Defence and Security Accelerator

DASA INNOVATION FOR A SAFER FUTURE

Delivering operational advantage via improved self-sufficiency and operational energy innovation - Full Challenge Details

This document outlines the full details of the challenges for the competition and should be read in conjunction with the competition document.

All Challenges

For all challenges please tell us the following about your innovation:

- which, if any, additional challenge areas are impacted by your innovation and how (detailing the benefits and disadvantages)
- any current challenges to the development / maturation of your innovation
- what level of modular flexibility it provides
- indicative volume and mass of the innovation
- how the innovation is transported
- the environmental conditions within which the technology is effective, including supporting evidence (testing regimes etc.)
- expected maintenance regime and the factors that affect it
- the level of knowledge required to operate and maintain it
- how it influences demand within the supply chain
- how it demonstrates cost benefit compared with traditional alternatives; you should understand the state of the art of your technology area and be able to articulate its cost benefits
- how it provides a step change in performance
- whether it is subject to any legislative requirements, and if so provide details

Challenge 1: FOOD - Feeding the Winning Edge

Improvements sought
For the purposes of this challenge, the solution should be scalable[1], reduce the logistic demand and / or provide solutions that can improve self-sufficiency and the agility of a deployed force. Proposals should demonstrate aspects of the following: • food solutions that can be utilised in the deployed space, reducing the logistic demand • food solutions that can be transported as feedstock and constituted into rations at point of consumption • packaging that can be reduced, reused and / or re-purposed, without compromising hygiene, longevity or quality of food, and without disproportionally increasing logistic demand on the reverse supply chain • reduced weight and bulk of operational ration pack[2] (ORP) and other food stocks, in order to decrease logistic burden on the person and the wider support chain, without affecting the nutritional value[2] or disproportionally affecting consumer experience / taste and quality • increased product longevity and/or innovative food cultivation, preparation and storage to enable self-sufficiency of a deployed force • solutions to minimise discards (items rejected by the individual that are classed as waste) from current feeding options, without affecting the nutritional value • Scalability, Modularity and Interoperability are desirable attributes of any innovation
Please tell us
• What energy / water / materiel / waste input is required for this capability and how this relates to the output commodity, i.e. kw/kg or litres/kg output of the proposed solution • Please refer to the All Challenges section for additional information we need you to tell us
We are not looking for

• Optimisation of human performance through nutrition
  • nutritional content
  • nutritional mix
• aquaponics
• intelligent monitoring systems
• AI and/or machine learning solutions
• solutions that compromise the nutritional value

Examples of potential solutions
<u>Example 1a:</u> Provide scalable (small scale through to large scale) fresh produce at or close to point of need, such as vertical farming solutions, to increase the self-sufficiency of a deployed force. **<u>Example 1b:</u>** 3D printing of analogous food to reduce logistical burden but remain appetising; supporting both physical and mental wellbeing.

1
Small Scale: 12 person mobile team for a period of 7- 30 days.
Medium scale: Up to 2750 personnel at a static location for a period of 30 plus days
Large Scale: Over circa 2750 personnel at a static location for over 30 days. <Return>

2 Current ORP metric is 4000 Kcals with a mass of 1.8 Kg per person per day. 7 days of ORP for 12 personnel weights a total of 151.2kg <Return>

Challenge 2: WATER - Harvest and Recycle Water with Increasing Efficiency

Improvements sought
For the purposes of this challenge, the solution should be scalable[3], reduce the logistic demand and / or provide solutions that can improve self-sufficiency and agility of a deployed force. Proposals should demonstrate aspects of the following: • new technologies that include solutions without reliance on a direct water source to enable the proposed technology • capture and recycle operational waste water (including but not limited to sewage, black, grey and rain water) into potable[4] / non-potable water • whilst deployed, process locally available water into potable / non-potable water, using less energy than existing ground source water techniques • future capability would ideally be modular and scalable to be able to produce/treat sufficient water at the different distributed nodes/locations within the deployed space • innovative water extraction and/or recycling methods • innovative short term storage methods
Please tell us
• the absolute energy cost per litre of water produced, i.e. measure of kW/litre • the processing time per litre of produced water, i.e. how long it takes to go from raw to potable per litre • what post processing is required, i.e. remineralisation • what volume of post processing additives is required, per litre • what the storage considerations are; is chlorination required for medium- to long-term storage (standard consideration for potable water supplies) • please refer to the All Challenges section for additional information we need you to tell us
We are not looking for
• improved filtration membranes • water sterilisation systems (unless a secondary element of another technology solution for water or any other challenge) • contamination sensing • improvements to existing infrastructure
Examples of potential solutions
<u>Example 2a:</u> Harvesting water from the environment through novel technologies to meet the deployable water demand (as shown in the competition document). Solutions should be scalable/modular. **<u>Example 2b:</u>** Solutions that reuse and recycle water that would currently not be viable[5] or otherwise require specialist disposal.

