

Weaponizing Winter: Energy Infrastructure, Coercive Strategy, and Civilian Vulnerability in the Russia-Ukraine War

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ABSTRACT: In the Russia-Ukraine war, energy infrastructure has emerged as a prominent arena for coercion, civilian security and resilience, and has been the target of repeated Russian attacks against Ukraine. This Article discusses the different types of seasonally concentrated attacks and clarifies the strategic aim behind them and their impact on IHL at stake if there are attacks on interconnected energy systems that leave civilians affected. The study utilises a qualitative approach using an embedded single-case design from February 2022 to 31 August 2026, combining peer-reviewed scholarship with the official documentation of the United Nations Human Rights Monitoring Mission (UHR) in Ukraine, the International Atomic Energy Agency, the International Criminal Court, and the ICRC treaty database. Three embedded sub-units are analysed (attacks on electricity and heating power stations in Ukraine, nuclear safety and legal issues at the Zaporizhzhia Nuclear Power Plant, and Ukrainian strikes against Russian oil power stations). The results show that the line of reasoning about Ukraine's energy system is a punishment/attrition/leverage line instead of capitulation. Official reporting reveals that attacks against power and heating systems enhance civilian impact, particularly during the winter season. The study establishes that the term “dual-use” should not substitute the Article 52 military objective test and that Article 56 precautions should be more specifically considered for nuclear facilities. It concludes that direct comparison of Russian and Ukrainian energy-targeting campaigns is challenging due to differing targets, civilian exposure, and assessment standards. Strategic and IHL assessments are strongest when viewed cumulatively rather than as substitutes for strike-specific legal analysis.

KEYWORDS: Energy Infrastructure, Coercion, Civilian Vulnerability, International Humanitarian Law, Zaporizhzhia Nuclear Power Plant, Russia-Ukraine War

Introduction

Energy infrastructure is playing a more important role as a target system in the Russia-Ukraine war. Electricity generation, transmission, distribution, and heating have been targeted repeatedly by missile and drone strikes since October 2022, resulting in cascading issues for the Ukrainian population regarding heating, access to water,

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healthcare, communications, transport, and all other essential needs. The “strategic importance of these systems” is obvious – armed forces rely on national energy systems and so do the citizens of every nation. That interdependence presents a challenging analytical challenge. A strike on an energy facility can have military significance and have widespread civilian impacts beyond the point of impact.

This problem is exacerbated by the winter dimension. Energy deprivation in moderate weather can be disruptive; it can become life-threatening in freezing weather. In no way is every winter strike the same in law and, more importantly, in strategy; nor is the fact that one occurs during the winter season enough to establish a motivation to harm the civilian population. It also does mean that the “predictable impacts” from outages in electricity and heating vary depending on the cold and the increased demand. According to the United Nations Human Rights Monitoring Mission in Ukraine (HRMMU), since October 2025 and through March 2026, the Russian forces have launched at least 423 attacks on electricity generation, transmission, and distribution facilities, and 74 attacks against combined heat and power plants and other heating infrastructure. Prolonged power outages depriving households and services were reported in the same reporting and attributed to these attacks (OHCHR, 2026). This evidence provides an empirical test for ‘weaponized winter’: the impact of infrastructure disruption could be exacerbated by the seasonal conditions, while the legality and strategic intent behind any given attack would need to be judged on a case-by-case basis.

Strategic studies and IHL seem to start out from different perspectives. The coercion literature considers questions about how attacks affect the behavior of an adversary and the difference between attacks that impose a cost on the adversary's behavior and ones that limit the adversary's ability to meet military objectives. A large-N analysis of aerial bombing campaigns by Horowitz and Reiter (2001) showed that denial was more associated with being effective at coercion than was punishment. But the situation between Russia and Ukraine makes for a not-so-simple punishment-and-denial classification. An energy campaign can be sustained, inflict economic damage, disrupt repair capabilities, restrict military-industrial activities, put pressure on a humanitarian front, and affect bargaining without immediate political ‘surrender’. The impact of these combined punishment, attrition, and leverage works better as a group than as one coercive mechanism.

IHL raises unique questions. Civilian objects may not be attacked, and only objects that, by their nature, location, purpose, or use, render an effective contribution to military action have been made military targets if they may be attacked, captured, or destroyed because these actions offer a clear military advantage in the specific circumstances (Protocol Additional I, 1977, art. 52). The word ‘dual use’ is a descriptive shorthand term and not a formal legal term. The challenge is highlighted by Capone (2025): infrastructure with both civilian and military purposes continues to be governed by the different categories of civilian objects and military objectives, as well as proportionality and precautions. However, Figueiredo (2026) also makes note of the challenge of looking past the initial injury and taking steps to prevent second-hand damage if service points are destroyed.

