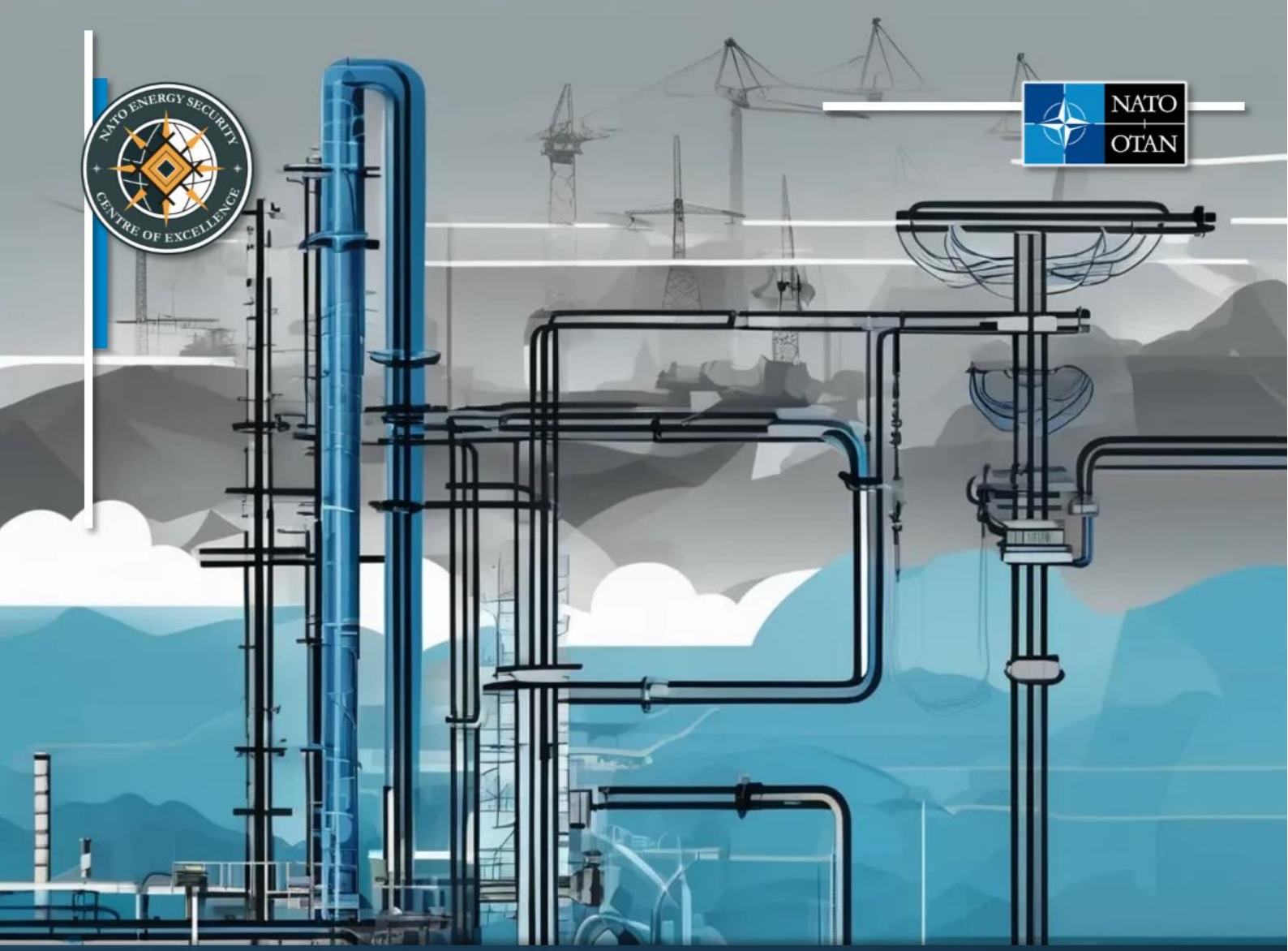

# Impact of Critical Energy Infrastructure Security on Military Resilience and Energy Security within NATO

By Rebecca Iotti

# IMPACT OF CRITICAL ENERGY INFRASTRUCTURE SECURITY ON MILITARY RESILIENCE AND ENERGY SECURITY WITHIN NATO

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## Abstract

The research report explores the concept of Critical Energy Infrastructure (CEI), military resilience, and energy security within NATO.

Chapter 1 provides a comprehensive definition of these terms and examines the impact of energy infrastructure on soldiers in the field. It also reviews recent NATO efforts to enhance energy security.

Chapter 2 delves into the various types of CEI, including land and maritime infrastructure, highlighting the significance of regions like the South China Sea in CEI security. Additionally, it examines the current state of Italy's underwater CEI and the gaps in understanding that remain. The paper concludes with a discussion on potential future actions by NATO to address the vulnerabilities of CEI, emphasizing the need for strategic measures to safeguard military operations and missions from infrastructure threats.

# INDEX

# Introduction

Economic stability and democratic systems heavily depend on critical infrastructure, which provides essential services to the public and supports economic functions. Military operations also rely significantly on both public and private civilian infrastructure to carry out their missions. The resilience of critical infrastructure is mainly the responsibility of individual nations. Resilience refers to the ability to prevent, protect, respond to, resist, mitigate, absorb, accommodate, and recover from incidents that could disrupt essential services. This is especially crucial for critical infrastructure, as complete protection is generally unattainable. Given that infrastructure often spans borders or provides cross-border services, regional and international cooperation, including through international organizations, is essential.[1]

NATO concentrates on critical infrastructure that is vital for its core tasks, such as deterrence and defense, crisis prevention and management, and cooperative security. Ensuring both national and collective resilience is fundamental to all of NATO's missions and supports efforts to protect member nations, their societies, and their shared values. Disruptions to critical infrastructure can have severe negative impacts on vital government functions, essential public services, and economic activities. They can also interfere with military operations, including exercises, deployment, reinforcement, and sustainment.[2] The complex interdependencies of critical infrastructure mean that disruptions can have cascading or mutually reinforcing effects. For instance, a disruption in the power supply can impact public services and the distribution of essential goods. These disruptions can also cross borders due to the interconnected nature of networks and, in some cases, the physical infrastructure itself.

In many instances, critical infrastructure is privately owned, managed, or operated. Since this infrastructure supports essential government and public services and sometimes serves security and defense purposes, it is crucial for governments to ensure its resilience against disruptions, which may include necessary investments. Efforts are ongoing to enhance the resilience of critical infrastructure. These include increasing awareness through monitoring and information sharing, preventing disruptions through security measures and preparedness actions, minimizing the effects of potential disruptions through rapid and effective responses, redundancy or backup measures, including restoration and repair capabilities, and ensuring timely recovery through contingency planning and preparedness.[3] Energy infrastructure is included both in civilian utilities and military operations. However, the increasing interconnectivity and dependency on these infrastructures have amplified their susceptibility to disruptions, whether from natural disasters, cyberattacks, or targeted military strikes. For NATO,

[1] Monaghan S., Svendsen O., Darrah M., Arnold E. (2023) "NATO's Role in Protecting Critical Undersea Infrastructure" CSIS Briefs.
[2] EU-NATO Task Force On The Resilience of Critical Infrastructure - Final Assessment Report (2023).
[3] EEAS (2022) Joint Progress Report on Climate Change, Defence and Security (2020-2022).

safeguarding critical energy infrastructure (CEI) is not merely a matter of national interest but a collective security imperative. The Alliance's ability to project power, maintain deterrence, and ensure readiness in the face of emerging threats hinges on the robustness of its energy infrastructure.

This research is situated against the backdrop of recent global events that underscore the critical nature of energy resilience. Energy resources and infrastructure have become both tools of statecraft and targets of conflict, underscoring the need for NATO to prioritize CEI in its strategic calculations. The concept of CEI encompasses a wide range of physical systems that are crucial for the generation, transmission, and distribution of energy. Within NATO's operational framework, these infrastructures are integral to both civilian and military functions, supporting base operations and combat missions. The disruption of energy supplies can have immediate and severe consequences, compromising the operational effectiveness of forces and, in extreme cases, threatening the stability of member states.

NATO's approach to CEI is informed by its broader understanding of resilience—a concept that is embedded in Article 3 of the North Atlantic Treaty.[4] Resilience, in this context, refers to the ability of member states and the Alliance as a whole to prepare for, withstand, respond to, and recover from disruptions across a spectrum of threats. For NATO, enhancing resilience involves a dual focus on civil preparedness and military capability, ensuring that both civilian and military infrastructures can function effectively under the stress. Military resilience is deeply intertwined with energy security, particularly in an age where military operations are increasingly reliant on advanced technologies that consume significant amounts of energy. The International Energy Agency (IEA) defines energy security as follows: "[…] energy security refers to the uninterrupted availability of energy sources at an affordable price."[5].

Meanwhile, the draft of the NATO Operational Energy Concept (OEC), developed in 2024 under the guidance of the NATO ENSEC CoE by an OEC Writing Team, composed of representatives of NATO countries, NATO institutions and the scientific community, defines energy security as a stable and reliable supply of required energy forms and quantities, enabling NATO's capabilities, operational effectiveness and resilience. This definition underscores the importance of diversifying energy sources, securing supply routes, and enhancing the energy efficiency of military systems.

The resilience of CEI is critical for maintaining the continuity of military operations. In conflict zones, energy infrastructure becomes a strategic asset and a potential vulnerability. Attacks on energy supplies and facilities can disrupt military logistics, impede operational effectiveness, and diminish the capacity of forces to sustain prolonged engagements. NATO's emphasis on CEI reflects its recognition of the strategic importance of energy in military planning and its commitment to ensuring that its forces remain capable and resilient in all operational environments.[6]

[4] North Atlantic Treaty Organization. (2001) North Atlantic Treaty Organization NATO. International Organizations. Retrieved from the Library of Congress, https://www.loc.gov/item/lcwaN0011199/.
[5] NATO ENSEC CoE (2014) Energy Security: Operational Highlights. p. 3
[6] MC 0560/2(Final), MC Policy for Military Engineering, dated 06 September 2017.

