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**ELIZABETH
WOOD:**

So hello and welcome to today's forum, from Chernobyl to Zaporizhzhia, the Atom and its Impact on Ukraine's Politics and Security. I'm Elizabeth Wood and a professor of Soviet and post-Soviet history at MIT and the director of the MIT Ukraine program and the MIT Eurasia program. My co-organizer and co-moderator is Carol Saivetz, senior advisor in the MIT Security Studies Program.

First I want to thank our sponsors, the MIT Center for International Studies, the MIT Security Studies Program, and the US and Eurasia programs, especially our organizers Michele and Sabina Van Mell. I also want to mention that this Wednesday we will have another star form, Grand Delusion, the Rise and Fall of American Ambition in the Middle East, with Steve Simon and Andrew Vucevic. It's on Wednesday at 4:30 through 6:00. It'll be in person for the MIT field, E25 111, and also you can also tune in on Zoom.

As is our custom, we will have a Q&A at the end of this talk. You can find the Q&A button at the bottom of your toolbar where you can type questions. We will try to get to as many questions as possible. Please keep them short and not too polemical so we can get through all of your questions. There's also the chat feature, which contains resource links, bios et cetera.

Our two speakers are Kate Brown and Mariana Budjeryn. Both have a long history of expertise on nuclear topics. Kate Brown came to MIT as Professor of Science, Technology, and Society in 2019. She is the author of four books, *Manual for Survival*, *Chernobyl*, *Guide to the Future*, *Dispatches From Dystopia*, [INAUDIBLE] and a biography of [INAUDIBLE]. She has been also involved with the American Historical review where she founded a special section called History Unclassified that has shorter, more self-reflective pieces for historians. Finally she has received numerous awards and grants, including the Guggenheim Foundation, the Carnegie Foundation, the Urban University Institute, the Kennan Institute, Harvard's Data Center for Russian Immigration Studies, and the US Holocaust Museum.

Mariana Budjeryn is senior research associate with the project on managing the atom at the Harvard Kennedy School Belfer Center. Most recently she has published, *Including the Bomb, the Collapse of the USSR and the Nuclear Disarmament of Ukraine*, which just came out from Johns Hopkins press this year. It's a fascinating and beautifully written analysis of how Ukraine dealt with its nuclear weapons after gaining full statehood in 1991. She has published widely and needed articles on nuclear foreign affairs, including *the Journal of Cold War studies*, *Non-proliferation Review*, *World Affairs Journal*, *Foreign Affairs*, *the Washington Post*, *the Bulletin of Atomic Scientists*, *War on the Rocks* and *Arms Control Today*.

So without further ado, I'll turn it over to Kate Brown and then Mariana will take over straight from her.

KATE BROWN:

Thanks, Elizabeth, for introduction. And thanks for the MIT Starr Forum for putting this together. I'm going to share my screen. And. OK. So we're interested in Chernobyl, the Chernobyl accident, because it stands as a litmus test for other nuclear projects in other parts of the world.

As the world's largest nuclear accident, policymakers and scientists look to Chernobyl in the aftermath of a disaster to investigate the effects of nuclear catastrophe and to make arguments for and against nuclear power. Chernobyl became, especially in the 1990s, a nuclear football. And I would argue that it still is one today. We see the Russian army engaged in nuclear terrorism from the start of the war in Ukraine in February, 2022. The Russian army entered Ukraine from Belarus into the shared Ukrainian Belarusian Chernobyl zone in part because there is no defense there. It was the softest entry they could find.

Huge convoys of trucks pass through the site and the larger zone kicking up clouds of dust. Radiation detectors in the zone spiked, and then went dead. And here I should be showing you some slides. Here's a map of those detectors and the hotspots you see right in that February of 2022. Russian generals ordered soldiers to dig trenches in the Red Forest, the most radioactive site of the Chernobyl zone. And in the red zone, I've been there myself, you accumulate daily the annual threshold dose for nuclear workers.

And so the soldiers were there, digging in, upsetting the soil where a lot of the radioactivity is stored, for over a month. Reportedly some soldiers fell ill and after the Russian army withdrew, they were treated, again reportedly, in the radiation hospital in Goma, Belarus. Now the carelessness with which Russian generals operated in the Chernobyl zone is an outgrowth of a great deal of mistruths and half truths told about the accident since it occurred in April of 1986.

Working at my book *Manual for Survival* I made my way through 22 archives having to do with Chernobyl in Ukraine, Russia, and Belarus from 2014 to 2018. And I found in this Klondike of records about Chernobyl a lot of surprises. Moscow leaders, for instance said that the disaster was safely contained within the Chernobyl zone, outlined here in red. I found records that pointed to the deliberate contamination of areas outside the zone.

A few days after the accident a storm was building up, powerful winds were blowing from Chernobyl to the Northeast towards the big Russian cities, including Moscow, so pilots left Moscow and flew over the site to manipulate the weather so that radioactive clouds and rain fell on Belarus in order to save urban Russia. And now this was a triage operation, there was about many millions of people in those Russian cities and just 200,000 people living in this area down here. I'm sorry, this area here. This is the Chernobyl zone. This area here.

The pilots held back as they passed over the city of Gomel, and then they let it rain here in the Mogilev province. The only problem is they didn't tell anyone in Belarus that they were doing this, not even the leader of the Belarusian Communist Party. So basically this what amounts to a second Chernobyl zone, one that no very few disaster tourists visit, remained a kind of secret until about 1999 when it was finally fully depopulated. So people here in the second Chernobyl zone as I'll describe later got a really big and terrible dose.

Here's another narrative. Soviet officials told people that they tested the food and they found it safe. Working through the Ministry of Agriculture records I found vectors of contaminated food spreading especially where humans congregated. There are about 100,000 head of livestock that were out underneath these Chernobyl clouds that the animals started to get sick. They got burns. And so in the summer of 1986, soldiers rounded up 100,000 head of sheep and cattle and slaughtered them.