The situation is complicated by the nuclear dimension. Zaporizhzhia Nuclear Power Plant (ZNPP) is not just another electric power station. When an attack on a nuclear electric generating station could lead to the release of dangerous forces and to severe civilian damage, there is the provision of special protections in Article 56 of the Additional Protocol I, subject to several narrowly framed conditions. Reports by the IAEA have consistently reported a risky situation with regard to the nuclear safety and security situation at ZNPP, citing lack of independent monitoring access, military operations around the plant, and the violations of safety pillars (International Atomic Energy Agency [IAEA] 2025). Thus, ZNPP cannot be evaluated on the basis of the so-called ordinary proportionality principle or traditional coercion theory. It is an energy asset, a nuclear safety risk, and a place that remains under military control, as well as a constant concern internationally.

The further drawback to all of this is the two ways energy is targeted. Ukraine has executed attacks with drones on Russian oil installations and refineries. Huff et al. (2026) estimate the impact of these strikes using satellite “verification” and production loss data, mainly for analytical purposes of strategic efficiency and economic damage. In contrast, the attacks on Ukrainians' electricity and heating infrastructure by Russians are analyzed in a humanitarian and legal context. However, variability in the difference is not always a sign of a lack of consistency of the scholarship; targets for a refinery and targets for a grid, attack scales, citizen dependence, and effects expected vary considerably. But it warns that only one of the metrics can be used to compare the two campaigns and that the symmetry should not be assumed — and calculated — without first addressing these differences.

All of the challenges discussed in this article are tackled by a comprehensive qualitative evaluation. It is not a determination of the legality of each strike nor an assumption of strategic intent based upon only timings. Instead, it looks at how strategic theory, civilian harm, nuclear risk, and IHL all come together to understand a cumulative energy targeting campaign. The article provides three contributions. How to move beyond capitulation punishment and recognise the longer-term attritional and leverage effects is a first attempt to interpret infrastructure coercion strategically. Second, it explains that the term 'dual use' has to be subject to legal standards that are expressed in Additional Protocol I, Articles 52, 56, and 57. Cumulative, system-level assessment is important despite the importance of attack-specificity, which is an *ex ante* assessment; this system-level analysis explains this issue.

What are the various ways repeated and seasonally significant targeting of Ukrainian energy infrastructure have functioned as a means of coercion, attrition, and strategic leverage? (RQ1) (RQ2) How well are current IHL rules able to cover the ongoing and far-reaching dangers for civilians from attacks against interdependent energy facilities such as nuclear facilities? (RQ3) What are the prospects and constraints in comparing Ukrainian energy infrastructure attacks against Russian and Ukrainian attacks on Russian energy systems?

Literature Review

The relevant literature consists of four overlapping areas: coercive airpower and strategic effectiveness; International Humanitarian Law (IHL) and critical or so-called “dual-use” infrastructure; nuclear safety and the Zaporizhzhia Nuclear Power Plant (ZNPP); and scholarship in the field of reciprocal energy targeting. While each body offers a particular part of the analysis, none of them can capture the relationship among strategic purpose, system-level dynamics, civilian effects, and legal classification.

Coercion literature forms the conceptual framework. An analysis of the aerial bombing campaigns of the twentieth century by Horowitz and Reiter (2001) concluded that the effectiveness of such punishment-oriented bombing as a means to coerce success was generally not as strong as bombing aimed at the effectiveness of the campaign's military targets. The conclusion makes sense of the traditional doubt about the idea that civilian loss is invariably correlated with political surrender. As far as Ukraine is concerned, the repeated attacks on the infrastructure that supports civilians have not led to any visible capitulation of the country. But what capitulation really measures is only one outcome measure of a strategy, which may also have the purposes of exhausting repair resources, economic costs, constraining war production, influencing expectations in bargaining processes, and the need to continue expenditure on air defense. As a result, a campaign can have considerable strategic costs, but not be effective as a compellence strategy.

The difference is significant because of the recent revolution in precision weaponry and one-way attack drones, which change the dynamics of any ongoing infrastructure attack. There's the ability to launch low-cost systems for repeated attacks against expensive, fixed, and hard-to-weave-through networks. In order to safeguard generation

plants, substations, transformers, transmission corridors, heating systems, and repair crews, a great deal of territory needs to be protected. So the ensuing debate isn't really a debate on the question of whether bombing works. It also has to do with the expense per attack, the speed the target system can recover, and whether the defender can be dispersed, made redundant, imported, protected, and repaired quickly.

The second literature study looks into the legal framework for civilian and military infrastructure. Along with other IHL experts, Capone (2025) argues that the term 'dual-use objects' is often discussed in IHL discussions, but isn't yet a legally settled category. The primary legal issue is whether the object is a military objective as defined in Article 52(2), and secondly, the issues of proportionality and precautions will be relevant in case an attack has been or is lawful. In infrastructure that has multiple overlapping functions, as in the case of the Russia-Ukraine conflict analyzed by Azzahra and Hastuti (2025), applying simple rules of traditional targeting is problematic. An issue Galletti Escobar (2022) broaches is that of the individual responsibility of criminal agents; in other words, the evidentiary problems of assigning unlawful acts against such objects to a particular decision-maker.