Despite its critical importance, CEI faces a range of challenges and vulnerabilities that complicate its protection and resilience. One of the primary challenges is the geographical dispersion of CEI across diverse and often hostile environments. For NATO, this means that energy infrastructures must be protected in a variety of settings, from the urbanized landscapes of Europe to the contested waters of the South China Sea. The varied nature of these environments requires a flexible and adaptive approach to CEI protection, one that takes into account the unique threats and vulnerabilities present in each area.

To address these challenges, NATO has been proactive in developing strategies and frameworks aimed at enhancing the resilience of CEI. This includes the formulation of policies that promote the sharing of best practices among member states, the integration of CEI considerations into military planning and exercises, and the establishment of collaborative mechanisms with international partners and organizations. NATO's approach is guided by a recognition that the protection of CEI is not solely a national responsibility but a collective one that requires coordinated action across the alliance.

# CHAPTER 1

## 1.1. The Definitions of Critical Energy Infrastructure, Military Resilience and Energy Security

Critical infrastructures refer to the physical and cyber-based systems vital for the basic functioning of the economy and security of states. Critical Infrastructure Protection (CIP) is a crucial initiative requiring governmental actions to address threats to critical infrastructure. The term "critical infrastructure" first appeared in a formal context in an executive order signed by the U.S. President on July 15, 1996.[7] This order identifies physical and cyber threats as the two primary types of threats to these systems. Historically, many critical infrastructures operated as independent systems with minimal interdependence. However, advancements in information technology and the demand for increased efficiency have led to greater automation and interconnection among these infrastructures. Thus, it is significant that the concept of "critical infrastructure protection" emerged following the widespread integration of information technologies into these systems.[8]

Critical Energy Infrastructure (CEI) constitutes the systems, assets, or components—both physical and virtual—responsible for generating, transporting, transmitting, distributing, or storing energy vital for maintaining a continuous and stable energy supply. Disruption or destruction of CEI would result in significant and sustained impacts on the health, safety, security, economic well-being, and effective functioning of society.[9] Critical Infrastructure can also be defined as "[…] a nation's infrastructure assets, facilities, systems, networks and processes that support the military, economic, political and/or social life on which a nation and/or NATO depends."[10]. Most countries have infrastructures that are complex, interconnected, and dependent on various components working together. The crucial role of infrastructure is to effectively perform its intended functions, providing essential services to both civilians and military personnel.

Understanding military resilience necessitates a deep comprehension of military culture, which profoundly influences the mental and physical development of Service Members (SMs). Military culture, as characterized by Siegl (2008), encompasses attitudes, values, and goals that shape behaviors deeply ingrained in customs, practices, and leadership traditions.[11] Regardless of their motivations for joining the military, individuals must demonstrate a willingness to serve the country, potentially risking their lives

[7] The White House, Presidential Decision Directive/NSC-63 at http://www.fas.org/irp/offdocs/pdd/pdd-63.htm (accessed June 2024).
[8] Edwards M. (2012) *Critical Infrastructure Protection*, Centre of Excellence, Defence against Terrorism, Turkey.
[9] Liberty Analytic Support Initiative (LASI) for the NATO Energy Security Centre of Excellence (2023) *Critical Energy Infrastructure Prioritization Assessment (CEIPA) White Paper.*
[10] MC 0560/2(Final), MC Policy for Military Engineering, dated 06 September 2017.
[11] Siegl, M. (2008) *Military culture and transformation*, JFQ: Joint Force Quarterly, 49, 103–106.

to protect the freedoms of every citizen. This ethos places the mission above all else, demanding selfless commitment from SMs who are on call 24/7 without extra compensation, regardless of personal obligations. This unique military culture instills a sense of duty, sacrifice, and unwavering commitment to national defense, shaping the behavior and outlook of SMs and underscoring their inherent resilience. Recognizing and appreciating this culture is essential for understanding the challenges faced by SMs and devising strategies to nurture their resilience in adversity.[12]

The concept of resilience is embedded in the Article 3 of the North Atlantic Treaty, which states: "In order to achieve the objectives of this Treaty more effectively, the Parties, individually and collectively, through continuous and effective self-help and mutual aid, will maintain and develop their individual and collective capacity to resist armed attack."[13]. Within NATO, resilience signifies the ability at both the national and collective levels to prepare for, withstand, respond to, and swiftly recover from strategic shocks and disruptions across a range of threats. Essentially, this means that the Allies individually, the Alliance as a whole, and the NATO as an organization must be capable of enduring disruptions and shocks while continuing their activities. The redistribution of geostrategic and military power necessitates the ongoing transformation of NATO's Military Instrument of Power and the alignment of military and non-military capabilities among NATO member countries. The Alliance's resilience is a blend of civil preparedness and military capacity. Civil preparedness is crucial for NATO's defense readiness, requiring well-maintained, adaptable, durable, and quickly recoverable military systems supported by civilian capabilities to ensure security and stability across the Alliance.[14]

Every NATO member must be resilient to withstand significant shocks such as natural disasters, critical infrastructure failures, or hybrid or armed attacks. Resilience encompasses the capacity to prepare for, resist, respond to, and rapidly recover from such shocks and disruptions, ensuring the continuity of the Alliance's activities. Civil preparedness is a cornerstone of Allies' resilience and is vital for the Alliance's collective defense, with NATO assisting Allies in assessing and enhancing their civil preparedness. Rooted in Article 3 of the North Atlantic Treaty, both national and collective resilience are fundamental to credible deterrence and defense, essential for NATO's mission to protect its societies, populations, and shared values.[15] In the NATO context, resilience involves the capacity to prepare for, resist, respond to, and quickly recover from disruptions and shocks. While strengthening resilience is primarily a national responsibility, the efforts of individual Allies also fortify the Alliance as a whole. Allies can bolster their resilience by developing national defense capacities, ensuring access to critical

[12] Simmons A., Yoder L. (2013) *Military Resilience: A Concept Analysis*, Nursing Forum, Volume 48, Issue 1, January-March.
[13] North Atlantic Treaty Organization. (2001) North Atlantic Treaty Organization NATO, Article 3. International Organizations. Retrieved from the Library of Congress, https://www.loc.gov/item/lcwaN0011199/.
[14] NATO (2023) Resilience in NATO, retrieved at: https://www.act.nato.int/article/resilience-in-nato/#:~:text=Resilience%20in%20a%20NATO%20context,the%20full%20spectrum%20of%20threats [last accessed August, 2023].
[15] NATO (2024) Resilience, civil preparedness and Article 3, retrived at: https://www.nato.int/cps/en/natohq/topics_132722.htm [last accessed August, 2024].

infrastructure, and formulating backup plans for crises. Effective action against threats or disruptions in the civilian sector requires predefined and regularly practiced plans and response measures.

The recent shift towards prioritizing resilience within the military landscape acknowledges the need for a comprehensive understanding of resilience beyond the individual level. At the 2011 Inter University Seminar Series on Armed Forces and Society (IUS conference), calls were made to differentiate resilience across individual, group, and organizational levels, broadening the discourse to encompass wider social groups and structures.[16] Despite progress, there persists a tendency to narrowly view resilience as an individual trait, particularly within psychological discourse. The evolving discourse on military resilience reflects a shift towards a holistic understanding, acknowledging the interplay between individual attributes, social connections, and institutional frameworks. By broadening the scope of resilience discourse, the military aims to cultivate a more resilient force capable of navigating the complex challenges of modern warfare.[17]

Energy security definition for the forces of NATO countries could be identified as a stable and reliable supply of required energy forms and quantities, enabling NATO's capabilities, operational effectiveness and resilience. This section will define energy security within the context of NATO, explaining why this particular definition is the most appropriate. Although NATO is not primarily an energy institution, energy developments significantly influence the international security landscape and can have profound implications for Member Nations. Given the ongoing global energy transition, ensuring a stable and reliable energy supply, diversifying routes, suppliers, and energy resources, and maintaining interconnected energy networks are crucial for enhancing resilience against political and economic pressures.[18]

NATO monitors energy trends and developments to increase its strategic awareness in this area. This involves consultations on energy security with Allies and partner countries, enhancing intelligence sharing and assessments, and expanding connections with relevant international organizations such as the International Energy Agency and the European Union. A vital aspect of energy security is the protection of CEI, which is essential for all countries. Energy infrastructure, particularly in conflict zones, is highly vulnerable. Attacks on these complex networks by hostile states, terrorists, or other malicious actors can have regional repercussions. As electricity becomes central to the global energy transition, securing power infrastructure is becoming a cornerstone of energy security. Consequently, NATO aims to enhance its capabilities in supporting the protection of CEI through training and exercises.

