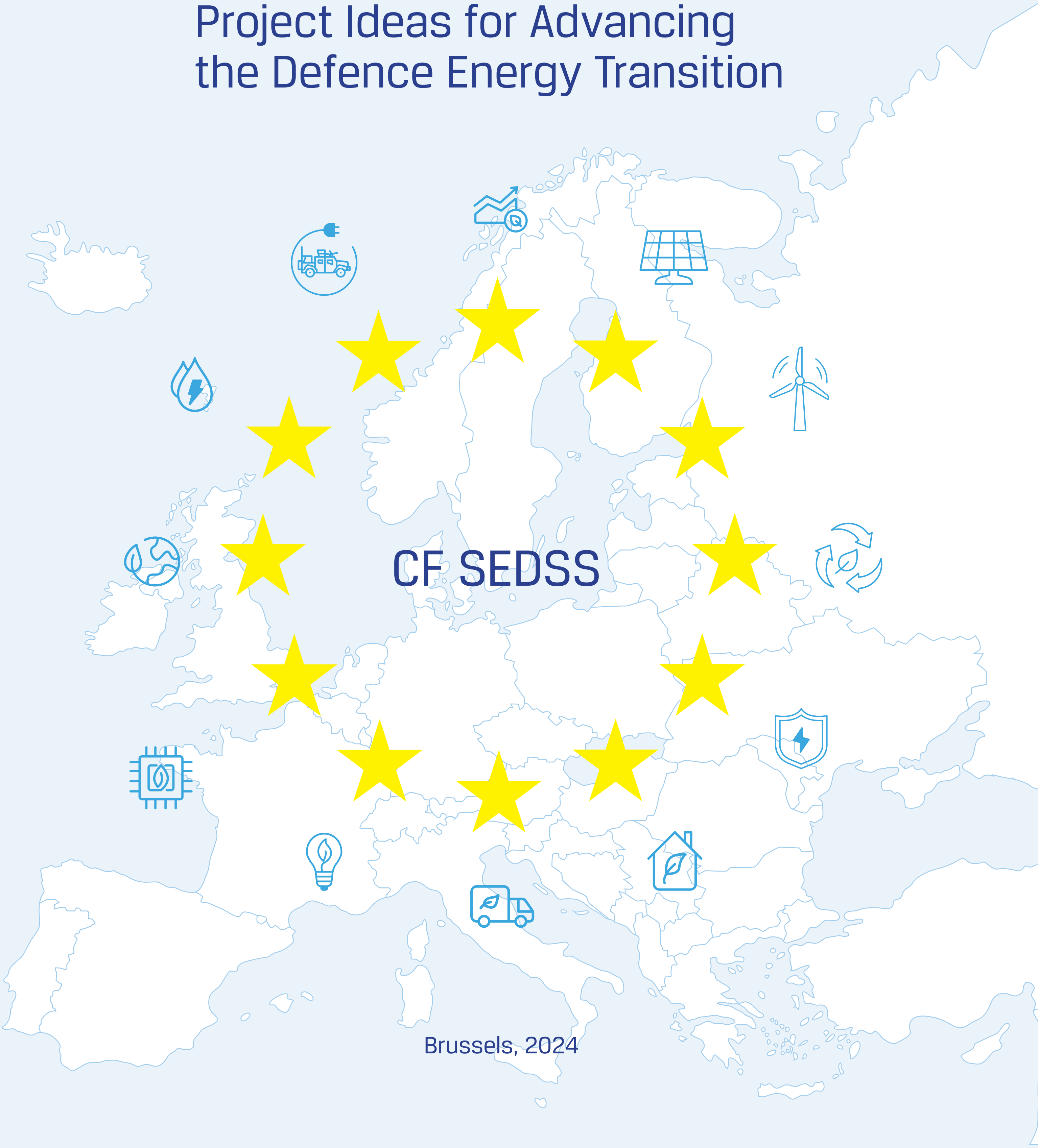
EUROPEAN DEFENCE AGENCY

European Defence Energy Network

CF SEDSS III
Consultation Forum for Sustainable Energy in the Defence and Security Sector

30 CF SEDSS Transformative Project Ideas for Advancing the Defence Energy Transition



CF SEDSS

Brussels, 2024

30 CF SEDSS Transformative Project Ideas for Advancing the Defence Energy Transition

September 2024

Editors:
Constantinos Hadjisavvas
Maja Kuzel
Alessandra Lazzari

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 882171

Consultation Forum for Sustainable Energy in the Defence and Security Sector - Phase III (CF SEDSS III)

30 CF SEDSS Transformative Project Ideas for Advancing the Defence Energy Transition

Acknowledgements

This booklet presents innovative defence energy-related project ideas conceptualised and developed by the working groups during the third phase of the Consultation Forum for Sustainable Energy in the Defence and Security Sector (CF SEDSS). The CF SEDSS management team thanks all Forum members for their unwavering engagement, insightful feedback, and significant contributions. We believe this booklet will serve as an essential resource for the ministries of defence, driving impactful energy solutions and fostering sustainable progress in the defence sector.

Disclaimer

Contents

1. Introduction

The defence sector is at a pivotal moment in its evolution, facing unprecedented challenges and opportunities in energy management and sustainability. As global energy demands intensify and geopolitical and environmental concerns become more pressing, the need for innovative energy solutions within defence is more critical than ever. This booklet presents 30 forward-thinking project ideas developed during Phase III (2019-2024) of the Consultation Forum for Sustainable Energy in Defence and Security Systems (CF SEDSS) – Europe's largest defence energy community. These projects, carefully conceptualised and developed within the Forum's four specialised working groups, highlight dual-use synergies between the defence and civilian markets, supporting the transition towards sustainable energy practices in the defence sector.

The Consultation Forum has proved to be an ideal platform for the European ministries of defence (MoDs) and relevant stakeholders to share information and best practices on improving energy efficiency and building performance, utilising renewable energy sources in the defence sector, and increasing the resilience of defence-related critical energy infrastructure. The Forum also addresses cross-cutting thematic areas such as energy management and policy, energy-innovative technologies, and identifies applicable funding or financing instruments for defence energy-related topics. By leveraging innovative perspectives and best practices, the Forum facilitates the generation of defence energy-related project ideas, leading to collaborative projects among Member States.

These 30 defence energy-related project ideas aim to enhance energy efficiency, integrate renewable energy sources, protect critical energy infrastructure, and develop comprehensive transversal strategies for energy management. This introduction provides an overview of the key areas addressed by the working groups and the potential impact of the proposed projects. In Phase IV (2024-2028), the working groups will assess these projects' continued relevance and interest to their MoDs and explore options for forming multinational collaborations and projects to implement them.

2. CF SEDSS Working Groups

2.1 CF SEDSS Working Group 1 "Energy Efficiency and Buildings Performance"

The first working group focuses on improving the operational energy efficiency of military building stock and fixed infrastructure. The group identified the opportunities that derive from the application of the amended Energy Efficiency Directive (EED), the amended Energy Performance in Buildings Directive (EPBD) and, whenever relevant, the Regulation on the Governance of the Energy Union and Climate Action. In this context, it explored sources and relevant technologies to:

- Reduce energy dependence and carbon footprint;
- Reach the highest energy efficiency without compromising operational effectiveness;
- Lower total energy costs while minimising environmental impact; and,
- Contribute to European and national energy security.

Projects like "Driving Sustainable Energy Through Military Behaviour Change" and "Big Data for Buildings" aim to transform how energy is consumed and managed in military installations. By promoting behavioural change and leveraging advanced data analytics, these initiatives seek to reduce greenhouse gas emissions and improve overall energy efficiency significantly. Additionally, projects such as "Defence Energy Benchmarks and Indicators (DEBI)" and "RE-FASYS Defence" emphasise the importance of setting energy benchmarks and renovating existing structures to meet modern energy standards.

2.2 CF SEDSS Working Group 2 "Renewable Energy Sources"

The second working group explores integrating renewable energy sources within the defence sector. The group identified the opportunities that derive from applying the amended Renewable Energy Directive (RED) and the amended Energy Efficiency Directive (EED). It also explored sources and relevant technologies to:

- Reduce energy dependence on fossil fuels and carbon footprint;
- Reach the highest energy efficiency without compromising;
- Operational effectiveness;
- Lower total energy costs while minimising environmental impact; and
- Contribute to European and national energy security.

Projects like "Decarbonisation Challenges in Defence" and "Defence Approach to RED II Implementation" aim to align defence energy practices with broader European Union directives on renewable energy. Initiatives such as "Applications for Hydrogen in the Defence Energy Sector" and "Repository of Islanding Projects in Defence" investigate the potential of hydrogen fuel and self-sufficient energy systems to reduce carbon footprints and enhance energy resilience.

2.3 CF SEDSS Working Group 3 "Protection of Critical Energy Infrastructure"

The third working group focuses on strengthening the research on the resilience and protection of defence-related critical energy infrastructure and identifying related hybrid and asymmetrical threats. In this context, the group explored opportunities that derive from implementing EU legislation on energy security, particularly the Critical Entities Resilience (CER) Directive (ECI), the Regulation on Security of Gas Supply, and the Regulation of Risk Preparedness in the Electricity Sector.

Projects like "Defence Energy Range (DER)" and "Defence Energy Data Protection" aim to enhance the security and resilience of energy systems against cyber threats and hybrid attacks. The "Hybrid Attack Response Team (HART)" and "C(EST)2 – Critical Energy Infrastructure and Electromagnetic Spectrum Threats" projects further underline the need for specialised response teams and methodologies to counter emerging threats. Additionally, initiatives like "Sea Infrastructures Monitoring and Control (SIMC)" and "Shore Connection Energy Security (SCES)" focus on securing maritime and shore-based energy systems.

2.4 CF SEDSS Transversal Working Group

The Transversal Working Group (TWG) addresses cross-sectorial topics on energy efficiency, renewable energy sources, and the protection of critical energy infrastructure, which are relevant to the other three working groups of the Consultation Forum. By providing a platform for discussion and sharing expertise among MoDs, research and technology organisations, academia, and industry, the TWG aims to improve energy management and performance in the defence sector. Its Policy and Management Observatory supports MoDs in establishing policies, strategies, and tools for better energy management and capacity building. The Technology, Research and Innovation Hub explores best practices in smart energy technologies, including intelligent metering, blockchain, artificial intelligence, and cybersecurity. Lastly, the Financing and Funding Gateway Cell uses the EDA's "IdentiFunding for Energy in Defence" methodology to identify funding mechanisms for implementing defence energy projects and explore innovative schemes for attracting private financing.

Projects like "Defence Energy Behaviour Management System" and "Defence Energy Resilience Model" aim to foster a culture of energy-conscious behaviour and resilience within military installations. The "EU Defence Energy Scorecard" and "Joint Defence Energy Policy Toolbox" provide frameworks for benchmarking and sharing best practices among EU member states. The innovative "Virtual Multi-Energy Systems (VirMES)" project offers a holistic tool for managing multi-energy systems, ensuring efficient planning, monitoring, and control.

3. Overview of Project Ideas

1. Driving Sustainable Energy through Military Behaviour Change
2. Big Data for Buildings
3. Defence Energy Benchmarks and Indicators (DEBI)
4. Renovating Existing Facades Applying the Off-site Construction System in the Defence (RE-FASYS Defence)
5. E-Mobility in Defence
6. AI-Based New Generation Metering Devices
7. Upgrading the Smartness of Existing Buildings through Innovations for Legacy Equipment
8. Next-generation of Energy Performance Assessment and Certification
9. Challenges of Decarbonisation in the Defence Sector
10. A Defence Approach to RED II Implementation
11. H2 Technology for Heavy Military Vehicles
12. Repository of Islanding Projects in the Defence Sector
13. Role of On-Site Generation and Energy Storage in the Decarbonisation of Defence Installations
14. Heating and Cooling in Defence Installations
15. Applications for Hydrogen in the Defence Energy Sector
16. Power Purchase Agreements for Solar PV Implementation
17. Defence Energy Data Protection
18. Defence Energy Range (DER)
19. C(EST)2 – Critical Energy Infrastructure and Electromagnetic Spectrum Threats
20. Hybrid Attacks Response Team (HART)
21. Towards an Action Plan for Military Energy Resilience
22. Sea Infrastructures Monitoring and Control (SIMC)
23. Shore Connection Energy Security (SCES)
24. Situation Awareness System for Systemic Decision Support for Defence Energy Infrastructures
25. Defence Energy Behaviour Management System
26. EU Defence Energy Scorecard
27. VirMES (Virtualisation of Multi Energy Systems)
28. Defence Energy Resilience Model
29. Joint Defence Energy Policy Toolbox
30. Capture and Documentation of Successful Decarbonisation Initiatives

4. Impact and Vision

These 30 project ideas represent a concerted effort to address the defence sector's energy challenges. Promoting innovative solutions and fostering collaboration between military and civilian stakeholders aim to enhance the energy efficiency, integrate renewable energy sources, protect critical infrastructure, and develop comprehensive strategies and practices for sustainable energy management. The successful implementation of these projects will contribute to the defence sector's operational effectiveness and support broader environmental and sustainability goals, positioning the defence sector as a leader in the global energy transition.

Ultimately, making buildings more energy-efficient will contribute significantly to the EU achieving its energy and climate goals. By using energy more efficiently and thereby consuming less, the MoDs can lower their energy costs, help protect the environment, and reduce the EU's reliance on external oil and gas suppliers while becoming more resilient to energy supply disruptions. Energy security requires adequate protection of critical infrastructure, which substantially secures strategic energy autonomy within the European defence sector. The TWG's efforts to develop dual-use research and explore synergies between military and civilian infrastructure will enhance the EU MoDs' capacity to prevent and respond to disruptions, ensuring the resilience and functionality of essential services and infrastructure.

This booklet provides a comprehensive guide to these project ideas, offering detailed insights into their objectives, methodologies, and potential impacts. It is a testament to the collaborative spirit and forward-thinking approach of the CF SEDSS and a blueprint for a more sustainable and resilient defence sector. In Phase IV (2024-2028), the working groups will assess these projects' continued relevance and interest for their MoDs and explore options for forming multinational collaborations and projects to implement them, either through the European Defence Agency's mechanisms or the broader EU context.

CF SEDSS management team

European Defence Agency | European Defence Energy Network

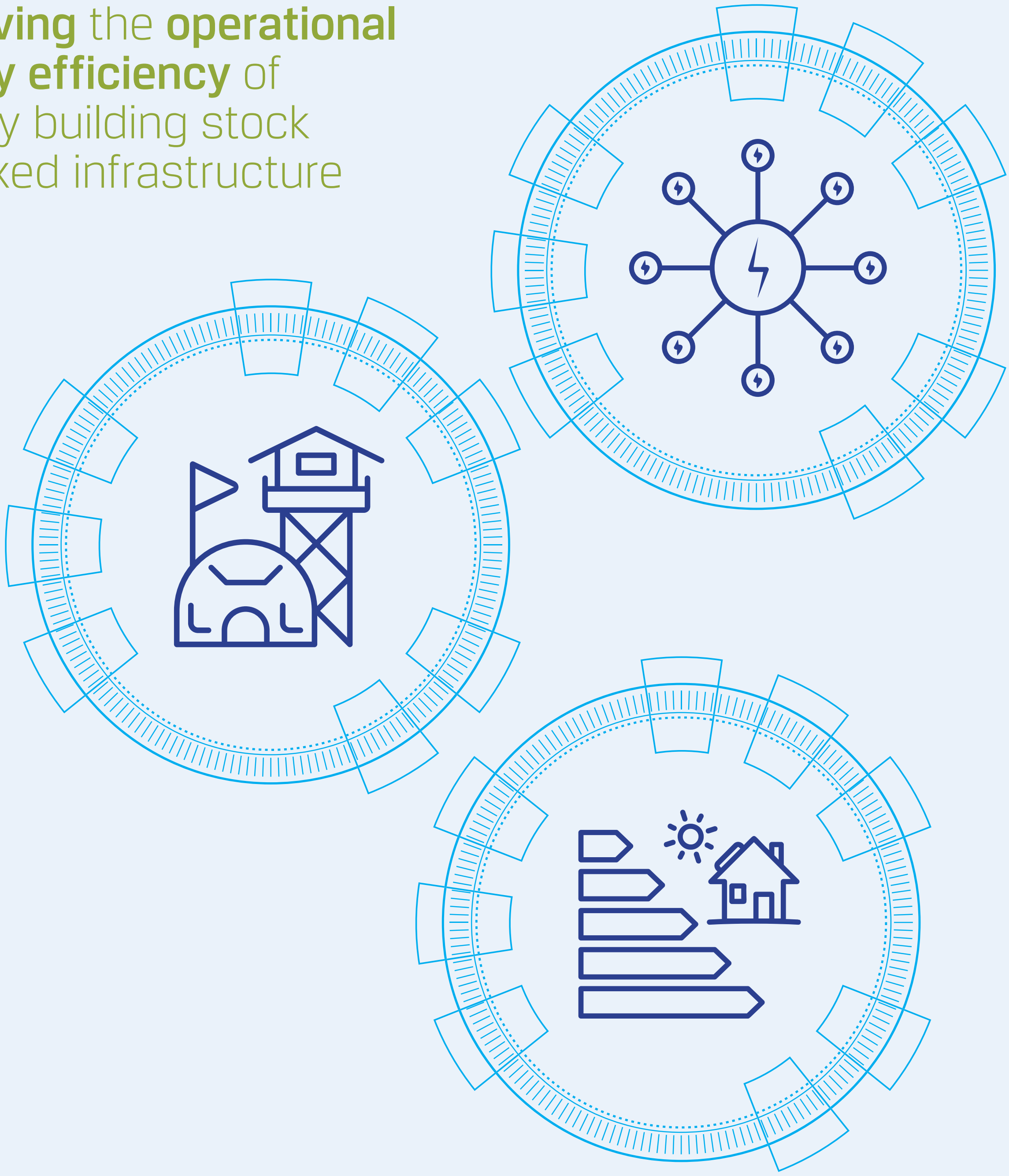
CF SEDSS III
Consultation Forum for
Sustainable Energy in the Defence
and Security Sector

5. PROJECT IDEAS

Boosting the defence energy transition

5.1 CF SEDSS Working Group 1: Energy Efficiency and Buildings Performance

Improving the **operational energy efficiency** of military building stock and fixed infrastructure



1. Driving Sustainable Energy Through Military Behaviour Change

What is the project about?

This project aims to reduce the defence sector's greenhouse gas emissions by increasing energy efficiency. In addition to technological solutions, behaviour changes could achieve this. Behavioural science techniques, such as nudging, should be used in the defence sector. Accompanying behaviour measures could guarantee the balance of factual military needs and general climate goals.

Background

DIRECTIVE 2012/27/EU on energy efficiency (EED) defines 'energy efficiency improvement' as an increase in energy efficiency as a result of technological, behavioural and/or economic changes.

Human behaviour represents a significant potential to increase energy efficiency. Although the end-user is a major determinant of energy consumption, the efficiency potential due to behaviour change is usually neglected. However, it is being referred to as effective as the one from technological solutions.

Most ministries of defence (MoDs) / armed forces do not have a comprehensive behavioural change programme being implemented or running across their whole organisation. This could be due to the difficulties involved in variables in cultural change initiatives or programmes, the difficulty in measuring results with only a few tangible indicators to measure impact, or the difficulty in articulating the benefits and translating them into monetary value to justify its implementation.

Behavioural measures are often cheaper and more sustainable than the technical ones. Technical solutions suffer from the rebound effect: People turn technical efficiency gains into increased consumption and higher comfort. Behavioural interventions might prevent this.

Moreover, no MoD has quantitative impact data based on behavioural change programmes previously implemented in their organisation. Some MoDs have qualitative data, surveys or only anecdotal evidence.

However, behavioural change programmes may be fitter for the defence sector than for the civil one, considering some of its particulars in relation to human factors such as:

- MoDs' / Armed Forces personnel are more well-disciplined and accustomed to following procedures and instructions than other public or private sector personnel.
- There is a direct link between operational capabilities and energy efficiency, which is in the interest of the defence institutions, but it also affects, in certain cases (e.g. deployment, crisis), the welfare of personnel.
- The core of military personnel entered the armed forces early, through military academies or recruiting that involved subsequent training. At these early stages, personnel was more adaptable to new mindsets and work approaches that may secure future leaders' commitment.

Scope and Objectives

This project idea aims to design and implement an effective behavioural change programme specific to the defence sector. It also defines the appropriate key indicators that will allow permanent control and end-evaluation.

Project Analysis

The project shall study and assess the existing, implemented, and most effective awareness and nudging campaigns on energy efficiency in the civil and defence sectors. It will also analyse and extract the best practices and key success factors from each to adapt them to the defence sector.

It will be of paramount importance to assess their content and scope (what?), method (how?), timing (when?), location (where?), lead/promoter (who?), target audience (to whom?), constraints (difficulties, obstacles, challenges, enablers), objectives and results (indicators?), etc.

Not only should a behavioural change methodology specific to the defence sector be developed, but the necessary tools and plans should also be developed for its implementation. Key performance indicators will be defined to measure results and check compliance with objectives.

Methodology

The project will be split into the following phases:

Phase 1 – Assessment of existing military and civil behavioural change programmes on energy efficiency.

Phase 2 – Development of defence-specific behavioural change approach, tools and indicators.

Phase 3 – Development of an implementation plan.

Phase 4 – Identification of defence facilities as pilot cases for implementation and testing.

Proposed Solution

The following is required to implement the project:

- Proposal to EDA as an "EDA project" under the umbrella of the Energy and Environment Capability and Technology Group (Category B ad-hoc project or an EDA's operational budget project).
- Creation of an "EDA Ad-Hoc Working Group" to facilitate multinational collaboration and development of the project.

Alternatively, interested MoDs may arrange these activities by themselves.

Impact and Opportunities

The main impacts and opportunities of the project are:

- Improvement of the greenhouse gas inventory of the defence sector;
- More sustainable energy efficiency by including the human factor;
- Reinforcement of technical solutions by complementing them with behavioural instruments;
- Positioning the military sector as a leader in energy efficiency.

Challenges and Risks

The main challenges and risks are related to:

- Exclusion of external factors that might influence energy consumption;
- Unavailability of appropriate information and data to calculate performance indicators;
- Unwillingness of pilot facilities to implement behavioural measures;
- Unwillingness of partners to implement instruments for wider dissemination;
- Cultural peculiarities hampering the implementation of measures.

