Centre for Information Resilience

Eyes on Russia

WEAPONIZING WINTER

The strategic shift in Russia's attacks on Ukraine's energy infrastructure

Photo by Iryna Chubarova / Adobe Stock: The capital of Ukraine Kyiv suffers blackout after Russia's terror-bombing campaign of civilian targets and critical infrastructure.

FEBRUARY 2023

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THE TARGETING OF ENERGY INFRASTRUCTURE

In October 2022, the world witnessed the result of a strategic shift in Russia's aggressive war against Ukraine.[1]

The 2022 Russian invasion of Ukraine represents one of the largest modern displays of attritional warfare[2] and has triggered the biggest refugee crisis in Europe since World War Two (WWII).[3] However, a new pillar in the Kremlin's war strategy has threatened the survival of Ukrainians during the winter months. While earlier attacks seemed to focus on the frontline, systematic attacks on critical civilian energy infrastructure throughout the country mean that civilians are now the target.

Since WWII, attacks on energy infrastructure have been considered a key feature of large-scale warfare. These attacks have the following objectives:[4]

- Placing psychological pressure on the civilian population.
- Creating political pressure on the enemy's government to force the desired outcome, e.g., in negotiations.
- Negatively impacting the enemy's economics and industry, including the war industry.

On 18 October, Ukrainian President Volodymyr Zelenskyy (Володимир Зеленський) reported that 30% of power stations had been "destroyed, causing massive blackouts across the country".[5] These sites provide heating and electricity to amenities that are indispensable to survival, including water supplies, domestic heating, hospitals, and other critical infrastructure facilities.[6] The Centre for Information Resilience (CIR)'s investigation shows that Russia is depriving Ukrainian civilians of objects essential to their survival,[7] and that the findings of this investigation warrant further scrutiny as a war crime.

Attacks from October were the scope of this investigation. Through a geospatial analysis of these attacks, this report demonstrates the systematic nature of attacks on critical energy infrastructure and identifies the shift in strategic focus away from the frontline.

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1 Bellamy (10 October 2022). Available at: https://www.euronews.com/2022/10/19/russia-has-begun-a-strategy-of-escalation-in-ukraine-says-analyst

2 Jones and Wasielewski (17 November 2022). Available at: https://www.csis.org/analysis/end-beginning-ukraine

3 Vierlinger (20 April 2022) Atlantic Council, Available at: https://www.atlanticcouncil.org/blogs/ukrainealert/un-ukraine-refugee-crisis-is-europes-biggest-since-wwii/

4 Gendelman in interview with Nacke (19 November 2022), Available at: https://youtu.be/oWuFfoRSHe8

5 AFP News Agency (18 October 2022), Available at: https://www.kyivpost.com/ukraine-politics/russia-destroyed-30-of-ukraines-power-stations-in-a-week-zelensky.html

6 Українська правда (5 November 2022) Available at: https://t.me/ukrpravda_news/23241

7 While this term is not formally defined in international law, according to the ICRC "relevant provisions provide a non-exhaustive list of examples such as foodstuffs, agricultural areas, crops, livestock, drinking water installations and supplies and irrigation works." Available at: https://casebook.icrc.org/glossary/objects-indispensable-survival-civilian-population#:~:text=%E2%80%9CObjects%20indispensable%20to%20the%20survival,and%20supplies%20and%20irrigation%20works

THE STRATEGIC SHIFT

Attacks before October

Concerns about the functioning of critical infrastructure and access to essential services did not begin in October. Even prior to the full-scale invasion, Ukrainian energy facilities were attacked. For example, on 21 February 2022, operations at a power generating station in Shchastia, Luhansk region (Ukrainian: Щастя, Луганська область) were stopped due to Russian shelling.[8] Facilities delivering power to the city of Shchastia were also allegedly damaged. The Ukrainian energy company DTEK stated that "because of this [damage], the city, the sewage and water pumping stations were cut off from the electricity". The heating system was also hit leaving residents of Shchastia without heating.[9]

In the first week of the full-scale invasion, Russian aerial bombardment of Okhtyrka, Sumy region (Ukrainian: Охтирка, Сумська область) reportedly destroyed a thermal power plant, leaving thousands of civilians without electricity, water supply and heating.[10] The bombardment of the city continued in the following days further destroying critical infrastructure and causing casualties among locals.[11] Evacuation from the city was challenged by heavy battles with Russian forces in the region.

By the end of October, systematic Russian attacks on the Ukrainian energy system had dire consequences all over the country. By the beginning of November, Kyiv's authorities highlighted the possibility of a prolonged blackout which could cause millions of civilians to flee the capital.[12]

Strategic Shift – 10 October

On the morning of 10 October 2022, Russia fired 84 cruise missiles and conducted 24 drone strikes at Ukraine.[13] The Ukrainian Armed Forces General Staff claim that Ukrainian forces shot down 43 of the 84 Russian missiles.[14] Kh-101 and Kh-555 cruise missiles were launched by strategic bombers from the Caspian region. Kalibr cruise missiles, Iskander missiles, S-300, and Tornado rockets were also launched from the Black Sea.[15] The missile strikes impacted civilian infrastructure in several Ukrainian cities, with the most noticeable strikes on Kyiv's city centre, where five explosions were reported on October 10.[16] The capital of Ukraine had not been subjected to such attacks for several months.

8 Stepura (21 February 2022) Suspilne, Available at: https://suspilne.media/209109-cerez-obstrili-okupantiv-zupineno-robotu-luganskoi-tes/

9 ДТЕК Луганська ТЕС (21 February 2022) Available at: https://www.facebook.com/119433589897503/posts/466099398564252

10 Hlushchenko (4 March 2022) Ukrainska Pravda, Available at: https://www.pravda.com.ua/news/2022/03/4/7328015/

11 Суспільне Суми (8 March 2022). Available at: https://t.me/suspilnesumy/3175

12 Українська правда (5 November 2022) Available at: https://t.me/ukrpravda_news/23241

13 The Kyiv Independent (10 October 2022) Available at: https://twitter.com/KyivIndependent/status/1579587036566401024

14 Roschyna (10 October 2022) Ukrainska Pravda, Available at: https://www.pravda.com.ua/news/2022/10/10/7371207/

15 ELINT News (10 October 2022), Available at: https://twitter.com/ELINTNews/status/1579406878794481664

16 The Guardian (17 October 2022), Available at: https://www.theguardian.com/world/2022/oct/17/kyiv-hit-by-a-series-of-explosions-from-drone-attack

Figure 1: General locations from which many of the strikes were launched.

