

Title of the Article:

Ukraine strains to safely operate nuclear power plants while under Russian invasion

Source of the Article:

NPR

<https://www.npr.org/2023/09/06/1197574725/russia-ukraine-war-nuclear-power-plants>

Date of Publication:

September 6, 2023

Word Count of the Commentary:

800

Date of Commentary Written:

January 17, 2024

Unit of the Syllabus:

Microeconomics

Key Concept:

Intervention

ARTICLE

Nuclear Power in Ukraine

KHMELNYTSKYI, Ukraine — The head of Ukraine's nuclear energy utility, Energoatom, says his country is trying to do something never before attempted: operate a large network of atomic reactors in the midst of a full-scale war.

"Never such case has happened before actually," said Petro Kotin, who spoke to journalists recently in a room deep inside the Khmelnytskyi nuclear power plant in central Ukraine.

"This is the first time when the country who possesses nuclear power came to another country with a developed nuclear industry and just captured the plant, the biggest nuclear power plant in Europe," Kotin said.

Kotin was referring to Russia's full-scale invasion and capture of Ukraine's Zaporizhzhia nuclear complex in March 2022.

During previous conflicts, nuclear facilities in other countries have occasionally come under attack. But those incidents involved complexes that were under construction, unfueled and nonoperational — or the attacks involved reactors used in military research or weapons development. Ukraine's network of more than a dozen civilian nuclear power reactors is the first to face a sustained war-time threat.

Kotin said the situation at Zaporizhzhia is dire, with safety systems forced at times to operate on backup diesel generators.

"It was full blackout at the plant and it was like the first stage of the Fukushima scenario where you do not have external power," he said. "It was an awful situation."

In 2011, a tsunami in Japan destroyed the power supply to three reactors at the Fukushima plant, triggering a nuclear accident that still poses major environmental challenges.

In Ukraine, a country still haunted by the 1986 nuclear disaster at Chernobyl, the threat of an event like Fukushima is galling. Kotin said what the Russians are doing "is crazy."

There are six reactors at Zaporizhzhia maintained by Energoatom personnel, according to Kotin, but Russia controls the plant. Those reactors are currently offline. Meanwhile, Ukraine is operating nine reactors generating electricity at three other locations around the country.

Ukrainian officials say they have no choice but to keep the plants operating. Together they provide roughly half of Ukraine's electricity.

Kotin spoke during a demonstration at the Khmelnytskyi plant staged for journalists. A team of technicians showed their step-by-step process for restarting a reactor and connecting it to the power grid.

Officials said the actual restart of one of the plant's Soviet-era reactors was happening in another part of the complex, after a cycle of routine maintenance and refueling.

COMMENTARY

Ukraine heavily relies on nuclear power for energy production, specifically electricity. The country's reliance on this service generates a negative externality of production. For instance, it can trigger environmental accidents and stimulate radiation, which needs additional maintenance for constant safety considerations. On top of protecting "Ukraine's Zaporizhzhia nuclear complex" from Russia's full-scale invasion, Energoatom with other nuclear enterprises will need to increase expenses and the workforce to prevent nuclear disasters. Overall, nuclear services are harmful to society and present a negative externality of production. Due to these spillover effects, a government **intervention** is required to reduce Ukraine's dependency on nuclear services and correct the externality to solve market failure. However, "Ukrainian officials say they have no choice but to keep the plants operating." Since 2022, they have kept operating the power plants despite being in the midst of the war. Reducing the production of nuclear energy would instead need a proper **intervention**.

