NATO ENERGY SECURITY
CENTRE OF EXCELLENCE

# ENERGY MANAGEMENT HANDBOOK:

## ENERGY MANAGEMENT FOR MILITARY DEPLOYED FORCE INFRASTRUCTURE

Written by NATO ENSEC COE, MILENG COE, NRCan, and UK MOD

**AUDIENCE**

The handbook should be a help to all personnel that are dealing with energy management in a mission or operation. This manual is primarily meant for tactical level, but everyone with interest in the topic might find it interesting.

Process developed in collaboration with Bright HF Limited, Trimetis Ltd, and BAE Systems (Defence Information).

## ENERGY MANAGEMENT HANDBOOK WAS PREPARED BY:


### NATO Energy Security Centre of Excellence:

Lt. Col. Cezary Kozłowski (POL Army)
Lt. Col. Massimo Dacchille (ITA Army)

### MILENG Centre of Excellence:

Lt. Col. Jean-Michel MEYER (FRA Army)
Lt. Col. Laurent Bellot (FRA Army)

### Natural Resources Canada:

Martin Kegel (CanmetENERGY)

### UK MOD:

Jennifer Doran (Dstl)

# Content

# Preface

During NATO summits (2016-2018) nations have declared *"We will further improve the energy efficiency of our military forces through establishing common standards, reducing dependence on fossil fuels, and demonstrating energy-efficient solutions for the military"*[1] and *"We will also further improve the energy efficiency of our military forces, including through the use of sustainable energy sources, when appropriate."*[2]

Energy, most often fuel and electricity, is indispensable to the sustainment of military operations. Military forces use large quantities of fossil fuels during operations and, in the specific case of Land forces, a substantial proportion of this consumption is dedicated to electrical power generation for Deployed Force Infrastructure (DFI).

The demand for energy during military operations has been increasing over the years, in part because camps and military personnel have been equipped with additional high energy demanding equipment that provides both increased fighting capabilities, defence capabilities and, in a general way, quality of life. The inefficient use of generators in camps, poor insulation of shelters, and a lack of desire or awareness of the requirement to control energy consumption have contributed further to the expanding energy demand. This has significantly distracted time and resources away from the primary mission of operations.

DFI should be more efficiently powered and managed, resulting in a reduced logistics burden (and commensurate reduced Force Protection) to sustain the camp, giving commanders greater flexibility, without sacrificing operational capabilities and while providing military personnel with an improved quality of life. Beyond the consideration of the personnel and logistics costs, plus the economic benefit, there is a need to consider enhancing capabilities to improve energy efficiency (EE), depending on the operational situation.

Often when talking about energy saving, the idea is attached to doing things such as switching off electrical equipment or lowering temperature, which can be thought of as removing some kind of a good, thus for many people energy saving is associated with a negative experience for the energy user. However, energy saving can bring many benefits to the energy user, such as improved indoor climate conditions and reduced noise from energy generating equipment.

## PURPOSE OF THE DOCUMENT

The purpose of the Energy Management Handbook for DFI is to explain the principles of, and provide advice on, the practical application of an energy management process during deployment. The purpose is not to dictate a list of EE measures that should be applied in every deployed camp; rather, the reader of the handbook should use the guidance to successfully implement an energy management process at their camp and apply context-specific measures. The handbook is primarily focused on Tier 2 standards of services and accommodation and, to a limited extent, Tier 3.[3]

The information is intended to assist and to provide a Quick Reference Guide for those personnel who are required to plan, deliver, evaluate, and support EM measure(s) to a force deployed on an expeditionary operation. This handbook is written to assist personnel in the following roles:

- The deployed Officer or Senior Non-Commissioned Officer in charge of implementing the energy management process (e.g. the Energy Manager);
- The deployed Environmental Officer;
- The deployed Infrastructure Officer;
- The deployed Engineering Officer;
- The operational Joint Engineer Officer.

Wherever possible, the relevant staff from the list above should become familiar with the handbook during their Pre-Deployment Training phase.

## EXCLUSION

This handbook is not intended for use as a planning-tool at the strategic and operational levels, but it can be a good source of information at these levels to understand the practical work required in the field of energy management.

[1] Warsaw Summit Communiqué, Issued by the Heads of State and Government participating in the meeting of the North Atlantic Council in Warsaw 8-9 July 2016, Issued on 09 Jul. 2016.
[2] Brussels Summit Declaration, Issued by the Heads of State and Government participating in the meeting of the North Atlantic Council in Brussels 11-12 July 2018, Issued on 11 Jul. 2018.
[3] Descriptions of the Tiers representing standards of services and accommodation can be found in Introduction v.

# Introduction

## I. STRUCTURE OF DOCUMENT

This handbook should be used by the Energy Manager[4] to guide them through implementing an energy management system inspired by the ISO 50001 four phase continuous improvement process for effective energy management: PLAN; DO; CHECK; ACT. Therefore, this publication is divided into four chapters accordingly, and each chapter is then divided into three sub-chapters to address the three pillars of energy management (see Figure 1), which are: **Command and Control (C2)[5]; Technological Applications; Behaviour Change**.

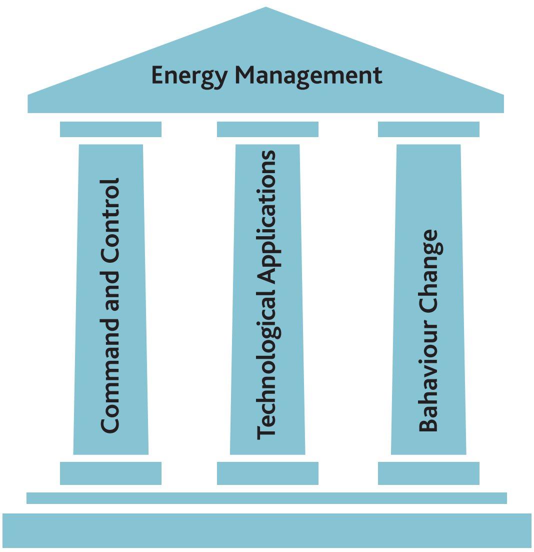



**Figure 1: The Three Pillars of Energy Management**

A concise description of the four phases is provided below.

➤ **Chapter 1 – PLAN:** explains how to develop an energy management action plan(s), based on an energy baseline study, to successfully identify measures to improve the EE of a DFI. The length of this chapter (PLAN) reflects the larger amount of effort required in comparison to the other phases of energy management (DO, CHECK, ACT).

- Command and Control;
- Technological Applications;
- Behaviour Change.

➤ **Chapter 2 – DO:** explains how to implement the action plan(s) developed under Chapter 1 (PLAN).

- Command and Control;
- Technological Applications;
- Behaviour Change.

➤ **Chapter 3 – CHECK:** explains how to monitor, measure, and report the impact of EE interventions implemented under Chapter 2 (DO), at appropriate time intervals.

- Command and Control;
- Technological Applications;
- Behaviour Change.

➤ **Chapter 4 – ACT:** explains how to take actions on results observed during the Chapter 3 (CHECK) activity and how to repeat the cycle to identify new strategies to continuously improve the energy performance of DFI and share lessons learned more widely for the benefit of other areas of the camp and other deployed camps.

- Command and Control;
- Technological Applications;
- Behaviour Change.

Figure 2 provides a visual representation summarising how the chapters combine the ISO 50001 four phases of continuous improvement process and the three pillars of effective energy management. Each page of the four main chapters of this handbook are colour coded to match Figure 2, for ease of reference. For example, all guidance related to the PLAN phase will be found on blue coloured pages, and all guidance related to the DO phase will be found on light green coloured pages.

At the end of each chapter a corresponding checklist is provided. In the same way an example of energy management case study will be found at annex G.

[4] See understanding of Energy manager under key terms.

[5] In this handbook, the term Command and Control is used instead of Organisational Management.

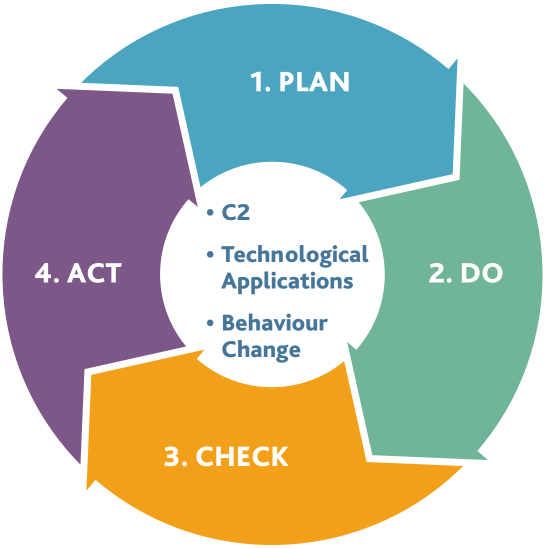



Figure 2: The Energy Management Process

## II. COMMAND AND CONTROL (C2)

Command is the exercise of authority and direction by a properly designated commander over assigned and attached forces.

Command and Control (C2) functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission.

The Energy Managers needs to identify and to understand the C2 in place in order to gain immediate benefit for execution of their duty. They also needs to identify as soon as possible the main stakeholders inside and outside their camp who will facilitate the implementation of the energy management tasks. Therefore, operational level commands should outline internal C2 responsibilities regarding energy management, to be able to support and enable the Energy Manager to complete their activities at the tactical level. At NATO level, the Chief MILENG is one of the privileged interlocutors (see sub-section vi for more information on MILENG).

## III. FUNDAMENTALS OF TECHNOLOGICAL APPLICATIONS

In the context of energy management for DFI, technological applications are used to identify trends, problems, and areas for improvement in energy use as well as implementing energy reduction measures using existing resources. Through metering, monitoring and walk-throughs an energy baseline can be established and used to identify suitable EE measures that can target Significant Energy Use (SEU) areas. Having an energy baseline also means that energy reductions from proactive improvements can be quantified.

The energy manager will need to be aware of what energy data is available to him/her and what tools are available to support the decision making. Along with monitoring the energy data of a camp, the energy manager will also need to have a good understanding what the energy metrics mean and what the energy performance indicators (EnPIs) are telling him/her. With that, the energy manager can consider what existing resources can be utilized within a camp to enable a more efficient camp operation. Additional information on energy in the DFI is provided in Annex F for the energy manager's reference.

## IV. BEHAVIOUR CHANGE

The behaviour change pillar of energy management follows a process known as the '7 Steps to Energy Behaviour Change' (7SEBC). The overarching behaviour change process is presented visually in Figure 3, and is essentially a method that guides the Energy Manager through the following seven steps, which are incorporated into the core PLAN-DO-CHECK-ACT phases at the heart of this handbook:

**1. *Scoping*** is the first step and is concerned with establishing the range of the possible energy behaviours and issues.

**2. *Context exploration*** is a step focused on collecting relevant baseline data on the possible energy behaviours and issues (e.g. through observation audits and surveys).

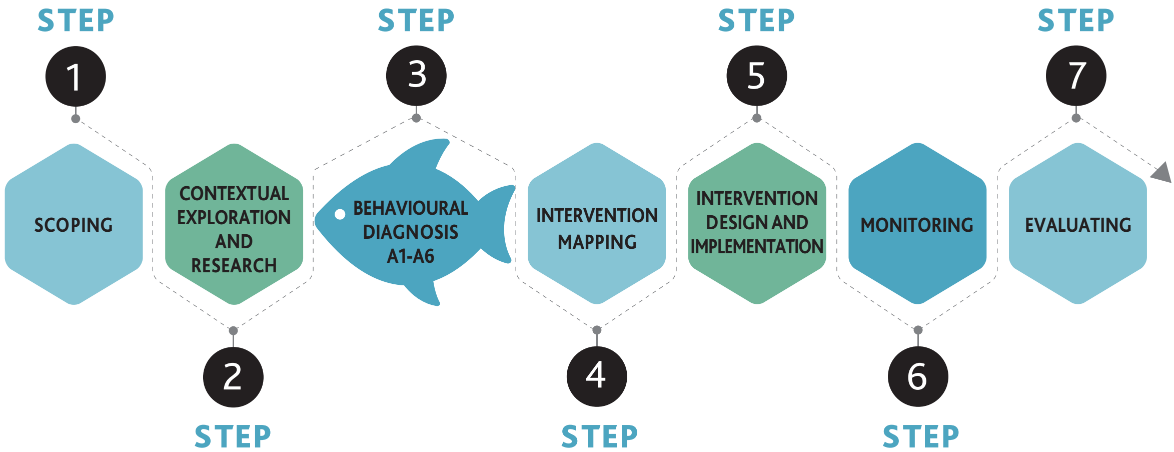



Figure 3: The 7 Steps to Energy Behaviour Change

**3.** ***Behavioural diagnosis*** is a step carried out to understand all of the data collected so far (e.g. who, what, when, how, and with whom is a behaviour being carried out). This part of the behaviour change process is referred to as the 'FISH' (as seen in Figure 3), because the useful phrase to remember at this point is 'Future Interventions Start Here'. It is during this step that all of the data are discussed and analysed (often in a workshop format) and it is the last step to do before starting to think about developing appropriate interventions.

**4.** ***Intervention mapping*** helps to select the appropriate and correct solutions to tackle the issues.

**5.** ***Intervention design and implementation*** is the creative part of the process in behaviour change, where ideas and materials can be tested to check if they resonate with the target audience, after which they should be updated and final versions fully implemented.

**6.** ***Monitoring*** is focused on checking progress on the interventions that have been/are being implemented.

**7.** ***Evaluating*** is the final step and is focused on collecting post-intervention data and comparing it to the baseline data, in order to assess the EM measure(s) that have been conducted.

You will find guidance on these seven behaviour change steps throughout the document as follows:

- **Chapter 1** – PLAN: *scoping, context exploration, behavioural diagnosis;*
- **Chapter 2** – DO: *intervention mapping, intervention design and implementation;*
- **Chapter 3** – CHECK: *monitoring;*
- **Chapter 4** – ACT: *evaluating.*

It should be noted that using a systematic approach to energy behaviour change, such as applying the 7SEBC process, can lead to achieving energy savings of 5-20%.[6]

## V. CATEGORIZATION OF DFI

As this document is focused on DFI, the NATO standard for DFI is expressed in STANAG 2632 Deployed Force Infrastructure (ATP-3.12.1.4 Edition A).

[6] Achieving energy efficiency through behaviour change: what does it take? Technical report No 5/2013. European Environment Agency, 2013. ISSN 1725-2237.

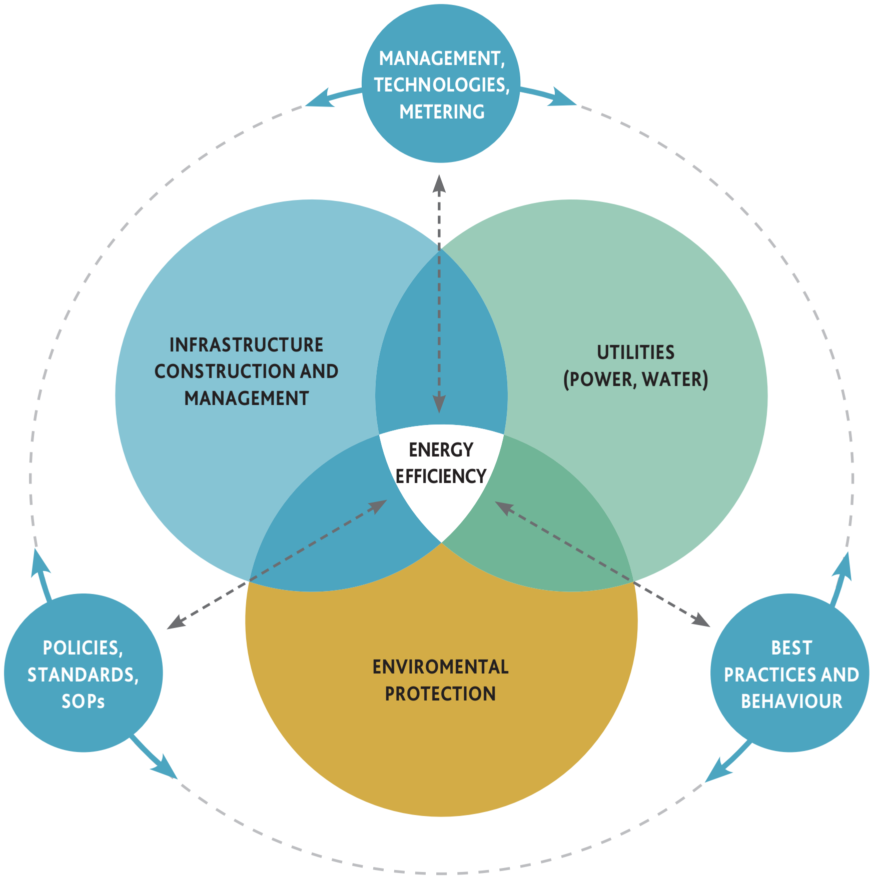



**Figure 4: Energy efficiency enabling capabilities**

• **Tier 1:** support equates to the limit that the initial personnel deploying on operations can carry on their person or in their support vehicles These personnel will operate under field conditions. Tier 1 will span a period of several weeks or months.