Roadmap

To achieve the proposed goals, this project specifies the following roadmap:

1. Survey of behaviour change instruments on energy efficiency;
2. Extraction of best practice and success factors;
3. Adaption of instruments in the defence sector;
4. Definition of key performance indicators;
5. Identification of pilot facilities for a test;
6. Calculation of key indicators before the test *(status quo ante);*
7. Implementation of behavioural instruments in pilot facilities;
8. Evaluation based on predefined KPI;
9. Regression analysis to exclude other influencing factors;
10. Deriving general recommendations on behaviour instruments;
11. Adaption of instruments to national and cultural particularities;
12. Dissemination and roll-out of results to organisations in the defence sector that are a part of the CF SEDSS network.

Way Ahead

Taking the project forward will require:

- A proposal to the EDA;
- Consultation with national partners and identification of potential facilities;
- Full development of project proposal, including financial plan;
- Setting up of contractual agreements between partners.

2. Big Data for Buildings

Background

European buildings are producing increasing data on energy generation and consumption from various sources (e.g., smart meters and building management systems). Collecting and making reliable data on buildings available is a key challenge for the European Union (EU). Enabling big data for buildings is vital to achieving the EU targets.

Scope and Objectives

This project idea aims to execute actions that will focus on developing and demonstrating large-scale pilot test-beds for big data applications in buildings. More specifically, these actions should:

- Define a reference architecture for building data and
- Develop and pilot an open, cloud-based data analytics toolbox.

Project Analysis

More and better data can enhance consumer information, contribute to the effective management of energy grids, and support the creation of innovative energy services, new business models, and financing schemes for distributed clean energy. Thus, this proposal triggers the development and demonstration of large-scale pilot test-beds for big data applications in buildings.

The reference architecture should ensure compatibility with existing dataset formats across Europe, allow integration with legacy architectures, encourage replication and scale-up, and comply with applicable EU standards (e.g., privacy, security, intellectual property).

The data architecture should be modular to accommodate data from various sources, including dynamic data from smart meters, sensors and other IoT devices, building management systems (BMS), energy market prices, weather data, currency exchange rates, as well as static data from existing databases such as consumer consumption data, energy performance certificates (EPC) repositories and building stock observatory (BSO).

Methodology

The proposal analysis should first perform an extensive review of existing datasets across the EU and take into account ongoing initiatives such as:

- EU directives and initiatives (e.g. Energy Performance of Buildings Directive (EPBD), Energy Efficiency Directive (EED), Ecodesign, INSPIRE, Digital Single Market);
- Reports and studies commissioned by the European Commission on relevant topics (e.g. EU BSO, data exchange study);
- Existing frameworks and architectures (e.g. Level(s), SAREF, BIM, legacy formats).

The data analytics toolbox should be able to process extensive and diverse data sets and perform statistical analysis, data visualisation, business intelligence (BI), and predictive modelling. The tools used should enable the integration of state-of-the-art data science technologies like statistics, artificial intelligence (AI), machine learning (ML), and deep learning (DL).

Proposed Solution

The data analytics toolbox should support third-party development of a wide range of services and business models with the objective:

- Monitor and improve the energy performance of buildings;
- Facilitate the design and development of building infrastructure (e.g. district heating and cooling networks);
- Support policy making and policy impact assessment; and
- De-risk investments in energy efficiency (e.g. by reliably predicting and monitoring energy savings).

The toolbox should also foresee communication protocols to automatically pull data from and push data to existing datasets (e.g., the EU BSO) without manual intervention (e.g., using APIs). The toolbox will be built on state-of-the-art technologies and hosted at a well-known, stable, secure, and scalable cloud service provider (IaaS/SaaS/PaaS).

Impact and Opportunities

The project is expected to demonstrate the impacts listed below, using quantified indicators and targets wherever possible:

1. Significant and measurable contribution to the standardisation of European buildings data;
2. Demonstrated interoperability with data hubs at national or supranational level;
3. Creation of new data-driven business models and opportunities and innovative energy services based on the access and process of valuable datasets;
4. Better availability of big data and big data analysis facilities for real-life-scale research, simulation, and policy-making.

Challenges and Risks

The main challenges are related to the fact that new, cross-cutting software and hardware technology will need the tangible engagement of end-users to be implemented and monitored. Therefore, demanding training sessions will be required to ensure the proper operating environment. Additionally, sophisticated electronic systems have been recently and repeatedly targeted for cyber-attacks and thus pose a potential vulnerability aspect for military infrastructure.

Way Ahead

To move the project forward, the standard process will be required, which, in this case, should follow the root:

- Developing the toolbox;
- Testing;
- Validation; and
- Pilot demonstrations at specific military buildings.

3. Defence Energy Benchmarks and Indicators (DEBI)

Background

Energy performance calculations for buildings compare the energy demand of a modelled "object" building to a modelled "reference" building using predefined energy consumption benchmarks.

Reference buildings for calculating cost-optimal energy performance requirements for new and renovated buildings are listed in Annex I of Directive 2010/31/EU (Energy Performance of Buildings Directive-EPBD) and Annex I of Regulation 244/2012. These include:

(a) Single-family houses of different types;
(b) Apartment blocks;
(c) Offices;
(d) Educational buildings;
(e) Hospitals;
(f) Hotels and restaurants;
(g) Sports facilities;
(h) Wholesale and retail trade services buildings;
(i) Other types of energy-consuming buildings.

Regulation 244/2012 establishes the methodology for calculating the building's energy performance in accordance with the common general framework described in the EPBD and the use of CEN standards (or an equivalent national calculation).

In general, the assumption has been made across the EU that non-operational defence buildings (offices, living quarters, hospitals, schools, canteens, etc.) have a similar consumption profile to those of their equivalent buildings in the civil sector, which means that the nationally defined minimum energy performance requirements, energy benchmarks, energy performance certification programs and nearly zero energy building (NZEB) concepts are directly applicable and can be extrapolated to defence non-operational buildings.

However, there are scores of defence operational buildings whose defence-specific characteristics and energy consumption profiles do not fall under the same parameters and metrics as any of the nationally defined reference buildings for the civil sector.

Even though defence-specific operational buildings are exempted from complying with EU energy performance legislation (Art. 5.2 of the Energy Efficiency Directive-EED and Art. 4.2c of EPBD), there is consensus in the defence sector that an appropriate categorisation of defence operational buildings, along with the definition of appropriate energy related metrics and indicators are necessary to allow the calculation of their energy performance and exploit opportunities for energy savings.

Moreover, existing energy performance indicators and certificates represent only a single set of information at a specific point in time and do not account for the full concept of sustainability and circularity of the building throughout its whole life cycle.

Scope and Objectives

This project idea aims to categorise defence operational buildings, study and analyse their energy consumption profiles, and develop appropriate reference models and energy performance metrics and indicators that allow an adequate assessment of their energy performance and, in general, of their whole life-cycle sustainability and an adequate definition of an NZEB concept for defence.

Project Analysis

The project shall assess the types and functions of the varied EU defence building stock and define appropriate categories for defence operational buildings, such as[1]:

(a) Military intelligence facilities;
(b) Data centres;
(c) Training facilities;
(d) Research facilities;
(e) Hangars;
(f) Weapons and ammunition production facilities;
(g) Weapons and Ammunition Storage Facilities;
(h) Weapons and ammunition repair and maintenance facilities;
(i) Vehicle repair, maintenance, and storage facilities;
(j) POL (petroleum, oils, and lubricants) storage and handling facilities;
(k) Other buildings.

Each category of building shall be assessed based on its construction type and design, materials and standards, and utilisation and energy consumption profile.

Appropriate metrics and cost-optimal minimum energy performance requirements, as well as energy efficiency measures for both new and existing buildings, shall be defined in accordance with provisions in Regulation 244/2012, which shall be adapted if and when necessary to the characteristics of defence operational building stock.

Buildings and energy consumption profiles reference models shall be developed for each category of defence operational building to allow for the calculation of their energy performance in accordance with the common general framework described in the EPBD, the methodology described in Regulation 244/2012 and the use of CEN standards (or an equivalent calculation), which shall be adapted if and when necessary to defence operational building stock's characteristics.

The project shall also investigate the new European framework for sustainable buildings called "Level(s)" and adapt the indicators contained therein to the specificities of the defence operational building stock if and when necessary.

A software (SW) tool shall be developed that allows the certification of the energy performance of defence operational buildings and classifies their sustainability in accordance with the "Level(s)" framework.

Methodology

The project shall survey and categorise defence operational buildings into representative reference categories to later identify statistically representative samples of each category of buildings across the EU.

The construction parameters and energy consumption profiles defining each building category shall be defined, as well as the cost-optimal energy performance requirements for new and existing operational buildings.

1. This list of buildings is just indicative and not intended to be final or conclusive in the face of the study.

Reference building models and reference energy consumption profiles specific to each of the defence operational building categories shall be developed, which will allow for comparison with the "object" buildings to calculate their energy performance.

Building sustainability indicators defined by the new European framework for sustainable buildings, "Level(s)," shall be studied in detail and adapted to the defence operational building stock specificities.

All parameters and calculation methodologies shall be coded into a SW tool for systematic and structured calculations and certifications.

Proposed Solution

To make the project a reality will require:
- Proposal to the CF SEDSS as a contracted study;

Alternatively:
- Proposal to EDA as an EDA project under the umbrella of the Energy and Environment Capability and Technology Group (CAT B ad-hoc project or EDA operational budget project).
- Create an "EDA Ad-Hoc Working Group" to facilitate the mutual collaboration and development of the project.

Impact and Opportunities

The impact on the defence sector will be high, as defence operational reference buildings and reference energy benchmarks will allow for the definition of minimum defence-specific energy performance requirements and NZEB concepts, the implementation of defence-specific energy performance certification programmes, and long-term renovation strategies and plans.

Challenges and Risks

Difficulties in finding enough commonalities in defence operational buildings and statistically representative samples across the EU that allow for the definition of defence operational reference buildings and energy benchmarks.

Way Ahead

Taking the project forward will require:
- Development of a project concept note and an infosheet.
- Proposal to CF SEDSS / EDA.
- Consultation with national partners and identification of potential facilities.
- Full development of the project proposal, including a financial plan.
- Setting up contractual arrangements between partners.
- Procurement of a contractor to execute the project.

4. RE-FASYS Defence

Renovating Existing Facades Applying the Off-Site Construction System in Defence

Background

Buildings are responsible for about 40% of the EU's energy consumption and 36% of greenhouse gas emissions from energy. However, only 1% of buildings undergo energy-efficient **renovation every year.**

To achieve at least 55% emissions reduction target for 2030, the EU must reduce buildings' greenhouse gas emissions by 60%, their energy consumption by 14%, and heating and cooling by 18%. By 2030, 35 million buildings should be renovated.

The revised Energy Efficiency Directive (EED) proposal introduces further obligations for public authorities, such as reducing the energy intensity of public installations, renovating public buildings, and considering energy efficiency in public procurement, including the defence sector. According to a recent study of nine European countries, implementing energy efficiency measures in existing housing stock could save 20% of current heating consumption.[2]

2. https://ec.europa.eu/environment/integration/research/newsalert/pdf/38si5_en.pdf

Among the main objectives of the multi-year collaboration between the Italian defence and ENEA[3] important research activity is underway on useful solutions to optimise and accelerate the energy renovation of existing buildings.

ENEA's Energy Efficiency Department is already involved in a national project for the civil sector funded by the Italian Ministry of Economic Development[4] called "Ambiente Costruito": the aim of the project is the off-site construction (OSC) applied to the renovation of existing facades, making the production process of the standardised module more efficient to reduce the energy consumption of the entire supply chain[5]. The modelling of the standardised system has returned a potential average reduction of energy consumption of about 35% in the north, center and south of Italy (with different latitudes and climatic conditions).

The project idea also meets the indications of the European SET PLAN, which underlines the OSC integration with the various disciplines involved in design and construction.

Project Analysis

The military sector requires fast refurbishment of its existing buildings. The overall objective is to reduce energy consumption in existing buildings through the off-site construction approach.

An off-site modular system can open the way for a quick and serial refurbishment of building facades. The approaches adopted are:

- Need for identifying solutions that can respond to different climatic needs;
- Develop "dry solutions", quick to install and energetically effective;
- Use a modular system optimised over the total supply chain.

The proposed project focuses on external opaque facade elements: some solutions already exist on the market, but without a real standardised system. Referring to the transparent elements of the facades, usually they are made ad hoc, so there is no need for a specific study.

Likewise, the opaque panels will be selected and conceived so that it will be possible to externally mount other modular systems for energy production (electrical or thermal, for example, PV cells or solar panels). A **dynamic matrix** will be used to identify the best suitable solution by inserting specific parameters like construction type, technological facilities, seismic risk, **and climate zone.** These parameters can be set according to specific requirements or national directives, and the suggested solutions will appear in any preferred order.

Impact – Expected Outcomes

Starting from the goals that ENEA aims to get from the ongoing Italian project for the civil building stock, the outcomes of the implementation of this project are:

- Replicate the methodology applied for the *"Ambiente Costruito"* project to the military sector in a transnational context;
- Validate, for the military buildings and this system application, the **energy saving** to assume short, medium and long scenarios (today, 2030, 2050) of renovation;
- Contribute to the EU Green Deal (e.g. Renovation Wave) and the Climate Change and Defence Roadmap.

Objectives

The project objective is to find standardised solutions to reduce energy consumption, reduction of installation times and overall costs related to the production/application process.

The design idea is to create a catalogue with limited solutions (for the integrated system of the opaque panel, the frame, and the fixing) **that can be adapted to different climatic conditions and military construction types.**

Moreover, starting from the tests that ENEA carried out on shaking tables to assess the capabilities of the proposed solutions to withstand extreme earthquakes, the **compatibility of the selected solutions in the military ambit with the seismic requirements** will be verified. This aspect is considered very important in particular for military structures, which are expected to preserve their functionality even when natural disasters arise in order to help the civilian population.

3. ENEA is the Italian National Agency for New Technologies, Energy and Sustainable Economic Development, aimed at research, technological innovation and the provision of advanced services to Government, Public Administrations, Enterprises and Citizens.
4. https://www.enea.it/en/research-development/electrical-system-research
5 https://www.eai.enea.it/la-rivista/efficienza-energetica-avanti-tutta/prospettive-e-potenzialita-dei-sistemi-off-site-il-progetto-ambiente-costruito.html

Therefore, the main advantages of the facade system will be:

- **Rapid** installation keeping users inside the buildings;
- Improvement of **energy efficiency**, also considering other characteristics of the panel system, as seismic safety, fire safety and acoustic characteristics;
- Reduction of environmental impacts on site, thanks to **limited** production of **dust** and **waste** integrability of the panel with a centralized distribution system (heating/ cooling) placed within the cavity of the panel;
- Develop a methodology that allows the military building stock to be energetically upgraded in a **short time,** keeping activities running and reducing refurbishment costs compared to the current market;
- Positive impact on the civilian sector and SMEs, which will be interested in the renovation works;
- Assessment of compliance with the requirements for green public procurement;
- Advance the transition towards more affordable, sustainable and resilient energy model in the defence sector.

Opportunities

The potential success of using a dynamic matrix offering **a modular solution for standardised renovation of opaque walls of the existing facades is rapid implementation time,** refurbishment in the **presence of inhabitants, air dust limitation** during the construction site and **low costs.**

Advantages of interest for the defence and security sector are:

- **Not interrupting activities** (work continuity with human presence and "livable" construction site during the refurbishment works);
- **Replicability,** on a large scale, on **residential and non-residential buildings;**
- Reduced impact on the environment thanks to limited production of waste and dust;
- **Applicability to any European climatic zone;**
- Development of **new technologies** in the building sector.

Challenges

The **main risks/challenges** which are identified are related to:

- Difficulties in the identification of military energy shortages and developing a large-scale problem-solving process;
- Difficulties in data gathering for preliminary energy analysis and type-of-building identification (a close interaction between research institutions and the military sector to organise an analysis on the state of the art is necessary);
- Application of standard solutions for facades to buildings with firm traditional characteristics or protected by cultural heritage is almost impossible, due to the construction limits and the previous characteristics respect;
- Access to incentive mechanisms and tax deductions, in both the public and private sectors, is allowed for this solution: it is necessary to conduct a preliminary evaluation of how the facade system proposal can be funded in the other Member States;
- The Energy Performance of Buildings (EPB) Directive requires Member States to define a detailed application in practice of NZEB solutions, in line with their local characteristics, the national contexts and the different climatic and local conditions; in the civil sector, the national approaches are not fully comparable, because of the absence of a harmonised methodology for energy performance evaluation.

Methodology

Assuming that the typological characteristics of the whole building stock cannot be known, ENEA conducted the project "Ambiente Costruito," starting with the definition of a "recurring building" model (it represents about 75% of the whole Italian existing civil building stock) to evaluate the energy savings likely achievable.

The project idea will be implemented, starting from a first application and validation of the model to a sample of well-known (in terms of energy consumption and building characteristics) prototypical military buildings within the participating Member States, and it is expected that it will be easily integrated with other related projects that could be started, contextually or subsequently, in the field of energy efficiency and performance of the military building stock.

In this way, the methodology can be easily replicated in the military field, and the achievable energy savings can be evaluated to define short-, medium-, and long-term scenarios.

The "RE-FASys Defence" facade system, with its own application in existing buildings, will contribute to the general improvement of the energy performance of military buildings and guarantee compliance with the NZEB requirements of certain Member States.

Way Ahead

It is reasonable to think that the main risk and barriers envisaged will be easily overcome, following an approach for later steps. In that way, both the standard typologies of military buildings and their consumption framework in the European defence will be gradually defined and taken into account.

Therefore, the new project idea for the military sector will be developed through the following three main steps:

- **STEP 1: Application** to a small number of pilot military districts of buildings **(one building for each pMS)** to define a first draft of a prototypical catalogue of standardised solutions (dynamic matrix), suitable for the involved Member States and, likely, for other European countries.
- **STEP 2: Extension** of the previous step goals to a cluster of strategic and energy-intensive military bases **(a sample of 10 to 15 pilot buildings per Member State),** to achieve a more complete catalogue in the dynamic matrix to choose the most suitable solutions.
- **STEP 3:** A **methodology** for the extension of the previous goals to the main typologies of the involved Member States' existing building stock.

5. E-Mobility in Defence

Background

Article 8.2 of DIRECTIVE (EU) 2018/844 (amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency), establishes the requirement for new non-residential buildings and non-residential buildings undergoing major renovation, with more than ten parking spaces, to ensure the installation of at least one recharging point within the meaning of Directive 2014/94/EU of the European Parliament and of the Council (*) and ducting infrastructure, namely conduits for electric cables, for at least one in every five parking spaces to enable the installation at a later stage of recharging points for an electric vehicle.

Moreover, Article 8.3 of DIRECTIVE (EU) 2018/844 establishes that Member States shall lay down requirements for installing a minimum number of recharging points for all non-residential buildings with more than twenty parking spaces by 1 January 2025.

The transformation of traditional internal combustion engine vehicle (ICEV) fleets into battery electric vehicles (BEV) fleets is already becoming a reality in the public sector. However, with a few exceptions, the defence public sector has not embarked on any pilot project to demonstrate the feasibility of or full-scale initiatives for transforming its vehicle fleets.

This is due to several factors, including budget constraints, legal obstacles, and limited political direction. Many factors need to be taken into account if we are to succeed in attaining an economically and technically viable investment and an efficient life cycle maintenance expenditure.

Scope and Objectives

This project idea aims to study and analyse the existing infrastructure and mobility needs in defence facilities and design economically and technically viable solutions and plans to facilitate a smooth and efficient transition from ICEV fleets into BEV fleets. The ultimate goal is to completely electrify car mobility within the premises of defence facilities.

Project Analysis

Based on initial feedback from five MoDs during a workshop on e-mobility conducted by WG1 during CF SEDSS Phase II, it could be observed that MoD vehicle fleets are comprised of hundreds of different vehicle types, mainly motorbikes, utilitarian cars, and different sizes of buses and trucks, both petrol and diesel, normally fully owned, of wide age ranges.

Detailed information about the defence vehicle fleets and infrastructure is key and paramount for designing and planning a successful vehicle transformation initiative. Business cases are normally solid in terms of technical and environmental aspects, but cost-benefit analysis is harder to justify on a like-for-like substitution and will only be sound under specific circumstances.

(*) 'recharging point' means an interface that is capable of charging one electric vehicle at a time or exchanging a battery of one electric vehicle at a time

Thus, this project shall study and assess existing defence vehicle fleets and facilities infrastructure, as well as their mobility requirements and all legal, technical, financial, environmental and managerial aspects affecting and impacting the transition from ICE fleets to BEV fleets.

For instance, some of the factors directly impacting the final solution that needs to be carefully analysed are the number of vehicle users, the utilisation profile, and daily mileage requirements, among others. These will define aspects such as the required autonomy of the BEV, charging speed, and minimum number of vehicles, which will ultimately affect the economic viability of the project.

The technical aspects of the BEV and charging points (high-slow charging speed) will directly impact not only the initial investment but also the whole life cycle operation and maintenance requirements and costs. Also, the capacity of the electricity distribution grid can be a constraint if it needs to be reinforced, and loading needs to be optimised.

Environmental aspects will also have to be taken into account, as battery manufacturing has a higher carbon footprint than manufacturing ICE and is more expensive. Therefore, it is critical that cost and environmental savings are achieved during the vehicle's operational life. Also, the energy mix heavily influences the carbon footprint of electric vehicles, with cases where ICEVs may result in fewer carbon emissions than BEVs.

An efficient management system is key to allowing for cheaper slow-charging infrastructure when vehicles are not required (normally at night). Solutions for carpool sharing and vehicle utilisation models must be considered to reduce the number of vehicles needed and maximise benefits.

The lack of legal framework and financial incentives for public authorities to transform their vehicle fleets into low-emission vehicles is a challenge that needs to be addressed.

Methodology

The project will be split into the following phases:

- Phase 1 - Assessment of existing defence infrastructure and mobility needs.
- Phase 2 - Design of e-mobility plans.
- Phase 3 - Pilot testing in a specific defence facility.
- Phase 4 - Pilot testing results in analysis, design, and elaboration of the guidance document and standardised, replicable solution packages.