Daniele 2024, in its turn, brings the discussion forward by putting the spotlight on the legal relevance of 'incidental' civilian damage. He warns that proportionality doctrines, which subject any civilian consequence that can be predicted to civilian involvement in armed conflict to balancing doctrine, violate the fundamental importance of the difference between intended or primary effects and incidental and genuine civilian damage under the IHL targeting law. This is especially relevant when the disabling of an interdependent energy system is likely to lead to the deprivation of civilians. But whether an act was "with the intention of causing serious harm" could only be established from the facts, and foreseeability cannot stand alone as evidence of this.

However, Figueiredo (2026) brings the discussion to law as well and the ripple effects on essential services. Loss of infrastructure can have ripple effects in other related infrastructure; loss of electricity can affect water pumping, hospital functions, communication and transport services, sanitation and heating. The impact of these may not be immediate or confined to the facility that is targeted. This is why the growing IHL literature explores reasonable foreseeable indirect consequences on a case-by-case basis in regard to implementing system-level and precautionary measures. This system-level perspective is especially applicable to energy war since the humanitarian damage of an attack relies more on the damage to the network to function than on physical damage. The third literature concerns Zaporizhzhia Nuclear Power Plant (ZNPP) and the specific dangers of nuclear facilities in times of war. Burke (2022) puts attacks on and combat operations in close proximity to the Ukrainian nuclear plants into perspective, calling upon a framework of international nuclear security and treaties. These studies also show that Tsagkaris et al. (2022) and Yurii et al. (2022) have noted hazard risks to public health, including radiological risks, disruptions in health care services, and wider humanitarian impacts. The IAEA monitoring offers added proof in successive evaluations of radioactive contamination, as well as the downgrade of nuclear safety and security, the lack of access for inspectors, and the movement by military forces around the site. These sources collectively give an idea of why ZNPP is not part of a larger concept of 'energy targets.' There is a qualitative difference between the repercussions of a severe nuclear incident and ordinary electric power outages, and this is best summed up by Article 56 of Additional Protocol I.

The collapse of the Kakhovka dam also, in the most acute way, draws attention to the need for special protection rules for facilities with dangerous forces, and further, to the nexus between the armed conflict and environmental damage. Babin et al. (2023) explore the potential impact of the dam destruction on the maritime ecosystem and the different mechanisms for assessment; and Gavrysh (2024) discusses potential individual criminal responsibility for damage to the environment following the destruction of the dam. The weaponisation of water governed by IHL is addressed by Szpak (2024). While this Kakhovka case is not the empirical primary emphasis of this article, it

illustrates that infrastructure warfare can have very wide-ranging environmental and humanitarian consequences that go beyond the immediate military application, and that installations storing dangerous forces must be safeguarded by overriding legal means besides normal target class assignment.

The fourth collection of essays focuses on how the Ukrainians have attacked Russian oil facilities. Sometimes, analyses of potential impacts see only one side's interests, and Huff et al. (2026) help correct this by showing how energy infrastructure is strategically relevant for both parties. The Ukrainian drone operations they studied validate drone-related strikes with satellite imagery, and then relate these strikes to losses in production, finding that Ukrainian drones can have an economic impact at relatively low costs of operation. Their dependent variable, however, is unlike the humanitarian or legal issues touched upon in publications about the strikes on the Ukrainian electricity and heating facilities, namely strategic efficiency in destroying oil infrastructure that is relevant for the war. For the direct comparison, therefore, one must consider differences in the target function, scale and civilian dependency, geographical effects and the envisaged military advantage.

The collective literature implies a smaller, but sturdier, literature than the widely espoused idea that four disciplines do not communicate. The main problem is the lack of analytical integration research; strategy theory looks at coercive purpose and effectiveness; IHL looks at lawful target status, proportionality, and precautions; public health and nuclear safety research at hazards and civilian consequences; and economic strike research at damage and cost. A comprehensive study of energy warfare must preserve these distinctions and show how information in one realm can assist with the interpretation of information in another realm. This is why the following theoretical framework was created.

Theoretical Framework

I have set out in this article to view infrastructure targeting as a strategy that uses more than one mechanism, rather than just being a punishment strategy or a denial strategy. There are four distinct means of action that are identified: punishment, denial, attrition, leverage. Punishment is meant to make something more expensive for their opponent -- social or political. Denial is an attempt to reduce the enemy's potential to accomplish military objectives. Attrition is the progressive loss in material, fiscal, organisational, and repair capabilities. Gregory Bateson describes leverage as power to be negotiated, which comes from ongoing costs, vulnerabilities, or potential future losses. These mechanisms can work together in the same campaign and have various empirical indicators.