3
Small Scale: 12 person mobile team for a period of 7- 30 days.
Medium scale: Up to 2750 personnel at a static location for a period of 30 plus days
Large Scale: Over circa 2750 personnel at a static location for over 30 days. <Return>

4 Potable water is defined as water that is suitable for human consumption (i.e., water that can be used for drinking or cooking). <Return>

5 Not viable in deployed environment; not technically possible; not cost effective; too labour intensive; takes too long to make water; requires too much real estate (that needs protecting and/or doesn't meet UK standards. <Return>

Challenge 3: Materiel - Reducing the Support Chain burden

Improvements sought
For the purposes of this challenge, the solution should be scalable[6], reduce the logistic demand and/or provide solutions that can improve self-sufficiency and agility of a deployed force. Proposals should demonstrate aspects of the following: • reduce the logistic demand and / or provide solutions to improve self-sufficiency and agility of a deployed force for Classes of Supply[7] II to IV inclusive (subject to exclusions listed in 'We are not looking for', below) • solutions that are modular by design, scalable to changing requirements • potential for increased interoperability with partners and allies • reduced volume and mass to be distributed across the support chain • enhanced equipment / platform availability – staying in the fight for longer • materiel packaging that can be recycled, reused or repurposed; this is further articulated in Challenge 4: Waste. • reduce the traditional volume and mass to be distributed
Please tell us
Please refer to the All Challenges section for information we need you to tell us
We are not looking for
• Class I items (covered by challenges 4 and 5) • weapons, clothing, vehicles (Class II) • aviation fuel (Class IIIa) • storage solutions, e.g. warehouse optimisation (Class IV) • Class V items (not covered in this competition) • robotic Autonomous Systems (RAS) for logistic distribution, i.e. uncrewed vehicles • AI and/or ML enabled capabilities • procurement solutions • optimisation of supply networks • management and configuration solutions of the supply chain • assurance and distribution of supplies solutions • additive manufacturing that does not represent a significant step change i.e. being able to manufacture on the move, from a non-static base, on current available options • enabling logistics support services • health and safety optimisation • morale optimization
Examples of potential solutions
Example 3a: Bio-degradable packaging reducing the reverse supply chain burden and potentially becoming feedstock for other technologies. **Example 3b:** Innovative deployable additive manufacturing solutions that can be operated 'on the move' to produce the relevant materiel at the point of need **Example 3c:** Infrastructure support: Lighter weight, modular deployable infrastructure, which would allow for infrastructure to be tailored to changing demand, increasing agility and reducing logistics burden. For instance, novel additive manufacturing solutions for defence stores and infrastructure

---

6
Small Scale: 12 person mobile team for a period of 7- 30 days.
Medium scale: Up to 2750 personnel at a static location for a period of 30 plus days
Large Scale: Over circa 2750 personnel at a static location for over 30 days. <Return>

7
Class I - Items of subsistence, e.g. food and forage, which are consumed by personnel or animals at an approximately uniform rate, irrespective of local changes in combat or terrain conditions.
Class II - Supplies for which allowances are established by tables of organization and equipment, e.g. clothing, weapons, tools, spare parts, vehicles.
Class III - Petroleum, oil and lubricants (POL) for all purposes, except for operating aircraft or for use in weapons such as flamethrowers, e.g. gasoline, fuel oil, greases, coal and coke. (**Class IIIa** - aviation fuel and lubricants)
Class IV - Supplies for which initial issue allowances are not prescribed by approved issue tables. Normally includes fortification and construction materials, as well as additional quantities of items identical to those authorized for initial issue (Class II) such as additional vehicles.
Class V - Ammunition, explosives and chemical agents of all types. <Return>