Proposed Solution

To make the project a reality will require:

- Proposal to EDA as "EDA project" under the umbrella of the Energy and Environmental Capability and Technology Group (CAT B Project or Operational Budget).
- Creation of an "EDA project Ad-Hoc Working Group" to facilitate the joint collaboration and development of the project.

Alternatively, interested MoDs may arrange these activities by themselves.

Impact and Opportunities

The impact on the defence sector will be high, as defence non-operation vehicle fleets are massive and show a wide variety of engine types and uses.

Developing e-mobility strategies and plans, including transforming existing combustion engine vehicles into new green vehicles and acquiring new green vehicles, will help MoDs and armed forces on their path towards greener mobility.

Challenges and Risks

The main risks are related to limitations in support infrastructure and a lack of budget to make big investments in the implementation of greener fleets.

Way Ahead

To take the project forward will require:

- Development of a project concept note and an infosheet.
- Proposal to EDA for the way ahead.
- Consultation with national partners and identification of potential facilities.
- Full development of the project proposal, including the financial plan.
- Setting up contractual agreements between partners.
- Procurement of a contractor to execute the project.

6. AI-Based New Generation Metering Devices

Background

Based on the feedback provided by the ministries of defence (MoDs) during the WG1 Energy Efficiency and Buildings Performance parallel sessions at the CF SEDSS Phase II, almost all MoDs do collect energy consumption data related to infrastructure, though the levels of detail and exploitation of the data vary among MS. However, the granularity of data, the use of smart meters and the level of record keeping for infrastructure consumption differ.

In addition, MoDs explored and acknowledged how having the right level of energy consumption data can bring energy bills down by simply monitoring and analysing the data properly and identifying where energy is being used inefficiently and, consequently, where savings can be achieved. This is even more so when energy data can be cross-checked with appropriate information from their building stock (including state of building and technical building systems and building use, among other variables).

However, despite the benefits of deploying metering in their military bases and buildings, and even though metering and data analysis are central to the transformation of existing conventional buildings into smart buildings, decision-makers seem still not to be convinced.

Discussions are ongoing about how to deploy sub-metering alongside main base meters, develop appropriate policies, and estimate costs and payback periods. Key considerations include whether metering should be manual or automatic, the extent to which extensive metering can drive energy savings through behavioural change, and how to avoid or mitigate cybersecurity risks.

Innovative and inexpensive artificial intelligence (AI) based solutions for non-intrusive smart energy metering are now available in the market, which enable a single meter to measure the consumption of different types of equipment using algorithms to disaggregate electrical signatures. This can assist energy managers in the data monitoring and analysis by building, by zone or even by type of equipment, helping identify inefficiencies very easily and the taking and prioritising of appropriate measures with much more flexibility in terms of installation and data analysis than the traditional smart meters. Development of a non-cloud-based solution will be needed to meet defence cyber security protocols.

Scope and Objectives

This project idea aims to study and analyse the viability and justification of fully deploying AI-based metering technologies at large scale in the defence sector.

Project Analysis

This project shall study and assess existing metering capacity and information security requirements in defence facilities. It will thus explore if and how using algorithmic-based AI in smart metering would allow for measuring and analysing defence facilities' energy consumption data with a single (or a very reduced number of) inexpensive AI-based meters.

The project shall also explore all technologies commercially available in the market for AI-based meters and justify their deployment in defence facilities (vs. standard metering devices and smart metering devices) through a technical and economic feasibility study that takes into account not only the energy savings and the metering devices' whole life cycle costs but also the information security aspects.

The project shall conclude with the development and cost assessment of the implementation of 2-3 "conceptual" defence facilities representing the basic defence configurations in the EU and identifying real defence facilities where AI-base metering devices could be deployed and tested.

Methodology

The project will be split into the following phases:

- Phase 1 - Assessment of existing defence facilities metering infrastructure. Market research on commercially available AI-based metering devices.
- Phase 2 - Technical / Economic justification. Impact assessment.
- Phase 3 - Develop "conceptual" defence facilities and implement cost assessments.
- Phase 4 - Identify real defence facilities for technology deployment and testing.

Proposed Solution

To make the project a reality will require:

- Proposal to EDA as "EDA project" under the Energy and Environmental Capability and Technology Group (CAT B Project or Operational Budget).
- Creation of an "EDA project Ad-Hoc Working Group" to facilitate joint collaboration and development of the project.

Alternatively, interested MoDs may arrange these activities by themselves.

Impact and Opportunities

The impact on the defence sector will be high, as defence building stock is massive and smart metering of different types of energy consumption requires ample deployment of metering devices and complex data collection, analysis and management. AI smart metering solutions would significantly reduce the number of smart metering devices required and the complexity and resources dedicated to the collection, analysis and management of energy consumption data.

Challenges and Risks

The main risks are related to the complexity of the technology used, which can be mitigated through education and training.

Way Ahead

To take the project forward will require:

- Development of a project concept note and an infosheet;
- Proposal to EDA for the way ahead;
- Consultation with MoDs and identification of potential facilities.
- Development of the project proposal, including the financial plan;
- Explore contractual agreements between partners and procurement of a contractor to execute the project.

7. Upgrading the Smartness of Existing Buildings through Innovations for Legacy Equipment

Background

An essential part of Europe's clean energy transition is the changing role of buildings from consuming energy to actively controlling and optimising indoor environment while contributing to energy system flexibility by ensuring distributed energy generation from renewable energy sources, energy storage, facilitating smart charging of EVs, smart metering, load reduction through energy efficiency and load shifting through demand response.

Innovative technologies will enable smart buildings to interact with their occupants and the grid in real-time and manage themselves efficiently to become an active element of the energy system. Intelligent and connected devices, smart sensors, and controllers, supported by the development of new business models for new energy services, will create new opportunities for energy consumers.

Scope and Objectives

The current proposal aims to develop and demonstrate cost-effective low-carbon technological solutions to manage energy within existing buildings and interact with the grid, providing energy efficiency, flexibility, generation, and storage based on user preferences and requests.

Project Analysis

More analytically, the project's proposed interventions should demonstrate how the smart systems, smart controls and smart appliances can be integrated seamlessly into existing buildings to interface and/or control the major energy-consuming domestic appliances that are already installed (like boilers, radiators, DHW preparation, motors for ventilation, windows opening and shading; lighting, dryers, washing machines, fridges, etc. The expected TRLs of the proposed technologies are from 6 to 8.

Methodology

This project idea will highlight cost-effectiveness and user-friendliness: easy installation and maintenance, maximising consumer comfort (e.g. self-learning) and information on own consumption (e.g. recommendations to the user to maximise savings), and gains from its contribution to grid operation.

Moreover, the proposal should build on innovative technologies, initiatives and approaches contributing to building smartness: semantics, data models, data layers, protocols, software building blocks, APIs, middleware, solutions for smart services, standards, relevant industrial consortia or technology initiatives, etc. Interoperability is essential to ensure the required smart readiness, in particular integration with legacy equipment, user-friendliness and broad market uptake.

Proposed Solution

The project proposal offers solutions to upgrade existing residential or tertiary buildings, using automation and IT to offer new services and control to the building users, thereby improving their comfort and satisfaction. This upgrade should translate into improvements in the areas put forward by the revised EPBD in relation to the smart readiness indicator. In addition to the "demo" aspect, the project will develop holistic business models with a clear path to finance and deployment.

Impact and Opportunities

The expected impact of the project is related to the aspects listed as follows:

- Primary energy savings triggered by the project (in GWh/year);
- Investments in sustainable energy triggered by the project (in million Euro);
- Upgrade of existing buildings to higher smartness levels, including a significantly enlarged base of existing building equipment and appliances monitored by energy management systems and activated through demand response actions;
- Reduction in energy consumption and costs, exceeding the additional consumption from IT and its cost.

Challenges and Risks

The main risks are related to existing security protocols associated with the normal operating conditions of the defence infrastructure, which may pose additional costs and paperwork to avoid unwilling interactions with technological solutions to be designed and installed. Also, extended modifications in terms of architecture and mechanical equipment are required to ensure the unimpeded operation of the new systems, mainly due to the age and lack of proper maintenance of military buildings.

Way Ahead

The standard procedure will be required to move the project forward, which involves the following stages/steps: solution design and manufacturing, testing, validation, pilot implementation, feedback about effectiveness in normal operating conditions, dissemination of the project results, and lessons learned.

8. Next-generation of Energy Performance Assessment and Certification

Background

Under the Energy Performance of Buildings Directive, all EU countries have established independent energy performance certification systems supported by independent mechanisms of control and verification. However, current practices and tools of energy performance assessment and certification applied across Europe face several challenges. They have to reflect the smart dimension of buildings increasingly and, at the same time, facilitate the convergence of quality and reliability of energy performance certificates (EPCs) across Europe.

The building energy performance methodologies should also ensure a technology-neutral approach, be transparently presented, making use of International and European standards, in particular the ISO/CEN standards developed under Commission mandate M/480 aimed at enabling the presentation of national and regional choices on a comparable basis.

Scope and Objectives

This project idea aims to develop strategies to encourage the convergence of EPC practices and tools across Europe to ensure a comparable level of high quality, independent control and verification. The applicability of assessment and the certification schemes should be processed through a broad set of well-targeted and realistic cases, featuring various locations, building types, climatic conditions and field practices, including existing national EPC schemes. The assessment will demonstrate the potential of a Europe-wide uptake of the proposed assessment and certification schemes, along with well-defined criteria.

Project Analysis

Next-generation energy performance assessment schemes will value buildings in a holistic and cost-effective manner across several complimentary dimensions: envelope performances, system performances and smart readiness (i.e. the ability of buildings to be smartly monitored and controlled and, to get involved in demand-side management strategies). The assessment should be based on an agreed list of parameters/indicators, such as e.g. calculated annual final energy use, share of renewable energy used, past (climate corrected) final energy consumptions and energy expenditure, comfort levels or the level of smartness. The assessment methods should increasingly take into account output measures of performance (actual measured data) making use of available and increasing number of building energy-related data from sensors, smart meters, connected devices etc. These new schemes should improve the effectiveness of certificates by demonstrating how these could be strengthened, modernised and best linked to integrated national/regional certification schemes within a framework that aids compliance in checking and the effectiveness of financial support.

Methodology

The proposal will involve relevant stakeholders (including national and regional certification bodies) to take on board the lessons learnt and the innovative approaches demonstrated in similar previous projects as well as any developments on the use of EPCs that have taken place in the Member States, to further stimulate and enable the roll-out of next-generation of energy performance assessment and certification. The proposal should also aim at developing strategies to encourage the convergence of EPC practices and tools across Europe to ensure a comparable level of high quality, independent control and verification. The applicability of the assessment and the certification schemes should be assessed.

Proposed Solution

The proposal will feature a broad set of well-targeted and realistic cases, featuring various locations, building types, climatic conditions and field practices, including existing national EPC schemes. The assessment will aim at demonstrating the potential of a Europe-wide uptake of the proposed assessment and certification schemes, along well-defined criteria. It should also address issues regarding the training requirements and certification procedure for experts who are allowed to issue EPCs.

Proposals should demonstrate the benefit of EPCs increasingly covering also work on inspections (Articles 14 and 15 of the Energy Performance of Buildings Directive).

Impact and Opportunities

The expected impact of the project is related to the demonstration, depending on the scope addressed, of the aspects listed using quantified indicators and targets wherever possible:

- Primary energy savings triggered by the project (in GWh/ year);
- Investments in sustainable energy triggered by the project (in million Euro);
- Increased convergence of good quality and reliable energy performance assessment and certification and uptake and compliance with EU Directives and related standards.

Challenges and Risks

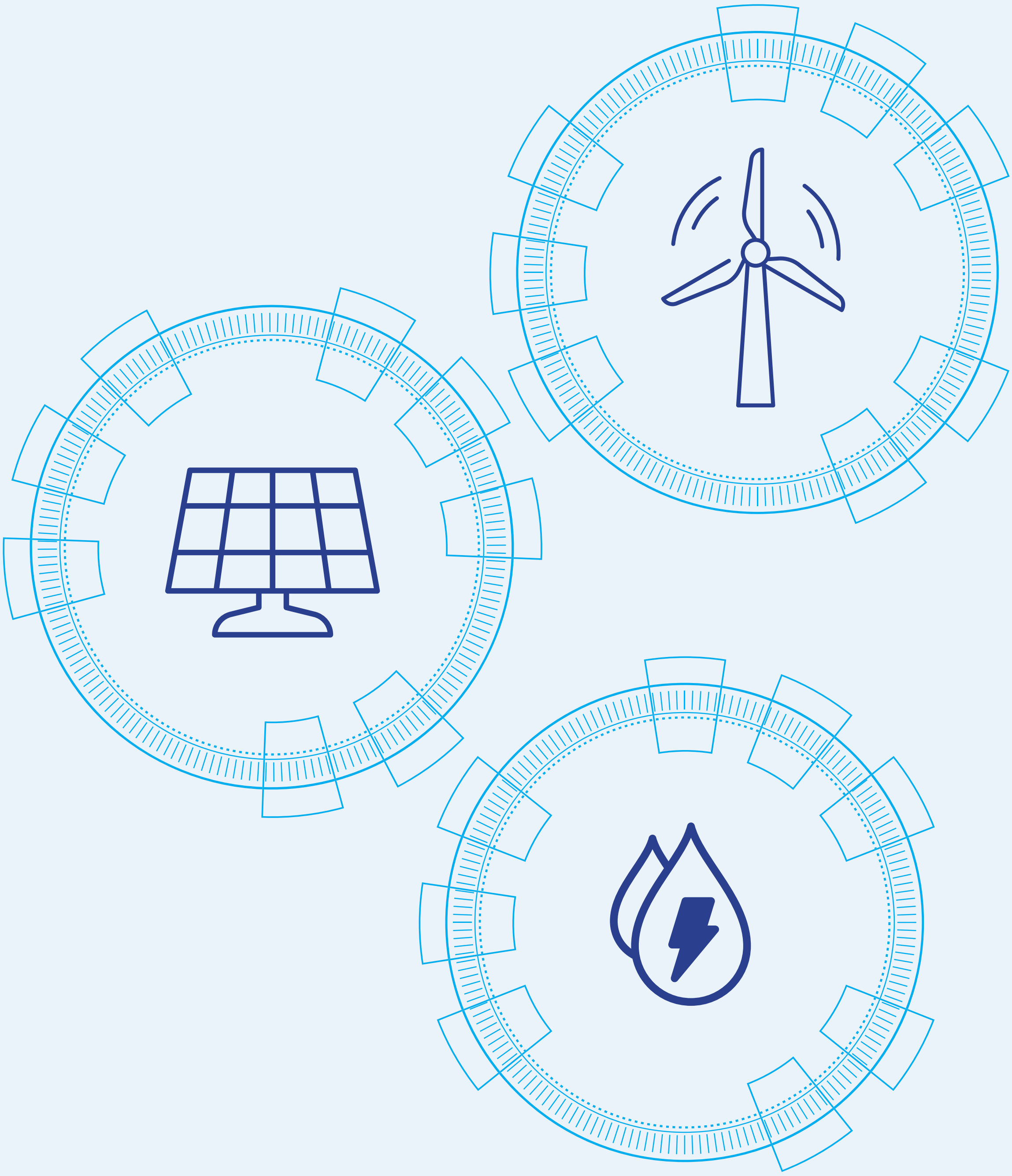
The main risks are related to the required variety of climatic conditions (thus an adequate number of pMS in the project), as well as an effective number of pilot cases which will capture the whole EU energy demanding / consumption spectrum and ensure the validity of the new homogenised EPC assessment and certifications method.

Way Ahead

Moving the project forward will require accumulating a selective sample of defence infrastructure (reflecting the variety of climatic conditions across the EU), developing the appropriate EPC assessment method, conducting bed-testing, validity checks, pilot demonstrations, and disseminating results and lessons learned.

5.2 CF SEDSS Working Group 2: Renewable Energy Sources

Enhancing the use of RES in the defence sector



9. Challenges of Decarbonisation in the Defence Sector

Background

Since the adoption of the European Green Deal in December 2019, EU Member States (MS) have committed to ambitious and challenging reductions in carbon use. Most EU MS have aligned their national targets with EU targets of a 55% reduction in carbon by 2030 and a carbon-neutral Europe by 2050.

The defence sector will be expected to contribute to the carbon neutrality objectives at the national level. Decarbonisation will present formidable challenges to armed forces in terms of land, sea and air mobility and energy use by defence infrastructure. There may also be a requirement to consider indirect emissions arising from equipment manufacturing, infrastructure developments, etc.

The defence also plays a leadership role in most societies and possesses large portfolios of land and infrastructure suitable for decarbonisation, which could contribute to the overall national effort. Additionally, the REPowerEU Plan highlights the need to decouple from dependency on fossil fuels.

While every CF SEDSS participating state will develop its decarbonisation strategy, there will be many standard features and there is value in examining the task facing defence, from a collective perspective.

Scope and Objectives

This project will seek to identify the decarbonisation challenges facing defence throughout Europe and identify approaches that maximize carbon reductions while minimising impairment of defence capabilities in the short term to 2030 and in the longer term to 2050.

Project Analysis

The decarbonisation challenge will impact every facet of defence activity. It will require an overarching strategic plan in each MS. While defence energy requirements are very diverse, involving many platforms and types of infrastructures, they can be broadly divided between mobility and infrastructure. Mobility can be further divided into maritime, aviation and land domains, each of which has its own very different characteristics in terms of decarbonisation. Decarbonisation can also adversely impact defence capabilities, as evidenced by recent studies on both off-shore and on-shore wind installations.

Methodology

This project idea seeks to identify the essential elements in such planning and will capture the relevant experiences of individual member states. There is a need to benchmark the scale of the challenges, e.g. measurements, baselines, targets, and gap analysis, before recommending courses of action to states.

Special factors applying to the defence sector need to be taken into account, such as the need for operational readiness and responsiveness, high-performance specifications, the storage of large quantities of military equipment and material and the large percentage of legacy infrastructure in defence portfolios.

Proposed Solution

Develop a recommended general roadmap for MS to address decarbonisation in their defence sectors. It should also be possible to list the diverse challenges across the defence sector, rate them in terms of difficulty and identify the obstacles to progress.

Impact and Opportunities

A successful project of this nature could boost decarbonisation throughout Europe and shorten timelines for national planning. It will also demonstrate the value of collaboration between participating ministries of defence (MoDs) facilitated by the EDA. Moreover, public-private collaborations may foster the development of new projects and cutting-edge technologies in the renewable energy sources (RES) domain.

Challenges and Risks

The main risks are related to the unique role of defence at the national level, which may make it difficult to recommend common approaches. Factors of special concern would include the long active life of defence equipment and specialised infrastructure, which may extend the period of high dependency on fossil fuels.

Way Ahead

To move the project forward, detailed input from a sufficient number of MS will be required to provide a representative overview of the state of play.

As a first step, a Terms of Reference document should be drafted, and suitable contractors/ consultants should be identified who may be interested in undertaking the project. The project will elaborate a recommended roadmap to decarbonise armed forces, addressing all relevant energy consumption, including mobility, infrastructure, and indirect emissions. The project should identify areas suitable for multinational collaboration.

The project could be a contracted study, but there may be an opportunity to undertake a more ambitious project with MS engagement, e.g., one or more MoDs engaging directly with a contractor.

Consideration should also be given to organising workshops dedicated to addressing the challenges of decarbonisation in the defence sector and acting as a forum to exchange good practices.

10. A Defence Approach to RED II Implementation

Background Description

Directive 2009/28/EC established a regulatory framework for promoting energy use from renewable sources, with binding national targets on the share of renewable energy to be met by 2020. After several amendments and in the interest of clarity, the Directive was recast on 11 December 2018 and has since been referred to as the "RED II".

A new target for the share of renewable energy was set at 32%, this time at the European Union (EU) level, which leaves greater flexibility for Member States (MS) targets, i.e., specific circumstances, energy mix, and production capacity). Meanwhile, RED III has introduced a more ambitious binding target of at **least 42.5%** renewable energy in the energy mix for 2030, with the potential to **reach up to 45%.**

Definition of the calculation of the share of energy from renewable sources:
"The share of energy from renewable sources shall be calculated as the gross final consumption of energy from renewable sources divided by the gross final consumption of energy from all energy sources, expressed as a percentage (Sum of electricity, heating and cooling and transportation)."

Important Remark:
The RED III requirements, as in the case of RED II, shall apply to the armed forces only to the extent that their application does not conflict with the nature and primary aim of the armed forces' activities, with the exception of material used exclusively for military purposes. This ensures that the defence sector's operational effectiveness is not compromised by the directive's provision.

Objectives

The CF SEDSS is tasked with distilling guidance for the Ministries of Defence (MoDs) based on the recitals and articles of RED II and identifying topics for information sheets and project ideas. The objective of this information sheet is to explore ways to measure, calculate, monitor, and enhance MoDs' contribution to the EU targets set out in RED II. The RED III analysis will occur in the context of the CF SEDSS phase IV.

Impact – Expected Outcomes

In addition to setting the EU target and providing legal frameworks and measures for increased RES use, RED II describes calculation rules for the Member States' renewable energy share in their respective energy mixes.

It is, therefore, key that MoDs identify ways to increase the RES share of their energy mix. They should also identify methodologies to measure and calculate the current baseline status of renewable energy penetration in the armed forces and monitor its future evolution. **This could be supported by developing specific analysis tools, potentially funded as a project idea outcome of the CF SEDSS.**

RED II Relevance for Defence

Most of the guidance in the recitals and articles of RED II is relevant to defence. Some elements will be directly used as input for the CF SEDSS Guidance Document on Advancing Sustainable Energy in the Defence Sector, while others have already been captured or will be captured in information sheets and project ideas.

Scope

The material scope of RED II concerns all energy from renewable sources, including wind, solar (thermal and PV) and geothermal energy, ambient energy, tide, wave and other ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogas.

Challenges

Because of their specific nature and the current technological constraints, not all of the defence sector's activities can be considered for short—and even medium-term decarbonisation. Therefore, a thorough screening and classification of all activities is necessary to draw timelines, set ambitious but achievable targets, and develop credible roadmaps for the defence sector. Moreover, measuring and calculating the RES share in the defence sector and its contribution to the higher EU targets are complex undertakings that may benefit from professional external support.