Now Soviet leaders hated to throw out meat, as they should have, as radioactive waste. So they sent out orders, that make sausage with the lower level, lower graded radioactive meat, and the really hot stuff, stick in freezers and wait until the radiation decays. They quickly ran out of freezers in places like Gomel and Zhytomyr in Ukraine, and so they got-- they found a train car and refrigerated train car, stuffed it with 60 tons of high level radioactive meat, and sent it to Baku. There the Geiger counters went off, and they sent it on to Georgia. And on and on and on, this radioactive ghost train circulated the Western half of the Soviet Union for a full four years before the train and the meat inside of it was buried in the Chernobyl zone as nuclear waste.

Meat was not the only contaminated product. The second Chernobyl zone I just described, 3/4 of milk was over permissible levels in 1987. 22% of all mother's milk had higher than permissible levels of radioactivity. In 1988 still a quarter of all milk was still too hot to drink.

Another story is officially Soviet leaders said that they gave medical exams to 900,000 people in the larger realm of contamination, and they saw no change in health statistics. Moscow Officials also said that 300 emergency workers have been hospitalized and that was the sum total of hospitalizations. But working with two research assistants through the Ministry of Health records we counted 40,000 people hospitalized, among them 11,000 were children.

Records show that immediately after the accident doctors treated sick children and sick adults. They recorded an increase in thyroid problems, complications at birth, birth defects, and infant mortality. Children and pregnant women were especially hard hit. In 1987 in contaminated regions half of children had enlarged thyroids. Perinatal deaths doubled in 1987 and tripled in 1988.

Among adults cases of heart disease and enlarged thyroid, gastrointestinal and urinary tract disorders, cataracts, liver, and blood disease tripled or doubled between 1984 and 1988. Cancer rates climbed from 1986 to 1989 five times higher per capita in that second Chernobyl zone in 1988 than in the Belorussian Republic as a whole. And here are two individuals post-op from thyroid cancer.

The simple questions of fatalities is hard to answer. UN websites give numbers ranging from 33 to 54 people dead from the accident with projections of 4,000 to 9,000 cancer deaths sometime in the future. But I found that in Ukraine alone 35,000 women receive compensation because their husbands died of a Chernobyl related exposure. Now that count is only for married men, it doesn't count any women or any children or any people who weren't married.

Off the record in 2016 officials gave me the number of 150,000 deaths in Ukraine alone. Ukraine received 20% of Chernobyl fallout, 80% went to Western Russia, and Belarus. Neither of those countries have released any public information or any information we could find relating to public health statistics related to Chernobyl.

Another troubling question is the timeline of the catastrophe. I found that in the 1960s, when did the accident start? And when did it end? If you watch the HBO show, it's all happens in the course of 1986, and it's over by the trial of the perpetrators in 1987. But I found that in the 1960s, Soviet experts in nuclear emergencies carried out a four year study in this area right here, just to the North of the not yet built Chernobyl plant. And they found in this area radioactive cesium in soils, plants, and animals. They discovered 10 to 30 times more cesium in bodies of villagers than in people living in Minsk and Kyiv, and they produced this map of radioactive contaminants. This is from 1965. And this is the hotspot. Chernobyl is down right about here.

My thought is that this was a former-- that area that I was just showing you on the map-- is a former Soviet bombing range, and I found these bomb craters, and from the bomb craters are growing pine trees, and the pine trees have these sort of traditional mutations that biologists see when they work in the Chernobyl zone. These pine needles are supposed to grow straight, all in one direction. And you see them curling around in what the biologists would call a disorderly fashion. One of the possible causes of this could be from radioactive contaminants.

So perhaps the Soviets were testing small strategic nuclear weapons in this area. There's other accounts from soldiers making these same allegations at this time. So we can't get into the archives to see for sure if this has happened. Those are all close to Moscow.

But then the accident continues after, well after 1986. In 2018 I was in northern Ukraine and I saw thousands of people picking blueberries from those Pripjat marshes to go over the border to be sold to Poland to go into the EU and American markets. This nice lady was testing the berries as they were brought in to buy them. She bought all the berries whether they were over the permissible level or under. I asked her, how many of these berries are radioactive? And she said, all the berries are radioactive. But some are just really radioactive. But as I said, she bought all of them, the really radioactive ones for lower prices. And just like the meat and the sausage, they would mix them together to get to the permissible level to go over the border to be sold in the global commodity chains.

Fires ran through the Red Forests of the Chernobyl zone in 2017, and again in 2019. This is the charred remnants when I was there probably in 2017. My Geiger counter was going off and screeching because there was so much radiation. And these radioactive clouds reached the Netherlands, where I am right now, in 2019.

So rather than thinking of Chernobyl as a one off accident, it might be better to conceive of it as an acceleration on a timeline of nuclear events that has no clear beginning, and certainly no clear end. The use of nuclear power plants in the war in Ukraine as nuclear hostages and for nuclear terrorism makes this point even stronger today.

So the question remains, why, three decades after the event, do we know so little publicly about the damage from Chernobyl? Especially in terms of Public Health and environmental health. The answer is that in the 1990s, just as leaders in Ukraine and Belarus were announcing that they had a public health emergency on their hands, and they're asking the UN for help, UN agencies came in and took over managing assessments of the disaster.

The International Atomic Energy Agency asserted that Chernobyl doses were too low compared to Hiroshima studies of bomb survivors. We shouldn't find any disease, they kept saying. They admitted that when they did do a study, a small pilot study, that they found elevations of diseases and in five categories. But they said people were sick from nerves or anxiety. It can't be, they said, radiation.