The framework does not take "national capitulation" as the only criterion of strategic effect in the context of Ukrainian energy infrastructure. Denial can be seen through decreases in energy availability or disruptions in logistics and energy production, which are vital to warfare capabilities. Throughout these occurrences of renewed expenditure on repair, replacement, air defense, imports, and decentralization, there are certain signs that attest to attrition. For punishment to be necessary, a nexus between civilian hardships and an intent to affect political behavior must be established. Leverage is manifested through the use of infrastructure vulnerabilities to affect bargaining or to drive continuing costs. Due to the partial nature of direct evidence for decision-makers' intent, the analysis distinguishes between observed effects, patterns consistent with specific strategies, and confirmed intent.

The seasonal vulnerability multiplier has been included in the framework. Winter is not considered a deterrent or proof of illicit intentions and is not a weapon in its own right, but only affects the consequences of equally severe damage to infrastructure. Cooler weather raises the need for electricity and heating, boosts demand, makes repairs more difficult, and doesn't allow for options for homeowners. An outage from a strike with mild weather can have far more human impacts in long periods of cold weather. So, while seasonality in terms of effect and foreseeability

is analytically relevant, it is at the same time important to remember that there can be no legal consequences from an attack without taking the specific circumstances into consideration.

The legal aspect of the framework follows in turn and consequences. First, energy facilities must be deemed to be a military objective, for civilian objects are protected while an object is only a military objective if it “by its nature, location, purpose or use makes a specific and direct contribution to the combatant power of the armed forces and its destruction, capturing or neutralisation would provide definite military advantage in the circumstances.” Second, in the event of an attack on a military objective of a lawful military force, any damage to civilians (which may reasonably be anticipated, but is not a primary aim of the attack) must be reviewed in the context of the specific and tangible military gain expected. Third, Article 57 mandates precautions to prevent and reduce civilian casualties, and feasible verification. Fourth, special rules apply in some installations. Article 56 also deals separately with dams, dykes and nuclear electrical generating stations, in which case a conflict could see dangerous forces released and a significant number of civilian casualties.

This first sequence is important because it is not a shortcut under the laws of ‘dual use’. On the other hand, some electricity facilities are not inevitably a lawful target simply because of their military nature; others are not necessarily protected simply because civilians rely on them. The legal definition of classification varies depending on the context. Likewise, for the same type of analyses, repeated offensive strikes on the same civilian targets can be of strategic and humanitarian importance but cannot take the place of the proportionality assessment with respect to the offensive action. To integrate properly, foreseeability must be addressed, reverberating effects and campaign consequences must be assessed using system-level evidence, and there is a legal requirement to focus on each threat assessment at the time.

Methodology

Research Design and Case Boundaries

A qualitative, single-case, and embedded design is used for the study. This is the main case related to energy-infrastructure targeting in the Russia-Ukraine war between 24 February 2022 and 31 August 2026. The evidentiary record is reproduced by choosing a time-specific date rather than the words ‘to the present’. Three units of embedded analysis are undertaken: (1) attacks against Ukraine’s conventional electricity and heating systems; (2) nuclear safety risks and legal issues of ZNPP; and (3) Ukrainian strikes against Russian oil refineries and pipelines. The design of the study is not of a statistical type but is explanatory and interpretive. The use of this approach is suitable as the research questions focus on the inferences from different strategic and legal frameworks about the same set of events rather than investigating the average effect of an intervention over time for each individual case. The article is not trying to build up a package with event-level data for all the strikes or to go for the classification of the satellite images. Where satellite data is relevant to Ukrainian attacks on Russian oil installations, the study uses verified analysis from Huff et al. (2026), but does not necessarily present its own as an innovation.

Sources of Evidence

There are three levels of evidence. This first tier consists of: official or quasi-primary sources, such as reports by HRMMU/OHCHR on attacks and civilian impact; IAEA reports and updates on nuclear safety and security in ZNPP; texts of Additional Protocol I from the ICRC treaty database and official institutional statements used to set the date or reported impacts. These sources support factual and legal claims and do not reject the existence of differing lists or official reports, which may have differing mandates, levels of access, and evidentiary standards. The

second tier consists of peer-reviewed academic journals on coercive bombing, international humanitarian law (IHL), critical infrastructure, nuclear safety, public health, and energy targeting.

These sources mainly cover the interpretation of documented patterns of empirical realities, the identification of legal discussion, and the definition of theoretical concepts. The third level includes in-depth studies of specific campaigns and is exemplified by Huff et al. (2026). These are used if they are sufficiently transparent with regard to their methods and underlying evidence. The Source Strategy deliberately adopted is conservative. These statements about attack frequency or civilian consequences are those of the reporting institution, not ascertained by anyone. Strategic intention claims are not necessarily made simply on the basis of the nationality of the attacker and the scale of the civilian damage, or when attacks are carried out during winter. Rather, it identifies effects that have been documented, effects that have been publicly acknowledged and necessary objectives, and effects that are likely to have happened as part of the fulfillment of strategic mechanisms.

