



# Energy Options for Ukraine to Replace the Chornobyl Nuclear Plant

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## Overview

Following the nuclear accident, in 1986, at the Chornobyl Nuclear Power Plant (NPP), the international community has been pressuring Ukraine to de-commission the remaining operating nuclear reactors at Chornobyl. A few years after the accident, a fire crippled Unit 2, at the Chornobyl NPP, further heightening international concern about the safety of nuclear power plants in Ukraine. At the recent G-7 summit in Naples, an offer of US\$2.5 billion was made to Ukraine as an incentive to reverse its earlier decision to close-down the Chornobyl NPP -- Ukraine plans to keep Chornobyl going for a couple of decades.

While Canada has been closely involved with Ukraine in extending assistance in the area of nuclear reactor safety and nuclear waste management, President Kuchma's visit to Canada provides an opportunity for Canadian help to review safe, efficient, and environmentally sound energy options that could facilitate the replacement of the Chornobyl NPP electricity generating capacity and its earliest possible shutdown.

Alternative energy options for replacing Chornobyl could include:

- Completion of partially constructed VVER-1000 nuclear power reactors and completion of a pumped-storage hydroelectric plant currently under construction at Dnister;
- Upgrading of existing fossil-fuelled plants to extend operating lifetimes, increasing energy output, and improving operating efficiency;
- Construction and implementation of renewable energy resources, especially wind power plants and upgrading of existing hydroelectric plants;
- Improvements in energy efficiency for heavy industry (primarily chemical and

metals industries) and for lighting; and

- Upgrading the electricity transmission system.

Thus far, no environmental assessments have been done to assess the possible energy options for Chornobyl replacement. Such assessments would be appropriate in order to evaluate alternative energy options under consideration -- an area of possible Canadian assistance.

## Nuclear power

Fourteen operating nuclear reactors currently provide about 40 percent of Ukraine's electricity generation and account for 26 percent of installed generating capacity. Five new VVER-1000 reactors are under construction at Zaporizhia, Rivne, and Khmelnytsky. The estimated completion costs these units range from \$34 million to \$1.27 billion per unit (1994 U.S. dollars). These costs include some limited safety upgrades and additional safety upgrades to be installed during planned shutdowns following startup.

The total cost of shutdown for Chornobyl units 1, 2, and 3, is estimated at \$1.396 billion. Considerable additional funds are urgently required to replace the sarcophagus encasing the destroyed unit 4.

The electricity transmission switching substation at Chornobyl was contaminated and must be closed down. In order to maintain grid structure and to be able to provide sufficient power to the Kyiv region, a new substation is required outside the contamination zone.

## Fossil-fuels

In Ukraine, there are 14 major fossil-fuelled electric power generating stations. The majority of these plants have been in operation for 20-40 years, as such they do not include modern features and require upgrades and

rehabilitation. Ukraine is self-sufficient only in coal, however, the quality of coal available has deteriorated and significant quantities (20-50 percent) of imported fuels are required for stability (or co-firing) in power generation operations. The coal-fired stations are becoming obsolete and require major investments for upgrades, if they are to continue to supply power in the future. A major investment program would extend plant life, increase efficiency, reduce or eliminate the need for imported fuel (for co-firing), and allow for clean coal technology.

Estimated costs for upgrading five existing fossil-fuelled plants to increase capacities, extending plant lifetimes, improving efficiency and on-line operations, and eliminating the need for co-firing with imported oil and gas, range from \$275 million to \$1.2 billion.

## Renewable Energy Options: Hydroelectric and Wind-power

Conventional hydroelectric generation accounts for 4700 MW of Ukraine's installed generating capacity, however, many of these plants are old and require extensive refurbishment. With new premium-efficiency turbines and generators installed on older plants, 500 additional MW can be obtained.

Wind-power constitutes a major renewable energy option for Ukraine, which is estimated to have the capacity to produce up to 30 billion kilowatt hours (kWh) of electricity annually. At present, three locations have been identified as capable of supporting 500-1000 MW wind-power plants. One wind-plant joint venture project involving the Krimenergo utility is already underway at Lake Donuzlav in western Crimea, and would reduce the need for electric transmission to Crimea from other regions within Ukraine. Additional benefits to be derived from this proposed acceleration include the conversion of many of Ukraine's military and industrial jobs and resources to civilian jobs and products.

## Electrical Transmission

Ukraine's national electricity system is a well-developed 330 KV and 750 KV grid. Operation of the power system is controlled almost entirely by manual means. Frequency control in such a hierarchial system is a problem in Ukraine that has not been adequately addressed since the breakup of the Soviet Union. This frequency instability results from inadequate control strategies and limited control capacity, and has caused Ukraine to be