Lesson with Washington Post Article: “Ukraine found an unlikely tool to resist Russia: solar panels” Slide # 15

SOLAR ENERGY SOLUTION DESIGN AND DEBATE

Objective:

- Understand the role of renewable energy, specifically solar energy, in enhancing energy security and resilience.
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Materials:

- Paper
- Article copies
- Self Assessment Rubric
- Group Rubric
- Canva Login

Procedure

1. Prior to reading the article, discuss with students the potential role of solar energy in energy security. Ask them how could solar energy provide the Ukranian youth they read about with some energy security? Ask how it could provide them with energy security?
2. Divide students into small groups (3 or 4) and provide them with the Washington Post article “ Ukraine found an unlikely tool to resist Russia: Solar panels”. Students should read the article quietly to themselves. Encourage them to take notes related to energy security as they will soon take on the role as European Union Energy Consultants for regions facing energy security in a conflict zone.
3. Provide each group with a folder containing instructions from their government (in this case they will play the role of an EU country). Create some fun by including fake airline tickets, hotel reservations, rental car, and if time a passport with the country’s stamp in it (I have had students create these on Book Creator, and it is cool if you have activities in various parts of the world throughout your class. I actually require them to include more than just a stamp on any given country’s page. They usually must include the country’s flag, a cultural site, and a second tourist attraction of their choice that is natural). There should also be an instruction page identifying a region from the maps they studied earlier. The page should include some key details of the region and a map showing them where it is at. Details should include if the area is urban or rural, if it is in a conflict zone, time of year, average weather, and if they have functioning electrical infrastructure.
4. From the maps and the data provided their energy consultant team must design a solar energy solution that will enhance energy security in their region.
5. Each group will make a very simple and brief presentation of their solution to the rest of the groups, and that will be followed immediately by an equally brief question and

answer session. Students are limited to who, what, when, where, how and why questions.

6. Finally, facilitate a reflection session. Ask students what they learned about solar energy and its role in energy security. Plant the seeds for solar energy as a means for energy security for the planet as a whole. Mention here that the EU and US both have solar energy as a part of their plans and policies for energy security. This should come across as a key concept/main point. It will be the topic going forward. If the students did not create solutions that included distributed energy and off-grid energy, this would be the time to point out how this enhances energy security too. It would be appropriate to briefly identify other renewables as methods for increasing energy security as well.
7. The next days warm up activity should be a short essay that reflects on what was learned about the role of solar energy in energy security.

RENEWABLE ENERGY: A SYMBOL OF HOPE AND A CATALYST FOR POSITIVE CHANGE

EU-US ENERGY SECURITY AND THE WAR IN UKRAINE

3 DAY UNIT

Day 1

Introduce the topic with a Canva presentation. Make sure students have a copy of guided notes/graphic organizer. Have them write the guided notes, not type them online. It provides time to process.

Slide 1:

Let students know that the opening picture is a picture I took while learning about the European Union through CES. It is a giant poster/picture that is hanging on the building that houses the European Union's European Commission. Briefly explain what the European Commission does. Ask students what they think this is all about. They should answer in their guided notes. Briefly discuss their answers.

Slide 2:

Highlight the importance of energy in our everyday lives using slide 2. Have students write a brief (one or two paragraphs) energy story of a time when energy impacted their lives in a difficult way. If you choose to prompt them with an example, do so with only one. Let them identify issues, perhaps allow them to talk among themselves. Common examples include losing electricity and subsequently phone service, tv, food in frig, losing the ability to buy stuff at the store, inability to get gas for a car, or get to work and the subsequent loss of pay. There may be positive stories like a parent working for a utility, or as an electrician, etc.) Ask, based on their experiences, is energy a basic human need? A basic human right?

Slide 3:

Define energy security and briefly explain the 4A's of energy security. Have them identify which of the 4A's their previous example met and which ones it did not meet. Fill in on guided notes/graphic organizer. Remind them that all 4A's should be met to be energy secure.

Slide 4:

Explain that energy security is more than a local issue. Use the OPEC Oil Embargo to explain. Discuss the strategies the US used to address energy security at that time. Ask if the US has good energy security now?

