# SECTION 4 - NUCLEAR POWER

## Nuclear Power Generation in Virginia

- Dominion operates four nuclear units at its two Virginia nuclear power plants.
- These plants provided 38.4 percent of the electricity generated in Virginia during 2008.
- Two units are located at the South Anna Power Station in Louisa County and two are located at the Surry Power Station in Surry County.
    - Dominion owns an 88.4 percent share of the North Anna station. The Old Dominion Electric Cooperative owns the remaining 11.6 percent share.
    - Dominion owns 100 percent of the Surry Station. The Nuclear Regulatory Commission (NRC) has extended both Surry's and North Anna's operating licenses

**Table 4-1: Virginia Nuclear Generating Units – Startup Date**

| Unit Name | Year | End of Operating License Term |
|---|---|---|
| Surry Unit 1 | 1972 | 2032 |
| Surry Unit 2 | 1973 | 2033 |
| North Anna Unit 1 | 1978 | 2038 |
| North Anna Unit 2 | 1980 | 2040 |

- Dominion has made operating and capital improvements to the plants that have reduced down time for refueling and repairs and increased plant capacity.
    - Operating capacity for the four reactors in Virginia in 2009 ranged from 91.6 to 99.87 percent. Historic operating capacity has been between 74 and 83 percent.
- Virginia's four reactors consume approximately 1.6 million pounds of uranium oxide, or approximately 30 metric tons of uranium fuel, on average per year to fuel its four nuclear reactors.

## Nuclear Power Plant Designs

- Nuclear power plant design has evolved since the first-generation prototypes were built.
    - Generation III+ reactors are under construction around the world (none in the United States as of 2010). These include the AREVA US-EPR reactor design and the Mitsubishi US–APWR (Advanced Pressurized Water Reactor). Dominion has identified the Mitsubishi US-APWR as the technology of choice for its proposed third unit at the North Anna Station.[1]

[1] Dominion, Dominion Virginia Power Selects Mitsubishi Reactor Technology for Potential North Anna Unit 3, http://dom.mediaroom.com/index.php?s=43&item=888, May 12, 2010

    - New reactor designs, such as the Babcock & Wilcox (B&W) mPower reactor and pebble bed reactors, are being developed to serve the smaller reactor market. [2]
- Operational costs of nuclear power plants are the lowest of any type of generation except for hydroelectric, wind, and solar.
- Nuclear power plant capital costs are very high. The capital cost risk may be mitigated through shared risk management among utilities, nuclear plant technology providers, and the federal government.

## Spent Fuel Management

- Nuclear fuel is currently stored on the North Anna and Surry sites in spent fuel pools and dry storage casks.
- Dominion customers have been paying a fee of one tenth of one cent/kilowatt hour ($.001/kWh) generated by nuclear power plants into the federal Nuclear Waste Fund to finance a permanent spent nuclear fuel storage facility.
- The Nuclear Waste fund had financed design and construction of the canceled Yucca Mountain nuclear waste repository in Nevada.
- New plans, such as long-term storage sites or reprocessing, must be developed to address management of spent nuclear fuel.