Opportunities

The CF SEDSS offers an appropriate framework to promote the use of energy from renewable sources. Furthermore, the CF SEDSS toolbox (including questionnaires and contracting studies) can be used to quantify the current contribution to the EU and national targets and monitor the progress made by MoDs.

Methodologies

1. Identify and list the activities which can be decarbonised using RES in the short and medium term.
2. Establish a baseline for RES penetration.
3. Identify national benchmarks and targets.
4. Monitor progress towards these targets.

Way Ahead

Step A:
An analysis is required within the CF SEDSS context to ensure that any differences in RED III do not impact defence operations.

Step B:
A contracted study is recommended to:
- Identify the most promising opportunities for decarbonisation;
- Assess the potential for increased use of RES;
- Map the associated challenges;
- Calculate the current RES share in the MoD's energy mix and to develop a "Data Collection and Analysis Tool" to monitor future progress.

11. H2 Technology for Heavy Military Vehicles

Background

The EU has identified green renewable hydrogen as having a key role in achieving the ambition of 2050 climate neutrality. Hydrogen-based technologies may be especially relevant to supporting a clean transition in hard-to-decarbonise sectors such as defence.

Defence mobility across the aviation, marine and land domains significantly contributes to greenhouse gas emissions. Aviation and marine mobility have yet to overcome severe challenges in developing viable hydrogen-based solutions. Land mobility, including heavy logistic vehicles, looks more promising in the short term for using hydrogen-related technologies. While smaller administration-type military vehicles can be addressed with electric batteries (such as lithium-ion), electric solutions become progressively less practical as weight increases. There is, therefore, value in examining the viability of hydrogen in powering heavy military vehicles.

Scope and Objectives

This project idea aims to explore the benefits and challenges of using hydrogen technologies in heavy military vehicles, including military adaptations of relevant civilian solutions, to help decarbonise military land transport.

The scope will be limited to heavy-land vehicles above ten tonnes in weight. Due to the more onerous performance requirements and the risks arising from combat conditions, the scope should also exclude vehicles primarily designed to be used as weapons platforms.

Project Analysis

Hydrogen technology solutions already exist on the market, but further research is needed on how they can be used in the defence sector, given its specificities. For example, there may be higher drive train performance requirements than civil use. The need for immediate resupply and storage in operational theatres will also present challenges.

Several substances have potential as a storage and transportation medium for hydrogen, including ammonia, toluene (liquid), magnesium, formic acid (liquid), sodium borohydride (salt), and powdered iron (solid matter). These may be of value from a defence perspective, including maritime applications.

This project idea will focus on the advantages of green hydrogen technologies in terms of energy autonomy, zero greenhouse gas emissions, and logistics cost reduction, but it will also consider the logistic and security challenges of hydrogen use, transportation, and storage.

Methodology

The research will focus on the benefits and opportunities of existing H2 technologies for heavy military vehicle use, including H2 storage, transport (as part of synthetic gas ammonia, etc.), and transferability of civil solutions. Challenges will be identified, and ideas for future projects will be suggested.

Proposed Solution

This project idea will focus on the applicability of H2 technology to heavy military vehicles exceeding ten tonnes, excluding combat platforms, to facilitate the decarbonisation of a significant portion of military energy consumption.

Impact and Opportunities

Hydrogen can be produced using renewable energies (solar, wind, etc.), thus significantly reducing the carbon footprint. There is also the potential to reduce costs. Compared to battery-powered vehicles, hydrogen vehicles can have higher ranges (up to 600 km) and are cost-competitive from a 100 km range. Other advantages include higher energy density, rapid refuelling (faster than fast charging and requiring less space for recharging infrastructure), and minimal range loss in low temperatures.

While hydrogen may be produced locally, it can also be transported or stored in gaseous, liquefied, or solid forms. It has low thermal and noise signatures (compared to combustion engines) and is an excellent energy vector for sector coupling. There is scope for transferring solutions from the civil to the defence sector, adapting technology to the specificities of the defence sector.

Challenges and Risks

Challenges and risks of introducing hydrogen into the military logistics fleet include unstable energy supply, hydrogen storage in demanding environments, availability of green hydrogen, logistical implications of high volumes to be supplied and stored, fuel cell start-up at low temperatures, risks related to mechanical energy stored in the compressed gas in case of a rupture, and efficiency of the conversion process into electricity (30-40%).

Producing green hydrogen will require high electric power inputs and a substantial amount of very clean water, although improvements in water supply technologies may reduce this constraint over time. Another challenge may be risk aversion among military decision-makers who prefer to stick with proven fossil fuel and battery technologies and avoid the additional safety and resupply risks likely to occur with hydrogen.

Way Ahead

A proof-of-concept work or a feasibility study is necessary to assess the applicability of hydrogen technology to the specific requirements of the military sector, taking into account the factors and considerations set out in this paper.

This study should include an examination of the most suitable types of hydrogen transportation and storage (e.g. gaseous, cryo-compressed, onboard reformation and water splitting, solid H2 storage) for military purposes, an adaptation of the existing hydrogen refuelling protocols to military purposes as well as fuel cell reliability in military conditions, e.g. off-road, fire, impacts of hostile fires etc. Comparisons with other low-carbon solutions (H2 combustion, batteries, biofuels) would also be useful. Furthermore, synergies with other related initiatives, including the RESHUB project, may be explored.

As an initial step, a low-value contracting study would be useful in fully elaborating on the issues involved and recommending the next steps.

Ultimately, however, more ambitious international work involving industry, academia, and the defence sector will be needed to address the issues identified, including the construction of prototypes and field testing and exploring synergies with other related projects, including within the European and NATO frameworks.

12. Repository of Islanding Projects in the Defence Sector

Background

There is an increasing interest in improving the operational autonomy of defence installations through islanding, i.e., making the installation independent of common energy grids (electricity, gas, district heating, etc.).

Gas supplies are under threat, and national electricity grids are under pressure. The resilience of defence installations is dependent on international supplies. Energy costs have been rising and this is likely to continue.

Islanding of installations will contribute to achieving decarbonisation targets, and smart grid technologies and distributed grid installations will be available to facilitate this.

Scope and Objectives

The islanding projects in scope would have the following elements in common:

- At least two renewable energy generation technologies, at least one storage technology and be interconnected with an energy network (e.g. electricity, heat or gas);

- The projects should aim at operational autonomy from a few hours to several days.

The islanding repository project, with the underlying goal of reducing the dependency on fossil fuels, and improving operational resilience, should:

- Present key data from running projects;
- Define and evaluate performance indicators (including technical, financial, environmental, social and other factors);
- Identify risks and benefits of islanding and
- Share good practices among CF SEDSS participating Member States.

Project Analysis

Several CF SEDSS participating states have islanding projects at various development levels. Establishing a repository of relevant islanding projects would improve the basis for exchanges of good practices and prevent the duplication of efforts.

Methodology

As a preliminary step, states will be asked to indicate if they have projects within the scope of this paper and if they are willing to share experiences with other Member States.

Thematic workshops and site visits should be considered to exchange good practices. Member States may also benefit from field test opportunities offered and/or experimentation results conducted by states as a basis for new creative ideas.

While a lead nation could be identified to manage the repository, consideration could also be given to contracting a company to develop and maintain it based on terms of reference developed by the CF SEDSS. Additionally, the company could also be contracted to analyse the data submitted.

Proposed Solution

A repository of islanding projects should be developed and maintained.

Within the CF SEDSS calendar, a thematic conference with a site visit based on the information in the repository should be organised.

All data in the database will be accessible to all CF SEDSS participating states without restriction.

Impact and Opportunities

Encourage ministries of defence (MoDs) to undertake islanding projects and use renewable energy technologies, including smart grids, more extensively in military installations.

Reduce fossil fuel dependency in the defence sector.

Encourage MoDs to share relevant data that will benefit all CF SEDSS participating states.

Challenges and Risks

The main risks are related to lack of participation by MoDs and a clear definition of requirements.

There is also a need to identify where the repository will be located and who will manage the data.

MoDs may be reluctant to share data to the required level.

Way Ahead

Include at least four islanding projects from different CF SEDSS participating states.

Identify the repository's location and the repository's custodian on behalf of the participating states.

Examine the viability of contracting a company to develop and maintain the repository.

13. Role of On-Site Generation and Energy Storage in the Decarbonisation of Defence Installations

Background

Armed forces in Europe are seeking to reduce the level of carbon emissions arising from their homeland activities and to increase the energy resilience of their installations, particularly by addressing the grid dependency of their large portfolios of installations and other infrastructure. However, progress has been uneven across and within European countries, and the process needs to be boosted.

The Consultation Forum for Sustainable Energy in the Defence and Security Sector (CF SEDSS) has already adopted an information sheet on islanding of defence installations and a general information sheet on decarbonisation in 2022 and finalised a research study on energy storage systems for defence installations early in 2023.

In April 2023, the Forum's Working Group (WG) on Energy Efficiency and Buildings Performance and on Renewable Energy Sources (RES) held a joint thematic workshop in Crete on decarbonising defence installations through energy efficiency measures, on-site RES and on-site storage. The participants completed a practical exercise on reducing the carbon footprint of a sample installation.

A research study on the decarbonisation of the defence sector in general was completed in early 2024. This project idea builds on this work and deliverables.

Scope and Objectives

This project idea seeks to analyse the current state of play concerning carbon emissions in a sample number of homeland installations across several EDA Member States and Member States (MS) of the Forum. Ideally, there should be one installation per MS. The installations should be roughly comparable, e.g. an infantry base of approx. 600 personnel with similar administrative, accommodation, equipment storage and security infrastructure elements. The overall scope would include all infrastructure within the installation (electrical and heating and cooling) and road transport assigned to the installation.

While this idea is not explicitly focused on naval and air installations due to their specialised nature, such installations could also form a similar exercise. Based on this analysis the project would estimate the potential for decarbonisation within each installation through energy efficiency measures, and by on site generation of RES supported by appropriate energy storage solutions.

The project would present findings on two levels, providing recommendations to each individual installation to inform a roadmap towards decarbonisation and providing a general analysis that would be relevant across all participating MS.

Project Analysis

Although developing cross-national projects through the EDA Consultation Forum has been challenging at times, there have been some positive developments, such as the EDA Defence Energy Managers Courses and the provision of data to various contracted studies conducted through the Forum. The recommended project would consolidate this progress and help address the common challenges participating states face in decarbonising their homeland installations.

Methodology

The preparatory work can be accomplished in a number of different ways.

- The simplest method is that each MS will conduct its own independent analysis of every installation and implement the resulting recommendations.
- Another approach would be for interested MSs to combine in a Category B EDA ad hoc project with a designated lead nation.
- A third approach would be to appoint a contractor to do the work with the cooperation of the participating states based on terms of reference approved by and funded by the EDA.

Proposed Solution

The proposed solution is to prepare terms of reference for a contract that would conduct an independent analysis of installations proposed by the participating states, providing detailed feedback to each participating state and general recommendations through the Forum on how best to address this issue across European armed forces. The EDA Smart Blue Water Camps project successfully used such an approach in 2017-18.

Impact and Opportunities

The project will positively impact participating states by providing them with possible technical solutions to support the installation decarbonising effort through on-site energy generation and storage.

Armed forces can also benefit from the collective analysis, which will identify common challenges facing MoDs across Europe. The project may also identify and encourage opportunities for follow-on work within participating states. It may also create an opportunity for a follow-up project to monitor and analyse the future implementation of the recommendations arising from this project.

Challenges and Risks

The diverse nature of defence installations may make it difficult to recommend common approaches. It may also be challenging to convince participating states to share sensitive data.

Factors of special concern would include the antiquity of many defence buildings and the specialised nature of some types of defence infrastructure.

Way Ahead

The project will require support from the EDA and the participating states to move forward. Terms of reference for a contract will have to be drafted and approved.

Another approach would be to ask participating states to conduct their own analyses of relevant installations and discuss the findings at another thematic workshop. This would pool the findings at the national level and help develop Europe-wide recommendations.

14. Heating and Cooling in Defence Installations

Background

Over 50% of defence energy consumption in homeland defence installations is used for heating and cooling activities. This energy is typically used to heat accommodation and work areas in winter and cool the same areas in summer.

Energy will also be required for space heating and dehumidification in storage buildings, refrigeration all year round for food and other perishable substances, and heating of water throughout the year.

Reducing the energy used for heating and cooling will significantly reduce the carbon footprint in defence installations.

Scope and Objectives

This project idea will consider the heating and cooling requirements of defence installations across the range of European climatic conditions and installation sizes and functions.

Among the objectives of such a project would be to:

- Identify the challenges to decarbonisation of defence on heating and cooling requirements.
- Assess the viability of possible solutions such as heat pumps, on-site generation, hydrogen-based applications, fabric upgrades, geothermal, district heating systems, waste-to-energy, heat-to-energy, including from data centres, and the potential role of the 'circular economy'.

- Conduct an analysis of advantages and constraints for heat pump projects in defence installations taking into consideration emerging heat pump technologies (propane, CO_2, ammonia, thermo-acoustic) and assess their expected benefit with regards to such constraints and limitations.
- Perform a selection of a suitable cross-section of installations to examine with permission of participating states.
- Estimate the carbon footprint of the heating/cooling system.
- Analyse options to decarbonise the heating and cooling requirements.
- Consider temperature and humidity controls for long-term storage of military equipment.

Project Analysis

The project will assist armed forces/MoDs in moving away from dependence on fossil fuels in their homeland installations. The challenges arising will vary from state to state and from region to region, but many challenges will be common to all or most states.

At present, most heating and cooling in defence installations are provided by fossil fuels delivered to the site by truck or pipeline, such as kerosene, gas, and LPG, or by grid-delivered electricity.

Fabric upgrades will improve the effectiveness of heat-pumps by improving air-tightness of a building and reducing the energy required by improving the overall energy efficiency of the building.

Most states will have both heating and cooling requirements with those further north having more heating requirements and those further south being more concerned with cooling. An initial overview would suggest that electrification of heating/cooling would be effective in most instances, provided such electricity came either wholly or in large part from renewable sources. The most widely used technology to achieve the electrification of heating and cooling in military installations to date has been heat pumps. Biomass has also been used and remains a viable option if circumstances are favourable.

Methodology

This project will examine the current state of play with regard to heating and cooling across the scope of the project. It will then examine the opportunities that exist to reduce the carbon footprint arising from heating and cooling, including inter alia the opportunities for the use of heat-pump technology supported by on-site electricity generation, geothermal, biomass, solar heating, waste-to-energy, heat to energy and on-site energy storage including the potential use of hydrogen.

Proposed Solution

A comparative study could be launched across participating states to identify current technological solutions in both military and civilian sectors and assess the opportunities to decarbonise heating and cooling in homeland defence installations across a range of climates, installation sizes and installation functions.

Impact and Opportunities

The project's principal impact will be to assist participating states in decarbonising heating and cooling within homeland defence installations.

The project will also provide opportunities for sharing knowledge and good practices across participating states and for exploitation of the outcomes jointly.

The project will also contribute to CF SEDSS guidance to participating states on heating and cooling.

Challenges and Risks

The project will have to address very different challenges across member states. It may be challenging in some instances to persuade participating states to share the relevant information.

Way Ahead

Explore the availability of a decision-support tool or the viability of developing one based on the proposed project's outcomes. Further elaboration of this prospect to be held in the CF SEDSS phase IV.

15. Applications for Hydrogen in the Defence Energy Sector

Background

Hydrogen is frequently recommended as a source of clean energy and has been proposed as an appropriate fossil-free fuel for transportation and as an energy storage medium. An expanded role for hydrogen was a significant plank in the EU Green Deal and the REPower EU plan. A cornerstone in that respect was the provisional agreement reached 8th December 2023 between the European Parliament and Council on updated EU rules to decarbonise the gas market and create a hydrogen market. The new rules will facilitate the uptake of renewable and low carbon gases, including hydrogen, while ensuring security of supply and affordability for consumers in the EU.

Hydrogen had featured in the Consultation Forum for Sustainable Energy in the Defence and Security Sector (CF SEDSS) discussions from an early stage particularly within Working Group 2 on renewable energy and hydogen was the major component of the RESHUB project[6] launched in 2018. Working Group 2 of the Forum also produced an information sheet in 2022 on the potential use of hydrogen as a fuel for heavy logistics vehicles above 10 tonnes in weight. A considerable amount of work has also been completed at the EU level, and in December 2023, a provisional interinstitutional agreement was reached on the rules for the gas and hydrogen market.[7]

The EDA Consultation Forum decided to devote its first-ever thematic workshop to hydrogen. This workshop was conducted in Ljubljana in 2022. The thematic workshop examined in detail many potential hydrogen applications broadly divided into infrastructure and transportation applications. While the workshop agreed that there were many potential defence applications, there were also many difficulties and obstacles to be overcome.

Scope and Objectives

This project idea seeks to examine the feasibility of hydrogen as a fuel and as an energy storage medium for specific applications in the defence sector. Because the potential scope is so broad there is an argument that it would be better to focus on a small number of potential defence applications. This would limit the scope of the project. One focus of consideration could be the use of hydrogen as a storage medium within defence installations, where the hydrogen is produced on-site by renewable energy sources (RES).

Another would be the use of hydrogen as a fuel for land transport possibly combined with production and use within an installation. Hydrogen could also be of value in the large-scale production of e-fuels (i.e. renewable liquid and gaseous transport fuels of non-biological origin, RFNBO), where relevant. Hydrogen production has also been of assistance in powering outposts in remote off-grid locations. Hydrogen has significant potential as a flexible and efficient energy vector and storage medium.

The project's objective is to assess the feasibility of an integrated energy system in a defence installation in which hydrogen plays a key role. Such a feasibility study would be best conducted with inputs from real-world installations, preferably based in more than one participating state.

Project Analysis

The project should, inter alia, consider production, conversion, storage, distribution, transportation, and final usage and identify any specific issues of concern from a defence perspective. It should also consider timelines and the evolution of the civilian economy in hydrogen.

6. cfii-wg-2-infosheet-reshub.pdf (europa.eu)
7. Deal to decarbonise EU gas markets and promote hydrogen (europa.eu)

Methodology

This project could be conducted on a number of different levels or a phased basis. The most basic project would be based on a contracted (research) study underpinned by clear terms and conditions. A more complex project could entail a contractor creating a simulated installation and modelling the impacts of a variety of inputs relevant to the use of hydrogen.

A third approach could be to conduct a pilot study within a real installation or pilot studies in more than one installation with the cooperation of a participating state or state.

Proposed Solution

Any of the courses of action above would be valuable. Consideration could also be given to a phased approach incorporating all three, e.g., beginning with a focused contracted study, following up with a modelling exercise simulating a fictional installation based on real-world factors, and finally, if appropriate, extending to a pilot study or studies on real-world installations.

Impact and Opportunities

The proposed project can significantly positively impact raising awareness across Europe of the feasibility of hydrogen applications in the defence sector and advancing the defence energy transition.

It could assist defence planners in assessing future investment requirements and the advantages and disadvantages of using hydrogen as an energy carrier. It would also align the defence sector more closely with implementing an important element of the EU Green Deal.

Other opportunities for studies and pilot projects could evolve from this work involving hydrogen in the defence sector.

Challenges and Risks

Implementing new contracting models as required for the three-phased approach will be challenging, and procedures to ensure compliance with EU business principles may need to be developed.

Way Ahead

The first step will be to develop terms of reference for each individual phase.

Then, to implement a three-phase approach, institutional support at the EU level will be needed.

Participating states should be circulated on their readiness to provide data for a contracted study, to provide data to help develop a fictional installation or to provide a suitable installation for a pilot hydrogen project.

16. Power Purchase Agreements for Solar PV Implementation

Background

Increasing demands to reduce carbon emissions within military barracks require an appropriate investment budget (CAPEX - capital expenditure). While the availability of these investment budgets varies across Member States (MS) it is clear that (all) MS have to pay an annual energy bill for water, electricity, gas or fuel (OPEX - operational Expenditure).

Although solar PV is a well-known and widely implemented technology, tremendous potential still remains to be exploited. One of the main reasons for this is the high CAPEX for such installations. **To overcome this barrier, a solution could be offered by power purchase agreements (PPA) involving a contractor who installs, maintains, and runs the installation.**

The use of PPAs for implementing solar PV not only shifts the budgetary provision from CAPEX to OPEX, but the budget used to pay the above-mentioned energy bill can also be used to pay for these types of contracts.

Scope and Objectives

This project idea would, therefore, explore the option of using on-site PPA for RES implementation (solar PV), essentially on rooftops or canopies, and evaluate best practices, feasibility and risks for its application within the armed forces.

Some concrete objectives:

- Create a good understanding of the on-site PPA concept by exploring and presenting the contractual forms, the duration and the involved entities.
- Elaborate on the common price-setting methods used within an on-site PPA and define which are the most suitable for the solar PV applications.
- Evaluate participating states cases through a survey to identify which practices are already being used and what lessons learned are already available.
- Evaluate the legal implications of on-site PPA for solar PV applications, covering ownership, contractual management of the excess electricity, "in volume" public property leasing for rooftops and canopies, maintenance, insurance and guarantees.
- Estimate the budgetary impact of on-site PPA projects by comparing them to full ownership of the solar PV installations (CAPEX).
- Explore opportunities for EU cooperation.
- Check market availability (supplier sourcing) for such PPA.

Impact and Opportunities

The installation of solar PV within the barracks of an MoD through PPA could **increase the rollout speed** (RES penetration) of these installations by lowering the required CAPEX. This would accelerate the **decarbonising** of military installations by implementing a well-known and proven technology.

Besides the increase of RES penetration, the on-site PPA will also **provide stability in energy cost** as the energy price can be decoupled from the energy market and its price fluctuations. Reduced price variation allows for more stable and easy budget planning, traditionally on a yearly basis, and could liberate funds since covering price margins will no longer be needed.

Furthermore, installing solar PV is a first step towards **reducing the grid dependency** of individual barracks.

Lastly, using an on-site PPA will also **shift the maintenance and output requirements to a third party** through the embedded service level agreements.

Challenges and Risks

Increasing the rollout speed of solar PV installations will not come without a challenge for MoDs. In order to publish a market tender for a specific site the contracting MoD will need to conduct site visits, group technical documentation, have insulated and watertight roofs and have a clear vision of the barracks and their use in the future. These non-exhaustive points will **generate a significant workload** that has to be absorbed by the available personnel and means.