While several notable cases stand out as particularly egregious acts of aggression against civilians, notably a missile strike on a children's play park,[17] the wider operation has crippled Ukraine's energy infrastructure.

Russian narrative: revenge for the Crimean Bridge attack

A common narrative for the 10-11 October missile strikes is that they were revenge for the explosive attack that destroyed part of the Crimean bridge that connected Russia to occupied Crimea on 8 October 2022. The bridge is a key symbol of Russia's illegal occupation of the Crimean Peninsula and a vital logistical link for the Russian military. Vladimir Putin used this narrative himself,[18] and much of the messaging across the Telegram channels analysed during this investigation follows this narrative. For example, a post on pro-Kremlin[19] Rybar's channel dated 8 October called for "decisive measures" in response to the Crimean Bridge attack, stating that "the people demand revenge."[20] Three separate posts made on Rybar's channel on 10 October after the missile strikes in Ukraine all contain language tying the bridge attack to the missile strikes.[21] While the Russian Ministry of Foreign Affairs' Telegram channel

17 CNN (10 October 2022), Available at: https://edition.cnn.com/videos/world/2022/10/10/playground-russian-missile-strike-kyiv-ukraine-pleitgen-ip-vpx.cnn

18 Президент России (10 October 2022). Available at: http://www.kremlin.ru/events/president/news/69568; Российская газета (10 October 2022). Available at: https://rg.ru/2022/10/10/udary-v-ukrainskih-gorodah-naneseny-po-obektam-energetiki-voennogo-upravleniia-i-sviazi.html.

19 The Bell (22 November 2022). Available at: http://webcache.googleusercontent.com/search?q=cache:https://thebell.io/unmasking-russia-s-influential-pro-war-rybar-telegram-channel

20 Рыбарь (8 October 2022). Available at: https://t.me/rybar/39915.

21 Рыбарь (10 October 2022). Available at: https://t.me/rybar/40024; Рыбарь (10 October 2022). Available at: https://t.me/rybar/40025; and Рыбарь (10 October 2022). Available at: https://t.me/rybar/40040.

mentioned the bridge attack in several posts dated 8-9 October, these posts did not call for revenge.[22]

Russian narrative: desired material and psychological harm to Ukrainian civilians

Another narrative is that Russia was intending to impose material and psychological costs on Ukrainian civilians. This argument arises from the fact that the 10-11 October missile strikes had little to no impact on Ukraine's ability to wage war[23] as the targets were nowhere near the frontlines.[24] CIR's analysis indicates that these attacks were largely centred on civilian infrastructure. Both state-affiliated propagandists and military bloggers identified during this investigation were supportive of the 10-11 October missile strikes.[25] Some of them even called for repeated strikes of the same nature.[26]

In two separate posts on 8 October, Vladimir Solovyov, a popular talk show host on Russian state television, called for the Russian military to plunge Ukraine into "dark times" and push it "into the eighteenth century" via attacks on its energy infrastructure.[27] Both of these messages were in response to the Crimean Bridge attack. Other well-known figures also called for attacks on Ukrainian civilian infrastructure – though not necessarily energy infrastructure – in response to the bridge attack.[28] For example, CIR identified posts calling for attacks on bridges and military targets, indicating that although civilian infrastructure was a commonly favoured target for retaliation, it was not the only one.[29]

The impact of the shift in Russian strategy

This shift in strategy has meant that accessing the means necessary for survival is not guaranteed with distance from the frontline. In October and November 2022, Russia extensively attacked energy infrastructure all over Ukraine from the air.[30] The timing of such attacks corresponded with the dates that Ukrainian municipalities typically turn on the heating systems in preparation for winter.[31] Millions of Ukrainian civilians living almost a thousand kilometres from the frontline were directly affected.

Energy companies have had to introduce stabilising power outages to compensate for the absence of a

22 МИД России (8 October 2022). Available at: https://t.me/MID_Russia/23452; МИД России (8 October 2022). Available at: https://t.me/MID_Russia/23453; and МИД России (9 October 2022). Available at: https://t.me/MID_Russia/23471.

23 Collier (12 April 2022), NBC News, Available at: https://www.nbcnews.com/tech/security/ukraine-says-russian-cyberattack-sought-shut-energy-grid-rcna24026

24 See the section containing geospatial analysis of these attacks earlier in this report.

25 СОЛОВЬЁВ (10 October 2022). Available at: https://t.me/SolovievLive/133082; and СОЛОВЬЁВ (10 October 2022). Available at: https://t.me/SolovievLive/133253.

26 See for example: Рыбарь (10 October 2022). Available at: https://t.me/rybar/40028.

27 СОЛОВЬЁВ (8 October 2022). Available at: https://t.me/SolovievLive/132548; and СОЛОВЬЁВ (8 October 2022). Available at: https://t.me/SolovievLive/132592.