• **Tier 2:** provides basic support for the initial phase of an operation. It provides only austere working and living space, and it will span the period of between one and two months to two years.

• **Tier 3:** infrastructure provides semi-permanent accommodation for the sustainment phase of an operation. It will span the period of over six months to more than 10 years.

• **Tier 4:** facilities include permanent infrastructure and installations, for example the SHAPE HQ building near Mons in Belgium is classed as a Tier 4 structure.

## VI. ENERGY MANAGEMENT LINKAGES

The below developed chapter will provide limited tactical application. However, it will contribute to a better understanding of and close cooperation with the following military responsibilities by offering a broader vision of the general energy management linkages. These might provide to the energy manager more opportunity for implementation of improvements at his level.

### MILITARY ENGINEERING (MILENG) AND ENERGY EFFICIENCY (EE)

Military Engineering. At NATO level MILENG is a function in support of operations to shape the physical operating environment. MILENG as a function is coordinated by a military engineering staff.

MILENG incorporates areas of expertise such as engineering, explosives ordnance disposal (EOD), environmental protection (EP), military search and management of infrastructure, including contracted civil engineering.

MILENG is involved in energy efficiency aspects of deployed force infrastructure. In this regard MILENG responsibilities include infrastructure management, including camp design and set-up, construction, support to contracting, and utilities (water, power). In addition, MILENG can provide support to fixed or already existing facilities, e.g. Host Nation installations. The Chief MILENG (CMILENG), as the focal point for infrastructure, EP, and utilities, is responsible for ensuring the force's compliance with energy policies, standards and standing operating procedures, the management, technologies and metering of energy and the promotion of best practices and behaviour to deliver energy efficiency.

## ENVIRONMENTAL PROTECTION (EP)

The concern for EP is not focused on the protection of military personnel from the environment, but rather the protection of the environment from the military. Allied Joint Environmental Protection Publication (AJEPP) 2 Standard Agreement (STANAG) 2582[7], refers to energy management in relation to the aspects of energy efficiency and energy conservation. The following objectives of AJEPP 2 (STANAG 2582) can be supported by effective energy management:

**1.** To optimize the consumption of energy whilst maintaining or improving mission performance.

**2.** To reduce adverse environmental impacts.

**3.** To improve operational resiliency and sustainability.

**4.** To reduce logistical footprint.

It is clear that EP Officers can contribute advantageously to energy management, therefore close coordination and cooperation between the EP Officer and the Energy Manager is advised and could provide enhanced energy management results.

## ENERGY SECURITY AND ENERGY EFFICIENCY (EE)

As stated by Heads of State and Chiefs of Government during the last NATO Summit "Energy security plays an important role in our common security".[8]

As one of the three lines of effort towards the Alliance's energy security goal, NATO sets EE improvement within military forces as an imperative issue to be achieved.

The optimization of all the 'energy process phases' (e.g. production, management, distribution and consumption) is the way ahead for enhancing NATO forces' sustainability, because autonomy, asset mobility and resilience can be positively influenced, thereby improving the force Commander's operational capabilities.

There are essentially two areas of intervention to achieve EE:

- technological solutions – such as the adoption of new technologies (e.g. to replace inefficient equipment), research and development for future procurement options, and improvements to processes (e.g. military plans, procedures, SOPs);

- non-technological solutions – such as behavioural and cultural changes, through provision of appropriate interventions (e.g. training, removing barriers, and incentivisation).

In recent years, many allied nations have been addressing energy management for their forces, often by implementing ISO 50001 with a dual purpose:

- to integrate the civil standard with the experience gained during research activities conducted in military operational environments;

- to guide allies towards interoperability criteria for energy management aspects in DFI environments.

[7] STANAG 2582, Environmental Protection Best Practices and Standards for Military Camps in NATO Operations (AJEPP-2).

[8] Brussels Summit Declaration, Issued by the Heads of State and Government participating in the meeting of the North Atlantic Council in Brussels 11-12 July 2018.

# Chapter 1:

# Plan

This chapter provides guidance on establishing an energy baseline at the start of deployment, linked to each of the three pillars of energy management. In order to successfully identify, and eventually implement EM measure(s) in DFI, a plan must be developed. The focus of this chapter is at the tactical level in an existing camp; however strategies or key points can be applied and incorporated during, for example, the operational level design of a new camp, or a camp expansion.

## 1.1 COMMAND AND CONTROL (C2)

Energy management must be incorporated into C2, in order for energy to be considered proactively, rather than reactively. This requires assigning responsibility for energy management to appropriate staff, providing time and resources for energy to be monitored and managed, reviewing energy use at periodical assessments, and taking action when needed. The key elements of C2 to engage in during the PLAN phase of energy management include:

- knowing who to report energy management progress to;
- establishing relevant networks and relationships conducting a Handover/Takeover (HOTO) with predecessor;
- developing an Energy Management Team (where possible);
- securing energy management buy-in and authority from team and commander;
- securing the right degree of authority from commander and staff;
- introducing or updating in-processing / out-processing procedures;
- establishing an energy management data collection and analysis plan, and
- developing or identifying relevant SOPs.[9]

## 1.2 TECHNOLOGICAL APPLICATIONS

In the context of energy management, technological applications are used to identify trends, problems, and areas for improvement in energy use. This data helps to establish the energy baseline in order to be able to develop suitable EE measures that can target Significant Energy Use (SEU) areas, and gathering this data also means that energy reductions from proactive improvements can be quantified.

As a first step in addressing technological applications for the PLAN phase, a walk-through of the camp should be undertaken to gain an understanding of the type of infrastructure present and identify potential SEUs, as well as opportunities to implement efficiency measures using existing resources or making better use of existing systems. The walk-through should be done with a team such that Subject Matter Experts (SMEs), who may be specialist contractors, can be consulted and operational requirements identified that could restrict implementing an EE measure. The walk-through should also provide the opportunity to ensure the camp electrical layout and diagram is up-to-date, such that the observations made during the walk-through can be correctly referenced when identifying trends from the metered energy data. If no camp electrical layout is available, one should be produced during this PLAN phase. This will help to identify key zones in a metering plan as well as help to record occupancy data. An example camp layout with desired sub-metered zone is shown in Figure 5.

In addition to a walk-through energy profiles from the metered energy data can be developed to further identify potential processes that are consuming more energy than anticipated. The energy profiles could be developed prior to the walk-through, so that additional information can be collected to identify possible strategies to reduce or shift the energy use of the process.

The basis for each of the three pillars of energy management is the establishment and continuous monitoring and improvement of the DFI's EE, and the identification of the correct EnPIs to quickly track progress. Without a suitable energy metering plan or regular monitoring of EnPIs, ap-

9 Such as SOPs for accommodation, duty staff, ablutions, gym use, environmental protection, etc.


Figure 5: Example Energy Metering Camp Layout

plying the three pillars of energy management is not possible.

### 1.2.1 ESTABLISH AN ENERGY METERING PLAN

Creating an energy metering plan is essential as it helps to establish a baseline and identify SEUs in a camp (e.g. heaters in accommodation tents tend to use lots of energy). A plan also helps to track the progress of reducing the camp's fuel dependency and increasing its EE. An example energy metering plan is shown in Figure 6. The baseline also provides an overview of the electrical demand profiles; without a suitable baseline, EnPIs cannot be measured and, ultimately, verified to see whether the EM measure(s) implemented have had an impact.

In the event of a HOTO, the energy metering plan may have already been established and implemented by the previous Energy Management Team; however it should be reviewed and potential additional metering points identified by the new Energy Manager and their team.

Baseline energy consumption may already be measured at the camp in terms of fuel delivered or daily electricity produced; however to gain insight into specifically where the energy is used within a camp, more detailed sub-metering may be required. This data can be acquired through stand-alone building electrical meters or potentially interfaced directly with equipment to be sub-metered if so equipped. Figure 7 shows what a stand-alone electrical metering solution can look like[10].

Although fully sub-metering a camp can require thousands of sensors, implementing this type of monitoring system in DFI is not practical. From previous research studies[11] a baseline energy consumption profile can be acquired by sub-metering different levels of the camp:

- **Level 1:** Total power generation of a camp;
- **Level 2:** Power distribution within a camp;

[10] An interoperable energy metering kit has been developed under the NATO SPS G5525 Project, Harmonized Energy Monitoring and Camp Simulation Tools for Energy Efficiency (2018-2022).

[11] NATO SPS G5525 Project, Harmonized Energy Monitoring and Camp Simulation Tools for Energy Efficiency (2018-2022).

| Sample Metering Plan for a Deployed Camp | | | | |
|---|---|---|---|---|
| | Instrument Tag No. | Channel No. | Instrument Measurement Description | Sensor Type |
| | | | **Diesel Generator Electricity Production** | |
| 1 | Genset 1 | Meter 1 | Genset 1 500 kW Electricity Output - 3 Phases | 3 x 400 amp CT |
| 2 | Genset 2 | Meter 2 | Genset 2 500 kW Electricity Output - 3 Phases | 3 x 400 amp CT |
| 3 | Genset 3 | Meter 3 | Genset 2 500 kW Electricity Output - 3 Phases | 3 x 300 amp CT |
| 4 | Loadbank | Meter 4 | Load Bank Electricity Input - 3 Phases | 3 x 400 amp CT |
| | | | **Primary Distribution Unit (PDU)** | |
| 1 | SDU 1 | Meter 1 | Secondary Distribution Unit (SDU) 1 - Accommodations | 3 x RoCoil CT |
| 2 | SDU 2 | Meter 2 | SDU 2 - Accommodations | 3 x RoCoil CT |
| 3 | SDU 3 | Meter 3 | SDU 3 - Accommodations | 3 x RoCoil CT |
| 4 | SDU 4 | Meter 4 | SDU 4 - Accommodations | 3 x RoCoil CT |
| 5 | SDU 5 | Meter 5 | SDU 5 - Accommodations | 3 x RoCoil CT |
| 6 | SDU 6 | Meter 6 | SDU 6 - Accommodations | 3 x RoCoil CT |
| 7 | SDU 7 | Meter 7 | SDU 7 - Accommodations | 3 x RoCoil CT |
| 8 | SDU 8 | Meter 8 | SDU 8 - Accommodations | 3 x RoCoil CT |
| 9 | SDU 9 | Meter 9 | SDU 9 - Accommodations | 3 x RoCoil CT |
| 10 | SDU 10 | Meter 10 | SDU 10 - Offices | 3 x RoCoil CT |
| 11 | SDU 11 | Meter 11 | SDU 11 - Ablutions Accommodation Area | 3 x RoCoil CT |
| 12 | SDU 12 | Meter 12 | SDU 12 - Ablutions Office Area | 3 x RoCoil CT |
| 13 | SDU 13 | Meter 13 | SDU 13 - Kichen and Prep | 3 x RoCoil CT |
| 14 | SDU 14 | Meter 14 | SDU 14 - Dining Area | 3 x RoCoil CT |
| 15 | SDU 15 | Meter 15 | SDU 15 - Recreation | 3 x RoCoil CT |
| 16 | SDU 16 | Meter 16 | SDU 16 - Workshop | 3 x RoCoil CT |

**Figure 6: Example Energy Metering Plan for a Deployed Camp**

(a) (b) (c)

**Figure 7: Example Stand-Alone, Non-Intrusive Energy Meters (a) Generator Farm with Display (b) Primary Distribution Unit and (c) Shelter Energy End Use**

If further insight is required into specific processes additional metering can be installed (considered Level 3), where power consumption and potentially the environmental conditions should be monitored:

- **Level 3:** Power consumption and temperature in individual shelters or processes.

To normalize data and establish trends, the weather should also be recorded. Ideally, weather data from the previous 18 months would be available, as this would give you two data sets for two of the four seasons to help you identify any climate trends; this can be acquired from various websites, if not directly measured. An example of a deployable weather-station is shown in Figure 8. Additionally, historical fuel consumption data or historical metered data should be acquired, along with current and historical camp occupancy data, if available.

The power distribution sub-metering (Level 2) should aim to capture different processes in order to identify specific EM measure(s). For example, the accommodation shelters, dining facilities, and work space offices should ideally all be sub-metered separately. As such, specific trends can be identified for specific space functions when analysing the data. The total power generation of the camp will provide insight into how efficiently the generators are operating and whether shifting certain processes to different times could be beneficial. An example of an energy metering plan is shown in Figure 6 for reference.

(a) (b)

**Figure 8: Example of a Deployable Weather-Station in Two Different Climates to Monitor Local Weather for Data Normalization**

ANNEX A provides a suggested list of data that should be collected to support informed decision-making. To provide sufficient insight into identifying EE measures, the data measurement frequency should be averaged over 15 minutes or less.

### 1.2.2 IDENTIFY ENERGY PERFORMANCE INDICATORS (ENPIS)

Energy Performance Indicators (EnPIs) are critical in developing metrics to track a DFI's energy consumption. Discovering what energy data is accessible helps to establish relevant and available EnPIs, as you may find that an EnPI you would like to monitor can't be included because the data isn't available or doesn't exist. The EnPIs should be established in accordance with an energy policy to help with reporting, and in conjunction with the development of the energy metering plan to ensure that relevant energy data is prioritised for reporting. Typically, EnPIs can include:

- electricity consumption/person (kWh/person)*;
- electricity consumption/area (kWh);
- peak and average electricity draw/person (kW/person);
- peak and average electricity draw/area (kW);
- fuel consumption/person (L/person), and
- fuel consumption/area (L/area).

### 1.2.3 ESTABLISH AN ENERGY MANAGEMENT DATA COLLECTION AND ANALYSIS SCHEDULE

Once an energy metering plan has been developed (see section 1.2.1), an energy management data collection and analysis schedule should be established to routinely collect the information needed to update the EnPIs and track progress. It is recommended that the data be collected and analysed on a weekly basis (e.g., every Monday morning at 09:00), built into a routine to ensure changes in energy usage can be quickly identified and addressed, if necessary.

Immediate data analysis and identification of trends can be facilitated with an energy meter dashboard (this is a piece of software or a technological application to store and present data) or pre-developed templates to visualize data. It is important that time and resources be allocated to properly develop templates or an energy meter dashboard, as these will facilitate the data analysis to be able to identify energy consumption trends and the impact of implemented EM measure(s). Various companies offer energy meter dashboard solutions, or they can be custom developed through reach back (Figure 9). Templates provide a way to capture EnPIs for monitoring and reporting purposes. To facilitate reporting, EnPI calculations can be averaged over a weekly basis, although further refinement may be required if trialling EM measure(s) over a short period of time.

