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Energy Management in a Military Expeditionary Environment: *an assessment of three energy management case studies in operational settings*

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List of Acronyms and Abbreviations

1ESU	1 Engineering Support Unit
7SEBC	7 Steps to Energy Behaviour Change
ADL	Advanced Distributed Learning
A/C	Air Conditioning
BG	Battle Group
C2	Command and Control
CAF	Canadian Armed Forces
CES	Camp Engineering Services
CIS	Computer and Information Systems.
CJOC	Canadian Joint Operations Command
COM-B	Capability Opportunity Motivation - Behaviour
Coy Sgt Mjrs	Company Sergeant Majors
CT	Current Transformer
DEES	Defence Energy and Environment Strategy
DEU	Germany (Deutschland)
DFI	Deployed Force Infrastructure
DND	Department of National Defence
DoD	Department of Defense
DT	Distribution Tertiare (third level distribution panel)
eFP	enhanced Forward Presence (eFP)
EnPIs	Energy Performance Indicators
EEMOC	Energy Efficiency in Military Operations Course
ETED	Education Training and Exercise Division
FISH	Future Interventions Start Here

FORCE-SIM	Forces Operational Resource Calculator for Energy - Simulation
ISO	International Standard Organisation
IT	Information Technology
JNCO	Junior Non-Commissioned Officer
kW	kilowatt
kWh	kilowatt hour
LSA	Life Support Area
MCR	Minimum Capability Requirement
MOD	Ministry of Defence
NSE	National Support Element
NATO	North Atlantic Treaty Organisation
NATO ACT	NATO Allied Command Transformation
NATO ENSEC COE	NATO Energy Security Centre of Excellence
NATO MILENG COE	NATO Military Engineering Centre of Excellence
NCO	Non-Commissioned Officer
NDPP	NATO Defence Planning Process
NPS	Naval Postgraduate School
NRCan	Natural Resources Canada
OC	Officer Commanding
OF	Officer
Ops	Operations
Op Sec	Operational Security
PDU	Primary Distribution Unit
POC	Point of Contact
pw	per week
Recce	Reconnaissance

RLSZ	Real Life Support Zone
SITREP	Situational Report
SME	Subject Matter Expert
SNCO	Senior Non-Commissioned Officer
SNR	Senior National Representative
SOP	Standard Operating Procedure
SPS	Science for Peace and Security
STANAG	Standardisation Agreement
TD	Tableau Divisionnaire
TFSO	Task Force Standing Order
TLSA	Temporary Logistics Storage Area
TNA	Training Needs Analysis

1. Executive Summary

This report presents a research project led by the NATO ENSEC COE that focuses on how to improve military energy management on deployed operations. An energy management methodology was developed, which involves establishing *organisational management* (known in the military as Command and Control [C2]) for energy management, using *technological application*s to monitor energy usage, and influencing energy *behaviour change*. These core elements are referred to as the 'three pillars of energy management'.

The energy management methodology was implemented and partially tested in a series of case studies to assess the utility and practicality of introducing energy management as a specific military responsibility. The intention is to use the results of the energy management case studies to develop a NATO approved handbook on military energy management.

The data and analysis offered in this report are the result of two years of research across three operational camps, over 700 questionnaire responses from military personnel from a range of NATO nations, and a large volume of electricity meter data gathered from each case study location in one minute intervals. Once baselines had been established for each case study, a range of energy management processes were tested, all of which were inspired by the International Standard Organisation (ISO) publication on energy management; ISO 50001:2011.

Case Study 1 was conducted with French Armed Forces in Niger from November 2017 to March 2019. Case Study 2 was conducted with German Armed Forces in Lithuania from March to October 2019. Case Study 3 was conducted with Canadian Armed Forces in Latvia from March to November 2019.

Twelve recommendations are submitted for a NATO audience; at the highest and most important level are recommendations to develop an energy management handbook, and to develop energy management training. The implementation of these two key recommendations would lay the foundations for the remaining recommendations to be achieved.

The metering conducted at two of the case study locations[1] also supported the NATO Science for Peace and Security (SPS) Project (G5525)[2] by providing data to determine the minimum requirements for conducting an energy study at military camps.

[1] eFP Lithuania and eFP Latvia.
[2] For more information about the NATO SPS Project G5525 contact Martin Kegel at NRCan on martin.kegel@canada.ca

The NATO ENSEC COE would like to thank the following organisations[3] for their invaluable contribution to this research:

- Canadian DND
- French MOD
- German MOD
- Latvian MOD
- Lithuanian MOD
- Natural Resources Canada
- UK MOD - including contracted defence-industry experts from BAE Systems, Bright HF, and Trimetis.
- US DoD

[3] The NATO ENSEC COE would also like to thank Lisa Strippchen and Goda Tamosaityte for their data collection, data input, and data analysis contributions to this project during their internships at the NATO ENSEC COE.

2. Caveats

The following caveats are to be considered:

- The case studies presented were conducted in field settings, not laboratory settings. This means that many external factors are out of the control of the researchers, which can affect the margin of error of results.
- The researchers are impartial to the results and remain objective.
- The case studies were conducted with operational camps, which provides both advantages and disadvantages for research. A key advantage is the realistic setting to test processes, whereas a key disadvantage is the lack of control researchers have as a result of being outside the military chain of command. Operational military camps are inherently located in challenging environments, in terms of factors such as climate, operational tempo, high variation in camp occupancy rates, and – moreover - the fundamental attitude that other military activities take precedence over implementing energy management. A case study approach allows for the impact of these variables to be explored but not controlled.
- Currently, there is a lack of training on energy management in pre-deployment training of NATO nations, which affects the extent to which energy management is, or can be, accomplished on operations.
- Participants involved in implementing energy management changes had no prior energy management training, and energy management was an additional duty to their daily tasks and battle rhythm.
- The International Standard Organisation (ISO) publication on energy management 'ISO 50001' was used as the basis for the research, but was not tested page by page. Moreover, the core ISO 50001 continuous improvement process of 'Plan-Do-Check-Act' was the guiding principle of the energy management methodology.
- The case studies were conducted across different climates, seasons, and countries. These factors had effects on data and conclusions, which are individually discussed in relation to each case study, where relevant.
- All recommendations were low-zero cost and did not require any of the lead nations of the case study locations to invest money into infrastructure, equipment or technological solutions.
- This is a research project and not a test of any individual participating nation's effectiveness.

3. Research Requirement

To understand the rationale for researching military energy management, it is important to be made aware of how it relates and contributes to the topics of energy efficiency and, ultimately, energy security.

- **Energy Security.** The mission of the NATO ENSEC COE is *'to assist NATO, Nations, Partners and other bodies by supporting NATO's capability development process, mission effectiveness and interoperability, providing comprehensive and timely expertise on all aspects of energy security'*. Improving the energy efficiency of military forces is one of these aspects of energy security.

    - **Energy Efficiency.** There are many ways and many tools available for improving energy efficiency, and while a lot of them have been implemented by individual nations, it has been a largely uncoordinated effort within the NATO sphere. Additionally, energy efficiency tools, whether material (for example, equipment and technology) or non-material (for example, energy management techniques), need to be standardised with commonly understood and implemented processes in order to obtain and maintain interoperability. Looking to national decision makers, the NATO ENSEC COE strongly recommends that energy efficiency becomes a Minimum Capability Requirement (MCR) for national initiatives and innovative solutions. In parallel, it is argued that energy efficiency considerations should be included in the NATO Defense Planning Process (NDPP).

        - **Energy Management.** One tool for achieving energy efficiency is energy management, which is an instrument that can be implemented with low-zero economic impact, and which can be standardised for interoperability. Therefore, it is hoped that the present research undertaken will contribute to the development or amendment of NATO Standardisation Agreements (STANAGs) related to energy management in operational environments and, as a consequence, the energy efficiency and energy security of NATO forces will be strengthened.

Benefits of Energy Management. By implementing best practice energy management, the benefits can improve military operations in several invaluable ways. Effective energy management can deliver the following advantages:

- reduce the number of lives lost and injuries caused through enemy attacks on fuel supply convoys;

- increase the range, number, and type of operations possible to a Commander, as a result of more energy, and possibly more soldiers, available;
- reduce the logistics burden of military units, by requiring less energy, such as fuel and generators, to be moved around; and
- improve the comfort of military personnel, as a result of paying attention to the use of energy equipment in living areas such as tents and washrooms;

NATO ACT Tasking. As a result in the knowledge gap within NATO on energy management solutions, NATO Allied Command Transformation (ACT) set NATO ENSEC COE the task of researching available solutions that could be adapted for military use. The NATO ENSEC COE conducted a literature review and presented the findings in a report titled *'Energy Management in a Military Expeditionary Environment'*[4]. This report presented information gathered from various national records and reports on best practices in energy management based on trials, experiments, and operational energy usage. The main finding was that 'International Standard Organisation (ISO) 50001:2011'[5] – an international civilian standard for energy management – could be adapted for military benefit.

First drafts of military versions (v0.1) of an energy management application plan and corresponding handbook based on ISO 50001:2011 were prepared, and the next stage of the research was to test their utility for Tier 2[6] military camps. This report presents three case studies in different settings that tested the utility of the principles of the energy management application plan and handbook, with the intention being to use the results to update the material (v0.2) based on real experiences of managing energy in deployed environments.

The overarching aim of this project is to identify how energy is managed on Deployed Force Infrastructure (DFI) Tier 2 military camps before and after implementing new energy management guidance.

[4] NATO ENSEC COE. Energy Management in a Military Expeditionary Environment Study. Report no. 190215/DCD/6.01/I/02. Lithuania, 2014.
[5] ISO 50001:2011 Energy Management, www.iso.org
[6] Tier 2 infrastructure is defined as facilities that provide an improved standard of accommodation and utility services to that of Tier 1. Usually operational within six months of the decision to proceed. Tier 2 facilities will normally be constructed, operated and maintained by a contractor, with an expected life of up to five years without major refurbishment. Camps can comprise structures and equipment transported into theatre and/or sourced locally, or constructed from local materials. They are not normally expected to be re-deployable without substantial refurbishment. (Joint Tactics, Techniques and Procedures 4-05. Operational Infrastructure. Doctrine and Concept Development Centre. UK. 2012.)

4. Methodology

The research team assessed that v0.1 of the ISO 50001-inspired military energy management materials were predominantly focused on *organisational management* processes (also understood as Command and Control [C2] in the military environment), and that *technological applications* and *behaviour change* processes could offer additional benefits to energy management. Therefore, the research team developed a method for implementing energy management that involves these three interdependent pillars. It is through applying these pillars that the NATO ENSEC COE has tested a more robust energy management process than currently exists for the military. The three pillars of energy management, presented visually in Figure 1, are described below.

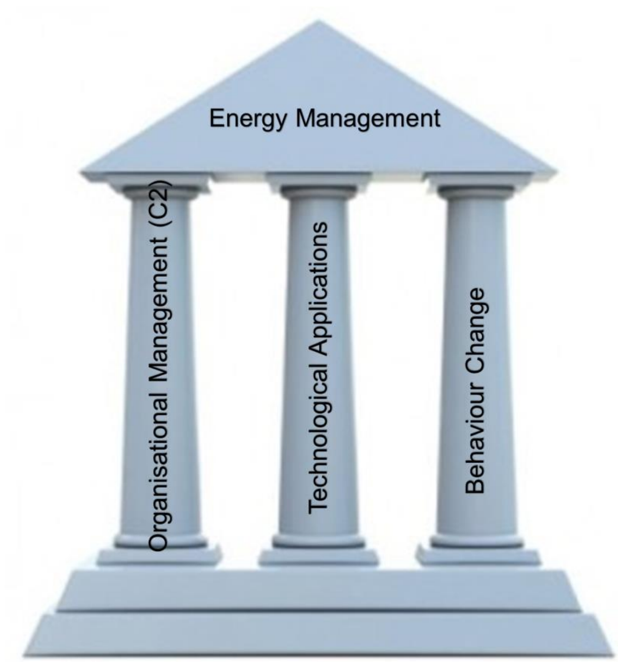

Figure 1 - The Three Pillars of Energy Management

Organisational Management (C2). Energy management must be incorporated into organisational structures and procedures, in order for energy to be considered proactively, rather than reactively, in any business – including the military. 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 core organisational management principles used in this project were taken from v0.1 of the ISO 50001-inspired military energy management material and are summarised by a continuous improvement process of ‘Plan-Do-Check-Act’.

Technological Applications. In the context of energy management, technological applications do not refer to technology for producing or storing energy, but to metering and monitoring how much energy is used. Metering and monitoring can contribute to good energy management by providing the capability needed to identify trends, problems, and areas for improvement in energy use

The technological application used in this project was an electricity metering and monitoring solution developed by Natural Resources Canada (NRCan). The meters were adapted from a solution developed for the Canadian Department of National Defence (DND) and have the capability of non-intrusively metering various levels of DFI. This can range from the total electricity produced by a diesel generator, to how it is distributed within a camp, to the energy end-use of an individual shelter. The electrical meters are preconfigured to communicate with a local data storage device, programmed to store 30 days of data at one minute intervals. The uniqueness of the solution is the ease of installation and avoidance of complex onsite programming to get the device up and running. Figure 2 shows the energy meters installed at a generator farm and a Primary Distribution Unit (PDU) in a deployed camp. Figure 3 shows the components of a preconfigured multi-channel electrical meter.

Figure 2 - Non-Intrusive Electrical Meters Installed at EXERCISE MAPLE RESOLVE 2017 (Wainwright, Alberta, Canada)

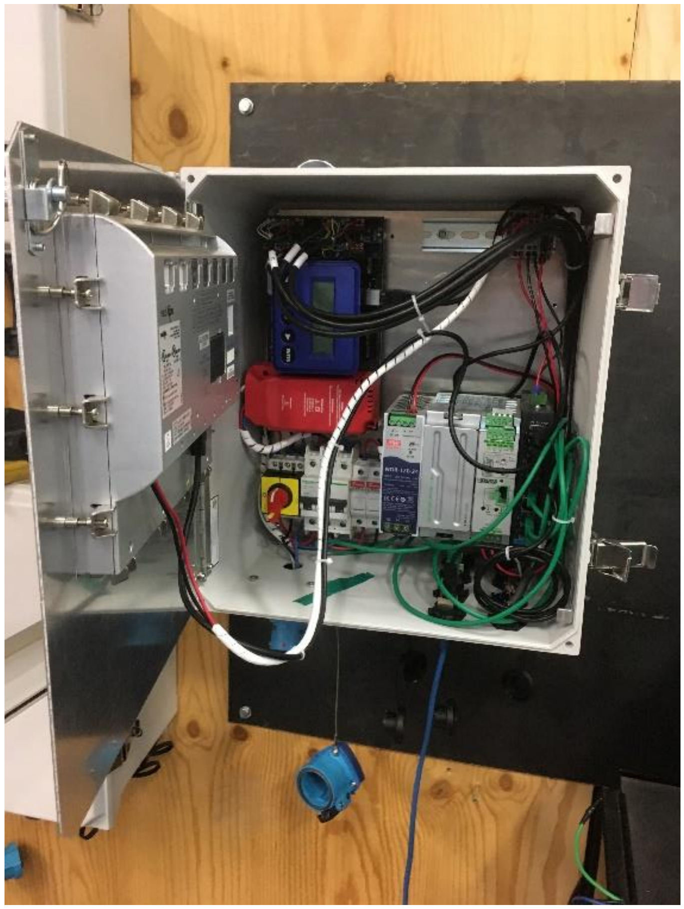

Figure 3 - Multi-Channel Electrical Meter With Data Storage

Behaviour Change. Through applying behaviour change processes, people can become more aware of how their individual actions contribute to energy efficiency and energy security.

The behaviour change process used in this project was the 7 Steps to Energy Behaviour Change (7SEBC)[7] process developed by the UK Ministry of Defence (MOD) and defence industry partners, at the heart of which sits the model of behaviour known as 'Capability + Opportunity + Motivation = Behaviour' (COM-B). The COM-B model proposes that for an individual or a group to engage in a behaviour, they require the relevant capability (such as skills or knowledge), opportunity (such as time or resources), and motivation (such as values or beliefs). Using a systematic approach to energy behaviour change, such as applying the 7SEBC process, can achieve energy savings from 5-20%.[8] Furthermore, the 7SEBC process has been aligned with key steps of ISO 50001:2011, as presented in Figure 4.

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

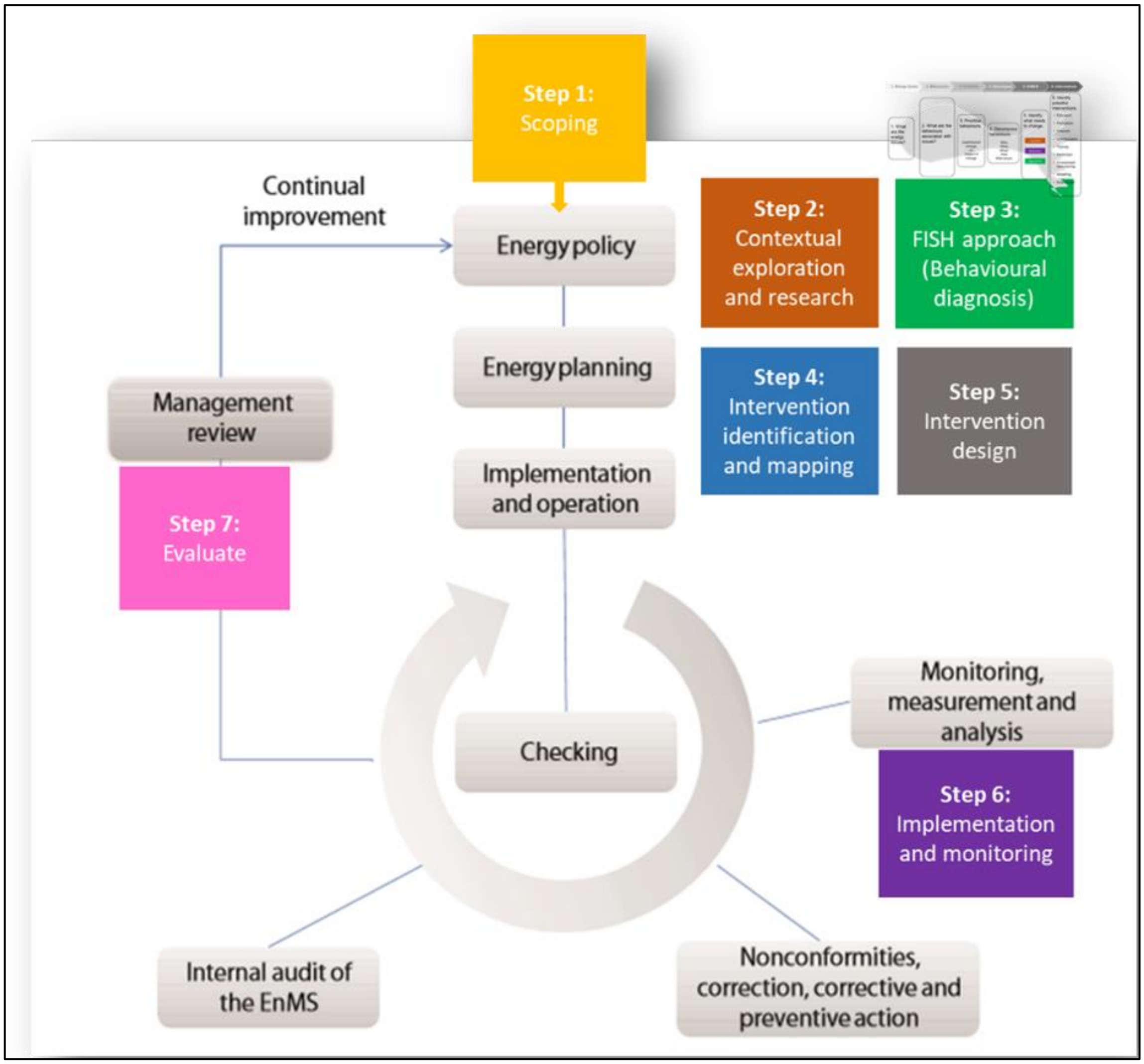

Figure 4 - The 7 Steps to Energy Behaviour Change (7SEBC) Process and ISO 50001:2011

Combined Case Studies Timeline. Figure 5 presents the combined timeline for all three case studies; Case Study 1 ran from November 2017 to March 2019. Case Study 2 and Case Study 3 both began in March 2019, with Case Study 2 finishing at the end of October 2019 and Case Study 3 finishing one week later at the beginning of November 2019.

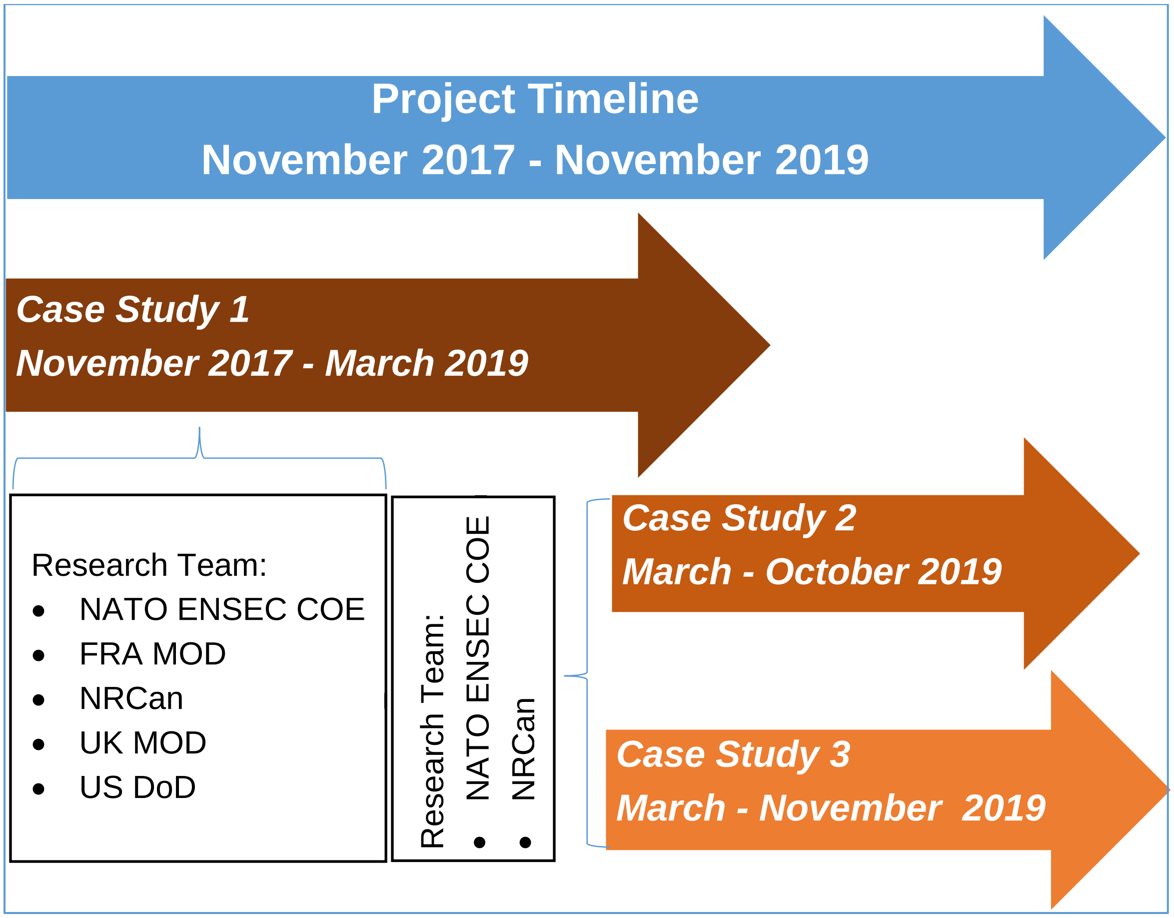

Figure 5 - Combined Case Studies Timeline

5. Case Study 1: Niger (French Military)

Caveats. In addition to those presented in Section 2 of this report, the following caveats are to be considered:

- The UK MOD research team members were prohibited from visiting the case study location due to restrictive UK Foreign and Commonwealth Office (FCO) guidance preventing all non-essential travel for UK personnel to Niger. This reduced the extent to which the research team members responsible for the behaviour change processes could access and understand the target audience.
- Behaviour change interventions were undertaken by personnel who had little or no prior experience of energy behaviour change training (i.e. the members of the research team who travelled to the case study location and French military personnel).
- The effectiveness of transferring energy behaviour change interventions and techniques from the UK MOD to French MOD personnel is not known.
- For the reasons presented above, this case study is considered to be a particularly difficult setting for researching energy management.

Case Study Location and Timeline. In 2017, after reaching an agreement with the French MOD, a French operational military camp in Niger, West Africa, was selected for the case study location. The research team were given access to the Real Life Support Zone (RLSZ), to focus on energy use in accommodation and recreation areas. The original timeline for case study 1 is presented in Figure 6.

#	1	2	3	4	5	6	7	8	9	10
Location	Niger 1	Vilnius 1	Niger 2	Paris 1	Vilnius 2	Niger 3	Niger 4	Paris 2	Remote	Remote
Activity	Recce	Post-recce discussions	Baseline data collection	Post-baseline data collection working meeting and FISH workshop	Presentation and discussion of prototype interventions	Implementation of interventions	Post-implementation data collection	Post-implementation data collection working meeting	Analysis of results	Revision of handbook
Date	Dec 2017	Dec 2017	Feb 2018	Mar 2018	Apr 2018	Jun 2018	Sep 2018	Sep 2018	Oct-Nov 2018	2019

Figure 6 - Case Study 1 Timeline

Project Team Capabilities. The skills required to effectively change behaviour require a detailed understanding of the operational system of interest (provided by military personnel), an understanding of the technical system (provided by engineers) and an appreciation of psychological drivers (provided by behaviour change specialists). Therefore, a multi-disciplinary research team was brought together. The composition of the research team is depicted visually in Figure 7 and detailed below.

- The NATO ENSEC COE were responsible for project management and the lead for the *organisational management* pillar. Additionally, the NATO ENSEC COE provided a Lithuanian civilian management consultant and international military expertise.

- NRCan and the US Department of Defense (DoD) contributed with civilian engineers, as well as cutting edge technology in the form of metering and monitoring equipment and techniques. NRCan and the US DoD were co-leads for the *technological applications* pillar.

- The UK MOD provide a team of civilian behavioural science experts from the defence-industry sector. The UK MOD were the lead for the *behaviour change* pillar, through the application of the 7SEBC process, which has been successfully used in several UK MOD energy management case studies.

- The French MOD provided the case study location, and therefore also the C2 structure for the group of participants based at the case study location. Additionally, France invested prominent military engineers in the project as advisers for the applicability of the recommendations for change.

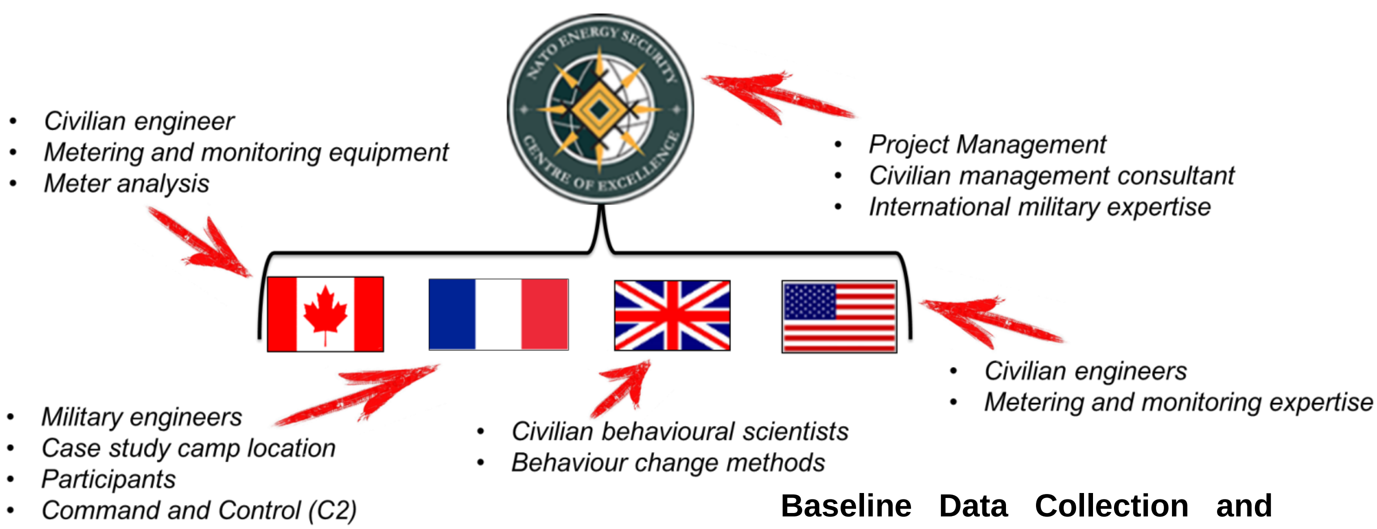

Figure 7 - Case Study 1 Research Team

Baseline Data Collection and

Findings. The case study began with a reconnaissance (recce) visit to the camp, this was important for developing relationships with the right people, gathering context information about how the camp operates, and installing energy meters. A briefing sheet was developed for the camp authority, which outlined the intent and outcomes of the case study. This was disseminated during the research team's first visit to the camp, in late November 2017, and it enabled the camp authority to gain a detailed understanding of the purpose and scope of the case study, the extent to which it would affect the camp, and the intended results. This visit also helped to gain stakeholder buy-in and support for the research, which is invaluable for the implementation phase of any such project. The objective of the second visit to the camp was to collect baseline data in the following formats: questionnaires; observations; meter readings, and context information.

Questionnaires. Questionnaires[9] were completed in order to assess levels of awareness and engagement in energy management. The sampling strategy required a range of ranks, age, and roles, with both male and female respondents, proportionate to the camp personnel. Hard copies of the surveys were distributed; personnel were briefed in groups of four to six about the nature of the research and then left to complete their responses. There were no financial, emotional or organisational inducements to complete the survey. The key findings from the baseline questionnaire data are outlined below.

- A total of 46 questionnaires from a population of 450 personnel were completed, representing a 10% response rate.

- The majority of respondents were males aged 25-34 and were Non-Commissioned Officers (NCOs). Other than the target audience of key decision makers (i.e. the Camp Commander and the Chief of Infrastructure), this provided the research team with the knowledge of who the target audience was on the largest scale.

- Both NCOs and Junior Officers appeared to have the least awareness of initiatives, 35% and 17% respectively, in comparison to both Troop Ranks and Senior Officers. Awareness of energy saving initiatives can be used as a measure of performance for interventions at an organisational level, therefore in this instance an effective intervention would be expected to increase the levels of energy initiatives awareness in NCOs and Junior Officers.

- Within the COM-B model, a score of 1 represents that the respondent strongly disagrees that they have the relevant capability/opportunity/motivation to be energy efficient, and 5 represents that they strongly agree that they have the capability/opportunity/motivation. For example, for the statement *'I think it is important to save energy (in general)'*, those who circled the response *'strongly disagree'* were recorded as giving a score of 1 for that statement, and those who circled *'strongly agree'* were recorded as giving a score of 5. This particular statement is an example of an insight into a person's level of motivation. The COM-

[9] See ANNEX B for the Questionnaire Template.

B element with the highest average score was opportunity (3.1), and the weakest was motivation (1.9), as seen in Figure 8. This suggested that the main area of improvement to focus on for interventions was the motivation to be energy efficient.

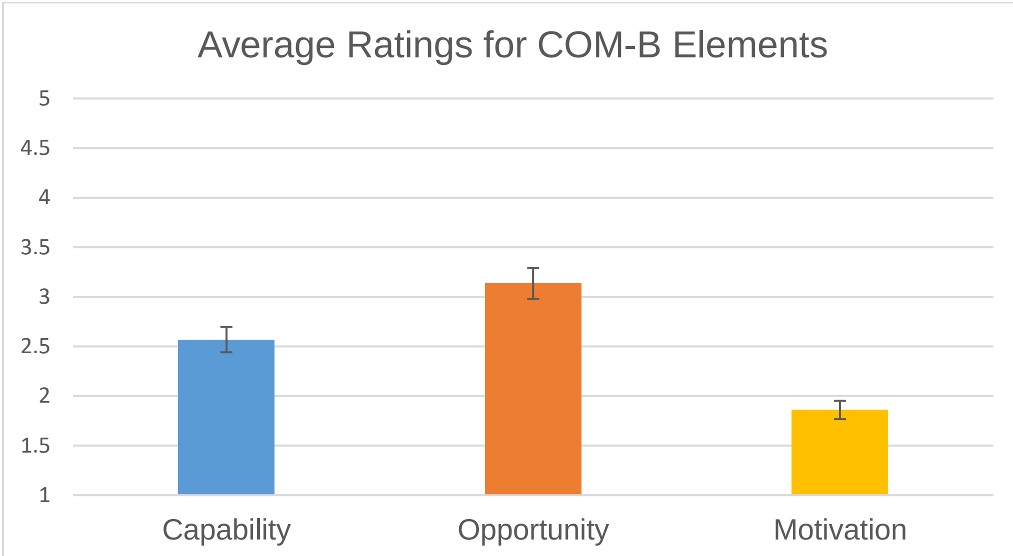

Figure 8 - Case Study 1 Average Ratings for COM-B Elements

- The COM-B pattern was similar across ranks, as is seen in Figure 9. This suggested that motivation was the weakest COM-B element, regardless of rank. Since motivation was the weakest COM-B element and the dominant group of personnel in the camp were NCOs, it was important that interventions were tailored to address the motivation of NCOs.

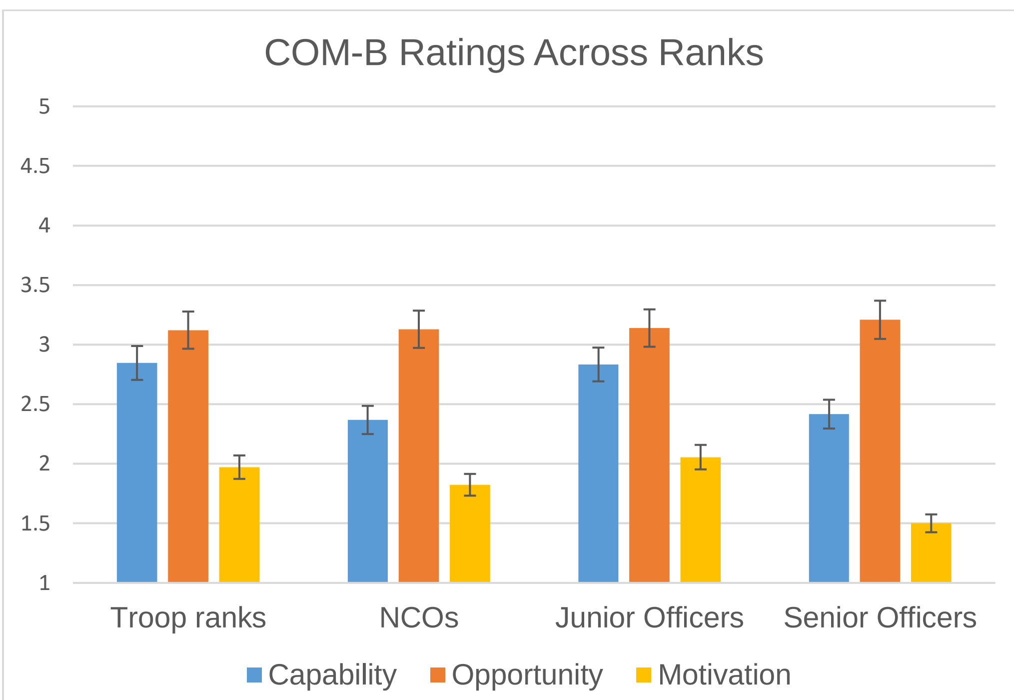

Figure 9 - Case Study 1 COM-B Ratings Across Ranks

- The majority of respondents reported that they switched off electrical items when not in use, but that their colleagues did not. This pattern is often found in behavioural science studies, where people rate their own behaviour as more virtuous than the behaviour of others. The truth probably lies somewhere between the two responses but closer to the end of the spectrum where people do not switch off equipment.
- The main reasons given for not switching off items are listed in Table 1:

Table 1 - Case Study 1 Reasons for Not Switching Off Items When Not in Use

No.	Reason	COM-B Element	Solution
1	*'I forget to'*	Motivation	Develop reminders
2	*'It is not something I think about'*	Motivation	Incorporate into Standard Operating Procedures (SOPs)
3	*'I don't care'*	Motivation	Provide information on consequences of poor energy management

- Respondents noted that the main reasons for why they did switch off equipment was because it prevented equipment from being damaged by power surges, and because they switched off equipment at home. Therefore, interventions and messaging should build on these existing habits, rather than trying to address new attitudes and behaviours.

Observations. Observation audits[10] were conducted around the camp to capture the range of good and bad energy management practices currently in place. The information captured in the observation audits included what the behaviour was, when it occurred, who performed it, what equipment was associated with it, and other relevant context information. An example of a completed observation audit is provided at ANNEX D. The following five key observations were made:

1. Seldom cleaning/changing of the air filtration of the tent Air Conditioning (A/C) units.
2. A/C units left in the sun without shading.
3. Tents cooled by A/C power at all times, even when the tents were unoccupied.
4. Buildings were painted dark colours, which increases heat absorption and leads to higher levels of A/C power demand.
5. Most refrigeration units were left in the sun all day without shading.

[10] See ANNEX C for the Observation Audit Template.

Meter readings. Meter readings were taken from more than 30 Current Transformers (CT) installed throughout the RLSZ of the camp to measure electrical energy consumption and establish the current energy usage profile. The data from the CTs were recorded on data loggers, and downloaded and sent by French military personnel at the camp on a weekly basis. The data were sent by email through channels approved by the French MOD, to the NATO ENSEC COE, who then shared the data with the other contributing project partners.[11] The following points explain the configuration of the meters.

- The electricity consumption of the camp was monitored between December 2017 and March 2018. Each of the five electrical panels in the RLSZ were sub-metered in order to provide sufficient insight into the electricity consumption within the selected areas. Data was recorded every minute, measuring voltage, amperage, phase and power draw.

- From 1st December to 1st March 2018, the electrical panels were metered with single channel electrical meters measuring the total electricity consumption of each panel. From 1st March to 6th March 2018, the electrical panels were updated with multichannel electrical meters providing an enhanced level of detail of how the electricity is consumed or distributed within the camp. During installation, the electrical sub-meter readings were verified and confirmed to coincide with the readings from a fluke power meter. The daily peak demand at the generator farm was also recorded daily by the generator technician to provide additional validation of the sub-meters. Figure 10 lists the electrical panels sub-metered and the description of their end uses.

- Through electrical sub-metering, it can be identified if there are any processes or energy end-uses that can be changed to eliminate the need to start an additional generator.

[11] See Figure 7 for the research team composition.

PS1	***Name***	***Description***	***PS2***	***Name***	***Description***
A	DT01-L1	Unknown - Not metered	**A**	**DT05_L1**	**Main Dist Panel #5**
B	DT01-L2	Unknown - Not metered	B	DT05_L2	Tentes gauches +Batiment
C	DT01-L3	Unknown - Not metered	C	DT05_L3	Mess
D	DT01-L4	Tableau divisionnaire 2.1	D	DT05_L4	Batiment 1
E	**DT02-L1**	**Main Dist Panel #2 (TD)**	E	DT05_L5	Tentes gauches
F	DT02-L2	Tableau divisionnaire 2.4	F	DT05_L6	Small surrounding buildings
G	DT02-L3	Tableau divisionnaire 2.3	G	DT05_L7	EDA KC20
H	DT02-L4	Tableau divisionnaire 2.2			
PS3	***Name***	***Description***	***PS4***	***Name***	***Description***
A	**DT06_L1**	**Main - Dist Panel #6**	**A**	**DT07_L1**	**Main Dist Panel #7**
B	DT06_L2	Bat 2	B	DT07_L2	UTE Water plant
C	DT06_L3	ELC	C	DT07_L3	Batiment 4
D	DT06_L4	Bat 3	D	DT07_L4	KG Allemand Q2
E	DT06_L5	Empty	E	DT07_L5	Batiment 6
F	DT06_L6	Kitchen	F	DT07_L6	Q6 to Q13
G	DT06_L7	Cat input - Not Metered	G	DT07_L7	Batiment 5

Figure 10 - Case Study 1 Sub-Metered Electrical Panels and Description of End Use

- A comparison of the sub-metered electrical data against the daily peak recorded by the generators from 1st December 2017 to 30th April 2018 is shown in **Error! Reference source not found.** 11. From 1st December 2017 to 1st March 2018, the electrical panels were sub-metered with a single channel electrical logger measuring the main incoming line. Looking at Figure 11, it can be seen that the daily peak power draw values did not coincide with the peak electrical draw recorded at the generator power plant. This suggests that one of the following happened:

  1. Not all panels are fed by the generator farm.
  2. One or several electrical panels feed the other panels.
  3. There was an error in the configuration file.
  4. The current transducers were malfunctioning.