Pressured by the International Atomic Energy Agency UN delegates voted down Chernobyl aid in the form of a billion dollars in money today for two causes, resettlement of those people in that second Chernobyl zone especially, and for long term health study. I found working my way through five UN archives that UN agents worked to cover up the story of a public health disaster. I found them hiding biopsies, burying data, slandering and discrediting and trying to fire opposing scientists. And you might ask, why would UN agencies do that?

But I found that UN officials serve their client states, and the biggest client states are the nuclear powers. The US, Russia, and Great Britain were in the 1990s on line for billions of dollars of liability as a record of Cold War nuclear weapons development and testing was gradually declassified, and people were going to court claiming nuclear damage to their health.

International scientists devised a narrative that Chernobyl was the world's worst nuclear disaster, yet the event was manageable. Only 54 people dead. We could handle those kinds of fatalities, they would say. This is where the accident narrative was useful. See Chernobyl as a one off, and the liability, the cost of cleanup, and the ongoing public health disaster dissolves. And the new post carbon nuclear Renaissance can begin.

The compromised nature of the International Atomic Energy Agency today has made it difficult for the agency to work to secure nuclear installations in war torn Ukraine. We've seen IAEA agents, officials go in, wave their hands, but not be able to make sure that those plants are no fly zones. Downplaying the impact of the Chernobyl disaster has in short made Ukraine's security especially threatening.

I just want to say a final few words on decommissioning. There have been lots of attention from scholars like myself on nuclear weapons and nuclear accidents, but far less attention has been paid to nuclear decommissioning. A process just as accident prone and dangerous as running a nuclear power plant. A recent University of Chicago PhD student, Stephanie Palazzo, has been paying attention to the mothballing of nuclear facilities. She notes that nuclear decommissioning has become an economic rather than a public safety process, as finance companies, lured by lucrative investment possibilities, have taken over the job of decommissioning mothballed plants.

In what Palazzo calls a strange corporate financial calculus, investment companies like the American company Holtec that works in both the US and Ukraine venture to decommission nuclear power plants in less time and for less money than the utility. When they purchase a decommissioning plant, the investment companies often acquire the utilities decommissioning trust funds, which have been paid for over the years by ratepayers and taxpayers. They bank on cutting corners, speeding up timelines, in order to keep their profit margins.

Pursuing these timelines such as moving or mishandling unstable radioactive waste before it's safe to move, and cutting down on staff, could lead to other liabilities and accidents. In Plymouth, Massachusetts, not far from where many of you are in Boston, Holtec has been saving money by breaking the plant's Union. They've been hiring scabs who do not have the proper safety training or security backgrounds or the expertise to work on nuclear decommissioning. So it's not-- we're not just talking about Europe's threat from radioactive fallout, but the East Coast of the United States too.

Ukraine is one of Europe's largest nuclear power countries with 15 operating reactors and four decommissioned reactors. All of the reactors are decades old and add to Ukraine's security threat. And also that of downwind Europe. Ukraine, we did the calculations here at MIT, has enough sunshine and wind to replace nuclear energy by 150%. So if the Russian army Russian Today were attacking solar panels and wind turbines, or investment companies like Holtec were decommissioning them, I would feel a lot safer. Thank you very much. I'm going to hand it over to Mariana.

**MARIANA
BUDJERYN:**

Thank you so much, Kate. And thank you to the Starr Forum for holding, hosting this important discussion. What I'm going to try and do with my 10 or so minutes is to put the story and stories that Kate has related into a broader historical narrative as it relates to Ukraine's history in particular. So Chernobyl certainly was the first major act of Ukraine's history as an independent state. It was a prequel to its independent statehood in a very important sense. It was as where a very pronounced tragedy in this classical sense, where the Soviet Union with its great big technological prowess, something that the regime was extremely proud of and tried to tout to as its competitive advantage, and have deployed all these reactors through starting building and construction and late '70s, and putting many of them on line in the '80s. A sort of this sign of its technological advancement.

It was a very proud thing. And also for the Republican leadership of Ukraine. They were the site of these important investments by Moscow. Until of course in 1986, there were several smaller accidents beforehand, as Kate has mentioned. We don't really when that tragedy started. But we certainly do remember the date, we all know the date of April 26, 1986, when the fourth reactor on the Chernobyl nuclear power plant exploded due to sort of human error, but also faulty reactor design, and a whole host of reasons.

The disaster was exacerbated by the mishandling, the great mishandling of this accident by the central authorities in Moscow. And the leader of the Soviet Union at the time, Mikhail Gorbachev, himself admitted that Chernobyl became one of the major reasons for the Soviet dissolution. Because for all the numerous industrial disasters that the Soviet Union has lived through, Chernobyl was simply too big to hide. You simply couldn't continue to lie about it as the Soviet regime tried initially. You couldn't hide it.

And it came at a time where the Soviet leadership, in particular Mr. Gorbachev himself, was prone to a greater openness and inaugurated the policy of glasnost. So Chernobyl became that first marker of the policy of glasnost, where large numbers huge chunks of Soviet population learned what happened, not certainly in the full extent. As Kate presented, we are still learning what exactly has happened. But it had an enormous social and demand political effect on the fate of the USSR.

In Ukraine in particular the accident itself and its mishandling by the central authorities became part and parcel of a pro-independence movement. In Ukraine itself and its pull away from the Soviet Union was really of mark the death knell of the Soviet Union more broadly. So in a way this greatest sort of proud thing of the Soviet Union, this cutting edge nuclear technologies, became had in it the seeds of the system's undoing in a very salient way.

And in Ukraine the pro-independence forces picked up on this narrative, this anti-nuclear narrative as also to rally the whole country, the whole of Ukraine, which at the time had a very uneven identity landscape, to rally all of Ukraine's population against the central Moscow authorities on the civic and humanitarian basis rather than on ethno-nationalistic basis that would have resonated very differently with various parts of the country.