Slide 5:

Focus on efforts at conservation. Students may be intrigued by the "new" interest in this area. They may not know where the 55mph speed limit came from, turning your thermostat to 68, etc. Nixon's speech to sacrifice a little to avoid bigger problems might be an interesting historical moment. This may be a good time to BRIEFLY show the hope in renewables. Most of that will come later.

Slide 6

Mention OPEC round two and move into a general statement of how the War in Ukraine has once again challenged energy security.

Slide 7

Slide 7 sets up the war's direct impact on energy security and the next mapping activity. It simply explains the War in Ukraine for those not fully aware of why or what was going on. It is, in a sense, a war on an energy front.

Slide 8

This slide is just highlighting for students that we are moving into Ukraine's energy security.

Slide 9, 10, 11 and 12:

These slides show the maps of the Ukrainian Power Sector including critical mineral, coal, and gas deposits, gas lines, gas storage facilities, and oil lines and transportation infrastructure. Identify icons for students and briefly discuss what interconnections are. Answer general questions about the maps.

Break students up into small groups (3-4). Give each group a set of maps and have students identify energy security issues based on what they see on the map. They should list all that they see on poster paper and be prepared to present. They should also pick out one area/infrastructure that seems particularly vulnerable and be prepared to point it out on the slide presentation and explain why they think it is an energy security risk. Be prepared to discuss their findings.

Slide 13: SLIDE TO COME…I THINK I want to highlight a particular energy security issue with the Zaporizk npp and/or Pivdennoukrainska NPP and HPP. There is an article I can get about the attacks and problems created. I would do this after the students have done their work.

Slide 13:

Introduce two Ukrainian youth who have suffered due to the lack of energy security in Ukraine. If it can be connected to any of the student suggestions from the map exercise highlight it. Otherwise, identify how energy security impacted the youth. Attempt to develop real empathy in students for their situation. Their future as voters may require an understanding that we are all connected and we all deserve to be secure. It may or may not include Ukraine, but imagine approving US funds for some Island Atoll suffering from climate change. (I don't know that I will mention this directly, just try to build the empathy I would like).

*Also, I have one or two incredibly impactful videos on Ukraine's children and the war, but they are deeply emotional…I am hesitant to show them, but they would accomplish the deep connection I wish to make with students, make this all real.

Slide 14:

Have students read a WaPo article “After missile strikes Ukrainians persist without electricity, water, heat”. Revisit the slide Energy is Everything. Ask students how they feel about Russia attacking Ukraine and specifically attacking the energy infrastructure. Break into small groups for a “role playing” activity. They are to imagine they are a crisis management team in Ukraine tasked to develop a short-term and long-term plan to restore energy security in their assigned region and season (capital, rural, frontlines, winter, summer, hospital, school, etc). They should consider factors such as resources available, potential challenges, and the needs of citizens. They will present their plants to the class with open question and answer period. Follow all presentations with a facilitated reflection. Ask students what they learned about energy security from the activity and discuss how it is linked to other aspects of society. This should also help build the desired student empathy as well as an understanding of energy security.

Slide 15:

Introduce this slide either as another way of promoting energy security, or as confirmation that some group(s) idea was in fact a real life solve. Ukraine has resisted Russian attacks and increased their energy security. Have students read another WaPo article: “Ukraine found an unlikely tool to resist Russia: solar panels” Have students summarize in their guided notes how this impacts energy security. Discuss briefly with students.

*This might be a neat time to have a guest speaker from the solar industry. They could speak to advantages and disadvantages of solar in a war zone. It would make a good distributed energy source, it would be quick to set up and less expensive than replacing transmissions and distribution lines, substations, etc. Training could be done quickly as well.

Finally, segue into Ukraine’s hope could also be the planet’s hope…renewables as energy security devices.

Slide 16:

This Slide is just the set up to move from energy security in Ukraine, to energy security internationally as a result of the war in Ukraine.

Slide 17:

This is a review. I expect this will start day 3 as there is so much going on with the previous 16 slides.