**Figure 9: Example of an Energy Metering Dashboard** [12]

* kVAh and kVA can also or alternatively be reported if it is the preferred respective energy and power metric by the nation"

[12] Image taken from eSIGHT Energy Inc. Brochure, 2020, www.esightenergy.com

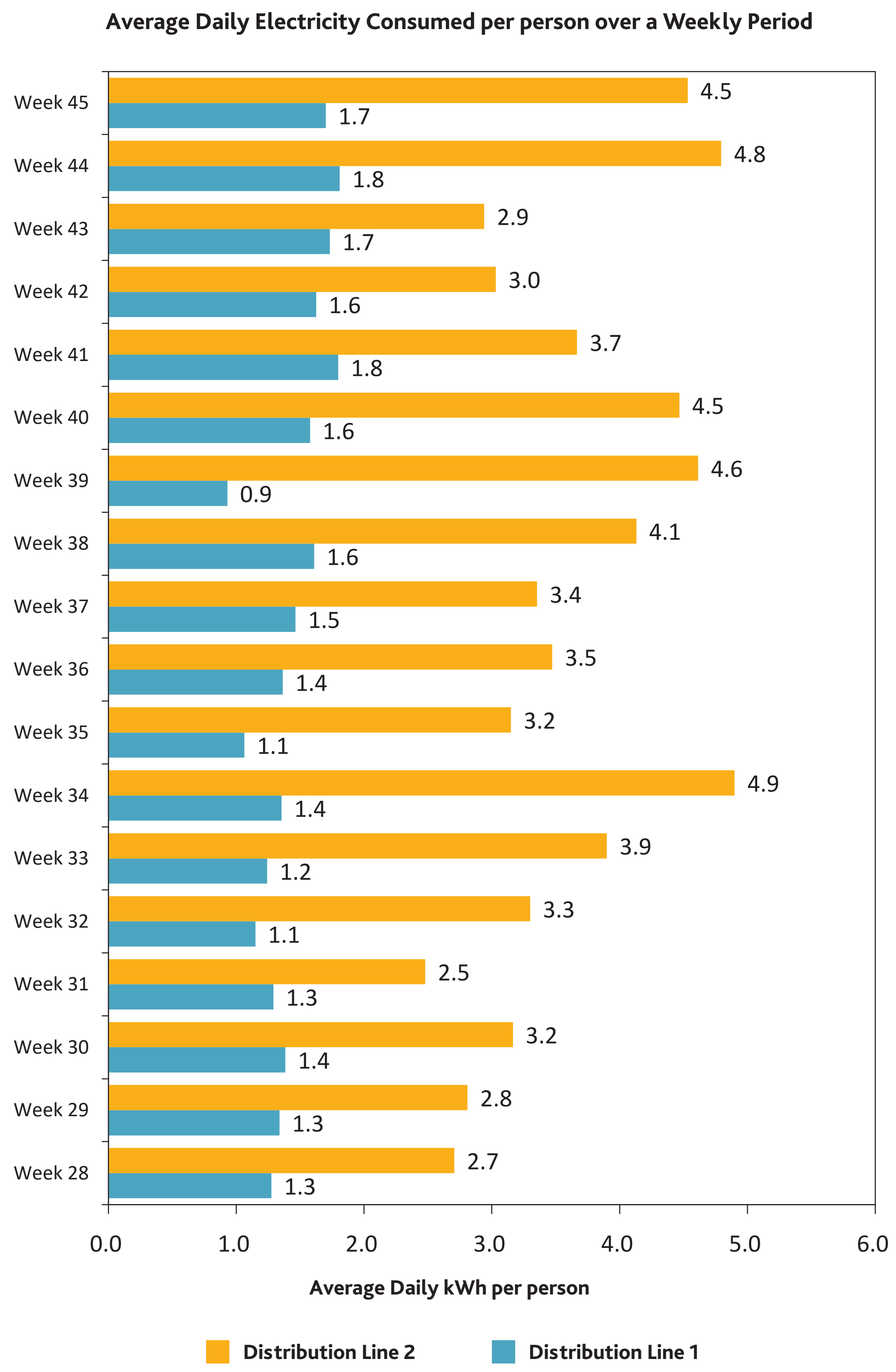



Figure 10: Example of a Weekly EnPI Summary of a Deployed Camp

An example plot tracking the weekly average daily electricity consumption per person per day is shown in Figure 10.

### 1.2.4 DEVELOP OR REFINE A CAMP ENERGY PLANNING MODEL

The use of deployed camp energy calculators or energy simulation tools can help to develop a camp energy planning model to predict how much energy will be needed based on the number of, for example, military personnel, beds, work desks etc. The camp energy planning model can also be used to identify and quantify the EE potential of technological improvements. During the PLAN phase, a camp energy planning model can be developed and validated with the metered data to estimate the daily camp energy consumption. This in turn can help quantify the energy savings potential of new technologies (e.g. efficient heating or cooling systems, right sized generators) ultimately assisting with the decision-making on what EM measure(s) should be implemented to achieve the desired energy targets. Examples of camp planning software include the NATO Zero Footprint Calculator[13] and the Forces Operation Resource Calculator for Energy Simulator (FORCE-SIM)[14] developed under the NATO Science for Peace and Security G5525 camp energy efficiency project, which is shown in Figure 11.

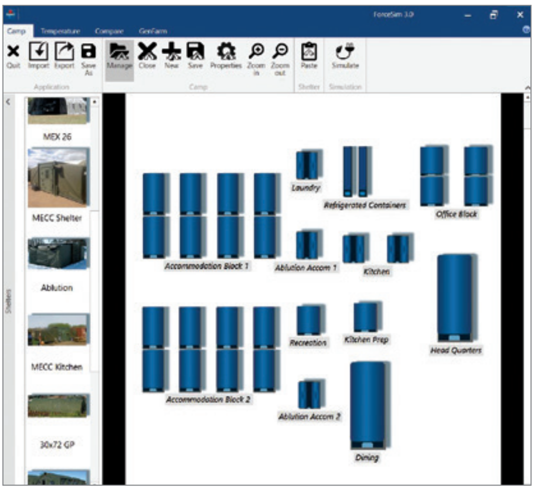



**Figure 11: Example of the FORCE-SIM Camp Energy Planning Software Tool**

### 1.2.5 IDENTIFY SUITABLE TECHNOLOGICAL ENERGY MANAGEMENT INITIATIVES

From the walk-through, energy metered data and camp energy models, action plans can be developed to implement EM measure(s) to meet the energy targets. An example energy management case study is provided in ANNEX G to provide guidance on how the handbook can be applied. While, EM measure(s) will depend on the context of each individual camp, the following general approach can be taken:

1. Reduce camp energy demands.
2. Recover waste heat where possible to use for other processes.
3. Implement energy efficient equipment.

Low or no cost EM measure(s) should be addressed first. These are measures that are easy to implement and would have a high potential to positively impact the energy targets. This can also be tied in with identifying opportunities through behaviour change, where there may be a lack of capability, opportunity or motivation to address certain measures (see section 1.3.3). Implementing these measures first will ensure that more complex EM measure(s) receive more attention and are likely to have a higher impact. Upon identifying the suitable EM measure(s), an action plan can be developed to implement them. A proposed method for prioritising possible technological EE initiatives can be found in Figure 12 (Section 1.3.3).

While each deployed camp will have its own unique characteristics and there is not one uniform solution, some examples of low or no cost EM measure(s) can include:

[13] "Sustainable Operational Military Compounds – Towards a Zero Footprint Compound", NATO Science for Peace and Security (984464, 2012-Sep 2014).

[14] "Forces Operation Resource Calculator for Energy – Simulator (Force-Sim)", NATO Science for Peace and Security (G5525, 2018-2022).

**a.** Ensuring tents are not conditioned unless necessary (e.g. avoid cooling shelters that are unoccupied). For each air conditioner that is turned off, up to 40L of fuel can be saved per day.

**b.** Ensuring windows and doors are closed in air conditioned tents or structures, to avoid unnecessary heating or cooling losses.

**c.** Turning off lights in unoccupied shelters or rooms.

**d.** Under-loaded diesel generators can operate 20% less efficiently than if they were operating at their prime efficiency (i.e. 75% of their rated capacity). Identify potential processes that can be served by one diesel generator instead of two in spot generation set-ups, or identify if processes can be shifted to another time of the day to avoid bring on line a second or third generator in a centralized plant.

**e.** Solar shades can reduce the cooling load on a shelter by up to 20%. This will in turn reduce the load on the air conditioner.

**f.** Regular maintenance on air conditioning units, such as filter cleaning, outdoor coil cleaning, and ensuring there is sufficient airflow around the outdoor coil can all lead to improved EE. Performing regular maintenance can improve air conditioner EE by as much as 30%.

## 1.3 BEHAVIOUR CHANGE

During the PLAN phase of energy management, the pillar of behaviour change is focused on developing an understanding of the current energy behaviours, which could largely be inherited from a previous rotation. This section will explain how to conduct the following three steps of the behaviour change process (see Figure 3 in section Introduction iv for an overview of all 7 Steps to Energy Behaviour Change process):

- Scoping;
- Context exploration;
- Behavioural diagnosis.

By carrying out these three steps, a good understanding can be formed of the energy behaviour baseline and the possible courses of action to help achieve the energy targets. Practical guidance for how to conduct these steps is provided in this section (1.3).

### 1.3.1 SCOPING

The scoping activity is focused on obtaining approval to proceed with energy behaviour change. Engaging in the following high level questions will take you through the scoping activity:

- Have you been given the authority to act as Energy Manager?
- Have you been given the Terms of Reference (ToR) of Energy Manager?
- Have you conducted a HOTO in relation to energy management?
- Do you know the energy policy of your camp / HN / home nation / NATO (one or more, as applicable)?

### 1.3.2 CONTEXT EXPLORATION

The context exploration activity is focused on understanding the energy behaviours in the current context. It is necessary to identify the reasons why people engage or do not engage in positive and efficient energy behaviours before developing a plan to change behaviours, otherwise ineffective plans could be put into action and waste precious resources.

The following activities will help to explore the context:

• Gather any further context information not already captured through engaging in the C2 and Technological Applications activities of the PLAN phase.

• Conduct behavioural observations by capturing evidence of good and bad practice energy behaviours using the observation audit template provided at ANNEX B. This activity can be completed at the same time as the technological applications walk-through activity detailed in Section 1.2, whereby the camp electrical layout and SEUs are established. There is no exhaustive list of energy behaviours that you might observe, but in addition to the list of low or no cost initiatives presented under Section 1.2.5, you may also find evidence of instances such as poor ventilation habits, equipment left on when not in use, inadequately positioned equipment, and so forth.

• Distribute a questionnaire to assess levels of awareness and engagement in energy management across the camp. This helps to understand where there are gaps in knowledge and where to focus interventions in the DO phase (i.e. the next phase, covered in Chapter 2) of energy management. Comparing data from questionnaires given both before and after interventions help to monitor and evaluate the effectiveness of energy management changes. Wherever possible, try to include participants from a range of ranks, age, sex, and roles, proportionate to, or reflective of, the camp population. A suggested questionnaire template is provided at ANNEX C, which can be adapted to suit your context.

### 1.3.3 BEHAVIOURAL DIAGNOSIS

Behavioural Diagnosis is focused on using the information gathered from the scoping and context exploration activities (e.g. TORs, energy policy, observations, and questionnaire responses) to understand exactly what to change and what not to change. This is achieved by engaging the Energy Management Team - and, if possible, one or two military personnel who live in the tented accommodation or who work in the tented office space, who can comment from the end-user perspective on what they think any day-to-day issues are - in the following six activities, which are best done in the format of a FISH workshop, where possible.

• **A1. What are the energy issues?** Use sticky-notes to note down the energy issues that have been identified from the scoping and context exploration activities, as well as from any of the C2 and Technological Application activities to-date.

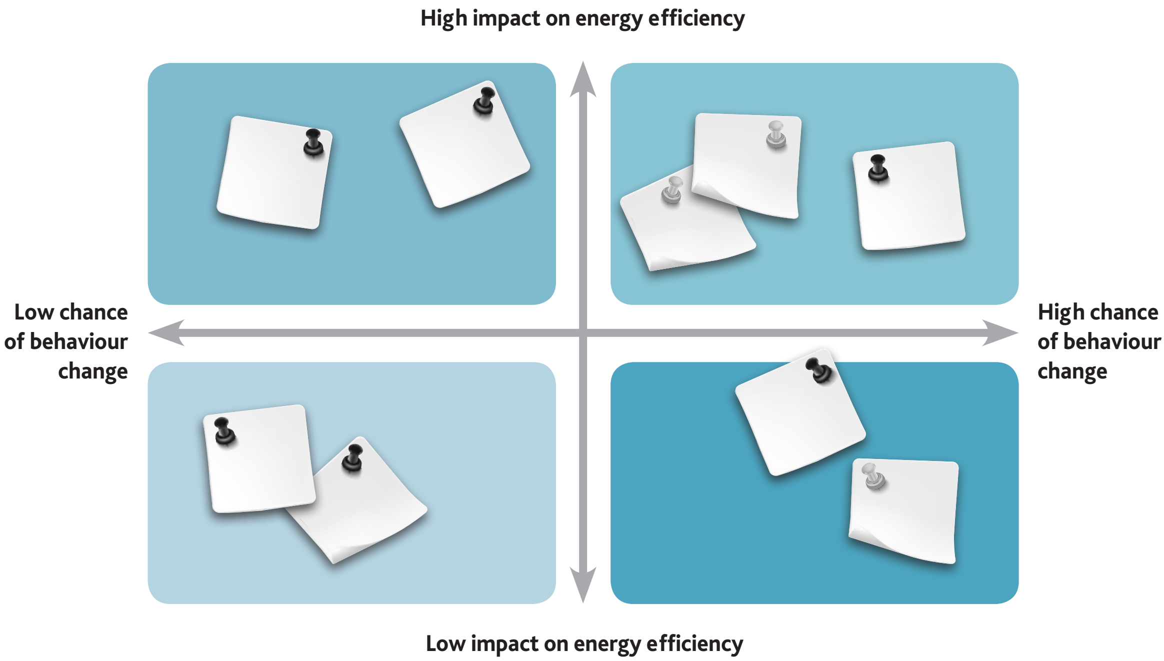



Figure 12: Behaviour Change Quad Chart

• **A2. What are the behaviours associated with the energy issues?** Again, use sticky notes (perhaps a different colour for this activity) to consider the desired behaviours that are associated with the issues. There might be more than one behavioural explanation for one issue - for example, if an issue identified was that accommodation tents were found to have air gaps due to holes in the material or faulty zips, the behavioural explanations for this might include (a) people not reporting the issue, or (b) nobody assigned to repair air gaps in accommodation tents.

• **A3. Prioritise the behaviours.** Develop a quad chart using the axes of 'chance of behaviour change' and 'impact of change on energy efficiency'. The behaviours that you believe have a high chance of change (as a result of knowing your target audience) and would have the larger impacts on energy efficiency should be placed in the top right hand quadrant, and so forth. A template of the quad chart is provided in Figure 12.[15]

• **A4. Decompose the behaviours.** Take the behaviours from the top right quadrant, which can be considered as low or no cost initiatives, as these are the behaviours assessed as having a high chance of change and a high impact on EE, and use the following questions to start to develop an action plan:

**a.** Who needs to do the desired behaviour?

**b.** What do they need to do?

**c.** When do they need to do it?

**d.** How do they do the behaviour?

**e.** With whom do they need to do the behaviour (e.g. with an electrician, on their own is sufficient, etc.)?

• **A5. Confirmation of what needs to change.** A model of behaviour known as 'Capability + Opportunity + Motivation = Behaviour' (COM-B) proposes that for an individual or a group to engage in a desired behaviour, they require the relevant capability, opportunity, and motivation[16]. Table 1 presents the definitions for these three elements of behaviour, and a simple example of how to understand the model is provided in ANNEX D. Use the data that you have gathered and analysed to assess which element(s) of the COM-B is the area to focus on for the EM measure(s) that will be developed during the DO phase. By

**Table 1: COM-B Definitions**

| COM-B Element | Definition |
|---|---|
| **Capability** | • **Physical:** having physical skills, strength, or stamina.<br>• **Psychological:** having the knowledge, psychological skills, strength, or stamina to engage in the necessary mental processes. |
| **Opportunity** | • **Physical:** what the environment allows or facilitates in terms of time, triggers, resources, locations, and physical barriers.<br>• **Social:** interpersonal influences, social cues and cultural norms that influence the way we think about things. |
| **Motivation** | • **Reflective:** self-conscious planning and evaluations (beliefs about what is good or bad).<br>• **Automatic:** processes involving wants and needs, desires, impulses, and reflex responses. |

[15] This method for prioritisation can equally be used for assessing the technological energy efficiency initiatives discussed under Section 1.2.5.

[16] Michie, S., Atkins, L. and West, R. (2014). The Behaviour Change Wheel: A Guide to Design Interventions. Great Britain: Silverback Publishing.

[17] This method for identifying potential EM measure(s) can also be used for considering appropriate technological energy efficiency initiatives discussed under Section 1.2.5.

categorising the issues into these three elements, it helps to summarise the apparent route cause of any energy management problems.

• **A6. Identify potential behaviour change interventions.**[17] The last activity involved in behavioural diagnosis is to consider the possible appropriate behaviour change interventions from the list in Table 2, which includes a description and an example for each. The specific action plans to implement the interventions will be developed during the DO phase (i.e. the next phase, covered in Chapter 2). Familiarise yourself with the categories in Table 2 before moving to Chapter 2.