  As the trend lines of both the metered data and recorded generator data followed very closely, it suggests that the scaling factor of the CTs was set incorrectly. From 5th December 2017 to 16th January 2018, one of the meters was disconnected, further skewing the results.

- On 6th March 2018, the single channel electrical sub-meters were replaced with the multichannel electrical meters to gather further details on the electricity distribution within the camp. Unfortunately, some of the CTs left behind during the December 2017 visit could not be found and thus some of the electrical sub-panels could not be fully metered. As such, the recorded electricity consumption could not give a complete overview of the camp electricity use. In particular, for the DT-01 panel, only one channel was metered like this and, as a result, the peak electric demand recorded is typically off by 140 kW to 170 kW.

- It can also be seen that from 6th March onwards, there was one day of data missing on a weekly basis. This was attributed to the configuration of the data storage system that was programmed to store a maximum of seven data files, with each data file configured to hold one full day's worth of data. Thus, with a download of data conducted on a weekly basis, on Tuesdays at around 08.00, data from the previous week for Tuesday from 08.00 to midnight is lost.

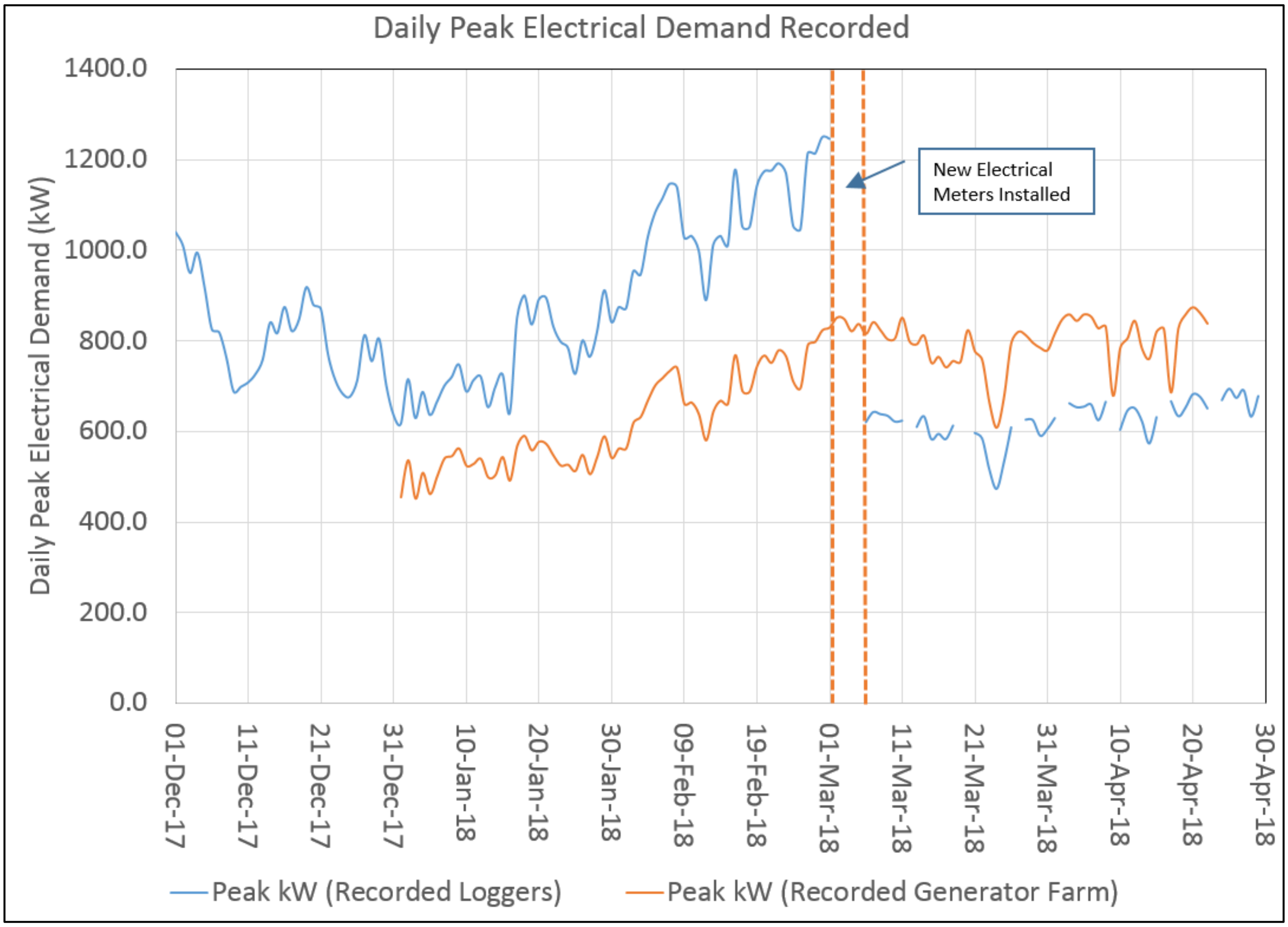

Figure 11 - Case Study 1 Comparison of Daily Peak Electricity Demand Recorded by Electrical Sub-Meters at the Generator Farm

- To compensate for the incorrect scaling factor and missing measurements, adjustments were made to better match the peak electricity draw recorded at the power plant. For the single channel meters (in place from 1st December 2017 to 1st March 2018), it was noted that the DT-02 and DT-05 readings appeared to be off in comparison to the measurements made by the multichannel meters. It is still unclear why this occurred as all readings were validated during the initial installation, however dividing the power consumption recorded by 2.75[12], resulted in a very close match with the peak electricity draw recorded by the generator farm.

- To account for the partially sub-metered DT-01 panel, it was assumed that the three lines not sub-metered followed the same trend as the fourth line that was sub-metered. A daily multiplication factor was applied to the DT-01 sub-metered line, such that the total recorded electricity consumption of all electrical panels matched to the total peak demand recorded at the generator farm. As a result, a better estimate on the fuel savings that could be attained through a reduction in loads or shifting of loads could be provided. Figure 12 confirms the match of the daily peak electrical demand.

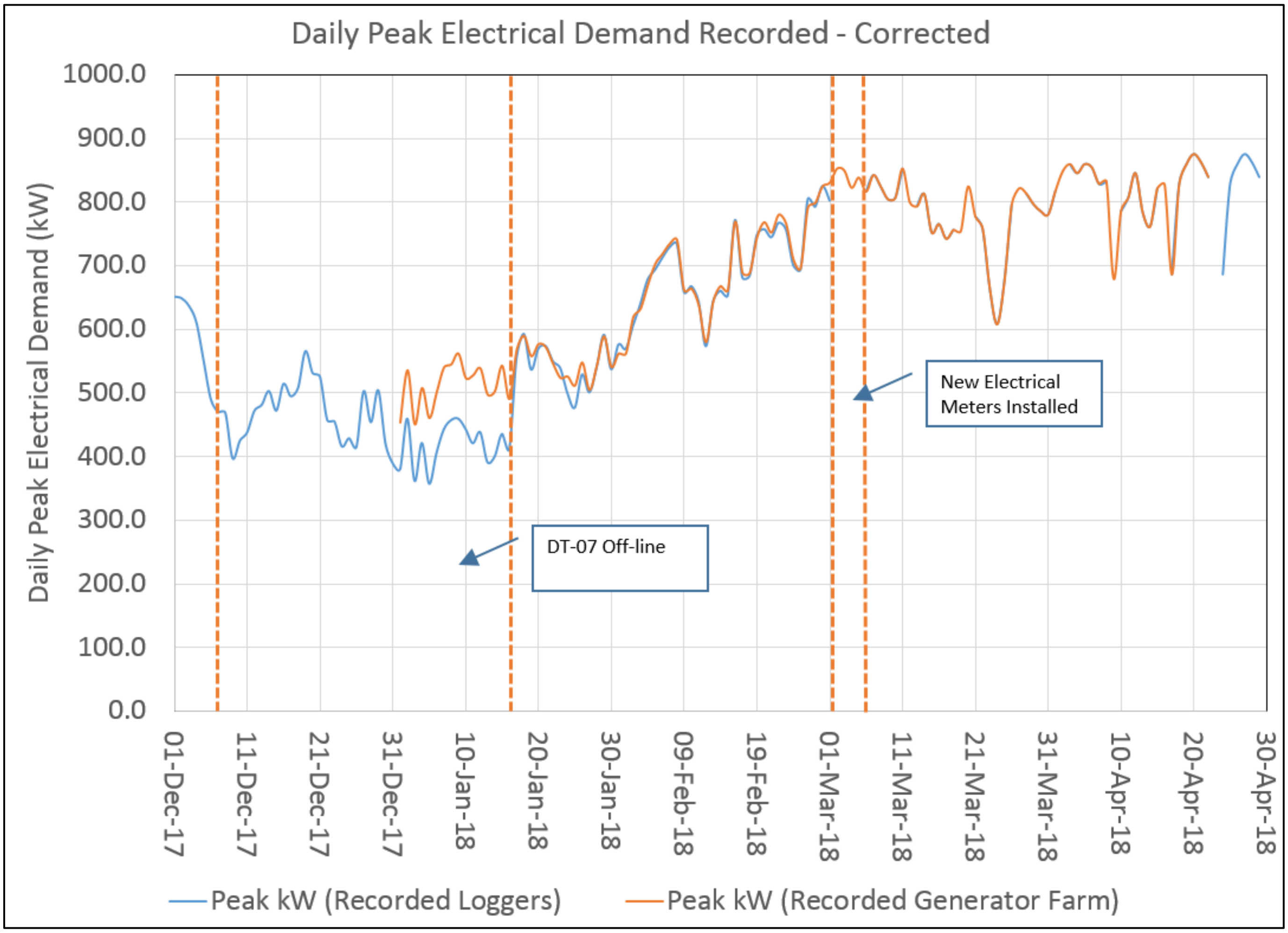

Figure 12 - Case Study 1 Comparison of Daily Peak Electricity Demand Recorded by Corrected Electrical Sub-Meters and at the Generator Farm

- A corrected camp power draw profile recorded on a minute basis is shown in Figure 13 for the period 16th January to 30th April 2018. Due to one of the electrical meters being disconnected prior to 16th January 2018, the data from 1st December 2017

[12] This was determined by performing a goal-seek.

to 15th January 2018 has been excluded. The plot also indicated the threshold power draw in which a second or third generator was brought online. Although the generators were sized for 400 kW, due to high temperatures at the case study location, the maximum power output was derated to 350 kW.

- From Figure 13 it is seen that from 5th February 2018 onwards, a third generator was brought online for a short period to meet the peak electrical demand. This peak electrical demand profile is further highlighted in Figure 14, showing the metered data for Week 10.[13] With a similar trend found in the other weeks with detailed sub-metering[14], the third generator was typically brought online from noon to 18.00 each day. This coincided with the hottest period of the day when the cooling loads are highest; however by reducing or shifting some electrical loads by 150 kW, the use of the third generator could be avoided, resulting in less required maintenance, and savings in diesel fuel.

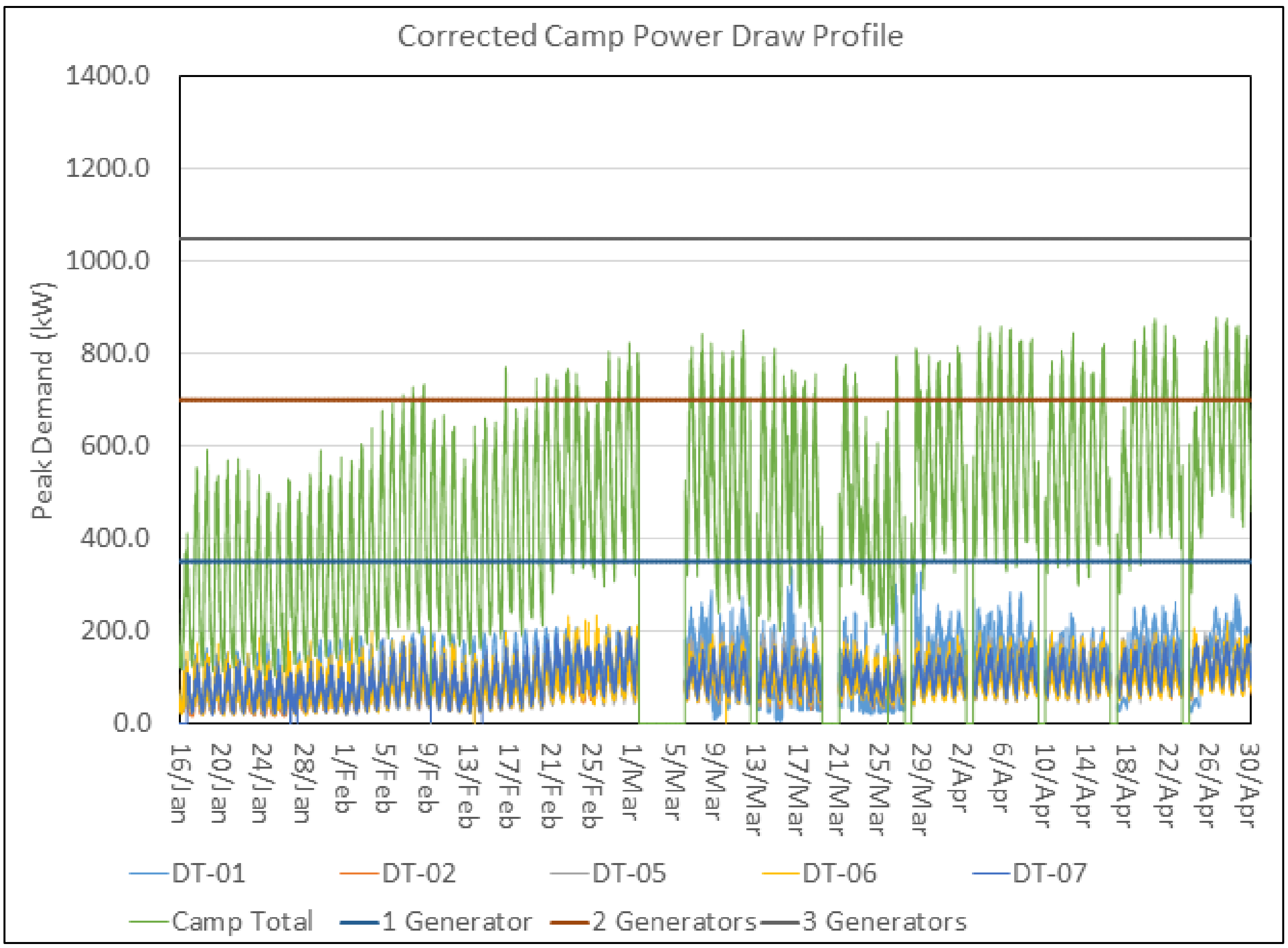

Figure 13 - Case Study 1 Recorded Minutely Corrected Camp Power Draw Profile

[13] Any references to Week data correspond with the calendar week for that year.
[14] See ANNEX E.

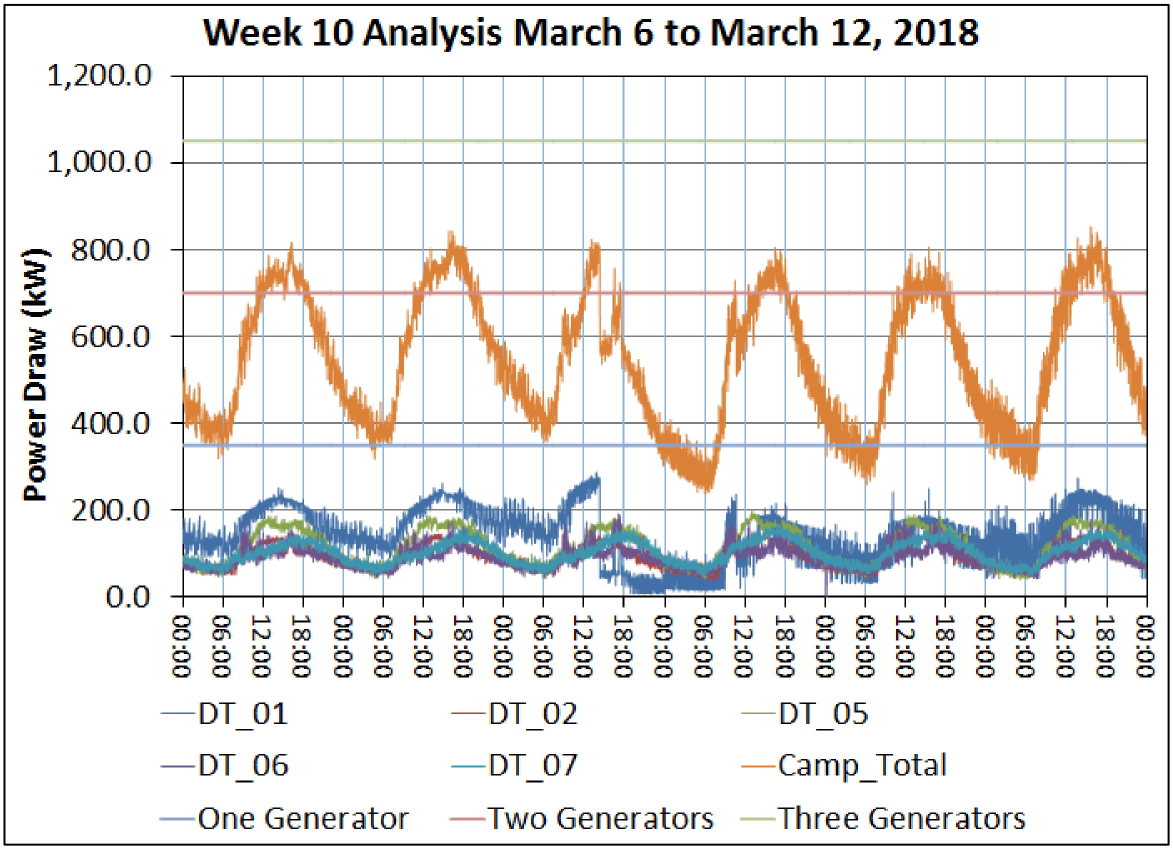

Figure 14 - Case Study 1 Recorded Minutely Corrected Camp Power Draw Profile for Week 10

- Further breakdown of each sub-metered electrical panel is shown in ANNEX E for Week 10 (Week 10 to Week 17 show similar results) to determine the highest energy end-uses and if there were any processes that could be shifted to avoid the peak electrical demand exceeding 700 kW.

- The DT-02 sub-panel demonstrated similar load profiles for the breakers monitored, suggesting that it was likely providing electricity to the soft shelters (e.g. accommodation, medical tent). The 'Tableau Divisionnaire 2.2' (TD2.2) sub-panel consistently demonstrated the highest electricity consumption of the sub-metered panels, which could be because TD2.2 was a tent with a high occupancy rate, or because it was the medical tent. This peak could be mitigated by having A/C units turned off when the shelter is unoccupied, or setback if the tent is occupied only during the night.

- The DT-05 sub-panel showed that the Mess hall had a twin electrical peaking profile – one right after lunch and one right after dinner, likely attributed to the increased cooling needed due to the increased occupancy load right before meal times. To mitigate this electrical peak, the Mess hall could be pre-cooled before the lunch hour such that the A/C system is not turned on during the high electrical peak periods.

- In DT-06, the kitchen represented the highest consistent electric demand, while the ELC electric line (thought to be refrigerated containers) showed a sporadic higher peak sometime between noon and 18.00. Electricity use in the kitchen was as anticipated, with increasing electric demand with higher associated cooling demands. The ELC sporadic high peak power draws were likely attributed to the cooks continuously opening the container doors for food preparation (if, indeed, the ELC is refrigerated containers). While it was observed that refrigerated doors were closed when not in use, this should be re-iterated during in-processing as leaving the doors open can contribute to the peak electrical demand.

- In DT-07 panel, the KG Allemand Q2 had the highest electricity consumption. The three buildings all had similar power draw profiles. The water treatment plant was also sub-metered on the DT-07 panel and demonstrated constant power draws of 20 kW when in operation. Its operation coincided with the peak electrical demand periods and thus, this load could be shifted to avoid contributing to the highest electrical peak demand. The electricity consumption profile of the water treatment plant is shown in ANNEX E.

Context information. Context information was gathered to help to develop situational awareness. Information that fits under this category of data includes topics such as camp occupancy numbers, maps, rotation cycle, battle rhythm, and chain of command. Much of this data is sensitive and therefore not contained in this report.

Data Triangulation. In addition to analysing each category of data individually, the data collected were also brought together for analysis in a workshop. This workshop provided the opportunity to conduct triangulation; the cross-verification of data from two or more sources in order to establish the full situational awareness of the topic under investigation. The workshop followed the UK MOD's FISH[15] workshop method (step 3 of the 7SEBC), which allows for all types of data to be examined and used to develop evidence-based and context specific recommendations for behaviour change. The FISH workshop steps are presented visually in Figure 15 and include the following activities:

1. Identify the energy issues.
2. Identify the behaviours associated with the energy issues.
3. Prioritise the behaviours using a chart of likelihood of change versus impact of change.
4. Decompose the behaviours into who, what, when, how, and with whom something needs to be done.

[15] Future Interventions Start Here (FISH).

5. Identify which element of the COM-B model requires the most focus.
6. Identify potential interventions from nine behaviour change techniques.

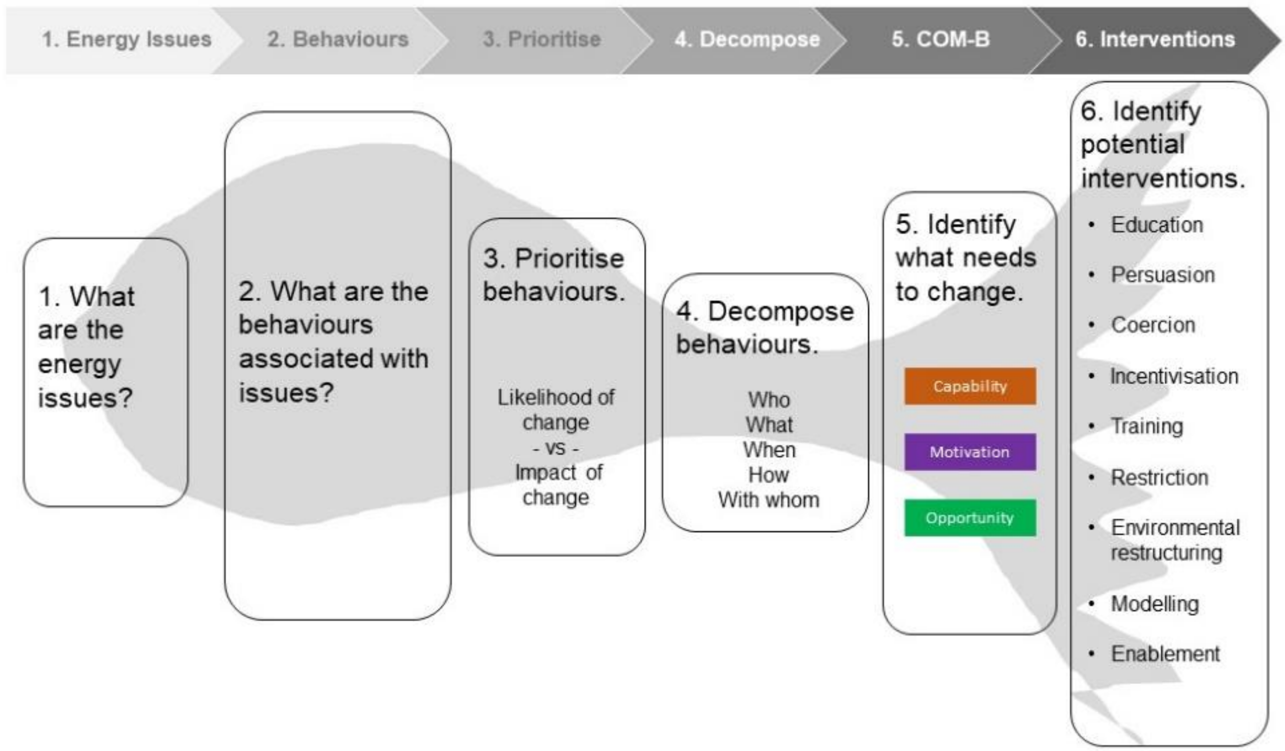

Figure 15 - FISH Workshop Method

Energy Management Recommendations. Following analysis of all of the baseline data, recommendations were developed and then refined through discussions with the French MOD; those responsible for the C2 of the implementation of any recommendations. The recommendations all aligned with the principles of ISO 50001:2011 and the final set of agreed recommendations are presented in Table 2. The total number of recommendations was 36, which were prioritised into three categories:

1. Essential (17)
2. Highly recommended (10)
3. Recommended (9)

While the total number of recommendations may at first seem high, it should be noted that they differ in magnitude and amount of effort required. For example, using existing excess or unused material available in-situ to provide shading to A/C and refrigeration units (recommendation 4) is something that could take a few hours and is a one-off task, perhaps with periodic checks to ensure the shading object / material has not been damaged or removed. Similarly, adding information to the in-processing material for new troops that leaving the doors open contributes to the amount of fuel needed to be delivered to the camp (recommendation 12) is something that can be changed quickly and, once added to standard briefing material, the recommendation has been completed. Some recommendations may require significantly more manpower or time to complete, such as obtaining or creating SOPs related to energy use (recommendation 20), or analysing data (recommendation 23).

It was assessed that to be able to validly claim that the energy management process had been tested in this case study, at a minimum, the 'Essential' section of recommendations would need to be implemented.

Table 2 - Case Study 1 Recommendations

ENERGY MANAGEMENT RECOMMENDATIONS	
ESSENTIAL (1-17)	
1.	Establish an energy team: • Commander • DFI Base Energy Manager • Unit Energy Manager • wider team
2.	Write and disseminate Commander's Order about the Energy Management System.
3.	Establish awareness and communications plans.
4.	Use available shades to reduce heat on: • tent A/C units • building A/C units • refrigeration units
5.	Move a/c units to enable maintenance: • tent A/C units • building A/C units
6.	Clean a/c units: • filters • coils
7.	Introduce tent scheduling to maximise energy efficiency: • categorise tents and use in order of efficiency / state of repair • increase occupancy levels • turn off A/C units when unoccupied
8.	Schedule the generator demand load in order to reduce the peaks.
9.	Shift the operating times of the water treatment plant to avoid contributing to the highest peak demand for DT-07. *This is one way to achieve recommendation 8. The ultimate goal is to avoid bringing the third generator on occurring from 12.00-18.00 almost every day. The Energy Team might think of other actions, based on an understanding of*

ENERGY MANAGEMENT RECOMMENDATIONS	
	the timeframe, specific duration of the peak, and reduction in power required to stop the third generator from starting.
10.	The peak for DT-02 (accommodation shelters) to be mitigated by having the A/C turned off if a shelter is unoccupied, or setback if a shelter is occupied only during the night.
11.	The peak for DT-05 to be mitigated by pre-cooling the Mess hall before the lunch hour so that the A/C system is not turned on during high peak periods.
12.	Include in the in-processing / a briefing that leaving the doors open can contribute to the peak demand (for DT-06).
13.	Set up energy team meetings.
14.	Establish a process for how personnel can submit energy management ideas.
15.	Set targets for, at least, the next 4-6 weeks.
16.	Implement action plans.
17.	Monitor progress.
HIGHLY RECOMMENDED (18-27)	
18.	Identify documents needed to operate an Energy Management System.
19.	Identify other data needed – e.g. SITREPs[16], rotations, budgets, etc.
20.	Obtain or create SOPs – e.g.: • energy management • A/C maintenance • accommodation • water management
21.	Develop a scheme of energy uses.
22.	Analyse data and present analysis to decision makers.
23.	Take action on the findings of analysis.
24.	Establish areas of no information.
25.	Establish areas or actions requiring other chains of command.
26.	Establish energy equipment operated by a 3rd party.

[16] Situational Reports.

ENERGY MANAGEMENT RECOMMENDATIONS	
27.	Calibrate equipment.
RECOMMENDED (28-36)	
28.	Establish an energy policy.
29.	Set objectives.
30.	Conduct a financial assessment of DFI lifecycle consumption and assets.
31.	Establish future energy use / plans.
32.	Determine any needs to meet other requirements - e.g. LEGAD[17], EPO[18], NATO.
33.	Establish what Commanders need to know and what they do not know in order to make decisions relating to energy management and energy use.
34.	Identify what tools are needed to record the execution of the plan.
35.	Identify training requirements related to energy management.
36.	Establish a list of contractors working at, or for, the location / unit.

Implementation and Monitoring. The implementation visit took place in June 2018, during which the recommendations were delivered to the relevant chain of command, along with supporting documentation. An observation audit was also conducted with the Camp Major to identify areas for possible energy management improvements. During the implementation and monitoring period (June 2018 to January 2019), the research team prepared a range of supporting material in both English and French, such as:

- Job descriptions for energy management team personnel (in accordance with v0.1 of the military version of the ISO 50001:2011 material; one related to responsibilities of the Commander, one for the assigned DFI Base Energy Manager, and one for Unit Energy Managers).
- Energy Performance Indicators (EnPIs) (Table 3).
- Energy management documentation templates.[19]
- Behaviour change action plans for the five key behaviours to change. [20]
- Branding for energy management material.
- Material to raise awareness of energy management benefits and requirements.[21]

[17] Legal Adviser.
[18] Environmental Protection Officer.
[19] Available upon request.
[20] See Annex F.
[21] See Annex G.

Table 3 - Case Study 1 Energy Performance Indicators (EnPIs)

No.	EnPI	Data Required	
		Data	**Data Collection Process**
1	Average daily kWh/area in RLSZ (Zone Vie)	1.1 Meter data for entire camp	1.1 Electrician to download meter data from 3 electrical meter substations every Tuesday.
2	Average daily kWh/pp in RLSZ (Zone Vie)	2.1 Meter data for entire camp	2.1 Electrician to download meter data from 3 electrical meter substations every Tuesday.
		2.2 Daily occupancy rate for Life Zone (Zone Vie)	2.2 FRA POC to provide Zone Vie (buildings and tents) occupancy data to NATO ENSEC COE research team
3	Average daily kWh/area for Buildings	3.1 (See 1.1)	3.1 (See 1.1)
4	Average daily kWh/pp for Buildings	4.1 (See 2.1)	4.1 (See 2.1)
5	Average daily kWh/area for the Tented area	5.1 (See 1.1)	5.1 (See 1.1)
6	Average daily peak kWh/pp for Tented area	6.1 (See 2.1)	6.1 (See 2.1)
7	Average daily peak kW/area for RLSZ (Zone Vie)	7.1 (See 1.1)	7.1 (See 1.1)
8	Average daily peak kW/pp for RLSZ (Zone Vie)	8.1 (See 2.1)	8.1 (See 2.1)
9	Average daily peak kW/area for Buildings	9.1 (See 1.1)	9.1 (See 1.1)
10	Average daily peak kW/pp for Buildings	10.1 (See 2.1)	10.1 (See 2.1)
11	Average daily peak kW/area for Tents	11.1 (See 1.1)	11.1 (See 1.1)
12	Average daily peak kW/pp for Tents	12.1 (See 2.1)	12.1 (See 2.1)

Along with identifying possible areas to implement energy management measures, the research team took the opportunity to trial different options to reduce the peak electrical demand around noon. One of the identified areas for improvement was the high peak electrical demand of the Mess at noon, due to the lunch period and an increase in A/C load. To offset this, it was attempted to pre-cool the Mess for two hours and then increase the thermostat set-points of the A/C units to 26°C during the lunch hour. The measured electricity consumption for the day is shown in Figure 16, and compared to the anticipated electrical demand based on historical data (normalised to weather data).

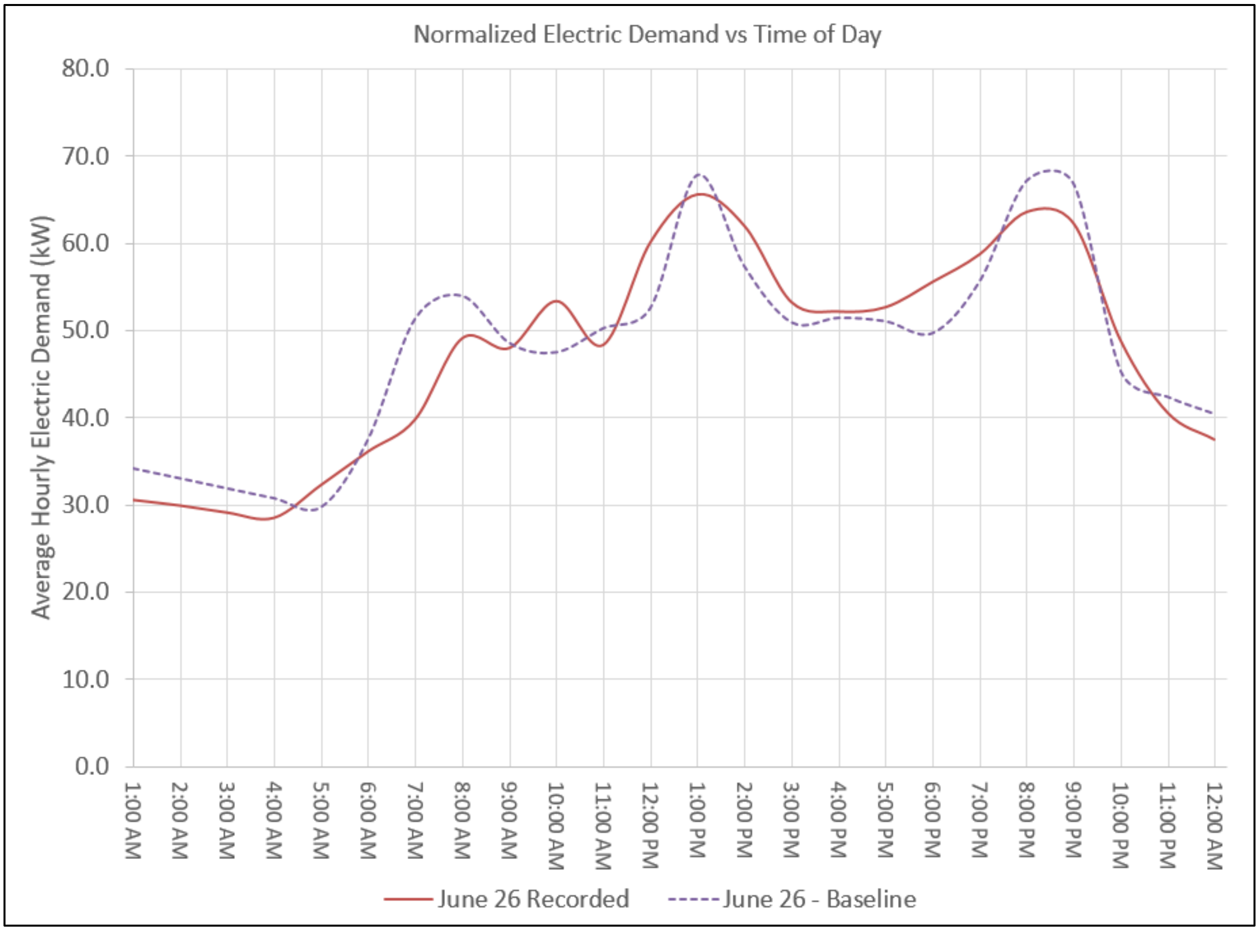

Figure 16 - Mess Peak Electrical Demand Shift Trial

From the trial, it can be seen that from 09.00 to 10.30, the Mess electrical demand increased over the normalised curve due to the pre-cooling. When the thermostats were increased to 26°C, the peak electrical demand was slightly lower the normalised data for 15 minutes, but then followed the same trend as much of the pre-cooled air escaped to the outdoors because the entrance doors were left open.

Post-Change Data Collection and Findings. Due to reasons beyond the control of the research team, including a lack of sufficient implementation of the recommendations, an inadequate amount of post-change data was available. Comparisons between pre and post-change data were not able to be made to assess any changes. However, the research team identified a number of useful insights from Case Study 1 to inform future energy management research and any further case studies. These insights are presented in the conclusions sub-section below.

Conclusions.

- The implementation phase of an energy management case study is the most challenging phase to execute because a lot of the responsibility for change is transferred to the military chain of command and their 'energy team' to ensure that recommendations are actioned.

- Currently, there is a lack of training on energy management included in the pre-deployment training of NATO nations, which affects the extent to which energy management is accomplished on operations, as was experienced in Case Study 1.

- Communication is the key to raising awareness about the need for effective energy management, and together with training, both should be implemented before deployment.

- Understanding the context is imperative; seeking first to understand, then to be understood. This is the reason why a general list of energy management recommendations cannot be applied to all types and sizes of camps and operations. The recce visit was invaluable for establishing an energy management baseline and any future studies should continue to include this stage.

- ISO 50001:2011 advocates; *"Successful implementation depends on commitment from all levels and functions of the organisation, and especially from top management"*. For this reason, engaging key stakeholders and decision makers who are a mixture of people in a position of authority and people who are considered influential amongst peers, is vital.

- Time is a crucial variable when attempting to implement change, because it takes time for changes to become embedded into people's routines and become part of the daily battle rhythm. A minimum period of three months should be factored into any similar case study for the implementation stage alone. In the case of time constraints, it may be possible to focus on implementing fewer interventions, but this can limit savings. Moreover, the less amount of time given for change to take place, and the fewer number of recommendations implemented, the higher the percentage of procedural error.

- Data must be used to support decision making processes. Data collected but unused equates to wasted resources and missed opportunities.

- The results of the questionnaire highlighted that some military personnel have a tendency not to link energy saving with increasing operational effectiveness. This potentially makes energy management difficult, as successful behaviour change is more effective if it can be aligned with key organisational goals, such as operational capability. Social norms can be changed through increased engagement, awareness, and support from the middle of the organisation and addressing split incentives.[22]

- There is significant benefit from having a multi-disciplinary team working on energy management. The holistic understanding of the ‘energy system’ in the Case Study 1 camp could not have been developed without energy and engineering experts, behavioural scientists, and personnel who had a deep understanding of the French military context and decision-making systems.

- Behavioural-based changes can be realised very quickly, unlike major refurbishments or system upgrades that can take months or years to be agreed, funded, and implemented. C2 restructuring and behaviour change can be highly cost-effective as upfront costs are low and can be put in place to achieve immediate savings until appropriate technology is procured. C2 and behavioural interventions can then work alongside technological improvements to maximise potential energy efficiency.

[22] Split incentives occur when a person or group is asked to do something that they do not have direct responsibility for; for example, senior military staff asking troops to help to save money is a message unlikely to influence the behaviour of troops because the troops are not responsible for paying operational energy bills. In other words, different personnel are responsible for managing and paying for energy on behalf of those that consume it. Target audience-specific benefits should always be highlighted to improve the chance of change.

6. Case Study 2: eFP Lithuania (German Military)

Caveats. The following caveats are to be considered, in addition to those set out in Section 2 of this report:

- Behaviour change interventions were undertaken by personnel who had little or no previous experience or exposure to energy behaviour change training.
- The effectiveness of transferring energy behaviour change interventions and techniques from UK MOD to German MOD personnel is not known.
- Due to a rotation of troops at the case study location in the middle of the scheduled timeline, links had to be developed with new points of contact in the new chain of command before acceptance of the recommendations. This reduced the implementation period to two months.

Case Study Location and Timeline. An agreement was reached with the Commander of the NATO enhanced Forward Presence (eFP) camp in Lithuania to collaborate with the German element of the eFP. The research team were given access to the RLSZ as well as the Temporary Logistics Storage Area (TLSA)[23], and six specific areas were chosen:

- Building 44 (main camp) – a three story accommodation block made up of container units, providing accommodation and bathrooms for German military personnel, running off host nation grid power.
- Building 45 (main camp) – a three story accommodation block made up of container units, providing accommodation and bathrooms for German military personnel[24], running off host nation grid power.
- Maintenance Tent 1 (TLSA) – a large tent used for repairing vehicles, running off diesel generator power.
- Maintenance Tent 2 (TLSA) - a large tent used for repairing vehicles, running off diesel generator power.
- Maintenance Tent 3 (TLSA) – a large tent used for repairing vehicles, running off diesel generator power.
- Officer containers (TLSA) – a set of container units for desk-based work offices at the TLSA, running off diesel generator power.

