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Homeland Security and Defense Center

Capabilities-Based Planning for Energy Security at Department of Defense Installations

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Summary

Extensive energy delivery outages in 2012, such as the widespread electricity, natural gas, and refined oil product disruptions due to Hurricane Sandy; the summer weather-related outages in the Washington, D.C., area; and the largest blackout in global history in India, have reinforced public and policymaker awareness of risks to the electricity infrastructure system. The U.S. electricity grid is vulnerable to disruptions from natural hazards and actor-induced outages, such as physical or cyber attacks.

Since Department of Defense (DoD) installations in the United States rely on the commercial electricity grid for 99 percent of their electricity needs, nearly all critical functions on installations depend on infrastructure outside DoD's control. In the event of a catastrophic disaster—such as a severe hurricane, massive earthquake, or large-scale terrorist attack—DoD installations would be a base for emergency services. The 2010 Quadrennial Defense Review therefore identified diversifying energy sources and increasing efficiency in DoD operations as critical goals. In response, DoD is developing installation energy security portfolios to enhance energy security that use a mix of new technologies and modifications to operations.

Currently, the notion of enhancing energy security on DoD installations is not fully defined. Energy security for how long? Under what conditions? At what cost? And most importantly, for what reasons? Without an understanding of these issues, planning for, executing, and evaluating proposed enhancements is challenging. The underlying analytical question for energy security is, "What critical capabilities do U.S. installations provide, and how can DoD maintain these capabilities during an energy services disruption in the most cost-effective manner?" Answering this question requires a systems approach that incorporates technological, economic, and operational uncertainties. In other words, this problem is well suited for capabilities-based planning (CBP)—planning under uncertainty that (if done well) provides capabilities for a wide range of challenges within economic constraints.

Capabilities-based planning means different things to different people, and some aspects of its implementation in DoD have been appropriately controversial. In this report, we have in mind the core feature—planning under uncertainty—to provide capabilities for a wide range of challenges (including diverse circumstances) while working within economic constraints. This means making choices in allocating lim-

ited resources to be best able to deal with future demands, which cannot be perfectly anticipated or defined in advance. In this context, *capabilities* includes the broad meaning associated with "ability and wherewithal," not just "assured ability to do a very specific task in a very specific set of circumstances." Further, this form of planning is inherently about making choices; it is the opposite of a blank-check approach. Finally, despite confusion on the matter a decade ago, capabilities-based planning also includes using concrete scenarios to test the effectiveness of options. However, such scenarios should be chosen analytically to be good test cases of broad capability, with no illusions about their being meaningful "best estimates." This interpretation of capabilities-based planning is quite consistent with the most recent Quadrennial Defense Review.

In this short report, we use RAND's portfolio analysis methods for assessing capability options to present the foundation of a framework that could be developed to evaluate energy security portfolios for these installations. While capabilities-based planning is now a component of DoD decisionmaking, we discuss how it might be extended and used for energy security planning. We outline an approach with some examples and detail, but these should be viewed as scoping suggestions—a fully developed DoD planning framework would incorporate mission context and relevant current issues. Our intention with this think piece is to stimulate a discussion of how DoD installation energy services contribute to homeland defense and homeland security, how DoD can evaluate choices to maintain adequate energy services to critical missions located in the United States, and how DoD can make tradeoffs among capabilities and costs to maintain these capabilities during disruptions.

DoD Could Use Joint Capability Areas (JCAs) as the Foundation for Measuring Energy Security

DoD analysts planning for installation energy security rely on the broad energy security definition established in the 2012 National Defense Authorization Act—assured energy access, reliable supplies, and sufficient energy to meet mission essential requirements. The remaining challenges for decisionmakers include measuring these terms, defining and ranking mission essential requirements, and making tradeoffs among costs and capabilities. Each of these can and should be undertaken for each installation, but a broader, DoD-wide capabilities assessment could inform decisionmakers on maintaining overall capabilities during the loss of energy services.