**Table 2: Categories of Behaviour Change Interventions**

| No. | Intervention | Description | Example |
|---|---|---|---|
| 1 | **Education** | Increasing knowledge or understanding | Providing all staff with a leaflet about how to save energy |
| 2 | **Persuasion** | Using communication to induce positive or negative feelings or stimulate action | Unit Heads discuss the importance of saving energy with all staff |
| 3 | **Incentivisation** | Creating an expectation of rewards (social and/or financial) | Percentage of cost savings returned to accommodation occupants in an appropriate format (e.g. savings used for social or welfare activities/items) |
| 4 | **Coercion** | Creating an expectation of punishment or costs | Infrastructure projects for the camp will receive less budget during the next rotation if the current rotation doesn't meet targets |
| 5 | **Training** | Imparting skills | Training on how to turn off a complex piece of equipment |
| 6 | **Restriction** | Using rules to reduce the opportunity to engage in the target behaviour (or to increase the target behaviour by reducing the opportunity to engage in competing behaviours) | Last out of the tent must switch off all electrical items |
| 7 | **Environmental restructuring** | Changing the physical or social context | Providing prompts (instructions, stickers, reminders etc.) next to switches |
| 8 | **Role modelling** | Providing an example for people to aspire to or imitate | Influential staff members switch off IT equipment (e.g. the Energy Manager) |
| 9 | **Enablement** | Increasing means / reducing barriers to increase capability (beyond education and training) or opportunity (beyond environmental restructuring) | All staff made aware of their responsibility to switch off IT equipment |

## 1.4 CHECKLIST

Table 3: Checklist: Chapter 1 – PLAN

| No. | Action | Tick when complete | Notes |
|---|---|---|---|
| | **C2** | | |
| **1.1** | Know who to report to | ❏ | |
| **1.2** | Establish relevant networks on arrival | ❏ | |
| **1.3** | Conduct a HOTO with predecessor | ❏ | |
| **1.4** | Develop an Energy Management Team (if possible) | ❏ | |
| **1.5** | Secure energy management buy-in and authority from team and commander | ❏ | |
| **1.6** | Introduce or update in-processing/out-processing procedures | ❏ | |
| **1.7** | Establish an energy management data collection and analysis plan | ❏ | |
| **1.8** | Develop or identify relevant SOPs | ❏ | |
| | **Technological Applications** | | |
| **1.9** | Conduct a walk-through of the camp to gain an understanding of infrastructure and SEUs | ❏ | |
| **1.10** | Consult with SMEs (this may include specialist contractors) | ❏ | |
| **1.11** | Clarify the camp electrical layout (Figure 5: Example Energy Metering Camp Layout) | ❏ | |
| **1.12** | Complete an Energy Metering Plan (Figure 6: Example Energy Metering Plan for a Deployed Camp and ANNEX A: Harmonized Energy Metering Points Guide) | ❏ | |
| **1.13** | Identify the extent of sub-meter requirements | ❏ | |
| **1.14** | Collect weather data | ❏ | |
| **1.15** | Collect historical fuel data | ❏ | |
| **1.16** | Collect occupancy data (current and historical) | ❏ | |
| **1.17** | Establish EnPIs (Figure 10: Example of a Weekly EnPI Summary of a Deployed Camp) | ❏ | |
| **1.18** | Complete an Energy Management Data Collection and Analysis Plan | ❏ | |
| **1.19** | Develop an energy meter dashboard or templates | ❏ | |
| **1.20** | Develop or access a camp energy planning model (Figure 11: Example of the FORCE-SIM Camp Energy Planning Software Tool) | ❏ | |

| No. | Action | Tick when complete | Notes |
|---|---|---|---|
| **1.21** | Identify possible EM measure(s) | ❑ | |
| | **Behaviour Change** | | |
| **1.22** | Scope existing practices | ❑ | |
| **1.23** | Complete behavioural observations (ANNEX B: Observation Audit Template) | ❑ | |
| **1.24** | Distribute an energy management questionnaire (ANNEX C: Questionnaire Template) | ❑ | |
| **1.25** | Conduct behavioural diagnosis (ideal format – workshop):<br>• A1. What are the energy issues? | ❑ | |
| **1.26** | • A2. What are the behaviours associated with the energy issues | ❑ | |
| **1.27** | • A3. Prioritise the behaviours | ❑ | |
| **1.28** | • A4. Decompose the behaviours | ❑ | |
| **1.29** | • A5. Confirmation of what needs to change (ANNEX D: COM-B Example) | ❑ | |
| **1.30** | • A6. Identify potential behaviour change interventions (Table 1 – Categories of Behaviour Change Interventions) | ❑ | |

# Chapter 2:

# Do

This chapter provides guidance on developing actions plans, and designing and implementing EM measure(s) based on the results of the baseline completed under the PLAN phase (Chapter 1).

## 2.1 COMMAND AND CONTROL (C2)

During the DO phase of energy management, the following C2 activities should be completed:

- presentation of the findings from the PLAN phase to the chain of command;
- feedback on proposed EM measure(s) from all levels to ensure comprehension and buy-in;
- documented approval of the action plans;
- authority given for the Energy Manager to implement the EM measure(s), and dissemination of orders, directives, guidance communicating any significant changes to camp infrastructure or policies (e.g. if there needs to be a power outage for the installation of new equipment, camp personnel should be notified).

## 2.2 TECHNOLOGICAL APPLICATIONS

### 2.2.1 ENERGY METERING

To ensure sufficient data is collected to CHECK (Chapter 3) and ACT (Chapter 4) on any of the EM measure(s), the installation or relocation of the energy metering equipment identified as required during the PLAN phase, should be coordinated. Establishing an energy metering plan during the PLAN phase will ensure that suitable energy metering devices are acquired and can be installed. Often, this will require a Technical Assistance Visit (TAV), or in-theatre support from specialist contractors and/or technicians[18]. Shut down of equipment may also be required for a period of time. See Figure 6 (section 1.2.1) for an example of an energy metering plan.

Upon completion of the energy metering installation or relocation, the readings should be validated and ensured that data is being collected and that there are no faults or technical issues with the energy metering equipment. This can often require the installation, or use, of a second electrical power meter to verify real-time readings and should be installed during the allocated shut-down period. Without proper validation, there is a risk that unsuitable data could be collected and the baseline or comparative energy study would thus be inconclusive.

Data from the energy metering system should be collected on a daily basis for the first week, to ensure the metering system is collecting data as required, in addition to also helping validate whether the identified EnPIs can be and – more importantly – are being captured.

### 2.2.2 ENERGY MANAGEMENT MEASURES (EM MEASURE(S))

After having identified promising possible EM measure(s) for the camp during the PLAN phase, these improvements can be implemented through the execution of an action plan(s). This will require planning with reference to the resources required, acquiring quotations (if necessary) to perform the work, acquiring approvals, and revisiting whether the EM measure(s) is still the most economically feasible. Once the EM measure(s) has been approved by the appropriate Chain of Command, a TAV should be initiated (or a contractor hired), and a project team should be built to support the installation as well as provide support to manage the project. Depending on the extent of the proposed EM measure(s), an installation plan may be required in order to coordinate shutdowns or minimize the impact to onsite personnel (this is a C2 responsibility, see section 2.1).

## 2.3 BEHAVIOUR CHANGE

During the DO phase of energy management, behaviour change is focused on designing and implementing action plans, which can be incor-

[18] Technical SMEs, such as civilian government staff or specialist contractors, are able to support the development of the specific list of metering and monitoring equipment required, identified during the PLAN phase.

porated with the technological applications action plans (see section 2.2.2) or can be managed separately.

This sub-section of Chapter 2 will explain how to conduct the following steps of the behaviour change process:

- Intervention mapping;
- Intervention design;
- Implementation.

### 2.3.1 INTERVENTION MAPPING

At the end of behavioural diagnosis (section 1.3.3), the possible categories of behaviour change interventions were presented for consideration based on all of the understanding developed through the energy management activities conducted so far. Table 4 below now brings together the COM-B elements of behaviour (see Table 1 in section 1.3.3) and the categories of behaviour change interventions (see Table 2 in section 1.3.3) to specifically highlight which intervention is best suited to strengthen each element of behaviour (capability, opportunity, or motivation).

To use Table 4, read across the COM-B row (or rows) that relate most closely to the findings of the energy management baseline data, which was collected during the PLAN phase to find out which behaviour change intervention(s) is appropriate to address the issue; the appropriate behaviour change intervention(s) will be signified by the boxes with ticks.

- **For example:** if the baseline data showed that there was low physical opportunity for good energy management, focus should be on behaviour change interventions of (one or more of) training, restriction, environmental restructuring, and enablement[19].

Once the above intervention mapping activity has been completed, specific Behaviour Change Techniques (BCTs) can be taken from the list of best practice in ANNEX E to develop the ac-

**Table 4: Mapping Behaviour Change Interventions to the COM-B Model**

| | Behaviour Change Interventions | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| COM-B | Education | Persuasion | Incentivisation | Coercion | Training | Restriction | Environmental restructuring | Modelling | Enablement |
| Physical capability | | | | | ✔ | | | | ✔ |
| Psychological capability | ✔ | | | | ✔ | | | | ✔ |
| Physical opportunity | | | | | ✔ | ✔ | ✔ | | ✔ |
| Social opportunity | | | | | | ✔ | ✔ | ✔ | ✔ |
| Automatic motivation | | ✔ | ✔ | ✔ | ✔ | | ✔ | ✔ | ✔ |
| Reflective motivation | ✔ | ✔ | ✔ | ✔ | | | | | |

[19] For a reminder of the descriptions of the categories of behaviour change interventions, see Table 2 in section 1.3.3.

Table 5: Best Practice Behaviour Change Techniques (excerpt from ANNEX E)

| Behaviour Change Intervention | Behaviour Change Technique (BCT) | Description of the BCT | Example |
|---|---|---|---|
| **Enablement** | Action planning | Prompt detailed planning of performance of the behaviour (must include at least one of context, frequency, duration and intensity). Context may be environmental (physical or social) or internal (physical, emotional or cognitive). | Encourage the creation of a department end of day shutdown checklist. |
| **Enablement** | Adding objects to the environment | Add objects to the environment in order to facilitate performance of the behaviour. | Place stickers on all equipment detailing what can be switched off at the end of the day. |

tion plan. BCTs can be considered as the most specific pieces of behaviour change 'equipment', because they are the most granular level techniques for encouraging behaviour change, such as providing prompts, demonstrating the desired behaviour, or giving information about social and environmental consequences All behaviour change campaigns will be 'built' from BCTs. Use ANNEX E to select the relevant best practice BCTs.

• **For example:** based on the example on the previous page, by applying the behaviour change process it was found that:

- the COM-B element preventing good EM was **PHYSICAL OPPORTUNITY**
- this can be improved through an intervention of **ENABLEMENT**
- **ACTION PLANNING** and **ADDING OBJECTS TO THE ENVIRONMENT** are effective BCTs (ingredients) to support enablement. This example is shown in Table 5, which is taken from ANNEX E.

### 2.3.2 INTERVENTION DESIGN

The next activity is focused on pulling together all of this context-specific understanding to design action plans, energy management processes, materials, military orders etc.; in order, to design the intervention(s)[20]. Understanding of the C2 and technological applications' data should also be used to design the intervention(s).

Intervention design is the creative step in the process, and it is important to remember that interventions / EM measure(s) are more likely to be adopted and be effective if input is gained from those who will be expected to implement and follow the changes. Therefore, this step is about co-creating effective EM measure(s), which is a principle that should also be applied when assessing technological EE initiatives (see Section 1.2.5), such as by seeking feedback from camp personnel on the possible initiatives.

Figure 13 provides best practice principles for designing effective EM measure(s), note that not every principle will be relevant for every measure. When designing an energy management measure, Figure 13 should be used as a reference to check against to ensure a well-designed, robust measure:

[20] There should be a detailed understanding of the energy behaviours of the audience – see section 1.3.3.

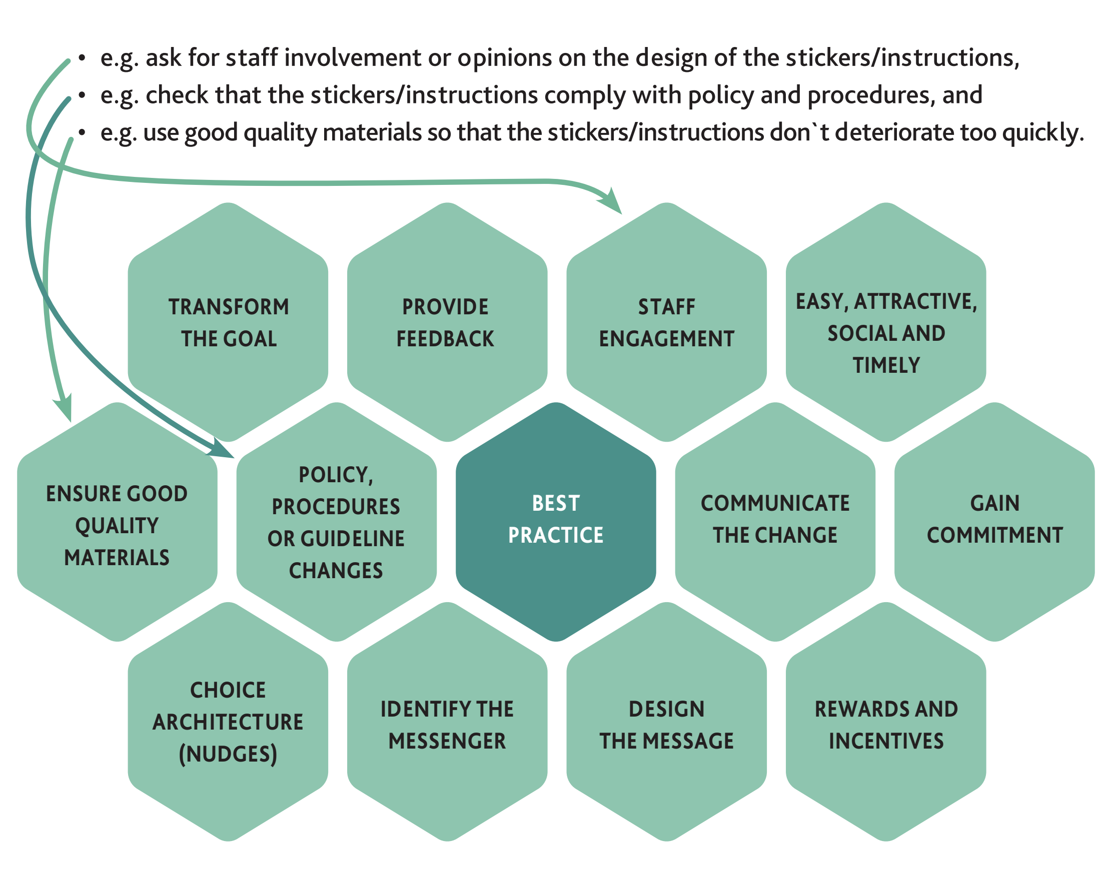



**Figure 13: Best Practice Principles for Designing Effective EM measure(s)**

• **For example:** continuing with the example from the previous page, the BCT of **ADDING OBJECTS TO THE ENVIRONMENT** could be completed by adding stickers or instructions to all equipment detailing what can and cannot be switched off at the end of the day. As shown in Figure 13, the following design principles should be applied when making the stickers or instructions:

- **STAFF ENGAGEMENT** - ask for staff involvement or opinions on the design of the stickers or instructions.
- **POLICY, PROCEDURES OR GUIDELINE CHANGES** - check that the stickers or instructions comply with policy and procedures.
- **ENSURE GOOD QUALITY MATERIALS** - use good quality materials so that the stickers or instructions don't deteriorate too quickly.

### 2.3.3 IMPLEMENTATION

Any energy management measure, should be tested for comprehension and ease of compliance by the intended end-users. This test should include:

- Asking a small sample of the end-users for their feedback on the energy management measure(s).
- Observing how the sample of end-users use the energy management measure (this could be a new piece of equipment).

Based on the feedback and observations, update the energy management measure(s) as appropriate and then implement in accordance with the action plan, which has been approved by the relevant Chain of Command.

## 2.4 CHECKLIST

Table 6: Checklist: Chapter 2 – DO

| No. | Action | Tick when complete | Notes |
|---|---|---|---|
| | **C2** | | |
| **2.1** | Present findings from the PLAN phase to the chain of command | ❑ | |
| **2.2** | Obtain feedback on the proposed EM measure(s) from all levels to ensure comprehension and buy-in | ❑ | |
| **2.3** | Document the approval of the action plans | ❑ | |
| **2.4** | Confirm authority for the Energy Manager to implement the EM measure(s) | ❑ | |
| **2.5** | Distribute orders, directives, guidance communicating any significant changes to camp infrastructure or policies (e.g. if there will be a power outage while new equipment is installed) | ❑ | |
| | **Technological Applications** | | |
| **2.6** | Install or relocate energy metering equipment | ❑ | |
| **2.7** | Validate meter readings (if necessary) | ❑ | |
| **2.8** | Check meter readings after one week to ensure EnPIs can be / are being recorded | ❑ | |
| **2.9** | Request assistance and quotations for level of investment required to implement any technological EM measure(s) | ❑ | |
| **2.10** | Develop installation plan (if necessary) | ❑ | |
| **2.11** | Coordinate shutdowns (if necessary) | ❑ | |
| | **Behaviour Change** | | |
| **2.12** | Map behaviour change interventions to the COM-B model (Table 1) | ❑ | |
| **2.13** | Map the best practice BCTs to the behaviour change interventions (ANNEX E) | ❑ | |
| **2.14** | Design the behaviour change intervention(s) / energy management measure(s) | ❑ | |
| **2.15** | Check the behaviour change intervention(s) / energy management measure(s) against best practice design principles (Figure 13) | ❑ | |

# Chapter 3:

# Check

During CHECK phase of energy management, the focus is on checking that the action plans are being implemented and identifying any barriers related to carrying out the EM measure(s).