The narrative of Chernobyl, the trauma, and also this anti-Moscow anti-institutional context, under institutional meaning that it had gained through the late '80s and in 1990 became the basis for Ukraine actually unilaterally codifying its desire to become a nuclear free state. When it passed its declaration of state sovereignty in July, 1990, so a full year and a half before the Soviet Union officially fell apart.

When I talked to the person who proposed this anti-nuclear clause into the founding document of Ukraine statehood, he did refer to the so-called Chernobyl mood where all things nuclear were associated with the repressive policies of Moscow. So both the nuclear energy on which Ukraine the Ukraine at the time and the same kind of the same month in July, 1990, declared a moratorium on all new construction of nuclear reactors in Ukraine that were at least two, perhaps three reactors under construction at the time. It ended up reversing these policies for a variety of reasons.

But that came as a package. So Ukraine's path towards independent statehood had a very expressed sort of anti-nuclear elements in it. And that became important when the Soviet Union, in the end collapsed in December 1991, and a new predicament emerged. And one of world's-- one of two world's major nuclear superpowers ceased to exist. And its vast nuclear arsenal was now situated on the territory of not one, but four sovereign states.

The Russian Federation, of course, but also Ukraine, and Kazakhstan, and Belarus. And the question emerged, what is to be done with this arsenal? How-- the questions of inheritance, questions of legal succession, in the nuclear realm are to be dealt with. Of course for a variety of reasons, both the existence of the nuclear nonproliferation regime, the interests of Russia, and the United States, and the more the broader international consensus on nonproliferation, a single policy or concerted policy emerged outside of Ukraine in Western circles, in Europe, and Washington, that there should be only one nuclear successor to the Soviet Union. And of course it was taken for granted that nuclear successor should be the Russian Federation.

There were decades of dealing with Moscow. In addition, there was traditionally this conflation of the Soviet Union and Russia. So that was sort of commonsensical, and went largely uncontested outside of the Soviet Union, although both Ukraine and Kazakhstan at the time questioned this uncontested succession in the nuclear realm, and actually ended up staking a claim to a kind of ownership over their nuclear inheritance, and negotiating a deal, a nuclear deal to which they felt at the very least, they were entitled as a compensation for surrendering their property, their strategically important property.

And so in this way the second act, the drama of this disarmament where Ukraine's newfound agency as a sovereign state came up against the international structures, the international regimes, the Chernobyl tragedy, the Chernobyl accident, laid the groundwork in a very, again, in a very salient way, and guided or impacted Ukraine's deliberations on how to deal with this important, strategically important-- some in Ukraine had argued nuclear inheritance.

In the end in 1994, Ukraine made the decision to disarm and join the non-proliferation treaty as a non-nuclear weapon state. A decision that, by any measure was the right one for a number of reasons, including those that Ukrainians understood themselves. Right? And there is a narrative now in Ukraine that prevails sort of saying, oh, Ukraine inherited the third largest nuclear arsenal, and gave it away under international pressure for nothing. That certainly was not the case. Ukraine had agency, and Ukraine had options, and it deliberated these options. In the end made a decision that made a lot of sense at the time.

Clearly as history developed and Ukraine came under attack, well, the first time in 2014, with annexation of Crimea. And the war in the Donbas. There has been a lot of new attention to Ukraine's decision to disarm, and there have been revisionist claims that had Ukraine kept nuclear weapons, that it wouldn't have gone-- wouldn't have been attacked by Russia. And I'd be happy to discuss this very rather problematic counterfactual in the Q&A.

But suffice it to say that this nuclear past, Ukraine's nuclear history, came to strike back right in, well, about 14 months ago, 15 months ago when Russia launched a major full scale invasion of Ukraine, doing so under the shadow of nuclear threat. So its military actions on the ground were accompanied by rhetoric of nuclear threats, initially focused or targeted on the West to try to dissuade Western powers on getting involved on the Ukrainian side directly. Something that seemed to have held over the past year and a half or so where the Western powers made it very clear, they would not get directly involved in the war in Ukraine, although they have extended generous military and financial aid to Ukraine.

But the fears of nuclear escalations are real. And the deterrent effect of these threats seem to be quite at work. A year or more into the war, the war is contained on the original territory in Ukraine, Ukraine's territory, with the original two belligerents, Russia and Ukraine. At the same time, very early in the conflict, Russian forces occupy one of four operating Ukrainian nuclear power plants. Zaporizhzhia, nuclear power plant in the South, they roll in, there's shelling and shooting at the site. And since that time the drama of Zaporizhzhia keeps unfolding in starts and fits during the summer of last year. The situation was rather quiet and then escalated in August, September where the power plant lost offsite power, putting the safe operation of the cooling systems at risk.

The IAEA got involved and sent a recurring rotating missions. But in the course of the last year or so, we see that nuclear power itself, or nuclear power plant itself, becomes a sort of tool of war, and the concept of weapons and power generating facility has in a way merged into one. The Russian forces have used this particular nuclear power plant as the staging ground, as a military base, knowing, sheltering behind it, knowing that Ukrainians will not dare to retaliate even though there have been accusations of mutual shelling.

And they're also raising those fears. Those old fears and hankering back to the memories of Chernobyl. And we hear all the time through the press, will there be a second-- is there a second Chernobyl brewing in Ukraine. Zaporizhzhia become a second Chernobyl. And so mobilizing those fears in Ukraine, but also in the West is part of the Russian strategy.

As Kate mentioned, Ukraine is a heavily nuclearized economy. And it has become more so throughout the war. The share of nuclear power production has actually increased. And this is the double edged effect, of double edged sword, of Ukrainian nuclear power generation. The Russians have targeted critical infrastructure. Many, a lot of the utilities and nuclear generating, power generating facilities have been hit. More than 40% is damaged.