Challenge 4: Waste - trash into treasure

Improvements sought
For the purposes of this challenge, solutions are sought for waste items from NATO's Classes of Supply[8] I to IV. The solution should be scalable[9] reduce the logistic demand and / or provide waste and / or circular economy solutions (recycle, regenerate, repurpose and reuse) to improve the self-sufficiency and agility of a deployed force. Proposals should demonstrate aspects of the following: • ability to recycle, regenerate, repurpose and / or re-use biological and organic waste into a needed resource, across Classes of Supply I and III including Energy • demonstrate the ability to recycle and / or re-purpose non-organic waste into a needed resource; e.g, energy, materiel (clothing, weapons, tools, parts, vehicles) food and / or water • innovative solutions for packaging which can be re-purposed into a feedstock for a separate capability • reduction of current waste by volume or mass and / or capability to recycle, reuse and / or repurpose to produce either food, water, fuel, energy and / or enhance self-sufficiency of a deployed force • the ability to enhance the circular economy, reduce waste, scalability, modularity and interoperability of a deployed force are desirable attributes of any innovation provided
Please tell us
• what the unit/commodity output is per kg of waste product processed, including the minimum waste input requirement for this solution to be viable and scalable and the logistic consequences of introducing the solutions • how much waste this approach / concept removes from the reverse supply chain or from disposal within the local economy / area • Please refer to the All Challenges section for additional information we need you to tell us
We are not looking for
• solutions for waste electrical and electronic equipment • solutions for vehicle and oily wastes • solutions for infectious or hazardous medical waste • solutions for construction and demolition waste • recycling plastics - Defence is moving away from single use plastic Please see this link for further details on the classification of waste
Examples of potential solutions
Example 4a: Taking food and/or human waste and turning it into fuel, water and/or feedstock for other technologies, thereby enhancing self-sufficiency, reducing the amount of waste in the reverse logistics chain, supporting fuel efficiencies and valorising waste products. **Example 4b:** Waste disposal that removes or reduces the need to carry waste with you, reduces mass or provides means of secure disposal **Example 4c:** A combined system, which autonomously takes the waste from one technology and feeds it into another as feedstock e.g. valorisation of bio-waste to produce energy for powering another technology, or harvesting waste to produce water, which is distilled to a drinking (potable) water vessel. Both of these will benefit from a reduction in waste storage. **Example 4d:** A vertical farm housed in an iso-container producing fresh food and generating grey water and green waste, which are converted into potable water and/or recycled as grey water and fertiliser to feed the vertical farming iso-container.

8
Class I - Items of subsistence, e.g. food and forage, which are consumed by personnel or animals at an approximately uniform rate, irrespective of local changes in combat or terrain conditions.
Class II - Supplies for which allowances are established by tables of organization and equipment, e.g. clothing, weapons, tools, spare parts, vehicles.
Class III - Petroleum, oil and lubricants (POL) for all purposes, except for operating aircraft or for use in weapons such as flamethrowers, e.g. gasoline, fuel oil, greases, coal and coke. (**Class IIIa** - aviation fuel and lubricants)
Class IV - Supplies for which initial issue allowances are not prescribed by approved issue tables. Normally includes fortification and construction materials, as well as additional quantities of items identical to those authorized for initial issue (Class II) such as additional vehicles.
Class V - Ammunition, explosives and chemical agents of all types. <Return>

9
Small Scale: 12 person mobile team for a period of 7- 30 days.
Medium scale: 500 - 2750 personnel at a static location for a period of 30 plus days
Large Scale: Over circa 2750 personnel at a static location for over 30 days. <Return>

Challenge 5: Platform Power & Energy – Enduring energy

Improvements sought

For the purposes of this challenge, the solution should be scalable[10], reduce the logistic demand and/or provide solutions that can improve operational energy and agility of a deployed force. Proposals should demonstrate as pects of the following:
 	
• a step change in gravimetric and volumetric energy density of platform power systems across all domains from the dismounted soldier to land platforms, maritime platforms and air platforms. This could include crewed and uncrewed platforms. Of particular interest is:
  • increased energy density of soldier worn power sources
  • increased endurance of electrically powered uncrewed systems
• safe operation of high energy lithium batteries in a kinetic military environment as well as under civilian / climatic stresses and strains
• novel ways of utilising liquid fuel more efficiently or on smaller platforms / soldiers
• increased temperature operating window of high energy batteries. A challenging target would be - 40°C to +70°C but any significant improvement from current capability[11] is of interest.
• a step change in the energy density of primary thermal reserve batteries for missile and counter measures
• a step change in the energy density of high energy primary lithium batteries beyond that afforded by lithium thionyl chloride batteries.