## 3.1 COMMAND AND CONTROL (C2)

During the CHECK phase of energy management, the following C2 activity should be completed:

• deliver progress updates on the EM measure(s) to the relevant chain of command.

## 3.2 TECHNOLOGICAL APPLICATIONS

Upon confirmation that the metering system is properly configured, energy meter data should be collected on a weekly basis. The metered data can be compiled and automated to generate the EnPIs. The EnPIs should be updated on a weekly basis to track progress of the EM measure(s). Bar graphs, such as the one presented in Figure 10 (see section 1.2.3), can be used to show weekly trends, as well as highlight the target for a quick visual.

A walk-through should be done regularly done, weekly, to identify any changes to the camp, such as; reassignment of shelter functions, increased occupancy, shut down of certain buildings, stoppage on the use of specific equipment, shelter status etc. Severe weather can also impact energy consumption, such as high wind and rain blowing sand into air conditioning coils and diminishing the EE of the system. Changes should be noted in order to identify trends and explain any abnormalities in the data, which can then be addressed by updating relevant SOPs (during the ACT phase, covered in Chapter 4).

Depending on the energy management measure and the season, the impact of an energy management measure may not immediately be seen. For example, if heating equipment is installed during the summer months, the effect on energy use may not be apparent until colder months when the heating equipment is turned on and used. It is important to verify that the energy management measure is in place and identify the reason why the measure might not be as effective as anticipated (for example, the week prior it was colder than usual and upon installing a solar shade, the ambient temperature the following week rose, resulting in an increased cooling demand). Therefore, trends can often take a few weeks to establish and it is vital to identify any relevant context data (such as changes in weather conditions) to be able to interpret trends correctly.

The walk-through and compiled results should also be used for reporting on how the energy management measure has helped to meet the energy objectives or targets, or where further improvement is required.

## 3.3 BEHAVIOUR CHANGE

During the CHECK phase of energy management, the pillar of behaviour change is focused on monitoring the implementation of the behaviour change interventions designed and applied under the DO phase This sub-section will explain how to conduct the following step of the behaviour change process:

• Monitoring.

### 3.3.1 MONITORING

The following points provide guidance on good practice for monitoring the behaviours that are the focus of change:

• Gather behavioural observations (e.g. complete post-intervention observation audits, see ANNEX B) and responses to a questionnaire (e.g. distribute a post-intervention questionnaire, see ANNEX C).

• Speak to end-users to gather continuous feedback on what is working well / not well.

• Analyse the data gathered and triangulate with the data obtained from other sources, such as the data from the technological applications (see section 3.2). For example, cross-check meter readings of accommodation areas with observations and data about occupancy levels to ensure trends can be understood.

• Compare the monitored data to the baseline data.

The following points provide advice on the presentation and reporting of results:

• Report findings regularly to relevant personnel, including SMEs and the Chain of Command, so that evidence-based decisions can be made in preparation for the ACT phase (i.e. to address any findings, where necessary).

• There are many ways to capture and illustrate data, but findings should be presented in a format that is simple to understand, noting that the recipients are likely to need high-level summaries to inform their decisions.

• Use appropriate colours to highlight good and poor performance.

• Use graphs to highlight trends and comparisons.

• Ensure EnPIs are presented and discussed.

Table 7 presents six criteria that can be used to assess the progress of a behaviour change intervention / energy management measure: affordability; practicability; effectiveness and cost-effectiveness; acceptability; side effects / safety, and equity.

• **For example:** based on the example used under section 2.3.1, whereby stickers / instructions were added to equipment detailing what can be switched off at the end of the day;

♦ ***Affordability*** – how much has been spent on producing the stickers / instructions, and is the spend within budget?

♦ ***Practicability*** – have stickers / instructions been added to all the proposed equipment, and if not why not? Were there any items of equipment that could not be accessed, reached, found etc.?

**Table 7: Assessing Progress Using APEASE Criteria**

| Criterion | Description |
|---|---|
| **Affordability** | Interventions often have an implicit or explicit budget. It does not matter how effective, or even cost-effective it may be if it cannot be afforded. An intervention is affordable if within an acceptable budget it can be delivered to, or accessed by, all those for whom it would be relevant or of benefit. |
| **Practicability** | An intervention is practicable to the extent that it can be delivered as designed, through the means intended, to the target population. For example, an intervention may be effective when delivered by highly trained staff, but in routine practice this may not be achievable. |
| **Effectiveness and cost-effectiveness** | Effectiveness refers to the effect size of the intervention, in relation to the desired objectives.<br>Cost-effectiveness refers to the ratio of effect (in a way that has to be defined, and taking account of differences in timescale between intervention delivery and intervention effect) to cost.<br>If two interventions are equally effective then clearly the most cost-effective should be chosen. If one is more effective but less cost-effective than another, other issues such as affordability, come to the forefront of the decision-making process. |
| **Acceptability** | Acceptability refers to the extent to which an intervention is judged to be appropriate by relevant stakeholders. Acceptability may differ for different stakeholders. |
| **Side-effects/ safety** | An intervention may be effective and practicable, but it may have unwanted side-effects or unintended consequences. These need to be considered when deciding whether to proceed. [Note: It is advisable to conduct a risk assessment prior to implementing any interventions]. |
| **Equity** | An important consideration is the extent to which an intervention may reduce or increase the disparities in standard of living, working, wellbeing, or health between different sectors of the group(s). |

Table 8: Checklist: Chapter 3 - CHECK

| No. | Action | Tick when complete | Notes |
|---|---|---|---|
| | **C2** | | |
| 2.1 | Schedule a progress update with the Chain of Command and any other relevant personnel | ❑ | |
| | **Technological Applications** | | |
| 3.2 | Collect meter data at regular and appropriate intervals (e.g. the same day each week) | ❑ | |
| 3.3 | Analyse the meter data in-theatre or through a reach-back function - analysis should include looking for trends and anomalies | ❑ | |
| 3.4 | Develop graphs to present the meter data | ❑ | |
| 3.5 | Conduct walk-throughs to clarify the meter data analysis | ❑ | |
| 3.6 | Compare the current meter data analysis with the baseline meter data analysis | ❑ | |
| 3.7 | Identify areas for corrective action | ❑ | |
| | **Behaviour Change** | | |
| 3.8 | Gather continuous feedback from end-users on the new behaviour change intervention(s) / energy management measure(s) | ❑ | |
| 3.9 | Complete behavioural observations (ANNEX B: Observation Audit Template) | ❑ | |
| 3.10 | Compare the current behavioural observations with the baseline behavioural observations | ❑ | |
| 3.11 | Distribute an energy management questionnaire (ANNEX C: Questionnaire Template) | ❑ | |
| 3.12 | Compare the current questionnaire responses to the baseline questionnaire responses | ❑ | |
| 3.13 | Triangulate feedback from end-users, behavioural observations, questionnaire responses, meter data, and any other relevant context data | ❑ | |
| 3.14 | Present overall energy management findings in a plain language format in order to be understood by a range of decision-makers who may not have technical expertise or backgrounds | ❑ | |

# Chapter 4:

# Act

During ACT phase of energy management, the focus is on addressing any issues identified during the CHECK phase by putting mitigations or solutions in place, where possible.

## 4.1 COMMAND AND CONTROL (C2)

It is important to remember that changes to EM measure(s), may need to be authorised by the Chain of Command.

During this phase of energy management, the following C2 activities should be completed:

- obtain approval for any changes required to the EM measure(s);
- task appropriate staff to develop new, or update existing, SOPs based on the validated EM measure(s) tested during the previous phases;
- obtain authorisation to implement the validated EM measure(s) in other areas of the camp, where they could be replicated and there would likely be additional benefit, and
- record lessons learned and archive energy management findings for future use.

## 4.2 TECHNOLOGICAL APPLICATIONS

Improving the energy performance and the energy management system is a continuous process. It is likely that the energy policy will not be achieved with one single energy management measure, but rather a series of measures implemented over time. It is therefore important to document success and failures of the energy meters and any energy related equipment (e.g. generators, air conditioning units) for HOTO, to ensure continuity and identify areas for corrective action.

Communication is essential in the ACT phase, to ensure the progress of meeting the energy objectives and targets is conveyed and continuous action is taken to comply with the energy policy; this includes communicating both success and failure.

• Messaging success is important because it keeps personnel informed and reinforces the commitment that EM measure(s) are important. Simple graphs highlighting how the measures are impacting the EnPIs is an approach to message the success; this material can also be used in briefings to the Commander and the Energy Management Team, which can then subsequently be used to update existing, or develop new, SOPs. Highlighting contributions from team members is important for encouraging positive behaviour change.

• Failures and lessons learned are also important to communicate; this helps to identify whether changes are needed in the approach taken to implement the EM measure(s), or identify the reasons why they were not as successful as anticipated and potentially what corrective actions could be applied. In the continuous improvement process, this will lead back to the PLAN phase in order to implement the corrective actions in the hopes of meeting the targets. Identifying lessons learned can also be communicated to personnel, to highlight the transparency in the process, to maintain the continued interest and support, and to inform other camps of what has and has not worked well.

## 4.3 BEHAVIOUR CHANGE

During the ACT phase of energy management, the pillar of behaviour change is focused on evaluating the behaviour change interventions and amending, where necessary, to ensure continued positive energy management behaviours. This sub-section will explain how to conduct the following step of the behaviour change process:

• Evaluating.

### 4.3.1 EVALUATING

The evaluation process should recognise that behaviour change is not a single event but a process, therefore the results may become increasingly positive over time. For example, behaviour-based data collected one month after implementing an energy management measure may show little progress, but it is important to remember that the time it takes to change habits can vary and are influenced by many factors. Furthermore, it may be necessary to implement multiple EM measure(s) at different times, in order to change one behaviour.

The key activities to engage in during evaluation include:

- revising or redesigning energy management interventions, based on the findings of the CHECK phase (if necessary), and
- where appropriate, scale-up the measures by suggesting other parties on the camp (such as other nations) adopt the behavioural practices (i.e. lead by example). The more nations that agree to adopt validated EM measure(s) across a multi-national camp will increase the return on investment for NATO.

The types of activities that can build momentum, widen participation, and embed change include:

- sequencing the campaign activities (i.e. don't feel the need to implement all EM measure(s) at once);
- creating 'energy champions', who should liaise closely with the EP Officer and other relevant personnel;
- providing energy management information briefings, such as by delivering a short update to all inhabitants of one tent / building on the progress of the EnPIs, how they can help to improve the results, and how this will benefit them (e.g. improved comfort levels);
- using a range of communication channels to strengthen the message and create a sense of ongoing progress and achievement, such as through emails, briefings, infographics in the welfare areas etc., and
- highlighting examples of good practice and good results regardless of size/camp impact (never underestimate the power of one person's good idea or practice). Good practice should always be recognised and reported through the appropriate chain of command.

## 4.4 CHECKLIST

Table 9: Checklist: Chapter 4 - ACT

| No. | Action | Tick when complete | Notes |
|---|---|---|---|
| | **C2** | | |
| **4.1** | Obtain approval for any changes required | ❑ | |
| **4.2** | Develop new or update existing SOPs (or task staff, as appropriate) | ❑ | |
| **4.3** | Obtain authorisation to implement the validated EM measure(s) in other areas of the camp | ❑ | |
| **4.4** | Share best practice with others, such as with operational command, other nations, strategic working groups, and energy related training courses | ❑ | |
| | **Technological Applications** | | |
| **4.5** | Document success and failures of energy meters or technological EM measure(s) | ❑ | |
| **4.6** | Update any camp energy maintenance plans, if required (e.g. new meters, new equipment) | ❑ | |
| **4.7** | Implement corrective actions, where necessary | ❑ | |
| **4.8** | Identify potential technological applications to invest in for the next energy management continuous improvement cycle | ❑ | |
| | **Behaviour Change** | | |
| **4.9** | Revise behaviour-based measures, if necessary | ❑ | |
| **4.10** | Encourage other parties to adopt the best practice behaviours | ❑ | |
| **4.11** | Identify potential 'energy champions' to engage with during the next energy management continuous improvement cycle | ❑ | |
| **4.12** | Provide energy information briefings (when and where appropriate) | ❑ | |
| **4.13** | Advertise the improvements in energy use across the camp, in a range of effective formats | ❑ | |
| **4.14** | Highlight good energy behaviours by any individuals or teams | ❑ | |

# List of Acronyms and Abbreviations

## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AC | Alternating Current |
| AJEPP | Allied Joint Environmental Protection Publication |
| AJP | Allied Joint Publication |
| Amps | Amperes (unit of electrical measurement) |
| ATP | Allied Tactical Publication |
| Bi-SC | Bilateral Strategic Command |
| C2 | Command and Control |
| CIS | Communication and Information Systems |
| CRO | Crisis Response Operations |
| DFI | Deployed Force Infrastructure |
| EE | Energy Efficiency |
| EM Measure(s) | Energy Management Measure(s) |
| EP | Environmental Protection |
| FORCE-SIM | Operation Resource Calculator for Energy Simulator |
| HN | Host Nation |
| HOTO | Handover / Takeover |
| ISO | International Standards Organisation |
| kW | Kilowatt |
| kWh | Kilowatt Hour |
| kWh/L | Kilowatt Hour per Litre (of fuel) |
| kW/kVA | kilowatt / kilo-Volt-Ampere |
| MC | Military Committee |
| MILENG COE | Military Engineering Centre of Excellence |
| NATO | North Atlantic Treaty Organisation |
| NATO ENSEC COE | NATO Energy Security Centre of Excellence |
| NSIP | NATO Security Investment Programme |
| PDU | Power distribution unit |
| PF | Power Factor |
| SEU | Significant Energy Uses |
| SHAPE | Supreme Headquarters Allied Powers Europe |
| SME | Subject Matter Expert |
| SOP | Standard Operating Procedure |
| STANAG | Standard Agreement |
| TAV | Technical Assistance Visit |
| TOR | Terms of Reference |
| VA | Voltage-Amperes |

# List of Figures

## LIST OF FIGURES



# List of Tables

## LIST OF TABLES

# Key Terms

The following are not necessarily NATO approved definitions, but are used as described below in the context of this handbook.

**BEHAVIOUR CHANGE:** any changes in human actions which were directly or indirectly influenced by a variety of interventions (e.g. legislation, regulation, incentives, subsidies, information campaigns, peer pressure etc.) aimed at fulfilling specific behaviour change outcomes. In the context of energy, these outcomes can include any changes in energy efficiency, total energy consumption, energy technology uptake, or energy demand management, but should be identified and specified by the 'behaviour changer' designing the intervention for the purposes of outcome evaluation[21].

**COMMAND AND CONTROL:** is defined by NATO as *"the authority, responsibilities and activities of military commanders in the direction and coordination of military forces and in the implementation of orders related to the execution of operations"*[22].

**ELECTRICITY GENERATION:** is one – but not limited - area where energy management is focused. Electricity generation is the process of generating electric power, which may comprise of a mix of military and commercial deployable generators, hybrid systems, and innovative systems utilizing renewable energy sources, energy storage and energy management tools and processes, as well as host nation (HN) resources. Electricity generation is often the greatest consumer of fuel in DFI and therefore an area where energy management is focused.

**ENERGY BEHAVIOUR:** all human actions that affect the way that fuels (e.g. electricity, gas, petroleum, coal etc.) are used to achieve desired services, including the acquisition or disposal of energy-related technologies and materials, the ways in which these are used, and the mental processes that relate to these actions.

**ENERGY EFFICIENCY (EE):** is not currently defined by NATO, however the NATO ENSEC COE use the following; *"The optimization of power generation, energy management, distribution, and consumption in order to enhance the sustainability of NATO, allied and friendly forces, thus positively influencing autonomy, resilience and mobility of their assets, thereby enhancing the force Commander's operational capabilities"*.

**ENERGY MANAGEMENT SYSTEM (EnMS):** is described as "management system to establish an energy policy, objectives, energy targets, action plans and process(es) to achieve the objectives and energy targets"[23].