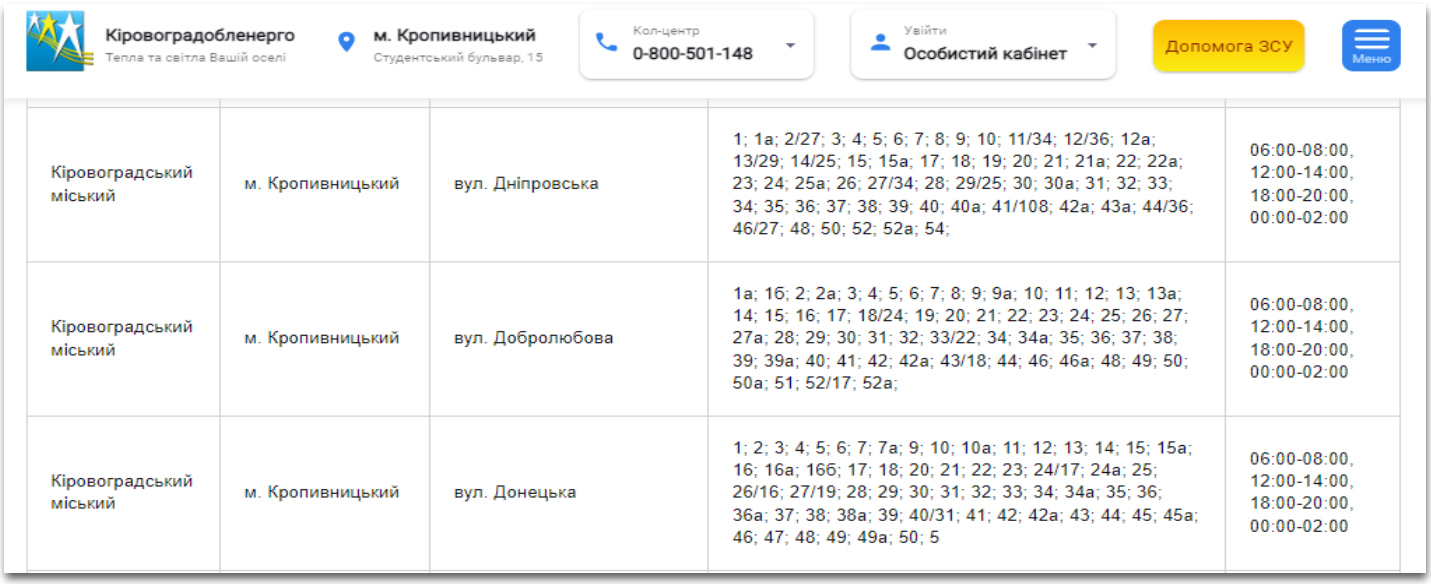
28 The three channels that posted such content were Solovyov's, Rybar's, Starshe Eddy's. See for example: СОЛОВЬЁВ (8 October 2022). Available at: https://t.me/SolovievLive/132449; Рыбарь (8 October 2022). Available at: https://t.me/rybar/39925; and Старше Эдды (8 October 2022). Available at: https://t.me/vysokygovorit/9662.

29 For examples of Solovyov's six messages, see: СОЛОВЬЁВ (8 October 2022). Available at: https://t.me/SolovievLive/132456; and СОЛОВЬЁВ (8 October 2022). Available at: https://t.me/SolovievLive/132496. For Starshe Eddy's message, see: Старше Эдды (8 October 2022). Available at: https://t.me/vysokygovorit/9660.

30 Ukrenergo (7 November 2022). Available at: https://t.me/Ukrenergo/1644; Українська Правда (31 October 2022). Available at: https://t.me/ukrpravda_news/22997

31 Slovoidilo (30 July 2022) Available at: https://www.slovoidilo.ua/2022/07/30/novyna/suspilstvo/kabmini-nazvaly-datu-pochatku-nastupnoho-opalyuvalnoho-sezonu

sufficient amount of energy or to react to accidents caused by the overloaded and damaged system.[32] Spare parts to repair these systems are reportedly running low[33] and employees are endangered in the process.[34] Since the end of October 2022, millions of Ukrainians have experienced emergency and/or stabilising power outages more or less every day, often for many hours.[35] Energy companies released power outage schedules: civilians can look for their street name in the local schedule to see when they will supposedly have electricity at home (unless there is a new Russian attack or technical accident resulting in additional emergency outages).[36] In light of this, civilians were also asked to spare electricity, especially in the morning and in the evening (hours of most active energy consumption).[37] It was reported that in periods when it was only possible to deliver energy to a limited group of consumers, critical infrastructure, such as hospitals, are prioritised over individual, private consumers.[38] When there is no stable supply even for hospitals, they are mostly reliant on power from emergency electric generators.[39]



Кіровоградобленерго
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Меню

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Figure 2: Example of the power outage schedule in the city of Kropyvnytskyi, November 2022. Screenshot from the website of Kirovohradoblenerho.[40]

32 Shmyhal (1 November 2022) Government Portal, Available at: https://www.kmu.gov.ua/en/news/promova-premyer-ministra-ukrayini-denisa-shmigalya-na-zasidanni-uryadu-01112022

33 Karlashchuk (31 October 2022) Suspilne, Available at: https://suspilne.media/306670-v-ukraini-zakincuetsa-obladnanna-dla-remontu-poskodzenih-energeticnih-obektiv-dtek/?fbclid=IwAR22yG95EVAjeAw1yR-mgI9ZHVytGCUf7SYMc_jzocAwCrvobzgQF_Rujms

34 Суспільне Суми (17 October 2022) Available at: https://t.me/suspilnesumy/7603

35 Суспільне (9 November 2022) Available at: https://t.me/suspilnenews/15609

36 Українська правда (9 November 2022) Available at: https://t.me/ukrpravda_news/23339

37 Суспільне Хмельницький (12 October 2022) Available at: https://t.me/suspilnekhmelnytskyi/6316

38 Дмитро Живицький / Сумська ОВА (2 November 2022) Available at: https://t.me/Zhyvytskyy/5561

39 Твоє місто (8 November 2022) Available at: https://tvoemisto.tv/news/u_moz_zapevnyayut_shcho_na_vypadok_vidklyuchen_elektroenergii_u_kozhniy_likarni_ie_generator_139570.html; Дзеркало тижня (7 November 2022) Available at: https://zn.ua/ukr/UKRAINE/kozhna-ukrajinska-likarnja-zabezpechena-heneratorom-moz.html;
Українська правда (18 October 2022) Available at: https://t.me/ukrpravda_news/22570

40 Кіровоградобленерго Available at: https://kiroe.com.ua/energy/hourly

Importantly, the frequent power outages caused by Russian attacks on Ukraine's energy infrastructure are causing not just darkness on Ukrainian streets and in the homes of millions. Nowadays, most critical infrastructure facilities require power. Among those are electrical pumps that deliver water to civilians' homes and enable the operation of the sewage system, mobile network towers which provide mobile connection and internet, and equipment for cashless payments widely used by Ukrainians to pay for food and other products and services. For example, the various strikes have left a substantial number of residents without running water. Strikes on 31 October around Kyiv left 80% of residents without access to water forcing them to queue for essential supplies.[41] Much of the heating infrastructure in Ukrainian cities is centralised and reliant upon energy. Hot water is often generated at district heating stations and served across the municipality in underground pipes. In 2021, 53% of Ukrainian houses used heating from these stations. This system is efficient, however, its centralised nature means thousands of people can be affected by a single strike on a facility. Attacks on these sites increased in this phase of the invasion.