The main risks related to the on-site PPA are mostly linked to **legal aspects.** Allowing external parties to exploit terrain/surfaces on lands and infrastructure owned by a national government, raises multiple questions:

- *What requirements (operational, technical...) will be set out for the technical installations or for selecting contractors?*
- *Which entity has the authority to give the rights to exploit those MoD terrains/surfaces?*
- *Which party is responsible for the insurance of the PV panels in case of fire or other natural hazards?*

Besides the legal aspects, the on-site PPA also **limits the 'freedom of movement'** within the barracks where the MoD has to take into consideration the impact of leasing surface for 10-20 years.

In addition, the impact of the bankruptcy of the contractor or external claims on his property could affect the exploitation of the solar installation to the point where the **ownership could transfer to a different third party.**

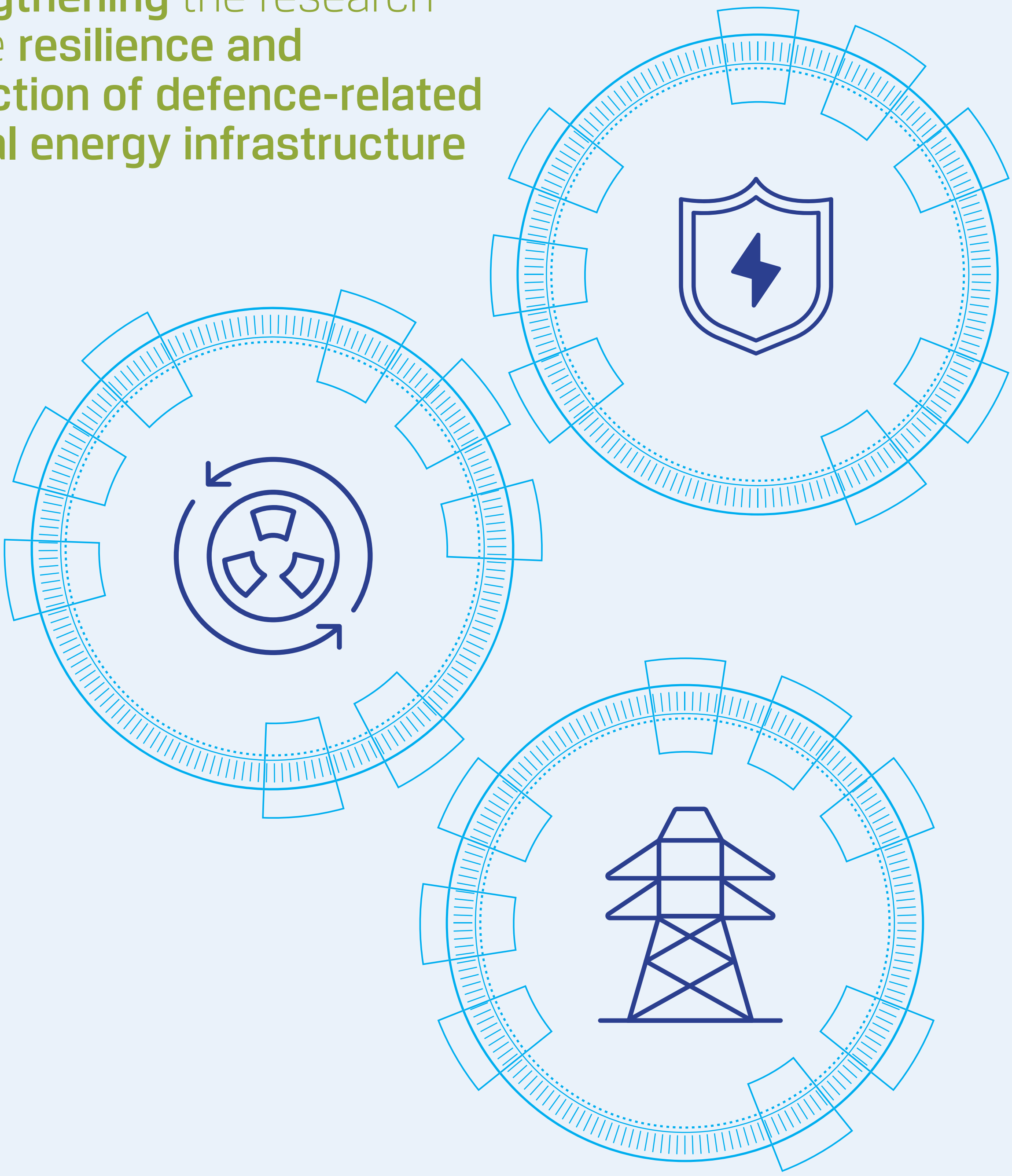
Way Ahead

Taking the project forward may require a contracting study, further elaborating on the opportunities and risks these PPA present for the armed forces on their path to carbon neutrality.

In addition, a survey would have to be conducted to gather information from the participating states with experience with these types of contracts. Their lessons learned can help all participating states to improve their contracts or to start implementing the concept.

5.3 CF SEDSS Working Group 3: Protection of Critical Energy Infrastructure

Strengthening the research on the **resilience and protection of defence-related critical energy infrastructure**



17. Defence Energy Data Protection

Background

The energy transition and the digital revolution are causing changes in equipment and military action methods, bringing new opportunities and risks.

Energy management is based on a prior knowledge of consumption to set goals for progress in terms of energy efficiency, both for systems and for facilities and mobility. The indispensable control of energy passes through several successive and complementary stages: the precise measurement of consumption by usage, their analysis, and the implementation of an improvement and optimisation strategy for energy performance.

The emergence of digital technology gives a glimpse of new perspectives in optimising energy consumption. Sensors and algorithmic analysis allow close monitoring and precise management, while modelling and the use of energy data offer the opportunity for predictive analysis, and thus energy optimisation. Digitalising military energy systems could, therefore, allow European ministries of defence (MoDs) to manage and reduce their energy consumption. Yet this digitalisation also creates new security issues, especially in cyber security.

Scope and Objectives

An adversary's interception and exploitation of energy data could lead to a comprehensive picture or even the anticipation of the armed forces' operational activities. For example, advanced analysis of electricity consumption data on the national territory could allow the detection of specific operational activities on dedicated military sites such as airbases.

This project idea aims to raise EU MoDs' awareness of the strategic nature of energy-related data and underline the specific risks associated with data interception and use by a potential adversary.

Project Analysis

While external operations abroad use their own supply-chain approach, partially independent of national networks and sources of electricity, this is not the case for sites on the national territory that are mostly, or with rare exceptions, supplied by the national civil network operators, whether public or private companies.

The large-scale collection and use of energy data allow the balancing of energy networks, the purchase and trade of electricity, and the improvement of energy efficiency. These effects are accentuated by the spread of access to energy data on shared or easy-to-access databases.

Methodology

The French MoD organised an Energy Data Hack in May 2021 to identify the risks and threats of adversary exploitation of energy data. Open-source electrical data has been available to civilian and military analysts. They had a few days to exploit the database to deduce the activities of public infrastructures (administrative buildings, industries, hospitals) for civilian participants and military infrastructures for the armed forces. The results of the data analysis made by the armed forces have not been published.

The participants of the CF SEDSS III, especially the working group 3 (WG3), which is focused on resilience of critical energy infrastructures, could lead a reflection on this topic.

Opportunities

- Develop a comprehensive approach to the risks related to energy data exploitation of MoDs;
- Improve energy resilience of MoD infrastructures;
- Raise awareness of the need to protect access of strategic energy data, including those stored by civilian partners such as electricity distribution system operator (DSO);
- Make sure that the European legislator takes defence issues into account.

Way Ahead

Conduct a simulation exercise to assess the vulnerabilities and threats associated with adversaries' interception and exploitation of energy data. This exercise should involve key stakeholders from the MoD s, cybersecurity experts, and civilian energy partners to develop robust risk management strategies.

18. Defence Energy Range (DER)

Background

Energy is an essential element of all critical infrastructures, including defence-related ones. The timely, predictable, affordable and sustainable energy supply for military facilities and non-military facilities on which military critically depends is vital for national and European security. However, we are undergoing a series of transformations which are leading to a complex and challenging security environment for defence energy concerns:

- The ubiquity of digitalisation leading to emerging risks, vulnerabilities and threats;
- The growing complexity of energy grids, which must accommodate intermittent energy sources and prosumers;
- The normalisation of hybrid and unconventional warfare targeting civilian infrastructures as well as measures under the threshold of war and with difficulties in attribution and collective response;
- The consensus on the need for shifts towards energy efficiency, decarbonisation and green energy.

The Defence Energy Range project offers decision-makers and planners a tool to understand the system-of-systems composed of the military building, the military facility, the network in which it is embedded and the national/regional perspective to anticipate defence energy issues, especially in a cyber context, to plan responses and to train responders, while also offering a basis for understanding the security impact of transformation such as the integration of new energy systems and control technologies. In addition to its security role, the Defence Energy Range idea also supports energy efficiency and transition priorities.

Scope and Objectives

The main objective of this project idea is the creation of a working prototype of a high-level platform (Defence Energy Range) for defence energy experimentation, training, validation and verification to integrate individual modules developed as part of the project or after its completion.

The platform would be endowed with specific modules related to energy usage analysis, cyber penetration testing, and other features, which will be determined during the project's definition phase. The list of features will also include a series of pre-built facility models and scenarios for testing with a teaching and training role. There are two key differences between the Defence Energy Range and other 'range' platforms.

It is, first, a federated range, bringing together energy and cyber issues. Secondly, it will integrate building information modelling software for greater detail and functionality. Though it is beyond the scope of the project proposal, the Defence Energy Range could also incorporate other software elements, such as life cycle assessment software that enables environmental impact analysis. The latter's use is growing in the design and building phase of construction, including military facilities, but it will also be essential to apply it in the context of expected retrofitting and change of existing facilities to comply with mandates for energy efficiency and security.

Project Analysis

The project idea addresses an emerging need to understand the complicated energy consumption and production profile of military buildings and facilities, including as part of wider networked systems such as urban areas, countries or regions, while incorporating the interactions between energy and cyber.

The need can be understood as having four components: understanding systems to identify emerging patterns, training personnel through scenarios, grounding decisions regarding energy allocation or investment, and assessing the security impact of the integration of new systems and new technologies.

The Defence Energy Range will offer a toolbox for decision-makers and facility managers from Member States to manage the growing complexity of defence energy issues in the context of cyber threats and structural shifts towards low emissions, green energy and energy efficiency.

Methodology

The Defence Energy Range should cover the following relevant levels:

- Individual building
- Camp/base
- Country/energy provision networks/governance
- Cross-national / EU-wide aspects

The individual buildings will be modelled by type (living quarters, offices, utilities, special buildings like hangar, berth, shelter, etc.) and probably building generation to the extent that relevant distinctions for energy management purposes can be modelled in terms of building information modelling data. The models should include simulation interfaces to sensors, that could simulate relevant environmental data. For instance, this would enable the building simulation software to react to environment-dependent energy consumption (HVAC), including prosumer behaviors.

Camp/base models will be used by integrating different building models/digital twins forming units to manage facility/local energy management and security management. This will include building management systems as targets of cyber-attacks. Site/camp models will be provided with energy provision/control interface simulation interfaces to simulate external prosumer interaction with energy providers.

To defend local energy provision, the digital twins will be provided as building blocks of cyber ranges for experimentation and exercises similar to the existing Locked Shields and Energy Data Hack.

To collaborate at regional, national, and transnational levels, the suitability of complementary aggregating simulation systems in use by energy (network) providers should be explored. The focus would be collaboration between the stakeholder (energy) management and governance systems. The information flows analysed by the Defence Energy Range will permit collaborative situational awareness. This includes models of overall energy consumption that provide sufficient levels of detail to simulate priority setting and decision-making.

Beyond energy network management, the platform will support the simulation of future "smart grid style" elements, which are notable in terms of fine-grained collaborative crisis energy management capabilities (e.g., collaborative, priority-based energy reduction of different prosumers). As an intermediary level of simulation, an additional urban dimension could be used to address the specific issues of energy network interactions between urban areas and military facilities located inside them or adjacent to them.

Deliverables

The project features an array of deliverables grouped under an energy range platform heading that integrates building information modelling software. The main elements of the project include:

- Modelling software platform with integrated BIM capability;
- Pre-existing archetypes and models for training and analysis (single buildings, bases, national military energy dependency network);
- A collection of pre-built scenarios for training;
- Relevant documentation and additional licenses for users.

Opportunities

The Defence Energy Range will serve both as a laboratory testbed for conceptual work and a platform for training. As such, it should be viewed as more of a toolbox containing combinable individual elements for the different levels ranging from BIM-enabled individual building-models to a multi-country model for testing cross-country provisions and a scenario collection used for test- and training-activities.

Taking into consideration the dynamic nature of the developments in the field, especially the drive for a zero-emissions end state, the framework should be amenable to development over time as well as the accommodation of alternative uses. Because of the inherent complexity of the potential use cases deriving from the needs of Member States and the complex nature of the subject, the toolkit will follow an "artificial world approach" that will allow the shared artefacts and a sufficient degree of abstraction suitable to the multiple levels of conceptual work, including for training and operational planning.

Way Ahead

After an overall proposal evaluation, a paper-based prototype version of the "energy range" could be built based on existing artefacts to be further explored in table-top exercises.

A second step could concentrate on a digital twin of a camp that should be developed and test implemented on a cyber range. A short-term benefit might be its availability for Red Team and subsequent life-fire exercises.

While the Defence Energy Range strictly focuses on energy provision, experience with similar developments shows that the range concept provides options to integrate other critical infrastructures over time in support of individual member state needs or respective R&D efforts. One possible avenue of development is water infrastructure and military dependency on civilian water and wastewater infrastructure.

19. Critical Energy Infrastructure and Electromagnetic Spectrum Threats (C(EST)2

Background

In physics, electromagnetic radiation (EM radiation or EMR) refers to the waves (or their quanta, photons) of the electromagnetic field, propagating (radiating) through space, carrying electromagnetic radiant energy. It includes radio waves, microwaves, infrared, (visible) light, ultraviolet, X-rays, and gamma rays.

All modern societies, in general, and militaries, in particular, depend on technologies using the EMS for communication, coordination and control capabilities. Telecommunications are a backbone critical infrastructure sector, and their evolution in the context of 5G, the internet of things (IoT), virtual infrastructure and other trends promise new efficiencies and applications and new risks, vulnerabilities and threats. These threats emanating from adversaries' exploitation of the vulnerabilities inherent in our use of the EMS are rapidly growing across both sides of the Atlantic, and they affect the defence-related critical energy infrastructures (CEI).

While cyber warfare has garnered most of the public attention, electromagnetic spectrum warfare is also growing rapidly and is becoming a key element of hybrid warfare toolboxes and a particular concern for decision-makers in charge of increasing resilience. It is also significantly interrelated with cyberwarfare, given the increasing use of the EMS for transferring information in complex systems (e.g., wireless components communications, IoT sensor suites etc.).

Project Analysis

The European Union (EU) must set the goal of developing EMS resilience for itself. This project proposal contributes to that inevitable effort by tackling these issues at the level of defence-related CEI.

The project proposes to analyse the current EMS threat landscape to defence-related CEI, to identify key trends, highlight potential solutions and generate, firstly, a methodology for assessing the vulnerability of defence-related CEI to EMS threats applicable voluntarily by EU MS, as well as a toolbox of best practices, commercial-off-the-shelf products and recommendations to increase resilience.

Through its limited component of stakeholder organisation into trust networks that can approach this issue from a multidisciplinary angle, the project provides an additional contribution to future European efforts in addressing EMS threats and enhancing European CI resilience to such threats.

Objectives

The project aims to identify the EMS threat profile of the European defence-related CEI and contribute to its amelioration through methods and deliverables that will support future European efforts in this field. These are the objectives of the project:

1. Investigate and map the EMS security profile of defence-related CEI, including power plants, electricity grids pipelines and various command and control capabilities;
2. Perform case studies on two or three discrete European CEI volunteered by the MS (for instance, one thermal power plant, one national electricity transmission operator, one national gas transmission operator);
3. Develop the toolkit to address EMS resilience issues and to support decision-makers;
4. Develop proposals for scaling up advanced electromagnetic spectrum management competencies and cooperation in the EU.

Opportunities

The project takes advantage of the alignment of certain key favourable factors:

- Increased awareness of the issue of EMS threats.
- Considering the United States Department of Defense work on the EMS Superiority Strategy, this project idea will also aim to i) develop superior EMS capabilities; ii) evolve to an agile fully integrated EMS infrastructure to pursue total force EMS readiness; iii) secure enduring partnerships for EMS advantage; and iv) establish EMS governance to support strategic and operational objectives;

- The current state of the art in IoT technologies and 5G implementation, also fraught with cybersecurity risks, presents a unique opportunity to implement resilience by design in new infrastructures and network capabilities, as opposed to trying to ameliorate problems post-fact;
- The potential for the European security industry, in the new context of European funding for cybersecurity, digitisation and climate change transition, to take a global lead in developing new EMS-resilient products and services;
- The drive in the European Armed Forces to recalibrate to address climate change creates an opportunity for paradigm shifts that enable security issues to be addressed as part of these investments;
- The global and regional conflicts have provided ample proof of the threat posed by hybrid warfare and the role that cyber and EMS warfare play in this, thereby creating a sense of urgency with regard to important security gaps, especially those resulting from military reliance on civilian infrastructure (energy, but also telecommunications);
- Since this is a current issue at the global level, the EU can take the lead in promoting resilient design, common standards and security-conscious development in line with other European priorities and values (such as addressing climate change).

Risks and Challenges

The project features a limited number of risks and uncertainties that must, nevertheless, be considered.

- Firstly, its interdisciplinary nature given the breadth of affected systems and the diversity of defence-related CEI means that the project team must be diverse, multidisciplinary and cross-sectional.
- Secondly, the mutable nature of the current hybrid security paradigm means that recommendations and best practices will have to be continuously updated, and the list of usable products and services will also be subject to frequent change beyond the lifetime of the project to stay current.
- Thirdly, the application portion of the project will require two or more Member States to facilitate a complete EMS threat analysis of specific defence-related CEI. This might be difficult to arrange, and there may be complications depending on the entity which is the owner/operator and its relationship to the government in question.

Methodology

The methods include:

- The in-depth analysis of critical infrastructure assets from an EMS perspective;
- Market analysis for the identification of commercial-off-the-shelf solutions with positive security impacts;
- Analysis of documents of reference concerning EMS resilience and existing methodologies;
- Foresight exercises regarding the evolution of the EMS-related security environment in the context of current technological trends;
- Network building to create the limited-scope stakeholder network envisioned to support the project's implementation and future European efforts in this field.

This project idea presents the proposed work packages and their respective deliverables:

1. Investigate and map the EMS security profile of defence-related CEI, including power plants, electricity grids pipelines and various command and control capabilities.

WP1 deliverables:

- General security profiles of CEI to EMS threats;
- Document on trends in the evolution of CEI exposure to EMS threats;
- Security environment analysis.

2. Case studies on two or three discrete European CEI volunteered by the Member States.

WP2 deliverables:

- EMS security assessment of chosen infrastructures;
- Historical study of CEI exposure to EMS warfare;
- EMS threat assessment procedure to be offered as a product to the Member States.

3. Addressing the EMS security threat.

WP3 deliverables:

- Identify and secure cooperation of a core EMS security expertise group;
- Best practices on securing CEI against EMS threats;
- List of technologies to be developed and existing technologies to enhance resilience to EMS threats.

4. Proposals for scaling up advanced electromagnetic spectrum management competencies and cooperation in the EU.

WP4 deliverables:

- Educational curriculum and associated pilot course organised with the European Security and Defence College (ESDC);
- Roadmap for European Electromagnetic Resilience Infrastructure Network.

Way Ahead

- Firstly, there is a need to identify two willing lead nations to enable the application portion of the project.
- Secondly, the scope of the project deliverables must be finetuned.
- The funding for the project must be identified, and a suitable consortium of entities covering the project's multidisciplinary needs must be formed.
- Lastly, the project must generate sufficient buy-in from Member States so that its deliverables will have an impact and will lead to a more wide-ranging and comprehensive effort to ensure EMS threat resilience.

20. Hybrid Attacks Response Team (HART)

Abstract

Hybrid attacks on critical infrastructures (CI) are often complex and obscure by nature. Threat actors are varied and can have different aims: infiltration, exfiltration, surveillance, control, damage, sabotage, denial of service, etc. Countermeasures are heterogeneous, and both cyber and physical defences (e.g., human factors) can play a vital role.

With this high complexity and diverse structure, **sharing best practices** can be a daunting challenge among CI operators, especially between different ownership statuses (state, privately owned or both), using different systems and processes located in different Member States (MS).

To **facilitate practice sharing** among CI and to **increase their overall defence readiness**, we propose the creation of a **practice sharing framework** composed of an incident-triggered technical task force, a regular indicator of compromise (IoC) sharing program and a series of regular multi-stakeholder meetings that allow for the dissemination of one or more incident-related case studies and best practices among CI representatives from all participating MS.

Background

In recent years, Europe has seen two primary hybrid attacks toward power plants:

- The December 23rd 2015, power outage in Western Ukraine at the Prykarpattya Oblenergo power plant [8] used a **malware** capable of compromising industrial control systems (ICS) that was **discovered one year prior** [9].
- Almost one year later, on December 16th 2016, a second attack on a power plant near Kyiv shut down the electricity in one-fifth of the Ukrainian capital for one hour; this malware had a function that launched a denial-of service (DoS) attack against Siemens protection relays [10].

Besides high-profile targeted attacks, CI suffers from a variety of other hybrid problems. Notable incidents include the 2016 malware outbreak in the Gundremmingen nuclear power plant in **Germany** [11], exfiltration and watering hole[12] attacks to CI in the **US, Turkey** and **Switzerland** discovered in 2017[13], the 2019 ransomware attacks in **South Africa** that left more than 250.000 residents of Johannesburg without power [14], the attacks to the largest Indian nuclear power plant also in 2019 [15], and a wide range of software failures, data theft and sabotage around the world.