DoD has divided the department's capabilities into functional categories (JCAs) to enable capabilities-based planning for warfighting needs. These Joint Capability Areas are Force Support, Battlespace Awareness, Force Application, Logistics, Command and Control, Net-Centric, Protection, Building Partnerships, and Corporate Management and Support. Although the current Joint Capability Areas are clearly written to codify many capabilities required for homeland defense, their applicability

in supporting homeland security functions in response to a natural disaster or terrorist attack is less clear. Portions of the existing JCAs do have language about providing essential services and protecting assets throughout disasters, but DoD would potentially need to refine the JCAs to further emphasize capabilities required for civil support. Yet, existing Joint Capability Areas can be used to demonstrate capabilities-based metrics for installation energy security analyses. The nature and extent of additional DoD capabilities required for civil support that are enabled by installation energy could be defined during a fully developed analysis.

To demonstrate an assessment of DoD capabilities, we use Joint Capability Areas to form the foundations of metrics to evaluate installation energy security decisions. In essence, we ask if existing or proposed installation energy security strategies enhance DoD capabilities, and we evaluate strategy cost-effectiveness. To define the capabilities used for an energy security analysis to be the most relevant for decisionmakers, we propose top-level, plain English functions across each Joint Capability Area. We define these functions to be the provision of training, information, materiel, care, and security. To assess effectiveness across each function under various energy security strategies, several analytic measures of effectiveness would underlie the evaluation of each function.

DoD Could Construct a Broad Scenario Space to Evaluate Energy Security Strategies

In planning, it is essential to consider a broad range of future challenges—what is often referred to as a broad "scenario space," with the word *scenario* referring not just to a generic category, such as a natural disaster, but to a specific example with all of the details that fully define it. An infinite number of such scenarios exist, so—after thinking about the broad scenario space—planners need a smaller set of test cases with which to work. These tests can only be illustrative but should be chosen analytically to stress the options under consideration in all the important dimensions. The resulting set of test cases has been called a "spanning set" to suggest that an option that does well in all of the test cases should be able to do well in a real world case, even though that would most likely be different from any of the test cases.

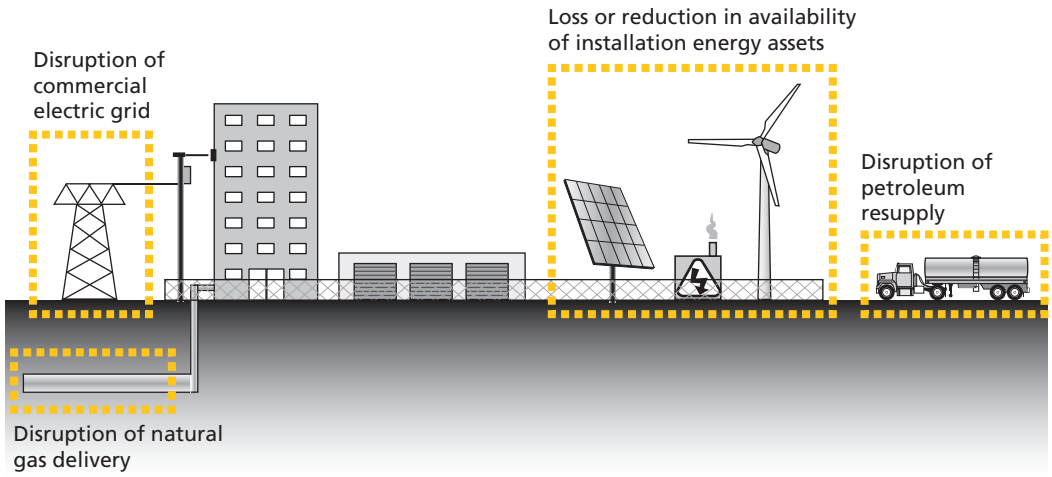
A starting point for developing a spanning set of test cases for evaluating energy security is defining the phenomena that lead to energy disruptions. Installations predominately derive energy services through use of energy commodities produced by others externally and delivered to the installation via public infrastructure. These include the commercial electricity fuels extraction, transportation, production, transmission, and distribution systems; the commercial natural gas extraction, processing, storage, transmission, and distribution systems; and the global and national markets for crude oil extraction, transportation, refining, storage, and distribution systems.