The coal and gas power plants have been hit the most. And yet the Russians have been deterred on targeting and destroying nuclear facilities altogether, for the obvious reasons that it is not even in Russian interest to cause a major nuclear accident, given that there is no guarantee which way the wind will blow at any given time. And so in a sense that has allowed Ukraine to-- or contributing to Ukraine's ability to save its grid, to provide electricity, and even recently resume exports of electricity, most of it 54% or so as of the last couple of months have been generated by nuclear power.

So this is, to conclude, to sum up, the nuclear matters, the things nuclear have impacted Ukraine's fate as an independent state, has in a way contributed to bringing Ukraine into being as an independent state, by kind of putting this stressors on the Soviet system. And also continue to shape Ukraine's fate probably in a way that perhaps only Japan could claim to have been affected to such an extent by nuclear energy, both weapons and civilian.

And with that, I will end here, and I look forward to your questions. Thank you.

CAROL

SAIVETZ:

Thank you very much to both of you. This was fascinating. And the links between Chernobyl and what's happening now, the legacy of Chernobyl and what's happening now, are really much more dramatic than even I, somebody who watched it happen at the time, Kate, obviously not as you have, just a fascinating story and a very striking story. Does either of you have a question for the other one, and then Elizabeth and I will ask questions, and then we'll open it up to the public. Kate, Mariana, do either of you want to ask the other one a question? All right. No?

I guess what I'm struck by is as I started to say before, this idea that Chernobyl helped to birth the Ukrainian state. At the same time as it was so terribly affected by the nuclear accident or intentionality or whatever of in 1986, and Kate, I'm really struck in your comments about how this is still ongoing. And how hard they worked to hide what was happening at the time, and certainly what the after effects were. So I guess the question for both of you is, what do you see as this legacy going forward? I mean, given that Zaporizhzhia sort of under stress at the moment, maybe not directly attack but under stress, what do you see as the consequences of this history going forward as Russia's continuing to conduct the war and Ukraine is continuing to defend itself? I don't know which one of you wants to answer first.

KATE BROWN: You want me to answer it first?

CAROL

Sure.

SAIVETZ:

KATE BROWN:

I'll answer in a more global way, then a little bit beyond that what this tells us about nuclear power in general is that as we think about going forward, and we're going to have more stress and crises and sinking cities and possibly climate change induced wars, these nuclear power plants are a huge liability, for not only the parties at war and the neighbors to those plants, but for everybody living nearby. And we think of we think of even without nuclear weapons being fired. And we talked about this a little bit when we were meeting that nuclear power and nuclear weapons and the war in Ukraine have become one thing. They are there together a threat and weaponized. So whether Russia sends a missile, a nuclear missile, or drops a bomb on the Zaporizhzhia plant or any of the other operating nuclear plants in Ukraine, we have very similar kinds of problems before Europe.

And so I think that this speaks to a real problem we have, of decarbonizing the future with nuclear power, in a much more uncertain world. I guess that's what I think going forward.

CAROL

Mariana.

SAIVETZ:

**MARIANA
BUDJERYN:**

So I think one thing that kind of jumps out is just how political nuclear power always is. It's in the construction of a nuclear power plant. And we know that, for instance, Russia's Rosatom is one of the major suppliers of nuclear reactors, nuclear fuel, around the world. It really is a 100 year marriage, political marriage, with the supplier of these reactors, and the full cycle from construction to decommissioning to the management of fuel and waste and so forth. And the question then becomes, is this kind of authoritarian power markets, will they kind of take hold, right? With the supplier like Russia, and how other states might look at Ukraine and what kind of what's going on in Ukraine, what kind of conclusions they will make.

I think different states will make very different conclusions. This is something, unfortunately we don't have that much influence of power of. I mean one way to look at it is to say, all right, in that 100 year stretch, how many countries can guarantee that they won't find themselves and their power reactors in a war zone? Which country now in Europe, well, other than maybe or in the West, which country other than maybe the United States or Canada can say that there weren't a major war on their territory within the last 100 years?

So these are the kinds of time frames and the kinds of consequences and calculations that we have to be thinking about when talking about construction of these kinds of major commercial reactors. Yet it is, again, a very difficult to see whether from the perspective of say Bangladesh or Egypt, or perhaps a different country that is thinking of deploying a Russia or Turkey, a Russian made reactor, whether the role of say even Rosatom in the occupation of Zaporizhzhia and in the serious breaches of safety and security procedures, they are nuclear safety and security procedures, and the really limited way in which the international community can respond at the time. With IAEA missions, they're working within a limited mandate, doing what they can, which is clearly not enough. Whether that will serve to problematize the deployment of this kind of reactor in general, and by that particular supplier in particular.

**CAROL
SAIVETZ:**

That's great. So my opening question to both of you is, was actually that very question about the IAEA. What could be done as far as to strengthen-- is that the appropriate organization? Is it too tarnished by what you found, that they may have hidden a lot of results, or not looked at the right kinds of cancers? I remember you have said that in other talks that they only looked at thyroid cancers, and you found stomach and mouth cancers. Are they too tarnished to be the right agency to play a role here?

How can other international organizations support the IAEA in Zaporizhzhia? Is there a way that can-- are there any conventions against using a nuclear power plant as a human shield, which is what they're doing? And think there aren't. Should there be? Any-- just because both of you on your thoughts on what else can be done to create a-- is there any way of creating more security there. I mean, they are just a few individuals who are rotating in, but what could they do?

KATE BROWN:

The historian Jacob Hamlin wrote a great part of a book about the creation of the International Atomic Energy Agency and how there were some especially Danish scientists who wanted to create a watchdog organization of scientists to monitor the production of nuclear weapons and nuclear power, because they're getting nervous about releases just in the day to day operations, and the US stepped in and said, no, let's make it a UN agency, and instead of having independent scientists work in this agency we'll have scientists who are appointed by each power.