Analytical Procedure

The methods used in the analysis are structured qualitative comparison, process tracking, and doctrinal legal analysis. The same set of questions is asked for each of the subunits: What infrastructure is involved? What effects are reported? Which strategic process or set of processes is the best fit with the pattern seen? What rules of international humanitarian law (IHL) are applicable to the situation? Which conclusions are supported and which would go beyond the evidence? This logical way of standardisation increases the comparable aspects and does not imply that electricity grids, nuclear plants and oil refineries are equally targeted.

Process tracing involves identifying trends in attack types while connecting with winter demand and infrastructure degradation, adaptation, and strategic persistence at the campaign level. The goal is not to infer that a season had a direct impact on the decision to attack an infrastructure area, but rather to determine if a season influenced the impact and strategic value of the infrastructure disruption. In this way, the analysis moves beyond considering winter as evidence of intent to a contextual amplifier.

The legal analysis is doctrinal but with limitations. Translated with reference to the NONFLORENCIUS of Articles 52, 56 and 57 of Additional Protocol I and with reference to the contemporary scholarship. The study does not engage in legal judgments on individual attacks, since important details to be weighed in the proportionality assessment can only be read from the attacker's perspective *ex ante*, such as the expected military utility, the likely civilian casualties, the available options in using force, and precautions. In the absence of this information, the article enumerates questions of law and evidentiary barriers to an attack, not an attack's "lawfulness" or "unlawfulness. ICC materials used at the warrant stage are thus not final findings of criminal responsibility and can be used to corroborate allegations.

Reliability, Reflexivity and Limitations

Triangulation keeps from relying on a single source type exclusively. Official humanitarian estimates are contrasted with legal documents and peer-reviewed research; IAEA reporting results are used to guide nuclear safety statements; additional analyses are only used within the distinctly different methodological frameworks. The article also identifies structural inequalities in the accessibility of sources. There are more Ukrainian institutions, international organisations operating in Ukraine, and plenty of Western academic sources than many of the military records in Russia. This gap also impacts confidence in determining intent and decision-making within.

Three main drawbacks are noted. First, the study does not report on the causal effects of energy attacks on negotiation results, public opinion, or battlefield performance. Second, it has no complete database of strikes, and so cannot indicate the rate of attacks over a season or statistically test whether temporal variations in strike levels are occurring. Third, the comparison of the Russian and Ukrainian energy attacks is not symmetrical analytically, but the target systems and civilian dependency vary, and available studies operationalize the concept of energy effectiveness differently. The scope of the claims is limited by these limits, but the extension, depth, and rigor of documented patterns and conceptual alignment can be pursued.

Findings and Critical Analysis

Conventional Energy Infrastructure: From Capitulation to Attrition and Leverage

The first one suggests that a capitulation-based punishment mechanism is not a sufficient explanation for the ongoing attacks against Ukraine's energy sector. Although Ukraine has not given up after the initial round of strikes in October 2022, strikes continue through intercycles. Given the continuous nature of the attacks in the absence of capitulation, it appears that the strategic importance goes beyond the immediate connection between civilians' suffering and surrender. A wider interpretation would be more in line with what has been seen: that this kind of attack can at the same time create civilian pressure, incur maintenance and replacement expenses, draw on air-defense resources, hinder economic life, and from time to time affect the operation of the systems in which military and civilian users are involved.

The magnitude and prevalence of the Infrastructure issue is reflected in official reports. The Office of the United Nations High Commissioner for Human Rights (OHCHR) reported 115 incidents of attacks on energy infrastructure from 1 December 2024 to 31 May 2025, including two significant attacks that involved the launch of multiple rockets on energy facilities in December 2024, January 2025, and March 2025 (OHCHR, 2025). During the following winter, the Human Rights Monitoring Mission in Ukraine (HRMMU) documented at least 423 incidents of violence against electricity generation, transmission, and distribution facilities, as well as at least 74 incidents of violence against combined heat and power plants and against other heating infrastructure between October 2025 and March 2026 (OHCHR, 2026). These are not directly comparable because of varying reporting periods and counting methods, but they do show a consistent, albeit large-scale, pattern again and again of attacks on energy systems each winter.

The seasonal vulnerability aspect of the analytical framework is backed up by the consequences recorded by OHCHR. In 2025/2026, there was an emergency outage of transmission and distribution infrastructure caused by attacks, which impacted many millions of civilians. Moreover, due to the loss of generation capacity, a considerable shortfall occurred in electricity generation in demand periods during colder periods (OHCHR, 2026). This is evidence that would help support the idea of a winter amplification effect, rather than civilians suffering being the sole/first goal. The empirical findings show that seasonality is associated with a large augmentation of the foreseeable civilian impacts of the disruption of such systems.