[16] Williams J., Vitas R., Shields P., Miller L., Morse E., McHenry T. (2011) *Inter University Seminar Series on Armed Forces and Society*, 21 - 23 October The Palmer House Hilton Chicago, Illinois, USA
[17] McGarry R., Walklate S., Mythen G. (2015) *A Sociological Analysis of Military Resilience: Opening Up the Debate*, Armed Forces & Society, Vol 41(2) 352-378
[18] North Atlantic Treaty Organization (2024) "Energy security", retrieved at: https://www.nato.int/cps/en/natohq/topics_49208.htm [last accessed August 2024]

While protecting energy infrastructure is primarily a national responsibility, NATO forces' reliance on civilian energy infrastructure makes it imperative for Allies to strengthen their infrastructure in line with NATO's resilience baseline requirements. NATO facilitates exercises and shares best practices with partner countries—many of which are key energy producers or transit countries—and with other international institutions and the private sector. Since 2018, the NATO-Istanbul Cooperation Initiative (ICI) Regional Centre has hosted training courses on protecting CEI. NATO supports national authorities in bolstering their resilience against energy supply disruptions that could impact national and collective defense.[19] This comprehensive approach to energy security, which includes monitoring, strategic awareness, infrastructure protection, and joint training, makes the above definition of energy security, in the opinion of the author of this article, the most appropriate for the NATO context. Ensuring a stable and reliable energy supply, diversifying routes, suppliers, and energy resources, and enhancing the interconnectivity of energy networks are critical for increasing resilience against political and economic pressures. Although primarily the responsibility of national authorities, energy developments can have significant political and security implications for Allies and affect partners as well. Regular consultations among Allies on energy security issues will continue. It is essential to prevent Alliance members from being vulnerable to political or coercive manipulation of energy, which poses a potential threat.[20]

Therefore, efforts will focus on diversifying energy supplies in line with specific needs and conditions. NATO's role in energy security will be refined based on established principles and guidelines, with ongoing efforts to enhance NATO's capacity to support national authorities in protecting CEI from hybrid and cyber threats. Strategic awareness will be improved through intelligence sharing and strengthened links with relevant international organizations, such as the International Energy Agency, the International Renewable Energy Agency, and the European Union. Additionally, measures will be taken to improve the energy efficiency of military forces, incorporating sustainable energy sources where appropriate.[21]

## 1.2. The Effect of Energy Infrastructure on Soldiers on the Field

Considerations regarding energy have always been integral to the operational effectiveness of armed forces globally. These considerations encompass various aspects, including operations in conflict

[19] North Atlantic Treaty Organization (2024) "Energy security", retrieved at: https://www.nato.int/cps/en/natohq/topics_49208.htm [last accessed August 2024]
[20] North Atlantic Treaty Organization (2018) "Brussels Summit Declaration: Issued by the Heads of State and Government participating in the meeting of the North Atlantic Council in Brussels 11-12 July 2018", retrieved at: https://www.nato.int/cps/en/natohq/official_texts_156624.htm?selectedLocale=en [last accessed August, 2024]
[21] North Atlantic Treaty Organization (2018) "Brussels Summit Declaration: Issued by the Heads of State and Government participating in the meeting of the North Atlantic Council in Brussels 11-12 July 2018", retrieved at: https://www.nato.int/cps/en/natohq/official_texts_156624.htm?selectedLocale=en [last accessed August, 2024]

zones, transportation via land, air, and water, as well as sustaining installations and forward operating bases. Recently, there has been a growing emphasis on clean energy and the evolving challenges faced by the military. Energy serves as the cornerstone for virtually all military activities, ensuring mission success and providing a decisive advantage on the battlefield. Security, in this context, is attained through the effective powering of major weapons systems and communication infrastructure, maintaining optimal levels of performance, range, and readiness.[22]

However, the reliance on energy supply lines for combat operations also presents vulnerabilities. Hence, security is also derived from minimizing energy consumption in vehicles and forward bases. Economic considerations further drive efforts to reduce and diversify fuel usage within military operations. The United States (US) Department of Defense (DoD) stands as the largest consumer of energy within the US government, and the volatility of energy costs poses risks to military operations and maintenance within constrained budgets. Moreover, defense policymakers must navigate paths that align with environmental performance objectives, shaped by Departmental and Federal guidelines. Environmental sustainability not only contributes to operational efficiency but also plays a crucial role in maintaining the DoD's social legitimacy, fostering support from host communities, both domestically and abroad.[23]

Energy has historically influenced every aspect of warfare, from troop deployments and defensive strategies to mobilization and offensive actions. The imperative to deliver timely and adequate energy supplies to military forces, particularly those in forward-deployed locations, has long been recognized as a strategic vulnerability. Disrupting enemy supply lines, including those related to energy, has frequently been employed as a tactic to weaken adversaries' operational capabilities. The logistical challenges of ensuring a reliable energy supply have been central to the narratives of both successful and unsuccessful military campaigns throughout history.

Many of the insights gained from the 20th-century world wars continue to resonate and inform contemporary conflicts. A notable illustration of energy's impact on military strategy dates back to 1911 when Winston Churchill, serving as the First Lord of the Admiralty, transitioned the British fleet from Welsh coal to foreign oil. This decision significantly enhanced the Royal Navy's speed while reducing logistical challenges, providing a critical advantage over opposing forces. This shift, often described as enabling the Allies to "float to victory on a sea of oil" not only improved operational efficiency but also minimized the conspicuous coal smoke, which could betray the fleet's position.[24]

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[22] Samars C., Nuttall W., Bazilian M. (2019) *Energy and the military: Convergence of security, economic, and environmental decision-making,* Energy Strategy Reviews

[23] U.S. DOD, (2011) *Energy for the Warfighter: the Operational Energy Strategy*, Assistant Secretary of Defense, Operational Energy Plans and Programs, U.S. Department of Defense https://www.acq.osd.mil/eie/Downloads/OE/Operational%20Energy%20Strategy,%20Jun%2011.pdf

[24] Crowley T., Corrie T., Diamond D., Funk S., Hansen W., Stenhoff A., Swift D. (2007) *Transforming the Way DOD Looks at Energy*, An Approach to Establishing an Energy Strategy, LMI

Concurrently, the US Navy began transitioning from coal to oil during World War I, primarily relying on domestic oil sources from Oklahoma, Texas, and California. In the Asia-Pacific theater, Japan's military and foreign policy were profoundly influenced by the imperative for oil and other resources. Similar to the surprise attacks in operation Barbarossa, Japan launched a surprise assault on the American naval fleet on December 7, 1941, seeking to secure vital oil shipping lanes. Earlier, in July 1941, the US had restricted oil exports to Japan following its invasion of French Indochina, leading Japan to adopt aggressive tactics, including the infamous attack on Pearl Harbor.

These strategic moves were central to Japan's broader strategy to control oil and other natural resources, such as rubber, in Southeast Asia. Japan's designation of the "Southern Resource Area" reflected its ambition to expand its influence, although its claim to liberate the region from European colonial rule rang hollow. Notably, United Nation (UN) Peacekeeping initiatives prioritize minimizing negative environmental impacts, recognizing the unique balance of priorities required in military endeavors, particularly in maintaining peacekeeping operations.[25]

UN peacekeeping operations, comprising approximately 115,000 personnel across 16 countries as of the end of 2012, account for 55% of the emissions generated by the entire UN system. The majority of these emissions stem from air travel (46%), followed by power generation (26%) and road vehicles (15%). Until 2009, decisions regarding the adoption of renewable energy sources and energy efficiency measures were typically made at the individual mission level, lacking a comprehensive UN-wide policy despite the potential for cost savings.[26]

Subsequently, the UN implemented a policy to reduce its environmental impact across all operations, including energy consumption for field missions, aligning with the Seventh Millennium Development Goal (MDG7) for environmental sustainability. This initiative led to the adoption of two key instruments: the Environmental Policy for UN Field Missions by the Department of Peacekeeping Operations (DPKO) and the Department of Field Support (DFS), and the Global Field Support Strategy by the General Assembly. These policies, mandatory in nature, encompass various aspects of environmental sustainability in peacekeeping operations, including camp management issues such as water usage, waste management, wildlife conservation, and energy consumption.[27]

The UN Environmental Programme (UNEP) has identified a challenge in adopting energy-efficient and renewable energy technologies due to the uncertainty surrounding the duration of field missions. This uncertainty makes it difficult to conduct future-oriented cost-benefit analyses of renewable technologies. Consequently, technologies are often chosen based on the initial mission length, typically six to twelve months, despite missions typically lasting much longer, often around seven years.

[25] Samars C., Nuttall W., Bazilian M. (2019) *Energy and the military: Convergence of security, economic, and environmental decision-making, op.cit.*
[26] UNEP (2012), *Moving towards a Climate Neutral UN: the UN System's Footprint and Efforts to Reduce it*, UNEP
[27] ibidem

Experience from implementing sustainable energy and energy efficiency measures in UN peacekeeping operations indicates a cost-recovery payback time of one to five years.

The persistent vulnerabilities in fuel logistics, observed since World War I and II, remain largely unchanged despite technological progress. Asymmetric conflicts like those in Iraq and Afghanistan, characterized by extended and vulnerable supply chains, underscore the preference among soldiers for approaches that minimize the need for frequent fuel resupply. The risks associated with resupply, including threats to soldiers' lives and logistical challenges, emphasize the importance of deploying more energy-efficient systems to mitigate vulnerabilities at the front lines.[28]

The examination of alternative energy integration in the military has focused on four main areas of development:

- Liquid fuels remain a significant focus area with vast potential. Most innovation in this domain has centered on the implementation of biofuel blends by the Air Force and Navy. Despite some skepticism regarding the economics of this endeavor, ongoing implementation and advancement of mixed fuel technologies have been mandated by legislation.
- Military installations have garnered attention for their potential to achieve energy and cost savings through efficiency and renewable energy systems. Shifting from reliance on diesel backup generators to advanced microgrids at installations could reportedly save the DoD between $8 billion and $20 billion over the next two decades.
- The necessity of maintaining power independence in forward operating bases has driven demand for innovative systems. Challenges associated with supplying fuel to generators have prompted various efficiency modifications, facilitating the development of more efficient microgrids for electrical power distribution at military bases and installations. These installations integrate smart information technology (IT) and environmental benefits akin to civilian equivalents, coupled with enhanced IT security and a strong emphasis on reducing fuel consumption. Technological leadership in this domain primarily stems from US initiatives.
- The deployment of small-scale systems at the platoon/company level is expected to continue as military leaders strive to provide small-scale fighting forces with independence from conventional fuel sources.[29]

Positive developments in energy and environmental innovation within the military and defense sectors are evident. Whether the evolving energy supply and utilization in military planning and tactics constitute a revolution in military affairs remains uncertain. However, there is potential for a significant shift, possibly reaching the status of a revolution in military affairs, emanating from the military domain.