## The Nuclear Fuel Cycle

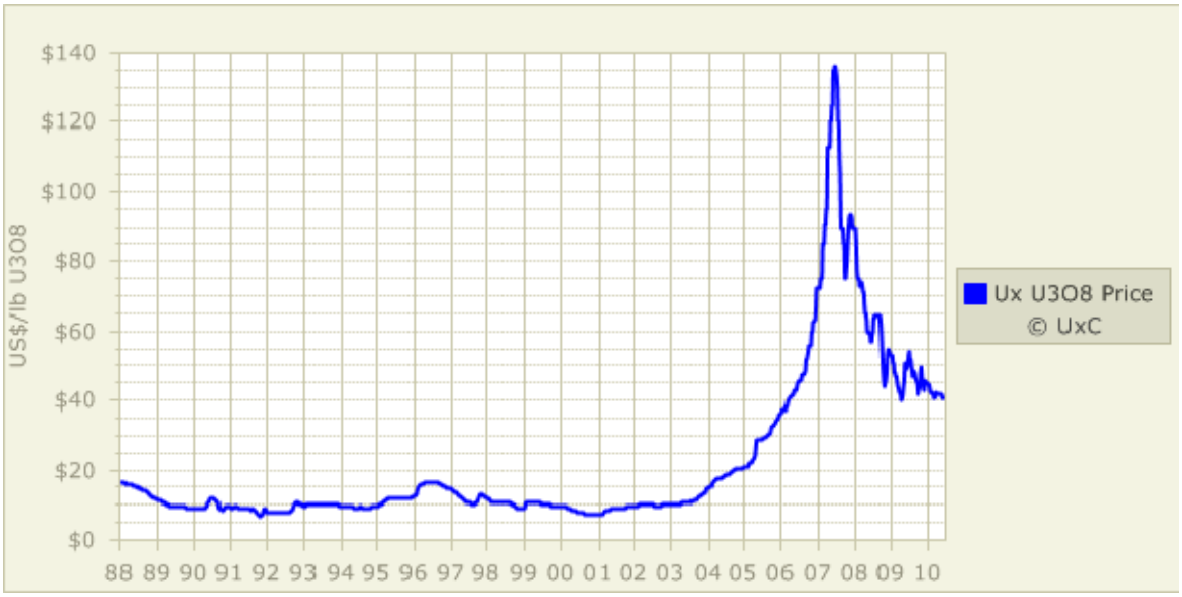
- The first step in the nuclear fuel cycle is mining and milling of uranium oxide, resulting in 0.7 percent $U_{235}$.
- The uranium oxide is then enriched to the 4.2 to 4.7percent level and fabricated into fuel pellets.
    - The United States has one enrichment plant, the USEC gaseous diffusion plant in Paducah, Kentucky. Four new nuclear fuel processing plants are under development:
        - Three centrifuge plants by AREVA in Idaho Falls, Idaho; URENCO in Eunice, New Mexico; and USEC in Piketon, Ohio; and
        - One global laser enrichment plant by GE-Hitachi in Wilmington, North Carolina.
    - These plants will have sufficient capacity to supply fuel to all existing nuclear power plants in the United States[3].
- Processed fuel pellets are then assembled into reactor fuel rods for use in nuclear power reactors.

[2] World Nuclear Organization, Small Nuclear Power Reactors, updated May 2010, http://www.world-nuclear.org/info/inf33.html, May 12, 2010
[3] World Nuclear News, Areva Selects Enrichment Site, May 7, 2008, http://www.world-nuclear-news.org/NN-Areva_selects_US_enrichment_site_070508.html

## Nuclear Fuel Costs

- Prices of uranium oxide were consistently below $20/pound until the mid 2000s. Since then prices have jumped to nearly $140/pound in 2007 before falling to the current $40 to $50/pound range.

**Figure 4-1: Uranium Oxide Costs[4]**




- Changes in spot nuclear fuel cost have a limited impact on the cost of nuclear generated electricity. Nuclear fuel is generally purchased through long-term contracts and costs are a much smaller percentage of total nuclear power cost than with fossil fuel technologies.

## Nuclear Plant Siting and Construction

- Nuclear power plant siting is largely regulated through the licensing process of the Nuclear Regulatory Commission (NRC).
    - Licensing requirements have been streamlined since plants were licensed in the 1960s and 1970s. Nuclear utilities now can receive an early site permit followed by a combined construction-operating permit.
- Dominion has received its early site permit for the proposed third North Anna unit.
- As of June 2010, Dominion's combined construction-operating permit application was pending before the NRC.

[4] The UxC Consulting Company, Ux U3O8 Price – Full History, http://uxc.com/review/uxc_PriceChart.aspx?chart=spot-u3o8-full, June 29, 2010