About the strategic implications, multiple mechanisms are suggested. It is possible for the punishment effects (civilian hardship), during an attack, denial effects (loss of active/inactive military support services), and attritional effects (necessary repairs, protection, and replacements) to continue being produced after acts of repeated attacks. Thus, it is not that punishment theory, as such, is misguided, but that using frameworks in which political capitulation is the only meaningful outcome is not adequate to explain the campaign observed. Their attacks persist, and the eventual total cost and leverage combine to contribute to their survival, even when they won't surrender.

Table 1*Selected Official Evidence on Energy and Nuclear-System Vulnerability*

Source/period	Documented evidence	Analytical relevance	Caution
OHCHR, Dec. 2024-May 2025	115 documented attacks on energy infrastructure; four large-scale coordinated attacks during the reporting period.	Shows repeated attacks across a winter and early spring period.	Not a complete independent strike census and not directly comparable with later counting periods.
OHCHR/HRMMU, Oct. 2025-Mar. 2026	At least 423 attacks on electricity facilities and at least 74 strikes on heating-related infrastructure.	Strong evidence of sustained winter pressure and system-wide civilian exposure.	Counts are institutionally documented; they do not alone establish the legal status or intent of each attack.
IAEA, 2025 reporting on ZNPP	Nuclear safety and security remained precarious; six of seven safety pillars were compromised fully or partly during the reporting period.	Confirms that ZNPP presents a continuing safety risk environment distinct from ordinary grid targets.	Safety findings do not by themselves allocate responsibility for every incident.
ICC Office of the Prosecutor, 2024	Warrants concern alleged attacks against Ukrainian electric power plants and substations and alleged war crimes/crimes against humanity.	Demonstrates that energy infrastructure attacks are subject to active international criminal law scrutiny.	Warrants reflect reasonable grounds findings, not final convictions.

IHL and the Problem of Interconnected Civilian Systems

The second finding is that the challenge that most often appears in the law is not a question of missing International Humanitarian Law (IHL) rules but is due to evidentiary and systemic difficulties with interconnected infrastructure. Article 52 provides a clear framework within the law: civilian objects are protected unless they pass a two-part test, that of effective support to the military action and definite military advantage. The term 'dual use' does not supplant this test. Consequently, the fact that military units make use of electricity does not mean that an electricity facility is automatically a lawful target.

After the status as "military objective" is given, the principle of proportionality and precaution comes into play. Energy systems are especially relevant because of their being interconnected. Potential foreseeable civilian consequences of a destroyed transformer substation or a generating unit can extend in both time and space from the direct event of destruction. According to Figueiredo (2026), the armed forces need to improve their capacity to be more capable of determining the ripple impact on essential services. The Ukrainian situation is a good example – hospitals, water systems, heating, communications, and transportation will be affected at the same time by power outages. The cumulative effects of these are analysed, but the legal proportionality test has its focus on what is expected to happen "in the event of the specific attack".

The original version of the manuscript seemed to be a willing gloss over the idea that cumulative civilian suffering could substitute for an individual calculation of proportionality. The more technically correct the conclusion, the more limited it will be. At the campaign level, evidence is relevant due to previous damage, known system weakness, seasonality request, and interactions between campaigns. Hence, in the absence of a balancing exercise assessment

ex post, i.e., campaign-based, proportionality may be taken care of with the ex ante assessment without spilling over to post-campaign.

This distinction is underscored by proceedings before the International Criminal Court (ICC), where the role of law in-everyday- *quotidien de justice* is gradually coming to be seen as a supplementary concern. Several warrants were issued in ICC chambers in 2024 for alleged "attacks on critical infrastructure in Ukraine, including electric power plants and electric power substations". There is reasonable cause to believe that attacks against civilian objects, excessive incidental harm, and other inhuman acts were committed. Although not all such attacks on energy infrastructure were unlawful, these proceedings highlight the continuous and international criminal law review of issues of target classification, proportionality, and civilian consequences (International Criminal Court, Office of the Prosecutor [ICC-OTP] [2024](#)).

Zaporizhzhia: Why Proportionality Alone is the Wrong Legal Frame

The third finding concerns the Zaporizhzhia Nuclear Power Plant (ZNPP) and emphasizes that just the ordinary proportionality doctrine is not enough to assess nuclear facilities. The International Atomic Energy Agency (IAEA) has repeatedly termed the situation of nuclear safety and security at ZNPP as critical. In its 2025 report, the Agency found that six of the seven essential pillars of nuclear safety and security were fully or partly compromised, along with continued military operations near the site and access to the site being hindered (IAEA, [2025](#)). The greatest risk is, therefore, permanent and wholesale, meaning safe operation requires physical integrity, competent staff, reliable offsite power, good cooling, reliable logistics, and no military activity that might undermine these factors.

Legally, Article 56 is absolutely imperative. It provides special protection to nuclear electrical generating stations (when an attack might cause forces to be released which are dangerous to civilians) and narrowly drawn exceptions, even though nuclear plants might otherwise be legitimate military targets. ZNPP is by no means an unusual scenario for the general proportionality rule: international humanitarian law (IHL) recognises the special risks of certain installations. That's a more solid proposition in view of the law than a lack of an applicable category of IHL.