Without electricity, hospitals, pharmacies, and supermarkets also cannot function. Without power, Ukrainians faced a winter without warmth. The damage caused by Russia's systematic attacks on energy infrastructure all over Ukraine placed the comfort and survival of millions of Ukrainian civilians at risk. To read more about the impact on daily lives, see Annex 1.

Figure 3: Iranian-made Shahed-136 suicide drone. / Courtesy of Yasuyoshi Chiba (AFP)

41 Polityuk and Bern (31 October 2022) Reuters, Available at: https://www.reuters.com/world/europe/series-blasts-heard-kyiv-reuters-witnesses-2022-10-31/

GEOSPATIAL ANALYSIS: THE SHIFT IN STRATEGY

Figure 4: Documented[42] October strikes (yellow pins) on a map of population density[43] in Ukraine (black: low density; white: high density). This shows the impact these strikes may have had on the population as the strike locations were typically near very populated areas.[44]

The escalation in the number and intensity of strikes against critical energy infrastructure in October, using a combination of kamikaze drones and missiles, follows a Russian strategic shift starting in September. Analysis of the strike locations shows a distributed series of attacks across the country. While critical energy infrastructure has previously been targeted, these strikes have typically been focused on the areas near the frontlines preceding October. Attacks on energy infrastructure primarily impacted buildings at thermal power plants, substations, nuclear power plants and hydroelectric stations.

CIR has identified more than 25 substations and several other energy infrastructure locations across Ukraine that were claimed to have been targeted in October. The bulk of the attacks occurred on 10 October and 22 October. Following the attacks on 10 October 2022, Ukrainian President Volodymyr Zelenskyy estimated that 30% of the energy infrastructure had been destroyed.

42 Includes strikes recorded that have not been visually confirmed with satellite imagery, however were immediately followed by confirmed power outages in the surrounding areas.

43 United Nations Office for the Coordination of Humanitarian Affairs (2020), Available at: https://data.humdata.org/dataset/worldpop-population-density-for-ukraine

44 This is partly because infrastructure sites are built in areas of demand.

As can be seen in the figure below, prior to 10 October, the strikes were located near the front lines, on the Eastern side of the country. After 10 October, the nature of the strikes changed. Rather than attacks on purely strategic targets, Russia attacked a broad range of sites with little military strategic value, away from the frontlines, that disrupt civilian life. The targets have included facilities generating or transmitting electricity as part of the electrical grid, close to major population centres. The pattern and timing of the attacks support the claims that these attacks formed part of a plan or policy to render energy infrastructure inoperable ahead of the winter months.[45] This section maps out the damage to these facilities.

Figure 5: Map of strikes[46] separated by date (Before 10.10.22, yellow; After 10.10.22, Dark Red). Dark red shapes show Russian occupation as of 15 November 2022. Yellow shapes show the Ukrainian counteroffensive in formerly Russian-occupied areas. (Areas of control adapted from source: Project Owl OSINT).[47] It should be noted that strikes on Kyiv and Lviv prior to 10 October did happen at the same location covered by the red pins indicating more recent strikes.

Many sites of attack in West Ukraine were hundreds of kilometres from the nearest active combat situations.

45 Adison (3 November 2022). Available at: https://www.gov.uk/government/speeches/russia-destroys-ukraines-civilian-energy-infrastructure-uk-statement-to-the-osce

46 Includes strikes recorded that have not been visually confirmed with satellite imagery, however were immediately followed by confirmed power outages in the surrounding areas.

47 Project Owl (15 November 2022), Available at: https://www.google.com/maps/d/u/0/viewer?mid=180u1IkUjtjpdJWnIC0AxTKSiqK4G6Pez&hl=en_US

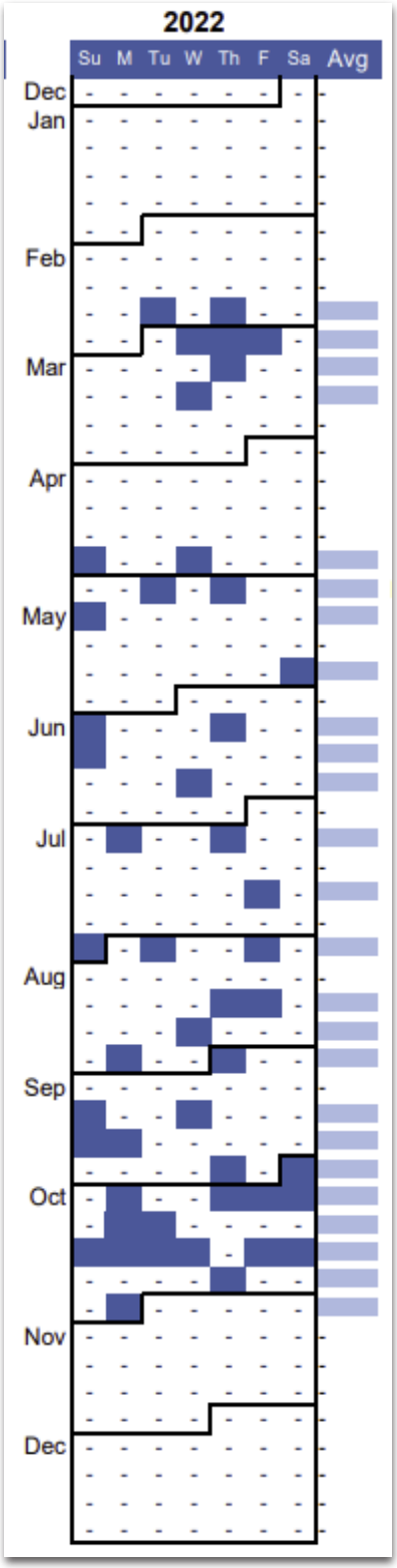

Figure 6: Calendar of reported strikes on energy infrastructure [48]

Temporal analysis of strikes on critical energy infrastructure collected by CIR investigators reveals a higher number of strikes in October compared to previous months in the war. This can be seen in the calendar graph, which chronologises all reports of attacks identified. However, this analysis must be caveated: some regions have opted to avoid reporting damage to prevent informing Russian targeting teams of their accuracy. This has been resolved where possible by forensically examining and geolocating social media reports and footage of strikes.