8. https://www.welivesecurity.com/2016/01/04/blackenergy-trojan-strikes-again-attacks-ukrainian-electric-power-industry/
9. https://ics-cert.us-cert.gov/alerts/ICS-ALERT-14-281-01B
10. https://www.welivesecurity.com/wp-content/uploads/2017/06/Win32_Industroyer.pdf
11. https://www.reuters.com/article/us-nuclearpower-cyber-germany-idUSKCN0XN2OS
12. A "watering hole" attack is a compromise of a third-party website that is likely to be visited by users in a specific industry, think e.g. IHS Jane's for defence personnel or Stack Overflow for developers.
13. https://www.symantec.com/blogs/threat-intelligence/dragonfly-energy-sector-cyber-attacks
14. https://www.bbc.com/news/technology-49125853
15. https://eandt.theiet.org/content/articles/2019/10/cyber-attack-on-india-s-largest-nuclear-power-plant-confirmed/

The Problem

Most cyber-attacks are preventable. Malware gets reused, attack vectors are often the same, and hacking groups do not change their techniques unless forced to. And yet, detailed information about attacks rarely leaves the CI premises. Depending on procedures (national laws, internal rules), they are communicated to selected offices, but there is little or no sharing among the IT security community, also due to soft reasons such as avoiding bad publicity, fear of exposing sensitive CI information, unwillingness to convey a sense of weakness, etc.

Without dissemination of incident-related technical information (including IoC) among CI operators, it is difficult to learn details on hybrid attack vectors and features, knowledge that is paramount to the creation of updated best practices and new protection schemes. Today, the perception is that the sharing of experience among CI cyber security teams is scarce and not ensured by proper protocols.

The Proposed Solution

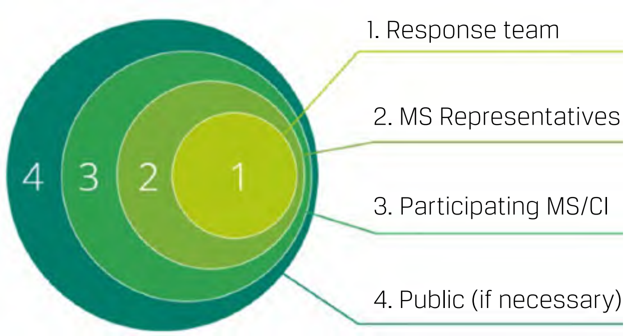
To help spread knowledge about current hybrid attacks, we propose the creation of an EDA-led framework that would have at its core a small (3-6 persons) group of IT security experts organised in a **post-incident team.** The task of this hybrid attacks response team (HART) would be to **investigate successful hybrid attacks** – or unsuccessful ones, if they are interesting enough – to any CI in a Member State by visiting the attacked CI premises and engaging in a series of meetings and data exchange with the technical staff of the CI, ideally those working in their security operations centre (SOC).

The team would then create a technically detailed report, indicating all necessary data useful to understand the attack, such as the vector, the IoC, the failed/successful countermeasures, and the consequences. The report would also indicate **suggested best practices** to avoid the success of a similar attack in the future. This report would then be presented in a **stakeholder meeting** with representatives from participating MS. Those representatives must be technically skilled to understand all aspects of the report.

Finally, each MS representative would **disseminate** the report and the information gathered during the meeting among all **pertinent CI in its State** (either with one or more local events, or with individual visits to selected CI, as the MS sees fit).

Note that meetings can be either in person or via remote connection. Both methods have advantages and disadvantages, e.g. in-person meetings are more secure and convey a higher level of intensity but require more time and resources to set-up than a simple webinar. The decision will likely be up to the team and the MS representatives, although it is safe to assume that high-profile attacks on an EU CI (e.g. with repercussions on the public, like blackouts) will likely call for an in-person meeting.

Figure 1: level of involvement by different groups/stakeholders



Main Objectives

The top objective of this project is to achieve a higher cyber-defence readiness for the CI in the EU so that the **same attack won't strike twice.** Ancillary objectives could also be reached:

- This cybersecurity sharing framework could promote CI practice sharing in other areas;
- EDA will have and nurture a team of experts in the protection of CI (→ skill growth);
- EDA will gain **first-hand practical knowledge of** hybrid activities from foreign threat actors.

Operational Details

- The response team should be composed of actual experts, not merely MS representatives. It would be helpful that each team member be a cybersecurity expert with a distinct specialisation, e.g., a SCADA/ICS expert, a phishing and social engineering expert, a malware analyst, a firewall/IDS expert, etc. MS will have their representatives in the multi-stakeholder group that will receive and discuss the team's report.
- MS representatives should be expert enough to understand the report in all its details, thus being able to relay it to their country's CI.

- Ideally, the response team should visit the CI premises in person, as a proper investigation can't be conducted remotely. They will need to see the logs, talk to SOC operators, and work with a higher information density than would transpire only from remote calls.
- In principle, the activities of this framework should not be open to the public and should not be publicised outside of the intended recipients, except in those cases where informing the general public is considered advantageous.

Challenges

Some CI might be unwilling to have an external group investigate their performance or "blunders" after an attack.

- Explain to CI that they will have **more to gain than to lose** from this project. They will receive reports on attacks from other CI, allowing them to strengthen their own systems: **the overall benefits greatly outweigh the inconvenience** of reporting on an incident.
- The affected CI might gain an advantage by having a team of experts on its premises. Although a full review of the CI systems would be out of scope, the team could be willing to help the CI personnel "in the here and now" to increase their defences.
- To obtain maximum cooperation, the response team should be trained to be non-judgemental and to refrain from any direct or indirect criticism during the visit. A MS representative could assist the team during the visit in the concerned country.
- Incident reports do not need to state which CI was involved, nor where (unless data makes it evident).
- Team and framework participants could be asked to get an EU security clearance.
- NDAs will be signed. A MS might not want to participate / might not want to allow the team inside a power plant for national security reasons.
- A decision should be made (by the response team) whether a remote assessment of the data could be sufficient to build the report.
- There "should" already be compulsory reporting between CI and its government (GDPR). EDA could ask to be informed of cyber incidents when they happen.

Way Ahead

- While the national CSIRT (Computer Security Incident Response Team) is the team designated for the abovementioned reports, this project idea proposes the establishment of a unit that goes **deeper** (e.g. with on-site visits and regular meetings), employs **industry-specific experts** (i.e. with knowledge of SCADA/ICS and CI operations) and operates within a national defence framework, being led, for instance, by the EDA.
- The framework not only drafts a report listing IoC; it also ensures that other CI receive the appropriate information that matters to them and creates moments of bidirectional exchange among all stakeholders.
- To address the above, it will require the CF SEDSS members to further elaborate on this idea in phase IV and present a concrete feasibility study for the Member State's review and guidance.

21. Towards an Action Plan for Military Energy Resilience

Abstract

The proposed project idea aims to assess the feasibility of creating an EU Action Plan on Civil-Military Collaboration for Critical Energy Infrastructures (CEI), referred to as the Action Plan for Military Energy Resilience (as an equivalent scheme to that of the European Union (EU) Action Plan of Military Mobility).

The idea aims to enhance cooperation between the ministries of defence (MoDs) and civilian CEI operators to ensure the resilience of energy supply for EU armed forces in case of disruptions. This idea will evaluate the potential benefits of developing an EU Action Plan, identify essential requirements and challenges for civilian CEI coming from the military, and assess the extent to which current policy and regulatory landscape can accommodate these requirements. It will also outline the structure of such an action plan focusing on military requirements, energy infrastructure, and regulatory and procedural issues and suggest a roadmap for its development.

Background

The EU's armed forces rely heavily on civilian CEI to meet their energy requirements. However, this means armed forces are vulnerable to disruptions of CEI services that are currently outside their purview. Hence, there is a need to enhance cooperation between MoDs and civilian CEI operators to ensure energy security in case of disruptions (including but not restricted to hybrid warfare scenarios).

A recent example of such collaboration between military and civilian authorities for another type of critical infrastructure (transport infrastructure) coordinated and facilitated at the EU level is the concept of military mobility and the related EU Action Plan. The EU Action Plan on Military Mobility is a comprehensive plan to improve the movement of military personnel and equipment across the EU and beyond. The plan was adopted by the European Council in March 2018 in response to concerns that existing infrastructure and procedures were hindering military mobility in Europe.

Scope and Objectives

The proposed project idea aims to assess the feasibility of creating an EU Action Plan on Civil-Military Collaboration for CEI referred to as the Action Plan for Military Energy. The idea focuses on identifying the essential requirements and challenges for civilian CEI coming from the military, evaluating the current policy and regulatory landscape, and proposing an Action Plan focusing on military requirements, energy infrastructure, and regulatory and procedural issues.

Additionally, the idea aims to provide a roadmap towards developing such an Action Plan, including key stakeholders and the role of the EDA. Specific objectives are to:

1. Identify the key requirements and challenges for civilian CEI coming from the military.
2. Assess how the current policy and regulatory landscape can accommodate these requirements.
3. Evaluate the potential benefits of establishing such an Action Plan at the EU level.
4. Sketch the outlines of an action plan with a focus on military requirements, energy infrastructure, and regulatory and procedural issues taking inspiration from the Action Plan on Military Mobility.
5. Propose a roadmap for such an action plan that includes key stakeholders and the role of the EDA.

Project Analysis

The proposed idea aims to comprehensively analyse the feasibility of creating an Action Plan for Military Energy Resilience. The analysis will involve the following tasks:

- **Task 1: Evaluation of Potential Benefits:** This task will assess the benefits of establishing an Action Plan on Military Energy Resilience at the EU level. It will include an analysis of the advantages for both the military and CEI operators, such as improved communication and coordination, enhanced situational awareness, and increased readiness to respond to disruptions in the energy supply chain.
- **Task 2: Identification of Key Requirements and Challenges:** The idea will identify the essential requirements and challenges for civilian CEI coming from the military, which will form the basis of the Action Plan. This task will involve expert interviews and a survey to gather information on stakeholders' perspectives and opinions and review relevant documentation and reports.
- **Task 3: Assessment of Policy and Regulatory Landscape:** This task will evaluate CEI's current policy and regulatory landscape and assess its ability to accommodate the requirements identified in Task 2. It will involve a literature review and analysis of existing policies, regulations, and guidelines as well as a proposal towards potential policy and regulatory changes needed to facilitate closer collaboration between the military and CEI operators (as part of an Action Plan).
- **Task 4: Outline of an Action Plan:** Building on the findings of Tasks 1-3, this task will outline the structure of an Action Plan with a focus on military requirements, energy infrastructure, and regulatory and procedural issues. The Action Plan will take inspiration from the EU Action Plan on Military Mobility, and the study will examine if the documentation produced for Military Mobility can be translated into suitable documentation for CEI.
- **Task 5: Roadmap towards an Action Plan:** The idea will propose a roadmap towards the development of an Action Plan, including critical steps needed and key actors that need to be engaged at each step, with a particular focus on the potential role of the EDA.

Methodology

The project will employ a mixed-methods approach, including a literature review, expert interviews, and a survey. The literature review will provide a comprehensive understanding of the relevant policy and regulatory landscape for CEI, while expert interviews will provide insight into the key requirements and challenges for civilian CEI coming from the military.

The survey (whose distribution will be facilitated through channels such as the EDA EnE Captech and the Forum) will gather information on stakeholders' perspectives and opinions. Relevant actors from the Military Mobility Action Plan (e.g., the Military Mobility PESCO project actors) will also be interviewed, and documents produced for Military Mobility will be examined to see if they can be translated into suitable documentation for CEI.

Deliverables

The project will produce a report summarising the research findings, including an analysis of the key requirements and challenges for CEI coming from the military, an assessment of the current policy and regulatory landscape, and a proposed roadmap towards an EU Action Plan on Civil-Military Collaboration for Critical Energy Infrastructures.

Opportunities

The proposed project presents an opportunity to enhance the resilience of EU defence forces by establishing closer collaboration between the military and civilian CEI operators. The project will identify potential benefits for both the military and CEI operators, including improved communication and coordination, enhanced situational awareness, and increased readiness to respond to disruptions in the energy supply chain. It should also be noted that the results of this project will help position the EDA in a leading position in the critical domain of civilian-military collaboration around CEI.

Way Ahead

The proposed project will provide a foundation for developing an EU Action Plan on Civil-Military Collaboration for CEI.

The project will identify key stakeholders and provide recommendations for the establishment of a dedicated civilian-military collaboration unit or agency. It will also identify potential policy and regulatory changes to facilitate closer collaboration between the military and CEI operators.

It can be used to initiate further research and collaboration (e.g., as part of a follow-up PESCO or EDF project, an EDA study or equivalent initiatives from Member States (e.g. CATB EDA Projects), to support the development and ultimate adoption by the EU of an Action Plan and the mobilisation of the relevant financial, regulatory and governance resources and tools needed to put the Action Plan into effect.

22. Sea Infrastructures Monitoring and Control (SIMC)

Abstract

This project idea suggests developing an innovative monitoring and control system for maritime infrastructures, including ports, offshore platforms, and submarine cables, as well as pipelines, natural gas pipelines, and internet connections.

Background

Recent events, such as the Nord Stream natural gas pipeline incident, demonstrate the sea infrastructure vulnerability. Regarding the Nord Stream incident, according to preliminary results of the damage site inspection, technogenic craters with a depth of 3 to 5 meters were found on the seabed at a distance of about 248 metres from each other. The section of the pipe between the craters is destroyed, and the radius of pipe fragment dispersion is at least 250 m[16].

Recently, several navies started monitoring and protecting critical infrastructures such as submarine cables. In this regard, endurance and range are key capabilities of AUVs (autonomous underwater vehicles). The two terms, endurance and range, are closely related and coupled through the vehicle's speed; at optimal speed, the AUV will travel the farthest, while at lower speed, the AUV will operate for a longer period of time.

16. https://www.nord-stream.com/press-info/press-releases/incident-on-the-nord-stream-pipeline-updated-02112022-529/

AUVs generally require power sources with high energy density and relatively low power density (due to typically low current draw).[17] Many studies are being conducted to increase AUV's energy efficiency, thus increasing the endurance and range of operations[18]. In addition to AUVs, ASVs (autonomous surface vehicles) and UASs (unmanned aerial systems) are constantly being developed.

To improve the endurance of the USV (Unmanned Surface Vehicle), an energy-efficient path planning approach for computing feasible paths for USVs that takes the energy consumption into account based on sea current data has been recently proposed[19].

Scope and Objectives

The Sea Infrastructures Monitoring and Control project's main objective is creating an innovative drones control system (DCS) to monitor and control the security of infrastructures such as ports, offshore platforms and submarine cables such as pipelines, natural gas pipelines and internet connections. The main objectives of the project are:

- Replace ship-based observation with autonomous drones which can be mobilised 24/7 regardless of weather conditions.
- Monitor suspicious activities conducted above and below the sea surface.
- Extend current efforts with data-driven operations based on shore-side models.
- Equip drones with an advanced AI decision engine capable of autonomously generating its goals based on online resources computation, continuous risk evaluation and models computed on shore[20].

Project Analysis

The core of the project is the development of the DCS module. This module will be developed to manage three different types of drones:

- UUV (unmanned underwater vehicle) or AUV (autonomous underwater vehicle) drones, developed to inspect, maintain and repair (IMR) the underwater infrastructures;
- USV (unmanned surface vehicle) or ASV (autonomous surface vehicle) drones, developed to monitor and control ports and offshore platforms;
- Stratospheric UAS (unmanned aerial system) or stratospheric drones, developed to identify suspicious activities on the water surface and to activate submarine and surface drones when needed.

UUV drones are well suited to execute inspection and light intervention missions on subsea structures, such as offshore wind farms, fish farms and oil & gas production facilities, pipelines and internet cables. These vehicles should also be able to complete simple maintenance and reparation activities.

A continuous IMR capability near the subsea installations without needing surface vessels means greener, safer, and less costly subsea operations. Subsea resident autonomous vehicles could minimize the cost of subsea operations. For missions of shorter duration, the vehicle may be launched from a ship or shore.

USV should be used to monitor ports and offshore platforms, identifying possible suspicious activities. The USV should be designed to be a cost-effective, man-power data collection platform with zero emission, extreme persistence and the capability of surviving extreme weather conditions.

Zero emission could be achieved solely by wave and solar power. UAS drones may be used to map the sea surface to detect malicious activities conducted by unidentified ships/ actors. Technology used to develop these drones may be developed even by start-ups and hydrogen-powered drones are also going to be more eco-friendly than conventional[21].

All types of drones should be characterised by high levels of automation. Energy-renewable sources such as solar panels should be used to increase autonomy and reduce the level of human intervention. Also, they should be able to characterise the detected events on a threat-level base. DCS module should be able to prioritise interventions of the autonomous drones according to level of threat.

17. https://www.diva-portal.org/smash/get/diva2:1658728/FULLTEXT01.pdf
18. https://kormushev.com/papers/Kormushev_IROS-2013.pdf
19. https://www.researchgate.net/publication/325371124_An_energy-efficient_path_planning_algorithm_for_unmanned_surface_vehicles
20. https://robots-wild-rss.github.io/rss2019-workshop/talk/rss2019_alberto_dallolio.pdf
21. https://www.edgeir.com/stratospheric-platforms-has-sky-high-ambition-provide-wireless-via-hydrogen-powered-drones-20211228

Methodology

The DCS module is expected to integrate the control systems of the three different types of drones (UUV, USV and UAS), allowing them to work together.

AI (Artificial Intelligence) algorithm will be used to guarantee continuous autonomous monitoring and control of the tridimensional space by the UUV, USV and UAS drones. The drones will be able to collect a significant amount of data related to sea infrastructures and related incidents.

The DCS module will elaborate on the collected data to underline trends and vulnerabilities. According to data gathered by drones, a forecasting system will be implemented. In view of the possible failure and attack scenarios generated by the forecasting system implemented, recovery plans will be defined to deal with the simulated impacts on the sea infrastructure model.

Deliverables

The project features an array of deliverables. Thus, the main elements of the project include:

- The state of the art of the UUV, USV and stratospheric drones;
- The DCS demonstrator to be realised taking into account solutions that guarantee security by design;
- A collection of impact scenarios automatically developed by the system;
- Relevant simulated red teaming activities to identify any critical issues and validate the recovery plans developed through specific malicious activities.

Opportunities

The DCS module developed will have the objective, on the one hand, to guarantee the monitoring and control of the tridimensional space and, on the other hand, to obtain a forecast analysis of the critical maritime infrastructures, thus increasing the awareness, protection, inspection, maintaining and repair of the infrastructure itself. This system will have its main application in the actual hybrid scenario where the confrontation among states manifests itself also in the control of maritime infrastructures.

Way Ahead

After an overall proposal evaluation, a prototype version of the DCS could be built.

Another step could be to develop the digital twin of typical maritime infrastructures to simulate the behaviour of the DCS in different situations.

Finally, the advantage of the SIMC model is integrating the control systems of the three types of drones considered. In particular, the UASs will be able to control the USV and the USV will be able to control the UUV in a hierarchical management mode[22].

22. https://robots-wild-rss.github.io/rss2019-workshop/talk/rss2019_alberto_dallolio.pdf

23. Shore Connection Energy Security

Abstract

This project idea suggests the development of an innovative energy management system (EMS), starting from the study of electrical shore connections between a naval base and ships connected to the shore in cold ironing (or shore connection) mode.

Background

A high voltage shore connection (HWSC) is a connection used to connect ships to the main grid, shutting the ship's engine to reduce energy consumption and carbon emissions. This technique allows the ship to use the energy directly from the naval base grid. However, connecting different Marine ships to a naval base's grid may lead to several security issues: *when connected to shore, a ship is more vulnerable to cyber incidents*[23]. This brings the greater risk of unauthorised access or malicious attacks to ships' systems and networks[24].

Ships are becoming increasingly integrated with shoreside operations because digital communication is used to conduct business, manage operations, and retain contact with head office. Furthermore, critical ship systems essential to the safety of navigation, power and cargo management have become increasingly digitalised and connected to the internet to perform a wide variety of legitimate functions such as:

- Engine performance monitoring;
- Maintenance and spare parts management;
- Cargo, loading and unloading, crane, pump management and stow planning;
- Voyage performance monitoring.

The above list provides examples of this interface and is not exhaustive. The above systems provide data, which may be of interest to cyber criminals or state-sponsored APT (advanced persistent threat) to exploit.

Modern technologies can add vulnerabilities to ships, especially if networks are insecure and there is uncontrolled access to the internet. Additionally, shoreside and onboard personnel may be unaware of how some equipment producers maintain remote access to shipboard equipment and its network system[25].

At first sight, the standard of electrical connection for military ships seems to be similar to that of commercial vessels and cruise ships. However, there are remarkable differences between them, which are given by "operative requirements."

Indeed, a vessel usually spends a high percentage of its operational life in a condition called "ready to start a mission." This situation implies many features "at berth" in naval stations, as follows[26]:

1. High standard of power quality in supplying various relevant loads (e.g., combat system's loads);
2. Proliferation of voltage levels;
3. Choice of frequency (50 or 60 Hz);
4. Shore connection sizing relating to maximum power dimension of an electrical plant;
5. Practical issues.

Scope and Objectives

The main objective of the Shore Connection Energy Security project is the creation of an innovative EMS to monitor and control the interface between the ship and the naval base during shore connection activities.

The EMS aims to map the port grid and simulate different ships' connections. Discontinuities in electrical signals may suggest suspicious activities on the electrical network.

The project's objective is to create an EMS demonstrator characterised by appropriate redundancies that ensures security by design and is capable of emulating the consequences of possible crisis scenarios. This will increase security from an energy and cyber perspective.

23. https://www.hattelandtechnology.com/blog/cyber-security-vulnerabilities-on-board-ships
24. https://www.ics-shipping.org/wp-content/uploads/2020/08/guidelines-on-cyber-security-onboard-ships-min.pdf
25. https://www.ics-shipping.org/wp-content/uploads/2020/08/guidelines-on-cyber-security-onboard-ships-min.pdf
26. https://arts.units.it/retrieve/handle/11368/2869798/410826/2869798_09-PostPrint.pdf

Project Analysis

The project's core is the development of the EMS module. This module will be developed since the model for the study of electrical power transits within the naval base, on the analysis of transients in the phase of connection/ disconnection of vessels moored at the dock. The electrical model will be appropriately validated using the collected real data.

The large amount of data collected will be processed using data science techniques and big data analytics to obtain behavioural trends of the naval base. The model to be developed will also have to consider the assessment of the naval base electricity dependencies on the external network and other harbour infrastructure services.