There must also be a distinction of concept between threats and other forms of military activity in or near a nuclear facility. The proportionality principle in attack applies only to attacks and not to any kind of risk associated with occupation, military presence or unsafe operational situations. These continuing nuclear safety hazards can thus give rise to a larger scale of law and operational obligations that go beyond what can, or is, taken care of by the law of attack. This clarification serves to locate the issue in how the special protection, precautionary measures, occupation-related situation, and nuclear safety governance are playing off each other rather than in an incorrectly implemented targeting rule, and adds substance to the analysis.

Ukrainian Strikes on Russian Oil Infrastructure: Comparative Analysis Without False Equivalence

The fourth is that this is analytically vital, but this cannot be called "symmetry". Huff et al. ([2026](#)) examined Ukrainian drone strikes against Russian oil infrastructure from February 2022 to May 2025 and confirmed these strikes through satellite proof and linked them to oil production losses. The central issue they must ask themselves is the concept of strategic efficiency: can relatively low-cost drones have an out-of-proportion economic impact on an enemy's war-relevant oil sector?

This analysis proves that energy infrastructure is a leverage point for both sides in conflict. Yet, oil refineries and the nation's system of electricity or heating are not the same. A temporary "shut-in" of refinery throughput can have quite different civilian impacts as compared to a "shutdown" of electricity distribution or a combined heat/power system in the event of a very cold spell. Likewise, there may be multiple points of military value or tangible military

benefit for each military activity pinned. Thus, the notion that 'energy infrastructure' is a morally, strategically, or legally equivalent two-way street is utterly incorrect.

Cross-Cutting Finding: System-Level Analysis Is Necessary but Not Legally Substitutive

Across the three sub-units, the central finding is that system-level analysis is essential for understanding strategy and civilian vulnerability, but it cannot substitute for event-specific legal analysis. Strategic effects are cumulative: infrastructure damage reduces redundancy, increases repair burdens, exposes bottlenecks, and amplifies the impact of subsequent attacks. Humanitarian consequences also accumulate as households, hospitals, water systems, and municipalities deplete backup capacity. These are authentic campaign-level phenomena.

International humanitarian law (IHL), however, requires a disciplined separation of legal questions. Target status, anticipated military advantage, expected incidental civilian harm, and feasible precautions must be evaluated in relation to attacks under the prevailing circumstances at the time. Campaign history is relevant only when it alters what consequences are reasonably foreseeable, but it does not justify a retrospective determination that every attack within a damaging campaign was unlawful. This distinction constitutes the article's most significant methodological and legal clarification, as it enables cumulative harm to be addressed without overstating the evidentiary basis.

Discussion

Key components of the article, specifically the revised analysis, are significantly changed. It is not that present disciplines cannot explain energy warfare, per se, but that they each have different units of analysis and outcome variables. The strategic theory focuses upon behavioral and material effects, the international humanitarian law (IHL) on the legality of the conduct used, the nuclear safety analysis on the risk of a nuclear accident and the system's integrity, while the economic strike studies center on the ratio of damage to cost. Confusion can arise, however, when results of something learned in one domain become misapplied in another.

The Ukrainian energy campaign shows that in strategic studies, the effectiveness of coercion may not be associated just with capitulation. Results similar to those of Horowitz and Reiter (2001) are still relevant, as it warns of not assuming that punishment of civilians always forces surrender. This conclusion is not negated by the Ukrainian case. Instead, it's just an example of how a sustained campaign of attacks against infrastructure could prove strategically desirable well after capitulation for various other reasons: attrition, diversion of resources, denial intermittently, bargaining leverage, etc. This difference is very important in modern warfare, where drones and missiles can be far more cost-effective and can require endemic costs of defense and repair even if the will to fight remains.

Further study on the notion of seasonality vulnerability multiplier is warranted. The attacks on the already vulnerable energy systems were compounded by cold weather and increased electricity usage, based on evidence from the 2025-2026 OHCHR. But this article does not make the claim that this seasonal synchronization establishes an intention to terrorize or coerce civilians. A good deal of work would have to be done to substantiate this claim, with a dataset covering the event level, the demand metric, the temperature measurement, statements from Russian officials and the military, and the methodology for deciding exactly how much is driven by military logic and how much is purposeful civilian exploitation in winter. This hypothesis can be specifically tested in future quantitative or mixed research studies.

The case teaches the importance of being precise with terminology, especially for an IHL scholarship. Although it is practical to describe it as 'dual use', this is not an independent legal state, nor can it be used as such. Article 52

test continues to bear weight. The same precision is needed in the other factor, proportionality. The human suffering from cumulative and reverberating hurt does not make it acceptable to make the proportionality an ex post assessment for a whole campaign. Rather, the effects of cumulative damage could have an impact on what planners should anticipate prior to subsequent attacks, and Article 57 levels of precautions could be more rigorous in recognition of the fragility of the system. The work of Figueiredo (2026) is significant here, as it focuses on ways to operationalize knowledge about the essential service dependencies.