So now they're diplomats, right? And now they're there at the behest of their government representing their governments. A very different kind of project. So I think until we can come up with an agency that we don't have diplomats, who have to answer to all kinds of political forces at home, but we really do have independent scientists. I think that would be the solution. They have an internationally funded watchdog agency with some kind of police forces.

**MARIANA
BUDJERYN:**

Yes, I think what we're seeing really is that the capacities of these institutions are really not up to the challenge at hand, and in the sense it is certainly not IAEA's fault. It's the way it's been constituted, and people within it today, I think we've got to give them credit, are doing what they can within the confines of that mandate of that institution, and within the confines of the structure. And certainly we have to give credit to Director General Grossi for sort of being personally very proactive and going in and brave and organizing these missions that if not anything else, perhaps offer some moral and psychological support to the people at the nuclear power plant, and Zaporizhzhia that they know that at least their fate is probably known to this agency and to the broader international public, and they're not being forgotten.

But it also highlights kind of the limitations of dealing with, we always designed safety and security system to the last disaster, right? So something happens. Something blows up and we then go and look and with various degrees of success as to what has gone wrong, and then we upgrade these safety and security systems, and this is certainly beyond anything that we have as an international community we have prepared for.

Although some of the provisions have helped, right? They having the extra generators there has been a good thing. Right? They kicked in when the off site power was lost. But that's kind of a Band-Aid approach to this kind of scope of potential disaster. And again, how do you if the IEA is, in a sense, part of the UN system, although we call it a UN watchdog, but it is kind of a separate institution. I think they have to-- I'm not exactly sure how it is set up, but it's not exactly properly part of the UN system.

It would still require a decision of the UN Security Council to authorize any kind of peacekeeping or policing or enforcement of a demilitarized zone type of action that might or might not be led by the agency. And that goes into a dead end if one of the perpetrators and the state that wields a veto power in the UN Security Council is also the belligerent in the conflict. So I think we beyond just the agency we have to rethink the broader institutions of international security.

**CAROL
SAIVETZ:**

Great, thank you. A couple of our members of our audience have asked a question about a Ukrainian announcement, and I have to admit, I didn't know about this, to create smaller, more localized reactors to provide power. And so the question, I guess in light of what you've been talking about, is how would those be protected? How would they be utilized? Is there a role for international monitors in that too? And if the war is ongoing, how do you take care of that? Go first, Kate.

KATE BROWN:

Who knows if they're smaller? I'll be broke-- their ideas are smaller though cause if they are blown up or something to spread less radioactivity. They're supposed to be safer. That's what others-- The same decommissioning company Holtec is-- Holtec Ukraine is set up to work with Ukraine to build those reactors.

MARIANA I think there have been also conversation with Nuscale and maybe some other producers of small modular reactors. The idea is, I suppose as Kate said, they're safe or safer in the way that nuclear fuel is deployed there, and they could be potentially, I don't know, situated on the ground. I don't know if that's exactly true, but I read that. And they would certainly be all under the IAEA safeguards.

The problem there is to-- I think the way I understand it, for the small modular reactor deployment to make a dent in, A, the contribution to the grid. But also in decarbonizing in any kind of meaningful, significant way. The scale of such deployments has to be rather large. And then that becomes the issue with siting, and also with all sorts of safeguarding and monitoring and then you have all these safeguards, missions, going to gazillion places, and things like that. So it creates its own set of logistical problems. But certainly they're supposed to be safer for kind of nuclear materials and facility security.

CAROL
SAIVETZ: So one of the questions for Mariana was about the 1994 moment. One of the questioners asked you to unpack what were some of the factors that caused Ukrainians to let go of nuclear power. And I think if I remember from your book, one of the things you argue is that it was about the reaction to Chernobyl and the anti-nuclear sentiment. And so a second part of that is unpacked in 1994, all the different factors that went in, which is if I remember correctly quite complicated. But also then to what extent, when you talk to people today do you see an anti-nuclear movement in Ukraine? Or is there a feeling that nukes are actually somehow should be-- I mean what kind of mood are you picking up when you talk to people about nuclear power? Because certainly the mood in '86 was very anti-nuke, and '91 and '94 at the time of the 1994 moment.

MARIANA
BUDJERYN: So the '94 moment. It is kind of a complicated and nuanced story, and it's not just that Ukraine gave up a world's third largest nuclear arsenal, or on the other hand Ukraine didn't have command control, couldn't do anything. It was overdetermined, Ukraine just had to give this inheritance up, and was just used it as political tool for haggling.

Ukraine did have agency, and it did have options. Nuclear technology is or is the technology of the 1940s. Right? Ukraine had many scientists, it had the nuclear science, it had people with clearances and in the Soviet bomb project. It had a whole missile army, so military personnel trained to deal with nuclear weapons and strategic nuclear deterrent. It had a major missile producer on its territory in [NON-ENGLISH] Design Bureau. So it had a lot of building blocks of a fully fledged sort of nuclear weapons program.

It lacked the fuel cycle. So it lacked everything that went beyond mining and milling of uranium. So through conversion and enrichment and/or reprocessing on the other side. But it had all that Chernobyl fuel, right? That kind of lended itself to plutonium reprocessing quite nicely. And in fact the RBMK reactors were derivative of the Soviet military plutonium producing reactors.

So the decision not to pursue that option had, as I mentioned, Ukraine started in a very kind of formalized legal-- it was in the law, passed by the Ukrainian parliament, that Ukraine set itself on this nuclear disarmament footing back in 1990. So even as more qualified political kind of opinions, or positions emerged, after the independence was attained, and after it emerged that Russia might be that kind of ongoing threat, those-- politically Ukrainians were sort of pegged to their own declaration that they passed back in 1990.