Discussions with relevant authorities[25] to gain permission to conduct a case study at eFP Lithuania took place between February and March 2019, followed by project planning between April and May 2019. Following these stages, the original planned timeline for

[23] The TLSA was used by all eFP nations.
[24] For the baseline data collection period, Building 45 housed only German military personnel. However, in the post-change data collection period, Building 45 housed predominantly Belgian military personnel. The impact of this change is discussed in the results section of this case study.
[25] Including, among others, the German Defence Attaché to Lithuania, the German Liaison Officer to the Lithuanian MOD, and the German civilian Quality Manager from eFP Lithuania.

running the case study is presented in Figure 17[26] followed by the revised timeline (due to the impact of a rotation of troops at both camps in summer 2019 and other external factors), which is presented in Figure 18.[27]

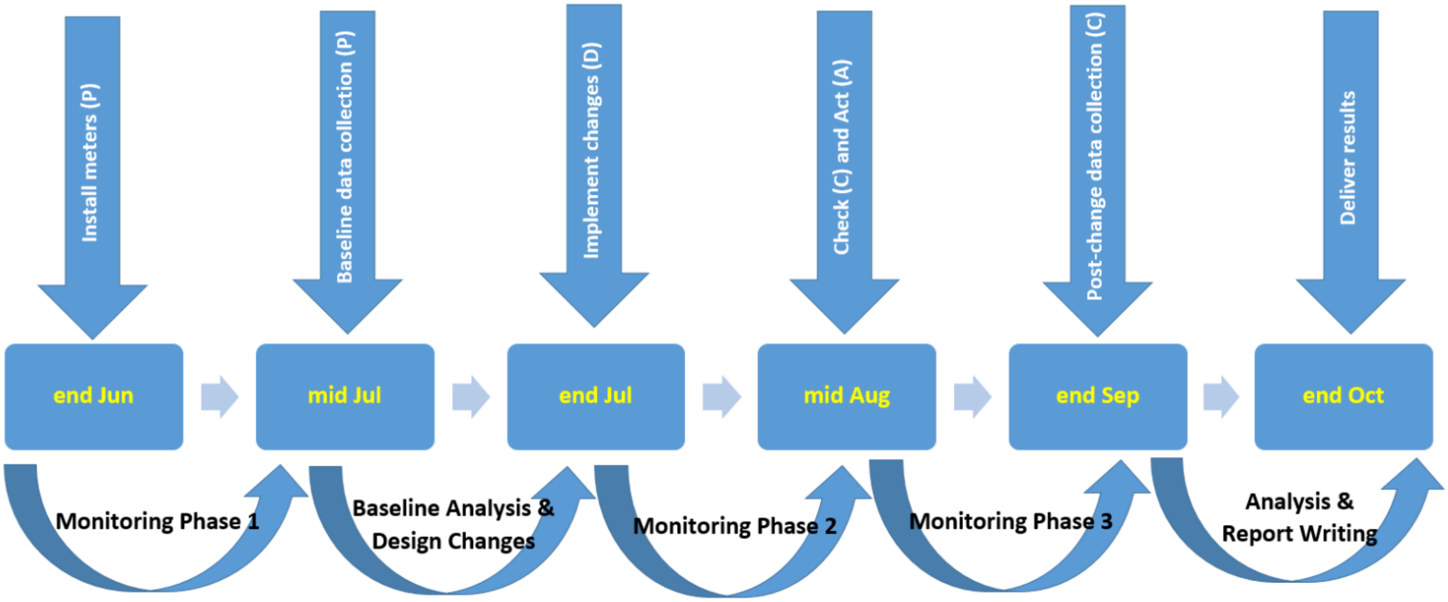

Figure 17 - Planned Timeline for Case Study 2 and Case Study 3 (parallel case studies)

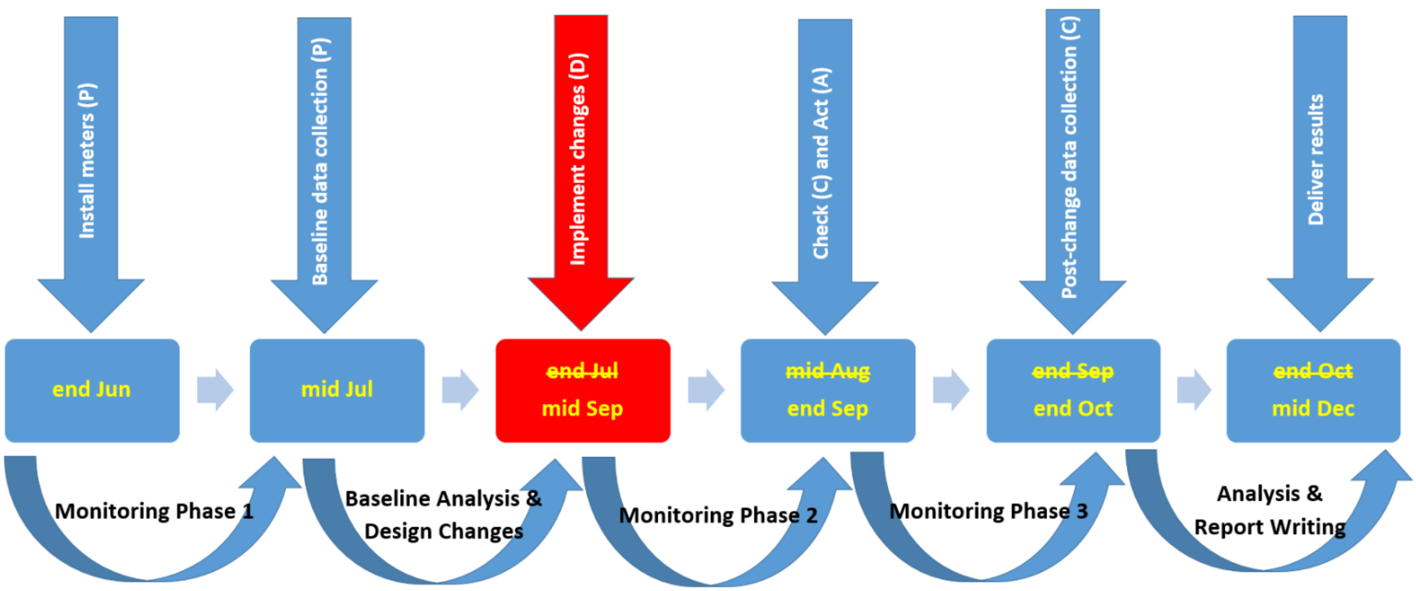

Figure 18 - Revised Timeline for Case Study 2 and Case Study 3 (parallel case studies)

[26] Case Study 2 and Case Study 3 were run in parallel and the same planned timeline applied to each.
[27] Case Study 2 and Case Study 3 were run in parallel and the same revised timeline applied to each.

Project Team Capabilities. The research team involved in Case Study 2 and Case Study 3[28] was considerably smaller than the team that participated in Case Study 1. The research team for Case Study 2 was comprised as follows:

- The NATO ENSEC COE were responsible for:
    - project management;
    - leading the *organisational management* pillar of energy management;
    - leading the *behaviour change* pillar of energy management.
- NRCan were reponsible for:
    - installing the electrical meters and monitoring the electricity data;
    - leading the *technological applications* pillar of energy management.
- The German MOD were responsible for:
    - providing the case study location;
    - providing data to the research team;
    - authorising the C2 required to implement energy management changes.

Energy Management Recommendations. In Case Study 1, a list of 36 recommendations was provided with limited guidance against each recommendation about how to implement the proposal. This was because the research team were advised by relevant military personnel to deliver the objectives that need to be achieved (i.e. the list of recommendations) leaving the military to decide how best to achieve them. For Case Study 2 and Case Study 3, a different approach was employed, whereby much shorter lists of recommendations were provided, but with more detailed accompanying implementation guidance. The much shorter timeframe available to conduct both Case Study 2 and Case Study 3 (six months in total) compared with Case Study 1 (16 months) was also a factor that influenced the number of energy management recommendations that could be tried.

Baseline data[29] (questionnaires, observations, meter data, and context information) were collected, analysed, and triangulated through a FISH workshop. Appropriate recommendations were developed, refined, and delivered to the chain of command at the case study location in August 2019. The energy management recommendations and guidance document for Case Study 2 was made available in both English and German; the English version can be found in Annex H.

The recommendations delivered to eFP Lithuania for Case Study 2 were:

1. Commander to specifically allocate an Energy Manager.
2. Energy Manager to develop an SOP for energy management.

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[28] Case Study 2 and Case Study 3 were run in parallel by the same research team.
[29] Baseline data is presented together with the post-change data under the sub-section 'Comparison of Pre and Post-Change Data'.

3. Create a feedback mechanism for personnel to understand how they are using energy - e.g. visualise the progress of energy usage.

Implementation and Monitoring. During the implementation and monitoring phase, several visits were made to the case study location to support the staff tasked with implementing the energy management recommendations. In addition, the research team prepared and delivered supporting material, such as:

- Job descriptions for energy management team personnel (as with Case Study 1, these included; Commander, DFI Base Energy Manager, Unit Energy Manager).
- EnPIs (Table 4).
- Energy management documentation templates (in German).[30]
- Guidance, tips and examples from social science on how to present energy data to energy users.
- Branding for energy management material.
- Material to raise awareness of energy management benefits and requirements (in German).[31]

The EnPIs for Case Study 2, along with the data required, and the associated data collection processes, are presented in Table 4.

Table 4 - Case Study 2 Energy Performance Indicators (EnPIs)

<table>
<tr><th rowspan="2">No.</th><th rowspan="2">EnPI</th><th colspan="2">Data Required</th></tr>
<tr><th>Data</th><th>Data Collection Process</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Average daily kWh/pp for Building 44 pw</td><td>3.2 Meter data for Building 44</td><td>1.2 Ecolog POC to download Building 44 meter data and send to NATO ENSEC COE project team every Friday</td></tr>
<tr><td>3.3 Daily occupancy rate for Building 44</td><td>1.3 DEU[32] BG[33] POC (TBC) to provide Building 44 occupancy data to NATO ENSEC COE project team every Friday</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Average daily kWh/pp for Building 45 pw</td><td>2.3 Meter data for Building 45</td><td>2.3 Ecolog POC to download Building 45 meter data and send to NATO ENSEC COE project team every Friday</td></tr>
<tr><td>2.4 Daily occupancy rate for Building 45</td><td>2.4 DEU BG POC to provide Building 45 occupancy data to NATO ENSEC COE project team every Friday</td></tr>
</table>

30 Available upon request.
31 See Annex I.
32 NATO abbreviation used to refer to Germany.
33 Battle Group.

No.	EnPI	Data Required	
		Data	Data Collection Process
3	Average daily kWh/area for Building 44 pw	5.1 (See 1.1)	3.1 (See 1.1)
4	Average daily kWh/area for Building 45 pw	4.1 (See 2.1)	4.1 (See 2.1)
5	Average daily kWh/area for the TLSA areas pw	5.2 Meter data for TLSA	5.2 Ecolog POC to download TLSA meter data and send to NATO ENSEC COE project team every Friday
6	Average daily peak kW/pp for Building 44 pw	6.1 (See 1.1)	6.1 (See 1.1)
7	Average daily peak kW/pp for Building 45 pw	7.2 (See 2.1)	7.1 (See 2.1)
8	Average daily peak kW/area for Building 44 pw	8.2 (See 1.1)	8.1 (See 1.1)
9	Average daily peak kW/area for Building 45 pw	9.1 (See 2.1)	9.1 (See 2.1)
10	Average daily peak kW/area for the TLSA areas pw	10.1 (See 5.1)	10.1 (See 5.1)

Comparison of Pre and Post-Change Data. The case study began with two recce visits to the camp in March 2019, which were important for developing relationships with the right people and gathering context information about how the camp operates. The objective of the third visit to the camp was to install the electricity meters and collect baseline (pre-change) data. Several other visits to the camp were made, including a visit to introduce the research to the new Commander following a rotation of the DEU BG at eFP Lithuania during summer 2019, and additional visits to support the Energy Manager in implementing the recommendations. The final visit to the camp was to collect the post-change data. The analysis below presents the key findings from comparing the pre and post-change data that was available to the research team.

Questionnaires. During the baseline data collection period, a German version of the questionnaire[34] was disseminated to German troops at eFP Lithuania. As with Case Study 1, the sampling strategy required a range of ranks, age, and roles, with both male and female respondents, proportionate to the camp personnel. Hard copies of the questionnaires were distributed and 106 responses were collected out of a possible 840 German personnel, representing a 13% response rate.

For the post-change data collection period, three important points are highlighted:

- Three questions in the German post-change version of the questionnaire were changed by German military personnel without discussion with the research team. Changes in questions reduce or remove the ability to make comparisons between two data sets.

- During the implementation period of the case study, Building 45 changed from being an accommodation building for German military personnel to being an accommodation building for Belgian military personnel. Cross-cultural comparisons between German and Belgian energy management attitudes and behaviours were unable to be made due to the fact that the nationality of individual respondents could not be ascertained from each completed questionnaire, nor was this an aim of the research.

- The sampling and distribution strategy of the post-change questionnaire differed from that of the pre-change condition. In the pre-change condition, the questionnaire was distributed to all German troops at eFP Lithuania. In the post-change condition, the questionnaire was distributed only to people living in Building 44 and Building 45. This makes response rates for the pre and post-change conditions difficult to compare. However, it is known that there were 500 people living in Building 44 and Building 45, and 238 questionnaires were completed from across these two buildings. Therefore, the response rate in the post-change condition was 48%, but this is representative of a much smaller population than in the pre-change condition.

The key findings of the pre and post-change questionnaire data are presented below.

- As shown in Figure 19, in the pre-change condition, the vast majority of respondents (98%) stated that they did not have a role in energy management. Of the two respondents who stated that they did have an energy role, one was a Junior Non-Commissioned Officer (JNCO) and one was a Senior Non-Commissioned Officer (SNCO). In the post-change condition, there was an

[34] German version of the questionnaire is available upon request.

increase of 4% of people who stated that they did have an energy role (from 2% to 6%). This could be a reflection of more participants feeling that they are in some way responsible for managing energy use, even if not in an explicit energy management role, due to heightened awareness about energy management related to the implementation of recommendations.

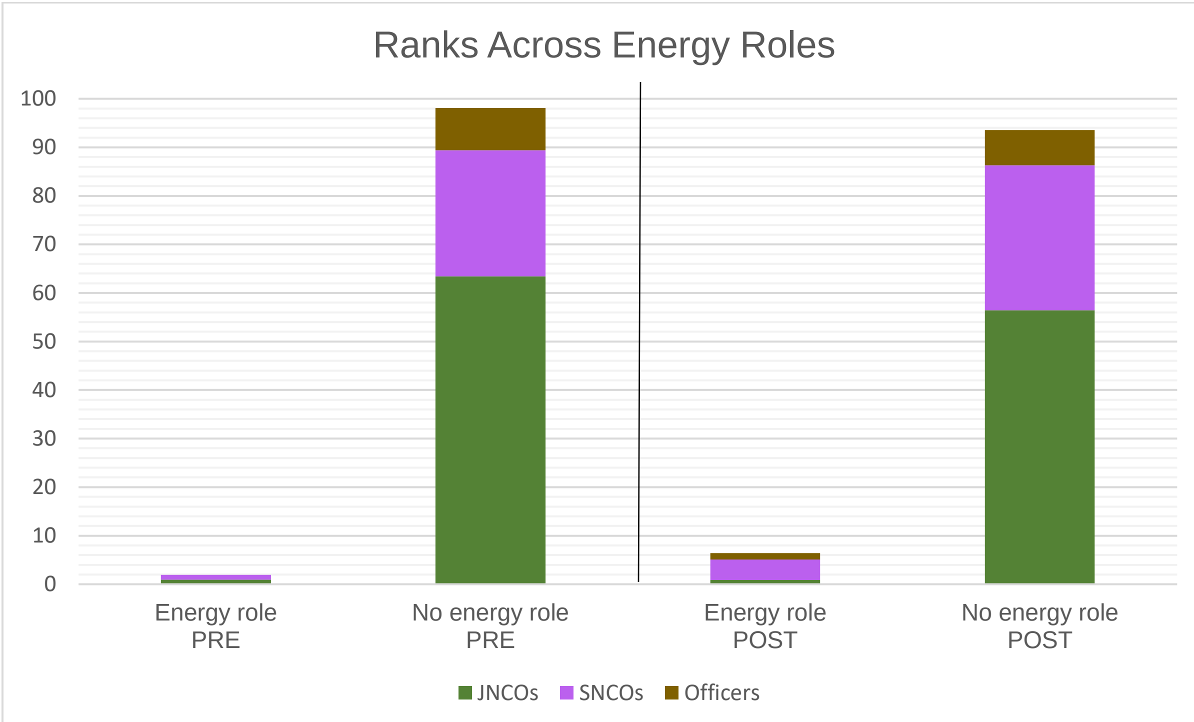


Figure 19 - Case Study 2 Comparison of Ranks Across Energy Roles

- Figure 20 shows the awareness of energy saving initiatives at the camp within each area of work. The largest category in the pre-change condition was logistics (43), followed by maintenance with 11 people, and there were less than 10 people in all other categories. Of those working in logistics, 26% stated that they were were aware of energy saving initiatives at the camp. In comparison, there were 60 respondents working in logistics who participated in the post-change questionnaire, 44% of who reported that they were aware. An increase of 18% is a positive sign of change in a key group of military personnel; people who work in logistics play a vital role in energy management, as they are involved in moving equipment, vehicles, and troops, all of which require substantial amounts of energy.

- Due to changes in the categories of work offered as response options in the pre and post-change versions of the questionnaire, only three categories remained in both; logistics, accommodation, and flight operations. A sufficient number of people reported working in logistics in both versions, which allowed for the responses of people in this category to be compared. The responses of the latter two categories are not compared because only one person stated that they worked in accommodation in the pre-change condition (versus 18 in the post-change condition), and for flight operations 10 people were in this category in the pre-change condition (versus one person in the post-change condition).

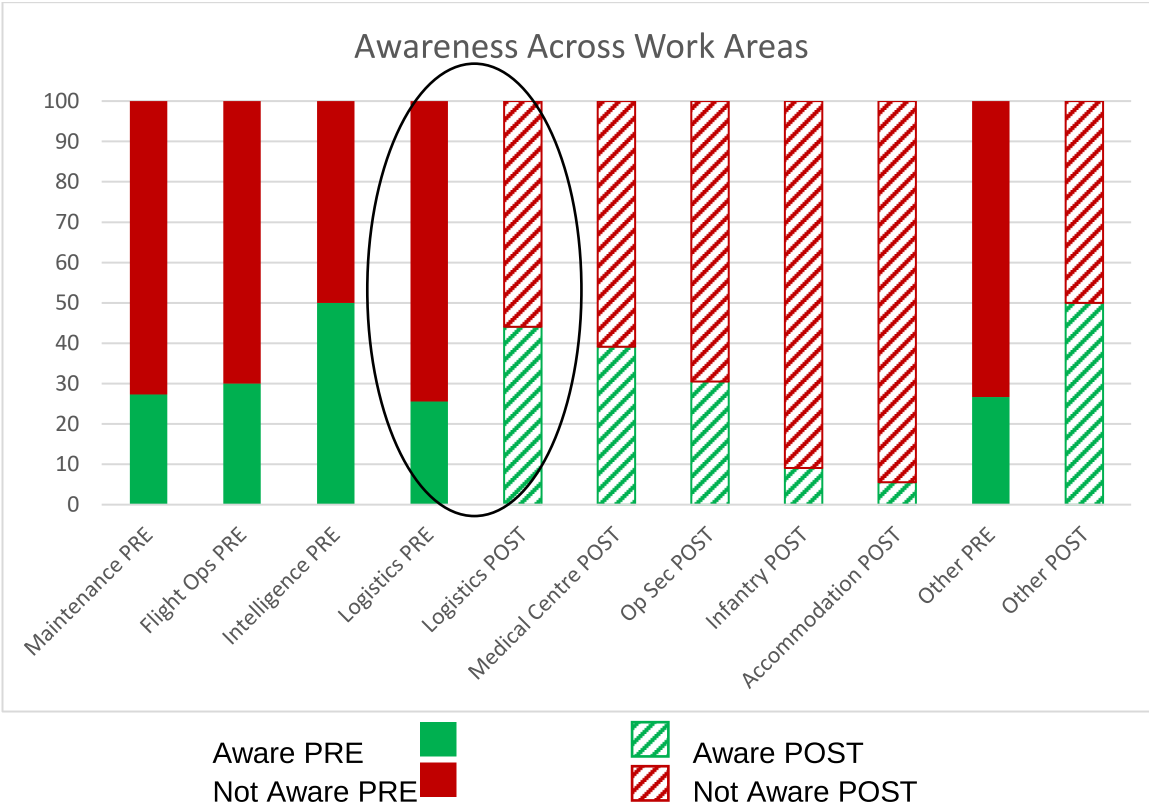


Figure 20 - Case Study 2 Comparison of Awareness Across Work Areas

- When comparing awareness of energy saving initiatives at the camp across ranks, 31% of JNCOs, 25% of SNCOs, and 33% of Officers stated that they were aware in the pre-change condition; leaving more than 65% of respondents in each rank category reportedly unaware. Figure 21 shows that in the post-change condition, the awareness of SNCOs increased by 13%, up to 38%, and the awareness of Officers increased by 12%, up to 45%. However, for JNCOs the figure dropped by 5%, down to 26%.

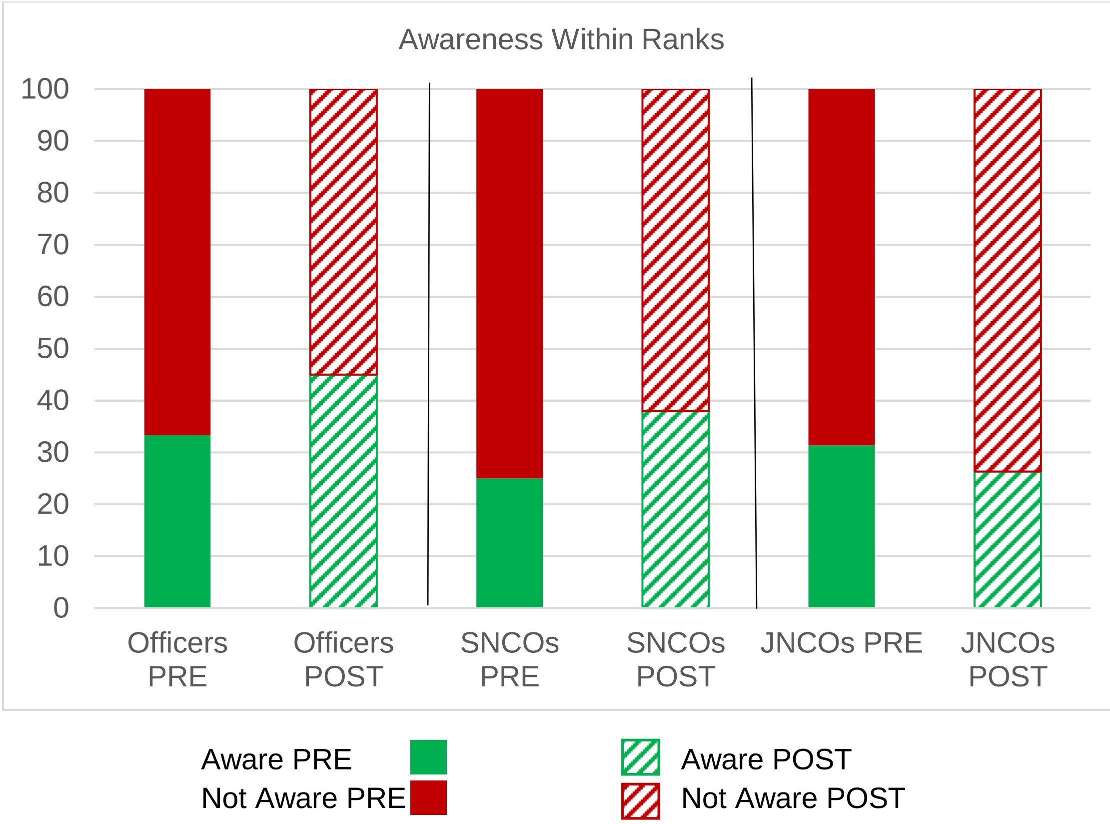


Figure 21 - Case Study 2 Comparison of Awareness of Energy Saving Initiatives Within Ranks

- To establish the average scores for capability, oportunity, and motivation (the COM-B elements) to save energy, the responses given to corresponding questions[35] on a five point likert scale (1 representing strongly disagree through to 5 representing strongly agree) were grouped together and averaged. The results presented in Figure 22 show that, in the pre-change condition, the average score for capability was 3.3, for opportunity it was 3.1, and for motivation it was 3.6. This means that, on average, people felt somewhere between neutral (a score of 3) and in agreement (a score of 4) that they had the capability, opportunity, and motivation to save energy. Feelings of motivation to save energy were closer to agree, and feelings of capability and opportunity were closer to neutral. These results suggested that the focus of behaviour change during the implementation of energy management recommendations should be on improving the opportunity to save energy, as this element of behaviour was rated the lowest across pre-change condition respondents.

- The average ratings for COM-B elements did not change significantly between the pre and post-change conditions; the average for capability in the post-change condition was 3.4, and for opportunity and motivation the average scores were 3.3

[35]Questions 9, 10, and 16 relate to capability; 11, 14, 17, 18, 19, and 20 relate to opportunity; and 13, 15, and 21 relate to motivation. See ANNEX B for the Questionnaire Template.

and 3.6, respectively. This provides support to the notion that behaviour change takes a minimum of three months to happen; the implementation period for Case Study 2 was only two months and therefore not sufficient to see significant results in changes in COM-B elements.

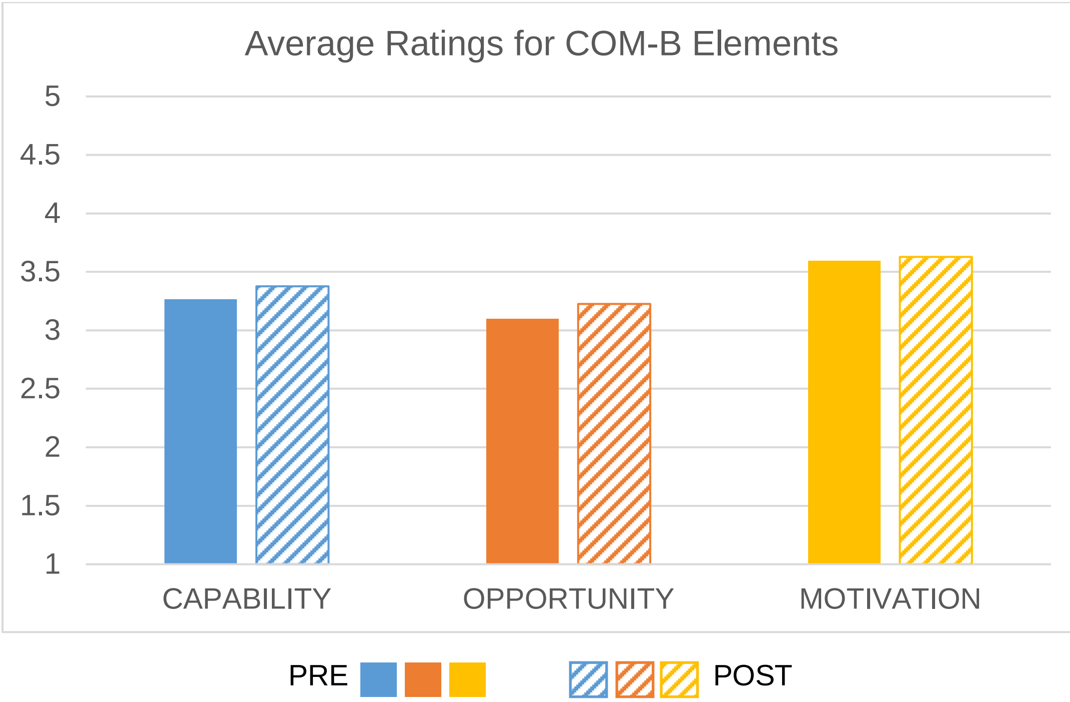


Figure 22 - Case Study 2 Comparison of Average Ratings of COM-B Elements

- The spread of responses to questions related to motivation changed positively between the pre and post-change conditions; with a decrease in the percentage of people who strongly disagreed they were motivated to be energy efficient and an increase in the percentage of 'agree' responses. This can be seen in Figure 23.

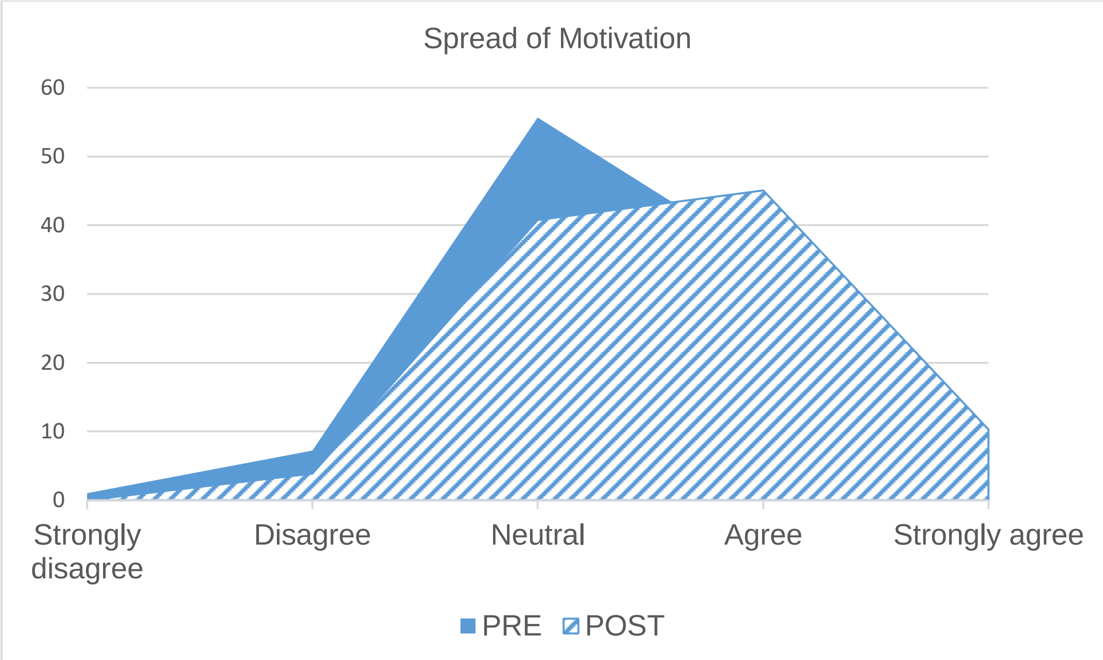


Figure 23 - Case Study 2 Range of Responses Related to Motivation to be Energy Efficient

- Respondents were asked to select reasons why they don't switch off electrical devices when they are not using them, selecting as many from a pre-set list of options as they felt were relevant[36]. Figure 24 shows the ascending results, where the top three reasons selected in the pre-change condition were: '*I forget to'; 'to help with software updates',* and *'it's an inconvenience'*. These insights helped to understand what could be done (i.e. interventions / changes) to improve the likelihood of people switching off devices when not in use. In the post-change condition, the top two reasons had not changed: *'I forget to'* and *'to help with software updates'*. This suggests that there was insufficient focus on challenging these reasons during the implementation period, or that the implementation period was not long enough to foster change in these attitudes and behaviours. The third most popular reason changed from *'it's an inconvenience'* in the pre-change condition, to *'it's not something I think about'* in the latter condition.

[36] See question 24 in the questionnaire at ANNEX B.

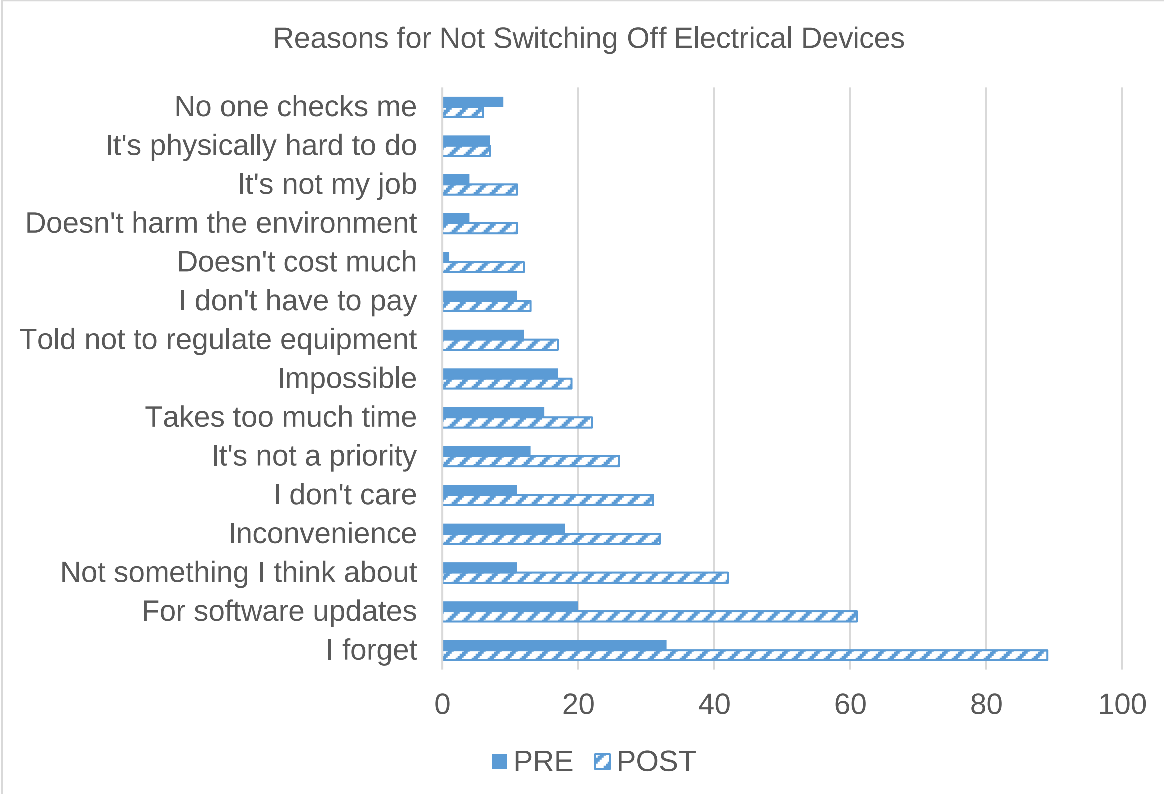


Figure 24 - Case Study 2 Comparison of Reasons for Not Switching Off Electrical Devices

Meter Readings. Electricity metering equipment was installed in the selected case study areas of the camp at the end of June 2019; weekly readings[37] were taken from eight electrical meters installed in Building 44, 45 and the TLSA area. The data from the electrical meters were downloaded and sent by German MOD civilian personnel at the camp on a weekly basis. The data were sent by email directly to research team points of contact at both the NATO ENSEC COE and NRCan. The baseline study was conducted from the beginning of Week 27 (1st July 2019) to the end of Week 34 (25th August 2019), with averages calculated for each EnPI for this period to be able to compare with the post-change EnPI data. The post-change EnPI data was taken during Week 44 (28th October to 3rd November 2019). Due to configuration issues with some of the metering equipment, there were only two weeks of baseline data available for the TLSA areas (Week 33 and Week 34), compared to a full eight weeks of baseline data for the areas at the main camp (i.e. Building 44 and Building 45).

The key findings of the pre and post-change meter data are presented below.

- Under low occupancy periods in Building 45, it is evident that there is a higher electricity consumption per person (Figure 25). This is attributed to electrical loads required to maintain the building, independent of the level of occupancy.

[37] See ANNEX J for the weekly meter data for Case Study 2, presented as EnPIs.

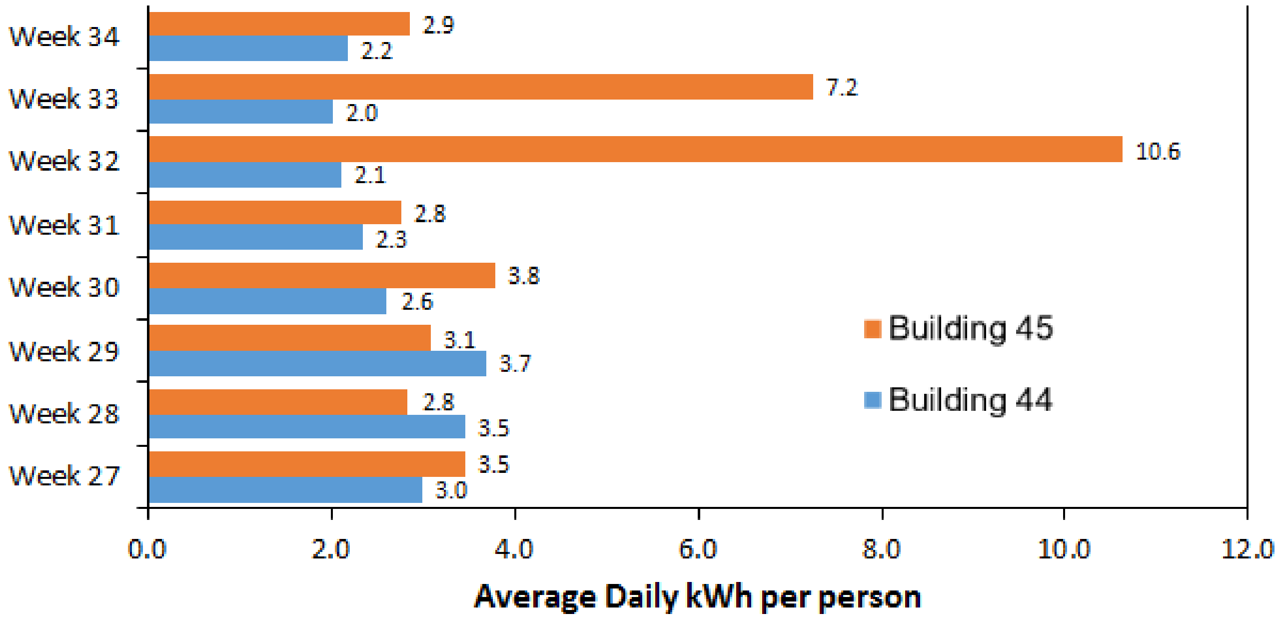


Figure 25 - Case Study 2 Effect of Low Occupancy Rates

- The pre-change data were collected during the summer season (July and August 2019), when no heating or cooling equipment was used. The post-change data were collected during the late autumn season (November 2019), when temperatures began to drop and newly installed heating units were turned on in the areas under investigation. When examined alongside available weather data, the increased electrical demands corresponded to increases in space-heating during low temperatures, this effect is illustrated in Figure 26. It is not possible to isolate the data related to the heating units to be able to conduct a true comparison agnostic of season and weather variation, therefore the figures presented show an increase in energy use in the post-change condition.

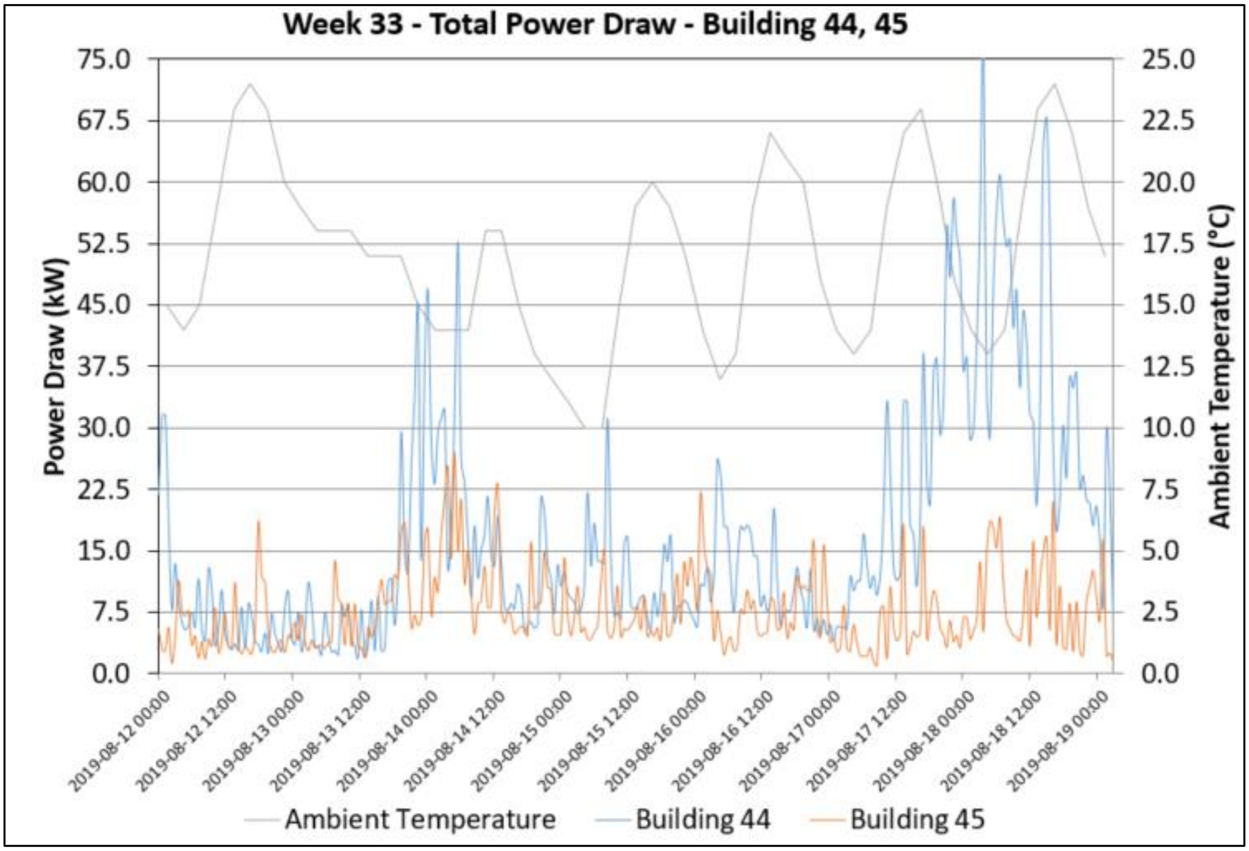


Figure 26 - Case Study 2 Week 33 Electricity Demand and Temperature

- The pre and post-change meter data for each EnPI are presented in Table 5.