[28] Samars C., Nuttall W., Bazilian M. (2019) *Energy and the military: Convergence of security, economic, and environmental decision-making, op.cit.*
[29] ibidem

A notable separation exists, both organizationally and socially, between experts engaged in civilian energy policy and innovation and their counterparts focused on military strategy, planning, and capabilities. It is suggested that stakeholders involved in civilian energy technology and policy should actively consider innovations emerging from the defense sector and leverage two-way technology spillovers. There is an increasing opportunity for a reverse flow of energy innovation from civilian to military applications, particularly concerning the greening of military operations. These opportunities for mutually beneficial exchange hold considerable potential to reshape how both the defense and civilian sectors utilize and manage energy, not only in the present and past but also in the foreseen future.[30]

The disruption of infrastructure can significantly impact both military operations and noncombatants in various ways. The extent and type of disruption or control over essential systems such as power grids or transportation networks can influence several critical factors. For instance, road conditions, obstacles, and mines can affect the rate at which movements occur. The availability of multiple routes for moving troops or supplies can be severely limited, which in turn impacts the speed at which resupply and reinforcement can be executed. Additionally, the level of situational awareness is influenced by the presence or absence of light, directly affecting operational efficiency.[31]

Furthermore, the assistance required to address the needs of noncombatants can be considerable, involving both costs and the diversion of personnel. This assistance may also be needed for varying durations, depending on the severity of the disruption. The financial implications and the time needed to restore power or transportation services are other significant concerns. These restorations can be costly and time-consuming, further complicating both military operations and civilian life. In essence, the control or disruption of critical infrastructure plays a pivotal role in determining the overall effectiveness and speed of military efforts, as well as the well-being and support required for noncombatants.[32]

The impact of energy-related infrastructure disruption on a military operation is largely determined by the specific circumstances of the location, combatants, and non-combatants involved. However, understanding the general effects of CEI on military operations and civilian life during and after conflicts remains essential. Firstly, logistics in urban combat require increased troops, ammunition, and supplies, thus placing higher demands on military logistics systems. It is crucial to ensure the timely delivery of personnel and supplies, which may necessitate adaptable transportation methods such as trucks, railcars, ships, or air transport depending on the deployment region. Secondly, when targeting CEI in a military operation, a well-defined procedure must be in place to evaluate potential targets. This process should start with an understanding of the various impacts that CEI disruption can have on both

[30] Samars C., Nuttall W., Bazilian M. (2019) *Energy and the military: Convergence of security, economic, and environmental decision-making, op.cit.*
[31] Patterson C. (2000) *Lights Out and Gridlock: The Impact of Urban Infrastructure Disruptions on Military Operations and Non-Combatants*, Institute for Defence Analyses
[32] ibidem

combatants and non-combatants, including potential ripple effects. Lastly, the term "civilian affairs" encompasses all military activities aimed at addressing civilian needs in conflict areas. This includes efforts to restore CEI services essential for daily life. The ultimate goal at the conclusion of a military operation is to transfer responsibility and control to a local civilian authority, ensuring a smooth transition and sustainable recovery for the affected population.

## 1.3. Recent NATO's Efforts to Strengthen Energy Security

In recent years, energy security has gained prominence on the agenda of the European Union (EU) and has been recognized as a challenge requiring the involvement of other international entities such as the North Atlantic Treaty Organization (NATO), the UN, the Organization for Security and Cooperation in Europe (OSCE). The ongoing concerns related to climate change and decarbonization are expected to sustain and possibly intensify the attention of these organizations towards energy security.[33] NATO emphasizes the importance of diversifying energy sources and achieving independence from external suppliers, considering this crucial for the energy security of its Members. High reliance on a single supplier due to a lack of diversified energy supplies exposes states to political interference by the supplier.[34]

Over the past decade, NATO, traditionally a security and military organization, has expanded its mandate to include energy security. It offers its Members a platform for consultation on energy security, provides information on global energy developments and their implications for international security, and assists in safeguarding CEI. Additionally, NATO advocates for enhanced energy efficiency in military operations.[35] NATO addresses energy issues through the lens of energy and defense, both for member countries and operations. Recognizing the central importance of energy security, NATO established the NATO Energy Security Centre of Excellence (NATO ENSEC COE) in Lithuania in 2012. This Center provides strategic analysis, research, development of doctrine and standards, education, training, and consultation services. NATO members collaborate to exchange smart energy solutions aimed at reducing fossil fuel consumption in their respective militaries and mitigating environmental threats.

The challenge of fuel consumption and supply security significantly impacted the largest NATO operation in history, Afghanistan. In late 2012, ISAF forces, comprising over one hundred thousand troops, consumed more than 1.8 million gallons of fuel daily, with 99% of it delivered by truck from abroad. Following a border closure by the Pakistani government after an air attack in 2011, NATO forces had to shift all energy supply to the North through the Northern Distribution Network (NDN), spanning over 5000 km. This logistical network, described as a "nightmare" by Foreign Policy, highlights the

[33] Bocse A. (2020) *NATO, energy security and institutional change*, European Security, DOI: 10.1080/09662839.2020.1768072
[34] ibidem
[35] Helfer L. (2006) *Understanding change in international organizations: globalization and innovation in the ILO*. Vanderbilt law review, 59 (3), 647–726.

enduring vulnerabilities and challenges in fuel logistics despite advancements in military technology. While some NATO members initially expressed doubts about NATO's role in energy security, they acknowledged the inclusion of energy security within NATO's mandate. This acceptance was driven by the desire to maintain overall cooperation within the Alliance or to leverage information on energy security shared within NATO or produced by the organization.[36]

Over the past decade, NATO has undertaken various initiatives related to energy security. Firstly, NATO monitors energy trends to enhance its own strategic awareness as well as that of its members regarding the energy landscape. For example, during the Russo-Ukrainian tensions in 2014, the NATO Energy Security Section provided Allies with insights into the energy implications of the crisis, recognizing that energy developments, such as supply disruptions, can have significant security implications for certain Allies.[37] Secondly, NATO serves as a platform for member countries to exchange information, intelligence, and best practices on energy developments with potential security implications. This exchange occurs at various levels, including high-level consultations within the North Atlantic Council. Thirdly, while the protection of energy infrastructure primarily falls under national jurisdiction, the NATO offers training and assistance to member countries and their partners in this regard. Workshops and training sessions have been conducted to facilitate the sharing of best practices in CEI protection, including those targeting regions like the Southern Caucasus and countries participating in the Istanbul Cooperation Initiative. Fourthly, NATO utilizes its maritime security capabilities to conduct surveillance of maritime routes and choke points critical for fuel transport. Anti-piracy operations, such as Ocean Shield in the Horn of Africa, have contributed to ensuring the safe passage of vessels transporting oil and other fuels. Lastly, the NATO has increasingly focused on promoting green defense practices to improve energy efficiency and environmental sustainability in its operations. Efforts have been made to develop energy efficiency standards for the military, and operations and exercises exploring "smart energy" options, like Capable Logistician 2019 in Poland, have been conducted to advance this agenda.[38]

The construction of pipelines like Nord Stream 1 and TurkStream, which provided alternative routes for Russian gas delivery to the Central and Eastern Europe (CEE) and EU energy markets, prompted differing reactions among NATO Members. While some, like Poland, expressed concerns about increased dependency on Russian gas, others, like Germany, viewed these pipelines as enhancing access to gas. Consequently, CEE states sought assistance from organizations like the NATO and the EU to bolster their energy security. CEE countries identified NATO as an institution capable of

[36] The North Atlantic Treaty Organization (2020) *NATO's role in energy security*, Available from: https://www.nato.int/cps/en/natohq/topics_49208.htm (last accessed May 2024)
[37] Bocse A. (2020) *NATO, energy security and institutional change*, *op.cit*
[38] ibidem

supporting their energy security interests, particularly through involvement in protecting CEI and facilitating information and intelligence sharing on energy security matters.[39]

As outlined in the 2022 NATO Strategic Concept, energy security has been elevated to a primary objective for NATO. The Alliance will implement a more robust, integrated, and coherent strategy aimed at enhancing resilience against a range of military and non-military threats and challenges at both national and Alliance-wide levels. This approach underscores a dual commitment: individual nations' responsibility and collective dedication, firmly rooted in Article 3 of the North Atlantic Treaty. A key area of focus will be the identification and mitigation of strategic vulnerabilities and dependencies, particularly in critical infrastructure, supply chains, and healthcare systems. Central to this strategy is the enhancement of energy security through investments in stable and reliable energy supplies, suppliers, and sources.