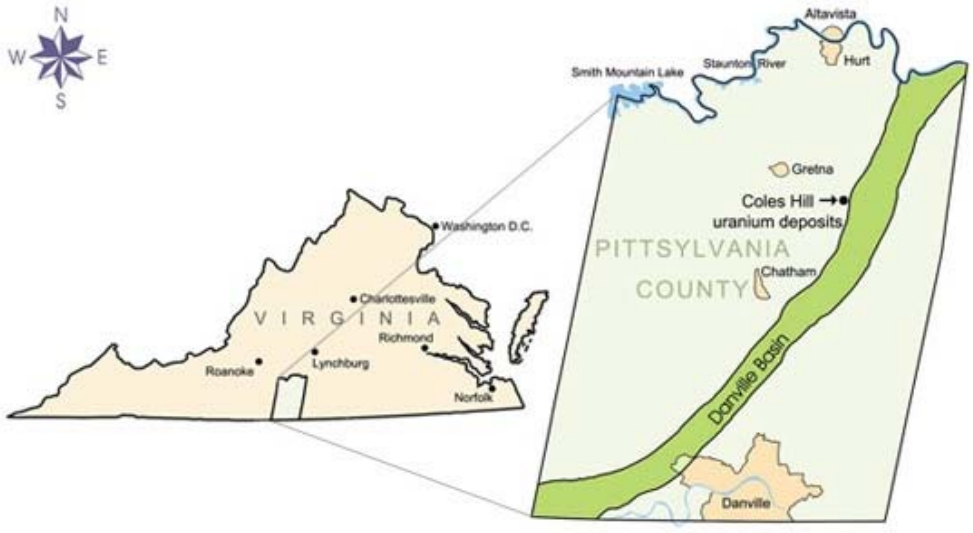
- Nuclear plant permitting and construction is expensive and time-consuming, taking 8-10 years.
- Variations in technical standards and construction costs, cost of capital, and other factors contribute to the risk profile of investments in new nuclear power plant construction.
- Time and budget experience with new plant construction overseas has been mixed.
- Shared risk between utilities and project design and construction firms is necessary to support financing new nuclear projects.
- State and federal incentives, including providing a higher rate of return under Virginia law for utility investments in new nuclear power plants and federal loan guarantees, help mitigate the financial risk.
- U.S. nuclear reactor manufacturing capability is growing with the resurgence of the international nuclear power industry. New facilities include the AREVA-Northrop Grumman plant in Newport News and the Westinghouse-Shaw Group plant in Lake Charles, Louisiana.
- A single international standard for nuclear power plant certification would expand the markets for the AREVA-Northrop Grumman Newport News and other U.S. manufacturers.

## Uranium Mining

- Wyoming, New Mexico, Arizona, Utah, Colorado, Texas, and Virginia have significant uranium reserves[5].
- Virginia has a uranium oxide resource in Pittsylvania County, estimated at 119 million pounds (at 0.025 percent uranium oxide cutoff) and worth around $5.4 billion at the mid-2020 price of $45/pound for uranium oxide.
- This site could be mined for 60 years at a production rate of 2 million pounds per year. Production of 2 million tons per year would be equivalent to adding 50 percent to 2008 domestic uranium production.[6]
- The Commonwealth has a moratorium on uranium mining due to questions about the safety of uranium mining in Virginia.
- The Virginia Coal and Energy Commission is undertaking two studies of uranium mining:
    - The Commission has contracted with the National Academy of Sciences' National Research Council to study the safety and environmental impacts of uranium mining.
    - The Commission is studying the social and community impacts of uranium mining.

[5] EIA, U.S. Uranium Reserves Estimates, June 2004, http://www.eia.doe.gov/cneaf/nuclear/page/reserves/ures.html, May 16, 2010
[6] EIA, Summary Production Statistics of the U.S. Uranium Industry, May 2009, http://www.eia.doe.gov/cneaf/nuclear/dupr/usummary.html, May 16, 2010

**Figure 4-3: Map of Coles Hill Uranium Deposit[7]**




- Federal laws and regulations controlling U.S. uranium mining include:
  - Uranium Mill Tailings Radiation Control Act of 1978;
  - Safe Drinking Water Act;
  - Underground Injection Control Program; and
  - National Emission Standards for Hazardous Air Pollutants.
- The federal government licenses uranium-processing mills and the disposal of associated mill tailings.
- States, including Wyoming, Colorado, and Texas, have developed uranium mining regulatory programs.

## Nuclear Industry Workforce Development

- Virginia is a leader in design, construction, and maintenance of nuclear power plants through AREVA, B&W, Dominion, and Northrop Grumman.
  - AREVA, B&W, and Northrop Grumman have an ongoing need for nuclear and other engineers and service technicians.
  - Northrop Grumman employs thousands of workers at its Newport News shipyard constructing nuclear powered ships.
  - Additional jobs will be available when the AREVA/Northrop Grumman power plant component manufacturing plant is completed.
  - Dominion's current nuclear workforce is nearing retirement age and trained technicians and engineers are needed to replace those leaving.

[7] Virginia Uranium, Location, http://www.virginiauranium.com/location.php, June 29, 2010

    - Dominion will also need additional nuclear plant operation, engineering, maintenance, and other workers if it adds the third unit to the North Anna power station.

- The University of Virginia, Virginia Tech, Virginia Commonwealth University, and the Virginia Community College System are rebuilding their nuclear-related teaching and research capacity to serve the industry. These new training programs provide educational opportunities ranging from advanced nuclear engineering degrees to training nuclear technicians.