Through this model, the objective is to identify and study the discontinuities and grid irregularities generated by the connection between the ship and the port, as well as by other possible impacts, to be able to cope with them through appropriate recovery mechanisms. Starting from the identified criticalities, it will be possible to develop a methodology of analysis which allows to increase the knowledge of the port network system through appropriate KPI (key performance indicator), KRI (key risk indicator), KVI (key vulnerability indicator) and KTI (key threat indicator).

Through advanced predictive algorithms, it will be possible to create the interdependence matrixes among the various components of the network (i.e. the matrixes representing the functional dependencies of the components composing the network), including the chain effects (the so-called "domino effect") of the interruption of the operation of each component on the others and identifying the different vulnerabilities to changes in the configuration of the network itself (due to the discontinuities resulting from the connection/disconnection of other ships).

Through machine-learning algorithms, it is possible to obtain an in-depth knowledge of the behaviour of both the naval base network and its effects caused by the connection of ships at the quayside. In this way, it will be possible to provide the basis for developing a predictive analysis model to make available to the decision-maker the best possible information asset and thus ensure the correct allocation of resources to maintain energy continuity.

Methodology

The EMS module is expected to combine the energy flow model of the naval base with the methodology for the study of critical issues to create an integrated management system that is able, on the one hand, to carry out monitoring and control activities on the network of the naval base and on the other hand to produce forecast analysis for the management of critical issues.

This module will be realised starting from the model of the electricity network, the data network that controls it and the electromechanical components, integrating advanced simulation systems able to provide a predictive picture of the possible impacts on the naval base by impacts on the electricity/energy network.

Furthermore, a system for optimising load profiles will be developed, with consideration for the characteristics of prosumer (i.e. both energy production and consumption) and instability, both intrinsic and inducted of the harbour energy network, especially regarding the behaviour of the 50 / 60 Hz conversion units at the docks. The EMS module will, therefore, allow both the identification and analysis of any generator overloads or other grid anomalies and their management by means of appropriate actuators for power regulation. In view of the possible failure and attack scenarios generated by the forecasting system implemented, recovery plans will be defined to deal with the simulated impacts on the infrastructure model.

Deliverables

The project features an array of deliverables. A naval base should be selected to realise the electrical model and the EMS demonstrator. Thus, the main elements of the project include:

- The modelling of the naval base electrical grid;
- The EMS demonstrator to be realised taking into account solutions that guarantee security by design;
- A collection of impact scenarios automatically developed by the system;
- Relevant simulated red teaming activities to identify any critical issues and validate the recovery plans developed through specific penetration tests on the realised model.

Opportunities

The EMS module developed will have the objective, on the one hand, to guarantee the monitoring and control of the electricity grid and, on the other hand, to obtain a forecast analysis of the critical points of the ships that interact with a naval base, thus increasing the awareness, protection and energy efficiency of the port. Finally, with a view to dual-use application, such a system would also have implications in civil harbours. It would make it possible to improve the electrical/energy management of various services (logistics, loading and unloading of ships, handling of goods), while at the same time reducing operating costs, operating times and environmental impact (emissions, noise).

Way Ahead

After an overall proposal evaluation, a prototype version of the EMS could be built. A second step could concentrate on a digital twin of the naval base to simulate the interaction between the base itself and the connected ships. A digital twin is a virtual representation of a physical object or system across its entire lifecycle. It uses digital tools and real-time data to virtually create, test, build and monitor a product or process, closing the feedback loop between design and operations. It's an ingenious approach that facilitates transformation without risking operations. Digital twin technology has already been applied to the Port of Rotterdam, Europe's largest and busiest port.

24. Situation Awareness System for Systemic Decision Support for Defence Energy Infrastructures

Background Description

The critical (energy) infrastructure system of systems is very fragmented. It has a large number and variety of assets, resources, actors, owners, etc. It requires a situational awareness watchdog system that can integrate various information flows as a backdrop to decision-making, separate from the command-and-control system of the individual asset controllers.

A close example of this is the military's War Room, where decision-makers collate and interpret data before making decisions. Numerous types of sensors (in-situ, in space) and remote sensing techniques benefit us already. We must also consider the different data systems and data formats involved, which make it challenging to develop such an application at the level this document is proposing, while also taking into account the willingness to share data on the part of various actors.

The system can become a component of one which is also predicated on control, but it can also be used by non-controlling stakeholders (like defence sector energy users) to foresee problems with civilian systems and coordinate responses adequately.

Project Analysis

Situational awareness systems exist for individual asset owners but not for systemic stakeholders, whose security profile requires them to maintain awareness of an entire system's functioning. These would likely be regulators but also important consumers, such as the defence sector. Militaries require such a system to support adequate energy security governance for their assets (bases, etc.); not having such a system opens the defence sector to hybrid warfare operations aimed at civilian energy infrastructures on which it is critically dependent and hinders the militaries' future efforts at ameliorating this vulnerability.

We must also determine which standards will be used for the integration and security of data streams. Another issue is to make an inventory of systems and components to include – assets, resources, networks etc. While no technological advance or development is needed, the project still requires the application of existing techniques so data is collected and fitted within a logical scheme for its future processing and visualisation.

An important issue arises when data does not directly originate from its own sensors but from intermediaries with specialised collection roles, such as infrastructure operators. How do we make them share such important data on a continuous basis—authority, financial incentive, threat of punishment, convincing them of the importance, etc.? How would we position the actual user of the project platform within an organisation? This is important to state from the perspective of a decision-making flow.

The project ultimately proposes a geographic information system linking multiple data streams and with analysis capabilities based on the latest technologies related to AI and machine learning. The work packages presented towards the end of the document underscore these features.

Objectives

The project will enable real-time data flow integration. It must provide for an increasing level of (pre)-processing of data using AI and machine learning to provide valuable inputs for decision-makers. The user (defence sector or other) may then decide on further processing or on making a decision, even in the absence of control over the asset being monitored. Decisions involve activating fail safes, implementing emergency rationing procedures or deploying backup energy systems. The system provides actionable insight.

The data flow will eventually allow for coherent and rich data visualisation techniques, including through the use of Geographic Information Systems. Digital twinning is also an important element for the system topology that enables the creation of an added value for the end user. The complexity which can be supported by the platform will be sufficient to enable its use by government regulators, the military, or emergency response coordinators.

The platform will minimise the need for developing new hardware or software by utilising off-the-shelf products and pre-existing standards. It must also create an added value by also integrating relationships with important suppliers, such as Earth Observation data providers. The platform will also be usable for simulation, training and scenario development, which are vital in the rapidly shifting security environment to stay ahead of potential adversaries targeting civilian systems to erode defence sector capabilities.

Impact – Expected Outcomes

Firstly, such a platform provides the capability to identify and prevent cascading disruptions in critical infrastructures, especially energy-related ones. If widespread adoption of its components takes place in a sector, the project will also lead to the harmonisation of risk communication between companies, regulators, and authorities within the EU.

The platform enables better decision-making, compared to information sharing through points of contact without real-time data feeds, through situational awareness and the lower time for feedback reception. However, the integrative role of the system creates a new vulnerability in the existence of the system itself, whose host facility may become the target of physical or cyber-attack and disruption, which will require specific measures to prevent and mitigate. The system, as envisioned here, does not presuppose the existence of asset control on the part of the user, though it is possible for integration within such capabilities.

The platform offers the possibility of better communication with the general public and the political class, through the use of products like screenshots, videos, time lapses and reports by public communicators such as journalists, politicians and public intellectuals. Communication with the public is increasingly important on the part of all stakeholders, including the defence sector. Thus, it becomes a public communication tool for the defence sector, including with other institutional stakeholders, keeping in mind the need to maintain operational and informational security, including the sensitivity of highlighted security problems.

Opportunities

There is already a demand for such platforms, stemming from the growing complexity of the system of systems. Platforms of this type are already utilised by the operators of single assets or of networks. Therefore, we do not have just beneficiaries but also a potential user base outside of the defence sector.

The project contributes to the development of other projects dependent on complex situational awareness capabilities, by providing a key capability for integration in a command and control system, or one dedicated to other types of system governance activities (training, research etc.). There is the opportunity for very cost-effective development and implementation through the use of off-the-shelf products and mature technologies.

Risks and Challenges

Financial uncertainty is one of the main challenges, given the unknowns of developing a usable product. Another risk is mission creep, where the list of features and capabilities balloons until the project exceeds its time and budget. It is important for a minimal viable product to be defined and built, leaving it to beneficiaries to decide future avenues of development and new features. Therefore, the product needs to be defined with a realistic list of features and elements to ensure completion and delivery, based on consultation with the main envisaged stakeholder, the defence sector, specifically actors in charge of military bases.

We have numerous potential legal constraints – data protection, data confidentiality, proprietary data from companies in the area of situational awareness etc. There is the possibility of information overload, which is why we rely on AI and machine learning. The difference between this platform and other war room applications, mostly at the single asset level, is that, as the number of assets and relationships grow, we have a cascading complexity phenomenon leading to an exponential increase in interactions and, consequently, in the capacity for producing new vulnerabilities and threats. This generates challenges in making sense of the data, identifying the changes in the security environment and prioritising actions over others. Without the application of new systems, the war room platforms can only encompass systems at the level of complexity, detail and size, which is still intelligible and provides actional intel to users.

MS would have to commit to using this product at some level. This may be complicated because regulators and many companies already use and maintain geographic information systems for their activities, though the current proposal exceeds their capabilities and complexity. We must also consider the general unwillingness to share data and to cooperate not only between states but also among infrastructure owners/operators. While the system is applicable at the national level, we should also consider the challenges of its use cross-border; since energy networks do not stop at borders, neither do the risks and threats which will become increasingly relevant through the ongoing Europeanisation of the energy system-of-systems.

Methodology

Application-oriented project. The tasks include:
- Integration of existing solutions;
- Use of data analytics, advanced AI and machine learning to generate added value through analysis (example, selection by AI of most relevant information and most pressing threats, with machine learning used to increase accuracy of decisions);
- The integration of feedback from potential users;
- The analysis of existing war room and situational awareness platforms, to identify capability gaps and also existing solutions which would be integrated off-the-shelf;
- Use of rapid prototyping and of scenario testing to improve platform without wasted resources;
- Aiming for the maximum TRL of 5-6 and use of a minimum viable product philosophy.

Work packages:
- WP1 – Security environment analysis with an all-hazards approach;
- WP2 – Analysis of the state of the art;
- WP3 – Data sourcing analysis;
- WP4 – Prototyping data stream integration and visualisation;
- WP5 –Prototyping use of AI and machine learning in data selection and synthetic indicator;
- WP6 – Pilot testing;
- WP7 – Integrate feedback, assessment, recommendations;
- WP8 – Product development – outreach, standardisation, manuals, training support etc;
- WP9 – Management.

Way Ahead

Firstly, we need to find a willing lead nation whose MoD would also coordinate some key partners from academia and the private or state sector. Then, we must pare down the project ambition until it is achievable by a limited number of actors. The project may be split into two phases, the first incorporating WP 1-6 or 1-5.

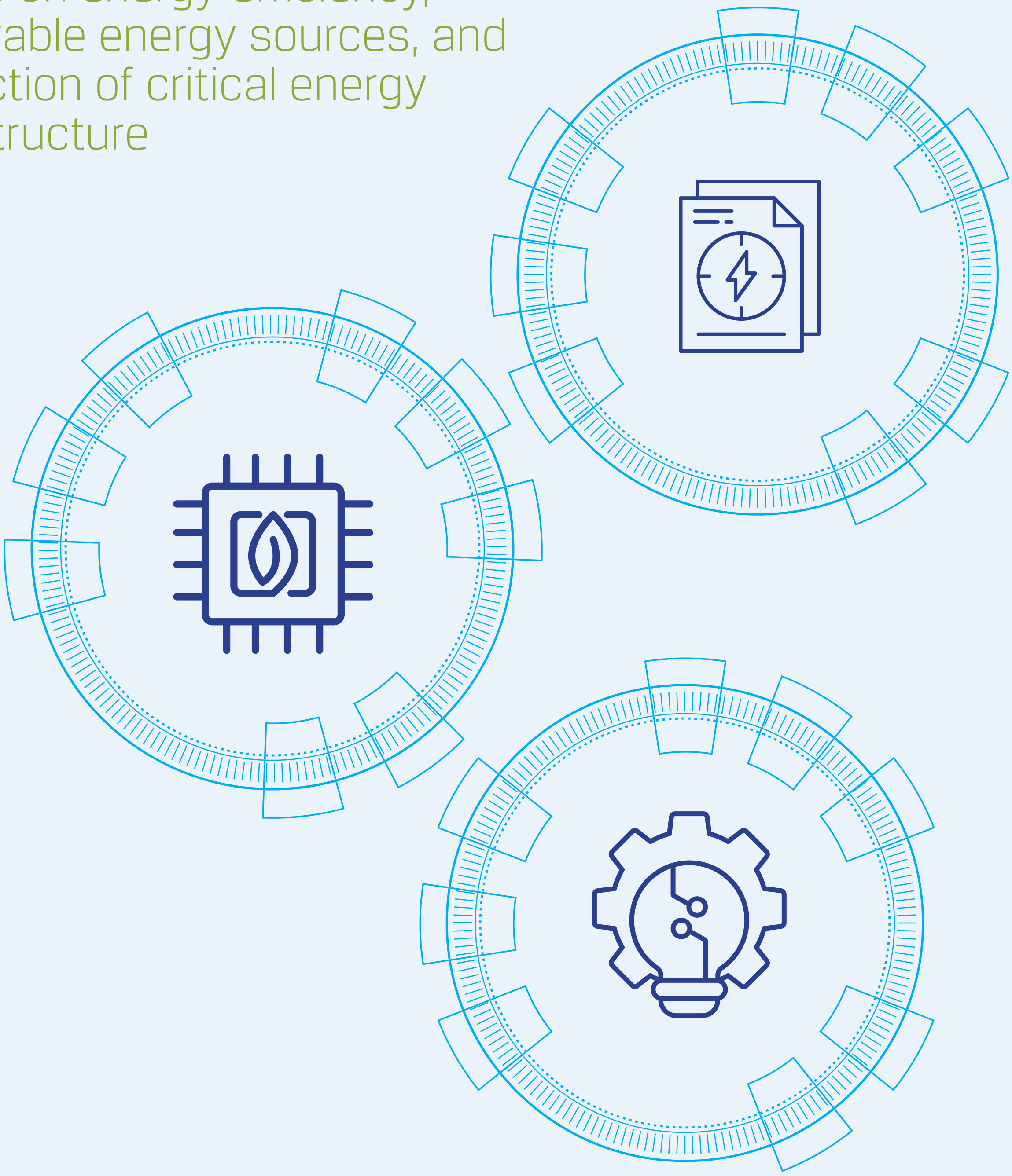
The funding must also be considered an issue, with some actors being able to make in-kind contributions. This means we must identify the actors who have the competencies to be involved and contribute to a sustainable initial financial framework.

This implies also outreach to promote the project. To ensure future funding success, one should pursue signed agreements with companies and authorities willing to test the platform, provide data and facility access for testing, or even implement it in pilot form.

Ultimately, the maximisation of benefits and revenue from the project will depend on a strategy for its development into a commercially viable product.

5.4 CF SEDSS Transversal Working Group:

Addressing cross-sectorial topics on energy efficiency, renewable energy sources, and protection of critical energy infrastructure



25. Defence Energy Behaviour Management System

Background

Since 2015, the European Defence Agency (EDA) has managed the Consultation Forum for Sustainable Energy in the Defence and Security Sector (CF SEDSS), Europe's largest defence energy expert community. The Forum helps the Ministries of Defence (MoDs) of the European Union (EU) move toward efficient, resilient, and sustainable defence-energy models. In this regard, it facilitates the sharing of energy-related information and best practices, increases energy efficiency and building performance, uses renewable energy sources, and increases the resilience of critical energy infrastructure.

To ensure coherence in the above thematic areas, the forum addresses cross-cutting energy-related perspectives such as energy policies and management, innovative energy technologies and financing schemes. The particular focus on the energy management policy dimension will support the MoDs in establishing energy and environmental policies, strategies, processes, roadmaps, and methodologies. Moreover, tools to further advance the defence energy transition and strengthen the culture are completing the CF SEDSS scope.

Problem Analysis

During the CF SEDSS phases I and II, the analysis of defence energy behaviour and the recommendations presented in the guidance document were focused on the application of the capability-opportunity-motivation-behaviour

(COM-B) approach. This approach was tested in numerous research and management projects, including investigations of energy-saving behaviour in the military. Applying the COM-B model for defence-energy behaviour change leads to a better understanding of pro-environmental conduct in the military facilitates. The COM-B model works in a context where three factors of behaviour (capacity, opportunity, and motivation) are surrounded by command and control of managerial interventions.

However, in 2018 the Lithuanian team of researchers extended this COM-B approach to clarify the existing interdependencies and interactions among the peer/fellow soldiers at selected military units in Lithuania. The results of this research strongly indicate the need for the extension and elaboration of the original COM-B model from individual energy behaviour patterns towards group/team-based energy behaviour.

The CF SEDSS Transversal Working Group (TWG), supported by other CF SEDSS working groups, considers designing and implementing an energy-related behaviour system as part of the energy management system (EnMS). It is expected that this designed and implemented defence-energy behaviour framework will facilitate national authorities and MoDs in reducing energy consumption and increasing energy efficiency and resilience, thus contributing to the achievement of EU climate and energy targets in a very cost-efficient way.

Scope and Objectives

This project idea aims to explore the opportunity to design and implement a defence-energy behaviour model at battalion-size military units or military installations.

More specifically, the **objectives** of this project aim to:

- Identify and analyse the existing civil energy behaviour models and provide recommendations on the potential applicability of those models for military and defence.
- Analyse the existing COM-B energy behaviour model and provide recommendations on the potential extension of this model for team/group dynamics.
- Analyse the existing energy-behaviour-related managerial systems among the EU MoDs and identify better practice solutions that can be applied to the defence energy behaviour model.
- Design the defence energy behaviour management system.
- Design energy behaviour-related process groups and install standard operating procedures.
- Integrate the energy-behaviour-related process groups into the EnMS.
- Propose EU MoD for the test exercises for the designed energy behaviour management system and run the test.
- Prepare the respective testing reports and improve the initial defence-energy behaviour managerial model.
- Prepare the Defence Energy Behaviour Handbook and receive feedback from EU MS MoDs.

In addition to research and analysis, the implementation and use of the energy behaviour framework will result in the appointment of energy behaviour managers who will be responsible for managing changes in energy conduct in selected military units/ battalions.

Methodology

The project's methodology is based on desk research and analysis of existing energy behaviour models. Energy behaviour subject matter experts will also provide input and guidance during the energy behaviour model design. Defence energy behaviour knowledge and competencies accumulated during the previous CF SEDSS phases will also be used to design and implement the respective energy behaviour management systems. The designed energy behaviour models will be tested in selected MoDs to improve the quality of the initial proposed energy behaviour management frameworks.

Impact and Opportunities

The defence energy behaviour management system, as a part of EnMS, will support EU MoDs in:

- Enhancing the long-term efforts on improving the performance of defence-energy, resilience and autonomy, while ensuring alignment with the EU efforts for achieving climate neutrality by 2050;
- Accelerating the sharing of energy defence related better practices and military cooperation in the defence-energy domain;
- Providing valuable defence-energy behaviour information for the other interrelated initiatives.

Challenges and Risks

Four key types of project risks have been identified:

1. Risks related to the competencies of the project implementation team competencies related risks;
2. Low level of interaction with key stakeholders;
3. Low contribution from subject matter experts;
4. Changes in project leadership.

Way Ahead

To promote the implementation of the defence energy behaviour management system, the following two actions need to take place:

- Launch consultations and interaction among the CF SEDSS working groups to clarify needs and future benefits of this project;
- Appoint a defence energy behaviour management system initiating team and leading MoD.

26. EU Defence Energy Scorecard

Background

Since 2015, the European Defence Agency (EDA) has managed the Consultation Forum for Sustainable Energy in the Defence and Security Sector (CF SEDSS), Europe's largest defence energy expert community. The Forum helps the Ministries of Defence (MoDs) of the European Union (EU) move toward efficient, resilient, and sustainable defence-energy models. The Forum places particular emphasis on addressing cross-cutting thematic areas on energy management and policy and energy innovative technologies and solutions.

Problem Analysis

Previously, the efforts to assess defence energy at EU MoDs were focused on collecting data on energy use. This approach of collecting defence-energy data followed by an extensive analysis of future energy-related is a good starting point for energy-related initiatives at MoDs. However, assessing defence energy is much more than just collecting data on energy usage/consumption. Elaborated assessment and analysis approaches can open other initiatives, including benchmarking opportunities among the EU Member States (MS). They can catalyse better practice sharing among the MS and lead to coordinated EU MoD efforts to position them as exemplary energy usage and management institutions.

The initial analysis of available scientific and managerial sources on state-level energy assessment frameworks and interrelated energy scorecards indicate the need and the prospects for more elaborated and extensive assessment besides the energy usage data. Other strategically important perspectives such as energy intensity in buildings, potable water intensity, renewable electricity, facility efficiency investments, data on high-performance sustainable buildings, fleet petroleum and alternative fuel, greenhouse emissions, sustainable acquisition, as well as other energy-related areas, are important to take into account.

The CF SEDSS Transversal Working Group (TWG) supported by other working groups of the Forum considers the design and implementation of an EU Defence Energy Scorecard as a beneficial energy assessment and benchmarking tool for further improvement of defence-energy efficiency and energy resilience among EU MS. It is expected that this designed and implemented EU Defence Energy Scorecard framework will assist national authorities (MoDs) to reduce energy consumption, increase energy efficiency and resilience, and thereby contribute to the EU climate and energy targets.