Attacks against energy infrastructure continued throughout October with multiple attacks occurring between 16-22 October. It should be noted that intercepted missiles intended for energy infrastructure targets are not considered in this dataset due to the inability to verify the target coordinates and lack of information relating to them.

Verified Russian attacks between 17-18 October were not as numerous as on 10 October but still caused significant damage in several regions of Ukraine. Ukrainian officials claimed that Russia had fired at least 33 missiles at Ukrainian energy infrastructure only on 10 October.[49] The most significant attack in October was at the Prydniprovska thermal power plant in the city of Dnipro (Ukrainian: Дніпро); Valentyn Reznichenko, the Head Governor of the Dnipropetrovsk regional administration (Ukrainian: Дніпропетровська область) claimed the plant had suffered "serious damage". Footage verified by CIR investigators showed multiple fires burning at the site (see the figure on next page).

48 This temporal analysis is based on data collected and analysed by CIR on behalf of Pax for Peace

49 Olearchyk (22 October 2022) Financial Times, Available at: https://www.ft.com/content/00433ac0-d6b4-41fe-b36c-f465cf53067c

Attacks on energy infrastructure also caused damage in Kyiv, including at the central office of Ukrenergo, and the national electricity transmission system operator based in Kyiv. During this attack, three civilians were killed after residential buildings were struck by loitering munitions (suicide drones). The mayor of the city of Kyiv, Vitalii Klyitschko confirmed the death toll.[50] After these strikes, Ukrenergo urged Ukrainians to try to reduce energy usage to limit strain on the infrastructure and minimise risks of blackouts. Oleksii Kubela, Head of the Governor of Kyiv regional administration, also urged citizens to save energy.[51]

Figure 7: Fires burning at Prydniprovska thermal power plant.

Analysis conducted by CIR suggests that during October key substations responsible for the distribution and provision of electricity to the civilian population were targeted leading to the complete or partial loss of electricity to towns and cities in the surrounding areas. In the following section, CIR has assessed the damage to five substations and the impact on the surrounding population. The attacks have not only led to power outages but created power surges across the country causing significant damage to other systems.

50 Kossov (17 October 2022) The Kyiv Independent, Available at: https://kyivindependent.com/national/Russia-attacks-Kyiv-with-28-drones

51 Kuleba (20 October 2022) Twitter, Available at: https://twitter.com/OleksiiKuleba/status/1583159766183948289?s=20&t=URgYAr5waJuurH7kEMPcHw

Targeting substations

Outside of Kyiv, on 10 October multiple missiles were launched at other regions in Ukraine, like Lviv, Dnipropetrovsk, Vinnytsia, Zaporizhzhia, Sumy, Kharkiv, Khmelnytskyi and Zhytomyr (Ukrainian: Львівська, Дніпропетровська, Вінницька, Запорізька, Сумська, Харківська, Хмельницька та Житомирська області).[52] The following five examples of attacks on substations allegedly occurred on or around the 10 October. Using available open source data, verifiable information and geospatial analysis, CIR can confirm that each of these sites was significantly damaged.

According to the Ukrainian Ministry of Internal Affairs, critical infrastructure objects were affected in eight regions (and Kyiv city). Furthermore, the ministry reported that a total of 11 people were killed and 64 more injured across Ukraine.[53]

Mapping of strikes across Ukraine reveals a notable relationship between the targets and regions with a high-population density. This can partly be explained by the fact that the most critical energy infrastructure will be positioned by design near population centres. Simultaneously, it indicates that the areas that will be most impacted have a high civilian population.

1. Trychaty Substation in the Mykolaiv region

Satellite imagery indicates that on 3 October 2022 the Trychaty Substation [47.128260, 31.810956] in northern Mykolaiv (Ukrainian: Миколаїв) was damaged by Russian strikes. The Trychaty Substation, which is operated by Ukrainian electricity transmission system supplier Ukrenergo, is a 330kV substation.[54] At the time, both the Kherson and Mykolaiv regions were powered by the Trychaty station.[55] By 22 October Mykolaiv residents were experiencing full power outages due to the damage to the Trychaty Substation and other stations in the region.[56]

Imagery of the station prior to the strike (29 September 2022) shows the grids and the substation undamaged. First signs of damage, including a large crater, can be seen on 8 October 2022. Further damage to the substation can be seen on 17 October, possibly indicating a second attack between 8 and 17 October. The damage can be seen in Figure 7 on the next page.

52 Trew (10 October 2022) Twitter, Available at: https://twitter.com/Beltrew/status/1579385086428205056

53 These figures were from 1400 local time, 10 October 2022 and might have increased as events unfolded. МВС України (10 October 2022) Available at: https://twitter.com/MVS_UA/status/1579446931411308544

54 Carmen (8 September 2021) Power Technology, Available at: https://www.power-technology.com/marketdata/trykhaty-substation-ukraine/

55 Ukrenergo: Development plan of the United Energy System of Ukraine for 2016-2025 years, Available at: https://de.com.ua/uploads/0/1704-План%2016-25%20з%20додатками.pdf

56 Hauer (22 October 2022) Available at: https://twitter.com/NeilPHauer/status/1583728099703009280; Landay (22 October 2022) Available at: https://twitter.com/JonathanLanday/status/1583833966057902080

Figure 8: Planet imagery showing Trychaty Substation [47.128260, 31.810956]. Top - seen on 29 September 2022 prior to the strikes in October. Bottom – Damage sustained to the substation. The area highlighted in red indicates damage occurring between 1 October 2022 and 8 October 2022 where a large crater is visible. The area highlighted in Yellow shows possible sandbag defences being established around the equipment.

2. Konotop Substation in the Sumy region

Analysis conducted by CIR suggests that the Konotop Substation in the Pryvokzal'ne (Ukrainian: Привокзальне) village area of Sumy region [51.192110, 33.166011] was damaged as a result of Russian strikes in October. Media claims indicate that this strike caused outages across the area.[57]

Figure 9: Planet imagery from 8 October (left), and 13 October showing the before and after of the strike.