**ENERGY MANAGEMENT:** using organisational management, technological applications, and behaviour change to reduce or redistribute energy usage, without creating any shortage or negative effect to capabilities or operations.

**ENERGY MANAGER:** the person in charge of the energy management system.

**ENERGY SECURITY:** is not currently defined by NATO, however the NATO ENSEC COE use the following definition; *"Energy security refers*

[21] International Energy Agency, Demand-Side Management Technology Collaboration Programme, http://www.ieadsm.org/task/task-24-phase-1/

[22] NATO - ATP-3.2.2 Command and Control of Allied Land Forces.

[23] ISO 50001:2018 Energy management systems - Requirements with guidance for use.

*to the uninterrupted availability and resilience of energy sources to support alliance security interests".*

**ENERGY PERFORMANCE INDICATOR (EnPI):** is a measure of energy intensity used to gauge the effectiveness of energy management efforts[24].

**ENERGY SAVING:** defined as "designed to make economical use of electricity, gas, or other forms of energy"[25].

**ENVIRONMENTAL PROTECTION (EP):** is defined as; *"The prevention or mitigation of adverse environmental impacts"*[26].

**INTERVENTION:** is an action to cause an effect on something in a process.

**MANAGEMENT SYSTEM:** "set of interrelated or interacting elements of an organization to establish policies and objectives and processes to achieve those objectives" [27].

**ORGANISATIONAL MANAGEMENT:** is one of the three pillars of effective energy management, it requires assigning responsibility for energy management to appropriate staff, providing time and resources for energy to be monitored and managed, reviewing energy use at periodical assessments, and taking action when needed. This handbook, for better understanding, uses C2 instead of organisational management.

## OTHER ENERGY MANAGEMENT RELATED PUBLICATIONS

This document has linkages to the following principal source publications:

- NATO MC 0626 Policy on power generation for deployed force infrastructure;
- MC 0560/2 Policy for military engineering;
- MC 0469/1 NATO principles and policies for environmental protection;
- NATO STANAG 2238 Allied joint doctrine for military engineering;
- NATO STANAG 2394 (ATP 3.12.1) Allied tactical doctrine for military engineering;
- NATO STANAG 2582 (AJEPP 2) Environmental protection best practices and standards for military camp in NATO operations;
- NATO STANAG 2632 (ATP -3.12.1.4) Deployed Force Infrastructure;
- ISO 50001:2018 Energy management systems - Requirements with guidance for use.

## POINT OF CONTACT

**NATO ENERGY SECURITY CENTRE OF EXCELLENCE**

Silo g. 5A (K-22)
LT-10322 Vilnius
Lithuania
Phone: +370 5 203 26 86
Fax: +370 706 71010
Email: info@enseccoe.org

24 https://50001store.com/articles/energy-performance-indicator-enpi

25 Lexico: https://www.lexico.com/en/definition/energy-saving

26 NATO/MC, MC 469 - NATO Military Principles and Policies for Environmental Protection.

27 ISO 50001:2018 Energy management systems - Requirements with guidance for use.

# ANNEX A:
# Harmonized Energy Metering Points Guide

| Chanel Number | Instrument Tag No. | Instrument Measurement Description | Units | |
|---|---|---|---|---|
| **Local Weatherstation (One minute timestep) or (Reference Location)** | | | | |
| | Actual Location, Longitude/Latitude/Grid | | | |
| 1 | T-AMB | Ambient temperature | °C | *Decimal / Comma* |
| 2 | RH-AMB | Ambient Relative Humidity | % | |
| 3 | WIND-SPD | Wind Speed | m/s | |
| 4 | WIND-DIR | Wind Direction<br>(0° South, 90° West etc.) | ° | |
| 5 | SOLAR_RAD | Horizontal Solar Radiation | $W/m^2$ | |
| **Generated Power (One minute timestep)** | | | | *Significant Digits* |
| 1 | GEN_1_LINE_VOLTAGE | Generator 1 Line Voltage<br>(Line to Neutral) | V | *x.x* |
| 2 | GEN_1_LINE_PHASE_A_AMPS | Generator 1 Line Phase A Amps | A | *x.x* |
| 3 | GEN_1_LINE_PHASE_B_AMPS | Generator 1 Line Phase B Amps | A | *x.x* |
| 4 | GEN_1_LINE_PHASE_C_AMPS | Generator 1 Line Phase C Amps | A | *x.x* |
| 5 | GEN_1_LINE_kW | Generator 1 Line Total True Power | kW | *x.x* |
| 6 | GEN_1_LINE_kVA | Generator 1 Line Total Apparent Power | kVA | *x.x* |
| 7 | GEN_1_LINE_kVAR | Generator 1 Line Total Reactive Power | kVAR | *x.x* |
| 8 | GEN_1_LINE_PF | Generator 1 Line Power Factor | -- | *.xx* |
| 9 | GEN_1_HZ | Generator 1 Frequency | Hz | *xx.xx* |

| Chanel Number | Instrument Tag No. | Instrument Measurement Description | Units |
|---|---|---|---|
| | Renewable Energy Type | | |
| 9 | RENEWABLE_1_DC_VOLTAGE | Renewable 1 DC Voltage | V |
| 10 | RENEWABLE_1_DC_AMPS | Renewable 1 DC Amps | A |
| 11 | RENEWABLE_1_DC_Power | Renewable 1 DC Total Power | kW |
| 12 | RENEWABLE_1_AC_VOLTAGE | Renewable 1 AC Voltage (after inverter) | V |
| 13 | RENEWABLE_1_AC_A_AMPS | Renewable 1 AC Phase A Amps (after inverter) | A |
| 14 | RENEWABLE_1_AC_B_AMPS | Renewable 1 AC Phase B Amps (after inverter) | A |
| 15 | RENEWABLE_1_AC_B_AMPS | Renewable 1 AC Phase B Amps (after inverter) | A |
| 16 | RENEWABLE_1_AC_kW | Renewable 1 AC Total Power | kW |
| 17 | RENEWABLE_1_AC_kVA | Renewabe 1 AC Total Apparent Power | kVA |
| 18 | RENEWABLE_1_AC_kVAR | Renewable 1 AC Total Reactive Power | kVAR |
| 19 | RENEWABLE_1_AC_PF | Renewable 1 AC Power Factor | -- |
| 20 | RENEWABLE_1_AC_HZ | Renewable 1 AC Frequency | Hz |
| | Battery Chemistry | | |
| 20 | RENEWABLE_BATT_VOLT | Renewable Battery Storage Voltage | V |
| 21 | RENEWABLE_BATT_FSOC | Fractional State of Charge | % |
| * "GEN" can be generator or grid power, each generator should be measured for total generated power and % load on gen | | | |
| **Distributed Power (One minute timestep) – type of load (shelter group/lighting/conditioning)** | | | |
| | **Type of load - accomodation block/lighting/air conditioning/offices** | | |
| 1 | PDU.01_LINE_1_VOLTAGE | Distribution Unit 1 Line 1 Voltage (Line to Neutral) | V |
| 2 | PDU.01_LINE_1_A_AMPS | Distribution Unit 1 Line 1 Phase A Amps | A |
| 3 | PDU.01_LINE_1_B_AMPS | Distribution Unit 1 Line 1 Phase B Amps | A |

| Chanel Number | Instrument Tag No. | Instrument Measurement Description | Units | |
|---|---|---|---|---|
| 4 | PDU.01_LINE_1_B_AMPS | Distribution Unit 1 Line 1 Phase C Amps | A | |
| 5 | PDU.01_LINE_1_kW | Distribution Unit 1 Line 1 Total Power | kW | |
| 6 | PDU.01_LINE_1_kVA | Distribution Unit 1 Line 1 Apparent Power | kVA | |
| 7 | PDU.01_LINE_1_kVAR | Distribution Unit 1 Line 1 Reactive Power | kVAR | |
| 8 | PDU.01_LINE_1_PF | Distribution Unit 1 Line 1 Power Factor | -- | |
| 9 | PDU.01_LINE_1_HZ | Distribution Unit 1 Line 1 Frequency | Hz | |
| * Repeat for each line in distribution unit and for each distribution unit | | | | |
| **Shelter Energy End Use (One minute timestep)** | | | | |
| | **Shelter Occupation, dimensions, colour, shading** | | | |
| 1 | SHELTER_1_VOLTAGE | Shelter 1 Voltage (Line to Neutral) | V | |
| 2 | SHELTER_1_A_AMPS | Shelter 1 Phase A Amps | A | |
| 3 | SHELTER_1_B_Amps | Shelter 1 Phase B Amps | A | |
| 4 | SHELTER_1_C_AMPS | Shelter 1 Phase C Amps | A | |
| 5 | SHELTER_1_kW | Shelter 1 Total Power | kW | |
| 6 | SHELTER_1_FLR_TEMP | Shelter 1 Floor Temperature (Centre Right) | °C | *Include variable for no value (e.g. 9999)* |
| 7 | SHELTER_1_MID_TEMP | Shelter 1 Mid Temperature (Centre Right 1m) | °C | *Include variable for no value (e.g.9999)* |
| 8 | SHELTER_1_TOP_TEMP | Shelter 1 Top Temperature (Centre) | °C | *Include variable for no value (e.g. 9999)* |
| 9 | SHELTER_1_CU_IN_TEMP | Shelter 1 Conditioning Unit Inlet Air Temperature | °C | *Include variable for no value (e.g. 9999)* |
| 10 | SHELTER_1_CU_OUT_TEMP | Shelter 1 Conditioning Unit Outlet Air Temperature | °C | *Include variable for no value (e.g. 9999)* |
| 11 | SHELTER_1_I_SURFACE_TEMP | Shelter 1 Interior Surface Temperature (Centre Right 1m) | °C | *Include variable for no value (e.g. 9999)* |
| 12 | SHELTER_1_O_SURFACE_TEMP | Shelter 1 Exterior Surface Temperature (Centre Right 1m) | °C | *Include variable for no value (e.g. 9999)* |
| 13 | SHELTER_1_S_SURFACE_TEMP | Shelter 1 Exterior Shade Surface Tempera-ture (Centre Right 1m) | °C | *Include variable for no value (e.g. 9999)* |

# ANNEX B:
# Observation Audit Template

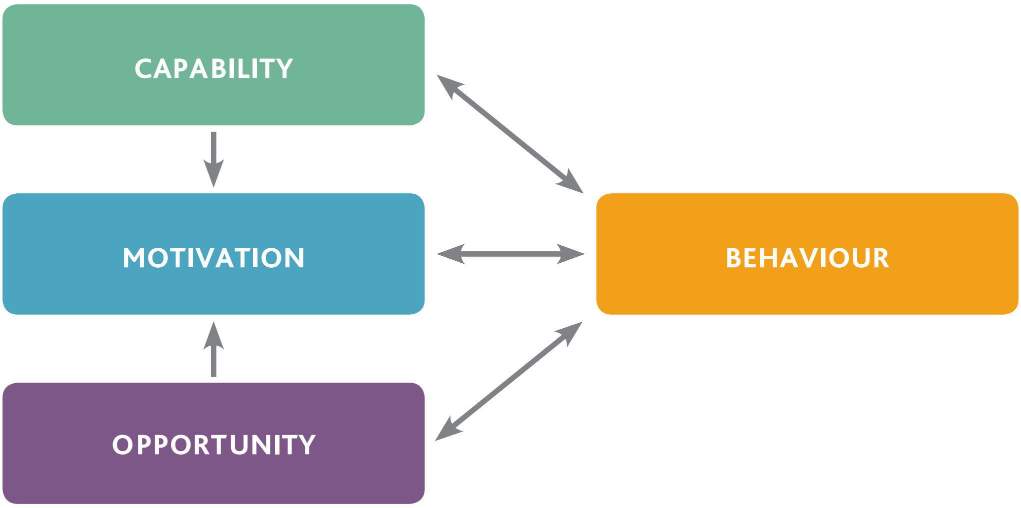
| No. | Context | Observation Description | | |
|---|---|---|---|---|
| 1 | What is the behaviour? | | | |
| | What is the frequency of the behaviour?<br>*(Please circle)* | LOW | MEDIUM | HIGH |
| | Is the behaviour positive or negative?<br>*(Please circle)* | Positive | Negative | |
| 2 | When: what time of day did you observe the behaviour? | | | |
| 3 | Where: what is the location / building?<br>*(If possible, highlight on a map)* | | | |
| 4 | Who: personnel type / role?<br>*(Do not provide names)* | | | |
| 5 | What: describe the equipment type. | | | |
| 6 | How: how is the energy being used?<br>*(e.g. messing, hoteling, gym power)* | | | |
| 7 | Why: define the reason for behaviour.<br>*(e.g. your interpretation OR ask the person doing the behaviour)* | | | |
| 8 | Any other relevant contextual information?<br>*(e.g. are there any existing energy efficiency initiatives?)* | | | |
| 9 | Any other comments?<br>*(e.g. capture best practice)* | | | |
| 10 | Circle the most relevant item lacking that could explain the behaviour*:<br>• CAPABILITY (C)<br>• OPPORTUNITY (O)<br>• MOTIVATION (M) | C | O | M |

### EXAMPLE BEHAVIOURS:

• Tent door left unzipped / open.
• Air conditioning unit left on in empty tent.
• Using cars to drive short distances around camp.
• Water for showers kept constantly hot.

### *Q.10 COM-B GUIDANCE:

| COM-B Element | Definition |
|---|---|
| CAPABILITY | • **Physical:** having physical skills, strength, or stamina.<br>• **Psychological:** having the knowledge, psychological skills, strength, or stamina to engage in the necessary mental processes. |
| OPPORTUNITY | • **Physical:** what the environment allows or facilitates in terms of time, triggers, resources, locations, and physical barriers.<br>• **Social:** interpersonal influences, social cues and cultural norms that influence the way we think about things. |
| MOTIVATION | • **Reflective:** self-conscious planning and evaluations (beliefs about what is good or bad).<br>• **Automatic:** processes involving wants and needs, desires, impulses, and reflex responses. |



# ANNEX C:
# Questionnaire Template

## SECTION A. BACKGROUND AND INSTRUCTIONS

This questionnaire aims to identify important information about how we can manage energy in the most effective manner. The questionnaire will take about five minutes to complete. Your responses will not be able to be individually identified. Please complete the questionnaire with reference to your current role. For the purpose of this questionnaire, 'energy' includes all liquid fuel, gas, and electrical power.

## SECTION B. QUESTIONS ABOUT YOU

**1. Please select your service:** *(Please circle)*

Army | Air Force | Navy | Civil Servant | Other*

Other: *(Please specify)* ..................................................

**2. What is your age?** ..................................................

**3. What is your gender?** ..................................................

**4. What is your rank, or civilian equivalent**? *(Please circle)*

- OF4 | OF3 | OF2 | OF1
- OR9 | OR8 | OR7 | OR6 | OR5 | OR4 | OR3 | OR2 | OR1
- Other: *(Please specify)* ..................................................

**5. How satisfied are you with your job?** (*Please circle a number on the scale below)*

Completely dissatisfied ⟷ Completely satisfied

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|

**6. What is your area of work?** *(Please circle)*

| Accommodation | Medical Centre | Flight Operations | Operational Security | Logistics (J4) | Laundry | Kitchen | Other*|

*Other: *(Please specify)* ..................................................

**7. Do you currently have any official role and / or responsibility for energy management?** *(Please tick)*

❑ Yes ❑ No

**8. Are you aware of any initiatives on the camp, either large or small, to save energy?** *(Please tick)*

❑ Yes ❑ No

## SECTION C. ENERGY BEHAVIOURS AND YOU

Please choose your response according to the following statements.