They kind of were things on both sides, right? That weighed on both sides of that ledger. So in favor of nuclear retention or entertaining a nuclear option, where of course, the security concerns, concerns over territorial integrity, with Russians making claims and fueling the separatist movement in Crimea, there was the Ukrainian leaders realized also just how important the nuclear issue is to the West. Kyiv, that would have been a very obscure place for most people and in Washington, suddenly became a destination for all these high ranking US delegations. And the first thing they asked when they came to Kyiv was, what are you going to do with nuclear weapons?

So that inadvertently served to elevate the value of that nuclear inheritance in the eyes of many Ukrainian leaders. Something I think we should really be thinking about in the way the West engages with the rest of the world. So for Ukrainians then understood then that was one of the ways to keep Western attention to Ukrainian kind of predicament, security predicament, and Ukrainian problems. And it also had as, I mentioned, kind of an internal lobby. All those missileers. That was mostly on the delivery vehicle front, not on the nuclear front, since nuclear scientists actually did not-- they wanted to engage with international community of scientists. They did not want to be boxed back into some secretive program.

But on the other hand, yes, you had Chernobyl. That kind of set the stage for nuclear war-- not unilateral, voluntary nuclear renunciation. You had an economic crisis, right? To build up these missing parts of the fuel cycle would have taken investment that would have had to be diverted with very scarce resources from other parts of the economy. You had concerted US and Russian pressure, and you had the international non-proliferation regime. There was that kind of zeitgeist, right? Internationally where there were deep reductions in superpower nuclear arsenals, with INF, with Start One, treaties, South Africa, disarm join the non-proliferation regime.

The NPT was going into the 1995 review and extension conference. It was important to get sort of as many people on board as possible and to get Ukraine and Kazakhstan and Belarus to join the NPT by that time. So all in all, the Ukrainian decision makers sort of looked and deliberated internally and inter-agency and between the branches of government, and in the end made a very prudent decision at the time.

And it pains me to hear today, to the second part of the question, where the explicit anti-nuclear sentiment has fizzled away, and there is much regret in Ukrainian publics. Again, I'm not-- I can't speak authoritatively. I have not taken a survey. But those surveys that do exist, they do show that Ukrainians think it was a mistake. Many Ukrainians think it's a mistake. More-- close to a half.

**CAROL
SAIVETZ:**

Right. Picking up on some of the points that you just made, Mariana, several of our audience asked about these module nuclear reactors. I'm back to the other issue again. About the costs, about how safe they are, and maybe both of you can answer this. And then what strikes me is we're talking about this is that we're weighing these elements about whether this is a good way to go in the middle of a war. In the middle of a war where there's no security over anything at this point.

So I'd love to hear both of you comment on what you know about the safety costs of these new kinds of technologies. And then are they vulnerable? I mean, could the Russians attack them where they might not attack Zaporizhzhia, could they attack this modular nuclear power plant, power energy generating resource?

KATE BROWN: They're not as safe as solar and wind, that's for sure. They're far, far more expensive, usually the kilowatt hour is two, three, or four times more. We haven't seen-- I mean we don't see any small reactors plugged into the United States into any grid in the United States, in large part because communities don't want them. And they're small, they need to be right on Main Street. And so as I said, siting them is a real problem.

So you have just a different scale. The same sets of problems. There's no place to store the waste. If you're a customer of a Russian reactor, they will put all-- they will take back all that spent radioactive fuel and put it out in the Urals, where they used to make plutonium. It's a godforsaken mess out there in terms of radioactivity, but they just-- it's now a sacrifice, so they just put more there and reprocess it.

But places that have stronger environmental regulation can't do that. So if Ukraine is trying to join the EU, they're going to run into all kinds of problems I think with that, I'll hand that over to you, Mariana.

**MARIANA
BUDJERYN:** I have to be honest, I do not-- I cannot authoritatively speak to the safety and security features of the small modular reactors. The way I understand it they are in the way that the fuel is deployed within the reactor is sort of better protected, as it were, than in the kind of large scale commercial reactor. And I think going to kind of the small-- that one of the major reasons going to the smaller scale reactor is the cost. Right? The cost of building a giant nuclear power plant has been prohibitive for a lot of countries. Their cost overruns, it goes way over timelines and things like that.

So these major constructions of the kind scale as say Zaporizhzhia is or the other major nuclear power plant has proved to be increasingly economically unsustainable. You have to have a huge CapEx or investment upfront, and then there kind of make sense to run afterwards. But normally that's at least twice the sum that has been projected in the beginning.

So the SMR is a sort of the answer to that. I'm not sure how much sense they make for Ukraine that already has such a large nuclear industry. And two more reactors actually under construction, allegedly. I don't know when the construction will happen given the war. But it just-- to me that kind of the spread, whatever the upsides in the actual nuclear safety perhaps of operating a small modular reactor might be offset by the fact that there just-- there will be many of them, right? If they are to make any difference in the energy mix.

So then you have more sites to look after, to protect. You have more sites to inspect. You have perhaps a more sizable asset, right? Because what is Zaporizhzhia today? It's the largest theft, industrial theft, probably in history, right? It's however many billion, maybe \$6 billion, it's a billion per reactor. I'm not sure. It was just grabbed and stolen. So imagine that a smaller facility might be easier to steal by an occupying force, even if it is not made into a disaster. So I'm not sure this is a satisfactory answer, but these are just some of the things that came up in my mind when I'm thinking about it.

**CAROL
SAIVETZ:** Well, I think those are great answers both of you. So we've got a couple of questions about Russian behavior in this war. One asks whether the Russians are deliberately not damaging the nuclear power plants. I don't know that that's true. Another asks whether the Russians are thinking about the wind's blowing East, and is that keeping them from launching tactical nuclear weapons. I know neither of you actually works on this topic, but I do know that our audience might be curious. What are your views? It's the \$64 million question. No one knows the answer, but do you have a thought on whether Russia-- what are the pros and cons of Russia using nuclear weapons for themselves, or of course for the rest of us? Like either of you go first.