Table 5 - Case Study 2 Pre and Post-Change EnPI Data

	EnPI	Pre-Change	Post-Change
1	Average daily kWh/pp for Building 44 pw	2.68	9.1
2	Average daily kWh/pp for Building 45 pw	4.59	9.0
3	Average daily kWh/area for Building 44 pw	503.01	2072.4
4	Average daily kWh/area for Building 45 pw	294.46	2329.4
5	Average daily kWh/area for TLSA pw	1372.55	2434.8
6	Average daily peak kW/pp for Building 44 pw	0.36	0.74
7	Average daily peak kW/pp for Building 45 pw	0.78	0.68
8	Average daily peak kW/area for Building 44 pw	68.53	169.1
9	Average daily peak kW/area for Building 45 pw	44.09	176.6
10	Average daily peak kW/area for TLSA pw	80.7	135.0

Assessment of the Implementation of Recommendations. Table 6 presents summary assessments of each of the three recommendations delivered to the Case Study 2 audience at eFP Lithuania.

Table 6 - Case Study 2 Summary Assessment of Recommendations

<table>
<tr><th>No.</th><th>Assessment of Recommendations</th></tr>
<tr><td>1</td><td>Commander to specifically allocate an Energy Manager.</td></tr>
<tr><td></td><td>This recommendation was fully implemented, however due to the rotation of troops during the case study, there was one person in the Energy Manager role for the baseline data collection period, and another person took over from the beginning of the implementation period. The majority of comments on the Energy Manager role relate to the experiences of the second Energy Manager, who was in the role for the longer period of time. Another key point to note is that the (second / main) Energy Manager was undertaking a relatively short deployment of four months. In relation to these points, it should be noted that a lack of end-to-end involvement in a process often hinders effectiveness, and the short rotation cycle of some military positions is not ideal for a role involved in implementing changes in procedures. The Energy Manager should be in post for a minimum of six months.

The Energy Manager was a dedicated OF1 whose main job was in the area of infrastructure management, with the Energy Manager role a secondary duty. Without prior energy management training, the Energy Manager ‘learnt on the job’. Without an Energy Manager, it is very likely that no energy management recommendations would have been tried.

The composition of eFP Lithuania means that energy management is required at two separate but interdependent areas; the main camp and the TLSA - which is approximately 3km away from the main camp. It was discovered late on in the case study that there was a separate Infrastructure Officer at the TLSA who was not involved in the project.

Considering that (currently) an Energy Manager has other roles and duties, it was felt that allocating 20% of work time to energy management was a realistic proposal, although relevant pre-deployment training should be provided. It was also felt that the position should be for military personnel and not civilian, and be undertaken by a person of, at minimum, an OF2 rank, to be able to give authoritative orders. It was also stated that an Energy Manager should have engineering expertise.</td></tr>
</table>

No.	Assessment of Recommendations
2	*Energy Manager to develop a Standard Operating Procedure (SOP) for energy management.*
	An SOP was drafted during the implementation period of the case study[38], however it was not approved by the chain of command and disseminated before the post-change data collection activity. Therefore, its utility cannot be fully assessed. It was suggested that, if approved, the Coy Sgt Majs[39] would be the recipients of the SOP, and it would be their responsibility to ensure that their troops adhered. It was also said that it would likely be something that would be attached to notice boards in each room.
3	*Create a feedback mechanism for personnel to understand how they are using energy - e.g. visualise the progress of energy usage.*
	Supporting material for this recommendation was drafted by the research team, ready for weekly energy data to be added and displayed for German military personnel to see. However, due to technical problems[40] with recording and sending the weekly meter data, the templates could not be populated quickly enough to be used.

Conclusions.

- An increase in energy consumption was found in the post-change data, however this was almost entirely attributable to the non-heating baseline context versus the heating-on in the post-change period, where the electricity consumption of the heating sources could not be isolated within the configuration of the metering software. Hourly weather data is required to be able to make meaningful assessments of energy use per person and energy use per area. Additionally, meters should be placed on heating and cooling energy sources to be able to isolate this data from all other electricity being used if the case study period is less than a full year.

- There were some positive changes in the behaviour-based data, such as an increase in the amount of people who felt that they had an energy related role, an increase in the proportion of people working in the area of logistics who stated that they were aware of energy saving initiatives at the camp, and an increase in the proportion of awareness of SNCOs and Officers on the same measure. However,

[38] Available in German, upon request.
[39] Company Sergeant Majors.
[40] Remote access to meter data would mitigate for many technical problems, however current thinking on the security of the electrical metering and monitoring technology means that remote access was not an option in any of the present case studies.

there was no real change in the average scores for the COM-B elements for the pre and post-change groups, and there was no change in the top two reasons given for not switching off items when not in use *('I forget to'* and *'to help with software updates'*). It is assessed that the low rate of change is directly related to the scarce amount of time spent on the implementation stage. To observe a reliable positive change, more time is needed to allow for recommendations to be incorporated into daily routine and individual habits.

- Although the between-groups design used in the research method was valid, the two German Battle Groups involved in the pre and post-change conditions were from different areas of Germany and a limited amount of information is known about any cultural differences to be able to make an assessment of the effect of German regional culture.

- The unplanned inclusion of Belgian military personnel in the post-change condition reduced the extent to which pre and post-change differences could be assessed.

- For valid and reliable conclusions to be made from data, it is important to control for certain variables, such as comparative populations, consistent questions, and normalising data to account to variation in weather conditions.

7. Case Study: eFP Latvia (Canadian Military)

Caveats. The following caveats are to be considered, in addition to those set out in Section 2 of this report:

- Behaviour change interventions were undertaken by personnel who had little or no previous experience or exposure to energy behaviour change training.
- The effectiveness of transferring energy behaviour change interventions and techniques from UK MOD to Canadian MOD personnel is not known.
- Due to a rotation of troops at the case study location in the middle of the scheduled timeline, links had to be developed with new points of contact in the new chain of command. This reduced the implementation period to two months.

Case Study Location and Timeline. An agreement was reached with the Commander of the NATO eFP camp in Latvia to collaborate with the Canadian element of the eFP. The research team were given access to the RLSZ and three specific areas were chosen for inclusion:

- LSA[41]1 – accommodation tents and ablution buildings for Canadian military personnel, running off diesel generators at the beginning of the case study and off host nation grid power by the end of the case study.
- Building 073 - multinational accommodation building (hard shelter), running off host nation grid power.
- Gym - multinational use, managed by Canadian civilian contractors, running off host nation grid power.

Discussions with relevant authorities[42] to gain permission to conduct a case study at eFP Latvia took place between February and March 2019, followed by project planning between April and May 2019. The original timeline for running the case study is presented in Figure 17 (see Section 6), followed by the revised timeline in Figure 18 (see Section 6) as a result of a rotation of troops in the middle of the case study.

Project Team Capabilities. The research team involved in case study 2 and case study 3[43] was considerably smaller than the team that participated in case study 1. The research team for case study 3 was comprised as follows:

[41] Life Support Area.
[42] Including, among others, Canadian Joint Operations Command (CJOC) and the Canadian National Support Element (NSE) at eFP Latvia.
[43] Case Study 2 and Case Study 3 were run in parallel by the same research team.

- The NATO ENSEC COE were responsible for:
    - project management;
    - leading the *organisational management* pillar of energy management;
    - leading the *behaviour change* pillar of energy management.
- NRCan were responsible for:
    - installing the electrical meters and monitoring the electricity data;
    - leading the *technological applications* pillar of energy management.
- The Canadian Armed Forces (CAF) were responsible for:
    - providing the case study location;
    - supporting the energy meter installation;
    - providing data to the research team;
    - authorising the C2 required to implement energy management changes;

Energy Management Recommendations. Baseline data[44] (questionnaires, observations, meter data, and context information) were collected, analysed, and triangulated through a FISH workshop. Appropriate recommendations were developed, refined, and delivered to the chain of command at the case study location in August 2019. The energy management recommendations and guidance document for Case Study 3 can be found at ANNEX K.

In the same format as Case Study 2, a short list of recommendations were provided with detailed accompanying implementation guidance. The relevant chain of command for the Case Study 3 location were provided with six recommendations, whereas eFP Lithuania (Case Study 2) were provided with three; this is because CAF already has in place a Defence Energy and Environment Strategy (DEES)[45], one of the targets of which is to reduce petroleum-generated electrical energy consumption by 50% at deployed camps by 2030. Therefore, it was assessed that Canadian military personnel were already somewhat pre-disposed, aware, or bought-in, to the need for better energy management on operations, and therefore a greater amount of recommendations could be tried.

The recommendations delivered to eFP Latvia were:

1. Commander to specifically allocate an Energy Manager.
2. The NSE to task the development and implementation of last-person out checks.
3. Gym staff to review plans and procedures, and to update where relevant.
4. Create reminders to drive the desired behaviour of switching off items when not in use.
5. Commander to ensure cooperation of energy management staff with relevant POCs of other eFP Latvia contributing nations.

[44] Baseline data is presented together with the post-change data under the sub-section ‘Comparison of Pre and Post-Change Data’.
[45] https://www.canada.ca/en/department-national-defence/corporate/reports-publications/dees.html

6. CIS[46] authority (e.g. S4) to confirm when IT[47] software updates need to be done; eFP Latvia staff to adapt IT habits as a result of the information.

Implementation and Monitoring. As with Case Study 2, during the implementation and monitoring phase, several visits were made to the Case Study 3 location to support the staff tasked with implementing the energy management recommendations. In addition, the research team prepared supporting material such as:

- Job descriptions for energy management team personnel (as with Case Study 1 and Case Study 2, these included; Commander, DFI Base Energy Manager, Unit Energy Manager).
- EnPIs (Table 7).
- Energy management documentation templates.[48]
- Guidance, tips, and examples for developing last-person out checks.
- Guidance, tips, and examples for reminding people to switch off items when not in use.
- Branding for energy management material.
- Material to raise awareness of energy management benefits and requirements.[49]

The pre-change questionnaire was delivered in French, as the majority of the Canadian troops at eFP Latvia during the baseline data collection period were from the French-speaking Canadian province of Quebec. Later, the recommendations and guidance document, as well as all of the supporting material, were delivered in English because the French-speaking Canadian troops had rotated out of eFP Latvia in July, which was before the implementation period of the recommendations. The next rotation of Canadian troops were predominantly English speaking from Western Canada.

The EnPIs for Case Study 3, along with the data required, and the associated data collection processes, are presented in Table 7.

[46] Computer and Information Systems.
[47] Information Technology.
[48] Available upon request.
[49] See ANNEX G and ANNEX I; awareness raising material developed for other case studies was provided to eFP Latvia for inspiration.

Table 7 - Case Study 3 Energy Performance Indicators (EnPIs)

No.	EnPI	Data Required	
		Data	Data Collection Process
1	Average daily kWh/pp for LSA1 pw	5.2 Meter data for LSA1	1.4 Energy Manager to download LSA1 meter data and send to NRCan every Friday
		5.3 Daily occupancy rate for LSA1	1.5 Energy Manager to provide LSA1 occupancy data to NRCan every Friday
2	Average daily kWh/pp for Building 073 pw	2.5 Meter data for Building 073	2.5 Energy Manager to download Building 073 meter data and send to NRCan every Friday.
		2.6 Daily occupancy rate for Building 073	2.6 Energy Manager to provide Building 073 occupancy data to NRCan every Friday
3	Average daily kWh/area for LSA1 pw	7.1 (See 1.1)	3.1 (See 1.1)
4	Average daily kWh/area for Building 073 pw	4.1 (See 2.1)	4.1 (See 2.1)
5	Average daily kWh/area for the Gym pw	5.3 Meter data for the Gym	5.3 Energy Manager to download Gym meter data and send to NRCan every Friday
6	Average daily peak kW/pp for LSA1 pw	6.1 (See 1.1)	6.1 (See 1.1)
7	Average daily peak kW/pp for Building 073 pw	7.3 (See 2.1)	7.1 (See 2.1)
8	Average daily peak kW/area for LSA1 pw	8.3 (See 1.1)	8.1 (See 1.1)
9	Average daily peak kW/area for Building 073 pw	9.1 (See 2.1)	9.1 (See 2.1)
10	Average daily peak kW/area for the Gym pw	10.1 (See 5.1)	10.1 (See 5.1)

Comparison of Pre and Post-Change Data. The case study began with a recce visit to the camp in March 2019, which was important for developing relationships with the right people, and gathering context information about how the camp operates. The objective of the second visit to the camp was to install the electricity meters and collect baseline (pre-change) data. Several other visits to the camp were made, including a visit to introduce the research to the new OC[50] of the Camp Engineering Services (CES) unit following a rotation of Canadian troops at eFP Latvia during summer 2019, and additional visits to support the Energy Manger in implementing the recommendations. The final visit to the camp was to collect the post-change data. The analysis below presents the key findings from comparing the pre and post-change data that was available to the research team.

Questionnaires. During the baseline data collection period, a French version of the project questionnaire[51] was disseminated to French speaking Canadian troops[52] at eFP Latvia. As with Case Study 1 and Case Study 2, the sampling strategy required a range of ranks, age, and roles, with both male and female respondents, proportionate to the camp personnel. Hard copies of the questionnaires were distributed and 174 responses were collected out of a possible 594, representing a 29% response rate. During the post-change data collection period, a total of 134 responses were collected out of a possible 410, representing a 33% response rate.

The key findings of the pre and post-change questionnaire data are presented below.

- Figure 27 shows that there were increases in levels of awareness of energy saving initiatives at the camp across all rank categories. The level of awareness of Officers increased from 32% to 38%, the level of awareness of SNCOs more than doubled by jumping from 29% to 65%, and for JNCOs the figure rose from 26% to 43%.

[50] Officer Commanding.
[51] The French version of the questionnaire is available upon request.
[52] The majority of the Canadian troops involved at the beginning of the case study were from the French-speaking Quebec province of Canada.

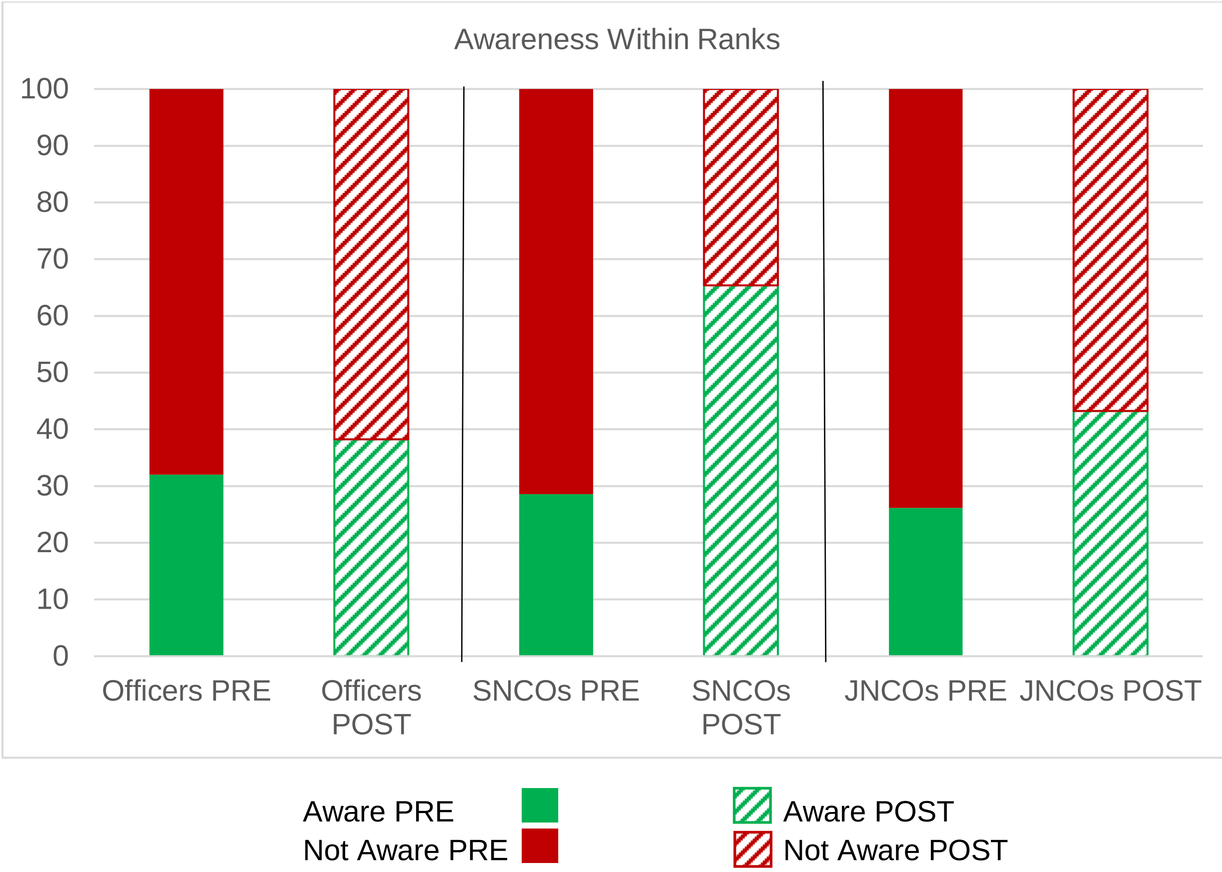


Figure 27 - Case Study 3 Comparison of Awareness of Energy Saving Initiatives Within Ranks

- As shown in Figure 28, in the pre-change condition the proportion of people who stated that they had an energy role and who were aware of energy saving initiatives at the camp was 57%; in the post-change condition this figure jumped up to 67%. Additionally, the proportion of people who stated that they did not have an energy role but were aware of energy saving initiatives at the camp increased from 24% to 44%. This is a positive result, suggesting that awareness of energy saving initiatives increased considerably as a result of energy management changes.

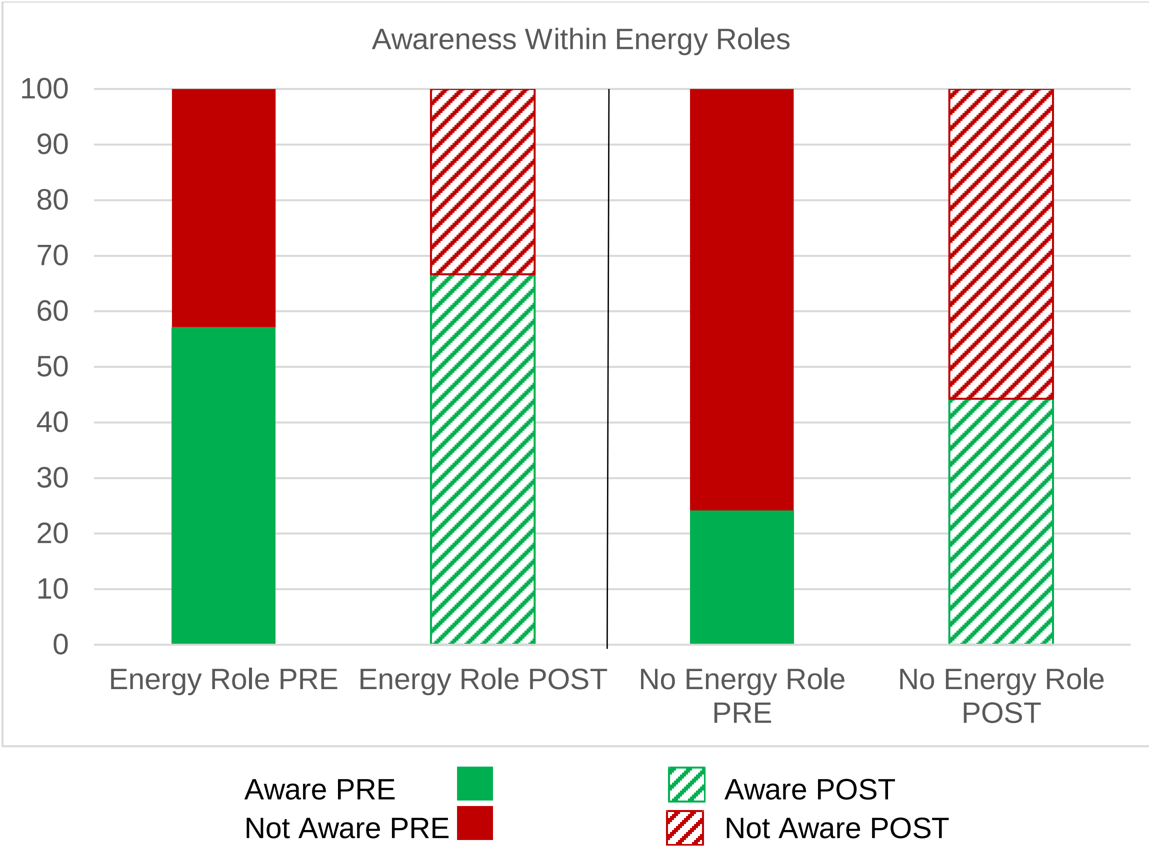


Figure 28 - Case Study 3 Comparison of Awareness Within Energy Roles

- With reference to the COM-B results, the data were almost identical, as can be seen in Figure 29. The average rating for capability in the pre-change condition was 3.3 and was 3.4 in the post-change condition. The average rating for opportunity was 3.4 in the pre-change condition and 3.4 in the post-change condition. The average rating for motivation was 3.9 in both conditions.

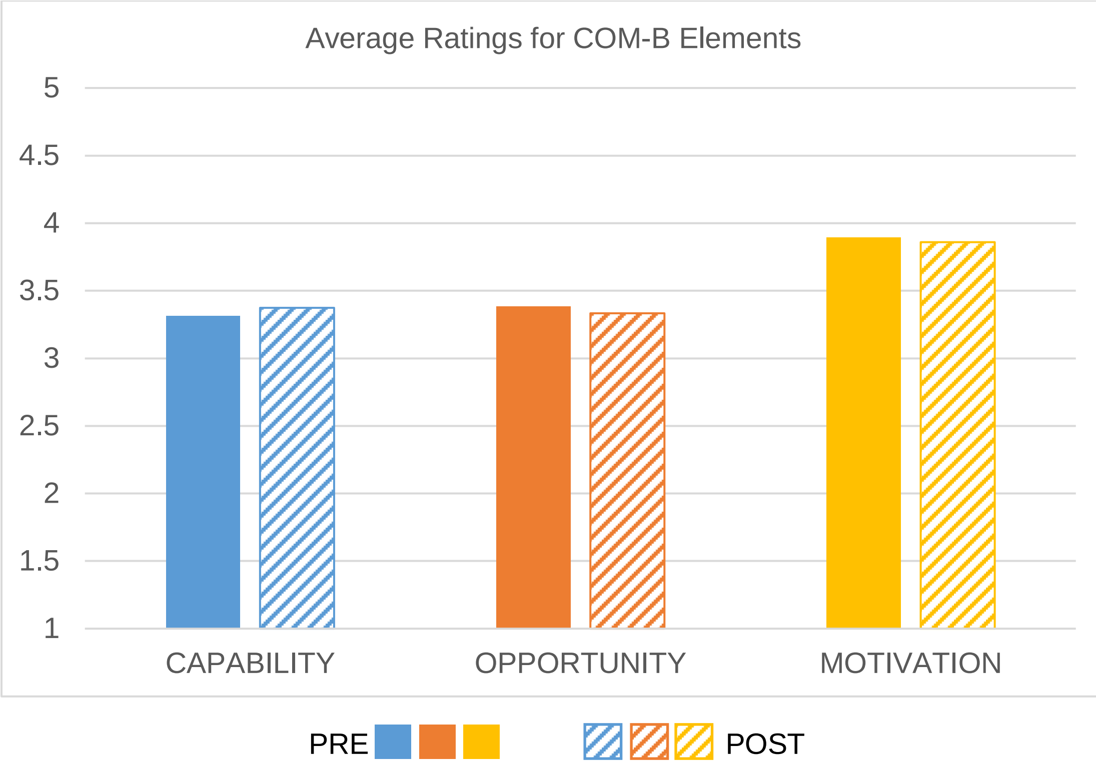


Figure 29 - Case Study 3 Comparison of Average Ratings for COM-B Elements

- When the data are broken down into the average rating for each COM-B element for each rank category, the story is similar. The average scores given for each COM-B element and for each rank are presented in Table 8, with green representing an increase, amber representing no change, and red representing a decrease.

Table 8 - Case Study 3 Average COM Ratings per Rank Category

	Capability		**Opportunity**		**Motivation**	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
Officers	3.2	3.2	3.6	3.4	4.2	4.2
SNCOs	3.4	3.6	3.4	3.4	3.9	3.8
JNCOs	3.3	3.4	3.3	3.3	3.8	3.7

- These findings provide further support to the notion that more than two months of implementing change is needed to have an effect on behaviour. The implementation period did not provide sufficient time to see substantial change; it is recommended to re-visit the case study location after an extended time of three-six months to see if COM-B changes have taken place. Motivation scored the highest average in both conditions, suggesting that increasing the capability and opportunity to be energy efficient should be the focus of any interventions.

- Figure 30 presents data showing the effect of age on perceived importance of saving energy. In the post-change condition, 86% of ~25s either agreed or strongly agreed that it's important to save energy, this is a 6% increase from the baseline data for this age group. There was a small but positive increase of 2% for the age group 26-35, no change for the 36-45 age group, and a small decrease of 1% in people aged 46+ who agreed or strongly agreed that it's important to save energy. Additionally, the pattern of responses for 46+ year olds is almost identical in the pre and post conditions, which suggests that it is more difficult to change the attitudes and behaviours of older people. The responses of the younger age groups correlate with the pro-environmental stance seen among youth in modern society.

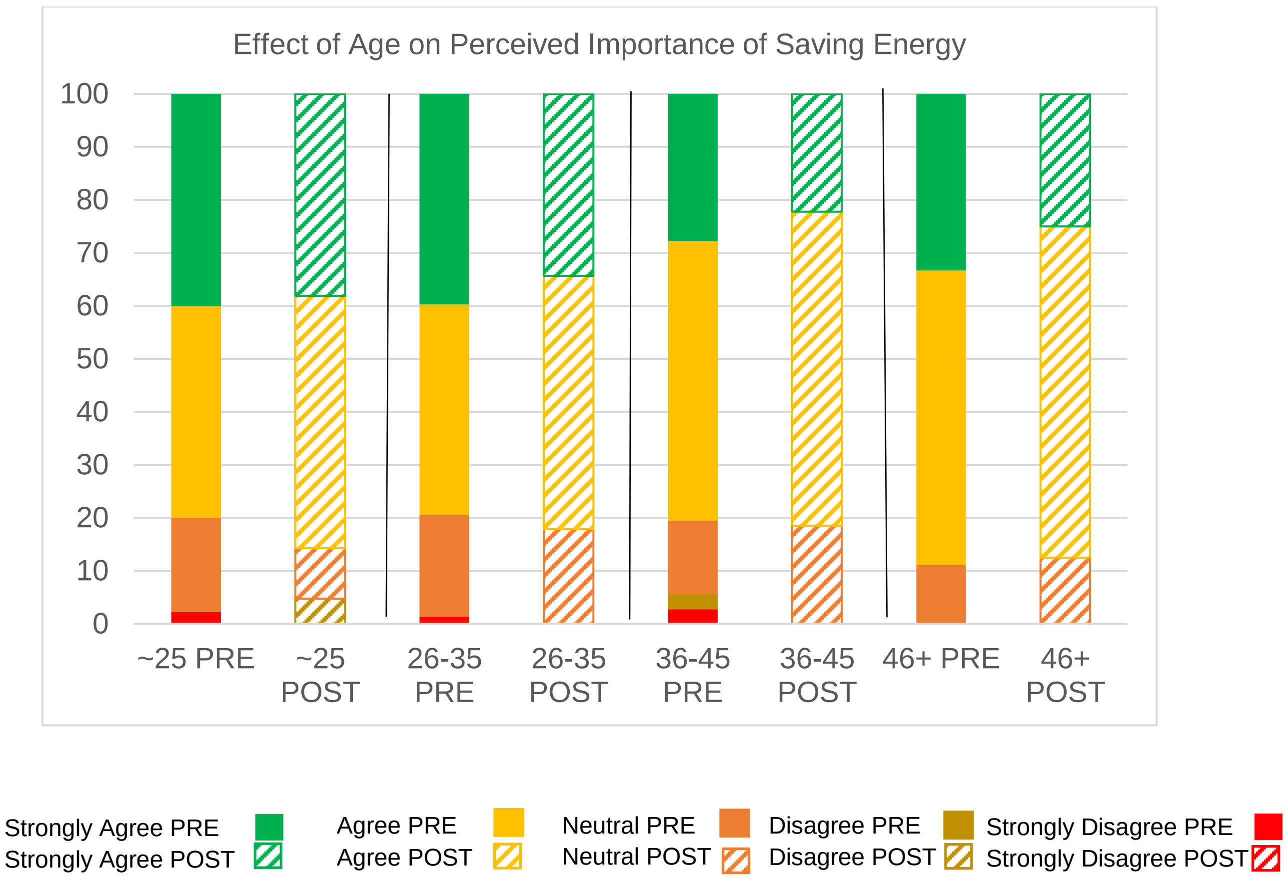


Figure 30 - Case Study 3 Effect of Age on Perceived Importance of Saving Energy

- In terms of people who felt neutral about saving energy, the figure for those aged ~25 dropped from 18% to 10%, for 26-35 year olds the figure dropped very slightly from 19% to 18%. The reduction in neutral responses in the post-change condition suggests that people in these age groups had a more informed opinion on the topic of saving energy after the period of implementing energy management changes and moved out of the 'neutral zone'.

- For people aged 36-45 and 46+ there were increases in neutral responses of 5% and 2%, respectively. Coupled with the fact that 6% of 36-45 year olds either disagreed or strongly disagreed that it was important to save energy in the pre-change condition and there were no people in this age group who chose disagree or strongly disagree in the post-change condition, this suggests that this age group shifted from a negative to a neutral view on saving energy.

- In the pre-change condition, there were strongly disagree responses in the ~25, 26-35 and 36-45 year age groups. In the post-change condition, there were no strongly disagree responses in any age group.

- People aged 35 and under were the majority of respondents for both pre (73%) and post-change (72%) groups, which (if representative) suggests that the majority of people on the camp, and in the military per se, are aged 35 and under. Additionally, people in this age bracket are future military leaders and thus, it is the attitudes of those aged 35 and under that will affect future military and defence policy decisions.

- Figure 31 shows, in ascending order, the pre and post-change responses given for not switching off electrical items when not in use. Two reasons are in the top three in both conditions; *'I forget to'*, and *'to help with software updates'*. This suggests that there was insufficient focus on challenging these perceptions during the implementation period, or that the implementation period was not long enough to foster change in these attitudes and behaviours, related to the need for a minimum of three months of implementation of changes to start to see adjustments in attitudes, behaviours, and habits.

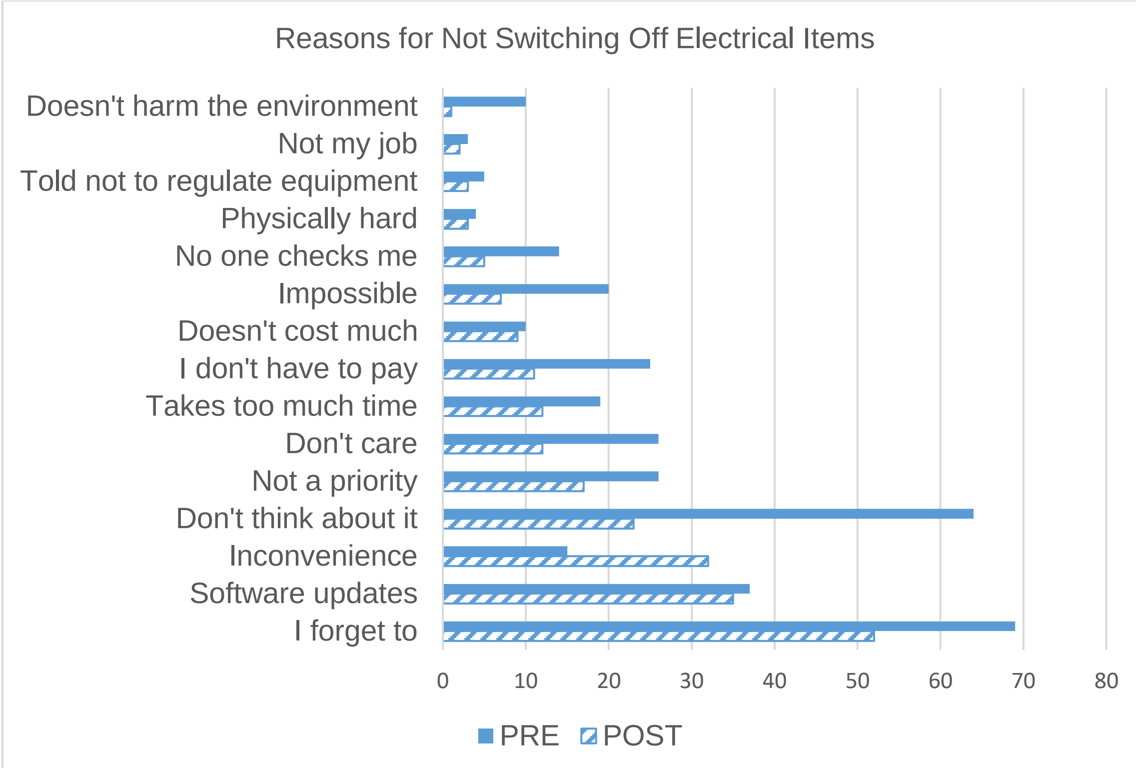


Figure 31 - Case Study 3 Comparison of Reasons for Not Switching Off Electrical Devices

Meter readings. Electricity metering equipment was installed in the selected case study areas of the camp at the beginning of July 2019. The data were recorded on data loggers, which were downloaded and sent by Canadian military personnel at the camp on a weekly basis by email directly to points of contact at 1 Engineering Support Unit (1ESU)[53] and NRCan. The baseline data was collected from Week 28 (8th July 2019) to the end of Week 35 (1st September 2019), with averages calculated for each EnPI for this period to compare with the post-change EnPI data, which was taken during Week 45 (4th November to 11th November 2019). For LSA1, electrical usage was divided into two groups; Ablutions (bathrooms) and Tents (accommodation). For Building 73 and the Gym, electrical usage was not divided into any sub-groups.

The key findings of the pre and post-change meter data are presented below.

- The baseline data showed a noticeable increase in demand and consumption in the Tents of LSA1 on 27th and 28th July. When examined alongside available weather data, this corresponded to an increase in space-cooling due to high temperatures. This effect is illustrated in Figure 32. There was also an increase in both peak kW demand and kWh consumption for the Tents of LSA1 beginning in

[53] 1ESU are a CAF unit based in Kingston, Ontario, Canada. 1ESU have been collecting meter data from a range of sites where there are Canadian military in order to better inform camp planning.

Week 38. This was attributed to the usage of space-heating commencing at the end of September, as well as an increase in occupancy rates.

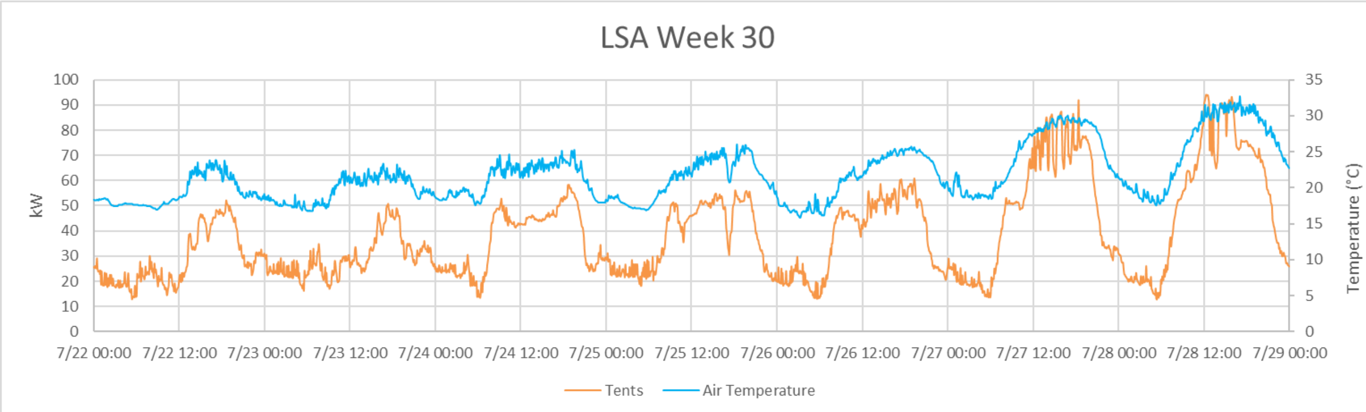


Figure 32 - Case Study 3 Week 30 Electricity Demand and Temperature

- During the baseline period and for much of the implementation period, the Gym showed little variation in either electrical demand or consumption, with weekly-average daily peaks ranging from 17.4 to 18.6 kW and weekly-averaged consumption between 393.4 and 409.5 kWh/day. This indicates that the facility had a nearly constant power draw during these weeks. There were daily variations in power demand corresponding to operating hours.

- Building 73 consumed approximately 66% less than the tented area per person (between 50% and 80% on a weekly basis depending on weather). This comparison can provide justification for moving into available containerized / rigid, or permanent, infrastructure from a tented area as soon as possible in order to conserve energy. While tents play a role in short deployments, the use of containerised / rigid, or permanent, infrastructure solutions should be considered for longer duration operations.

- The pre and post-change meter data for each EnPI are presented below in Table 9. The pre-change data were collected during the summer season (July and August 2019), when no heating or cooling equipment was used. The post-change data were collected during the late autumn season (November 2019), when temperatures had dropped and newly installed heating units were turned on in the areas under investigation. It is not possible to isolate the data related to the heating units to be able to conduct a true comparison agnostic of season and weather variation, therefore the figures presented in Table 9 show an increase in energy use in the post-change condition.

Table 9 - Case Study 3 Pre and Post-Change EnPI Data

	EnPI	Pre-Change	Post-Change
1	Average daily kWh/pp for LSA1 pw	3.22	4.5
2	Average daily kWh/pp for Building 73 pw	1.26	1.8*
3	Average daily kWh/area for LSA1 pw	1606.62	2311.3
4	Average daily kWh/area for Building 73 pw	383.69	550.1*
5	Average daily kWh/area for the Gym pw	399.2	359.1
6	Average daily peak kW/pp for LSA1 pw	0.25	0.31
7	Average daily peak kW/pp for Building 73 pw	0.16	0.20*
8	Average daily peak kW/area for LSA1 pw	124.13	156.10
9	Average daily peak kW/area for Building 73 pw	49.1	62.0*
10	Average daily peak kW/area for the Gym pw	18.0	17.5

**Week 44 data used, Week 45 data unavailable.*

Assessment of the Implementation of Recommendations. Table 10 presents summary assessments of each of the three recommendations delivered to the Case Study 3 audience at eFP Latvia.