**9. I feel I have a good understanding of where the most energy is used in my workplace.** *(Please circle)*

Strongly Agree – Agree – Neutral – Disagree – Strongly Disagree

**10. I know how to save energy in my role.** *(Please circle)*

Strongly Agree – Agree – Neutral – Disagree – Strongly Disagree

**11. I have the opportunity to save energy in my work place.** *(Please circle)*

Strongly Agree – Agree – Neutral – Disagree – Strongly Disagree

**12. What would help you to conserve / optimise energy usage in this camp?**

**13. I would like to save energy in my part of the organisation.** *(Please circle)*

Strongly Agree – Agree – Neutral – Disagree – Strongly Disagree

**14. Saving energy on operations is not in conflict with my role.** *(Please circle)*

Strongly Agree – Agree – Neutral – Disagree – Strongly Disagree

**Comments:** Please describe where there is a conflict between your professional role and saving energy.

**15. I think it is important to save energy (in general).** *(Please circle)*

Strongly Agree – Agree – Neutral – Disagree – Strongly Disagree

**16. I am provided with information about where energy is consumed that allows me to save energy.** *(Please circle)*

Strongly Agree – Agree – Neutral – Disagree – Strongly Disagree

**17. My immediate superior is involved with / concerned with saving energy.** *(Please circle)*

Strongly Agree – Agree – Neutral – Disagree – Strongly Disagree

**18. My colleagues would laugh at me if I were to try to save energy.** *(Please circle)*

Strongly Agree – Agree – Neutral – Disagree – Strongly Disagree

**19. Saving energy compromises safety (in general).** *(Please circle)*

Strongly Agree – Agree – Neutral – Disagree – Strongly Disagree

**20. Saving energy reduces operational security / compromises operations (in general).** *(Please circle)*

Strongly Agree – Agree – Neutral – Disagree – Strongly Disagree

***21. I want to do something to save energy.*** *(Please circle)*

Strongly Agree – Agree – Neutral – Disagree – Strongly Disagree

## SECTION D. ELECTRICAL DEVICES AND ENERGY

**22. My colleagues don't switch off their electrical devices when they stop using them.** *(Please circle)*

Strongly Agree – Agree – Neutral – Disagree – Strongly Disagree

**Comments:** If your colleagues don't generally switch off their devices, please briefly explain why you think this is the case.

**23. I switch off my electrical devices when I stop using them.** *(Please tick)*

❑ Yes ❑ Sometimes ❑ No

**Comments:** If you generally do switch off your devices, please briefly explain why.

**24. Please select all the options that explain why you may not switch off all electrical devices when you stop using them.** *(Please tick)*

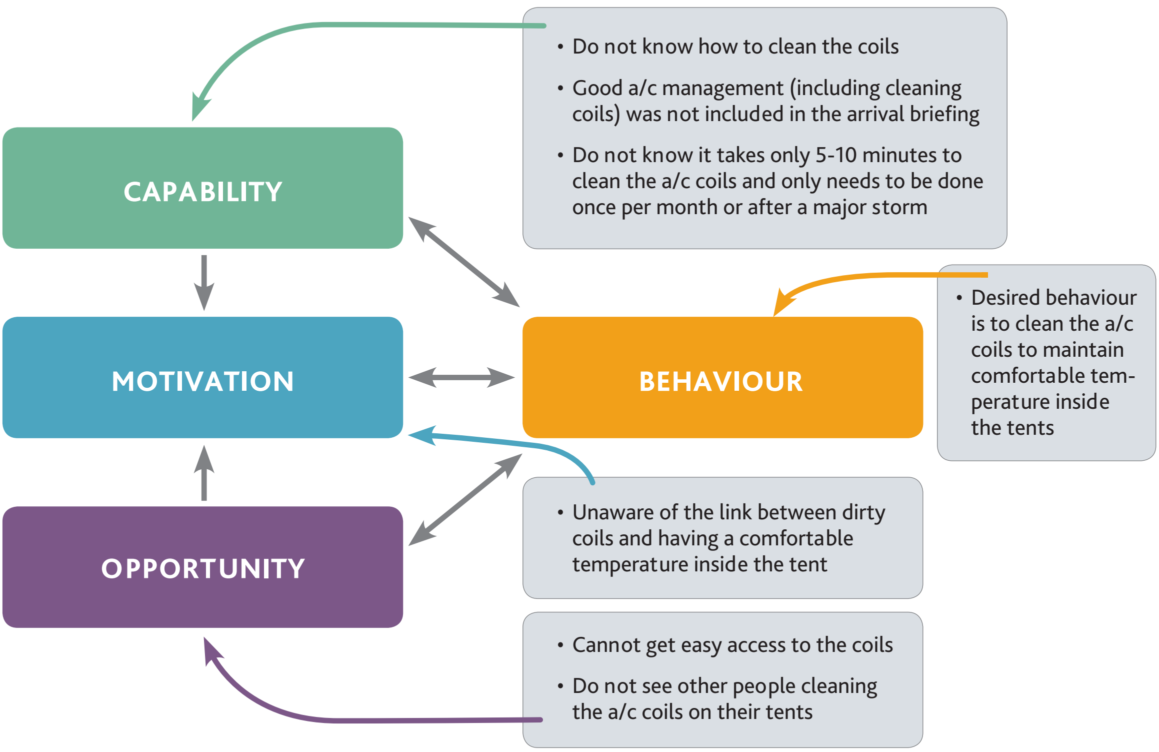
❑ It takes too much time
❑ It is an inconvenience
❑ I don't care
❑ It is physically hard to do so
❑ It is impossible to do so
❑ I believe I shouldn't switch off, to help with software updates
❑ It is not something I think about
❑ I believe it doesn't cost very much money to leave electrical devices on
❑ I don't have to pay for it (the invoice / bill)
❑ I don't believe it harms the environment
❑ I forget to
❑ No one checks on me
❑ It is not a priority
❑ It is not my job to do so
❑ I have been told not to regulate equipment

**Comments:** Please suggest any other reason why you don't switch off your electrical devices

**Thank you for your participation in this survey!**

# ANNEX D:
## COM-B Example

| COM-B Element | Definition |
|---|---|
| CAPABILITY | • **Physical:** having physical skills, strength, or stamina.<br>• **Psychological:** having the knowledge, psychological skills, strength, or stamina to engage in the necessary mental processes. |
| OPPORTUNITY | • **Physical:** what the environment allows or facilitates in terms of time, triggers, resources, locations, and physical barriers.<br>• **Social:** interpersonal influences, social cues and cultural norms that influence the way we think about things. |
| MOTIVATION | • **Reflective:** self-conscious planning and evaluations (beliefs about what is good or bad).<br>• **Automatic:** processes involving wants and needs, desires, impulses, and reflex responses. |



# ANNEX E:
# Best Practice Behaviour Change Techniques (BCTs)

| No. | BCT | Description | Energy Example | Links to Intervention Categories |
|---|---|---|---|---|
| 1 | **Action planning** | Prompt detailed planning of performance of the behaviour (must include at least one of context, frequency, duration and intensity). Context may be environmental (physical or social) or internal (physical, emotional or cognitive). | Encourage the creation of a department end of day shutdown checklist. | • Enablement |
| 2 | **Adding objects to the environment** | Add objects to the environment in order to facilitate performance of the behaviour. | Place stickers on all equipment detailing what can be switched off at the end of the day. | • Enablement |
| 3 | **Behavioural practice / rehearsal** | Prompt practice or rehearsal of the performance of the behaviour one or more times in a context or at a time when the performance may not be necessary, in order to increase habit and skill. | Practice switching on and off a complex piece of equipment. | • Training<br>• Environmental restructuring |
| 4 | **Commitment** | Ask the person to affirm or reaffirm statements indicating commitment to change the behaviour. | Postcard pledges e.g. "I will turn off my IT equipment at the end of the day". | • Incentivisation |
| 5 | **Credible source** | Present verbal or visual communication from a credible source in favour for or against the behaviour. | Commanding Officer | • Training<br>• Persuasion<br>• Role modelling |
| 6 | **Demonstration of the behaviour** | Provide an observable sample of the performance of the behaviour, directly in person or indirectly (e.g. via video) for the person to aspire to or imitate. | Demonstrate, using role-play how to shut down the office at the end of the day using the checklist. | • Training<br>• Role modelling |
| 7 | **Feedback on behaviour** | Monitor and provide informative or evaluative feedback on performance of that behaviour. | Create and send an email detailing how often they switched off their IT equipment. | • Training<br>• Education<br>• Persuasion<br>• Incentivisation<br>• Coercion |

| No. | BCT | Description | Energy Example | Links to Intervention Categories |
|---|---|---|---|---|
| 8 | **Feedback on outcome(s) of behaviour** | Monitor and provide feedback on the outcome of performance of the behaviour. | Provide information about how much energy has been saved following the implementation of the interventions. | • Training<br>• Education<br>• Persuasion<br>• Incentivisation<br>• Coercion |
| 9 | **Framing / reframing** | Suggest the deliberate adoption of a perspective or new perspective on behaviour (e.g. its purpose) in order to change cognitions or emotions about performing the behaviour. | Suggest that the person might think of switching off IT equipment as 'doing energy security'. | • Persuasion |
| 10 | **Goal setting (behaviour)** | Set or agree a goal defined in terms of the behaviour to be achieved. | Set the goal of switching off all IT equipment at the end of the day. | • Enablement |
| 11 | **Goal setting (outcome)** | Set or agree a goal defined in terms of a positive outcome of wanted behaviour. | Set an energy reduction goal (e.g. 10%) each month. | • Enablement |
| 12 | **Incentive (behaviour)** | Inform the target audience that a reward, material (e.g. money) or social (e.g. verbal or non-verbal), will be delivered if - and only if - there has been effort and / or progress in performing the behaviour. | Inform the target audience that a percentage of the costs saved from energy reduction will be spent on staff. | • Incentivisation |
| 13 | **Identification of self as a role model** | Inform the target audience that one's own behaviour may be an example to others. | Inform the permanent staff that if they switch off IT equipment it will be a good example for transient staff. | • Persuasion |
| 14 | **Information about others' approval** | Provide information about what other people think about the behaviour. The information clarifies whether others will like, approve or disapprove of what the person is doing or will do. | Get support email from the Commanding Officer. | • Education<br>• Persuasion |
| 15 | **Information about social and environmental consequences** | Provide information (e.g. written, verbal, visual) about social and environmental consequences of performing the behaviour. | Posters that show how many life jackets could be purchased with the saved costs. | • Education<br>• Persuasion |
| 16 | **Instruction on how to perform a behaviour** | Advise or agree on how to perform the behaviour (i.e. skills training). | Advise how to turn off IT equipment. | • Training |
| 17 | **Monitoring others' behaviour without giving feedback** | Observe or record behaviour with the person's knowledge, as part of a behaviour change / improvement strategy. | Conduct an observation audit on what IT equipment is left on. | • Incentivisation<br>• Coercion |

| No. | BCT | Description | Energy Example | Links to Intervention Categories |
|---|---|---|---|---|
| 18 | **Monitoring others' behaviour without giving feedback** | Observe or record outcomes of behaviour with the person's knowledge as part of a behaviour change / improvement strategy. | Record if IT equipment switched off. | • Coercion |
| 19 | **Problem solving** | Analyse, or prompt the person to analyse, factors influencing the behaviour and generate or select strategies that include overcoming barriers and / or increasing facilitators. | Prompt staff to identify barriers preventing them turning off their equipment at the end of the day. | • Enablement |
| 20 | **Prompts / cues** | Introduce or define environmental or social stimulus with the purpose of prompting or cueing the behaviour. The prompt or cue would normally occur at the time or place of performance. | Put a sticker on the light switch to remind people to turn it off. | • Education<br>• Environmental restructuring |
| 21 | **Restructuring of the physical environment** | Change, or advise to change, the physical environment in order to facilitate performance of the wanted behaviour or create barriers to the unwanted behaviour. | Make master off switch more easily accessible by moving closer to the door. | • Environmental restructuring |
| 22 | **Review behaviour goal(s)** | Review behaviour goal(s) jointly with the person; this may lead to re-setting the same goal, a small change in that goal, or setting a new goal instead of (or in addition to) the first, or no change. | Examine performance against goals and consider modifying future behavioural goals. | • Enablement |
| 23 | **Reward** | Arrange for the delivery of a reward, material (e.g. money) or social (e.g. verbal or non-verbal), if there has been effort and / or progress in performing the behaviour. | Spend a percentage of the costs saved from energy reduction on staff. | • Incentivisation |
| 24 | **Review outcome goal(s)** | Review outcome goal(s) jointly with the person; this may lead to re-setting the same goal, a small change in that goal, or setting a new goal instead of (or in addition to) the first, or no change. | Examine how much energy has been saved and consider modifying outcome goal(s). | • Enablement |
| 25 | **Self-monitoring of behaviour** | Establish a method for the person to monitor and record their behaviour as part of a behaviour change / improvement strategy. | Ask the person to record daily in a diary, whether they turned off their IT equipment. | • Training<br>• Enablement<br>• Education<br>• Incentivisation<br>• Coercion |
| 26 | **Social comparison** | Draw attention to others' performance to allow comparison with the person's own performance. | Use data from similar buildings to show how much energy they use. | • Persuasion |
| 27 | **Social support** | Advise on, arrange, or provide social and / or practical support (e.g. from colleagues), or non-contingent praise or reward for performance of the behaviour. It includes encouragement, but only when it is directed at the behaviour. | Arrange for department heads / line managers to encourage continuation with the behaviour. | • Enablement |

# ANNEX F:
# Energy in Deployed Force Infrastructure

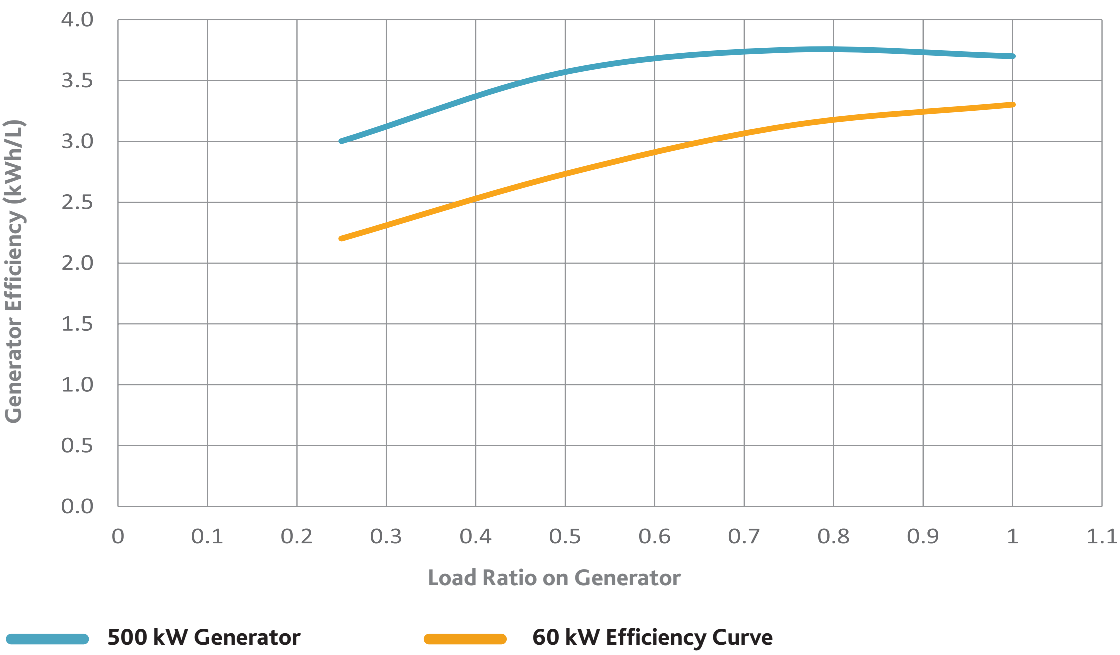
Energy is an essential element of every military mission or operation. It powers and supports every military system and unit, from the heating and cooling of facilities, to surveillance and communication systems. The fundamental concepts of energy related technology are introduced below.

## ELECTRICITY GENERATION

Electricity generation is one area where energy management can be applied. Electricity generation is the process of generating electric power, which for a DFI Tier 2 camp, may comprise of a mix of military and commercial deployable generators, hybrid systems, and innovative systems using renewable energy sources, energy storage, and energy management tools and processes, as well as Host Nation (HN) resources.

Diesel generators are common power generating sources in deployed camps. All generators are designed with an optimum operating point; therefore, it is important to be aware that the diesel generator efficiency can vary as a result of the power demanded. A diesel generator efficiency curve versus percent loading graph is shown in Figure F1 highlighting that the electricity generation efficiency can vary by as much as 20% if improperly selected.

**Figure F1 Diesel Generator Efficiency Curve for 60 kW and 500 kW Generator Versus Load**



## ELECTRICAL SYSTEMS

Energy efficiency measures will have an impact on both the amount of electricity consumed (kWh) and the amount of electricity demanded (power; kW). It is therefore important to understand the difference between them.

Power (kW) is the amount of electricity demanded by a process. The electricity demand of a camp will vary over time as processes are turned on and off, or pieces of equipment require more or less electricity due to factors such as changes in climate, or changes in operational requirements. The system employed to do the power generation must be able to meet this electrical demand and will therefore be sized to meet the highest instantaneous power demand of a camp/process.

Electricity consumed (kWh) is the amount of electricity demanded by a process over a period of time. A process that demands 1 kW of power for a period of one hour, consumed 1 kWh of electricity.