57 AGCNews (11 October 2022) Available at: https://www.agcnews.eu/ukrainerussiawar-moscow-now-the-turn-of-kievs-critical-infrastructure-putin-stop-sabotage-in-the-new-russia/

3. Zhytomyr Substation in the Zhytomyr region

Satellite imagery analysed by CIR investigators suggests that the 330kV Zhytomyr Substation in Zhytomyr region [50.291079, 28.700468] was damaged on 10 October 2022 following Russian strikes. Reports suggest that Pak-trade LLC, an agricultural supplier, that shares a wall with the energy installation was also impacted by the strike.

Pro-Kremlin online news outlet Rybar claimed that the station was targeted on 10 October 2022 and was subjected to further strikes on 18 October 2022.[58] According to Rybar, videos analysed by their team show that one of the three auto-transformers was damaged in the attack. This prevents the transmission of power to the grid from the station's generators.[59]

Figure 10: Planet imagery of Zhytomyr Substation [50.291079, 28.700468]. Top – seen on 8 October 2022 prior to the strike on the substation. Bottom – Image taken on 18 October 2022 showing the damage, which is a crater, sustained to the electrical substation highlighted in red.

58 Rybar (18 October 2022) Available at: https://twitter.com/rybar_en/status/1582370645391745024

59 Rybar (18 October 2022) Available at: https://twitter.com/rybar_en/status/1582370648348688384

Figure 11: Firefighters attempt to put out the fire at Zhytomyr Substation on 10 October 2022.[60] *EoR has geolocated the image to the Zhytomyr substation. Images were posted on Telegram by the Main Department of Ukraine's State Emergency Service in the Zhytomyr region.*

4. Ladyzhyn TPP Substation in the Vinnytsia region

Satellite imagery analysed by CIR investigators suggests that on 11 October, the 330kV transmission substation of the Ladyzhyn Thermal Power Plant [48.701626, 29.225723] was damaged following a reported missile strike. Reports also indicate that the facility was struck twice in a double-tap strike, with some stating that the second occurred as emergency responders were on the site following the first strike.[61]

As emergency responders are protected persons under the laws of armed conflict, and the double-tap strategy is known to impact first responders, it is often considered a war crime. CIR believes this event should be further scrutinised by international lawyers. Vyacheslav Sokolovy, the Head of the Vinnytsia Regional Council, suggested that Russian forces used Iranian Kamikaze drones in the attack.[62]

60 @DSNS_Zhytomyr (18 October 2022) Telegram, Available at: https://t.me/DSNS_Zhytomyr/4508

61 Pavlysh (11 October 2022) Epravda, Available at: https://www.epravda.com.ua/news/2022/10/11/692489/

62 Focus (11 October 2022) Available at: https://focus.ua/uk/voennye-novosti/532502-povrezhdeniya-na-ladyzhinskoy-tes-v-vinnickoy-oblasti-chto-izvestno-video

Figure 12: Planet imagery of Ladyzhyn Substation [48.701626, 29.225723]. Top – seen on 6 October 2022 prior to the reported double tap strike. Bottom – Image taken on 17 October 2022 showing the damage sustained to substation, area highlighted in red indicates damage that occurred.

Figure 13: Left – Images taken from the video posted on the 11 October showing first transponders as well as the damage to the transmission building.[63] Right – Google Earth Pro Satellite Imagery used to geolocate the images to the Ladyzhyn Substation with the distinct circular infrastructure highlighted in red.

63 FastFocus (11 October 2022) Available at: https://t.me/FastFocus/34293

5. Kremenchuck Hydro Power Plant Substation in the Poltava region

Satellite imagery analysed by CIR investigators confirms that a substation at the Kremenchuck Hydro Power Plant [49.075017, 33.253276] was damaged following an attack on the station on 31 October 2022. Satellite imagery taken on 31 October shows a large smoke plume at the site. This substation provides power to consumers in parts of eastern and central Ukraine, including the industrial zones of Krivoy Rog, Cherkasy, Poltava and parts of Kharkov. According to Rybar, the attack has limited the transmission of electricity to these areas.[64]

Figure 14: Top – Planet satellite imagery taken on 17 October 2022 showing the Hydro power plant and substation [49.075017, 33.253276]. Bottom – Planet image taken on 31 October 2022 showing large dark smoke plumes reportedly due to Russian strikes on infrastructure facilities.