Table 10 - Case Study 3 Summary Assessment of Recommendations

No.	Assessment of Recommendations
1	*Commander to specifically allocate an Energy Manager.*
	This recommendation was fully implemented, however due to the rotation of troops during the case study, there was one person in the Energy Manager role for the baseline data collection period, and another person took over from the beginning of the implementation period. Comments on the Energy Manager role relate to experiences of the second Energy Manager, who was in the role for the longer period of the two. It should be noted that a lack of end-to-end involvement in a process often hinders effectiveness. Without prior energy management training, the Energy Manager 'learnt on the job'. In the absence of a designated Energy Manager, it is very likely that no energy management recommendations would have been tested. Some possible energy management training was known of (although not experienced) by Canadian NSE staff at eFP Latvia. In order of depth of

No.	Assessment of Recommendations
	knowledge, the training courses identified were; the online NATO ENSEC COE Advanced Distributed Learning (ADL) course on energy security, the NRCan course on energy metering and monitoring, and the NATO ENSEC COE Energy Efficiency in Military Operations Course (EEMOC). However, without a mandate to have deployed Energy Managers within the CAF, these courses are not routinely attended. Both consecutive Energy Managers involved in the research at eFP Latvia were unfamiliar with these training materials. The (main) Energy Manager was a dedicated OF1 whose main duties were in the area of engineering and managing technicians, with the Energy Manager role a secondary responsibility. It was offered that an Energy Manger should have experience and expertise in engineering, infrastructure, or construction. However, it was also highlighted that the Energy Manager can equally rely on technicians that they work alongside in the Sustainment Engineer Troop to fulfil energy management tasks. It was considered that allocating 20% of work load to energy management was not sufficient; in particular it was stated that much more time is needed for energy management at the beginning of a deployment, in order to develop a thorough understanding of the energy situation. It was suggested that a more realistic estimate is 25-50% of one person's daily work routine allocated for Energy Manager duties. It was also proposed that energy management is not only the responsibility of those working in J4 roles, as it is something that affects the full J1-J9 spectrum. For Canada, there is no national directive to explicitly engage in energy management on operations yet and, if / when there was, it would need to come via CJOC to Task Forces. However, Task Forces can request support when needed, such as for a full time Energy Manager. In the absence of top-down (push) tasking at present, the bottom-up approach (pull) by requesting energy management staff is a worthwhile alternative. One further idea was proposed; to have regional Energy Managers. Again, in the absence of direction and / or manpower for full time Energy Managers at deployed camps, this may also be a valuable alternative.
2	*The NSE to task the development and implementation of last-person out checks.*
	Laminated last person out checks were developed and added to the entry doors at each end of each accommodation tent in area LSA1. It was said that welfare areas already have instructions for this type of action, but that it was more difficult to control in accommodation areas due to the need to respect

No.	Assessment of Recommendations
	privacy in individual / curtained-off areas (i.e. it is not always obvious if you are the last person to leave an accommodation tent). Although spot checks were not carried out during the case study period, it was said that there was no reason why they could not be done as standard tasking. Another barrier to last-person out checks identified was the problem of language differences, which is particularly pertinent in NATO camps with numerous nations contributing troops with differing levels of a common working language. Where possible, the format of last-person out checks should be more visual than written. It was found that the duty staff SOP does not mention doing anything about heating, lighting, or computers. The duty staff SOP is something that could be updated to support energy management requirements.
3	*Gym staff to review plans and procedures, and to update where relevant.*
	This recommendation was not implemented during the case study period. However, upon presenting the possible savings of closing the gym between midnight and 05.00 to the Canadian Commander of Task Force Latvia, the Commander expressed a desire to try this in the near-term.
4	*Create reminders to drive the desired behaviour of switching off items when not in use.*
	A Task Force Standing Order (TFSO) about the need to switch off unused items was drafted during the implementation period of the case study, however it was not approved by the relevant chain of command and disseminated before the end of the case study period. Therefore, its utility cannot be fully assessed. It was said that, currently, reminders tend to be reactive rather than proactive. It was also said that information about the need to switch off unused items (including the benefits mentioned in Section 3 of this report) could be added to the in-processing briefing. Instructions on how to clean the filters of the new heating units had been sent by email to personnel living in LSA1 tents, this supports the notion that people need the capability (e.g. knowledge, instructions, training) to be able to conduct a behaviour.
5	*Commander to ensure cooperation of energy management staff with relevant POCs of other eFP Latvia contributing nations.*
	While this recommendation was not fully implemented during the case study period, it was identified that energy management could be added to the agenda points discussed at both the ‘multinational logistics briefings’ and the ‘Senior

No.	Assessment of Recommendations
	National Representatives (SNRs) HQ meetings', both of which take place once per week. However, it was recognised that some nations do not have an equivalent to an Energy Manager or an 'Engineering Services' unit in their respective NSEs, because the responsibility for such services lies only with the lead nation of the eFP (i.e. Canada, in this case). It was also commented that, without a NATO standard on energy management agreed by nations, it would be difficult to encourage nations to introduce such a role in their postings.
6	*CIS authority to confirm when IT software updates need to be done - eFP Latvia staff to adapt IT habits as a result of the information.*
	The idea that computers need to be left on at all times for the purpose of receiving software updates may reflect outdated thinking and habits. For example, when computers are switched on they are given a 'boost' to proactively look for updates, and in other cases, updates can be scheduled to happen on specific days / times. During discussions with CIS personnel at the camp, it was clear that the true answer, and more importantly – reason - for whether computers should be left on or switched off was unknown. Similarly, any relevant policy or SOP could not be easily located. Therefore, people were reluctant to switch off in the absence of information that they were permitted to do this. Further discussions on this topic took place with staff from CJOC, and at the time of writing the definitive answers to the following questions were unknown: • How often, or on average, are software updates sent from Ottawa (CJOC) to eFP Latvia? • Are updates scheduled? • Can updates be scheduled? • Is information given to the camp about when to expect an update to be pushed down? • Are there any security reasons for never switching off or rebooting computers? • Are there any SOPs related to switching off computers? The research team ran a simulation to ascertain the savings of turning desktop computers off over the weekend, compared to being in sleep mode from 18.00 Friday to 06.00 Monday. The results were as follows: • 4kWh (equivalent to 1.2L of fuel) saved per desktop per weekend • 120L of fuel saved for one camp with 100 desktops per weekend • 6240L of fuel saved for one camp with 100 desktops per year

No.	Assessment of Recommendations
	Upon presenting the possible fuel savings of switching off work computers over the weekend to the Canadian Commander of Task Force Latvia, the Commander expressed a desire to undertake this change in the near-term.

Conclusions

- The post-change data was collected during the late autumn season, when temperatures had begun to drop and heating was turned on in the areas under investigation. An increase in energy consumption was found in the post-change data, however this was almost entirely attributable to the non-heating baseline context versus the heating-on in the post-change period, where the electricity consumption of the heating sources could not be isolated within the configuration of the metering software. Seasonal and weather data is required to be able to make meaningful assessments of energy use per person and energy use per area. Additionally, meters should be placed on heating and cooling energy sources to be able to isolate this data from all other electricity being used when the case study period is less than 18 months.

- There were some positive changes in the behaviour-based data, such as increases in levels of awareness of energy saving initiatives at the camp across all rank categories, and increases in awareness within both people who feel they have a role to play in energy use and also those who feel they don't have an energy related role. There were also some interesting findings with regards to the effect of age on perceived importance of saving energy; in both the pre and post-change conditions, the two `er age groups showed higher levels of strongly agreeing with the statement that it's important to save energy, than the two older age groups. Additionally, the two younger age groups seemed to be more open to changing their opinions, whereas the pattern of responses for the two older age groups were much more unwavering. In terms of the COM-B model, more time is needed for implementing change for it to have an effect on the three core elements of behaviour and change people's routines.

- The two Canadian Battle Groups involved in this case study (one during the baseline data collection phase and the next rotation for the remaining phases) were said to be from culturally different areas of Canada. The first group were mainly from the predominantly pro-environmental Quebec province and anti-Trans Mountain oil pipeline expansion project, which is somewhat of a polarising topic for some Canadians. Whereas, the second group were mainly from the predominantly western pro-oil provinces, where the Trans Mountain oil pipeline is mostly championed. Prior opinions on energy use, based on socio-political domestic settings and experiences, are likely to carry through to opinions on energy use in the work environment.

- During the running of Case Study 3, it was announced that the CAF had rolled out Energy Managers across all domestic military bases. Additionally, the Canadian Commander of Task Force Latvia expressed considerable interest in some of the preliminary results of the data analysis conducted by the research team, to the point where it may influence near-term decisions. Furthermore, it is Canada who have led the way in investing energy metering and monitoring technology and expertise at numerous military camps where they have forces, but they have also made these investments in camps where there are forces from other nations and no Canadian forces. These positive signs from Canada testify that, among NATO nations, they are leading the way in energy management research and application.

8. Recommendations

Three case studies were conducted in order to investigate energy management practices for the military in deployed environments. Conclusions were identified for each individual case study, the combination of which contribute to the overarching list of recommendations presented below.

1. NATO should develop an energy management handbook based on the results, conclusions, and lessons learned during this series of case studies. It is recommended that the handbook is developed in cooperation between the NATO ENSEC COE and NATO MILENG COE.[54] Military personnel should be involved in the writing phase to ensure validity, relevance, and applicability.

2. NATO should develop an energy management training course for military personnel, focused on energy management on deployed operations. This could be led by the Education Training and Exercise Division (ETED) at the NATO ENSEC COE, with contributions from the MILENG community.[55] A Training Needs Analysis (TNA) would inherently be conducted before designing a course, but it is suggested that the training should, at least, include coverage of the following topics:

    a. Conducting a camp energy audit.
    b. Establishing an energy management baseline.
    c. Developing obtainable EnPIs.
    d. Writing energy related SOPs.
    e. Data reporting processes.
    f. Identifying areas of improvement.
    g. Energy management handover requirements.

3. Future energy management projects at operational military camps should be led by the internal military chain of command, with NATO ENSEC COE taking an advisory role, if required. Energy management projects must have explicit buy-in from the Commander, or equivalent, to ensure top-down direction, and a trained Energy Manager must be assigned.

4. Any future energy management research studies should cover a minimum period of 18 months, to allow for at least one season to be repeated and compare like-for-like data. Alternatively, if an 18 month study is not possible, increase sub-

[54] As Canada have experience and expertise in the topic of military energy management, contributions from Canadian entities, such as NRCan and CJOC, would be greatly welcomed and beneficial.
[55] As per the comment in footnote 54, NRCan would be an ideal contributor to the development of an energy management training course, as would the Energy Academic Group from the US Naval Postgraduate School (NPS).

metering to be able to capture specific heating and cooling sources. This will aid normalising data and help to better identify trends. Sub-metering is even more relevant for locations where both heating and cooling is required. The use of a local weather-station can also help with the normalisation of data and identify specific climate-driven trends. Using weather data available online is often insufficient as a timestamp of five minute intervals is required to identify energy consumption trends.

5. Energy management considerations should be planned proactively during the camp design stage and not reactively once on deployment. Simulation tools, such as the Canadian-developed ‘Forces Operational Resource Calculator for Energy (FORCE)-SIM’[56] can predict and prevent energy management issues before even reaching the field, such as identifying when diesel generators are too large for the context of the camp based on the known size and climate.

6. Energy management decisions on military camps should be supported by external Subject Matter Experts (SMEs) to verify military plans before investment decisions are made. For example, SMEs can provide advice on the most suitable technology to use in different climates.

7. It is vital to have access to data on two context related variables; occupancy numbers (for example, to work out accurate kW/pp and kWh/pp) and climate data.

8. The optimum meter data time-step interval is five minutes (anything shorter than this, such as one minute, is not needed), this should be programmed into energy metering equipment installed.

9. Meter data collection can be facilitated through wireless connection and the security risk is low because, based on the metering technology used in the present research, the equipment is non-intrusive and stand-alone, allowing for data to be pulled and nothing to be pushed.

10. Energy management processes should be standardised across nations, to support interoperability between nations.

11. NATO should develop a certification scheme to assess, on a voluntary basis, the level of energy management at deployed operational military camps. This would increase the extent of motivation of key participants.

[56] FORCE-SIM has been developed by NRCan. Additionally, NPS have a similar Excel based capability, and NATO has a ‘Zero-Footprint Calculator.

12. As energy behaviour change is low cost and can take place in a shorter timeframe than some technology or investment solutions to energy problems, NATO should undertake an activity to identify areas of energy behaviour change ‘quick wins’.

ANNEX A: 7 Steps to Energy Behaviour Change (7SEBC)

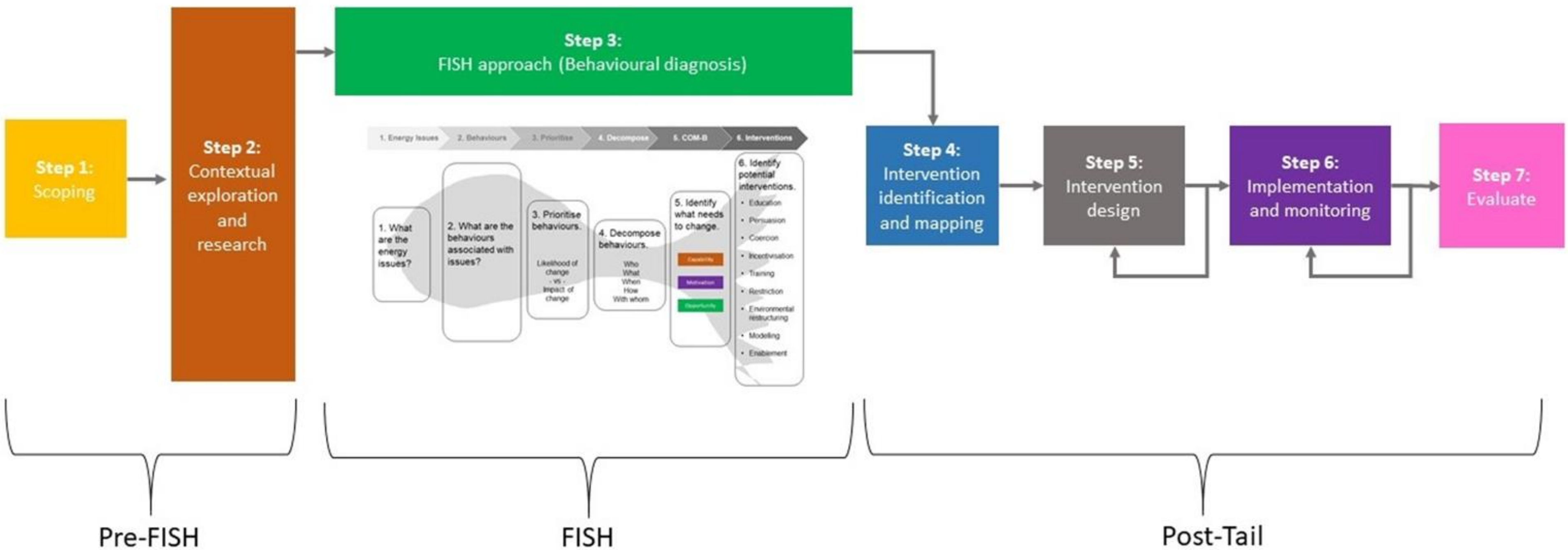


Figure 33 - 7 Steps to Energy Behaviour Change

The UK MOD developed the 7 Steps to Energy Behaviour Change (7SEBC) process; combining the most pertinent factors from a three year research project, the 7SEBC process provides a practical alternative to the wide range of existing behavioural models and theories available in the literature whilst maintaining an underpinning theoretical model of behaviour. For more information, contact Jennifer Doran at: jldoran@dstl.gov.uk.

ANNEX B: Questionnaire Template

NATO ENSEC COE
Project: Energy Management in a Military Expeditionary Environment
Questionnaire: Attitudes Towards Saving Energy on Operations

A. Background and Instructions

The survey aims to identify important information about how we can manage energy in the most effective manner. The survey will take about 5 minutes to complete. Your responses cannot be individually identified. Please complete this survey with reference to your current role. For the purpose of this survey the term ‘energy’ includes all liquid fuel, gas and electrical power.

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)

1 Completely dissatisfied	2	3	4	5	6	7	8	9	10 Completely satisfied

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

Accomm-odation	Medical Centre	Flight Operations	Operational Security	Logistics (J4)	Laundry	Kitchen	*

*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

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

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 physical 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

☐ 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.

ANNEX C: Observation Audit Template

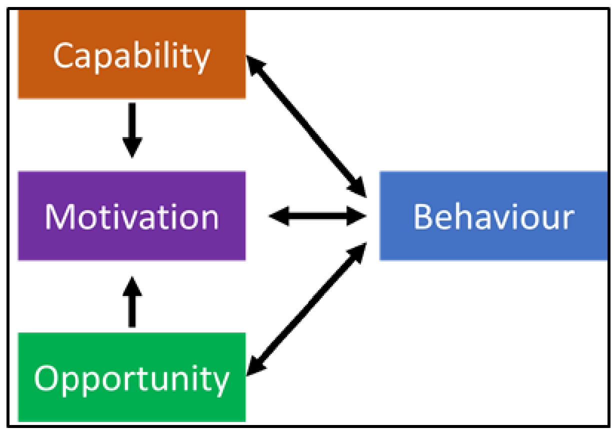
Date:		Observer Initials:		Photo Reference:	

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

No.	Context	Observation Description		
10	Does the behaviour relate most to a lack / evidence of: CAPABILITY (C) OPPORTUNITY (O) MOTIVATION (M) (Please circle)	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 component	Definition
Capability	Physical: having physical skills, strength or stamina
	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, physical barriers
	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)
	Automatic: processes involving wants and needs, desires, impulses and reflex responses.

ANNEX D: Example Completed Observation Audit

Date: 20180302 **Observer Initials:** VR **Photo Reference:** Attached

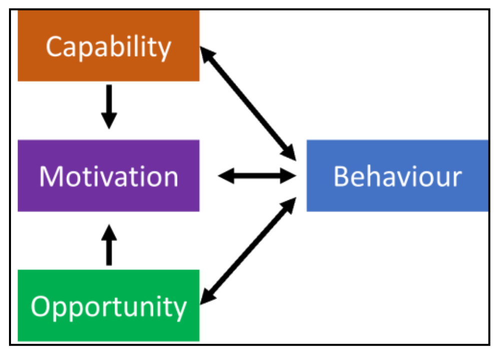
No.	Context	Observation Description	
1	What is the behaviour?	Seldom cleaning/changing of the air filtration of the tent A/C units.	
	What is the frequency of the behaviour? (Please circle)	LOW / MEDIUM / HIGH	
	Is the behaviour positive or negative? (Please circle)	Positive	Negative
2	When: what time of day did you observe the behaviour?	This is a lack on maintenance. In the dry hot season, the wind is filled with dust and sand particles that clog up the air filters. They need to be cleaned regularly to ensure efficient and prolonged usage.	
3	Where: what is the location / building? (If possible, highlight on a map)	Tent area	
4	Who: personnel type / role? (Do not provide names)	Refrigeration specialist (Technicien Froid/Chaud)	
5	What: describe the equipment type.	Tent A/C units	
6	How: how is the energy being used? (e.g. messing, hoteling)	The energy is behind wasted trying to push air through an obstructed air filter. The accommodations must be kept cool for comfort.	
7	Why: define the reason for behaviour. (e.g. your interpretation OR ask the person doing the behaviour)	The inaccessibility of the A/C units is to blame for this behavior. The size and weight of the units do not allow them to be moved by a single person. Therefore, no one goes to inspect/clean the filters on a regular basis. The cleaning only occurs once the unit is broken and taken out of place.	

<table>
<tr><th>No.</th><th>Context</th><th colspan="3">Observation Description</th></tr>
<tr><td>8</td><td>Any other relevant contextual information?
(e.g. are there any existing energy efficiency initiatives?)</td><td colspan="3">The interview with the technician revels that he is aware of the problem. The filters should be changed and they are quite easy to clean. A small training can be provided to the civilian cleaners and they are responsible for the daily maintenance.</td></tr>
<tr><td>9</td><td>Any other comments?
(e.g. capture best practice)</td><td colspan="3">The issue is the INACCESSIBILITY of the units. See attached pictures. It would be possible to place them in the rows between the tents with longer ducts.</td></tr>
<tr><td>10</td><td>Does the behaviour relate most to a lack / evidence of:

CAPABILITY (C)
OPPORTUNITY (O)
MOTIVATION (M)
(Please circle)</td><td>C</td><td>O</td><td>M</td></tr>
</table>

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.



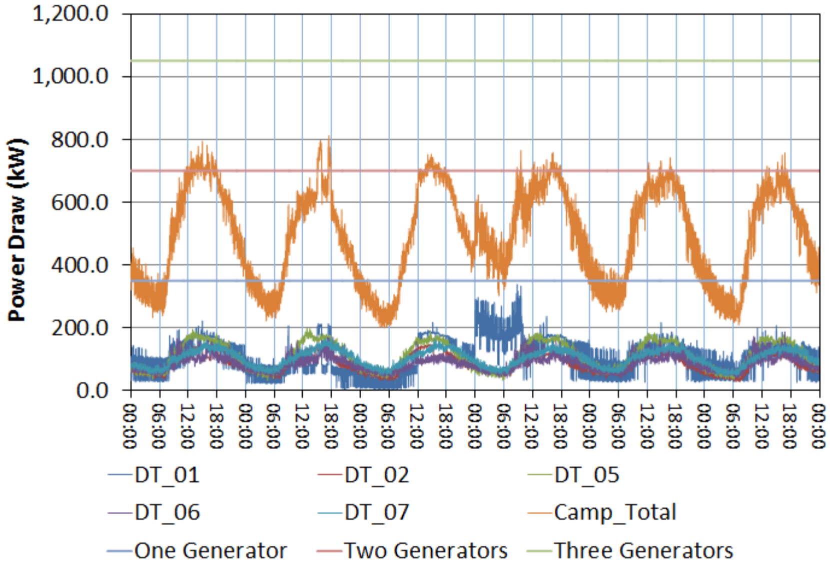
Q.10 COM-B Guidance:

COM-B component	Definition
Capability	Physical: having physical skills, strength or stamina
	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, physical barriers
	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)
	Automatic: processes involving wants and needs, desires, impulses and reflex responses.

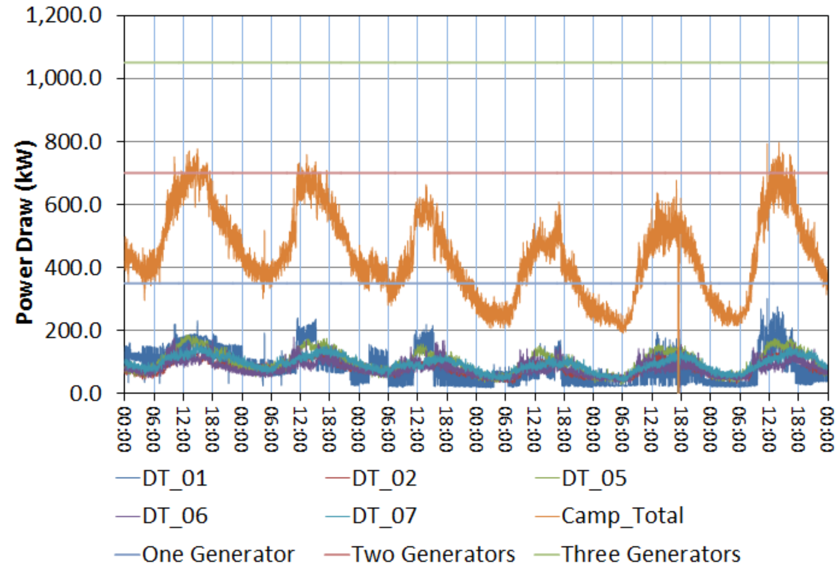
ANNEX D: Example Completed Observation Audit

ANNEX E: Case Study 1 – Baseline Meter Data

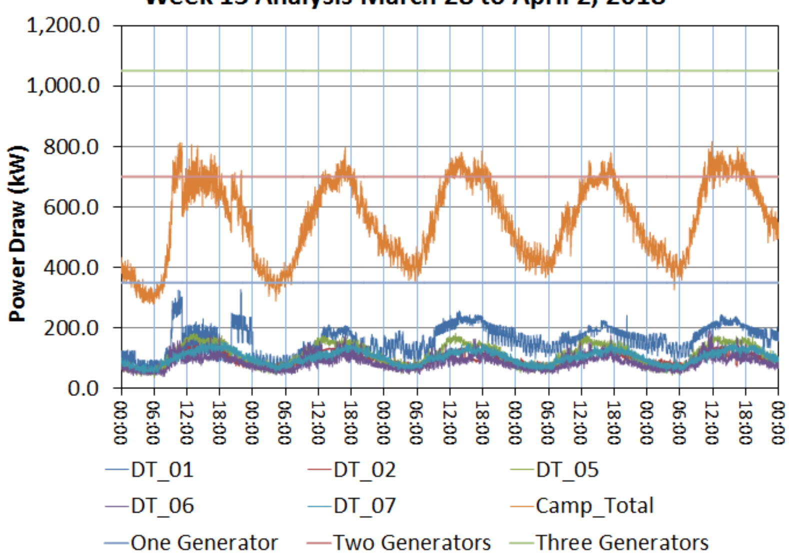
Week 11 Analysis March 13 to March 19, 2018



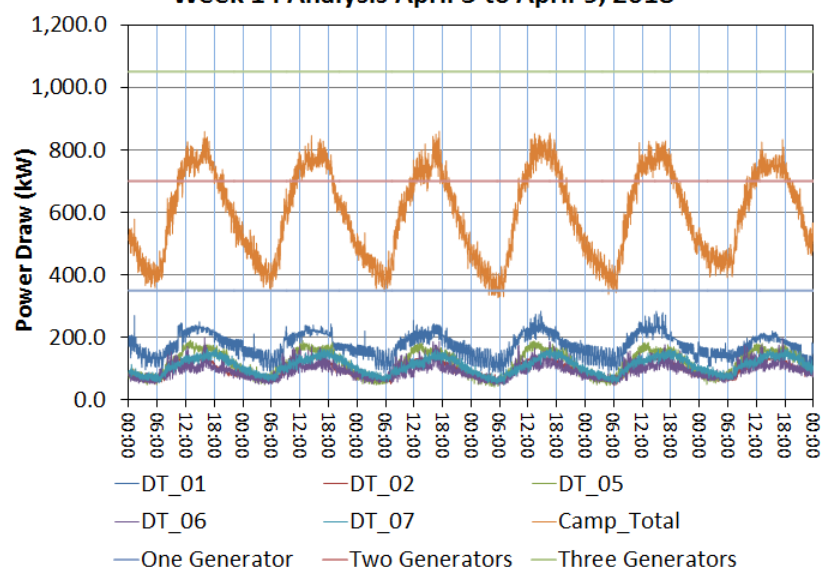
Week 12 Analysis March 21 to March 26, 2018

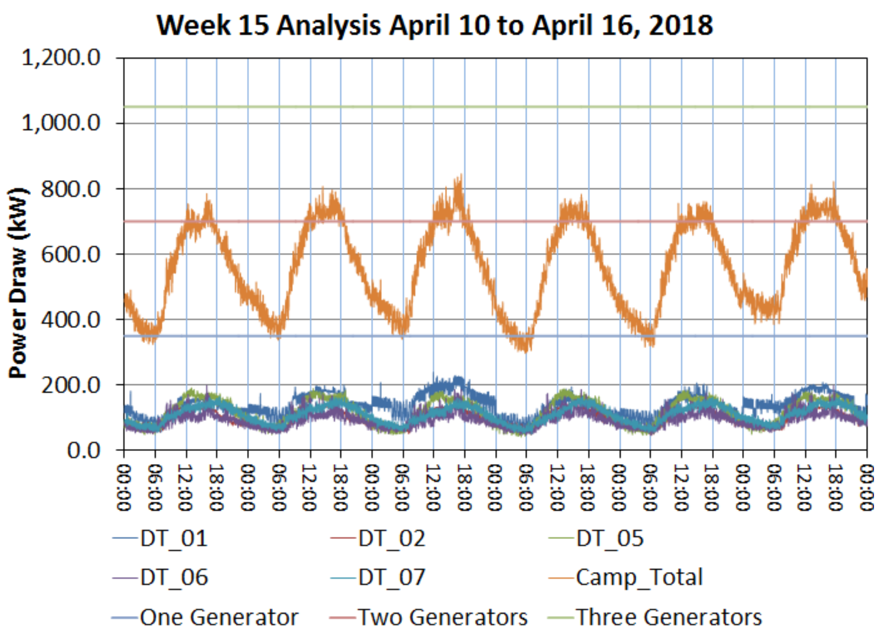


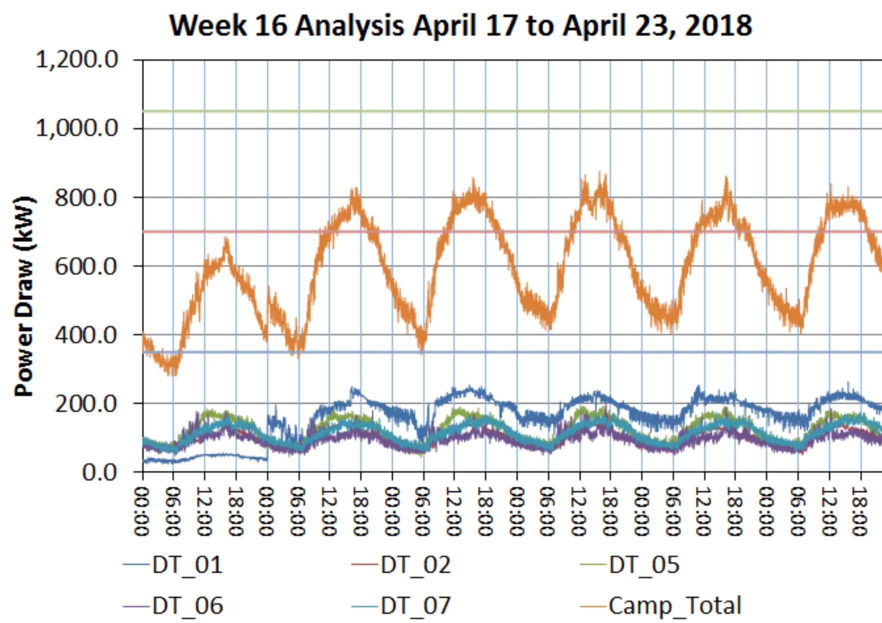
Week 13 Analysis March 28 to April 2, 2018

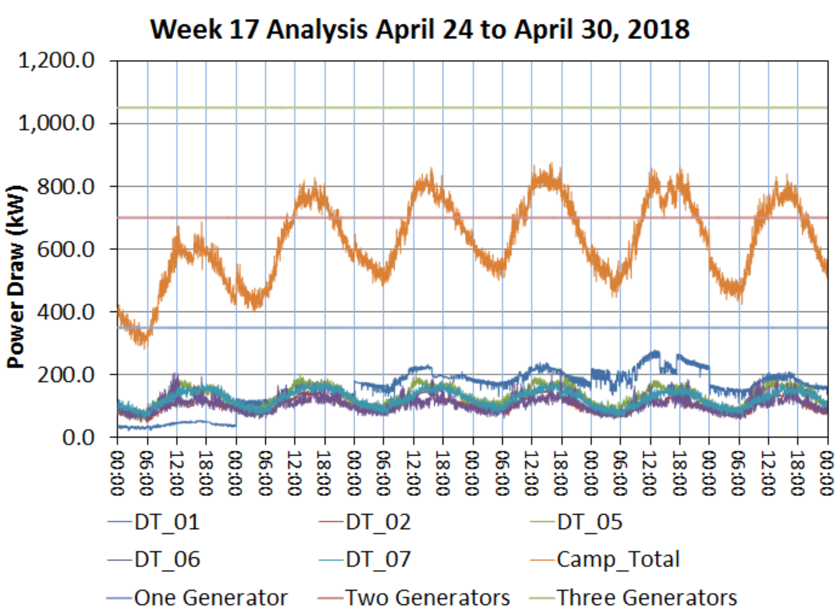


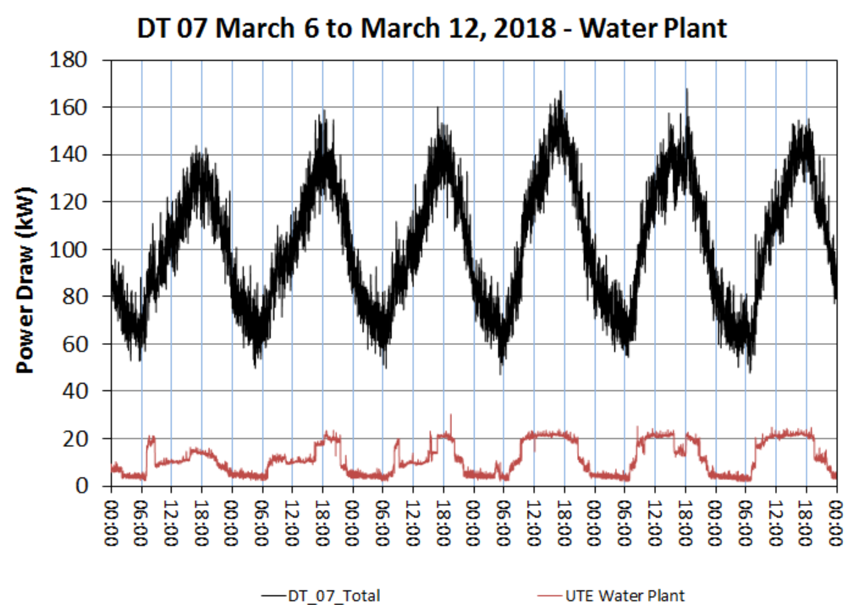
Week 14 Analysis April 3 to April 9, 2018

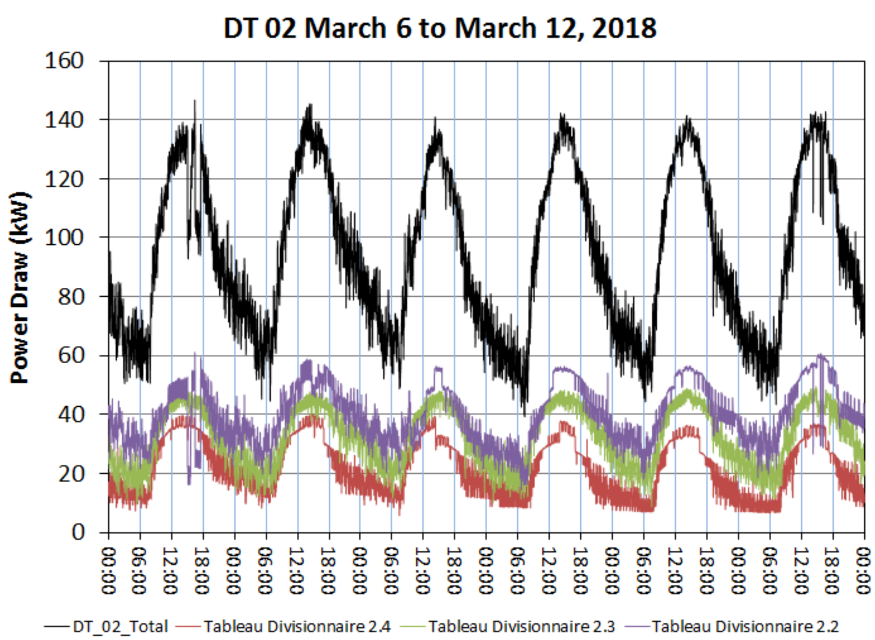


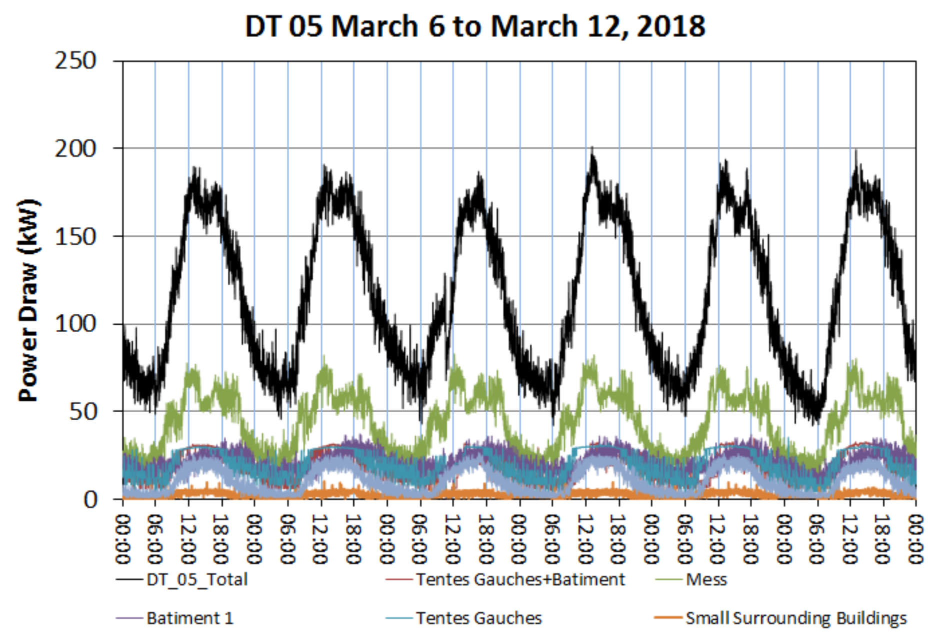

Week 15 Analysis April 10 to April 16, 2018
Power Draw (kW)
1,200.0
1,000.0
800.0
600.0
400.0
200.0
0.0
00:00 06:00 12:00 18:00
DT_01
DT_02
DT_05
DT_06
DT_07
Camp_Total
One Generator
Two Generators
Three Generators

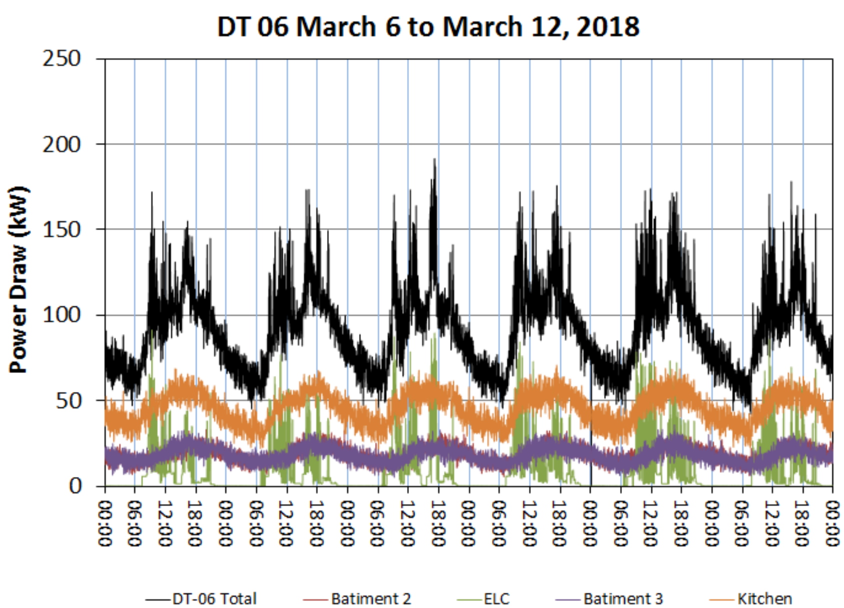

Week 16 Analysis April 17 to April 23, 2018
Power Draw (kW)
1,200.0
1,000.0
800.0
600.0
400.0
200.0
0.0
00:00 06:00 12:00 18:00
DT_01
DT_02
DT_05
DT_06
DT_07
Camp_Total

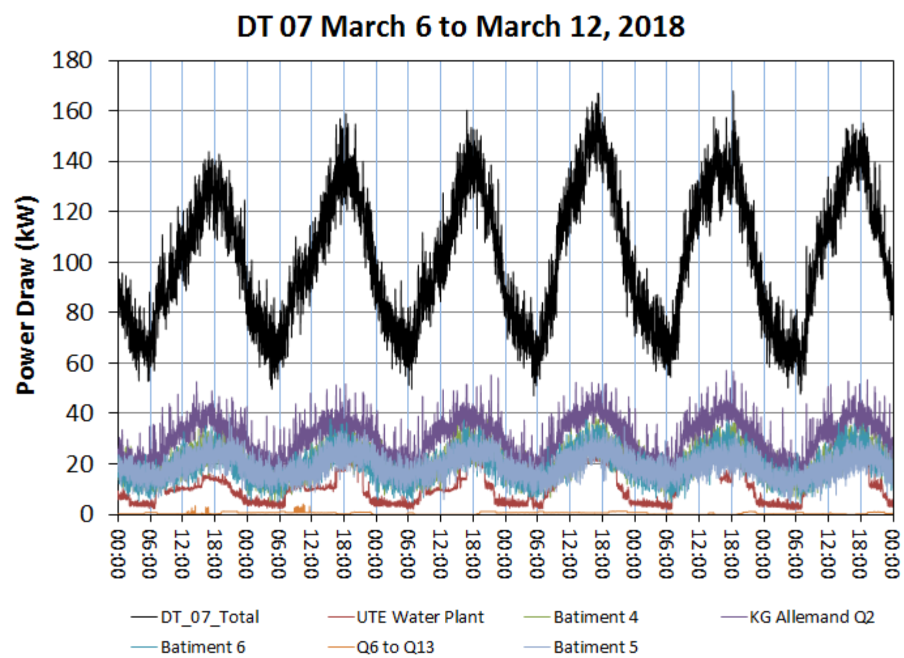

Week 17 Analysis April 24 to April 30, 2018
Power Draw (kW)
1,200.0
1,000.0
800.0
600.0
400.0
200.0
0.0
00:00 06:00 12:00 18:00
DT_01
DT_02
DT_05
DT_06
DT_07
Camp_Total
One Generator
Two Generators
Three Generators


DT 07 March 6 to March 12, 2018 - Water Plant
Power Draw (kW)
180
160
140
120
100
80
60
40
20
0
00:00 06:00 12:00 18:00
DT_07_Total
UTE Water Plant


DT 02 March 6 to March 12, 2018
Power Draw (kW)
DT_02_Total
Tableau Divisionnaire 2.4
Tableau Divisionnaire 2.3
Tableau Divisionnaire 2.2


DT 05 March 6 to March 12, 2018
Power Draw (kW)
DT_05_Total
Tentes Gauches+Batiment
Mess
Batiment 1
Tentes Gauches
Small Surrounding Buildings


DT 06 March 6 to March 12, 2018
Power Draw (kW)
DT-06 Total
Batiment 2
ELC
Batiment 3
Kitchen


DT 07 March 6 to March 12, 2018
Power Draw (kW)
DT_07_Total
UTE Water Plant
Batiment 4
KG Allemand Q2
Batiment 6
Q6 to Q13
Batiment 5

ANNEX F: Case Study 1 – Behaviour Change Action Plans

NATO ENSEC COE
EMMEE Project: Behaviour Change Interventions

Context

The French Ministère de la Défense (MOD) is committed to reducing fuel consumption and making the MOD more efficient, resilient and sustainable. As a result, the MOD is currently developing an energy management strategy which will be released in 2019. Whilst this strategy is being developed, the French MOD is supporting the NATO Energy Security (ENSEC) Centre of Excellence (COE) by taking part in the Energy Management in a Military Expeditionary Environment (EMMEE) project. This tasking from NATO Allied Command for Transformation (ACT) requires three pillars of work to be completed. They are:

1. Organisational issues for energy management (such as an adapted ISO 50,001 for expeditionary operations).
2. Technology recommendations that are suitable for the expeditionary environment.
3. Behaviour change to reduce unnecessary energy consumption.