We are not looking for
• Nuclear systems • Energy reduction technologies (see challenge 7) • Renewable energy technologies (see challenge 7) • Commercial Off The Shelf (COTS) batteries • Older / established secondary battery chemistries (e.g. Lead acid, Nickel Cadmium, Nickel Metal Hydride) • Older / established primary battery chemistries (e.g. zinc manganese dioxide, lithium sulfur dioxide, lithium thionyl chloride, lithium manganese dioxide) • Flow batteries • Lithium ion batteries that do not offer a step change in energy or defence usability (e.g. safety, temperature window etc.) • Combustion engine technologies • Electrostatic Capacitors • Low energy density fuels
Please tell us
Please refer to the All Challenges section for information we need you to tell us
Examples of potential solutions
Example 5a: Dismounted soldier energy This could include but is not limited to improving the energy provision to a dismounted soldier. It is noted that the average discharge rate for soldier power sources is variable depending on mission and equipment used but relatively modest, perhaps equivalent to a four hour (C/4) or slower discharge with higher unquantified peaks throughout the mission. Therefore energy is more important than power. Improvement could be enabled by: • Providing technology that enables a step change in lightweight wearable / portable battery energy • Providing a technology that enables the safe use of high energy batteries when subject to extreme abuse e.g. bullet strike, shock • Enables lighter, higher energy or power power provision than current and emerging batteries, perhaps by directly utilising current and future logistic liquid fuels in a soldier portable electricity generator.

10
Small Scale: 12 person mobile team for a period of 7- 30 days.
Medium scale: Up to 2750 personnel at a static location for a period of 30 plus days
Large Scale: Over circa 2750 personnel at a static location for over 30 days. <Return>

11 Current state of the art of approximately 250 to 300 Wh/kg for advanced Li-ion but in reality it is a balance between the specific energy at, roughly, 300 Wh/kg and many other factors.
<Return>

Example 5b - Improved uncrewed platform energy

Uncrewed aerial, ground and maritime vehicles need a source of motive power. There is a need for blended power sources that can provide a balance between power and energy (noting that one is usually optimised at the expense of the other). Power demand is variable but discharge rates of 1C to 8C (i.e. 60 to 7.5 min discharges) are typical. Improvement could be enabled by:

- Providing technology that enables a step change in lightweight battery energy blended with modest power capability
- Alternative electrical power generators that offer a better blend of energy and power than current and near term emerging batteries
- Enablers of alternative electrical power generators e.g. compact, efficient alternative fuel generators

Example 5c - Improved missile and countermeasure energy sources

Missiles and countermeasures have very specific energy requirements, typically met by thermal reserve batteries. Such batteries have a very long storage life with no self-discharge (~20 years); very quick activation; and high power and energy density. However, as missile capability improves there is an increased demand for power and energy within the same size and weight constraints.

Improvement could be enabled by:

- A reserve battery technology with improved (ideally double) energy density (In excess of 200Wh/kg for a nominal 14.4V battery).
- A reserve battery technology with improved (ideally double) power density.
- A reserve battery technology with a blend of improved power and energy density.
- Alternative technologies that can meet and improve on all the metrics of a thermal reserve battery.