64 Rybar (31 October 2022) Available at: https://t.me/rybar/40758

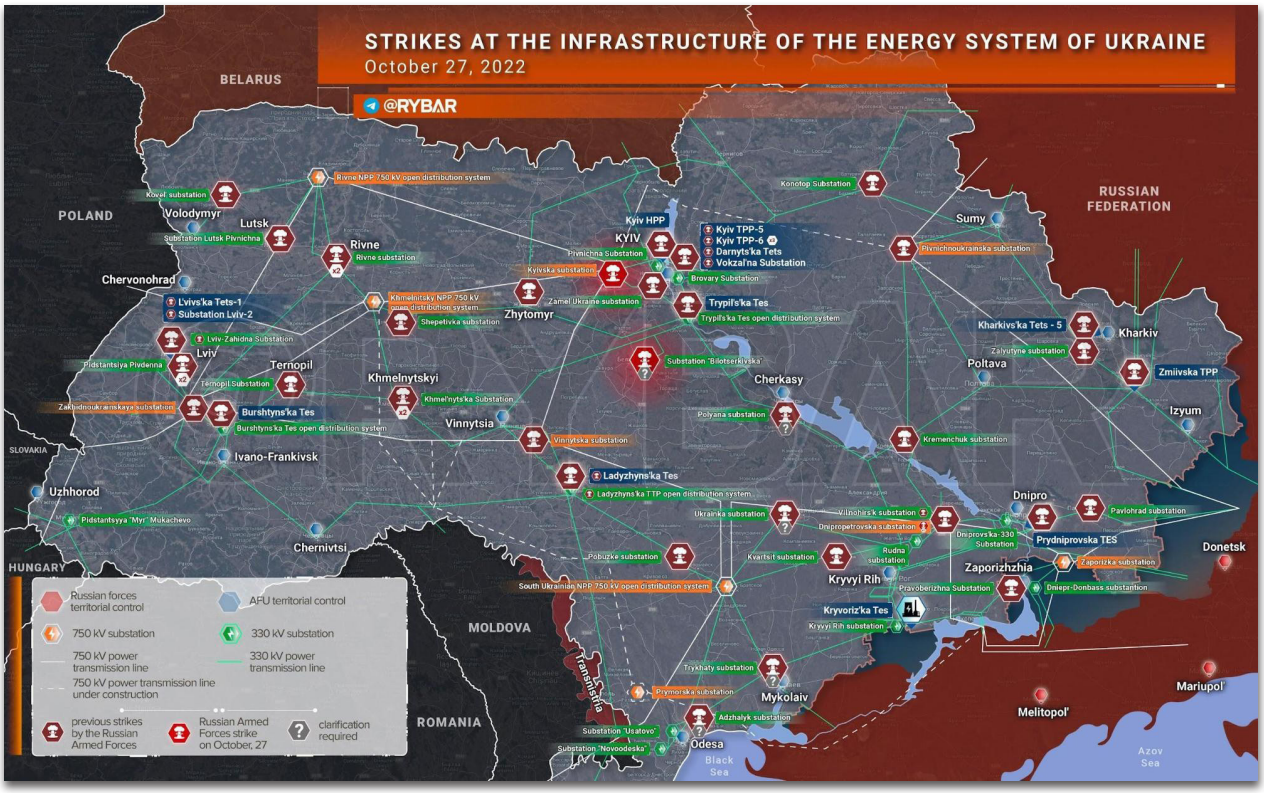

Figure 15: Attacks on substations and energy infrastructure damaged in October according to pro-Kremlin news site Rybar.[65] *To note: this map depicts Russian claims of territorial control and excludes Crimea.*

The deprivation of essential services

Through geospatial analysis, this investigation has revealed the systematic targeting of energy infrastructure across Ukraine. The examples provided above demonstrate the clear destruction of facilities which are essential for the supply of energy directly to civilians and to other critical industries, such as heating, and food processing. By targeting these sites which lack military significance, Russia has disrupted energy supplies, leading to a deprivation of essential services for civilians.

65 Zov Kyiv (27 October 2022), Available at: https://news-kiev.ru/society/2022/10/27/58475.html

CONCLUSION

According to data assessed by CIR, October 2022 marked a significant shift in the war in Ukraine. The unprecedented scale of Russian attacks on energy infrastructure plunged whole areas of Ukraine into temporary darkness.

Although Russia's bombardment on Ukraine's critical energy infrastructure continued unabated throughout November, this report focussed on attacks in October. The impact of these attacks has been felt by civilians across the country.

The geospatial analysis of attacks in October reveals the shift in military focus away from the frontline. Energy is indispensable to civilian survival in Ukraine, from powering payment systems used to buy essential food, to heating homes. Millions of Ukrainian civilians including those living almost a thousand kilometres from the frontline are still facing power outages and the challenges which ensue.

Despite attempts to repair damaged infrastructure, stabilising energy supply has become an increasing challenge. The partial or full disruption to energy supplies will place more pressure on the humanitarian response. Due to the centralised nature of heating systems in Ukraine, thousands of civilians are vulnerable. CIR continues monitoring attacks on critical energy infrastructure.

ANNEX 1: IMPACT ON CIVILIANS

Power outages also disrupt civilians' daily lives. The following pages provide examples to give the reader a less abstract understanding of the humanitarian situation caused by Russia's systematic attacks on the Ukrainian energy system. These examples are by no means the most severe. Moreover, they refer to the everyday lives of individuals in cities and regions, most of which are distant from the frontline, and are not under Russian occupation. The humanitarian situation is undoubtedly more critical in occupied areas.[66]

1. Impact on food supply and local businesses

On 31 October, a day that saw a significant number of Russian airstrikes on energy infrastructure, the residents of Kyiv were not able to buy food in the supermarkets. The system of cashless payment was disabled, in the absence of light inside supermarkets, customers would not be able to see the products, in the absence of electricity to power refrigerators, managers of the supermarkets could not guarantee the quality of the products they sell. Those civilians who tried to go grocery shopping, often came back empty-handed.[67] Since October, this situation is also forced by the emergency and stabilising power outages caused by the damage to the country's energy system.

The outages are also affecting local businesses. An owner of a bakery in the Cherkasy region, who uses electrical ovens to bake the bread, told 5 Kanal journalists that he had changed the production processes to do most of the baking outside daily peaks of energy consumption to lower the risk of outages and overloads of the energy system. If the electricity disappears when the baking is in progress, all the dough has to be thrown away.[68]

The same as in other regions of Ukraine, during power outages, numerous bakeries, supermarkets and pharmacies in the Odesa region are also unable to work. A small shop worker from the region reveals that even the local businesses that have small electric generators and fuel for them cannot work as they did before October's attacks on Ukraine's energy system. For example, the generator they have in the small shop does not produce enough electricity to power all the refrigerators, so she has to interchangeably switch on the refrigerators with dairy products, meat, and fish to prolong the time these products can be stored.[69]

Individual civilians have similar problems: a woman living in one of the high-rise residential buildings of the city of Zaporizhzhia says that due to power outages, perishable products, including those that were stored in her home freezer, are quickly getting spoiled.[70] In a situation when food supply to civilians in many cities and villages is already complicated due to the impact of the war,[71] inability to have some spare food at home makes the conditions in which Ukrainian civilians live even more challenging.

66 Українська правда (14 November 2022) Available at: https://t.me/ukrpravda_news/23571

67 ТСН (31 October 2022) Available at: https://www.youtube.com/watch?v=XiPuo0QXDbs

68 5 канал (28 October 2022) Available at: https://www.youtube.com/watch?v=xBVCHZ210yE

69 Суспільне Одеса (25 October 2022) Available at: https://www.youtube.com/watch?v=2mP21FjF5Y0

70 Суспільне Запоріжжя (21 October 2022) Available at: https://www.youtube.com/watch?v=ZD7F6-CT934

71 Суспільне Запоріжжя (22 April 2022) Available at: https://t.me/suspilnezaporizhzhya/4010

Some non-essential but pleasant routines that millions of Ukrainians managed to keep after the beginning of the full-scale Russian invasion are also directly endangered by the attacks on the Ukrainian energy system. For example, many cafes cannot work in the absence of electricity, thus, locals cannot buy their morning coffee before going to work.[72]

2. Impact on residential buildings

Another widespread outcome of attacks on the energy system is that elevators in high-rise residential buildings do not work. Because of power outages, civilians have been trapped inside dark elevators where they have to wait for help. The director of the elevator company in the city of Kropyvnytskyi reveals that in the period between 2 October and 7 November, the company received 229 outage-related requests for help from locals.[73] Limiting the usage of elevators due to the risk of getting trapped is one part of the challenge, another part is that the absence of working elevators limits the mobility of some groups of civilians, including seniors. The situation gets even more problematic when the absence of electricity is combined with the absence of water supply, then civilians, including those living in high-rise residential buildings, have to carry sufficient amounts of water home regardless of which floor they live on.