Scope and Objectives

This project idea aims to explore the conditions for designing and implementing an EU Defence Energy Scorecard that will be used by EU MoDs for benchmarking and as a better practice-sharing solution. In the end, this will support MoD-level initiatives to improve energy and energy resilience status. This project aims to design and implement a suitable assessment and an EU Defence Energy Scorecard-based framework for defence energy. More specifically, the objectives of the EU Defence Energy Scorecard aim to:

- Identify and analyse existing energy scorecards at the national/state level;
- Provide recommendations on the potential applicability of the know-how that was accumulated in the public/civil area;
- Analyse existing energy-related assessment frameworks among the EU MoDs;
- Design an energy assessment model that will lead to the design of the EU Defence Energy Scorecard;
- Propose a testing exercise of the assessment framework to the EU MoDs and run the test assessment;
- Produce the EU Defence Energy Scorecard;
- Prepare testing reports and improve the initial assessment model and the EU Defence Energy Scorecard;
- Prepare a Defence Energy Assessment Handbook as well as EU Defence Energy Scorecard modelling policies and procedures;
- Design and test an ITC solution for energy-related data collection and benchmarking analysis;
- Assist in establishing an initial benchmarking and better practice sharing and coordinating teams of EU MoDs for the respective EU Defence-energy monitoring.

Implementing and using the EU Defence Energy Scorecard will result in the establishment of permanent Defence Energy Assessment Teams within EU MoDs. These teams will be engaged in the following key activities:

- Activity 1: Collection, analysis, and sharing of defence energy-related data among EU MS.
- Activity 2: Sharing best practices among the EU MoDs.
- Activity 3: Offering support to MoDs to launch defence energy initiatives.

Methodology

The project methodology is based on desk research and analysis of existing energy and energy-related assessment frameworks and scorecards. The analysis is extended to a subject matter expert-based approach. Dedicated subject matter experts will provide input and guidance by applying their defence-energy-related judgment about assessment, scorecarding, and benchmarking related to standard operating procedures. Knowledge and experience accumulated during CFSEDS activities will also be used for defence energy assessment and benchmarking modelling, resulting in the EU Defence Energy Scorecard.

The designed defence energy assessment model and the EU Defence Energy Scorecard are planned to be tested at proposed MoDs to improve the quality of the assessment framework and consequently the EU Defence Energy Scorecard, including the practical aspects of this respective framework.

Impact and Opportunities

The EU Defence Energy Scorecard at EU MoDs would:

- Enhance a structured, coordinated, long-term/ longitudinal approach to defence-energy, resilience, and autonomy measurement. Additionally, this will support defence-energy related initiatives, while ensuring alignment with the EU efforts for climate neutrality by 2050;

- Accelerate the sharing of defence-energy related best practices and military cooperation in the energy and climate change domains;
- Provide valuable defence-energy information based on benchmarking approaches and methods.

Challenges and Risks

Four key types of project risks have been identified:

1. Project team competencies related risks;
2. Low level of interaction with key stakeholders and among the key stakeholders;
3. Low contribution from subject matter experts;
4. Changes in project leadership and project team personnel.

The following key types of further impact and benefit-related risks are identified below:

- Political risks:
  - Low MoDs buy-in at the political level;
  - Time and willingness of the MoDs to participate in the EU Defence Energy Scorecard and benchmarking initiative.
- Operational risks:
  - Setting up and maintaining the operational team with appropriate skills;
  - Execute benchmark initiatives according to the defined scope.
- Financial risks:
  - Obtaining a reasonable budget;
  - Creating a sustainable economic model.

Way Ahead

The CF SEDSS community is expected to positively influence the commitment of EU MoDs to engage in the EU Defence Energy Scorecard project and follow up on energy benchmarking initiatives. To be effective, this should require two preconditions:

- Launch the consultations among the CFSEDSS working groups to have a clear understanding of the needs and future benefits of the project;
- Appoint the project initiating team and leading MoD;
- Market the project idea and its benefits.

27. VirMES (Virtualisation of Multi Energy Systems)

Background Description

Future energy systems for defence applications will rely on advanced energy infrastructure featuring high energy efficiency, a high share of renewable sources, low emissions of greenhouse gas emissions and other toxic emissions, minimum multi-objective life cycle assessment (LCA) footprint, and a high level of resilience and adaptability to the local environment as a well as sources. These renewable systems are exposed to intermittency, which, in addition to the much higher heterogeneity of the system, significantly increases the complexity of their proper design as well as more control and monitoring. Therefore, reliable, interoperable, standardised control and monitoring model-based tools, denoted as VirMES modelling framework, represent a critical aspect to optimise the systems and to minimise associated risks to boost safety.

Project Analysis

Planners, energy managers, maintenance and site managers need a reliable tool that offers a fast representation of existing energy system performance and fast analysis of planned solutions. This respective tool would enable insight into the current energy situation for the particular site and for each element of that site. It significantly increases the awareness of energy situation including energy dependence, vulnerability, greenhouse emissions, system dynamics, life cycle costs and reliability.

VirMES would enable the planning of efficient future energy systems, and the same tool should also be applicable to monitor the current situation in real-time, which could be performed with the same model as used for planning or with its scaled version. When planning and designing the energy efficiency renovation and implementation of renewable energy sources, including energy storage, the tool would enable a fast prediction of design and prediction of life cycle costs. After implementation, the tool would enable real-time monitoring and control and would serve for maintenance activities. The solution leads toward implementing virtualisation of existing infrastructure and energy systems and virtualisation of future energy systems and energy efficiency elements.

Ministries of defence (MoDs) need ownership and full access to the source code of the simulation and modelling tools to ensure sovereignty over the entire process from planning, development, production, and maintenance to disposal. VirMES needs to serve all EU armed forces to assure interoperability and energy-efficient systems of camps.

Objectives

- Establishing a virtual environment;
- Developing a virtual tool for planning, designing, monitoring, control, maintenance and cost estimation of energy systems;
- Decreasing logistics and carbon emissions footprint of infrastructure;
- International cooperation and enhancement of industrial cooperation;
- Supporting the EU in achieving carbon neutral goals;
- Faster and consistent energy renovation of defence infrastructure;
- Interlink to e-mobility by implementing Grod-to-Vehicle(G-V) and Vehicle-to- Grod) (V-G).

Methodology

MoDs organised within a user club or similar need ownership and full access to the source code (or at least to the entire backbone structure and all critical functionalities) of the VirMES modelling framework to assure sovereignty over the entire process from planning, development, production, and maintenance to disposal.

Suppliers of energy management systems have access to the entire code and, along with other stakeholders engaged by MoDs, are responsible for upgrading the code according to a clear vision defined by the user club.

Component suppliers obtain a clearly defined interface, protocols, standards, and all other relevant information to develop proprietary component-level control and monitoring tools (which might not necessarily be fully disclosed to the user club) that are fully compatible with the VirMES modelling framework.

Impact

- Established virtual environment
  - of existing energy consumption;
  - of potential existing energy source, storage, and consumption;
  - of potential future energy source, storage, and consumption.
- Developed virtual tool;
- Decreased logistics and energy-efficient deployable smart camps;
- Significant impact on resilience and environmental protection and decrease of energy costs within defence sector;
- EU-wide use of a common virtual tool as an open source limited to MS;
- Standardisation of models and protocols
- High potential for dual use – interlink to civilian based smart cities;
- High impact on innovation potential on system or component levels:
  - Delivers the generally applicable advanced system-level modelling framework for the design of multi-energy-based renewable energy systems for defence applications;
  - Delivers component and system models that can be used in software-in-the-loop (SiL), hardware-in-the-loop (HiL) and XiL applications during demonstration activities on higher technology readiness levels (TRL);
  - Delivers component and system models for control and observer applications;
  - Provides the basis for standardisation activities.

Way Ahead – Next Steps

- Performing a feasibility study;
- Organising and implementing an international project;
- Organising a European-based user club.

28. Defence Energy Resilience Model

Background

Since 2015, the European Defence Agency (EDA) has managed the Consultation Forum for Sustainable Energy in the Defence and Security Sector (CF SEDSS), Europe's largest defence energy expert community. The Forum helps the Ministries of Defence (MoDs) of the European Union (EU) move toward efficient, resilient, and sustainable defence-energy models. The Forum places particular emphasis on addressing cross-cutting thematic areas on energy management and policy, energy innovative technologies and will identify the applicable funding or financing instruments for defence energy-related topics.

Problem Analysis

The emerging concept of a defence energy resilience framework is inseparable from energy security and other closely related aspects, such as energy efficiency and protection of critical energy infrastructure. However, most energy and environmental management systems focus on energy efficiency or environmental sustainability. Balancing the energy efficiency and energy resilience requirements provides new insights into energy security and energy assurance. In this regard, the concept of energy resilience and resilience management have to be included in energy management systems (EnMS).

However, to include energy resilience in defence, energy resilience assessment and valuation approaches have to be additionally explored, and new tailored-made energy resilience management maturity models and scenario-based energy resilience assessment approaches have to be analysed.

The CF SEDSS Transversal Working Group (TWG) supported by other CF SEDSS working groups considers the design and implementation of energy resilience assessment approach and energy resilience management as part of the EnMS. It is expected that the designed and implemented defence energy resilience framework will assist national authorities and MoDs in reaching the required balance among energy efficiency and energy resilience.

Scope and Objectives

The project aims to explore the conditions for designing and implementing a defence energy resilience model at a battalion-size military unit or military installation. More specifically, the defence energy resilience model intends to:

- Identify and analyse the existing energy resilience models;
- Provide recommendations on the potential applicability of the know-how that was accumulated in the public/civil area;
- Analyse the existing energy resilience models that have been previously used by the defence sector;
- Provide recommendations on the potential applicability of the know-how that was accumulated in military;
- Design the energy resilience assessment model the energy resilience related process groups in order to align them with EnMS or energy related standard operating procedures;
- Indicate EU MoDs for the testing exercise of designed and implemented energy resilience assessment and energy resilience management system;
- Integrate energy resilience assessment and energy resilience management system as well as process groups into EnMS;
- Prepare testing reports and improve the energy resilience assessment and management model;
- Prepare a Defence Energy Resilience Handbook and a Defence Energy Resilience Management Systems Description as well as approving it amongst stakeholders.

Methodology

The project methodology is based on desk research and analysis of existing energy resilience models, both civil and military. The analysis will be extended with an expert-based approach. Subject matter experts will provide input and guidance about the potential energy resilience management system. Knowledge and experience accumulated during CF SEDSS activities will also be used to design and implement energy behaviour management systems at EU MoDs.

The defence energy resilience model is planned to be tested in selected military units to improve the quality of the proposed energy resilience assessment and management framework.

Impact and Opportunities

The energy resilience assessment and management systems will support EU MoDs in:

- Enhancing the existing EnMS at military units;
- Enhancing the coordinated and long-term efforts on defence energy and defence energy resilience and autonomy, while ensuring alignment with the EU efforts for climate neutrality by 2050;
- Accelerating the sharing of energy defence related better practices and military cooperation in the energy and climate change domains;
- Providing valuable defence energy resilience information based on the experience from designing, implementing, and using energy resilience management systems.

Challenges and Risks

Four key project risks groups have been identified:

1. Risks related to the competencies of the project implementation team;
2. Low level of interaction with key stakeholders;
3. Low contribution from subject matter experts;
4. Changes in project leadership.

Way Ahead

The CFSEDSS community is expected to positively influence the commitment of EU MoDs to the installation of defence energy resilience systems. Paving this way forward should require two preconditions:

1. Sharing expertise and debate among the CF SEDSS III working groups to have a clear understanding on the needs and future benefits of this project;
2. Appointment of the defence energy resilience assessment model initiating team and leading MoD.

29. Joint Defence Energy Policy Toolbox

Background

Since the initiation of the 3rd phase of the CF SEDSS and the establishment of the Transversal Working Group (TWG), several challenges have emerged in supporting the defence energy transition. Achieving the targets of individual ministries of defence (MoDs) and the European Green Deal is possible but requires urgent and decisive action.

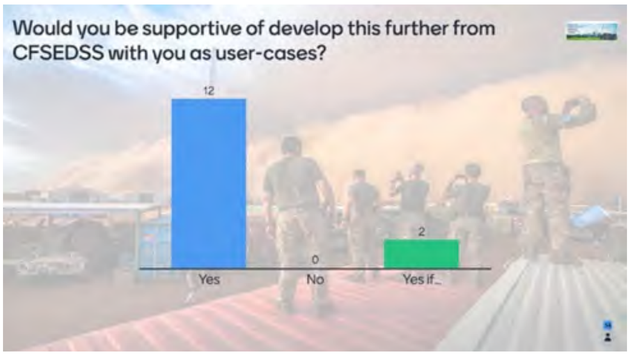
Policymakers aim to recognise the roles of all actors and stakeholders, including the MoD, private sectors, individuals, and households at local, national, European, and international levels. They seek to create an inclusive and participatory environment that supports low-carbon energy choices.

A coordinated combination of policies, measures, and instruments is needed to shape an effective and consistent regulatory system. This system will help MoDs identify and acquire the most suitable and valuable energy transition products and systems, ensuring these ideas are implemented effectively in European military cooperation.

Project Analysis

Policy officers can create an effective and consistent environment to enable these processes. Sharing the needs in several EU member states and a joint action in making use of the effort and knowledge that several policy areas are putting forward would be beneficial. Connecting from the policy view in a cross-cutting manner with relevant developments in other CF SEDSS working groups or relevant European military networks would make the policy work even more effective.

A Joint Defence Energy Policy Toolbox would provide tools supporting European military policy departments to make use of the joint knowledge, developments, best practices, potential financial instruments, decision-making supportive mechanisms and tools, (e)-learning and training facilities, leadership support and communication products. Most of the TWG considered the development of the Joint Policy Toolbox very valuable. A toolbox like this has not been made available until now. Designing favourable tools on behalf of more MoDs will help save costs and have a multiplier effect in the creation process as well as the user process.



Objectives

This project idea has the following objectives:

- Make the energy dimension in the policy area tangible for policy officers to work within the common policy workframe;
- Influence (military) behaviour of decision-makers;
- Cultivating an energy culture in MoDs;
- Promote the use of smart energy systems, including performance indicators and energy targets.

To achieve this, the following elements are proposed to be gathered, designed and shared in a toolbox:

- Create knowledge products related to a joint energy transition (webinars, infographics, factsheets, scorecards etc.).
- Use supporting communication tools like videos, podcasts of best practices, storytelling, etc.
- Financial tools for:

(a) Identifying a place for shared best practices business cases, roadmaps, projects, strategies etc. of MoDs;

(b) Designing education and training tools (like e-learning, shared training and leadership support).

Methodology

This project will identify what valuable policy tools are currently available within MoDs. In addition, it will define the requirements, including policy tools, and design these with policy officers from several MoDs and relevant institutes. MoDs will be able to use the Joint Policy Toolbox and keep its content up to date based on regular questionnaires and/or outcomes of the CF SEDSS. In this way, an enabling flywheel will be created, which will be validated continuously in this process from a multiview perspective (military and policy included).

Impact and Opportunities

- Accelerating and enabling policy environments resonating with a European cooperative defence energy culture.
- Establishing a coordinated way of realising policy-supportive tools.
- Lowering costs of relatively high-cost products, by jointly creating them.
- Creating a promotional wave for energy in the MoD policy/decision-making processes.
- Contributing to a unified approach in Europe on the way forward for energy transition (and transformation) in the MoD-domain.
- Acceleration in obtaining possible policy solutions to move forward from a joint European (multi-stakeholder) perspective to benefit European military capacities with the right choices of low-carbon energy.
- Creating impact on MoD-level to show more tangible tools to enable all CF SEDSS working groups and their implementation of the follow-up of projects.

Challenges and Risks

The main risks are related to creating the right boundaries for the Joint Policy Toolbox project scope since they are aligned to support the core policy processes in MoDs. An important challenge will be maintaining momentum while collaborating with representatives from various MoD departments. Viewing the diversity of policy approaches as an enrichment rather than attempting to unify them is crucial and should be addressed in other forums.

Way Ahead

Taking the project forward will require follow-up meetings with the CF SEDSS TWG participants and other working group team leaders to define the scope and identify what is already there and which particular tools need to be designed.

Ad-hoc expert meetings with policymakers of the CF SEDSS working groups should be organised to design the specifications for the tools to be included quickly. The group will also need to focus on how the Joint Policy Toolbox itself needs to be designed so that it is easy to use for all participating MoDs, gathering a network of users and experts to guide its building process.

30. Capture and Documentation of Successful Decarbonisation Initiatives

Background

The Corps of Engineers in the Irish Defence Forces (IE MoD) has been monitoring and managing energy use in the organisation since 2009. The IE MoD was the first military organisation to get ISO 50,001 'Energy Management Accreditation' in 2012. Since then, it has leveraged the standard to deliver energy savings and reductions in greenhouse gas (GHG) emissions. The IE MoD is committed to meeting the targets laid down in the EU 'Green Deal'. It is assessed to have been reasonably successful in reducing carbon emissions. Best practices and lessons learned were shared in the context of the CF SEDSS community, which expressed interest in further elaborating on them.

Scope and Objectives

This project idea aims to capture and document the practices that have worked for military organisations in their approaches to reducing GHG emissions. The project should facilitate them to adopt successful decarbonisation practices quicker thus creating momentum and shorter project lead-in times. The scope will include infrastructure and all forms of transport (road, maritime and aviation).

Project Analysis

The project should aim to capture and document decarbonisation initiatives that can be replicated and scalable. The IE MoD has been faced with the same challenges as other armed forces. The national defence building stock is primarily comprised of infrastructure that was constructed in the 19th century and is of a heritage value. This, coupled with road, maritime and aviation mobility as a significant contributor to GHG emissions, creates serious challenges to advancing the decarbonisation journey.

The project needs to focus on the 'toolkits' that will provide military decision-makers with the information to navigate the 'minefields' associated with energy and carbon reduction initiatives. The project will consider the security challenges associated with data from military installations and the applicable civilian solutions that can be adapted for military use.

Methodology

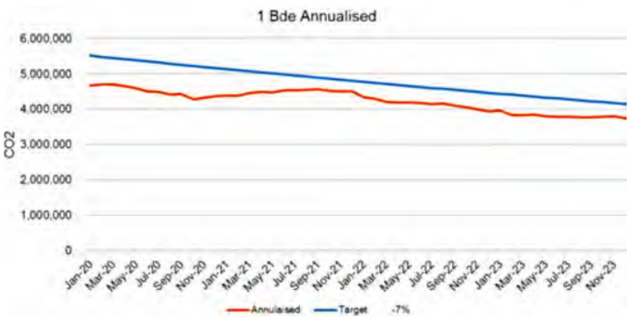
Initiatives that are delivered on carbon reduction need to be identified and documented. They should be collated so that personnel working on energy management have guidelines and tools to assist them. The initiatives can include work practices, behavioural changes, technological solutions, cultural changes, etc.

The management of carbon reduction processes in military organisations also needs to be examined. Leadership and buy-in from senior management will have the most significant impact on energy savings and GHG emissions reduction in military organisations.

Proposed Solution

The project will capture the lessons learned in a format that can help subsequent users to maximise the benefit and put the initiatives into practice at the earliest opportunity. The initial exercise that must be completed is data capture. To quantify the challenge, one needs to know the end goal and where one is in relation to it.

The graph below indicates the flight path (blue) to achieve net zero carbon in 2050 and 51% reduction of carbon by 2030 based on the 2016-18 carbon emissions for one of our Brigades. The orange line indicates the actual carbon emissions. This frames the challenge succinctly.



A Senior Management Energy Executive or Committee needs to be established to endorse SMART carbon reduction targets and develop a decarbonisation roadmap with an annual plan and programme of work. The Energy Executive needs to drive the programme with quarterly or bi-monthly meetings at the operational level.

This structure will signal to the organisation that senior management is committed to delivering on the carbon reductions.

Impact and opportunities

The impact that the energy executive will have on the organisation will be immediate, but energy saving opportunities (ESO) must be acted upon. A data-driven approach needs to be a central tenet in the process.

Opportunities will arise in the following areas:

- Road Transport
  - Introduce carbon budgets for military units.
  - Use EVs for all administrative journeys.
  - Change drivers' behavior.

- Infrastructure
  - Measure the energy being used by installation and by large buildings.
  - Understand the variable that is driving the energy use.
  - Deal holistically with refurbishment works to a building to improve energy efficiency.

- Marine and Aviation Transport
  - Focus on the efficiency of the ship/ plane and adopt a realistic energy metric.
  - Maximise the use of SAF and biofuels.

Challenges and Risks

The main risks are that organisations may slavishly follow a process that works for others but is not suitable for them. Organisations will have to be judicious in selecting any particular carbon reduction initiative. Analysis is required to ensure the project's applicability, and adjustments or amendments may be needed.

Way Ahead

Taking the project forward will require a template to document and capture the initiatives systematically. The shared platform of successful decarbonisation initiatives will only work if military organisations approach this project with an openness and willingness to be fully candid with the success/failure of energy projects undertaken.

6. CF SEDSS Management Team

CF SEDSS Project Management Team

Constantinos Hadjisavvas, *CF SEDSS Project Manager*
Maja Kuzel, *CF SEDSS Deputy Project Manager*
Alessandra Lazzari, *CF SEDSS Administrative Coordinator*

CF SEDSS Working Group 1 "Energy Efficiency and Buildings Performance"

Ilias Manolis, *WG1 Team Leader*
David Martin Borreguero, *WG1 Moderator*
Massimo Maraziti, *DG ENER*

CF SEDSS Working Group 2 "Renewable Energy Sources"

Jim Burke, *WG2 Team Leader*
Dirk Wauman, *WG2 Moderator*
Henrik Dam, *DG ENER*

CF SEDSS Working Group 3 "Protection of Critical Energy Infrastructure"

Ioannis Chatzialexandris, *WG3 Team Leader*
Alexandru Georgescu, *WG3 Moderator*
Nektarios Nasikas, *WG3 Moderator*
Natanael Cartaxo, *DG ENER*

CF SEDSS Transversal Working Group

Giorgos Dimitriou, *TWG Team Leader*
Moritz Haller, *TWG Deputy Team Leader*
Shana Leclercq, *TWG Moderator*
Robert Šipec, *TWG Moderator*
Gintaras Labutis, *TWG Moderator*
Xander Beks, *TWG Moderator*
Nicholas Kyriakides, *TWG Moderator*
Pierre Di Toro, *TWG Moderator*
Claudia Canevari, *DG ENER*
Oronzo Daloiso, *CINEA*

EUROPEAN DEFENCE AGENCY

European Defence Energy Network

CF SEDSS III
Consultation Forum for Sustainable Energy in the Defence and Security Sector

www.eda.europa.eu | @EUDefenceAgency

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 882171