The ZNPP case is an example of the need for specific protection regimes. Tacitly, the original manuscript suggested that proportionality may 'not apply at all', thereby brushing against a category mistake inasmuch as there may be a doctrinal gap. A more correct translation recognizes the proportionality principle for the rules of attack, and Article 56 affords extra security for nuclear plants. This is not to prematurely invent a new legal category but one of analysis of the interplay between Article 56, precautionary measures, classification of the target, nuclear security standards and the legal effects of military control in the particular context of ZNPP. This is a more technically sophisticated piece of work, which provides a more comprehensive research agenda for interdisciplinary studies.

The number of "reciprocal strikes" compared to that of other countries is therefore more cautious and of greater analytical merit. However, the attacks by Ukrainians against Russian refineries show that energy installations can have strategic worth as a target even if there is no citizen-punishment concept involved. This does not mean, however, that each and every energy initiative is the same, as these cases demonstrate. Rigorous comparative analysis should take into account such factors as target architecture, civilian service dependency, the military advantage anticipated, geographic scope, the accuracy of weapons, capacity for repairs, and extent of operations. The main insight gained from the scholarly process is that the conclusions drawn from a comparison can be very dependent on the variables chosen to be measured.

These findings have huge policy implications. States and humanitarian organisations should start from a stance of strengthening resilience not just at the level of large-scale power plants but also at network interdependencies such as transformer inventories, distributed generation, microgrids, alternative heat/cool sources, backup power for hospitals, water infrastructure, repair crews, cyber-physical redundancy, cross-border power support, etc. Operational and legal perspectives should incorporate reasonably foreseeable reverberating effects into proportionality and precautionary analysis through credible methodologies. Even stricter separation from military activity and persistent independent monitoring is required for nuclear installations.

However, the impact of the study needs to be carefully explained. It does not elucidate the intent of Russian decision-makers, the extent of causation of attacks on Ukrainian policy, or whether or not particular Ukrainian or Russian strikes are legal. It has the merit of combining the four elements of strategic investment, humanitarian investment, nuclear safety, and legal reasoning in a precise fashion, as well as of pointing out which claims are supported by existing evidence and, conversely, which call for alternative research designs.

Conclusion

Energy systems are a key target in geopolitical competition and a civilian target in the Russia-Ukraine war. The constant attacks on electricity and heating systems allow us to see that the effects of the infrastructure war go beyond destruction. These impacts cascade through interrelated services, increase repair and protective costs, and escalate during the winter months when demand is high and alternative civilian uses are few. This campaign is best understood not only through the lenses of successful or failed civilian punishment, nor simply in terms of whether

an impact was made or not. Instead, it is the mixed approach where punitive impacts are present along with denial, attrition, and leverage.

The same kind of precision is essential with legal analysis. Presuming automatic lawfulness of energy facilities that serve civilian and military purposes as 'dual use' will result in giving military entities an unfair advantage and weaken the implementation of domestic and international energy priorities. Where an attack might be otherwise lawful, Article 57 precautions apply, and where it is lawful, there must be a contextual determination of its military objective status. The more infrastructure is interdependent, the more significant the foreseeable reverberating effects. The cumulative civilian harm does not replace the structure of proportionality analysis *ex ante*, for individual attacks.

The ongoing crisis at the Zaporizhzhia Nuclear Power Plant (ZNPP) is also a case in point with respect to the "general targeting doctrine. The states are granted some specific protections for nuclear power plants under Article 56 because of how dangerous forces released from a plant could cause civilian harm. However, current safety concerns highlighted by the IAEA require an integrated analysis taking into account special protection considerations, precautionary measures, nuclear safety governance, and the specific situation of military control. This approach provides a more technically informed ending to the idea of being lawless than does the idea that its domains of proportionality signify a legal lacuna.

The attacks on Russian oil infrastructure by Ukrainians further underline the fact that energy systems are also prime targets – and strategic ones – for both warring sides, but, again, one does not necessarily make the other. Different types of energy resources enable different military and civilian capabilities—and the literature reviews their impacts with differing measures. Future comparative studies should be based on common metrics and should differentiate between strategic efficiency, civilian damage, and legal assessment, and shall not combine them.

What that means in a big-picture way is that for "infrastructure warfare," you need to be analyzing it both at a systemic level and an operational level simultaneously. Humanitarian consequences and strategy need to be considered at the system and campaign level, with impacts adding up over time and networks. Legal responsibility should always be governed by the rules that apply to particular conduct, and available evidence that can be used to assess responsibility. Keeping them parallel without conflating them provides the best window for comprehending the strategic opportunities, civilian affordability, and lawfulness of weaponizing energy vulnerability in today's wars.

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