To ensure civil preparedness, NATO will prioritize the continuity of government operations, the provision of essential services to populations, and civil support to armed forces. Efforts will concentrate on enhancing the ability to prepare for, withstand, respond to, and rapidly recover from strategic shocks and disruptions, thereby maintaining continuity in Alliance activities. Investments will enhance capabilities to deter and defend against the coercive use of political, economic, energy, information, and other hybrid tactics employed by state and non-state actors. NATO recognizes that hybrid operations against Allies could escalate to the level of an armed attack, potentially invoking Article 5 of the North Atlantic Treaty by the North Atlantic Council. In this context, the NATO will continue supporting partners in countering hybrid challenges and seek synergies with entities like the EU. These measures aim to strengthen energy security within NATO, ensuring a stable and dependable energy supply. This comprehensive approach is designed to safeguard CEI and bolster the overall resilience of the Alliance, enabling effective responses to current and future security challenges.[40]

# CHAPTER 2

## 2.1. Land Critical Energy Infrastructure

Land CEIs are indispensable systems and facilities that guarantee the production, distribution, and storage of energy on land. Examples of such infrastructures include various types of power plants, extensive oil and gas infrastructure, and diverse renewable energy facilities. Power plants are particularly

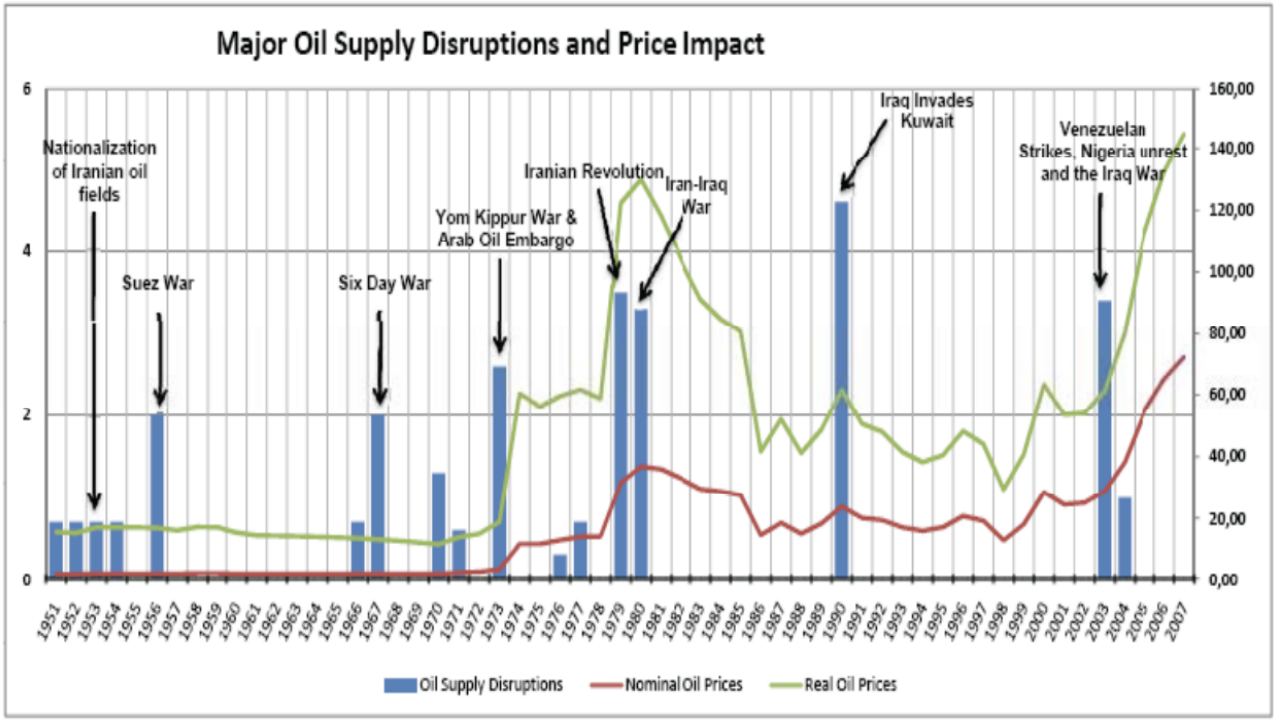
[39] European Commission (2009) *Commission staff working document accompanying document to the proposal for a regulation of the European Parliament and of the Council concerning measures to safeguard security of gas supply and repealing Directive 2004/67/EC, The January 2009 Gas supply disruption to the EU: an assessment*, SEC(2009) 977 final (Available from: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52009SC0977 [last accessed May 2024]

[40] NATO (2022) *NATO 2022 Strategic Concept*, Adopted by Heads of State and Government at the NATO Summit in Madrid, 29 June 2022

varied, comprising nuclear plants where nuclear reactions generate electricity, fossil fuel plants that combust coal, natural gas, or oil, and renewable energy plants such as wind farms, solar power installations, and hydroelectric dams. The oil and gas infrastructure is equally critical, with refineries processing crude oil into usable products like gasoline, diesel, and jet fuel. An extensive network of pipelines facilitates the transportation of oil, natural gas, and refined products across vast regions and countries. Additionally, storage facilities, including tanks and terminals, are essential for holding crude oil, natural gas, and refined petroleum products.

A related consequence of the disruption of oil infrastructures is the threat of global oil supplies. The body of research on oil supply interruptions has established a widely accepted compilation of historical incidents labeled as 'major disruptions.' Figure 1 and 2, provided by the U.S. Energy Information Administration (EIA) and the World Bank, illustrates these significant events. This figure highlights eight major disruptions, five of which stem from international conflicts, two from domestic political events, and one that combines both factors. The International Energy Agency (IEA) offers a slightly different catalog. Unlike the EIA, the IEA excludes the Iranian nationalization of 1951-54 but includes the Iraqi export suspension of 2001 and the effects of hurricanes Katrina and Rita in 2005, which are not geopolitical events. Additionally, the IEA distinguishes between the Venezuelan strike and the onset of the Iraq War.[41]

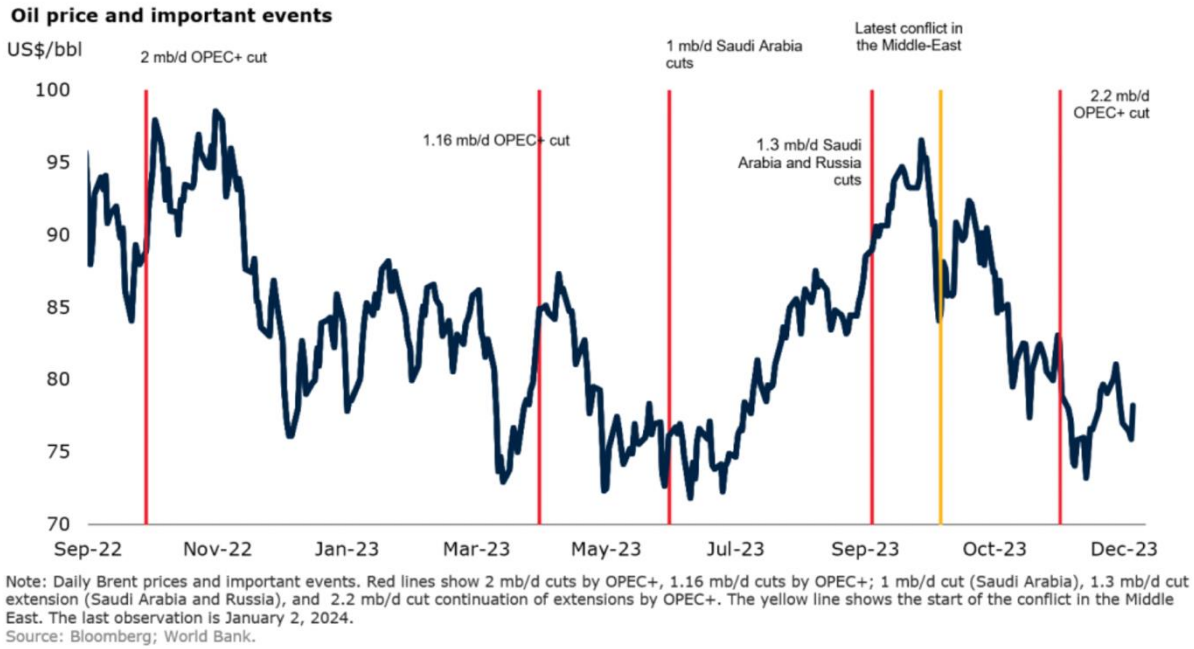
***Figure 1.*** *Major oil supply disruptions and price impact (1951-2008)*




*Source: EIA 2008*

[41] Luciani G. (2011) *Armed Conflicts and Security of Oil and Gas Supplies*, CEPS

***Figure 2.*** *Major oil supply disruptions and price impact (2022-2023)*




*Source: World Bank*

The integration of renewable energy sources into the power grid, exemplified by solar, wind and water dams' power, is increasingly significant for sustainable energy production. Safeguarding these critical assets is paramount to maintaining societal functions and preventing substantial disruptions. However, since the conclusion of the Cold War, the focus has shifted towards addressing the potential impacts of terrorism. Efforts to address these concerns fall under the umbrella of critical infrastructure protection (CIP), a concept distinct from the notion of "energy security," which primarily addresses politically and economically motivated supply disruptions.[42]

Different components of the energy infrastructure exhibit varying vulnerabilities. Breaches in security within nuclear plants pose the risk of large-scale environmental disasters, although these facilities are typically concentrated and relatively easier to defend. Conversely, the spatial concentration of oil and gas production, transportation, and refining infrastructures renders them susceptible to disruptions, potentially leading to shortages if supply is not swiftly restored. Traditional electricity grids face challenges in ensuring system-wide integrity for reliable supply, with critical facilities such as substations often spatially concentrated and limited emergency supply storage capacity.[43]

Key concepts such as redundancy, diversity, resilience, storage, decentralization, and interdependence are pivotal in shaping strategies to enhance the security of energy infrastructures. As the concept of CIP continues to evolve, there's a discernible shift away from a purely defensive "guards,

[42] Farrell A., Zerriffi H., Dowlatabadi H. (2004) *Energy Infrastructure And Security*, Annual Reviews, Vol. 29:421-469
[43] *ibidem*

gates, and guns" approach towards a design-oriented strategy. This approach aims to create systems that inherently pose greater challenges to potential attackers, featuring distributed intelligence, control, and operations, thereby fostering systems that are inherently more resilient and survivable.

