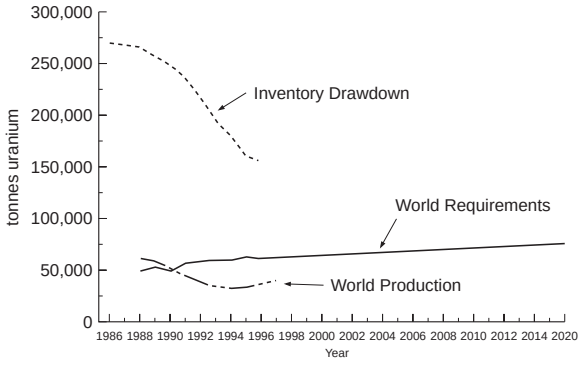
URANIUM PRODUCTION & SUPPLY FORECAST



GLOBAL URANIUM PRODUCTION, REQUIREMENTS, & INVENTORIES



Note: Data does not include civilian stocks from the CIS or high-enriched uranium from the United States and CIS.

Demand Projections. World uranium demand is reasonably well known up to 2005. After 2005 there is increasing uncertainty in projections resulting from potential nuclear plant closures, variable construction schedules, and a lack of new plant orders. In this analysis, the annual uranium requirements are projected to increase from 61,500 tU in 1997 to 75,000 tU in 2020.

This projection was developed as an approximate "best fit" of the middle of the demand range based on the analysis of several published projections of requirements. In this projection, reactor demand increases by about 600 tU/year over the period through 2020, equivalent to a growth rate of under 1% per year. The total cumulative requirements for the period stand at about 1.638 million tU.

Supply Projections. Sources of uranium supply that are expected to be available to satisfy reactor requirements include:

■ ***Utility and producer inventories.*** Two types of inventory are accounted for: excess inventory in Western countries and estimated inventory held by the Russian Federation. The majority of non-Russian inventories are held by utilities for security of supply reasons. There are also smaller amounts owned by producers, uranium traders and the US Department of Energy. Discretionary utility inventory (inventory held by utilities in excess of preferred or mandated levels) at the beginning of 1997 was estimated to total about 50,000 tU. The last amount of discretionary inventory is projected to be sold in the year 2000. The inventory of natural uranium and/or LEU held by the Russian Federation at the beginning of 1997 was estimated to total about 30,000 tU. This inventory is projected to be drawn down gradually through 2004.

■ ***500 tonnes of HEU from Russian nuclear weapons.*** Probably no other supply source is surrounded by more uncertainty than HEU held by the Russian Federation. Politics, economics, and technology will all play a role in determining the availability of uranium from this source. A total of 500 tonnes HEU, equivalent to 153,000 tonnes natural uranium, is scheduled for delivery. There are, however, political and technical uncertainties as to whether the proposed delivery schedule can be maintained. The assumption used in this projection is that the LEU from the Russian HEU will be made available to the market at the rate the LEU's delivery is scheduled to the United States. The prevailing schedule calls for the delivery of 18 tonnes, 24 tonnes, and 30 tonnes HEU equivalent (5733 tonnes, 7644 tonnes and 9555 tonnes, respectively, of natural uranium) in 1997, 1998 and 1999. Delivery at the rate of 30 tonnes HEU equivalent then continues through 2012. In this projection, it is assumed that additional LEU blended from HEU from Russian and the United States will continue to be delivered through 2020.

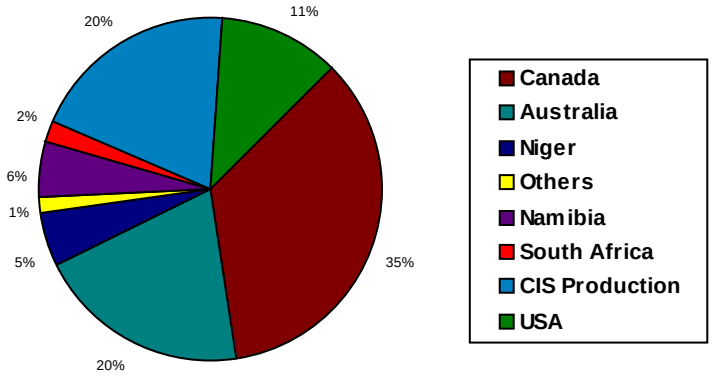
■ ***Mixed uranium-plutonium oxide fuel (MOX) and reprocessed uranium.*** Assuming that countries maintain existing policies regarding the reprocessing of spent nuclear fuel versus opting for direct disposal, the future market for these options will be limited. Reprocessed uranium and plutonium for MOX fuel is an important component of the supply in only a limited number of countries. The contribution of MOX and reprocessed uranium is not expected to exceed about 6% of total annual requirements through 2020. The requirements not filled by these sources will have to be met from production of natural uranium from the sources noted below.

■ ***Mined and processed natural uranium from the Commonwealth of Independent States (CIS).*** With an estimated 1997 production of 6285 tU, the CIS supply is forecast to increase to 9785 tU in 2001 and remain at this level through 2020. This represent 15% of world requirements. There are, however, uncertainties about the capability of the CIS to produce this amount of uranium.

■ ***Captive Production.*** This refers to national programmes in which production is dedicated to domestic nuclear power programmes. The production schedule for the captive programmes is balanced with reactor demand in Argentina, Brazil, India, Pakistan, Romania, and Spain. Also included in this category are the production industries of France (projected to produce through 1999); the Czech Republic (projected to produce through 2003); Hungary (production scheduled to terminate in 1997); and Portugal (projected to continue production through 2020). Captive production equals about 5% of requirements or 3200 tU per year.