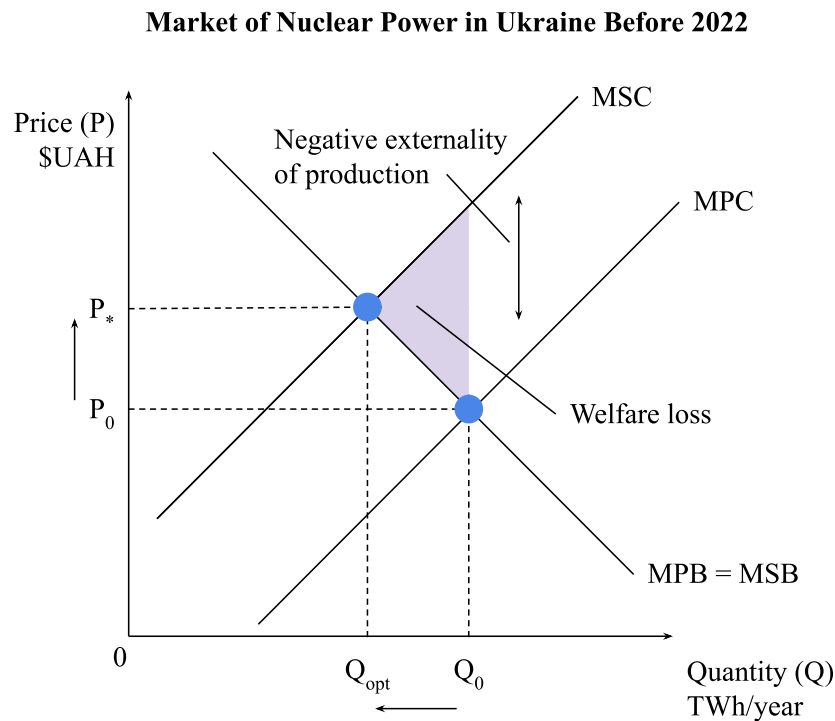


Figure 1
*Not to Scale

In Figure 1, to reach the socially optimal level of output where marginal social benefit (MSB) = marginal social cost (MSC), there must be an **intervention** to decrease the production of nuclear energy per year to correct the externality; shifting the supply curve from marginal private cost

(MPC) to MSC. This would increase the equilibrium market price P_0 to P_* and decrease the quantity of nuclear energy Q_0 closer to Q_{opt} of terawatt hours (TWh)/year. If a government **intervention** corrects the overprovision of this resource, the Ukrainian economy will achieve allocative efficiency where output is at the socially optimal level from society's point of view. Moreover, it will correct the market failure to Q_{opt} and P_* which completely removes the welfare loss.

Contrarily, the government of Ukraine officials reinforced the usage of power plants, as they need to “operate nine reactors generating [sufficient] electricity” and “to provide for half the electricity in the country”. This disallowed the shifting of MPC to the left and corrected the negative externality. Therefore, it is expected that there will be an overall welfare loss in the country and yet a market failure with the inefficient allocation of nuclear energy.

Market of Nuclear Power in Ukraine with the Russian Invasion Since 2022

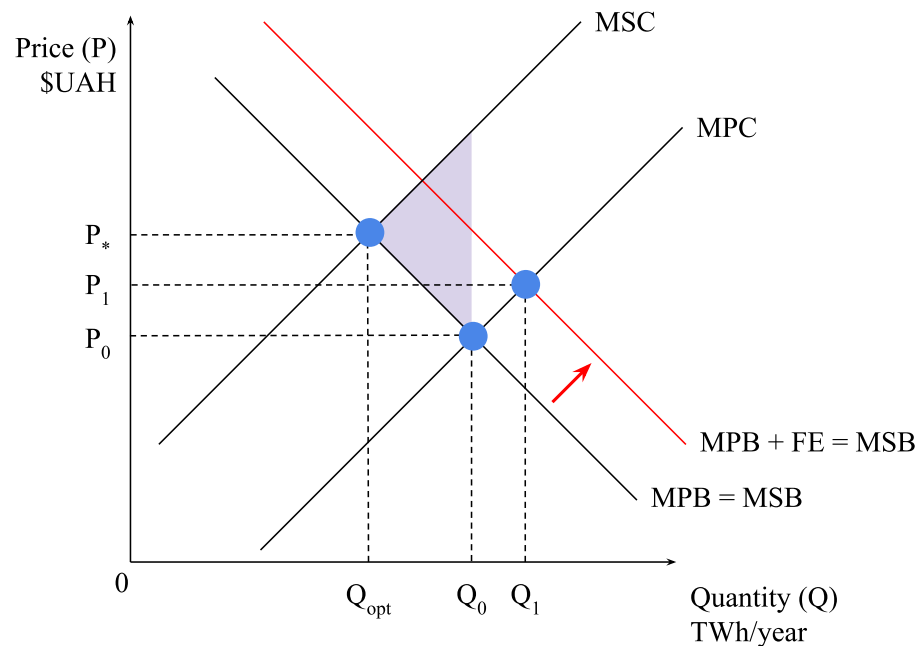


Figure 2
*Not to Scale

Figure 2 illustrates Ukraine officials' public statement to continue generating nuclear energy even with Russia's invasion, to provide for “half of [the country's] electricity.” This exemplifies a non-price determinant of demand of future expectations (FE) stimulated by the government's statement to survive the long-term war with electricity. However, these constant war attacks provoked additional expenses for Energoatom and other nuclear companies as they needed to care for safety precautions, such as leakage of radiation while generating an adequate amount of nuclear power. Alongside, communities need to rely on electricity to live indoors during