Slide 18:

Digging deeper into energy security. Again, try to connect examples the students gave earlier when looking at the maps. Move away from individual and national energy security and expand to international connections (for example pipelines from Russia to Germany). Connect energy security with National security issues. Ask student to identify ways that energy security impacts 1) economic stability, 2) social well being, and 3) overall quality of life. Remind them of their answers to the WaPo article. Ask why economics, social well-being and quality of life are National Security Issues?

Slide 19:

Slide 19 is confirmation and expansion of why energy security is tied to economic stability, social well being and quality of life, and it further helps explain the connection to national security.

Slide 20:

Use this slide to highlight how energy security is impacted by Russia's invasion of Ukraine in these three "nations". Explain that these three nations will be the focus of international energy security discussions, although there will be mention of other nations outside of the US and Europe..

Slide 21.

This slide merely sets up the beginning of the EU response to the challenges to their energy security.

Slide 22-30

These slides will delve deeper into the EU response, specifically the RePowerEU policy and what it is doing as a result of their energy insecurity due to the war in Ukraine. It will include policies to limit fossil fuels currently and eliminate them in the future. Students will follow the passage of the RePower EU policy through the political system and learn a bit about the EU system.

Fewer slides will follow on the impact of the US and I will choose a few smaller but highly impacted nations to discuss as well

This will need to be the big final push at the hope message. Focusing on the many ways to limit fossil fuels and promote renewables to help energy security and to help save the planet.

It seemed like it might be good to address climate as well, but I do not think that is going to happen for this current lesson.

POWERING EUROPE: EXPLORING ENERGY SECURITY AND EU GOVERNANCE

Objectives:

Students will be able to:

Gain a modest but clear understanding of the key EU governance institutions, including the European Commission, Council of Europe, European Council, and the European Parliament

Recognize the significance of these institutions in addressing energy security challenges within the context of the Ukraine war.

Identify and differentiate between the roles and functions of the EU governance institutions.

Understand the typical decision-making process within the EU governance structure, utilizing the REPower EU plan as a concrete example.

Deepen their understanding of the critical role of energy security in daily life, including the impact on economic stability, social well being, and overall quality of life.

Articulate the connections between energy security, environmental sustainability, and the resilience of a nation's energy infrastructure.

Engage in a role-playing activity that demonstrates an understanding of energy security and EU governance through generating and negotiating their own energy security plan for an assigned nation-state.

Apply critical thinking skills to analyze energy security challenges and formulate practical solutions within the context of EU governance mechanisms.

*Recognize and appreciate the intricate relationships between governance institutions, citizens, and the broader societal context.

*Infer the connection to the theory of relationality. Judge the significance of relationality to governance and societal well-being.

*Reflect on the importance of effective governance as a collaborative effort that transcends partisan politics, emphasizing the responsibility of informed citizens in shaping their nation's policies.

*Cultivate some of the skills and knowledge necessary to make informed decisions as future voters, understanding that governance involves careful consideration of diverse viewpoints and evidence-based decision-making.

*Acknowledge that good governance is rooted in open dialogue, transparency, and a commitment to the well-being of citizens.

Materials:

Clear Touch
Handouts with key information on REPower EU plan, EU governance institutions
Laptop/computer with internet access
Canva inforgraphic templates

Paper, scissors, markers, glue, etc
Rubrics
Duration: 1-2 days

Procedures:

Begin the lesson by using the presentation slides to introduce the concept of the European Union and its governance structures. Highlight the key governing institutions of the European Union: the European Commission, Council of Europe, European Council and European Parliament. Also, highlight the vast research staff and their commitment that all policy, regulations, laws, etc., are based on rigorous science.

If inclined, briefly introduce the concept of relationality. The key point is in the potential to transform our understanding of interconnectedness and complex systems. The concept exists in physics and philosophy, but the emphasis here is the interconnectedness and interdependence of governance systems (wade into the scientific parallels of entanglement at your own peril). Entities such as governments, organizations, and communities all interact and influence each other to shape policies, decisions, and outcomes. Focusing on relationality helps look at problems holistically and avoids solutions that are isolated from a societal framework.

Very briefly review the background of the Ukraine war and its impact on energy security. Facilitate a discussion on the role of the EU in addressing the energy security concerns, including diversifying energy sources, ensuring supply routes, and reducing dependence on external actors. Discuss why energy is important for the EU and its member states?