Below, in this document, are four tactical level recommendations that have been identified as a part of the EMMEE project working with the French military in a deployed tier two camp in West Africa. Each of the tactical recommendations are supported by engineering and behavioural science and will save fuel; however, these recommendations should be viewed in the wider operational level context of energy management in order to make them more likely to be effective, more sustainable, and more likely to obtain the substantial fuel and cost savings that could be realised with a “campaign” level approach.

We recommend that for the behaviour, organisation and technology interventions to be embedded and for the substantial energy savings to be realised, there should be a wider energy awareness campaign to explain the unifying purpose of the energy saving measures. This will harness the benefits of the military approach to mission command, where personnel will behave in line with the higher intent and allow more substantial energy savings to be made. Analysis from a survey of camp personnel suggests that junior officers and NCOs have significantly lower awareness and motivation regarding energy efficiency and that any energy efficiency campaign should particularly target this group.

It is expected that if all four interventions are implemented effectively as part of a wider energy management strategy, the associated benefits to the camp will be as follows:

1. The generators will need to be refuelled less often.
2. The generators will need to be maintained less often.
3. The electrical supply will be more resilient/reliable as the camp will not demand more electricity than the generators can supply.
4. The quality of the environment will be improved by a reduction in noise.
5. Potential increase in operations undertaken because more fuel will be available for flight operations.

The French MOD benefits from this successful intervention as follows:

1. Substantial costs savings. This could be in the region 15-40% because of the stepped nature of generator supply (e.g. small increase in demand requires another generator to be switched on resulting in two or three inefficiently operating generators rather than just one or two at their most efficient level).
2. Reduced logistics burden for support services. Fuel shipped to the location will be used for operations and not for “hoteling”.
3. Increased resilience of African operations as there is a reduced requirement for fuel for ‘hoteling’.

1. Use available shades to reduce heat on air conditioning and refrigeration units

Reason for change

Effective shading needs to be provided on cooled areas (i.e. gym area, ammunition storage, and outside refrigeration containers) and over AC units. Additionally, shades could be used on walk-ways between tents and buildings.

Figure 1: Example areas to be shaded

Military engineers specialising in energy consumption have estimated that each 20ft refrigerated container (e.g. freezer and other cooled containers (i.e. ammo containers) that maintain temperatures between approximately -20C to +25C) will require approximately 16,000 Litres (L) of fuel to run (55,000 kWh of electricity) over the entire year. No specific studies have been conducted into the efficiency of shading for outside refrigeration, but research indicates that 15% to 20% reduction in the air conditioning load of accommodation shelters can be achieved with solar shades. Based on engineering research and the amount of fuel required to run a refrigerated container, it is anticipated that 3,000 L of fuel savings can be made over the year for each currently unshaded 20ft refrigeration system and 1,500L for the smaller walk-in bottled water refrigerators. Likewise shading the air conditioning (AC) units or walk-ways between tents will avoid overheating cooling units resulting in efficient operation or cold air rapidly escaping the shelters when opened.

Intent

Make large energy savings by erecting simple solar shades that prevent direct sunlight heating the refrigerating containers and A/C units.

Benefits

- Return on investment is estimated to be high and quick. The saving from erecting simple solar shades will be approximately €3,600 per year (3,000L per shaded container at €1.2 per litre of fuel = €3,600)[57]. It estimated that the material cost of shading, if sourced locally, will be low hundreds of Euros (cost obtained from web prices in West Africa).
- Fuel savings estimated to be 15-20%.
- Improve well-being and comfort levels for personnel.
- Logistic footprint reduced (i.e. less fuel used and potentially fewer fuel convoys required).
- Noise reduction.
- Reduced corrective maintenance as a result of less mechanical failures.

[57] Assuming that current air conditioned buildings and/or fridges are not currently shaded.

- Aid in reducing the peak electrical demand of the camp resulting in a third generator from starting up.

Recommendations for the camp

#	Recommendation	Remarks
1	French MOD and Camp Commander should state their approval and the requirement for shading to relevant camp personnel.	-
2	Identify the areas, containers and equipment to be shaded.	Suggested priority: AC units for tents, cooled containers and AC on buildings, then walk ways between tents.
3	a) Define the timescales for start/completion. b) Identify additional time and/or manpower and/or materials needed to support the existing personnel to construct the shades, including a cost estimate.	Most effective is sandwich foam sheet, and other options are corrugated metal and netting. Consider using local contractors.

2. Move AC units for tents and buildings to enable maintenance

Reason for change

Approximately half of the camp AC units (approx. 25) are in the tented area and many AC units on the permanent buildings (approx. 10) are situated in the sun with no shade. Additionally, many AC units are inaccessible and so personnel cannot clean the filters or outdoor coils.Moving AC units out of the sun (or providing shading) could provide fuel savings of 15% to 20% and would enable personnel easy access for weekly cleaning of AC filters and other preventative maintenance tasks. The AC units could be placed in the wide walkways between tents with solar shading constructed above them[58].

Figure 2: Inaccessible AC units

Intent

Move AC units in tented area to enable access for regular preventative maintenance and easier repair.

Benefits

- Return on investment estimated to be high as the cost of moving units is low and the cost of electricity from inefficient air conditioning units is high.
- Fuel savings estimated to be 15-20%.
- Reduction of time out of action after failure.
- Mean time between failures is greater.
- Less down time when off.
- Improved personnel comfort.
- Facilitate/enable maintenance, including preventative maintenance and filter cleaning.
- Reduce maintenance costs.
- Improved airflow.
- Reduction of peak electrical demand aiding in avoiding the use of a third generator during the hottest periods.

Potential issues

- Health and safety approval to place AC units in walkways between tents.
- Moving the wall mounted AC units requires the AC technicians support.
- Solar shades must be erected high enough to ensure proper air flow circulation.

[58] Note: Each A/C unit weighs approximately 200 kgs.

Recommendations for the camp

#	Recommendation	Remarks
1	French MOD and Camp Commander should state their approval and the requirement for the AC moves.	-
2	a) Define the timescales for start/completion. b) Define the resources required for AC unit moves.	Moving the AC units in the tent area is either a 4 man lift or done using lifting equipment.

3. Clean AC filters and coils

Reason for change

AC units get full of sand which makes them less efficient and increases the likelihood of equipment break downs[59]. Both the coils and filters require regular cleaning. There are currently only two specialist technicians, and it is thought they are only able to work on reactive, rather than proactive, maintenance of AC units. An occupied shelter with a fully functioning (clean) AC will require about 55,000 kWh of electricity per year (16,000 L of fuel). An estimate by NATO military research engineers based on loading HVAC filters in building HVAC systems, suggests that a 10% decrease in capacity can occur due to a clogged filter or coil. It is estimated that more than 1,600 L of fuel could be saved annually per air conditioning unit.

Intent

Clean tent and permanent building AC filters weekly, and coils monthly, to increase efficiency and reduce breakdowns[60].

Benefits

- Return on investment is estimated to be high[61].
- Reduction of time out of action after failure.
- Mean time to failure is greater.
- Increased personnel comfort.
- Reduced maintenance costs.
- Improved airflow.
- Contribution to reducing peak electrical demand achieving greater energy savings and less generator maintenance.

Recommendations for the camp

#	Recommendation	Remarks
1	French MOD and Camp Commander should state their approval.	-
2	Set up demonstrations of how to clean the AC filters for permanent personnel (or those assigned to the task).	Technicians could provide this during in processing of personnel to the camp.

[59] Note: many AC filters are current inaccessible (see Move AC units).
[60] The outdoor coil heat exchanger should also be periodically washed/rinsed to improve efficiency.
[61] There are approximately 50 AC units on the camp and each unit is thought to use approximately 16,000L of fuel per year. Regularly cleaning the filters and cooling coils has been estimated by NATO military research engineers to save approximately 1,600L of fuel per unit. This could save up to 80,000L of fuel per year. If these assumptions hold true this could save approximately €96,000 per year, assuming that fuel costs €1.2 per litre.

#	Recommendation	Remarks
2	Instructional media (e.g. information sheet) should be placed in tents. This information should highlight the benefits.	Transient personnel should be provided with guidance to check the AC filter that includes photos of filters full of sand with the instruction "if the filter looks like this please report through your Chain of Command".
3	Provide prompts at the permanent buildings AC controls that include information about: • When the AC filter was last cleaned. • When the AC coil was last cleaned. • How to inspect and clean the filter. • How to inspect and clean the coil, including where to obtain the necessary equipment. • The benefits of weekly filter cleaning and monthly coil cleaning.	-
5	Create a weekly schedule for permanent and tented area AC filter cleaning and a monthly schedule for AC coil cleaning. This should be monitored by assigned personnel.	-
6	French MOD and Camp Commander should state their approval and the requirement for the weekly cleaning of AC filters.	-

4. Tent scheduling to maximise energy efficiency

Reason for change

Some tents at the camp are in a better state of repair than others and this has an impact on their energy efficiency (e.g. a broken shade can result in an additional 20% of fuel being used). Identifying the most energy efficiency tents would enable those tents to be allocated more effectively to personnel on arrival. In addition, ensuring personnel are optimally allocated and grouped together (i.e. avoid 1-2 personnel per tent) would allow unused tents to have the AC switched off when not in use[62].

An unoccupied tent with the AC left on at 25°C, will require about 16,000 L of fuel per year (55,000 kWh of electricity). An unoccupied tent with the AC temperature set to 40°C will require 13,000 L of fuel (45,000 kWh of electricity). That is with the AC unit running in stand-by mode the entire time (there is some significant energy consumption associated with that according to some testing on the Canadian Units). If the AC unit is off in an unused tent, savings would be 16,000 L of fuel per year. In addition, there may be opportunities to reduce the generator load during the day when tents are unoccupied, potentially allowing one less generator to be used.

Tents should be classified in the following way:

A. Ideal: good solar shading, minimal air gaps.
B. Moderate: some air gaps and some shading.
C. Avoid: absence or broken solar shades, large air gaps.

When scheduling, tents classified as A must be full before anyone is placed in B-tents, and B-tents must be full before anyone is placed in C-tents. Classifying and scheduling tent occupancy in this way could lead to fuel savings of approximately 25% annually.

Intent

Use tent scheduling to prioritise which tents are used (i.e. use more efficient ones first) and how personnel are assigned to them.

When personnel leave the camp do not cool unoccupied tents until new arrivals are on camp.

Benefits

- Return on investment is thought to be high[63].
- Increased personnel comfort.
- Reduced maintenance costs.
- Improved safety due to less chance of fire.

---

[62] AC should only be switched off when the tent has no occupants, i.e. not when occupants are elsewhere on camp.

[63] There are approximately 25 AC units for tents in the camp and military research engineers have estimated that approximately 25% saving can be derived from efficient tent scheduling. The 25 AC will use approximately 16,000L each resulting in 400,000L of fuel and saving 25% of this could result in a saving of 100,000L of fuel which is priced at €1.2 per litre which could save €120,000. The cost of managing the scheduling is thought to be minimal as it is a process change.

Recommendations for the camp

#	Recommendation	Remarks
1	French MOD and Camp Commander should state their approval and the requirement for energy efficiency tent classification and scheduling.	-
2	Assess and classify each tent in terms of efficiency so that more efficient tents can be identified, and occupancy scheduled more effectively.	A. Ideal: good solar shading, minimal air gaps. B. Moderate: some air gaps and some shading. C. Avoid: absence or broken solar shades, large air gaps.
3	Add information to the camp map for use by occupancy schedulers and/or create a tool that assists with ensuring that tent allocation is done effectively (i.e. huddling personnel and avoiding 1-2 personnel per tent) and that the most efficient tents are used where possible.	-
4	Supplement the tent occupancy procedure with energy efficiency information, i.e. turning on/off AC when tent is occupied/not occupied.	-
5	Ensure that tent efficiency is factored into occupancy allocations.	-
6	Create a switch off procedure when tent occupants leave and the tent is checked by camp personnel.	-

5. Schedule the generator demand load in order to level the load

Reason for change

Currently the generators experience very high loading at midday with four generators running inefficiently. For energy security reasons, if the load of the first generator increases above 320kW[64] (80% of the capacity of a 400kw generator) a second generator will automatically start. When the second generator starts, the load of the first generator drops to half resulting in both now running at 50% efficiency. Often, 2-3 generators are running continually, but the load could be scheduled to reduce the generators required from 3 to 2 during the day and 2 to 1 at night. Scheduling or shifting the load to reduce the number of generators used could provide savings of 150,000 litres per year (based on typical generator efficiency curves[65]), per generator based on ten hours switched off per day.

Intent

Take the demand during peak hours and schedule it towards a time when there is spare capacity (i.e. level the demand curve).

Benefits

- The return on investment is thought to be very high[66]
- Saves fuel and therefore money.
- Less resupply convoys.
- Less maintenance tasks.

Recommendations for the camp

#	Action	Remarks
1	French MOD and Camp Commander should state their approval.	-
2	The water treatment process was typically operated during the period of peak electrical demand (Noon to 6pm). If the water treatment process could be conducted outside of these hours, a 15 kW reduction could be achieved.	Determine if it is feasible to use the water treatment plant outside of the Noon to 6 pm hours. Is their sufficient water capacity for 48 hours.

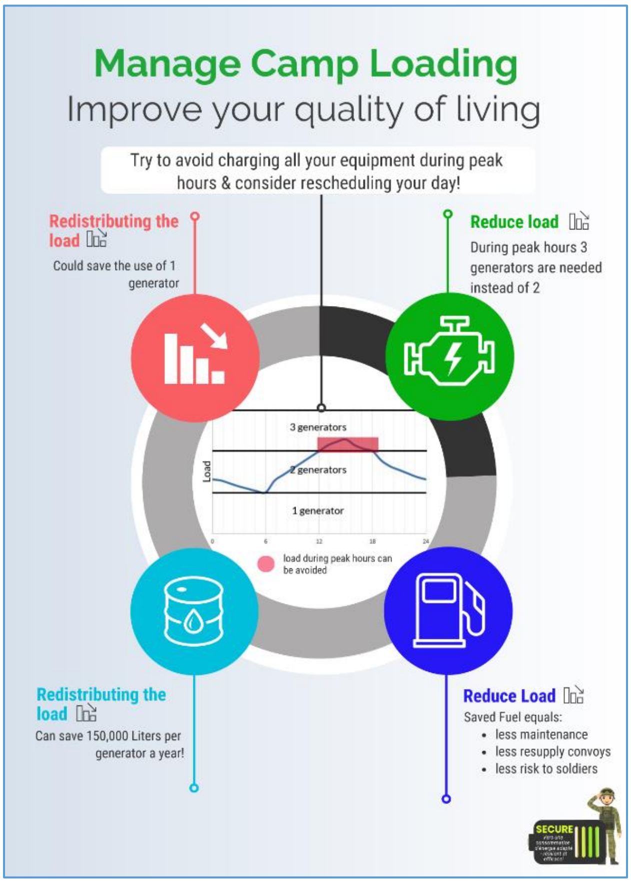
[64] The information highlighted in yellow will be checked and confirmed during the visit to the camp.

[65] A generator efficiency of 3.5 kWh/L is assumed at maximum operating capacity (100 L/hr) and 3.2 kWh/L at 50% to 70% of maximum operating capacity. Savings based on a reduction of 50 kW for five hours during the day and 50 kW for five hours during the night over the entire year.

[66] Load shifting the demand to reduce the use of additional generators could save up to 125,000L per year (€150,000 per year at a cost of €1.2 per litre) with very little cost. This would require a procedure change to move demand to low demand periods (night time when A/C load is least).

#	Action	Remarks
3	From metering the mess hall shows a high peak demand during the noon to 6 pm hours. In particular there is a high electricity demand from noon to 2 pm attributed to the high AC load caused by high occupancy. This load could potentially be shifted if the mess hall is pre-cooled before noon and thus the high heat gain from the increased load is anticipated. The doors to the mess hall should remain closed instead of kept open.	Implement a procedure to ensure the mess hall doors remain closed and determine if pre-cooling the space to 18degC is possible in order to anticipate the high heat gain caused by occupancy.
4	The refrigerated containers appear to have high peak electrical demands between noon and 6 pm likely attributed to refrigeration doors constantly opening and closing for food preparation. These spike could be shifted to earlier in the day if some of the food preparation can be conducted during the morning for dinner time, or food distributed to a smaller walk in refrigerator for dinner time preparation.	Determine the feasibility with the kitchen staff to see how entering and exiting the refrigeration containers can be accomplished during the peak demand period.
5	Air conditioning the shelters and buildings is the highest energy end use at the camp. Thus, peak electrical demand during the hottest period of the day can be reduced by ensuring unoccupied tents are not air conditioned or potentially thermostats set back to maintain the shelter slightly warmer during these periods. Significant electric demand reductions can be achieved with this.	Look into the possibility of implementing a thermostat setback control (each tent has an energy manager) and letting the tent stay slightly warmer during the day and then turning down after dinner for night time.
6	The generators are operated at a reduced capacity due to the high heat environment they are in. As such they are sequenced to bring on another generator every 350 kW of load. During the cooler period, the generators rating can be increased and thereby potentially avoid the need of a 2nd or 3rd generator from being brought on.	French MOD study the ability to upgrade the generator system during the cold season (e.g. 400KVA to 450KVA).

ANNEX G: Case Study 1 – Awareness Raising Material[67]



[67] These posters are also available in French, upon request.

ANNEX H: Case Study 2 – Recommendations and Guidance

NATO ENSEC COE
Case Study: eFP LTU (DEU BG)
Contact details[68]: Jennifer Doran
jennifer.doran@enseccoe.org +370 616 82431

Project: Energy Management in a Military Expeditionary Environment

ANNEX H.1: eFP LTU Energy Management Recommendations
ANNEX H.2: eFP LTU Energy Management Questionnaire Analysis

Context

NATO is committed to reducing energy consumption and making military operations more efficient, resilient, secure, and sustainable. As a result, the NATO Energy Security (ENSEC) Centre of Excellence (COE) has been tasked by NATO Allied Command Transformation (ACT) to research energy management practices in deployed force infrastructure environments. The DEU BG at eFP LTU is participating as one of three case studies for this project (the other two are at a French military base in Niger, and the CAN BG at eFP LVA).

The three pillars required for effective energy management are:

1. Command and Control (C2) / organisational structure.
2. Technological applications that are suitable for the operational environment.
3. Behaviour change to adapt the military mindset and habits related to energy use.

This document presents three recommendations and associated sub-tasks, all of which align with the above three pillars of energy management. The recommendations have been identified through collection and analysis of baseline data collected for eFP LTU during June-July 2019. The data sets that were used include; questionnaire results, observations at the camp, meter readings, and context information.

Caveats

1. The case study must be completed by the end of October 2019.
2. All recommendations correspond with ISO 50001[69].
3. For the purpose of this project, all recommendations are low-zero cost and do not require the DEU BG to invest money into infrastructure, equipment or technological solutions.
4. This case study is focused on practices in pre-agreed and selected non-operational areas of eFP LTU:
   - Main camp: Building 44 (DEU accommodation block); Building 45 (DEU accommodation block).
   - TLSA: Maintenance Tent 1 (location 8 on map), Maintenance Tent 2 (location 9 on map), Maintenance Tent 3 (location 10 on map), and the Offices (location 11 on map).

[68] The NATO ENSEC COE project team refers to a team of SMEs from the NATO ENSEC COE, Natural Resources Canada (NRCan), and the United States (US) Department of Defense (DOD).
[69] The international standard for energy management.

Benefits

Each of the recommendations are supported by engineering and behavioural science and will contribute to best practice energy management. Best practice energy management can:

1. Reduce the number of lives lost and injuries[70] caused through attacks on fuel supply convoys.
2. Increase the range, number, and type of operations possible, as a result of more energy available.
3. Improve the comfort of military personnel, as a result of paying attention to the use of energy equipment in living areas such as tents and washrooms.
4. Reduce the logistics burden of military units, by requiring less energy (e.g. fuel and generators) to be moved around.

Summary of recommendations:

1. Commander to specifically allocate an Energy Manager (p.3-6).
2. Energy Manager to develop a Standard Operating Procedure (SOP) for energy management (p.7-8).
3. Create a feedback mechanism for personnel to understand how they are using energy - e.g. visualise the progress of energy usage (p.9-12).

Energy Performance Indicators (EnPIs)

The NATO ENSEC COE Project team will provide and analyse four groups of EnPIs:

- Daily total kWh/pp; Daily total kWh/area; Daily peak kW/pp; Daily peak kW/area

In order to prepare the EnPIs, specific data is required from the relevant data owner or collector outside of the NATO ENSEC COE project team. Table 1 presents the EnPIs and the data needed to prepare them.

Table 1 – Energy Performance Indicators (EnPIs)

No.	EnPI	Data Required	
		Data	**Data Collection Process**
1	Daily total kWh/pp for Building 44	7.2 Meter data for Building 44	1.6 Ecolog POC[71] to download Building 44 meter data and send to NATO ENSEC COE project team[72] every Friday
		7.3 Daily occupancy rate for Building 44	1.7 DEU BG POC (TBC) to provide Building 44 occupancy data to NATO ENSEC COE project team every Friday
2	Daily total kWh/pp for Building 45	2.7 Meter data for Building 45	2.7 Ecolog POC to download Building 45 meter data and send to NATO ENSEC COE project team every Friday.

[70] In 2007, 35% of total USA casualties in Afghanistan were as a result of fuel convoy attacks.
[71] Mindaugas Cesnauskis – mindaugas.cesnauskis@ecolog-international.com.
[72] Jennifer Doran – Jennifer.doran@enseccoe.org and Jalomi Maayan-Tardiff – jalomi.maayan-tardiff@canada.ca.

No.	EnPI	Data Required	
		Data	**Data Collection Process**
		2.8 Daily occupancy rate for Building 45	2.8 DEU BG POC to provide Building 45 occupancy data to NATO ENSEC COE project team every Friday
3	Daily total kWh/area for Building 44	9.1 (See 1.1)	3.1 (See 1.1)
4	Daily total kWh/area for Building 45	4.1 (See 2.1)	4.1 (See 2.1)
5	Daily total kWh/area for the TLSA areas	5.4 Meter data for TLSA	5.4 Ecolog POC to download TLSA meter data and send to NATO ENSEC COE project team every Friday
6	Daily peak kW/pp for Building 44	6.1 (See 1.1)	6.1 (See 1.1)
7	Daily peak kW/pp for Building 45	7.4 (See 2.1)	7.1 (See 2.1)
8	Daily peak kW/area for Building 44	8.4 (See 1.1)	8.1 (See 1.1)
9	Daily peak kW/area for Building 45	9.1 (See 2.1)	9.1 (See 2.1)
10	Daily peak kW/area for the TLSA areas	10.1 (See 5.1)	10.1 (See 5.1)

ANNEX H.1: eFP LTU Energy Management Recommendations

1. Commander to specifically allocate an Energy Manager.

Reason for change

There is nobody officially responsible for energy management at eFP LTU. Effective energy management depends on the actions of a person with responsibility and authority for any tasks related to using energy more efficiently, resiliently, securely, and sustainably. The energy management role should take no more than 20% of the working week of the person selected to be the Energy Manager, leaving the person selected to undertake his/her other roles and responsibilities for the remainder of the working week.

Intent

To make the camp safe and comfortable for personnel working and living there by increasing the extent of energy efficiency.

Recommendation sub-tasks

#	Sub-Task	Remarks	Schedule	Monitoring
1.1	Identify the right person for the Energy Manager role; the person selected should be considered as an 'energy champion' and spend no more than 20% (equivalent to approximately one working day per week) of his/her time on this role. (See sub-task 1.4 for	The NATO ENSEC COE project team will: • Provide behavioural science guidance on how to develop as an 'energy champion'. The Commander will: • Identify the right person for the job; positive role model, likeable, good team player (to influence social norms at the camp and to work with the NATO ENSEC COE project team). • Communicate to the camp his/her decision to implement, and provide full support to, an Energy Manager for the benefit of improving the environment in	Within one week of agreeing to the recommendation.	• Eventual development of energy management ideas or procedures with little or no guidance.

#	Sub-Task	Remarks	Schedule	Monitoring
	advice on how to allocate sufficient time to conduct energy management responsibilities.)	which the troops are living and working, and that he/she expects full cooperation from all troops. The Energy Manager will: • Be visible, approachable, responsive, lead by example, reframe his/her colleagues' thinking towards energy. • Work closely with the NATO ENSEC COE project team. • Seek support from, and offer support to, eFP LVA in relation to energy management lessons.[73] • Make a commitment to be an 'energy champion'. • Identify context-specific incentives if the target audience behave in a way that supports the energy champion. • Monitor their own perception of their progress in this role.		
1.2	Apply an Energy Manager job description.	The NATO ENSEC COE project team will: • Provide information to the Commander/relevant Chain of Command about the benefits of improved energy management. • Provide the Commander/relevant Chain of Command with the job description of an Energy Manager. • Provide the Energy Manager with tools and templates for conducting his/her role. The Commander will:	Within one week of agreeing to the recommendation.	• Contact details of the Energy Manager. • Date Energy Manager assigned.

[73] A similar energy management case study is taking place at eFP LVA at the same time, the NATO ENSEC COE project team will facilitate the introduction of the Energy Managers at eFP LTU and eFP LVA to each other.

#	Sub-Task	Remarks	Schedule	Monitoring
		• Arrange a regular briefing from Energy Manager on the progress of both ongoing and planned tasks, as well as the outcome of the tasks. • Provide direction to the Energy Manager on tasks and goals, based on the findings from the regular briefings (i.e. use a feedback loop). The Energy Manager will: • Keep records of tasks, progress, and outcomes. • Work closely with the NATO ENSEC COE project team, seek advice whenever necessary. • Implement the agreed recommendations, identify barriers, and find solutions. • Practice, develop, and adjust energy management recommendations in non-high tempo situations, to develop good practice Energy Manger habits and skills.		
1.3	Complete and use ISO 50001 inspired Plan-Do-Check-Act (P-D-C-A) templates.	The NATO ENSEC COE project team will: • Provide P-D-C-A templates in the relevant language (German or English). • Provide support to completing the templates. The Energy Manager will: • Familiarise them self with the templates. • Practice completing the templates, to develop familiarisation, habit and speed, and to be able to	Implementation period August - October 2019.	• Completion of templates. • Use of templates. • Feedback on templates.

#	Sub-Task	Remarks	Schedule	Monitoring
		provide feedback on the templates for the purpose of the research. • Seek support from colleagues within eFP LTU or DEU MOD whenever needed. • Set effective prompts/cues/reminders to document the energy management paperwork and processes. • Send weekly updates to the NATO ENSEC COE project team. • Monitor how much effort (time and resources) is required to complete the P-D-C-A templates.		
1.4	Allocate sufficient time to conduct energy management responsibilities.	The Commander will: • Specify the approximate proportion of daily battle rhythm/daily workload the Energy Manager should allocate to this role; energy management related tasks should take no more than 20% of the working week of the selected person's time. The Energy Manager will: • Write an energy management schedule including frequency, duration, intensity, dates, times, priorities of tasks etc. • Set goals (e.g. 4/7 tasks to be completed by [date]). • Set reminders to conduct energy management tasks. • Practice conducting some energy management tasks to test the time they take, the ease of doing them, and to develop skills.	Implementation period August - October 2019.	• Planned energy management activities versus actual energy management activities.

#	Sub-Task	Remarks	Schedule	Monitoring
		• Provide demonstrations/examples to the wider target group to show the ideal length of time it takes to conduct an energy management task. • Provide instructions for the wider target group for when the Energy Manager is unavailable. • Restructure the environment where needed, possible, and relevant; e.g. add objects, remove barriers. • Assess whether sufficient time has been allocated to conducting the role, using a review of the schedule; consider the question to be ‘is the time spent on tasks proportionate to the benefits / outcomes?’ Provide the assessment to the Commander and the NATO ENSEC COE project team.		

2. Energy Manager to develop a Standard Operating Procedure (SOP) for energy management.

Reason for change

There is no clear structure for energy management, and unstructured communication lines between the various branches/teams at eFP LTU with regards to the specific topic of energy management. Guidance is available on best practice energy management, which should be incorporated into the battle rhythm. To develop the SOP, there are templates and guidance available from the NATO ENSEC COE project team (based on ISO 50001), which the Energy Manager should review as part of the task to develop an overarching Energy Management SOP.

Intent

To have a clear plan for energy management.

Recommendation sub-tasks

#	Sub-Task	Remarks	Schedule	Monitoring
2.1	Use templates/guidance available from the NATO ENSEC COE project team (based on ISO 50001).	The NATO ENSEC COE project team will: • Provide the Energy Manager with recommended templates/guidance. The Energy Manager will: • Set a schedule for reviewing the available ISO 50001 templates/guidance - e.g. three per day. • Review the templates/guidance. • Provide feedback on the utility of the templates/guidance. • Identify any alignment with pre-existing templates used within his/her unit. • Collect other SOPs to use as benchmarks.	Within three weeks of the start of the implementation period.	• Proportion of templates and guidance: a. understood and b. used

#	Sub-Task	Remarks	Schedule	Monitoring
		• Speak to people who have written or used other SOPs. • Observe/conduct work away from normal workplace (e.g. move from the HQ to the TLSA) to assess if guidance is practical and realistically achievable. • Identify barriers to any suggestions in the templates/guidance. • Set a goal/deadline for the SOP to be ready. • Use recognised NATO or DEU standard for writing an SOP. • Seek review and approval of the SOP.		
2.2	Allocate sufficient time to develop the SOP.	The Energy Manager will: • Provide feedback to the Commander on how long he/she spent developing the SOP. • Seek information from others on the time spent developing SOPs. • Set a time-dependent plan for focusing on different sections of the SOP. • Review progress on the SOP, identify barriers to progress, modify time-frames as necessary, record reasons for modifications. • Assess the utility of the SOP (outcome will only become apparent after a certain amount of time – e.g. at the end of the case study period).	Within four weeks of the start of the implementation period.	• Planned SOP development schedule versus actual SOP development schedule.

3. Create a feedback mechanism for personnel to understand how they are using energy - e.g. visualise the progress of energy usage.

Reason for change

There is a low level of awareness of where energy is consumed, what this means, and of energy saving initiatives at the camp.

Intent

To increase the awareness of personnel at eFP LTU of energy saving initiatives and where most energy is used within the camp, leading to improved energy management behaviours.

Recommendation sub-tasks

#	Sub-Task	Remarks	Schedule	Monitoring
3.1	Use sound data for the EnPIs.	The NATO ENSEC COE project team will: • Stress the importance of collecting data regularly. Change cannot be measured and trends cannot be established if there is no data collected. • Provide clear instructions to data collectors/owners of the exact data collection process; what data is needed, when, how to collect the data, and where to send it to. • Review the data collection process. • Check data is sound, without significant gaps or problems. • Conduct EnPI analysis. • Provide any required software for data collection.	EnPI data to be collected weekly (see Table 1 on p.2 for EnPIs).	• Frequency of data collected. • Accuracy (e.g. full set) of data collected.

#	Sub-Task	Remarks	Schedule	Monitoring
		The data owners/collectors will: • Set a data collection schedule and associated processes (adapt the plan provided by NATO ENSEC COE, if appropriate and useful, or develop a bespoke plan more suitable to their own context). • Provide all relevant data to the NATO ENSEC COE project team in a timely manner. The consequence of not providing data is that EnPIs cannot be processed, which results in no feedback being available. • Identify any barriers to data collection. • Inform the NATO ENSEC COE project team immediately of any problems collecting the data. • Practice collecting data, to improve skills and reduce mistakes or problems. • Set reminders for data collection. • Download/install any required software. The Energy Manager will: • Facilitate the collection and distribution of EnPI data between the NATO ENSEC COE project team, the data collectors/owners, and any other relevant bodies.		
3.2	Ensure all troops have access to and	The NATO ENSEC COE project team will: • Provide feedback format advice and draft samples.	Feedback to be presented weekly.	• Changes in behaviour of the wider target group,

#	Sub-Task	Remarks	Schedule	Monitoring
	understand the feedback format.	• Support the Energy Manager with the development and implementation of the feedback format. • Compare the feedback with the EnPIs. The Energy Manager will: • Collect comments on the formats of the feedback mechanism from samples of the target group. • Collect comments from the target group on the utility of the feedback format – e.g. do others think it is useful, have they witnessed changes, any anecdotes etc. • Use comments/reviews to evaluate and update the format. • Provide a demonstration/briefing on how to understand the feedback format. • Provide instructions on how to understand the feedback format for when he/she is unavailable. • Create a feedback/ideas submission format (e.g. ideas box). • Practice different feedback formats. • Identify context-specific social stimulus to prompt the wider target group to see it (i.e. where to locate it, how to present it etc.). • Ensure the feedback format is accessible to the largest likely number of people from the target group.		including but not limited to: - observations (throughout the case study period) - meter data (throughout the case study period) - questionnaire responses (at the end of the case study period.

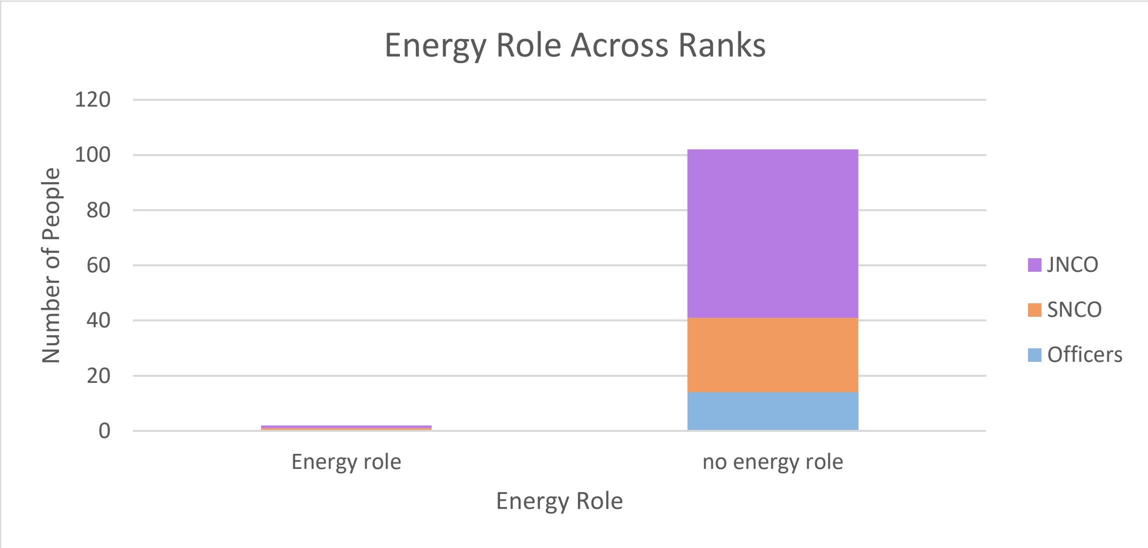
#	Sub-Task	Remarks	Schedule	Monitoring
		• Identify any barriers to using the feedback format and seek/develop solutions. The Commander will: • Instruct Branch Heads to inform their units to take the energy feedback into consideration in their daily battle rhythm.		
3.3	Commander and Energy Manager to use the feedback loop to make decisions.	The NATO ENSEC COE project team will: • Emphasise the purpose of collecting and analysing data – e.g. to inform decisions, monitor operations, plan future camps etc. The Energy Manager will: • Develop a feedback loop to represent the process or schedule on how the data should be used, in which briefings/reports/documents etc. • Seek advice from others with experience of using data to inform decisions (i.e. executing feedback loops). • Identify possible barriers to the feedback loop and develop solutions. The Commander will: • Use the energy data in decision making related to e.g. personnel, infrastructure, logistics, and operations. • Adapt plans or goals, if required.	According to the battle rhythm of briefings / decision making meetings.	• Occassions (briefings / meetings) where energy data was discussed or used. • Decisions made as a result of energy data.

ANNEX H.2: eFP LTU Energy Management Questionnaire Analysis

Context

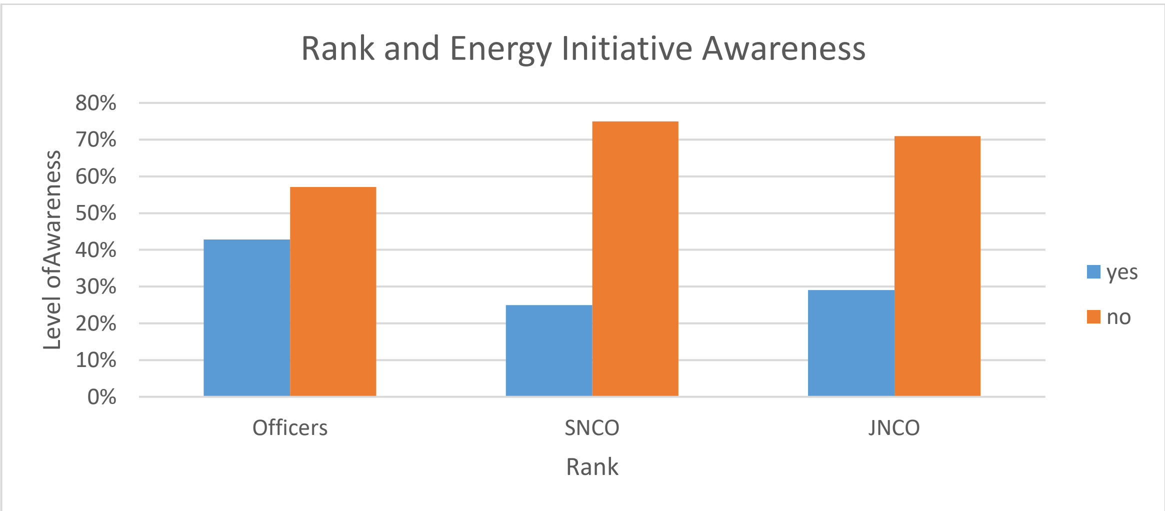
The seven graphs and corresponding analysis presented below are a selection of results from the questionnaire analysis conducted on responses from 106 participants of the 840 persons in the DEU BG, this represents a 12% response rate. The data was collected between 30th June and 14th July 2019. The full set of questionnaire analysis is available from the Project Lead (see p.1 for contact details).