3. Impact on education

The director of a kindergarten in the Lutsk region revealed that the kindergarten experienced a power outage on 31 October at 9 AM. The outage was announced, so the employees could prepare breakfast for the kids in advance. The kindergarten continued its work without electricity. When given warnings of a Russian air attack, the children were taken to the bomb shelter, where the employees had to use spare battery powered torches.[74] Power outages also further interrupt education at Ukrainian schools, including those schools that were forced to choose online schooling instead of in-person lessons due to the absence of bomb shelters on school premises. As pupils often join classes online from home, the online education process cannot continue in the absence of electricity and internet connection.[75]

4. Impact on professional activity

"Going to work" does not make much sense when there is no stable electricity or internet connection at the workplace. Ukrainians working remotely and as freelancers face the same challenges. Ukrainian employers are responsible for providing the employees with the means needed to conduct the work and (legally required) to keep paying the salaries if the work cannot be done because of reasons out of employees' control.[76] The situation for Ukrainians working as freelancers or working for non-Ukrainian companies is even more challenging because they risk losing their jobs and, therefore, their means of survival. To avoid such a development, they either have to somehow secure their ability to work or to flee the country and become refugees. Due to the recent attacks on the energy system and the following power outages harming the Ukrainian economy, the Ukrainian government predicts an even more severe decrease in

72 ТСН (31 October 2022) Available at: https://www.youtube.com/watch?v=XiPuo0QXDbs

73 Суспільне Кропивницький (11 November 2022) Available at: https://www.youtube.com/watch?v=7rLpnX3T37Y

74 Суспільне Луцьк (1 November 2022) Available at: https://www.youtube.com/watch?v=hENcpd8ANDk

75 Amelina (31 October 2022) LB, Available at: https://lb.ua/society/2022/10/31/534234_onlaynshkola_bez_svitla.html

76 Pecheniuk (8 November 2022) UNIAN, Available at: https://www.unian.ua/economics/other/viddalena-robota-pid-chas-vidklyuchen-svitla-ekspert-poyasniv-chi-mayut-pracivnikam-zberigati-zarplatu-12039075.html

the country's GDP than previously predicted.[77]

5. Impact on journalism and the collective response to the war

Ukrainian and international journalists providing audiences in Ukraine and across the world with information about the Russo-Ukrainian War are among the professional groups negatively influenced by Russia's systematic attacks on the Ukrainian energy system. The working time of cameras and laptops used by journalists can be prolonged with the help of power banks but these also need electricity to be charged. Moreover, the absence of a stable electricity supply, and mobile and internet connection also hinders or even disables work processes. No need to detail that in addition to professional challenges, Ukraine-based journalists also widely face the above-described problems, including with heating, food and water supply, as other Ukrainian civilians.

Figure 16: Journalists of Ukrainian English-language media outlet The Kyiv Independent continuing their work meeting despite the power outage. / Courtesy of Olha Rudenko [78]

77 Zharykova (10 November 2022) Ekonomichna Pravda, Available at: https://www.epravda.com.ua/news/2022/11/10/693663/

78 Rudenko (4 November 2022) Facebook, Available at: https://www.facebook.com/olga.rudenko/posts/pfbid0hTyUC6YrYQb3AZfoLtxRNmbdS8QPndm9A2QXX1iXjESSJQhTBJNz2CJqum8THuUQl

In the midst of all the challenges, people look for ways to adapt to the new status-quo where possible. As well as buying candles and power banks for personal use, and looking for coworking spaces with autonomous sources of electricity in order to keep working during power outages,[79] Ukrainian civil initiatives and authorities are also trying to approach the hardship collectively. For example, the Lviv water supply company has announced that it is repairing old and opening new public sources of water from wells powered by mechanical pumps to make sure locals will have access to water when electrical pumps which bring water directly to the flats cannot work due to the lack of electricity.[80] Kyiv authorities reveal that they are buying portable boiler rooms to secure the work of public heating points for civilians in the absence of the supply of thermal energy.[81] There is even a pilot project aimed at installing solar panels on the roof of a high-rise residential building in the Dnipropetrovsk region,[82] it will not be enough to secure sufficient amounts of energy for all the residents' needs, but, as the head of the housing cooperative says:

> "[t]he main task is to have backup power to stay connected and understand what is happening in the city and the country."

79 Smyrnova (11 November 2022) Speka Media, Available at: https://speka.media/kiyani-povertayutsya-v-kovorkingi-de-znaiti-roboce-misce-zi-svitlom-ta-internetom-p6egnv

80 Львівводоканал (2 November 2022) Available at: https://www.facebook.com/vodokanal.lviv/posts/456624556459657

81 Kolesnichenko (22 October 2022) Ekonomichna Pravda, Available at: https://www.epravda.com.ua/publications/2022/10/22/692937/

82 Vyshnytska (27 October 2022) The Heinrich Boll Foundation Ukraine, Available at: https://ua.boell.org/uk/2022/10/27/sonyachna-elektrostantsiya-v-bahatopoverkhivtsi-yak-tse-dopomozhe-perezhyty-zymu-pid?fbclid=IwAR1Ww-kjhG2-4X9vu0yWwaoSUk1_vW3bvTonI5xStvhqGa1x5vvXjg8e9Bo

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The strategic shift in Russia's attacks on Ukraine's energy infrastructure

Photo by Iryna Chubarova / Adobe Stock: The capital of Ukraine Kyiv suffers blackout after Russia's terror-bombing campaign of civilian targets and critical infrastructure.

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