# Energy Resilience Challenge

*Harnessing Microgrid Technologies for Disaster and Conflict Recovery*

## 1. Challenge topic

The Energy Resilience Challenge seeks advanced technology solutions that can provide rapid and sustained power to critical facilities in the aftermath of a natural disaster or during a crisis, including conflict. Solutions must be rapidly deployable, modular, interoperable, adaptable, affordable, and resilient in changing environments; and they must operate independently of pre-existing external power sources. **DIANA seeks to foster technological advances in micro-grid systems capable of scaling, including efficient renewable power generation; power storage; hardware and software for adaptive and intelligent power conditioning and management; and technologies that detect and protect the system and components from cyber-attack**.

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## 2. Background

Reliable, high-quality, and secure power is fundamental to the functioning of civilian communities during crisis events. As climate-change-influenced natural disasters and conflict become more frequent and severe, efficient means to re-establish power to hospitals or power emergency shelters and camps in the aftermath become critical. For such uses, self-contained power systems, such as micro-grids, that are quickly installed and maintained by a small team and operated independently of existing, compromised or threatened infrastructure would be highly valuable.

National defence organisations operate in a variety of ways, including the use of mobile units and Forward Operating Bases (FOBs). These mobile bases share common characteristics and requirements with emergency humanitarian teams and organisations helping to restore and establish vital civilian services. FOBs can vary in size, providing a secure area for critical activities, including those that require steady high-quality power that must be easily reconfigured to meet changing power demand priorities: command and control, communications, and medical facilities. Like humanitarian solutions, an FOB's power supply must be able to operate independently, be adaptive to changing threat environments, be both affordable and rugged, and include the ability to be installed and maintained by a small number of personnel. Existing solutions for defence also lack reliability or compatibility with components from other similar modular systems.

## 3. Technology Challenges

DIANA is seeking disruptive capabilities in the following areas:

### 3.1 *Adaptive, efficient, secure power control technologies that autonomously adjust/ reconfigure to provide continuous power at relevant scale:*

1. Power control systems able to characterise emergent surge requirements and faults, damage, and loss of capability, and responsively ensure electricity demands are met. This may include configurations that incorporate redundant power storage, sharing, and distribution components to ensure top-priority equipment requirements are met first;
2. Power control systems capable of managing a modular ensemble of power generation units responsive to predictable distributions of surge requirements and operational needs. Here the emphasis is on sustainability and optimisation for efficiency and includes both management of power distribution and of charging energy-storage devices;
3. Complex systems for which multiple hardware components are interlinked and reliant upon each other within a common control system offer multiple entry points for cyber-attack. As part of the power systems described here, we seek novel solutions for cyber-physical protection that deter, detect, and mitigate compromise of the individual and collective hardware components and their operation.

**3.2** ***Components and systems that are inherently reliable, rugged, modular, scalable, and reconfigurable:***

Here we consider equipment for primary power generation and microgrid components for power storage and distribution:

1. Power generators based on locally available and or sustainable sources e.g. solar, wind, tidal, hydrogen. Fuel cells and accompanying hydrogen storage technologies may be appropriate. It is critical that systems have form factors that facilitate mobility and rapid assembly and configuration, designed to work independently or in parallel with other units. Systems should be rugged and require minimal maintenance. Flexible solar cells that can be carried and quickly assembled by one or two persons would be one example. Tidal power generators that are of size and weight to allow for simple placement may also be considered for coastal areas or river basins. Lightweight wind generators (such as those found on sailboats and rooftops) are another example;
2. The application of advanced designs or novel materials for high-energy-density power storage and passive electronics for switches and control hardware are of interest. Recently developed polymer-based capacitors with high dielectric strengths and graceful failure for power storage units may be considered here. Advanced, safe and damage-tolerant high- energy-density batteries and their reliable life prediction and self-monitoring are encouraged. Hybrid systems that combine capacitors and batteries may offer more efficient charging schemes and will also be considered here.

**4. Deliverables (6 months for phase one, with potential for an additional second phase of 6 months)**

The challenge programme will be split across two phases of six months, with progress to the second phase being accessed via tangible and demonstrable progress in the first. Deliverables should, therefore, show considerable progress and clear development potential at the end of phase one, with phase two outputs providing sufficient demonstration of capability to attract further, onward, scale-up and development investment from entities other than DIANA.

We are looking for proposals that:

- Clearly address the problem to be solved by the proposed technology;
- Demonstrate the specific performance or characteristic that is disruptive;
- Deliver a modular system capable of scaling;
- Offer reliable, easy to maintain, robust and cost-effective solutions;
- Enable the uptake of locally available renewable energy sources;
- Allow for compatibility and interoperability with other similar technologies;
- Protect critical assets from disruption of power due to cyber-attack;
- Describe the technology developments and timeline needed to deliver the innovation;
- Make effective use of the funding available to progress the technology proposed; and
- Describe civilian or commercial applications and the defence benefits, where known.

By the end of the programme, the capability must contribute – plausibly and significantly – to the advancement of a solution and should be characterised by genuine innovation in the market. Existing commercial, off-the-shelf technologies will not be considered unless a novel modification is proposed.