Graph 1: Energy Role and Rank



- Of the 106 participants, 104 provide the details of their rank.
- There were 2 participants who self-identified as having an (informal) energy role, one was a Junior Non-Commissioned Officer (JNCO) and one was a Senior Non-Commissioned Officer (SNCO).
- No Officers felt they had any role or responsibility for energy management.

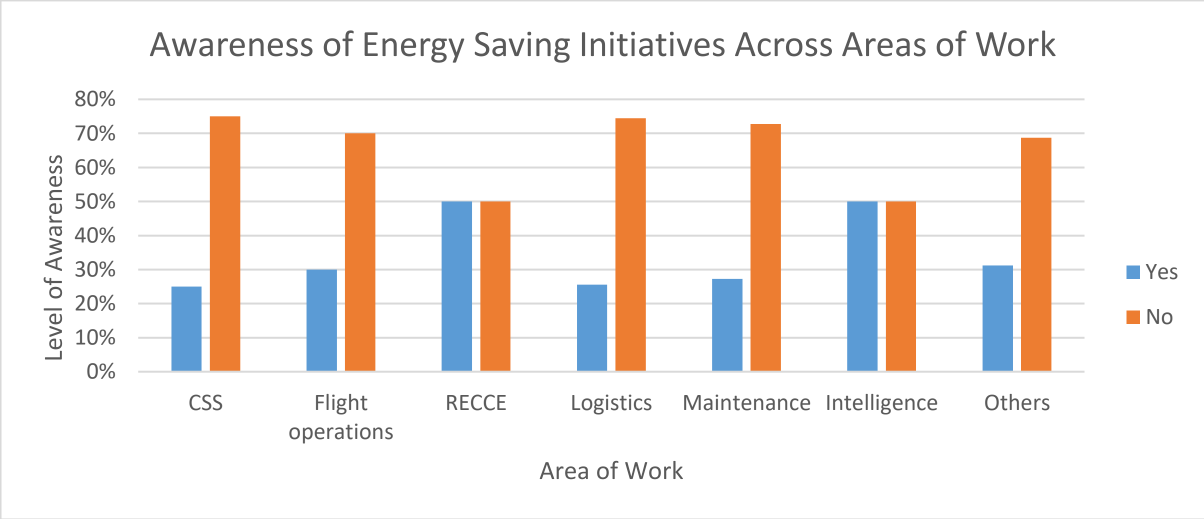
Graph 2: Rank and Energy Saving Initiative Awareness



- Within all rank categories, the majority of people responded that they were not aware of any energy saving initiatives at the camp.
- The rank category that reported the highest proportion of awareness of energy saving initiatives at the camp were the Officers. This provides an opportunity to use the Chain of Command

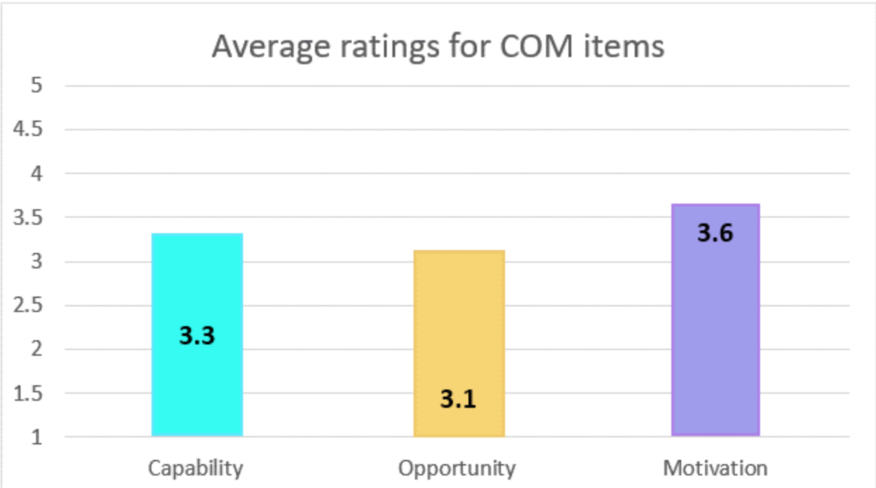
structure to relay the knowledge of Officers about energy saving initiatives to SNCOs and JNCOs.

Graph 3: Awareness of Energy Saving Initiatives Across Areas of Work



- There was only one participant who reported working under the pre-set option of ‘accommodation’; for the purposes of this graph, this participant’s response has been included in the ‘others’ category of work.
- This graph shows that within most areas of work (5/7 categories of work areas), the majority of people reported that they were not aware of any energy saving initiatives.
- The two areas of work where there was an equal level of participants who felt they were aware and were not aware of energy saving initiatives, were those on a reconnaissance (RECCE) visit to the camp, and those working in intelligence.

Graph 4: Attitudes on Capability, Opportunity, and Motivation to Saving Energy

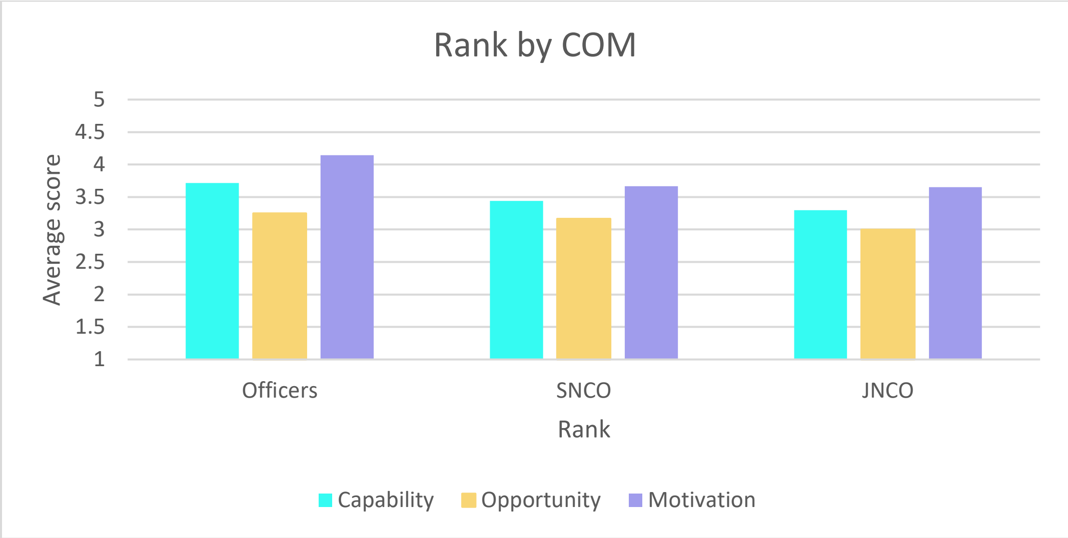


- A section of questions in the questionnaire were focused on identifying people’s attitudes towards their own Capabilities (C), Opportunities (O), and Motivation (M) to save energy.
- Participants were asked to indicate their level of agreement with a series of statements relating to Capabilities (C), Opportunities (O), and Motivation (M) to save energy, where 1 represents ‘strongly disagree’ through to 5 representing ‘strongly agree’.
- The results of analysing the responses to the COM-related questions show that, for all three items, the average rating was between 3 (representing a ‘neutral’ attitude to the statement) and 4 (representing ‘agree’ with the statement). This means that, on average, the participants are

slightly more likely to agree that they have the Capability (3.3), Opportunity (3.1), and the Motivation (3.6) to save energy than disagree.

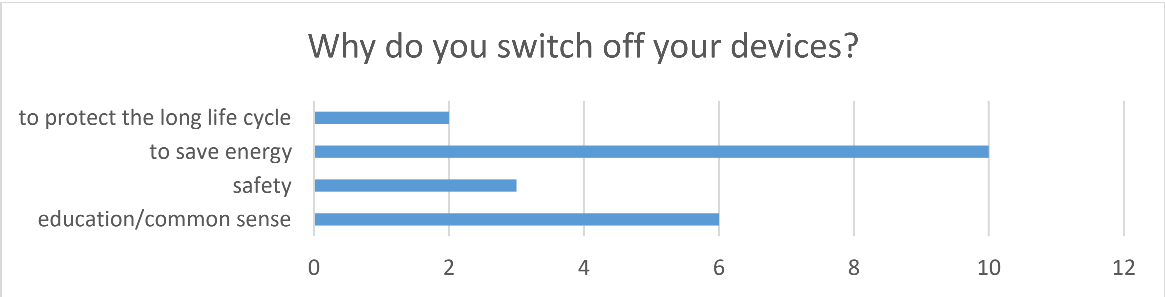
- In summary, this graph tells us that the DEU BG do feel they have the Capability, Opportunity, or the Motivation to save energy, but that there is room for increasing the strength across all three areas of behaviour.

Graph 5: Rank and Attitudes to Capability, Opportunity, and Motivation to Save Energy



- Officers were more likely to agree that they have the Capability, Opportunity, and Motivation to save energy, than SNCOs and JNCOs.
- In all three rank categories, people felt more Motivated to save energy than they felt they had the Capability or Opportunity.
- Thus, cooperation with Motivated Officers should be used to improve the Capability and Opportunity to save energy across other ranks.

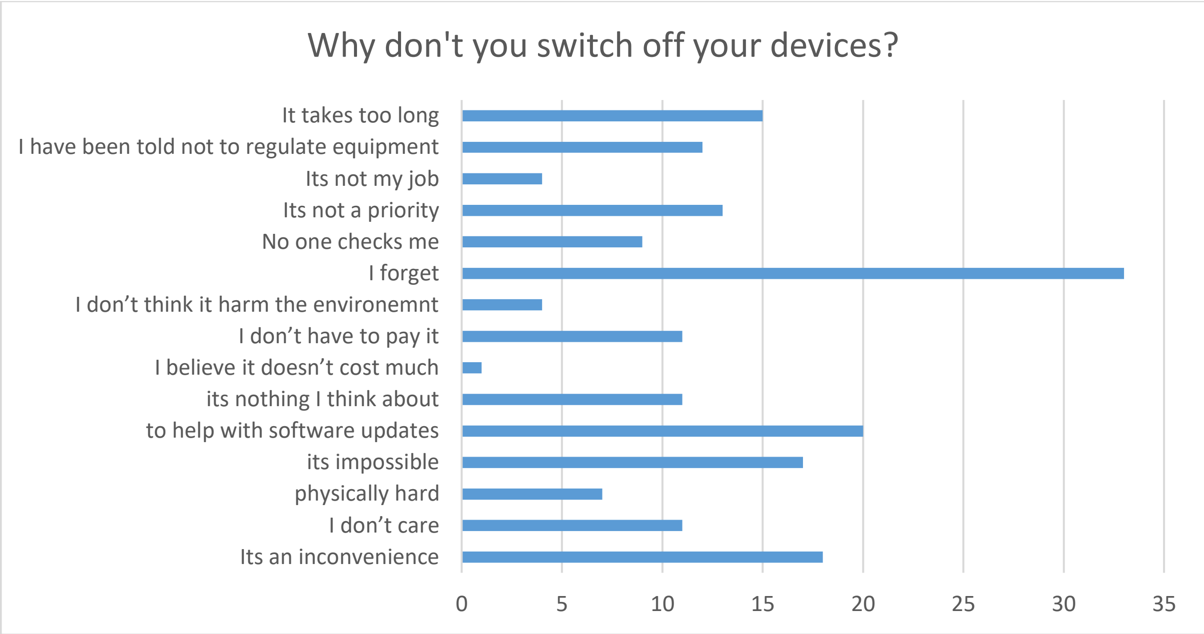
Graph 6: Reasons for Switching Off Devices



- The free-text responses given for "why do you switch off your devices?" were grouped into:
    - Common sense/education/habit
    - To save energy
    - To protect the life cycle of the device
    - Safety

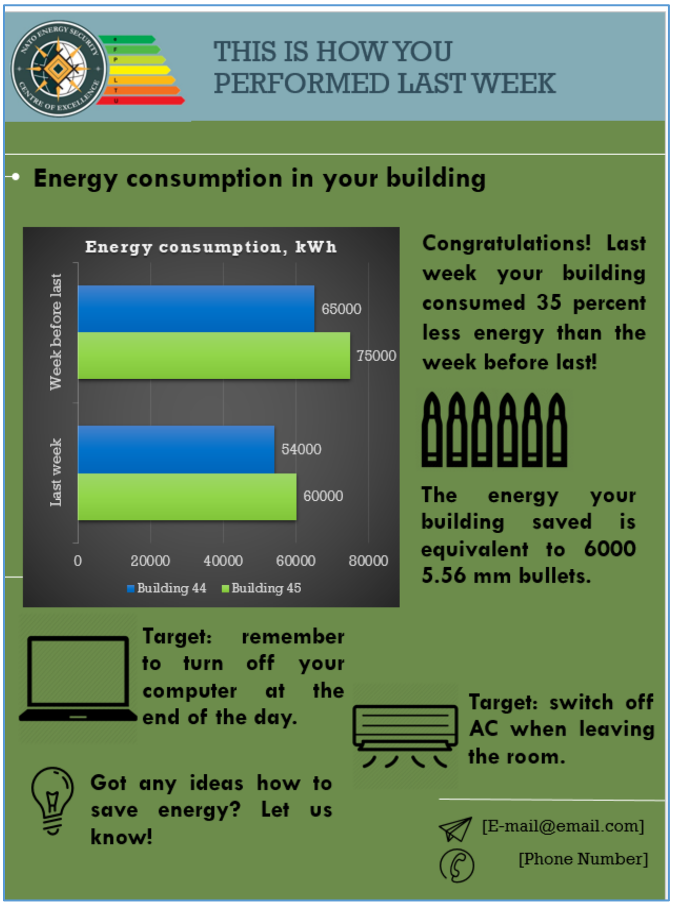
- Free-text responses for examples of things that would help to save energy included:
    - Timers
    - Buildings instead of tents
    - Having the option to turn off power points
    - Qualitatively better equipment

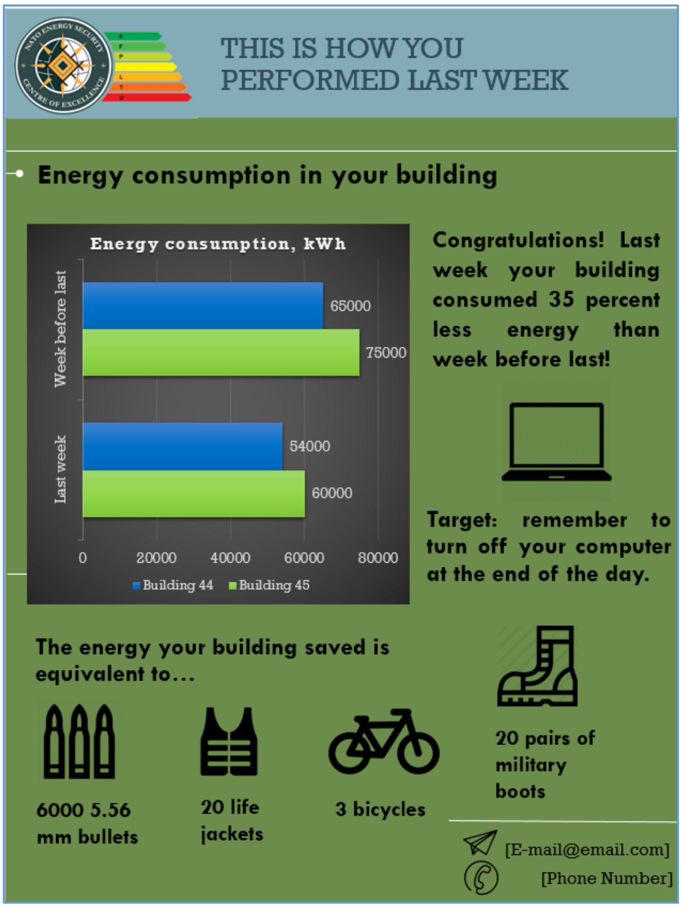
Graph 7: Reasons for Not Switching Off Devices

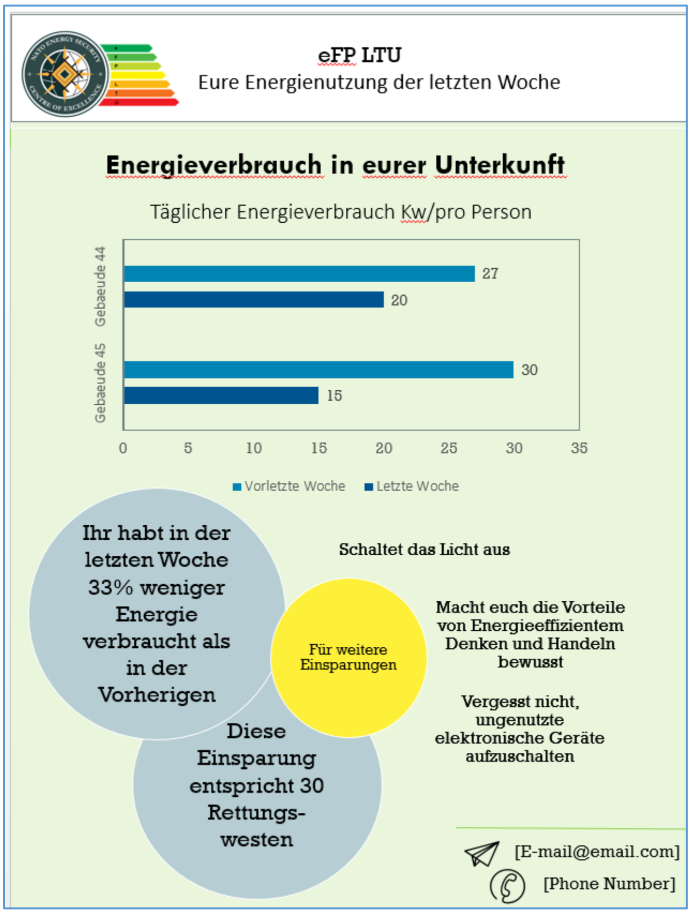


- The most chosen reason from the pre-set options provided for not switching off devices was “I forget” (33 people).
- The second most popular response was “To help with software updates” (20 people), and the third most popular response was “It’s an inconvenience” (18 people).
- Thus, changes to energy management procedures should focus on reminding people to switch off devices, and confirming the whether or not it is necessary to leave equipment on for software updates to take place.
- The most given free-text reason why people think that their colleagues don’t switch off devices was “laziness”.

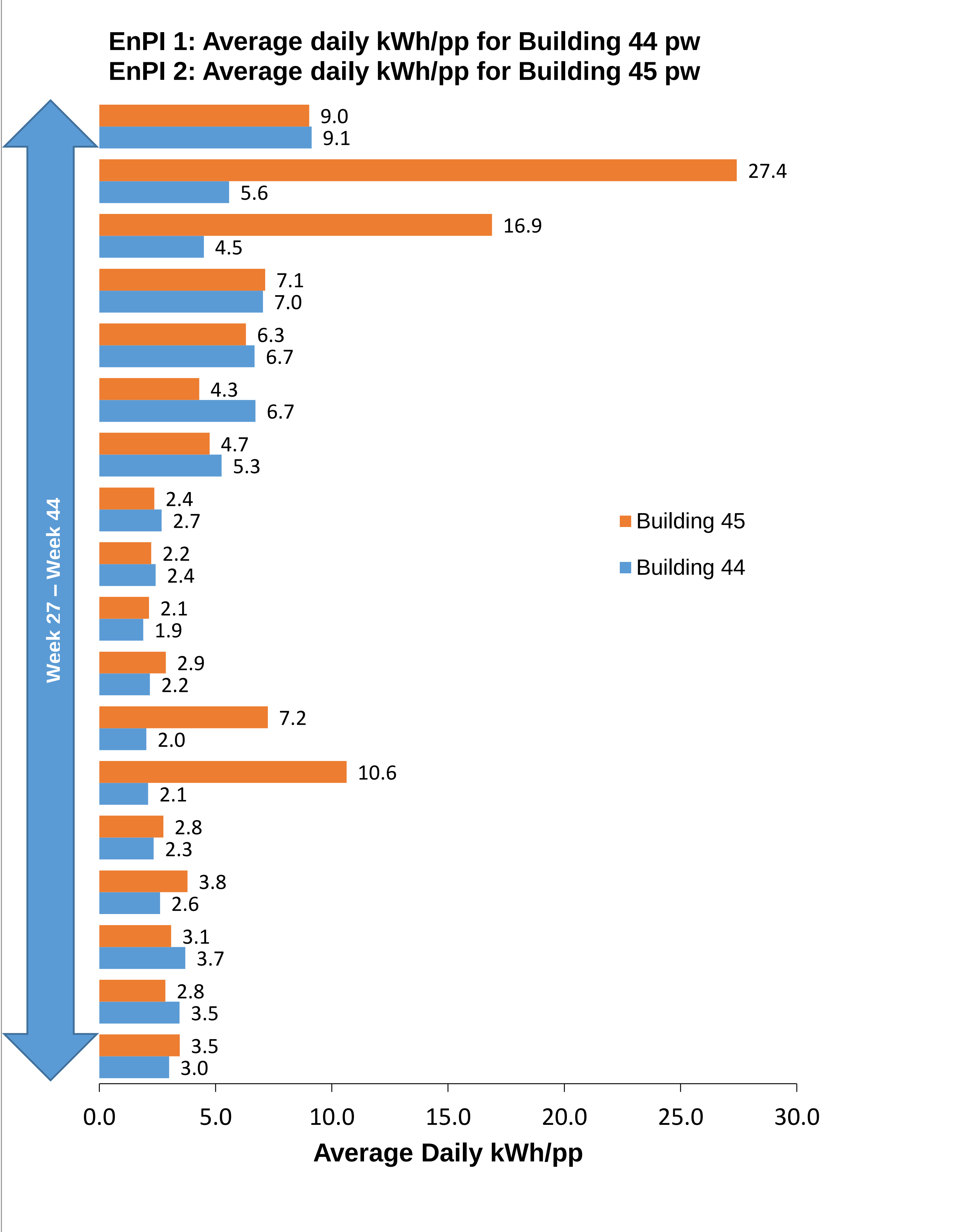
ANNEX I: Case Study 2 - Energy Management Awareness Raising Material

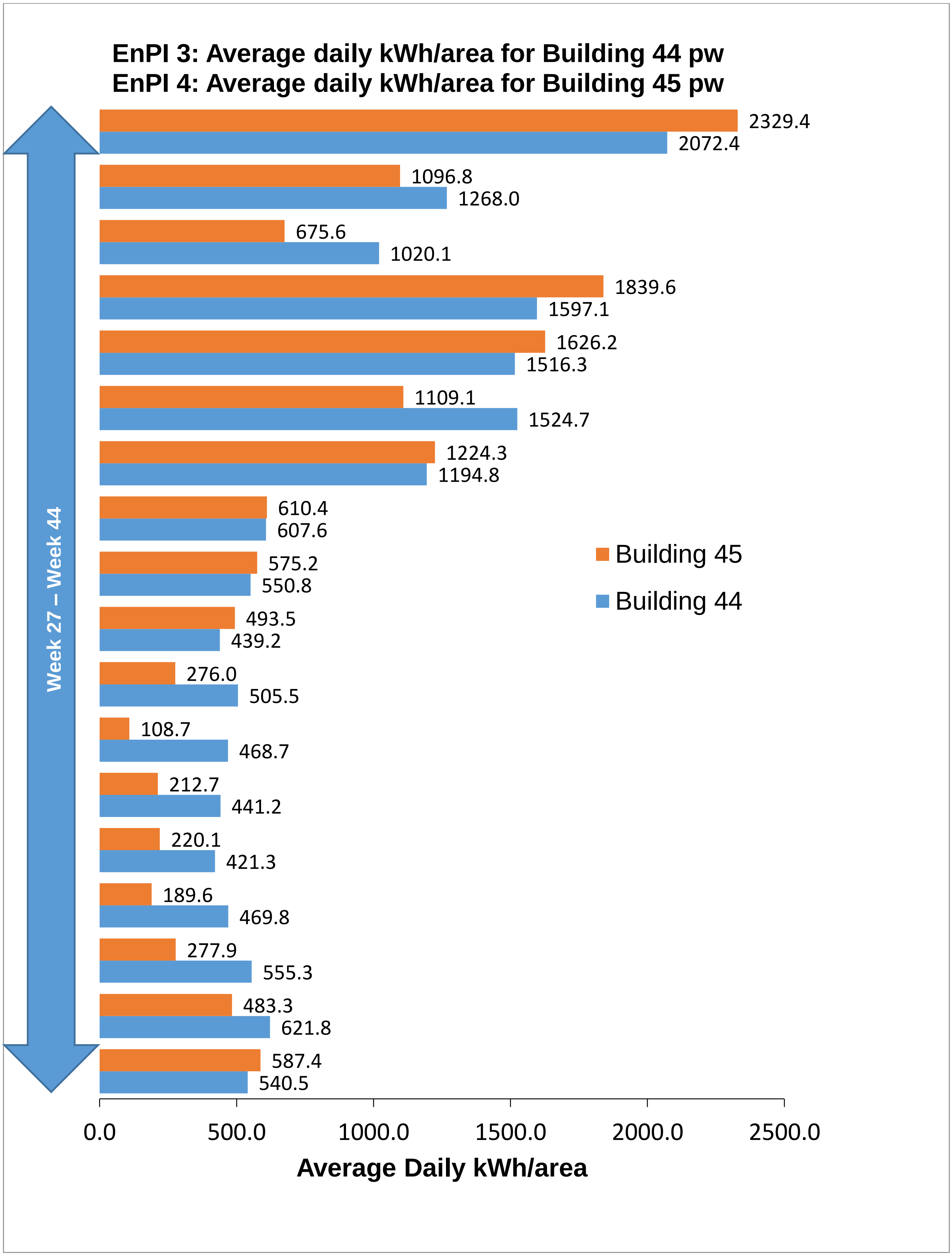


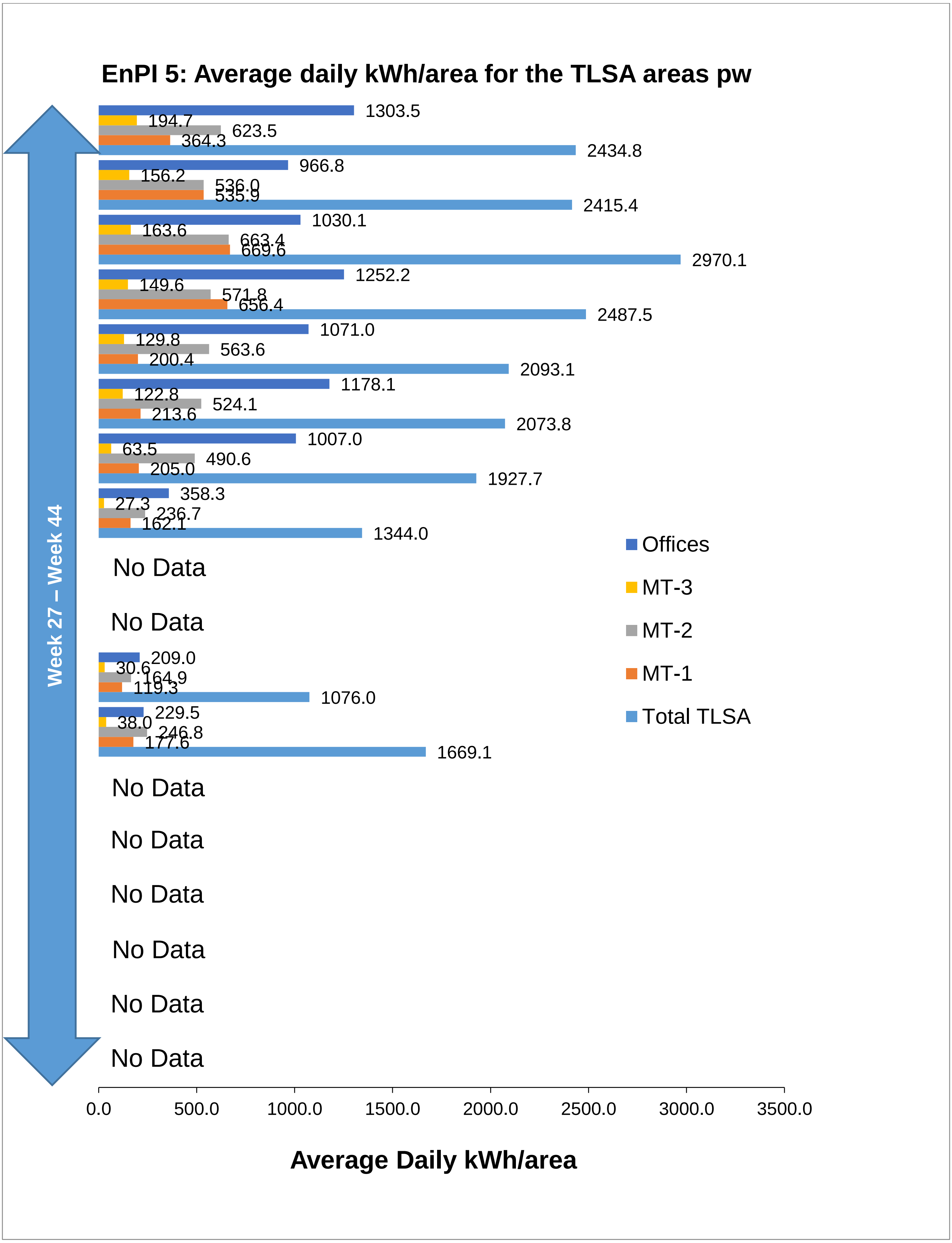


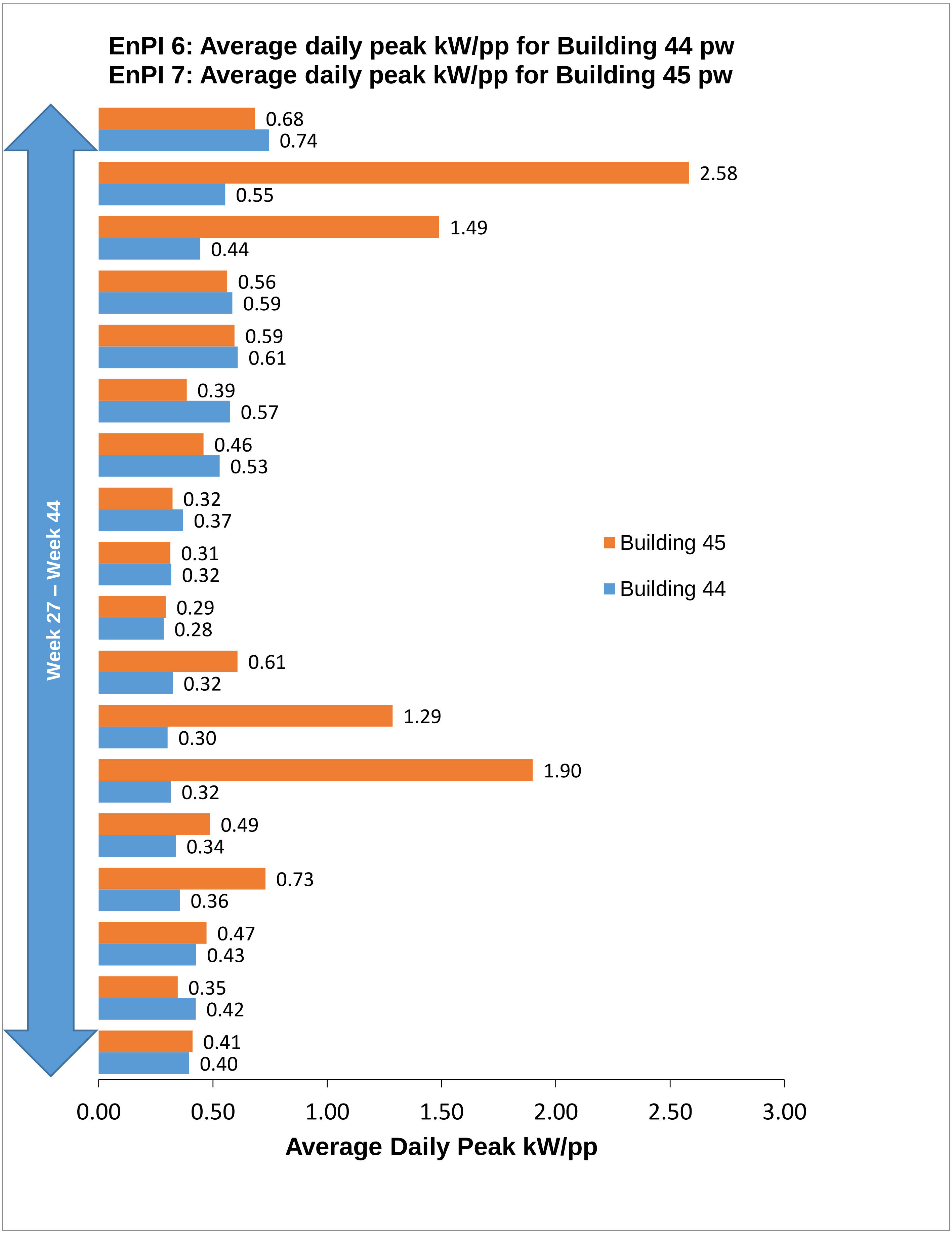


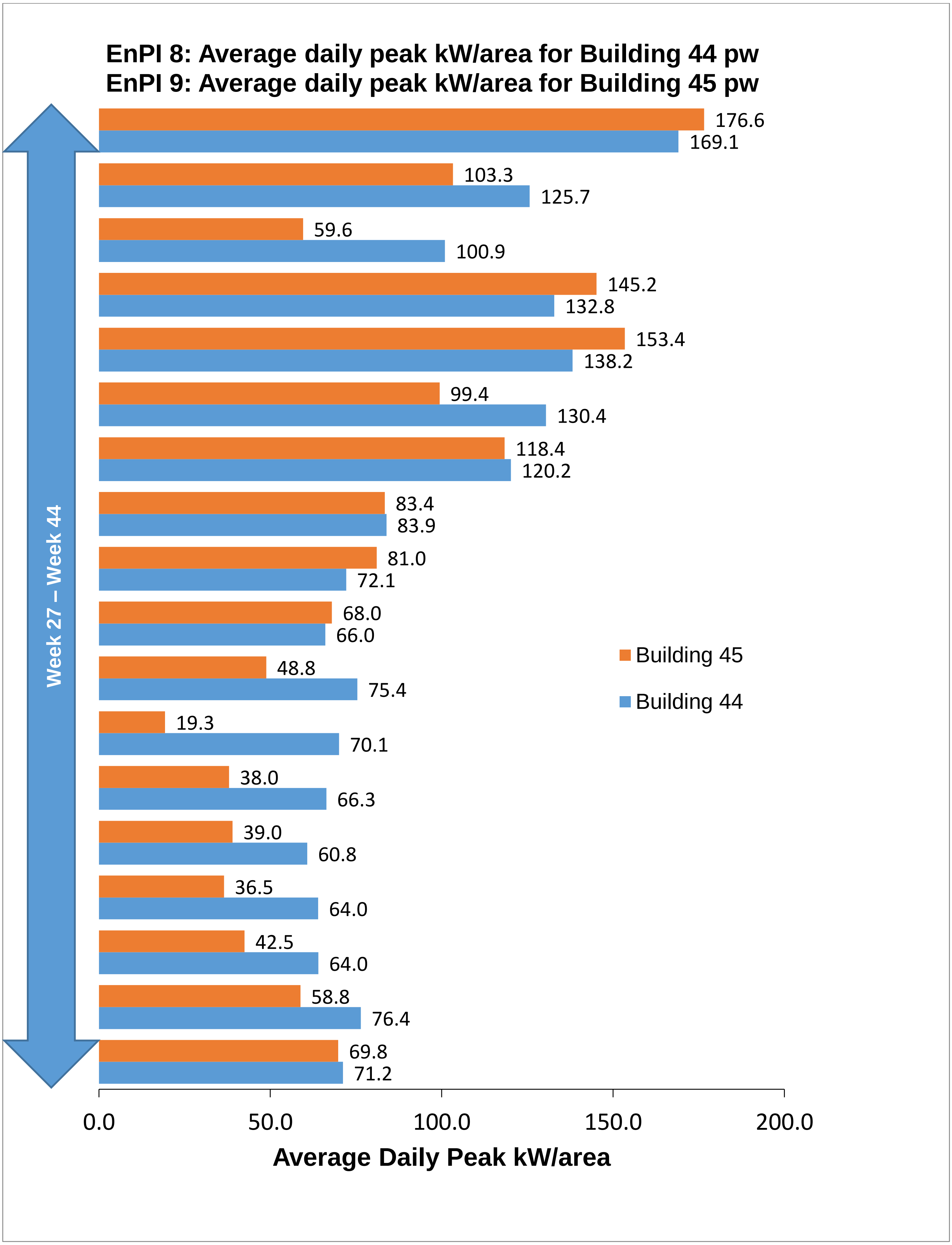
ANNEX J: Case Study 2 - eFP Lithuania EnPIs

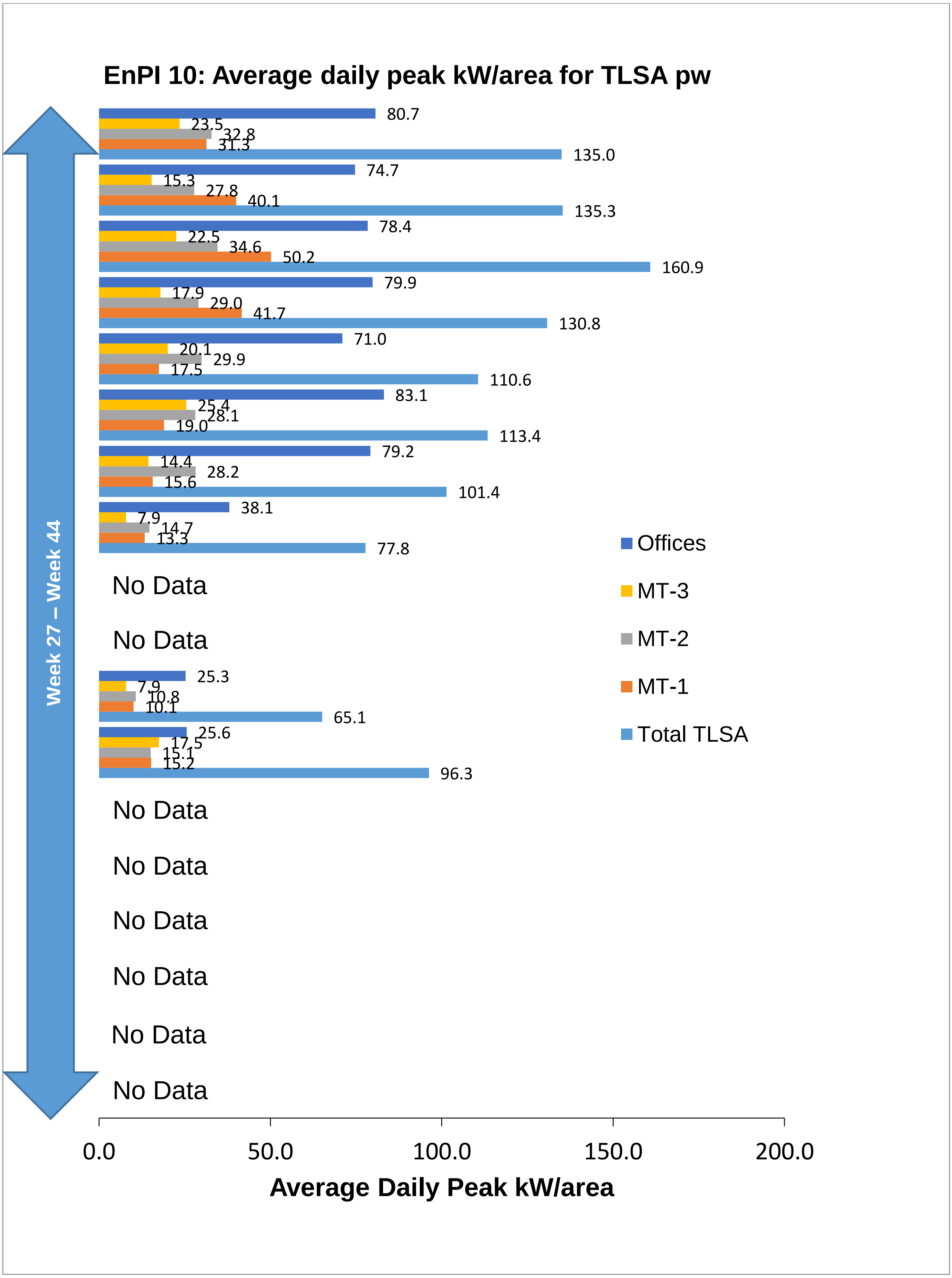



EnPI 3: Average daily kWh/area for Building 44 pw
EnPI 4: Average daily kWh/area for Building 45 pw
Week 27 – Week 44
2329.4
2072.4
1096.8
1268.0
675.6
1020.1
1839.6
1597.1
1626.2
1516.3
1109.1
1524.7
1224.3
1194.8
610.4
607.6
575.2
550.8
493.5
439.2
276.0
505.5
108.7
468.7
212.7
441.2
220.1
421.3
189.6
469.8
277.9
555.3
483.3
621.8
587.4
540.5
Building 45
Building 44
0.0
500.0
1000.0
1500.0
2000.0
2500.0
Average Daily kWh/area


EnPI 5: Average daily kWh/area for the TLSA areas pw
Week 27 – Week 44
1303.5
194.7
623.5
364.3
2434.8
966.8
156.2
536.0
535.9
2415.4
1030.1
163.6
663.4
669.6
2970.1
1252.2
149.6
571.8
656.4
2487.5
1071.0
129.8
563.6
200.4
2093.1
1178.1
122.8
524.1
213.6
2073.8
1007.0
63.5
490.6
205.0
1927.7
358.3
27.3
236.7
162.1
1344.0
No Data
No Data
209.0
30.6
164.9
119.3
1076.0
229.5
38.0
246.8
177.6
1669.1
No Data
No Data
No Data
No Data
No Data
No Data
Offices
MT-3
MT-2
MT-1
Total TLSA
0.0
500.0
1000.0
1500.0
2000.0
2500.0
3000.0
3500.0
Average Daily kWh/area


EnPI 6: Average daily peak kW/pp for Building 44 pw
EnPI 7: Average daily peak kW/pp for Building 45 pw
Week 27 – Week 44
0.68
0.74
2.58
0.55
1.49
0.44
0.56
0.59
0.59
0.61
0.39
0.57
0.46
0.53
0.32
0.37
0.31
0.32
0.29
0.28
0.61
0.32
1.29
0.30
1.90
0.32
0.49
0.34
0.73
0.36
0.47
0.43
0.35
0.42
0.41
0.40
Building 45
Building 44
0.00
0.50
1.00
1.50
2.00
2.50
3.00
Average Daily Peak kW/pp


EnPI 8: Average daily peak kW/area for Building 44 pw
EnPI 9: Average daily peak kW/area for Building 45 pw
Week 27 – Week 44
176.6
169.1
103.3
125.7
59.6
100.9
145.2
132.8
153.4
138.2
99.4
130.4
118.4
120.2
83.4
83.9
81.0
72.1
68.0
66.0
48.8
75.4
19.3
70.1
38.0
66.3
39.0
60.8
36.5
64.0
42.5
64.0
58.8
76.4
69.8
71.2
Building 45
Building 44
0.0
50.0
100.0
150.0
200.0
Average Daily Peak kW/area


EnPI 10: Average daily peak kW/area for TLSA pw
Week 27 – Week 44
80.7
23.5
32.8
31.3
135.0
74.7
15.3
27.8
40.1
135.3
78.4
22.5
34.6
50.2
160.9
79.9
17.9
29.0
41.7
130.8
71.0
20.1
29.9
17.5
110.6
83.1
25.4
28.1
19.0
113.4
79.2
14.4
28.2
15.6
101.4
38.1
7.9
14.7
13.3
77.8
No Data
No Data
25.3
7.9
10.8
10.1
65.1
25.6
17.5
15.1
15.2
96.3
No Data
No Data
No Data
No Data
No Data
No Data
Offices
MT-3
MT-2
MT-1
Total TLSA
0.0
50.0
100.0
150.0
200.0
Average Daily Peak kW/area

ANNEX K: Case Study 3 – Recommendations and Guidance

NATO ENSEC COE
Project: Energy Management in a Military Expeditionary Environment
Case Study: eFP LVA (CAN BG)
Contact details[74]: Jennifer Doran
jennifer.doran@enseccoe.org +370 616 82431

ANNEX K.1: eFP LVA Energy Management Recommendations
ANNEX K.2: eFP LVA Energy Management Questionnaire Analysis

Context

NATO is committed to reducing energy consumption and making military operations more efficient, resilient, secure, and sustainable. As a result, the NATO Energy Security (ENSEC) Centre of Excellence (COE) has been tasked by NATO Allied Command Transformation (ACT) to research energy management practices in deployed force infrastructure environments. The CAN BG at eFP LVA is participating as one of three case studies for this project (the other two are at a French military base in Niger, and the DEU BG at eFP LTU).