Measurements of electricity are expressed in Volts and Amperes (Amps). If an electric wire was considered to be like a hose, voltage (Volts) would represent the water pressure and current (Amps) would represent the water flow rate. The total power delivered can be considered the voltage-amperes (VA); however, this is not equivalent to kW in alternating current (AC) systems. The VA takes into account the peak voltage and the peak amperage and, depending on the process, the peak voltage may occur before or after the peak amperage in order to build sufficient pressure to deliver the amps.

Generators are sized to meet the required VA. Thus, if there are many processes where the peak voltage occurs before the peak amperage, the generator is significantly oversized for the true system power (kW). The difference between VA and kW is expressed as Power Factor (PF; kW/kVA). The lower the PF, the higher the utility bill (cost) in order to provide electricity for the same process. A power factor of 0.8 is typically assumed for DFI; however, a PF of 1 is ideal. Motors are typical sources of inductive loads and devices exist for PF correction.

## MECHANICAL SYSTEMS

Heating and cooling are typically the highest energy end uses for a deployed camp. Mechanical systems are employed to ensure comfortable heating and cooling conditions are met.

Space or shelter heating systems can be electricity or directly fuel-driven. Electrical systems can be purely resistive (i.e. 100% conversion efficiency), or can be in the form of a heat pump whereby energy is upgraded from the surroundings to meet a heating demand (e.g. two and a half times the heat is produced per unit of electricity input). Fuel-driven heating systems have a lower conversion efficiency (~80%); however globally they can be more efficient if a diesel generator is used to provide electricity for the electrical heating system. Similar to sizing a generator, heating systems are sized to meet the shelter's or building's peak heating load (requirement). Ambient temperature, wind, and solar radiation all affect the heating load and thus the load varies over the year. Similarly to a diesel generator, if the heating system is not operated at its design point, the system will operate inefficiently and also cause discomfort cycling on and off.

Space or shelter cooling systems are typically electrically-driven. Cooling systems pump warm energy from indoors to outdoors. Similarly to heat pumps, cooling systems utilise the energy in the surroundings to generate a cooler climate (e.g. three times the amount of cooling is produced per unit of electricity input).

Heat pumps can be dual purpose in that they can both heat and cool a space using the same technology, by using a reversing valve to switch between heating and cooling modes. Care must be taken that heating and cooling loads do not exceed the performance capability of the equipment as per the technical specification.

# ANNEX G:
# Energy Management Case Study

An example of energy management for a technological application

## BACKGROUND

Space or shelter cooling systems typically rely on electrically driven air conditioners. Similar to a heat pump or refrigerator, an air conditioner pumps energy from inside the building or shelter to the outdoors to maintain indoor comfort conditions. To dissipate the heat, large evaporator coils are used, which relies on the ambient air to dissipate. Thus if the coil is installed next to a heat source (exterior wall, directly in the sun), the system will operate inefficiently. Likewise, if the evaporator coil is not cleaned, there is insufficient airflow to dissipate the heat.

You are a newly appointed energy manager and given the authorization to identify and implement EM measure(s).

## PLAN:

You have arranged to do a walk through with you SMEs, two of whom are specialist contractors, to get started in the process. From the walk through with your SMEs you noticed that the air conditioning coils are dirty (Figure G1) and are causing comfort issues inside the tents because they are unable to maintain the desired indoor temperature.

With your SMEs you decide this would be a good low or no cost energy management measure to improve camp energy efficiency in addition to improving the comfort of the soldier.

From the handover, you know the previous energy manager installed extensive energy meters and each of the accommodation blocks where you noticed the dirty air conditioning coils are being sub-metered. You also have a local weather-station so that the data can be normalized or observed trends explained. Not needing to implement additional energy meters, you decide that an increased coil cleaning schedule could be implemented for one of the accommodation blocks and compared to another to see what kind of energy reductions are possible. To track progress, you decide to record the weekly daily average electricity consumption per person (kWh/person) in the two accommodation blocks under study.

**Figure G1: Example of a Dirty Air Conditioning Coil Providing Discomfort**

### CHECKLIST:

- ❑ Walk-through of the camp should be undertaken to gain an understanding of what type of infrastructure there is and identify potential SEUs and potential EM measure(s)
- ❑ Consult with SMEs (this may include specialist contractors)
- ❑ Energy Metering Plan
- ❑ Identify the extent of sub-meter requirements
- ❑ Weather data
- ❑ Occupancy data
- ❑ EnPIs
- ❑ Energy Management Data Collection and Analysis Plan
- ❑ Development of a template

### DO:

Having received the go-ahead from the commander to implement the energy management measure, you validate the accommodation block sub-meter readings and see that the weekly average daily electricity consumption per person is the same for both accommodation blocks from the historical data (Figure G2). Speaking with the relevant person at the camp, you see that the standard operating procedure to clean the air conditioning coils is once every three months (Week 1, Week 14, Week 27 and Week 40). The last time the air conditioning coils were cleaned was Week 14 and the energy consumption trends for both accommodation blocks increased from that time period. You confirm with him/her that for the study it would be necessary for someone to clean the air conditioning coils on a weekly basis for Accommodation Block 1 to see if there is a difference in performance between Ac-

**Figure G2: Historical Weekly Average Daily Electricity Consumption per Person in the Accommodation Blocks**

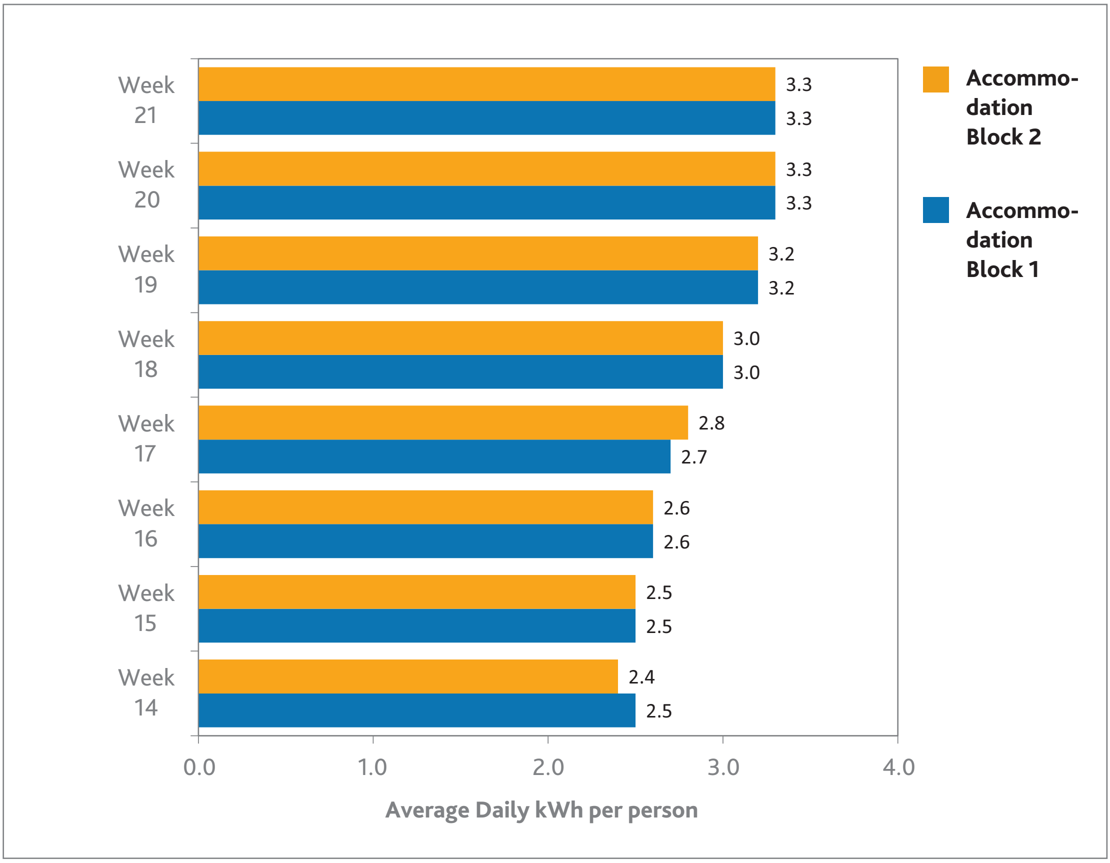
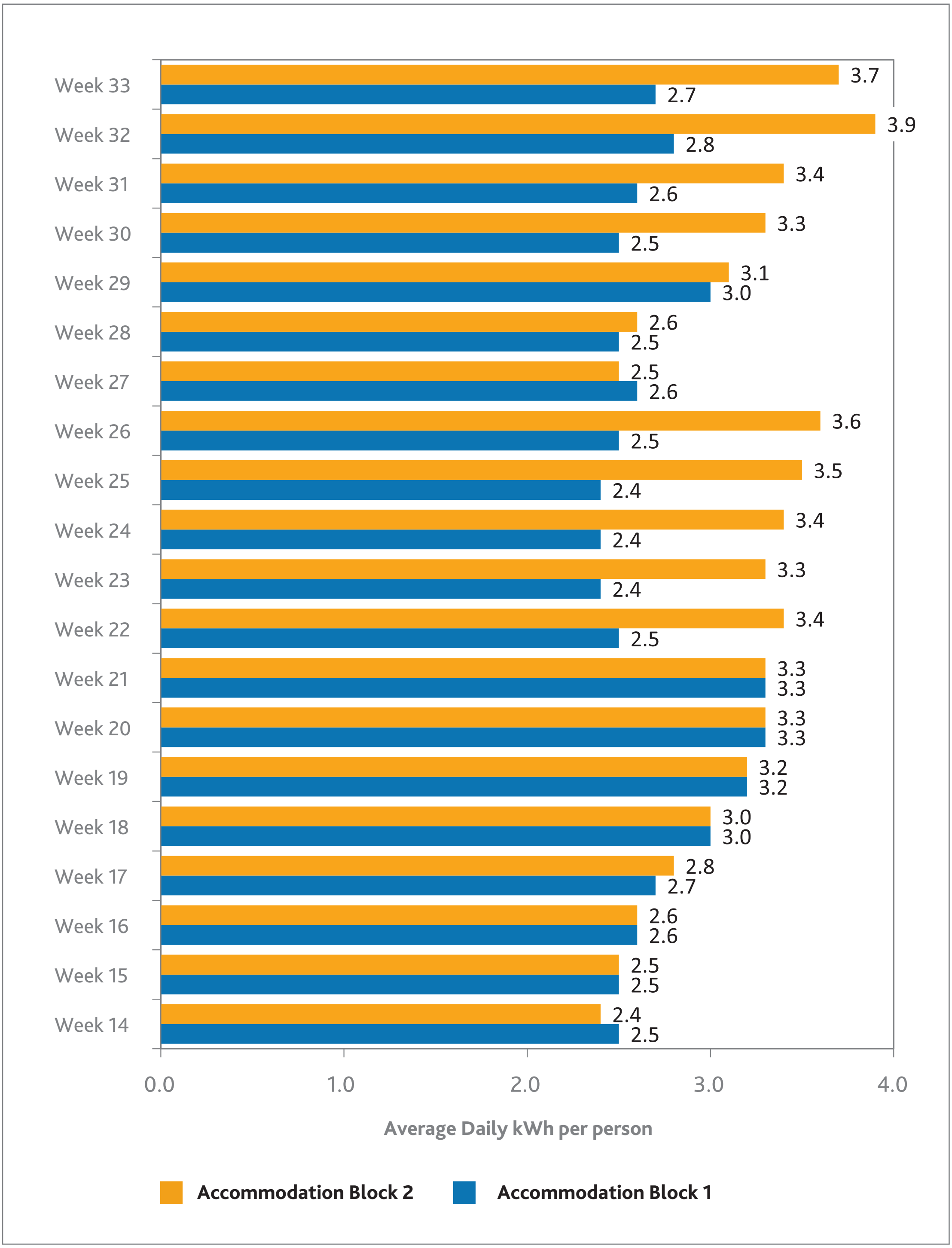


**Figure G3: Weekly Average Daily Electricity Consumption per Person in the Accommodation Blocks with Weekly Air Conditioning Coil Cleaning in Accommodation Block 1 Starting Week 22**



commodation Block 2. The study would be a duration of 12 weeks in order to generate conclusive evidence during the hotter summer period. The camp major agrees and the study would commence on Week 22, where the camp major will arrange for the accommodation block 1 air conditioning coils to be cleaned on a weekly basis. The regular scheduled cleaning would also be maintained on week 27. The study would terminate on week 33.

### CHECKLIST:

- ❑ Validate meter readings
- ❑ Check meter readings after one week to ensure EnPIs can be recorded
- ❑ Request assistance and quotations for level of investment required to implement any technological EM measure(s)
- ❑ Develop installation/maintenance plan

### CHECK:

The energy management case study has commenced and with a walk through you see that the air conditioning coils were cleaned in Accommodation Block 1 on the start of week 22. The template to track the weekly average daily electricity consumption per person has already been set-up and you decide to collect the meter readings on a weekly basis and analyse the data to see if the cleaning measure has an energy reduction potential. You plot the trends on a weekly basis (Figure G3) and make note in your calendar to remind yourself to do a walk through the camp on the start of each week to verify that the air conditioning coils have been cleaned. You also note that a major storm passed through in the evening of the first day in Week 29 after the air conditioning coils in Accommodation Block 1 had been cleaned (Figure G4). The storm resulted in an increased accumulation of dust and dirt on the air conditioning coils.

Analysing the data you are happy to see that overall by implementing a more frequent air conditioning coil cleaning routine, a reduction of close to 30% in electricity consumption was achieved. Based on the occupancy, this amounted to just over 1,400 L of diesel fuel savings. You also note, that both Accommodation Blocks consumed the same amount of electricity after the regular routine cleaning schedule until Week 30 after the major storm. While good practice to clean the air conditioning coils on a regular basis, perhaps on a weekly basis is not necessary and the cleaning schedule could be applied on a monthly basis or after a major storm.

### CHECKLIST:

- ❑ Collect meter data at regular and appropriate intervals (e.g. the same day each week)
- ❑ Analyse the meter data in-theatre, or through a reach-back function. The analysis should include looking for trends and anomalies
- ❑ Develop graphs to present the meter data
- ❑ Conduct walk-throughs to clarify the meter data analysis
- ❑ Compare the current meter data analysis with the baseline meter data analysis
- ❑ Identify areas for corrective action

### ACT:

With the case study completed you present the results to your Commander, highlighting the fuel savings achieved with just one accommodation block. While perhaps a more intensive routine to clean the air conditioning coils on a weekly basis, you also highlight that the need is really to clean the coils only after a major storm as witnessed during the week of June 29$^{th}$. The commander is pleased with the results and requests that the camp major update the air conditioning coil cleaning maintenance plans to once every month or after a major storm.

Pleased with the results you thank your energy management team and start the process again looking for new EM measure(s) to implement.

### CHECKLIST:

- ❑ Document success and failures of any of the energy meters or related technological EM measure(s).
- ❑ Update any camp energy maintenance plans, if required (e.g. new meters, new equipment).
- ❑ Implement corrective actions, where necessary.
- ❑ Identify potential technological applications to invest in for the next energy management continuous improvement cycle (i.e. PLAN-DO-CHECK-ACT).

Figure G4: Calendar of Significant Events and Reminders for Tracking EM measure(s) Progress

| MAY | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Mon | Tues | Wed | Thurs | Fri | Sat | Sun | Notes |
| Week 19 | 27 | 28 | 29 | 30 | 1 | 2 | 3 | |
| Week 20 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| Week 21 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | Baseline study ends May 17 |
| Week 22 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | Weekly cleaning of Accommodation Block 1 A/C coils start on May 18 - noted in green |
| Week 23 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | |

| JUNE | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Mon | Tues | Wed | Thurs | Fri | Sat | Sun | Notes |
| Week 24 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| Week 25 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | |
| Week 26 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | |
| Week 27 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | All Accommodation Block Coils Cleaned June 22 as per regular maintenance. |
| Week 28 | 29 | 30 | 1 | 2 | 3 | 4 | 5 | |

| JULY | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Mon | Tues | Wed | Thurs | Fri | Sat | Sun | Notes |
| Week 29 | 29 | 30 | 1 | 2 | 3 | 4 | 5 | Major storm on the evenining of June 29th |
| Week 30 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
| Week 31 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | |
| Week 32 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | |
| Week 33 | 27 | 28 | 29 | 30 | 31 | 1 | 2 | End of Study August 2nd |

# Notes

**NATO Energy Security**
**Centre of Excellence**

Šilo g. 5A, LT-10322 Vilnius, Lithuania
Phone: +370 5 203 26 86
Fax: +370 706 71010
Email: info@enseccoe.org
www.enseccoe.org