MARIANA Kate, do you want to take this on first or?

BUDJERYN:

KATE BROWN: Go ahead.

MARIANA So about-- I mean, I imagine. It's hard to know, right? So look, and Kate is looking at Chernobyl now, however
BUDJERYN: almost 30 years after it happened we're still finding out new information. We still finding out just all the things we didn't know.

Now in the middle of this war it's hard to know what the Russian motivations are and what's preventing them from doing things. I can imagine, it's really not-- no matter how nefarious Russians are, it's not in their interest to blow up a nuclear power plant for the very reason that their territory and their population might suffer just as much, given that we don't know where the winds will blow, and given how long they the aftermath and the consequences and the effects of pollution by that kind of nuclear disaster might be.

And certainly given that they're hoping to hold on to the Zaporizhzhia nuclear power plant. They don't really need it for power generation. It's kind of a tool of just depriving of an energy war, right? They just want to deprive Ukraine of it, at the very least. But given they're going to hold on to it at least as an asset, they might not want to create a major environmental disaster in the territory that they now consider their own.

Regarding other Ukrainian nuclear power plants, clearly I mean the Russians went after the grid in October and November. It's interesting to me how I was getting all sorts of phone calls when Zaporizhzhia was getting occupied and shelled, and in March of 2022, but in October, November, when I think was probably the single most dangerous time when the entire grid went bust, there was a total blackout. That meant also cutting offsite power to the other nuclear reactors operating in Ukraine.

I got very few phone calls from the press, right? That's just the understanding of the scale of those risks is I think is very poor out there. You know, Ukraine was able to salvage the grid, to restart it somehow. Ironically it seems because the grid itself was overbuilt, there's a huge capacity for electricity producing, it was overbuilt by the Soviets who seems like anticipated that in a major war with NATO, this might happen. That NATO might go after the grid in this theater of operations.

And Ukraine has a ton of extra capacity for generating electricity, more than it actually needs for its own needs. In terms of using a nuclear weapons, I mean, I suppose there are certain several-- at least three scenarios that I can imagine. None of them-- the risk of is non-negligible, which is more than certainly any of us should be comfortable with. But fortunately none of it has happened. Fortunately-- hopefully that risk is not still super high.

So one way is to do a demonstration shot, right? Now people are talking over the Black Sea or something and say, OK, Kyiv or whatever, Odessa will be next If you, Ukraine, don't agree to Russian terms and capitulate or whatnot. Another one would be to actually target a city, for the same sort of political reasons. Kind of psychological reasons. And say, all right, if here is the Odessa, or whatever, Kharkiv, and then Kyiv will be next if you don't surrender.

And of course, this is something we were all thinking about when Putin and his speech at the end of September mentioned American bombings of Hiroshima and Nagasaki as precedents. Because of course, let's be honest, this is exactly what had happened. A nuclear state used a nuclear weapon against a non-nuclear state with the intention of getting it to surrender unconditionally. And those kind of past sins have-- are coming to haunt us.

Another sort of a third scenario for tactical nuclear use is military. Is battlefield nuclear use. So to sort of break through fortified Ukrainian position in a particular stretch of front. We know that Soviet operational planning, back in the '60s and '70s, had certainly planned for this kind of use, for just efficiency reasons, really. When your supply lines are getting stretched and your conventional ammunition is running low, you can either try and transport hundreds upon hundreds of conventional munitions to the battlefield, or a dozen tactical nukes. Right? Does the job. The same kind of job.

They, again, there are several reasons beyond the obvious ones. But if we kind of obstruct this and there are several reasons not to do it, mostly because Russian troops themselves are just not prepared to operate in the theater that's affected by a nuclear blast. They haven't been training, there aren't protective gear for this. There used to be trainings like the Totskoye training where you would actually explode nuke, and send the troops into train how to operate on that. That has not been the case now for a long time.

Again, that is not to say that we should be complacent. We don't know how Putin thinks about these things. I'm not particularly reassured. But there are many practical and also, of course, moral reasons not to use nuclear weapons in Ukraine.

CAROL Kate, any last minute words or thoughts on this?

SAIVETZ:

KATE BROWN: Well, as an historian, I try really hard not to try to predict the future.

CAROL Safer.

SAIVETZ:

KATE BROWN: Safer. And what do I know about the future? I look at the past. But and I think my point is well taken, that in the past the Russians have shown a great deal of restraint. And pursued sort of nuclear talks, nuclear testing moratoriums, a lot of that in the Cold War came from Moscow. And it's the Americans who have been the aggressors.

When the Japanese were suing for peace, not one but two cities were struck by them. Nuclear weapons. Of course, nuclear weapons are now much stronger, and so I think hopefully world leaders are all the more careful.

CAROL Great. So, we've come to the end of our session. And this is the last one that will be focused on Russia, Ukraine, et cetera for this year. So I'd like to thank everybody for joining, and I'm really leaving with sort of a pessimistic note. Kate, I'm really struck by your statement that nuclear power and nuclear weapons are one and the same thing. And I think if we begin to think about some of the dangers of deploying nuclear power, even as we think it might be an alternative to coal or fossil fuels and everything, it's really interesting to think about all these other issues that have been raised today from both of you in your talk.

So I'd like to thank everybody and just to remind you that there is one other Starr Forum focusing on the Middle East, not on Ukraine and Russia, this coming Wednesday, April 26th at 4:30 to 6:00. It's both in-person and online. It's in building E25, room 111, and the speaker will be Steve Simon who has just published a book that was very well reviewed in the Financial Times over the weekend called *Grand Illusion, the Rise and Fall of American Ambition in the Middle East*, and the discussant will be Andy Vucevic, and we hope you can join us for that as well. So thank you everybody, and have a good rest of the semester.