Each node across these supply chains represents an opportunity for accidental or intentional disruption, which could potentially affect an installation's ability to receive these commodities as expected. Additionally, installation-distributed generating assets themselves, as well as their enabling infrastructure, remain vulnerable to disruption. This characterization defines a spanning set of test cases, illustrated in Figure S.1, that includes four classes of disruptions: (1) a loss or reduction of electricity from the commercial grid, (2) a loss or reduction of natural gas from the commercial distribution system, (3) a disruption of petroleum resupply to an installation, and (4) the loss or availability reduction of energy assets within an installation. The four classes should be analytically expanded into test cases along the dimensions of complexity, scale, disruption time, preparedness, and response resources. Using a common framework and systems approach, DoD can link and evaluate how energy security tasks and strategies affect DoD-wide Joint Capability Areas during a loss of installation energy services across the test cases constructed.

Using Capabilities-Based Planning to Inform Decisionmaking About Installation Energy Security

The examples described in this report demonstrate how capabilities-based planning could be used to inform choices about the adoption of technologies and practices to

Figure S.1
Four Spanning Test Cases Illustrating Pathways for Installation Energy Services Disruption



NOTE: Illustrative and not to scale.

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enhance energy security. In doing so, the report demonstrates the steps involved in this analysis and the types of data that are needed.

DoD can use a diverse set of technologies and strategies to enhance installation energy security. This large set might include locally generated renewable energy, implementation of emergency load management plans, purchasing energy storage assets, and many other choices. Using the language of previous RAND work on capabilities-based planning, we call each of the technologies and strategies for energy security a "building block." We characterize the sample building blocks into three groups: (1) efficiency, operations, and information investments; (2) energy generation, distribution, and control capital equipment; and (3) fuels, energy storage, and enabling equipment capital purchases. The performance of each building block would depend on assumptions about local resources and the technical and economic characteristics of each building block as well as the presence and synergies of other building blocks (e.g., microgrid availability and renewable electricity). After screening the landscape of building block combinations, several composite options could be chosen for analysis, each made up of a set of energy security building blocks. An analyst generating composite options with energy assets and strategies would necessarily need to incorporate the uncertainty of current and future costs and performance for each building block to fully represent the range of possibilities involved with each composite option. Energy security portfolios should be evaluated in terms of performance and effectiveness in maintaining the provision of training, information, materiel, care, and security over the test cases and their dimensions. This allows performance of energy security strategies to be evaluated *across* test cases, such as the loss of electricity and natural gas. Developing an analytical hierarchy of measures of effectiveness across test cases and dimensions allows decisionmakers to drill down and understand the drivers for shortfalls. These shortfalls could result from technical, economic, resource availability, or other reasons. DoD decisionmakers can then use the sensitivity analysis ranges established in the estimates to understand how underlying variables, such as technology cost and performance improvements, can affect outcomes.

For many applications, the thresholds revealed by these sensitivity analyses could inform technology cost and performance targets and decisionmaking across the DoD research, development, test, and evaluation (RDT&E) enterprise. For example, an estimated cost target for energy storage on a per-kilowatt-hour of energy basis that would enable greater cost-effectiveness of maintaining DoD capabilities could emerge from a capabilities-based portfolio analysis and inform RDT&E portfolio managers. Thus, broader opportunities can be identified with a capabilities-based analysis. Finally, these analyses can help researchers identify surplus capabilities, such as multiple, oversized diesel generators not integrated into microgrids. DoD could consider reducing the identified surpluses in one capability area to save resources for capability enhancements in other areas.

Over a range of decisionmaker perspectives, the use of cost-effectiveness landscapes generated from capabilities-based portfolio analyses can assist DoD in making choices about installation energy security strategies, both on individual installations and across the DoD's portfolio. The process is analytically intensive, yet it can reveal weaknesses and vulnerabilities in existing and proposed strategies to maintain installation energy services. By defining and evaluating a data-driven portfolio approach and incorporating the associated uncertainties, the DoD can better prepare for unexpected energy disruptions at installations that affect both homeland defense and homeland security.