## 2.2. Maritime Critical Energy Infrastructure

The maritime serves as a burgeoning domain for the security of CEI. While shipping lanes, ports, and telegraphic cables once dominated maritime activities a century ago, the rapid acceleration of oceanic endeavors has spurred a proliferation of infrastructures at sea. Both the shipping and port industries have experienced substantial expansion, both in terms of scale and quantity. Moreover, a significant portion of the world's fossil energy resources are either extracted from the ocean depths or transported via tankers and pipelines traversing maritime routes.

Beneath the ocean's surface lies a labyrinth of optic fiber data cables, stretching across millions of kilometers and serving as the backbone of modern digital communication networks. This extensive network facilitates global connectivity and information exchange, underpinning the functioning of modern societies and economies. The ocean's potential as a renewable energy source has sparked the development of offshore wind farms, marking a significant stride in the green energy revolution. These offshore installations not only contribute to the diversification of energy sources but also necessitate the deployment of subsea electricity cables to transmit the generated energy to shore.[44]

The dynamic growth of maritime CEI underscores the ocean's evolving role as a vital nexus for global energy production, transportation, and communication. As humanity continues to harness the vast resources and potential of the ocean, the development and safeguarding of these infrastructures remain paramount to sustaining our energy needs and advancing towards a sustainable future. Energy security in the maritime domain stands as a one of the cornerstone of energy security, necessitating effective measures to counter illicit activities and disruptions across vast expanses of oceanic terrain.

With over two-thirds of the Earth's surface covered by saltwater and approximately 80 percent of global trade traversing maritime routes, safeguarding maritime energy infrastructure assumes paramount importance. However, a significant portion of the world's oceans operates beyond any single state's jurisdiction. Even within areas under jurisdiction, complexities arise from potentially overlapping concepts of flag state, port state, and coastal state authority. The jurisdictional reach of coastal states, exemplified by the United States' Exclusive Economic Zone encompassing more than 90,000 miles of shoreline and 3.5 million square miles of water, further complicates regulatory oversight.[45]

[44] Bueger C., Liebetrau T. (2023) *Critical maritime infrastructure protection: What's the trouble?*, Marine Policy 155
[45] Bueger C., Liebetrau T. (2023) *Critical maritime infrastructure protection: What's the trouble?*, op. cit.

The maritime energy security challenge is underscored by the imperative to protect a vast array of vessels, including over 11,000 oil and chemical tankers and approximately 1,500 gas tankers constituting the global merchant fleet. While no singular international accord exclusively addresses maritime energy security, recent multilateral endeavors have seen the emergence of treaties and initiatives aimed at combating maritime terrorism, preventing the transport of weapons of mass destruction, enhancing security measures in ports, implementing ship tracking systems for improved threat response, and fostering collaboration in container inspection procedures.[46]

These treaties and initiatives, enacted over the past decade, epitomize the realm of energy diplomacy, fortifying countries' capacities to safeguard the maritime transport of oil, fuel, and critical maritime infrastructures. By fostering cooperation and coordination on a global scale, these efforts exemplify a concerted endeavor to bolster maritime energy security and uphold the integrity of vital maritime energy pathways.

## 2.3. The importance of the case of the South China Sea for the CEI security and energy resilience for NATO

The South China Sea is one of the most critical arteries of global energy trade, stretching from the Strait of Malacca in the southwest to the Strait of Taiwan in the northeast. This vital corridor facilitates the movement of nearly one-third of the world's crude oil and over half of global liquefied natural gas (LNG) annually, making it indispensable for global energy security.[47] The Strait of Malacca, in particular, serves as the shortest sea route between African and Persian Gulf suppliers and Asian consumers, acting as a critical chokepoint. A significant portion of crude oil arriving in the Strait of Malacca (approximately 1.4 million bbl/d) is first transported to Singapore and Malaysia for refining before being re-exported as petroleum products such as gasoline and jet fuel via the South China Sea.[48] The rest of the crude oil continues toward China and Japan, the two largest energy consumers in Asia. Additionally, 15% of crude oil shipments passing through the South China Sea proceed further to the East China Sea, primarily destined for South Korea. Given the dependence of NATO economies on stable global energy flows, any disruption in the South China Sea would have far-reaching consequences for energy markets, supply chain security, and economic stability.

Beyond its economic significance, the South China Sea has become a key theater of geopolitical competition, particularly between China and the United States (U.S.). However, beyond the military and strategic aspects, the region’s stability is crucial for global energy security, making it a matter of concern

[46] Wilson B. *Maritime Energy Security*
[47] EIA (2014) The South China Sea is an important world energy trade route. Last accessed: February 2025. https://www.eia.gov/todayinenergy/detail.php?id=10671
[48] Ibidem

for NATO. Given the importance of uninterrupted maritime trade routes for energy supply chains, disruptions in this region could have significant repercussions for NATO countries' critical energy infrastructure (CEI) security and energy resilience. While Taiwan and the Korean Peninsula have long been regarded as potential flashpoints, the South China Sea has witnessed a steady buildup of military capabilities by China, challenging the traditional dominance of the U.S. in the region.

China's increasing militarization of the South China Sea has raised alarms about potential risks to maritime trade and energy transit routes. The construction of artificial islands, the establishment of an Air Defense Identification Zone (ADIZ), and Exclusive Economic Zone (EEZ) expansion have reinforced China's ability to exert control over strategic chokepoints. If tensions escalate, China could restrict access or impose controls over these vital trade routes, leading to supply chain vulnerabilities, energy price volatility, and strategic energy insecurity for NATO members. Moreover, China's strategic investments in air, naval, and missile capabilities have transformed the dynamics of power projection in the South China Sea. Through the construction of artificial islands and military facilities on reefs and small islands within the two island chains, China has extended its operational reach and enhanced its military presence in the region. These developments have not only demonstrated China's growing military prowess but also reshaped the strategic calculus of neighboring Asian states, including U.S. allies and partners. The perceived aggressiveness of China's actions in the South China Sea has raised concerns among U.S. policymakers. However, it is essential to recognize China's perspective and underlying interests in the region. Beyond mere naval competition, the South China Sea holds strategic significance for China's trade routes and energy imports, underscoring its economic imperatives. Moreover, historical legacies of colonial exploitation further inform China's strategic calculus in the region.

Divergent approaches between the U.S. and China further complicate the maritime security landscape in the South China Sea. While the U.S. tends to compartmentalize trade and economic policy from its broader strategic objectives, China adopts an integrated approach, viewing economic and military dimensions as inherently interconnected. This dichotomy is evident in recent U.S. trade policies, characterized by trade wars and the withdrawal from multilateral agreements, juxtaposed with China's long-term strategic vision that prioritizes economic interests alongside military deterrence. The evolving dynamics in the South China Sea present complex challenges for both China and the U.S. While China seeks to consolidate its regional influence and safeguard its economic interests, the U.S. grapples with balancing strategic competition with the risk of escalation. As tensions persist and strategic interests intersect, the South China Sea remains a focal point for geopolitical maneuvering and maritime security considerations, shaping the broader strategic landscape of the Indo-Pacific region.[49]

[49] Cordesman A., Burke A., Molot M. (2019) *Military Build Up in South China Sea as Part of Overall Change in China's Strategic Posture*, CSIS

The Spratly Islands dispute, involving six claimants—China, Taiwan, Brunei, Vietnam, Malaysia, and the Philippines—highlights how territorial conflicts can impact regional stability. China's artificial island construction and military presence in locations such as Subi Reef and Fiery Cross Reef could be used to assert control over key maritime transit routes. This has implications for NATO's ability to project force, maintain energy supply lines, and support regional allies.

After NATO's involvement in the South China Sea, the People's Republic of China is included in NATO's new Strategic Concept. Indeed, the new NATO 2022 Strategic Concept[50] included an emphasis on the Indo-Pacific region, reflecting the strategic shift initiated by the Obama Administration and continued by both the Trump and Biden Administrations.

The "NATO 2030: United for a New Era" report, released on November 25, 2020, emphasized that NATO must allocate more time, political resources, and action to address security challenges posed by China, considering its national capabilities, economic influence, and ideological goals. The Brussels summit in June 2021 further stated that "China's stated ambitions and assertive behaviour present systemic challenges to the rules-based international order and to areas relevant to Alliance security. It is opaque in implementing its military modernisation and its publicly declared military-civil fusion strategy. It is also cooperating militarily with Russia."[51]. This concern about a Russo-Chinese alliance gained more significance after Russia's invasion of Ukraine in February 2022.[52].

The interest of key NATO members in the Indo-Pacific has been demonstrated through concrete actions. In 2021, NATO members deployed 21 warships to Asian waters, conducting joint operations with regional navies aligned against Chinese expansion. Naval forces have been the primary tool for European governments to project power and influence in the region, complementing the efforts of the United States and its Indo-Pacific allies and partners. A significant demonstration of force was the seven-month voyage (May–December 2021) of the British Carrier Strike Group 21 (CSG21), led by the new HMS Queen Elizabeth aircraft carrier, accompanied by two Royal Navy destroyers, two frigates, two support ships, and a nuclear-powered submarine. CSG21's passage through the South China Sea in July 2021 on its way to Japan drew strong protests from Beijing. The construction of military bases by Beijing on artificial islands in the South China Sea has prompted other nations to send warships through these waters to ensure they remain open to free navigation. In response, London has stationed two patrol

[50] NATO (2022) Strategic Concept
[51] NATO (2021) "Brussels Summit Communiqué Issued by the Heads of State and Government participating in the meeting of the North Atlantic Council in Brussels 14 June 2021" , retrieved at: https://www.nato.int/cps/en/natohq/news_185000.htm?selectedLocale=en [last accessed August 2024]
[52] NATO (2020) "NATO 2030: United for a new era", retrieved at: https://www.nato.int/nato_static_fl2014/assets/pdf/2020/12/pdf/201201-Reflection-Group-Final-Report-Uni.pdf [last accessed August 2024]

vessels in Singapore for a sustained presence and is considering basing access for periodic deployments of nuclear submarines in Australia, enhancing their operational capabilities in the region.[53]

As geopolitical competition intensifies, securing stable energy supply chains and safeguarding critical maritime energy infrastructure must remain a strategic priority for NATO. The South China Sea is not only a regional issue but a global energy security concern that directly impacts NATO's resilience and strategic interests.