Challenge 6: ENERGY – Platform Thermal Management - Keeping Cool for Persistent Power

Improvements sought

For the purposes of this challenge, the solution should reduce the logistic demand and / or provide solutions that can improve self-sufficiency and agility of a deployed force. Proposals should demonstrate aspects of the following:

- a step change in performance (e.g. flow rates), thermal capacity or power / energy density of defence cooling systems.
- more effective removal, transfer, converted or re-used thermal energy (losses) from current and future defence systems
- alternatives that can be used across multiple domains and platform applications
- approaches that reduce (or at least do not increase) risks around materials and environmental constraints on working fluids

Please tell us

Please refer to the All Challenges section for information we need you to tell us

We are not looking for

- solutions that offer only limited or incremental enhancements in response to thermal management challenges
- thermal management solutions specific to a single platform only
- human cooling systems
- building / tent cooling systems
- building / tent insulation systems
- standard heat exchangers
- single platform specific engineering solutions
- software

Examples of potential solutions

Example 6a - Thermal management to enable high power sensors and effectors

The integration of advanced sensor, electronic warfare and directed energy weapon systems onto future platforms will likely increase the magnitude, and decrease the response time, of cooling required. This will require novel thermal management approaches to minimise the impact on the overall size, weight and power of the thermal management system and hence platform integration. Improvement could be enabled by:

- Novel thermal storage concepts and technologies.
- Improved heat rejection concepts and technologies that result in increased heat sink capacity.
- Increased power/energy density (both gravimetric and volumetric) systems.

Example 6b - Increased efficiency systems

Platform thermal management challenges can be addressed through more efficient use of energy.
Examples of this include:

- Significantly more efficient components that reduce the amount of heat generated – examples of this include low power electronic components enabled through advanced materials, frictionless bearings, etc.
- More efficient thermal transfer or transport technologies that can reduce size, weight and power – examples include more lightweight and compact heat exchangers or other novel approaches such as loop heat pipes
- Heat recovery technologies that can utilise waste heat energy that would otherwise be lost – examples include thermo-electric generators.

Challenge 7: ENERGY – Deployable Power & Energy

Improvements sought
For the purposes of this challenge, the solution should be scalable[12], reduce the logistic demand and / or provide solutions which can improve self-sufficiency and agility of a deployed force. Proposals should demonstrate aspects of the following: • solutions that provide energy savings at deployed static and mobile locations, which also provide: • development and adaptation of energy generation technologies, including renewable technology innovatively applied to the defence environment, which can enhance operational effectiveness, as depicted the main competition document • solutions suitably designed for robust transportation, handling and usage for the distribution of electrical energy throughout the deployed space. •
Please tell us
Please refer to the All Challenges section for information we need you to tell us
What we are not looking for
• fixed base solutions • technologies that will significantly increase logistic burden elsewhere • microgrid network technologies • COTS renewables e.g. COTS solar and wind • low energy lighting e.g. LED
Examples of potential solutions
Example 7a - Improved electrical energy logistics Currently energy is moved around the battlefield by using liquid hydrocarbon fuels. The future battlefield[13] is expected to use greater amounts of electrical energy. Defence experimentation with Commercial Off The Shelf (COTS) power banks shows the ability to move electrical energy around the battlefield will become increasingly important. Solutions could provide improvement by: • Safer operation of equipment being used today • Capable of being used in extreme environments • Is designed for robust transportation, handling and usage • Can be carried by one person Electrical energy storage is in a common form factor with the ability to stack and manage both DC and AC electrical provision in an efficient manner **Example 7b - Harvesting energy from the environment** Harnessing the energy from a range of environments, e.g. hydroelectricity, novel solar, energy from the soil, could reduce the logistic challenges of power generation and energy distribution. However, simple demonstrations of COTS renewable technology, such as commercial solar panels and wind turbines, is not desired. The solution should generate an appreciable level of power and energy verses the volumetrics and mass of the equipment producing the energy. There is no simple metric for this but power levels approaching and exceeding kilowatts would be desirable. The smallest generator MOD currently fields is the 2 kW Lightweight Field Generator (LFG). **Example 7c - Reducing Deployed Static location energy requirements** Energy is used in deployed static, locations for a range of applications from heating, lighting, cooking, cooling and computing to unique military capabilities. Technologies that are scalable (up and down) that reduce energy demand may offer as much advantage as novel ways of generating energy. Examples may include ways to significantly reduce or smooth demand or ways of coupling waste energy, e.g. turning waste heat back into power.

12
Small Scale: 12 person mobile team for a period of 7- 30 days.
Medium scale: Up to 2750 personnel at a static location for a period of 30 plus days
Large Scale: Over circa 2750 personnel at a static location for over 30 days. <Return>

13 https://www.army.mod.uk/media/17010/british-army-approach-to-battlefield-electrification.pdf <Return>