<u>Group Acitivity 1: EU Governance Institutions</u>

1. Divide students into small groups
2. Provide each group with manila envelopes on the EU governance institutions with one particular institution highlighted (European Commission, Council of Europe, European Council, European Parliament)
3. Instruct each group to review the information and identify:
    a. The main responsibilities and decision-making powers of their highlighted institution with respect to energy security.
    b. The sequence of the decision making process, highlighting their institutions place and role in the sequence.
4. Each group should create a brief presentation, either a digital or physical representation, summarizing their findings and presenting them to the class. Facilitate the discussion of the interplay between energy security and EU governance.

Upon completion of class presentations and discussion, introduce the REPower EU plan which simulates a decision-making scenario related to renewable energy in the EU. Describe the context of the activity such as the need to reduce greenhouse gases, the transition to renewables, and securing an energy future.

Group Activity 2: The REPower EU Process

1. Students should be divided into small groups.

The Washington Post
Democracy Dies in Darkness

EUROPE

After missile strikes, Ukrainians persist without electricity, water, heat

By David L. Stern

December 9, 2022 at 1:00 a.m. EST

KYIV, Ukraine — The electricity was out and the water service was cut off, and in an eighth-floor apartment in one of Kyiv's outer neighborhoods, Olha Tkachuk felt like her world was coming apart.

A priest had come to her home to baptize her 4-month-old daughter, Nikol, who was scheduled to undergo lifesaving heart surgery the next day. Guests had arrived for the ceremony, and her oldest daughter, Kristina, 17, stepped out to grab extra pizza from a nearby cafe.

Just then, Russian missiles started slamming into the Ukrainian capital — again. The power went out. Kristina was trapped in the elevator. The surgery was thrown into doubt.

"I had one child in the elevator, the other I'm baptizing, and tomorrow we have a heart operation," Tkachuk said. "This was a horrible time."

The attack, on Nov. 23, was part of Russia's relentless missile campaign targeting Ukraine's energy systems, which has knocked out critical services across the country and, as the Kremlin clearly intended, disrupted the lives of ordinary Ukrainians, complicating decisions large and small.

With freezing temperatures setting in, residents of Kyiv and other cities are not only asking where to find heat, water and electricity but also wondering if they can stay in Ukraine. Officials are warning of a humanitarian catastrophe for those who remain and a new refugee crisis if too many leave.

In the meantime, stress is rising, including signs of tension among public officials responsible for making repairs, which are difficult, expensive, and, in some cases, impossible without scarce new equipment.

Ukrainian President Volodymyr Zelensky announced the creation of about 4,000 “Points of Invincibility” across the country — shelters where the population could keep warm, charge electrical devices, access the internet and get something warm to drink.

In a recent address, however, Zelensky said not all city governments “have done a good job,” singling out the Kyiv mayor’s Office.

“There are many complaints in Kyiv,” Zelensky said. “The points still need to be improved, to put it mildly. Please pay attention. Kyiv residents need more protection.”

Kyiv Mayor Vitaly Klitschko rejected the president’s criticism. “I don’t want to engage in political battles, especially in the current situation,” he said. “It’s pointless.”

As the damage from the missile strikes has grown more extensive, repairs are taking longer, and much of Ukraine is experiencing several hours per day without electricity.

In Olha Tkachuk’s case, it took two hours to rescue her older daughter from the elevator. Father Pavlo, an Orthodox priest, conducted the baptism for Nikol and her fraternal twin, Daniel — just in case the operation was not successful, Tkachuk said.

The next morning there was still no power, water and heat in their apartment nor, more importantly, at the Ukrainian Children’s Cardiac Center. Tkachuk and her husband, Volodymyr, nonetheless, collected their children’s belongings in the dark and headed to the hospital.

“When you are in a cold apartment, and you have to find water, which isn’t there, and there’s no light, and you have to bathe a small child in a cold bath, take it out and prepare it for surgery in the morning — this is very scary,” Olha Tkachuk said.

“But we had to go, because it was our last hope,” she added. “Because it could get worse.”