## 2.4. Underwater CEI: What's yet to understand from the Italian Underwater Approach?

Despite the increased efforts by various stakeholders to safeguard Critical Undersea Infrastructure (CUI), NATO continues to play a key role in deterring and countering both conventional and hybrid threats against its allies. NATO's commitment to protecting CUI is deeply rooted in its foundational principles, particularly Articles 2 and 3 of the North Atlantic Treaty, which emphasize the importance of strengthening democratic institutions, promoting economic cooperation, and enhancing resilience against attacks. During the 2023 NATO Summit in Vilnius, NATO member states reaffirmed that hybrid operations targeting the alliance could potentially be classified as armed attacks, thereby activating Article 5, NATO's principle of collective defense.[54] Given that CUI extends throughout NATO's operational jurisdiction, achieving comprehensive situational awareness across the network is a task too extensive for any single nation to handle alone.[55]

Recognizing the growing threats to undersea infrastructure, NATO has taken significant steps following the 2023 Summit to enhance its defensive posture. The Alliance launched the Maritime Centre for Security of Critical Undersea Infrastructure and established the Critical Undersea Infrastructure Coordination Cell at NATO Headquarters, both of which aim to improve threat monitoring, coordination, and response capabilities. These initiatives reinforce NATO's strategic approach to protecting undersea assets against both state and non-state actors. The 2024 NATO Summit Declaration underscored the Alliance's continued commitment to strengthening undersea infrastructure security. Member states reaffirmed the necessity of collective vigilance and information-sharing to counter emerging hybrid threats in the maritime domain.[56] Given that CUI extends throughout NATO's operational jurisdiction, achieving comprehensive situational awareness across the network remains a task

[53] Hawkins W. (2022) NATO "Navies Send Strategic Signals in the Indo-Pacific ", US Naval institute, retrieved at: https://www.usni.org/magazines/proceedings/2022/august/nato-navies-send-strategic-signals-indo-pacific [last accessed August, 2024]
[54] NATO (2023) "Vilnius Summit Communiqué," Press release, July 11, 2023, retrieved at: https://www.nato.int/cps/en/natohq/official_texts_217320.htm. [last accessed August, 2024]
[55] Monaghan S., Svendsen O., Darrah M., Arnold E. (2023) "NATO's Role in Protecting Critical Undersea Infrastructure" CSIS Briefs
[56] NATO (2024) Washington Summit Declaration

too extensive for any single nation to handle alone. These new initiatives mark a critical advancement in NATO's ability to safeguard vital infrastructure and deter potential adversaries.

A distinguishing characteristic of the underwater realm is the presence of privately-owned and operated critical infrastructures situated beyond continuous law enforcement and military surveillance capabilities. The sabotage incidents involving the Nord Stream 1 and 2 pipelines in 2022 served as a stark reminder to the Italian public and policymakers about their susceptibility, prompting heightened concern. While some practitioners, notably within the Navy, and experts had previously emphasized the imperative of safeguarding these critical infrastructures beyond national coastlines in the interest of national security, the events further underscored this need. Consequently, there is a growing acknowledgment in Italy of the necessity for navies to play a more proactive role in surveilling and protecting these infrastructures.[57]

From a defense standpoint, the underwater realm, extending from just below the surface to the seabed, is now recognized by the MMI (it. *Marina Militare Italiana*) as the fifth operational domain, alongside air, land, maritime, and space. This perspective is grounded in the unique characteristics of the underwater environment, where communication capabilities that are effective above the surface and in space face significant limitations or alterations due to the physical challenges inherent to underwater operations, such as restricted visibility and limited data transmission capacity. The MMI acknowledges that communication and operations underwater, particularly at the seabed, necessitate distinct technologies, capabilities, and doctrines that often diverge from those applicable to naval warfare and other physical domains. Consequently, mastery of naval operations does not automatically translate to control of the deepwater or seabed domains. The Italian navy views underwater warfare as encompassing Anti-Submarine Warfare (ASW), mine warfare, and seabed warfare, and is eager to initiate a review of doctrine at both national and NATO levels. Specifically, the underwater environment presents significant hurdles in terms of maintaining communication with submarines and controlling unmanned assets operating at depth. Therefore, the MMI contends that underwater operations require a fresh doctrinal approach, as well as different skills and technological solutions compared to surface operations, particularly given the expanding utilization of Unmanned Underwater Vehicles (UUVs) which extends operational boundaries for both naval forces and private entities.[58]

According to the MMI, the initial crucial step is to establish sufficient underwater situational awareness, a concept akin to those applied in other operational domains but more complex to implement due to the aforementioned physical and technological constraints.

The Italian defense and shipbuilding industry are witnessing a significant transformation driven by advancements in underwater technologies. Notably, the ongoing design and construction of the submarine U212 NFS for the Italian Navy represent a monumental leap forward in both

[57] Calcagno E., Marrone A. (2023) The Italian approach to the underwater domain, *op. cit.*
[58] Calcagno E., Marrone A. (2023) The Italian approach to the underwater domain, *op. cit.*

conceptualization and technological prowess for numerous Italian companies operating in the underwater domain. This progress has catalyzed the revitalization of an Italian underwater industrial cluster, comprising major corporations and numerous small and medium enterprises.

While primarily tailored to meet the Italian Navy's stringent requirements, the innovations stemming from this resurgence hold vast potential for civilian applications. These include tasks such as the search and recovery of submerged objects, environmental assessments, and seabed surveys for commercial exploitation. Notably, technologies originally developed for the civilian market, particularly in the offshore oil & gas industry, are being repurposed or adapted for underwater military applications. This symbiotic relationship underscores Italy's capacity for cross-fertilization between military and civilian underwater systems, mirroring similar dynamics observed in other advanced Defense-Technology and Industrial Base (DTIB) nations.[59]

In addition to submarines, which serve as complex systems comprising onboard communications, weapons, and combat management systems tailored for underwater operations, Italy's expertise extends to Unmanned Underwater Vehicles (UUVs) and their associated support systems. These versatile platforms, along with their launch and recovery mechanisms, and command and control infrastructure, find utility not only in military operations but also in various civilian endeavors. Italian technological and industrial capabilities in the military underwater domain span four interconnected areas. These encompass submarines, UUVs and their support systems, systems and sensors primarily designed for Intelligence, Surveillance, and Reconnaissance (ISR) operations, and command and control infrastructure for integrated underwater networks. The collaboration between numerous Italian large companies, small and medium enterprises, and academic institutions underscores a concerted effort to consolidate and enhance the capabilities of the Italian underwater industrial cluster.[60]

This collaborative ecosystem fosters innovation and facilitates the development of cutting-edge underwater technologies. By leveraging the collective expertise of industry stakeholders and academic partners, Italy is poised to maintain its position as a global leader in underwater systems integration and innovation. Moreover, the adaptability and versatility of these technologies ensure their applicability across a spectrum of military and civilian domains, further enhancing Italy's strategic and economic standing on the world stage. Italy's reinvigorated focus on underwater technologies underscores its commitment to both national defense and civilian innovation. By harnessing the synergies between military and civilian sectors, Italy is not only strengthening its maritime security capabilities but also driving economic growth and technological advancement in the underwater domain.[61]

The evolution of underwater technology has democratized access to maritime operations once exclusive to military navies. The emergence of advanced Unmanned Underwater Vehicles (UUVs),

[59] Cosentino M. (2023) *Italy's underwater technological and industrial capabilities*, IAI
[60] *ibidem*
[61] *ibidem*

encompassing Autonomous Underwater Vehicles (AUVs) and Remotely Operated Underwater Vehicles (ROUVs), has broadened the spectrum of actors capable of conducting seabed and deep-sea operations. No longer confined to armed forces, these capabilities now extend to law enforcement agencies and private sector entities, ushering in a new era of underwater surveillance, security, and defense. However, the broader use of these technologies also necessitates robust measures to protect CUI from unauthorized access, making it all the more crucial for NATO to develop advanced protocols and encryption standards to secure sensitive information in this new domain of operations.

For Italy, situated at the crossroads of the Mediterranean, the significance of safeguarding underwater infrastructure and Sea Lines of Communication (SLOCs) has never been more pronounced. Positioned as a commercial and potential energy hub in the region, Italy's strategic importance is underscored by its pivotal geographic location, as noticeable from Figure 3. As telecommunications cables and energy pipelines emerge as lifelines of the global economy, Italy has endeavored to position itself as a nexus for these critical arteries.[62]

***Figure 3.*** *Italy's Gas Pipeline Network, Encompassing Four Underwater Pipelines in Sicily and Southern Italy*


*Source: Global Energy Monitor, Global Gas Infrastructure Tracker – Tracker Map*

Southern Italy, in particular, serves as a vital conduit for gas pipelines linking various gas-producing nations to Europe. Infrastructure such as the Trans Mediterranean Gas Pipeline, Greenstream gas pipeline, and the Trans-Adriatic Gas Pipeline (TAP) converge on Italian shores, facilitating the transport of natural gas from Algeria, Libya, and Azerbaijan. Amidst geopolitical shifts triggered by events

[62] Calcagno E., Marrone A. (2023) *The Italian approach to the underwater domain*, IAI

like the Russian invasion of Ukraine, Italy's reliance on these pipelines has intensified, driving diversification efforts away from Russian gas and towards Mediterranean sources.