wartime, which increases the quantity demanded Q_1 further away from Q_{opt} . Altogether, the market price will increase closer to P_* as nuclear producers' main objective is to maximize profit, to compensate for the increased expenses from war. This reinforces a market failure where $MSB \neq MSC$ and there is still an inefficient overallocation of nuclear energy posing countless health risks to society.

Market of Nuclear Power in Ukraine with Tax After 2022

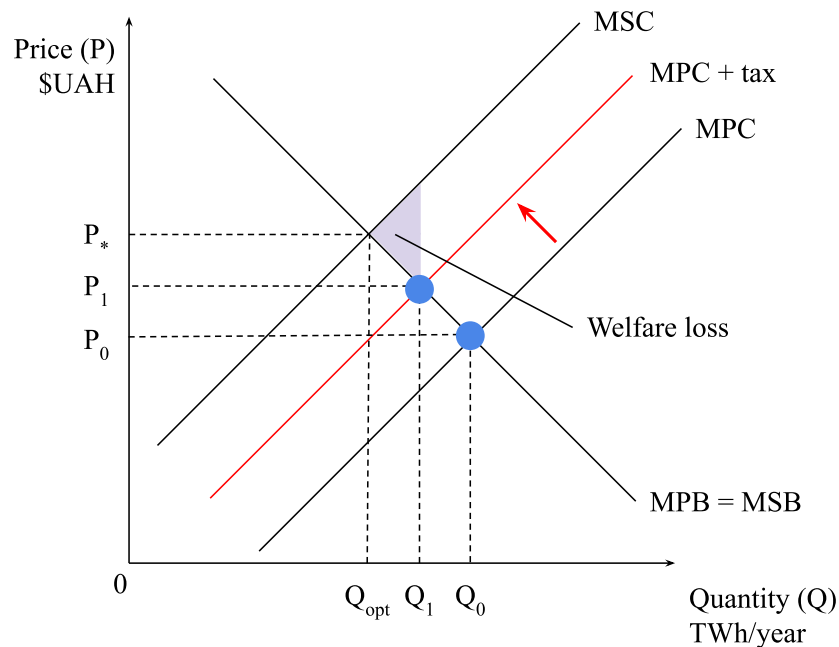


Figure 3
*Not to Scale

A potential solution for Ukraine to correct the negative externality is for the government to **intervene** through the imposition of Pigouvian taxes for producing one unit of TWh of nuclear energy. In Figure 3, it decreases the quantity Q_0 to Q_1 of nuclear energy produced, while increasing the market price P_0 to P_1 closer to the socially optimal level of output. In general, the quantity supplied will decrease as nuclear enterprises will be unable to produce more with these taxes that increase their production costs. With the revenue generated from these taxes, the government can subsidize renewable energy sources for a cleaner emission-free environment. The taxes can also be spent on military services to ensure Ukraine's protection in the ongoing war. However, there is an opportunity cost for the government as it restricts them from the second best alternative to spend on, such as health care and education.

Altogether, if Ukraine **intervened** through tax, it would allow the country to decrease the quantity of nuclear energy produced, which would reduce the health hazards and side effects of

radiation. This **intervention** would be able to bring MPC closer to $MSB = MSC$, which is optimal for society. As shown in the shaded region, the **intervention** would significantly reduce the welfare loss for society and bring it closer to correcting the negative externality.

To conclude, Ukraine heavily relies on nuclear energy for electricity, and a negative externality of production arises due to its harmful effects on society along with the Russian invasion. Yet, Ukraine said to keep the reactors operating, which further increased the negative externality, with additional maintenance costs for safety during the war. An **intervention** through Pigouvian taxes should alternatively be levied to achieve closer to allocative efficiency in Ukraine's nuclear energy market; correcting the negative externality of production.