■ ***"All Other" Mined and Processed Natural Uranium.*** This category represents uranium production from North America, Africa, Australia and Europe. It meets 57% of requirements, and increases from 28,000 tU in 1997 to 38,500 tU by 2001. It then gradually increases to 47,700 tU in 2020. Production from projects with well-defined uranium reserves is adequate to fulfill requirements through the year 2012. Beyond that time, resources defined with lower confidence will be required to fill demand. Canada is expected to be the dominant producer throughout the study period. Canada's production is expected to peak at 20,400 tU in the year 2002 and then decline to about 38% of total supply in this category by the year 2020. This is expected to occur as reserves are depleted and as low-cost production capacity increases elsewhere in the world. In 1997, production in Australia and the United States in this category was expected to increase from about 21% to 29% and from 10% to 16% respectively, of total natural uranium. Cumulative output from Niger and Namibia is expected to meet between 5% and 10% of demand through 2020. *(See graph.)*

CUMULATIVE WORLD URANIUM PRODUCTION
1997-2020 (total = 1.245 million tU)



As reported in the 1997 edition of *Uranium Resources, Production and Demand* (the Red Book, jointly produced by the IAEA and Nuclear Energy Agency of the Organization for Economic Cooperation and Development), the world annual production capability on 1 January 1997 was 43,000 tU. This is comprised of 8050, 2600 and 32, 350 tU/year, respectively, of the production capability in the CIS, Captive and "All Other" categories.

In 1996, uranium production was 36,195 tU, representing a utilization rate of about 84% of the world's production capability. (Production capability utilization is defined as production divided by available production capacity.) Of the total production, 6275, 2440, and 27,450 tU, respectively, came from the CIS, Captive and "All Other" categories. In terms of production capability utilization, this represented 78%, 93% and 85%, respectively for these three categories.

In 2005, the estimated production is about 52,500 tU,

TARGETING SUPPORT

Thirty-four IAEA Member States are involved in exploration for and/or production of uranium resources. Twenty-two of these Member States are developing or emerging countries that are benefitting from specific types of IAEA support. Major Agency activities include:

Preparation of the global status report Uranium Resources, Production and Demand, also known as the "Red Book" on a biannual basis. The report is jointly prepared with the Nuclear Energy Agency of the Organization for Economic Cooperation and Development. The 1997 edition is the most complete ever with reports from 59 countries. It includes for the first time reports from all uranium producing countries, including official submissions from Russian Federation and Uzbekistan. It is useful to planners and policy makers involved with both uranium supply and demand.

The World Atlas Database. This world map of uranium deposits and accompanying guidebook is the first worldwide compilation of all uranium deposits featuring technical descriptions of their geologic setting, tonnage, grade, mine type and status. It supports national strategic planning, including decisions about economically developing indigenous uranium resources.

Transfer of Experience. During the past 15 years, the declining uranium price and increasing safety and environmental concerns about uranium mining operations has led to more complex regulations and the closing of uneconomic operations. At the same time exploration and mining technology has advanced substantially, bringing methods that are environmentally friendly and economically more efficient. The Agency is actively involved in transferring associated technologies and technical experience. Drawing more interest in many countries is in-situ leach mining, which recovers uranium from water-saturated, permeable sandstone deposits. Leaching solutions are injected through wells that are then pumped to recover uranium-bearing solutions for further processing. The method, which doesn't require breaking rocks and transporting them to a mill, has economic, environmental and safety benefits if projects are well planned and operated and deposits are carefully selected. It is used or being planned in Australia, China, Czech Republic, Kazakhstan, Mongolia, Pakistan, the Russian Federation, the United States, and Uzbekistan. About 13% of total world uranium production in 1996 came from in-situ leach mining. As part of its activities in this field, the IAEA is carrying out several technical cooperation projects and recently convened a technical meeting for developing countries on this subject.

about 44% higher than the 1996 level. To produce this amount, the production capability has to increase between 22% and 26% from the existing level of 43,000 tU. Under this projection, only seven years remain to plan, license, construct and bring uranium projects into production. Additional capacity will be required to produce about 61,500 tU/year by 2020, as well as to replace capacity that closes as resources are depleted.

BALANCING NEEDS

Based on a projected, modest 1% annual growth rate, world uranium requirements are estimated to grow from 61 500 tU in 1997 to 75 000 tU in 2020. Cumulative demand over the period is 1.638 million tU.

In 1996, production met about 60% of world requirements, with most of the balance coming from inventory. This source, which has been supplying an average of about 23,000 tU per year since 1992, is coming to an end. With the end of excess inventory in sight, uranium supplies from other sources will have to increase to meet requirements. What supply sources are available to meet requirements through 2020?

Uranium mine production will continue to be the primary source of supply, meeting 76% to 78% of cumulative requirements through 2020. Alternative sources supplying the balance, in order of relative importance, are LEU blended from HEU released from weapons programmes (11% to 13%), reprocessing of spent nuclear fuel (6%), and excess inventory (5%). The contribution of US government and other Russian strategic stockpiles is not known at this time.

To meet these projected uranium requirements, all sources of supply will have to increase as planned. Otherwise, shortages could result early in the next century from one or more types of producers. ❐