The repercussions of these developments reverberate beyond Italy's borders, profoundly influencing Europe's energy security landscape. With a growing emphasis on transitioning towards renewable energy sources, the Mediterranean region assumes heightened significance as a potential alternative energy reservoir. This strategic realignment is poised to reshape Europe's energy dynamics, steering its reliance away from traditional fossil fuel suppliers towards its southern neighbors. As Italy assumes its role as a linchpin in the Mediterranean energy network, the imperative to safeguard its maritime infrastructure becomes paramount. The protection of underwater cables, pipelines, and maritime routes assumes heightened importance, ensuring the uninterrupted flow of goods, resources, and information across the region. In this evolving geopolitical landscape, Italy's strategic positioning and commitment to bolstering maritime security serve as linchpins for regional stability and economic prosperity.[63]

The integration of advanced underwater technologies into NATO's operational framework plays a critical role in enhancing the resilience and security of CUI. As underwater operations expand, particularly with the growing use of Unmanned Underwater Vehicles (UUVs) and other submerged platforms, the safeguarding of CUI becomes increasingly complex. These technologies not only enable more effective surveillance and protection of CUI, including CEI, but also introduce new challenges in terms of energy security, communication, data transmission, and information security. To ensure the resilience of CUI in these operations, it is imperative that NATO adopts cutting-edge encryption, secure communication protocols, and advanced situational awareness systems capable of protecting data from emerging threats. Moreover, the collaboration between military and civilian sectors in the development of these technologies fosters innovation in dual-use capabilities, which enhances both defense and civilian resilience. In this context, the strategic integration of these technologies is essential for safeguarding NATO's information networks and maintaining the integrity of operations across the alliance, thereby strengthening collective security in an increasingly complex hybrid warfare environment.

[63] *ibidem*

# Conclusion

NATO has a vital interest in preventing disruptions to critical infrastructure that is essential for providing services to citizens and supporting economic stability. It continues to strengthen its readiness to address disruptions to critical infrastructure by supporting its members with guidance, facilitating the exchange of best practices, conducting exercises, and offering resources and tools for resilience building. NATO has long understood that energy security, particularly the disruption of vital energy resources such as oil, can have significant implications for the security of its members.[64]

The Alliance has acknowledged the need to address the geopolitical and geoeconomic implications of energy security, as outlined in its discussions since the 2006 Riga Summit.[65] While the debate continues over NATO's specific role in this area, there is consensus that the organization should play a limited, complementary role in tackling the enduring energy challenge. During the 2008 Bucharest Summit, NATO leaders identified five key areas for engagement on energy security: sharing information and intelligence, promoting stability through partnerships, enhancing international and regional cooperation, supporting consequence management, and protecting CEI.

The rise of international terrorism, characterized by loosely connected networks without a centralized command, poses significant risks to both state and corporate interests. These groups operate independently, making them difficult to detect and counteract effectively. Terrorist attacks on energy infrastructure, such as oil and gas pipelines, have increased worldwide, often driven by economic or political motives..[66]

Furthermore, global natural gas consumption is expected to increase substantially, with significant implications for security. The transportation of Liquefied Natural Gas (LNG), which involves cooling gas to a liquid state, has been relatively safe for decades. As these threats evolve, NATO continues to adapt its strategies to ensure the protection of CEI and maintain stability in an increasingly interconnected and volatile global landscape. To further advance cooperation and enhance the resilience of CEI, several key recommendations have been identified. These include ensuring prompt engagement between high-level officials in the event of significant threats, conducting regular coordinated assessments of threats, and expanding dialogues on resilience and military mobility. Additionally, there is a focus on deepening the understanding of relevant tools and processes, analyzing the impact of conflicts such as the war in Ukraine on infrastructure resilience, and assessing the implications of supply chains, energy transitions, and new technologies. Further measures include leveraging synergies between policies and programs, incorporating resilience considerations into exercises, and holding scenario-based discussions to better

[64] Gheorghe, A., Muresan L. (2008) "Energy Security International and Local Issues, Theoretical Perspectives, and Critical Energy Infrastructures", NATO Science for Peace Security Series, Springer
[65] MC 0560/2(Final), MC Policy for Military Engineering, dated 06 September 2017.
[66] Giannopoulos G., Jungwirth R., Hadjisavvas C. (2023) "Fortifying Defence: Strengthening Critical Energy Infrastructure against Hybrid Threats", European Commission, Joint Research Centre (JRC)

understand challenges and interdependencies. Enhancing awareness of security risks associated with strategic competitors, improving maritime domain protection, and promoting best practices in cyber resilience are also prioritized.[67]

Moreover, efforts should be made to enhance the resilience of critical infrastructure by identifying alternative transport routes, fostering engagement with the private sector, and promoting cross-sectoral cooperation in managing disruptions. Finally, identifying synergies in security research and exploring new areas of cooperation will be essential in addressing emerging challenges related to critical infrastructure resilience.[68] These initiatives collectively strengthen NATO's approach to safeguarding critical infrastructure, ensuring the continuity of essential services, and supporting economic stability. By building on these collaborative efforts and recommendations, NATO is well-positioned to mitigate risks and enhance its collective defense capabilities.[69]

In an increasingly interconnected and technologically advanced world, the resilience of CEI has become essential for the military and economic stability of NATO and its member nations. This paper has delved into the complex interplay between CEI security, military resilience, and energy security, offering a thorough examination of the challenges and strategies integral to NATO's mission of maintaining operational effectiveness. The analysis commenced with a detailed definition of CEI, military resilience, and energy security, illustrating their vital roles in both national and international defense strategies. CEI, which includes both physical and cyber-based systems, is crucial for sustaining NATO's operational capabilities and essential services. The research highlighted CEI's significance in supporting military operations, safeguarding public safety, and ensuring economic stability across member states.

The Chapter 1 focused on recent NATO initiatives aimed at bolstering CEI resilience. Given the intricate and interdependent nature of modern energy infrastructures, which face threats ranging from natural disasters to cyberattacks and military strikes, NATO's strategy underscores the importance of both national and collective resilience. The security of CEI is recognized as a collective imperative for the Alliance, extending beyond individual nations.

The Chapter 2 explored the specific vulnerabilities and strategic importance of land-based and maritime CEI, using case studies from regions like the South China Sea and Italy's underwater energy infrastructures. These examples highlighted the diverse challenges NATO encounters in different geopolitical contexts, from securing nuclear power plants to protecting undersea cables and pipelines crucial for energy transmission. The analysis revealed gaps in understanding and protecting these

[67] EU-Nato Task Force On The Resilience of Critical Infrastructure - Final Assessment Report (2023)
[68] Monaghan S. (2022) "Resetting NATO's Defense and Deterrence: The Sword and the Shield Redux," CSIS, CSIS Briefs, retrieved at: https://www.csis.org/analysis/resetting-natos-defense-anddeterrence-sword-and-shield-redux. [last accessed August, 2024]
[69] Cullen P. (2018), "Hybrid Threats as a New 'Wicked Problem' for Early Warning", retrieved at: https://www.hybridcoe.fi/publications/hybrid-coe-strategic-analysis-8-hybrid-threats-as-anew-wicked-problem-for-early-warning/. [last accessed, August 2024]

infrastructures, especially in maritime environments, where enhanced surveillance and defense capabilities are needed. The discussion advanced by emphasizing the need for an integrated approach to CEI protection within NATO's military planning and operations. This approach includes incorporating CEI considerations into strategic planning, prioritizing energy efficiency, and strengthening energy supply chains to withstand disruptions. Military resilience was expanded to include not just physical endurance but also psychological and operational adaptability, advocating for a comprehensive strategy encompassing all facets of military readiness.

The findings underscore CEI's crucial role in maintaining NATO's operational effectiveness and strategic stability. As energy resources and infrastructures increasingly intersect with national security concerns, NATO must adapt its strategies to address emerging threats and vulnerabilities. This evolution demands ongoing research, policy development, and international collaboration to ensure the alliance remains responsive to the challenges of the 21st century.

Key areas for future attention and action by NATO and its member states include: promoting resilient technologies, such as smart grids, renewable energy sources, and energy storage systems, is essential for enhancing energy resilience. Diversifying energy sources and incorporating redundancy can reduce reliance on single points of failure; given the transnational nature of energy infrastructures, NATO must enhance partnerships with regional organizations, international bodies, and non-NATO countries. Joint exercises, intelligence sharing, and coordinated response plans will improve situational awareness and response capabilities; NATO needs to establish comprehensive policy frameworks that integrate energy security into all military planning and operations. Clear guidelines, prioritization criteria, and resilience standards will ensure a coordinated approach to CEI protection across the Alliance. Prioritizing energy efficiency and sustainable energy solutions is vital. Reducing energy consumption and transitioning to cleaner energy sources will enhance operational efficiency and minimize environmental impact. Ongoing investment in research and innovation is necessary to stay ahead of evolving threats. Supporting academic and industry research, developing new monitoring technologies, and fostering a culture of innovation will help NATO anticipate and adapt to future challenges.

Protecting CEI is a strategic priority for NATO, crucial for maintaining the resilience and readiness of its forces amid a complex security landscape. By embracing a holistic approach, investing in resilient technologies, enhancing cybersecurity, and fostering international cooperation, NATO can safeguard its energy infrastructures and ensure its continued operational effectiveness in the face of emerging threats.

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