At the hospital, Illya Yemets, the director, told them there were sufficient generators and enough diesel fuel to operate medical equipment for the duration of Nikol’s surgery. But lack of heating and water was a problem. Nikol had a condition that severely weakened her lungs and she needed to be kept warm to avoid illness or infection. Water was also needed for the surgery.

Yemets said they should operate. It was “the lesser evil,” he said in an interview.

He explained that there was a risk of another attack, making the situation even worse. “But if we don’t operate, the child will die,” he said.

The operation was a success. There was enough water still in the hospital's tanks. And while the lack of heat lowered the temperature in the operating room and intensive care unit, Nikol was kept warm by a special heated mattress and operating table.

"Thank God the temperature outside was only freezing, and not 10 or 15 degrees colder," Yemets said.

The missile attack on Nov. 23 was one of the worst since Russian forces started to bombard Ukraine's energy infrastructure in early October. When the barrage ended, almost all of Ukraine had been plunged into cold and darkness.

In Kyiv, a missile had damaged four lines, cutting power for nearly all the capital's population on the east bank of the Dnieper River. Within six hours, the engineers restored two lines that supplied electricity to area hospitals, heating plants and water supply facilities.

But at another site in the city, engineers from DTEK, the country's largest private electrical supplier, worked without sleep for 48 hours, in rain, snow and freezing temperatures. "This was probably the most difficult emergency recovery work for us — there was a lot of damage," Andriy Toyunda, head of the repair brigade, said. "They brought us dry clothes and hot food and drink."

On Monday, Russia again bombarded Ukraine's energy system, launching more than 70 missiles, which resulted in blackouts in the southern city of Odessa and other locations nationwide.

Military and intelligence analysts believe Russian President Vladimir Putin hopes to demoralize Ukraine's civilian population and compensate for Moscow's lack of success on the battlefield. Ultimately, he hopes to create cracks in Ukrainian society, they say. On Thursday, Putin admitted targeting infrastructure but blamed Ukraine for provoking the strikes.

So far, his plan seems to be backfiring. In interviews, Ukrainians said they were even more resolute to hunker down and suffer through whatever this winter may bring. But there are also signs that on the edges, tempers are beginning to flare, as with Zelensky's criticism of Kyiv.

Even when Russian rockets do not directly target Ukraine's heating and water systems, the blackouts have a knock-on effect, said Dmytro Novytskyi, chairman of the Ukrainian association of water supply and sewage facilities.

Without electricity, water pumps are unable to direct water to the population, Novytskyi said. The outages also hit Ukraine's urban central heating systems in two ways — first by cutting off the water they use and second by disrupting electricity required to heat that water.

Novytskyi said that during the Nov. 23 attacks "water supply was stopped in nearly the entire country." For the most part, he said it was restored "fairly quickly," and "collapse" of the water system was averted because electrical engineers knew to restore electricity first to water supply and drainage facilities.

A week after the heart operation, Olha Tkachuk and Nikol were getting ready to leave the hospital. Nikol slept soundly, a tiny bundle in her mother's arms. But her mother's anxieties persisted.

Nikol still needed to be kept warm, she said. "If they turn off the heat again, we'll need to go with our children to somewhere else," she said. One option was to move to her husband's parents' location in another city, where they have a wood-burning stove. If that doesn't work out, she said: "We'll search for heat."

Likewise, Yemets is confronting his own choices.

The Children's Cardiac Center is Ukraine's largest hospital for children with heart problems. It has been operating on 10 to 15 children per week during the war. A second location in Kyiv provides care to adults.

In the war's first months, when fighting was close to Kyiv, the center moved its work to the basement of its building, and sent some doctors and equipment to Lviv in western Ukraine.

Now Yemets is asking where he will get the diesel fuel to keep the generators running if the blackouts last for longer periods. Already, parts of the hospital are working with lowered temperatures and other conservation measures in place.

He is again contemplating moving part of his operations to Lviv. But Lviv is also experiencing blackouts.

The main part of the clinic will remain in Kyiv. "As long as it's possible," he said. "We have to give a chance to all children and older people."

For individual doctors at the hospital, the question of whether to stay also looms large.

"We are thinking about this every day and are discussing this every day with our friends and our colleagues — that this is a main question now," said Sergey Varbanets, the head of the cardiac surgery department for adults.

A week before Nikol's surgery, Varbanets was operating when the clinic suffered its first power outage resulting from a missile attack. Generators kicked in automatically, as planned, and all medical equipment worked without interruption. Still, Varbanets said there was unease in the operating room when it was announced that 10 more missiles were flying toward Kyiv.

Varbanets said the situation "will get even worse" because the Russians "don't have any other choice." He and his wife have discussed her leaving Ukraine with their children, as she did at the start of the war, before returning to Kyiv — an agonizing conversation.

"She does not want to escape without me — it's not easy just to go to Germany," Varbanets said, recounting their deliberations. "We are going to stay here," he said. "And somehow to survive this winter."

CLIMATE SOLUTIONS

Ukraine found an unlikely tool to resist Russia: Solar panels

By Michael Birnbaum

May 20, 2023 at 7:00 a.m. EDT

Russian airstrikes on Ukraine's power grid plunged many parts of the country into darkness in the fall, but one water company was able to keep its pumps going. Its field of solar panels, installed as an environmentally friendly measure before the war, turned into a tool to resist the Kremlin's attacks.

Now a growing number of Ukrainian hospitals, schools, police stations and other critical buildings are racing to install solar panels ahead of what many expect will be another hard winter.

A less carbon-intense, decentralized energy system is emerging as a key element of Ukraine's reconstruction efforts. Seven months of Russian attacks on the energy grid have left it severely damaged. Ukrainian doctors, teachers and others have discovered that efforts to boost sustainability can also improve security by making it harder to knock power offline. Ukrainian policymakers, meanwhile, are setting ambitious clean energy goals, trying to shake off their prewar reputation as lagging on climate issues.

Ukrainian Deputy Energy Minister Yaroslav Demchenkov said renewable energy and small modular nuclear reactors are among the country's priorities in its rebuilding effort. Both would help reduce Ukraine's prewar reliance on a heavily centralized power system, making it more resilient and helping lower emissions.

Ukraine generated 11 percent of its electricity from renewable sources in 2020, according to the International Renewable Energy Agency, although more than half of its electricity came from nuclear power plants, which have a low carbon footprint. The country's goal is to build capacity for 30 gigawatts' worth of clean electricity by 2030, which would cover about half of Ukraine's needs.

“Before the war started, people were thinking just about the economics. Now it’s energy security,” said Dmytro Sakalyuk, who works on energy projects at Ecoclub Rivne, an environmental organization based in western Ukraine.

A push for solar

Advocates of renewables want solar power to be a sizable chunk of the new capacity. Although solar panels can’t easily rival the power generation of a nuclear plant, proponents say they are cheaper, faster to install and more useful as a quick solution to Ukraine’s immediate energy and security needs than nuclear power, which can take years to build and install.

If the efforts to spread renewable power are successful, advocates hope that they can speed Ukraine’s green future far faster than had been expected before the war. Some hope that installing solar panels might be the impetus for some Ukrainians to take even more actions to reduce their carbon footprint, strengthen their self-sufficiency and improve their ability to resist Russian attacks.

“It will be much more difficult to destroy this kind of decentralized system,” said Kostiantyn Krynytskyi, head of the energy department at Ecoaction, a leading Ukrainian environmental organization. “You cannot bomb all the installations. And bringing self-sufficiency will help. We saw now what centralization in our energy system means.”

Even though Ukraine recently approved resuming electricity exports to neighboring countries — a sign that its ability to generate power has recovered, for now, from the wintertime bombardment of the energy system — the solar work still calls for intense urgency, officials say. Ukrainian and allied officials warn that the cold months later this year could be even harder than the winter that just ended, because of the extent of damage the grid has suffered. Getting enough diesel to power all the backup generators is also a challenge.

“The situation in the energy sector is still very fragile,” Demchenkov, the deputy energy minister, said in an interview. “It’s a very important challenge for us right now, during this period of time, to have enough equipment and allow a fuel stock, because we have information that Russia will use winter as a weapon again. For us, it is really important to have the physical protection of energy facilities.”

The European Union has pledged to ship thousands of solar panels to Ukraine. Ukrainians are also hoping for help from the United States and elsewhere.

In the meantime, advocates hope the existing solar installations will serve as examples that build interest in a greener future.

Wartime panels

At a small hospital in the Kyiv suburb of Horenka, the medical staff learned the difficulty of operating without electricity in the first hours of the war last year. Horenka is next door to Hostomel, whose military airport was one of the first targets that Russian paratroopers attempted to capture. The town faced heavy Russian shelling. The hospital never closed its doors, but it lost power on the second day of the invasion and didn't regain it for more than two months. Without power, its heating system partially failed. And then a shell landed on the street just outside the building, blowing out its windows and damaging the facade.

Now the hospital has been rebuilt. This past winter, along with much of Ukraine, it used diesel generators to keep going during blackouts. But these generators consume vast quantities of fuel, they are prone to breaking down, and their noise and fumes make them inconvenient for long-term use at places like hospitals.

Next winter, the medical personnel in Horenka hope to avoid them. In February, workers screwed solar panels onto its steeply pitched roof, completing a project that is expected to cover about half the hospital's typical power needs — enough to ensure that critical equipment stays online even if the grid fails. A battery will extend the reach of the solar panels into the night. And an electric-powered heat pump can keep the hospital warm even if it gets cut again from the grid. The solar panels and battery cost $11,700 for a 12.6 kilowatt system — comparable in size to what might go on a house.

"We need long-term solutions for such hospitals," said Denys Tsutsaiev, who works for Greenpeace Central and Eastern Europe in Kyiv and, along with Krynytskyi, helped organize the hospital's solar project.

One of the first questions Tsutsaiev gets from foreigners, he said, is whether it makes sense to push forward with renewable projects at a time when Russia is still shelling the country. But, he said, that misunderstands the need.

"People are back," he said. "People cannot live at the moment without hospitals. They can't live without schools."

Nor did he and others expect solar panels to become targets. Given the small scale of the projects, it would not make sense for Russia to use one of its expensive and scarce missiles to go after solar panels on roofs, he said.

"It's much more expensive to hit it with a missile than for us to rebuild it if it's damaged," he said.

Larger-scale renewable projects have proceeded despite the war, including a wind farm in the southern Mykolaiv region that just completed its first phase of construction in March.

An array of solar projects

The effort to expand solar power isn't always straightforward. Winters in Ukraine can be long, and the country is far enough north — roughly the same latitude as southern Canada and the northern United States — that daylight hours get short in December and January. Solar advocates say the panels still generate enough electricity during those months to be useful.

Ukraine doesn't have a net-metering law, which would allow owners of solar panels to sell their excess power back into the system, although the parliament is working on legislation and Demchenkov said he hoped it would be finalized by autumn.

German Vice Chancellor Robert Habeck visited the hospital in Horenka last month to announce that his government would offer $1.1 million toward eight similar solar pilot projects around Ukraine, and he urged German companies and philanthropies to follow suit. Ukrainian environmental organizations have identified dozens more hospitals, schools and public buildings where administrators would like to install solar panels or find other ways to be more self-sufficient.

The community where the municipal water utility installed solar panels proved the value of renewable energy in a time of war, said Sakalyuk, who met with Habeck during his visit. After the power went out for more than a week across much of the Mykolaiv region late last year, the utility in the town of Voznesensk was able to keep water flowing even though most other activity ground to a halt. The waterworks had installed a 50 kilowatt solar power plant in 2020 as part of a green initiative.

"People have changed how they think about solar power," Sakalyuk said. The resilience of the pumping station inspired a wave of new inquiries from businesses and homeowners who want their own solar panels, he said.

Solar advocates hope to make an impact that will last long beyond the war. Solar panels on schools, for instance, could make climate-friendly practices an ordinary part of children's lives, said Anastasiia Vereshchynska, international development manager at Energy Act for Ukraine Foundation, a group that installed solar panels on a school in the Kyiv suburb of Irpin late last year and has lined up 15 more projects this year across Ukraine.

"Our big goal is to change the culture in this country," she said. "We want kids to be part of the sustainable development of Ukraine in the future, especially in the postwar period."