The three pillars required for effective energy management are:

1. Command and Control (C2) / organisational structure.
2. Technological applications that are suitable for the operational environment.
3. Behaviour change to adapt the military mindset and habits related to energy use.

This document presents six recommendations and associated guidance remarks, all of which align with the above three pillars of energy management. The recommendations have been identified through collection and analysis of baseline data collected for eFP LVA during June-July 2019. The data sets that were used include; questionnaire results, observations at the camp, meter readings, and context information.

Caveats

1. The case study must be completed by the end of October 2019.
2. All recommendations correspond with ISO 50001[75].
3. For the purpose of this project, all recommendations are low-zero cost and do not require the CAN BG to invest money into infrastructure, equipment or technological solutions.
4. This case study is focused on practices in pre-agreed and selected non-operational areas of eFP LVA:
   - LSA1: CAN accommodation tents and ablution buildings.
   - Gym: multinational use, managed by CAN civilian contractors.
   - Building 073: multinational accommodation hard shelter.

[74] The NATO ENSEC COE project team refers to a team of SMEs from the NATO ENSEC COE, Natural Resources Canada (NRCan), and the United States (US) Department of Defense (DOD).
[75] The international standard for energy management.

Benefits

Each of the recommendations are supported by engineering and behavioural science and will contribute to best practice energy management. Best practice energy management can:

1. Reduce the number of lives lost and injuries[76] caused through attacks on fuel supply convoys.
2. Increase the range, number, and type of operations possible, as a result of more energy available.
3. Improve the comfort of military personnel, as a result of paying attention to the use of energy equipment in living areas such as tents and washrooms.
4. Reduce the logistics burden of military units, by requiring less energy (e.g. fuel and generators) to be moved around.

Summary of energy management recommendations:

1. Commander to specifically allocate an Energy Manager (p.3-7).
2. The NSE to task the development and implementation of last-person out checks (p.8-9).
3. Gym staff to review plans and procedures, and to update where relevant (p.10-11).
4. Create reminders to drive the desired behaviour of switching off items when not in use (p.12-13).
5. Commander to ensure cooperation of energy management staff with relevant POCs of other eFP LVA contributing nations (p.14-15).
6. Communication and Information Systems (CIS) authority (e.g. S4) to confirm when IT software updates need to be done. eFP LVA staff to adapt IT habits as a result of the information (p.16-17).

Energy Performance Indicators (EnPIs)

The NATO ENSEC COE Project team will provide the EnPIs displayed in Table 1. In order to prepare the EnPIs, specific data is required from the relevant data owner or collector outside of the NATO ENSEC COE project team; please see Table 1 for the requirements.

Table 1 – Energy Performance Indicators (EnPIs)

No.	EnPI	Data Required	
		Data	**Data Collection Process**
1	Daily total kWh/pp for LSA1	9.2 Meter data for LSA1	1.8 NSE POC (Lt Hufnagel) to download LSA1 meter data and send to NRCan POC (Jalomi Maayan-Tardiff) every Friday
		9.3 Daily occupancy rate for LSA1	1.9 CAN BG POC (TBC) to provide LSA1 occupancy data to NRCan POC every Friday

[76] In 2007, 35% of total USA casualties in Afghanistan were as a result of fuel convoy attacks.

No.	EnPI	Data Required	
		Data	Data Collection Process
2	Daily total kWh/pp for Building 073	2.9 Meter data for Building 073	2.9 NSE POC to download Building 073 meter data and send to NRCan POC every Friday.
		2.10 Daily occupancy rate for Building 073	2.10 CAN BG POC to provide Building 073 occupancy data to NRCan POC every Friday
3	Daily total kWh/area for LSA1	11.1 (See 1.1)	3.1 (See 1.1)
4	Daily total kWh/area for Building 073	4.1 (See 2.1)	4.1 (See 2.1)
5	Daily total kWh/area for the Gym	5.5 Meter data for the Gym	5.5 NSE POC to download Gym meter data and send to NRCan POC every Friday
6	Daily peak kW/pp for LSA1	6.1 (See 1.1)	6.1 (See 1.1)
7	Daily peak kW/pp for Building 073	7.5 (See 2.1)	7.1 (See 2.1)
8	Daily peak kW/area for LSA1	8.5 (See 1.1)	8.1 (See 1.1)
9	Daily peak kW/area for Building 073	9.1 (See 2.1)	9.1 (See 2.1)
10	Daily peak kW/area for the Gym	10.1 (See 5.1)	10.1 (See 5.1)

ANNEX K.1: eFP LVA Energy Management Recommendations

1. Commander to specifically allocate an Energy Manager.

Reason for change

There is nobody officially responsible for energy management at eFP LVA. Effective energy management depends on the actions of a person with responsibility and authority for any tasks related to using energy more efficiently, resiliently, securely, and sustainably. The energy management role should take no more than 20% of the working week of the person selected to be the Energy Manager, leaving the person selected to undertake his/her other roles and responsibilities for the remainder of the working week.

Intent

To make the camp safe and comfortable for personnel working and living there by increasing the extent of energy efficiency.

Recommendation guidance and sub-tasks

#	Sub-Task	Remarks	Schedule	Monitoring
1.1	Identify the right person for the Energy Manager role; the person selected should be considered as an 'energy champion' and spend no more than 20% (equivalent to approximately one working day per week) of his/her time on this role. (See sub-task 1.4	The NATO ENSEC COE project team will: • Provide behavioural science guidance on how to develop an 'energy champion'. The Commander will: • Identify the right person for the job; positive role model, likeable, good team player (to influence social norms at the camp and to work with the NATO ENSEC COE project team). • Communicate to the eFP his/her decision to allocate, and provide full support to, an Energy Manager for the benefit of improving the environment in which the troops are living and	Within one week of agreeing to the recommendation.	• Eventual development of energy management ideas or procedures with little or no guidance.

#	Sub-Task	Remarks	Schedule	Monitoring
	for advice on how to allocate sufficient time to conduct energy management responsibilities.)	working, and he/she expects full cooperation with the Energy Manager from all troops. The Energy Manager will: • Be visible, approachable, responsive, lead by example, reframe his/her colleagues' thinking towards energy. • Work closely with the NATO ENSEC COE project team. • Seek support from, and offer support to, eFP LTU in relation to energy management lessons.[77] • Make a commitment to be an 'energy champion'. • Identify context-specific incentives for if/when the target audience behave in a way that supports the energy champion. • Monitor their own perception of their progress in this role.		
1.2	Apply an Energy Manager job description.	The NATO ENSEC COE project team will: • Provide information to the Commander/relevant Chain of Command about the benefits of improved energy management. • Provide the Commander/relevant Chain of Command with the job description of an Energy Manager. • Provide the Energy Manager with tools and templates for conducting his/her role.	Within one week of agreeing to the recommendation.	• Contact details of the Energy Manager. • Date Energy Manager assigned.

[77] A similar energy management case study is taking place at eFP LTU at the same time, the NATO ENSEC COE project team will facilitate the introduction of the Energy Managers at eFP LTU and eFP LVA to each other.

#	Sub-Task	Remarks	Schedule	Monitoring
		The Commander will: • Arrange a regular briefing from the Energy Manager on the progress of both ongoing and planned energy management tasks, as well as the outcome of the tasks. • Provide direction to the Energy Manager on the tasks and goals, based on the findings from the regular briefings (i.e. use a feedback loop). The Energy Manager will: • Keep records of tasks, progress, and outcomes. • Work closely with the NATO ENSEC COE project team, seek advice whenever necessary. • Implement the agreed recommendations, identify barriers, and find solutions. • Practice, develop, and adjust energy management recommendations in non-high tempo situations, to develop good practice Energy Manger habits and skills.		
1.3	Complete and use ISO 50001 inspired Plan-Do-Check-Act (P-D-C-A) templates.	The NATO ENSEC COE project team will: • Provide P-D-C-A templates in the relevant language (English or French). • Provide support to completing the templates. The Energy Manager will: • Familiarise them self with the templates.	Implementation period August - October 2019.	• Completion of templates. • Use of templates.

#	Sub-Task	Remarks	Schedule	Monitoring
		• Practice completing the templates, to develop familiarisation, habit and speed, and to be able to provide feedback on the templates for the purpose of the research. • Seek support from colleagues within eFP LVA or CAN DND wherever needed. • Set effective prompts/cues/reminders to document the energy management paperwork and processes. • Send weekly updates to NATO ENSEC COE project team. • Monitor how much effort (time and resources) is required to complete the P-D-C-A templates.		• Feedback on templates.
1.4	Allocate sufficient time to conduct energy management responsibilities.	The Commander will: • Specify the approximate proportion of daily battle rhythm/daily workload the Energy Manager should allocate to this role; energy management related tasks should take no more than 20% of the working week of the selected person's time. The Energy Manager will: • Write an energy management schedule including frequency, duration, intensity, dates, times, priorities of tasks etc. • Set goals (e.g. 4/7 energy management tasks to be completed by [date]). • Set reminders to conduct energy management tasks.	Implementation period August - October 2019.	• Planned energy management activities versus actual energy management activities.

#	Sub-Task	Remarks	Schedule	Monitoring
		• Practice conducting some energy management tasks to test the time they take, the ease of doing them, and to develop skills. • Provide demonstrations/examples to wider target group to show the ideal length of time it takes to conduct an energy management task. • Provide instructions for the wider target group to complete energy management tasks for when the Energy Manager is unavailable. • Restructure the environment where possible and relevant; e.g. add objects, remove barriers. • Assess whether sufficient time has been allocated to conducting the role, using a review of the schedule; consider the question to be ‘is the time spent on energy management tasks proportionate to the benefits/outcomes?’ Provide the assessment to the Commander and the NATO ENSEC COE project team.		

2. The National Support Element (NSE) to task the development and implementation of last-person out checks.

Reason for change

A/C units were observed to be left on in empty tents. Implementing last-person out checks gives people the information (i.e. psychological capability) and/or instructions (i.e. physical opportunity) required to undertake the desired behaviour.

Intent

To avoid wasting energy in empty areas.

Recommendation guidance

#	Remarks	Schedule	Monitoring
2	The NATO project team will: • Provide information on the benefits of last-person out checks. • Analyse the EnPIs • Provide the EnPI analysis. • Support the development of the format of the last-person out checks and what it should include. The NSE will: • Communicate to the CAN BG their decision to implement last-person out checks, and that they expect full cooperation from all troops. The Energy Manager will: • Check the frequency and intensity of the behaviour. • Provide the required EnPI data sets to the NATO ENSEC COE project team. • Compare the last-person out checks to the EnPI results.	Implementation period August - October 2019. Weekly analysis of the previous week's last-person out sheets. Weekly update to NATO ENSEC COE project team.	• Number of last-person out checks conducted/signed for. • Comparison of extent of checks to EnPI data.

#	Remarks	Schedule	Monitoring
	• Lead the development of the format of the last-person out check, seek advice from the NATO ENSEC COE project team when required. • Provide a demonstration to the target audience. • Practice checking the process works. • Identify any barriers to the last-person out checks being completed and consider solutions. • Set goals for behaviours (e.g. number of checks completed) and outcomes (e.g. reduced energy use). • Seek support from colleagues and/or other Chains of Command to move any items that could assist in completing the last-person out checks more effectively (i.e. with minimal effort and time). • Provide weekly updates to the NATO ENSEC COE project team.		

3. Gym staff to review plans and procedures, and to update where relevant - e.g. what time they check or turn off equipment.

Reason for change

Some gym equipment seems to be on for 24 hours per day as there is a constant 15kw load. There has also been a peak in the gym at 03.00, which has been higher than at 15.00. The gym staff can be provided with the knowledge (i.e. psychological capability) of what consumes energy and when, plus the triggers, resources, and time (i.e. physical opportunity) to manage the energy used in the gym in a more informed way.

Intent

To reduce the amount of energy used in the gym through refined energy management.

Recommendation guidance

#	Remarks	Schedule	Monitoring
3	The NATO ENSEC COE project team will: • Provide information to gym staff on the benefits of improved energy management. • Analyse the EnPIs. • Provide the EnPI analysis. • Support the development of the revised procedures. The Commander will: • Communicate to the gym staff that he/she wishes for them to cooperate with the advice and implement any changes. The Energy Manager will: • Provide required EnPI data sets. • Support the gym staff with the review of energy management procedures.	Implementation period August - October 2019. Daily close-down checks. Weekly update to NATO ENSEC COE project team.	• Number of times the new process was followed. • EnPI data for the gym.

#	Remarks	Schedule	Monitoring
	The gym staff will: • Review the current procedures for closing down equipment in the gym, at what times, how often, how, who can do it etc. • Identify areas that can be amended. • Identify problems and barriers, and consider solutions. • Provide demonstration to the rest of the gym staff team and the Energy Manager. • Provide demonstration, or leave instructions, to gym users who use the gym in low energy / silent hours. • Set goals for behaviours (e.g. conduct revised procedures [X] amount of times) and outcomes (e.g. reduced gym energy use). • Provide weekly updates to the NATO ENSEC COE project team.		

4. Create reminders to drive the desired behaviour of switching off items when not in use.

Reason for change

The number one reason given for not switching items off when not using them was "I forget to" and the second most popular response was "It's not something I think about". Giving people the reminders (i.e. triggers and/or resources align with physical opportunity) and the reasons why (i.e. stimulating reflective motivation) can help to change this behaviour.

Intent

To increase the extent of items being switched off.

Recommendation guidance

#	Remarks	Schedule	Monitoring
4	The NATO ENSEC COE project team will: • Support the development of the format of the reminder(s). • Analyse the EnPIs. • Provide the EnPI data sets. The Energy Manager will: • Lead the development of the format of the reminder(s). • Collect information about what pieces of equipment need reminders, how, and when etc. • Provide a demonstration. • Provide instructions. • Make it easy to find/see/hear/access the reminder(s). • Identify barriers to implementing the reminder(s) and consider solutions. • Set behaviour goals (e.g. [X] number of pieces of equipment with reminders were found to be in the correct state) and outcome goals	Implementation period August - October 2019.	• Spot checks.

#	Remarks	Schedule	Monitoring
	(e.g. an [X] reduction in energy use two weeks after reminders implemented). • Conduct desired behaviour spot checks. • Compare desired behaviours across areas and present the data. • Lead by example. • Consider appropriate incentives or rewards. • Provide the required EnPI data sets to the NATO ENSEC COE project team. • Provide weekly updates to the NATO ENSEC COE project team.		

5. Commander to ensure cooperation of energy management staff with relevant POCs of other eFP LVA contributing nations.

Reason for change
There is assessed to be a fairly good energy management structure within CAN troops but not with other nations/across the eFP.

Intent
To increase the extent of CAN cooperation with other eFP LVA contributing nations on energy management related tasks.

Recommendation guidance

#	Remarks	Schedule	Monitoring
5	The NATO ENSE COE project team will: • Support the development of any strategies or documents to support cross-eFP cooperation for energy management. The Commander will: • Task the Energy Manager to work with relevant staff from other eFP LVA contributing nations on the topic of energy management. • Request updates about cooperation on energy management. The Energy Manager will: • Liaise with relevant staff from other eFP LVA contributing nations and provide them with the requirement and benefits of energy management. • Include the energy management cross-eFP cooperation task in his/her battle rhythm. • Lead by example. • Provide demonstrations. • Provide instructions.	Implementation period August - October 2019. Weekly meetings with relevant personnel from other eFP LVA contributing nations.	• Implementation period August - October 2019. • Weekly meetings with relevant personnel from other eFP LVA contributing nations.

#	Remarks	Schedule	Monitoring
	• Offer support to other eFP LVA contributing nations on the topic of energy management. • Seek support from colleagues and/or the NATO ENSEC COE project team. • Consider incentives and rewards for good examples of cooperation. • Set behaviour goals (e.g. cooperating with [X] number of nations or on [X] number of tasks per week) and outcome goals (e.g. observing improved energy management by other nations). • Identify barriers to cooperation on energy management and consider solutions. • Share EnPI data with other nations, particularly for Building 073.		

6. Communication and Information Systems (CIS) authority (e.g. S4) to confirm when IT software updates are or need to be done. Staff across eFP LVA to adapt IT habits as a result of the information given.

Reason for change

The number three reason given for not switching items off when not using them was "To help with software updates." This may be a reflection of outdated thinking and habits that need updating. For example, some software updates can be conducted when computers are turned off, most are more effective when computers are given a switch on 'boost' (therefore, they inherently need to be switched off to be switched on), and some updates can be scheduled to happen on specific days/times. People need the right information (i.e. psychological capability) to change their habits (i.e. impulses and reflexes are related to automatic motivation) to conduct the right IT behaviour.

Intent

To reassure people of the correct requirements for IT software updates and see an increase in IT equipment switched off.

Recommendation guidance

#	Remarks	Schedule	Monitoring
6	The NATO ENSEC COE project team will: • Support the development of the format in which best to present/inform the target audience of the correct information. The Energy Manager will: • Make a plan for how to confirm the correct IT software updates information and how to disseminate the information. • Provide the information about improved energy management benefits to the CIS authority raise their awareness • Seek clarification on the correct information about IT software updates.	Within four weeks of agreeing to the recommendation.	• If the information was sent, how, and when. • Ad-hoc checks of IT equipment.

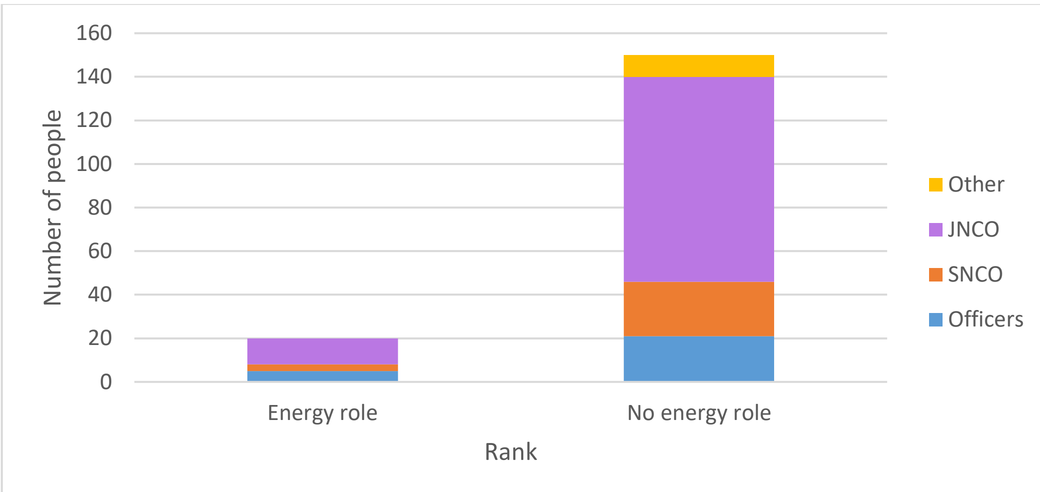
#	Remarks	Schedule	Monitoring
	• Support the CIS authority in distributing the correct information, including highlighting the benefits. • Identify any barriers to understanding or completing the confirmed procedure and consider solutions. • Monitor the frequency and intensity of the desired behaviour. • Provide comparative energy data to the CIS authority personnel after distribution of the correct information. • Set behaviour goals (e.g. [X] number or percentage of IT equipment switched off) and outcome goals (e.g. present equivalent energy use from IT switched off in a meaningful way). • Lead by example. The CIS authority will: • Clarify the situation with regards to IT software updates. • Provide a demonstration to the target audience. • Provide instructions, which have first been tested. • Practice checking the process works. • Identify any barriers to following the information and consider solutions. • Make it easy for people to shut down IT equipment. • Lead by example.		

ANNEX K.2: eFP LVA Energy Management Questionnaire Analysis

Context

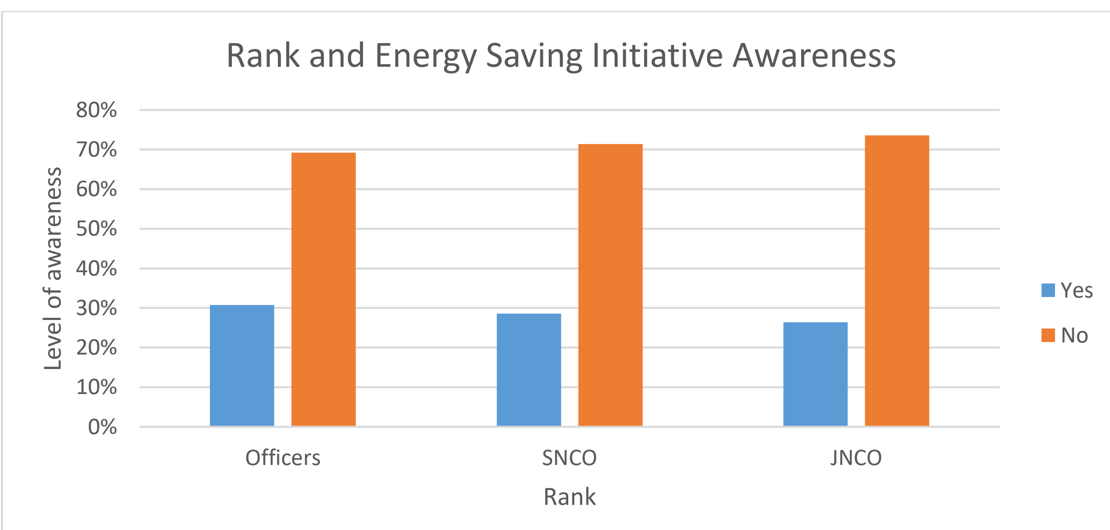
The seven graphs and corresponding analysis presented below are a selection of results from the questionnaire analysis conducted on responses from 174/594 participants of the CAN troops (BG and NSE) at eFP LVA, this represents a 29% response rate. The data was collected between 1st and 14th July 2019. The full set of questionnaire analysis is available from the Project Lead (see p.1 for contact details).

Graph 1: Energy Role and Rank



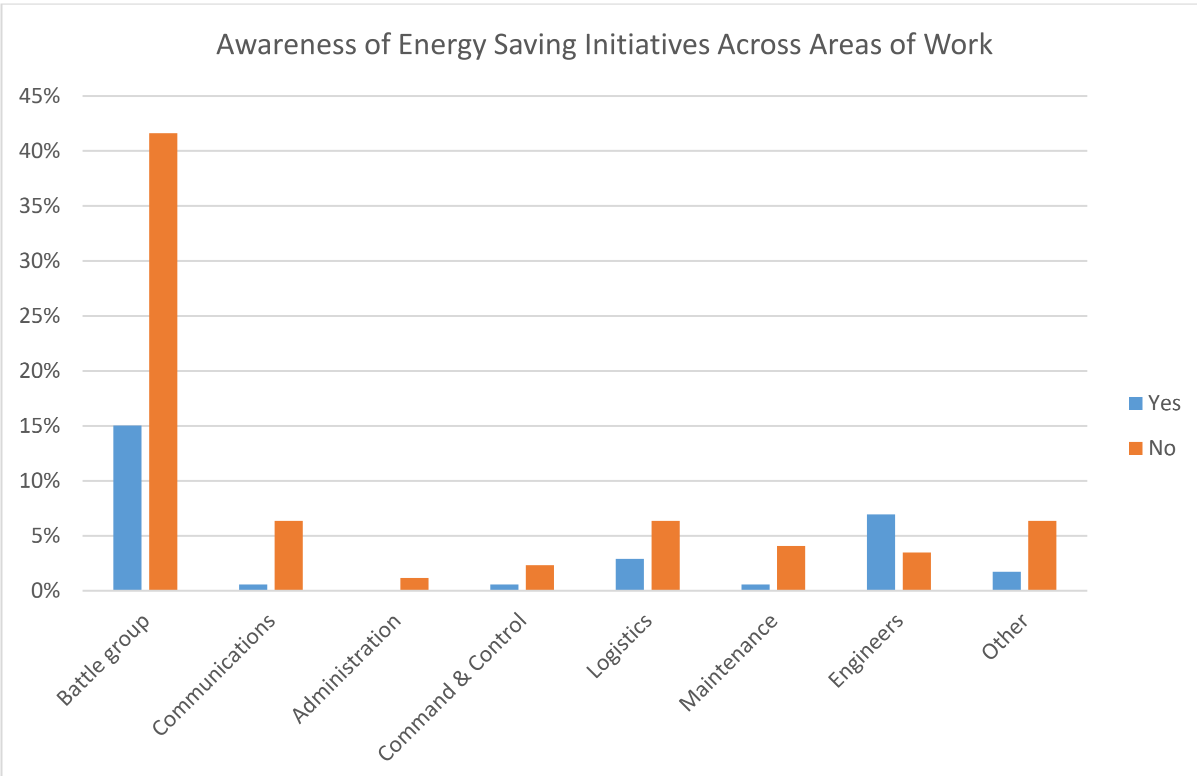
- Of the 174 participants, 170 provided the details of their rank.
- There were 20 participants who self-identified as having an (informal) energy role, five of who were Officers, three were Senior Non-Commissioned Officers (SNCO) and 12 were Junior Non-Commissioned Officers (JNCO).

Graph 2: Rank and Energy Saving Initiative Awareness



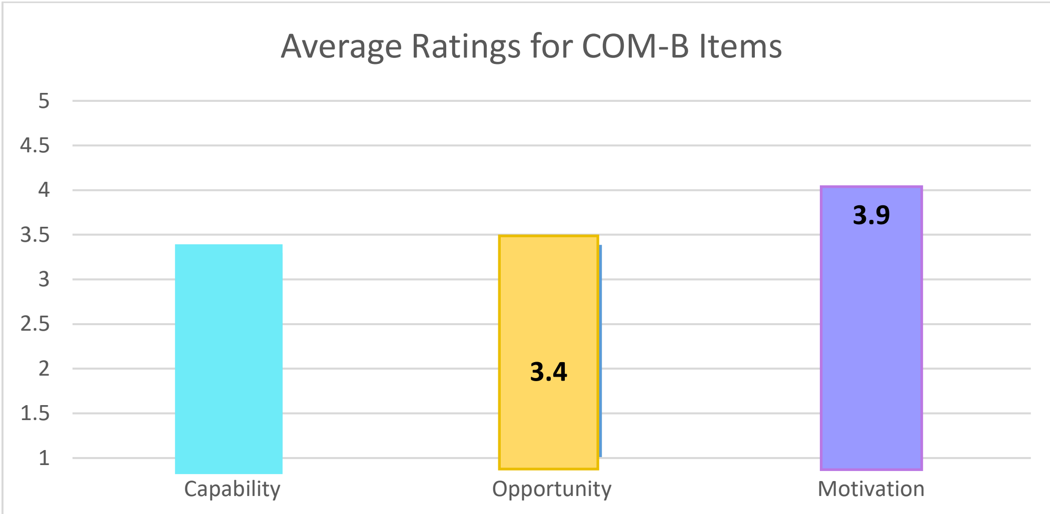
- Within all rank categories, the majority of people responded that they were not aware of any energy saving initiatives at the camp.
- The rank category that reported the highest proportion of awareness of energy saving initiatives at the camp were the Officers, but only marginally (31% compared to 29% for SNCOs and 26% for JNCOs). This provides some opportunity to use the Chain of Command structure to relay the knowledge of Officers about energy saving initiatives to SNCOs and JNCOs.

Graph 3: Awareness of Energy Saving Initiatives Across Areas of Work



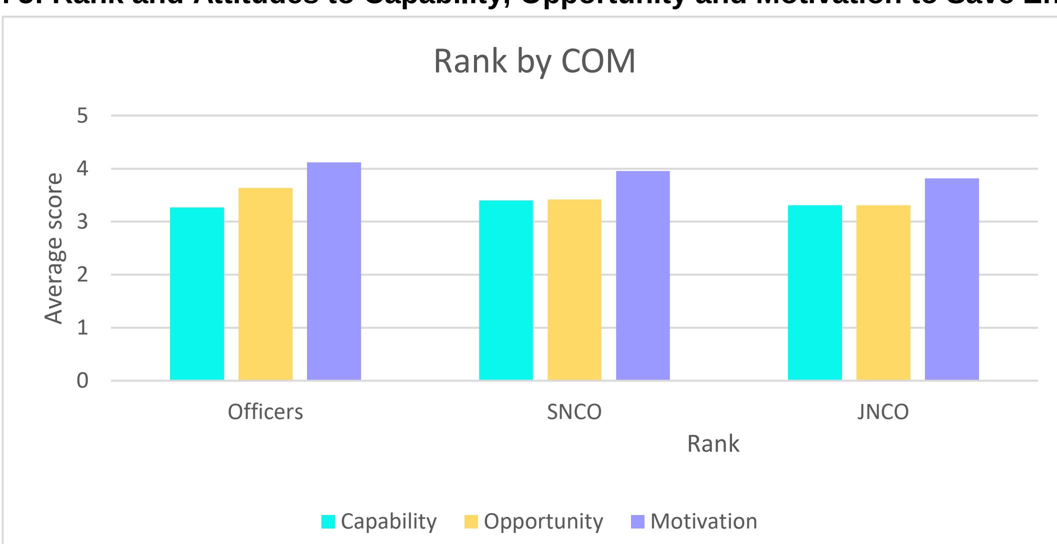
- The majority of people reported that they were working in the Battle Group (BG).
- This graph shows that in almost all areas of work (7/8), the majority of people reported that they were not aware of any energy saving initiatives.
- In the work category of engineers, more people stated that they were aware of energy saving initiatives thank those who said they were not aware.

Graph 4: Attitudes Towards Capability, Opportunity and Motivation to Saving Energy



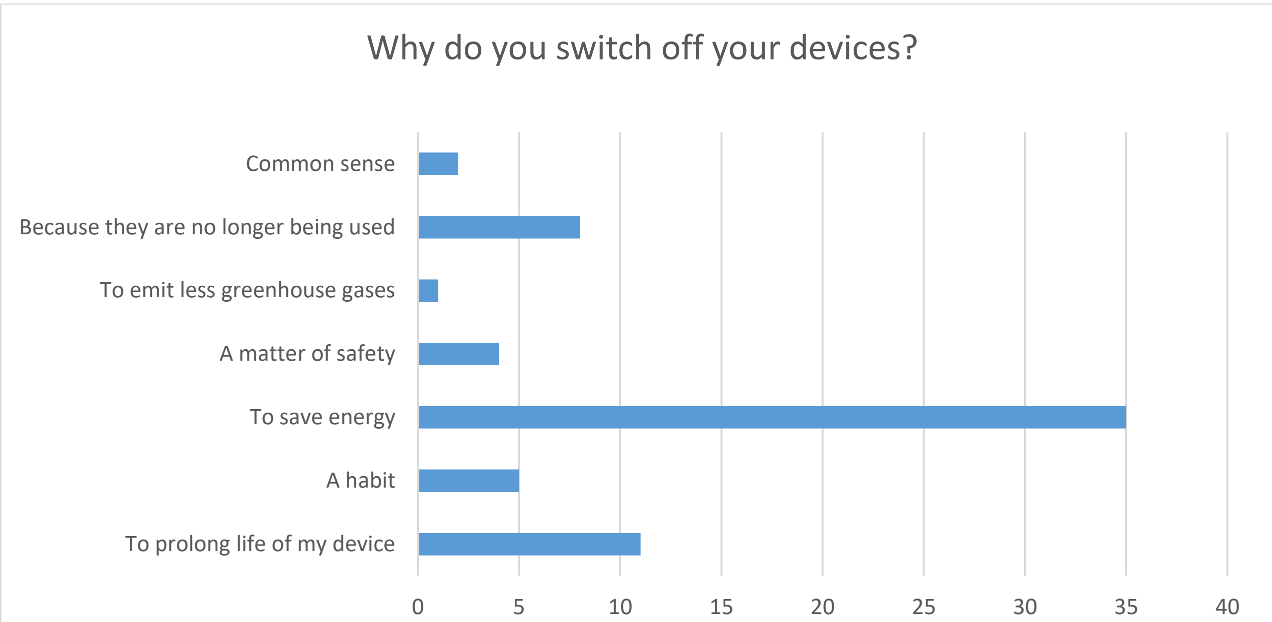
- A section of questions in the questionnaire were focused on identifying people's attitudes towards their own Capabilities (C), Opportunities (O) and Motivation (M) to save energy.
- Participants were asked to indicate their level of agreement with a series of statements relating to Capabilities (C), Opportunities (O), and Motivation (M) to save energy, where 1 represented 'strongly disagree' through to 5 for 'strongly agree'.
- The results of analysing the responses to the COM-related questions show that, for all three items, the average rating was between 3 (representing a 'neutral' attitude to the statement) and 4 (representing 'agree' with the statement). This means that, on average, the participants are slightly more likely to agree that they have the Capability (3.3), Opportunity (3.4) and Motivation (3.9) to save energy, than disagree.
- Motivation was found to be stronger than Opportunity and Capability to save energy, which leads to the recommendation to focus on improving the Opportunities and Capabilities to save energy.

Graph 5: Rank and Attitudes to Capability, Opportunity and Motivation to Save Energy



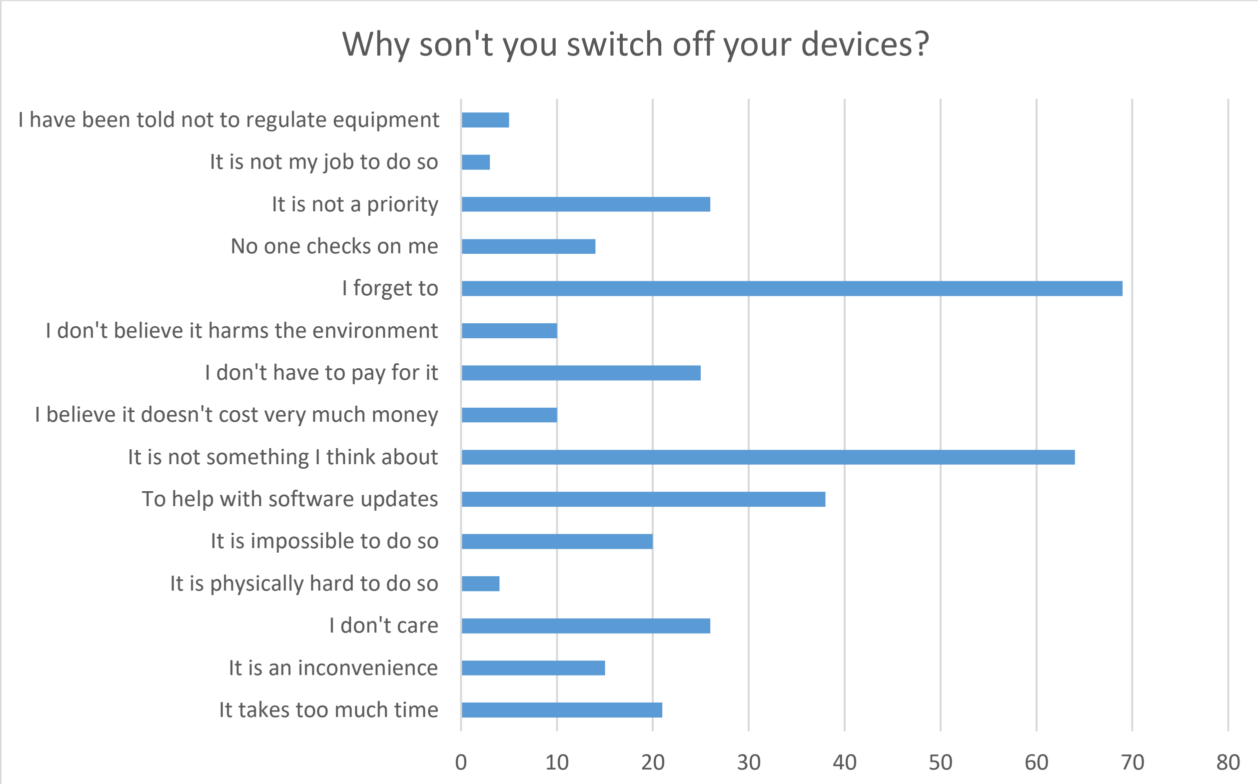
- Officers were more likely to agree that they have the Opportunity and Motivation to save energy than SNCOs and JNCOs.
- SNCOs were more likely to agree that they have the Capability to save energy than the Officers and the JNCOS.
- In all three rank categories, people felt more Motivation to save energy than they felt they had the Capability or Opportunity to do so.
- Thus, cooperation with Motivated Officers should be used to improve the Capability and Opportunity to save energy across other ranks.

Graph 6: Reasons for Switching Off Electrical Devices



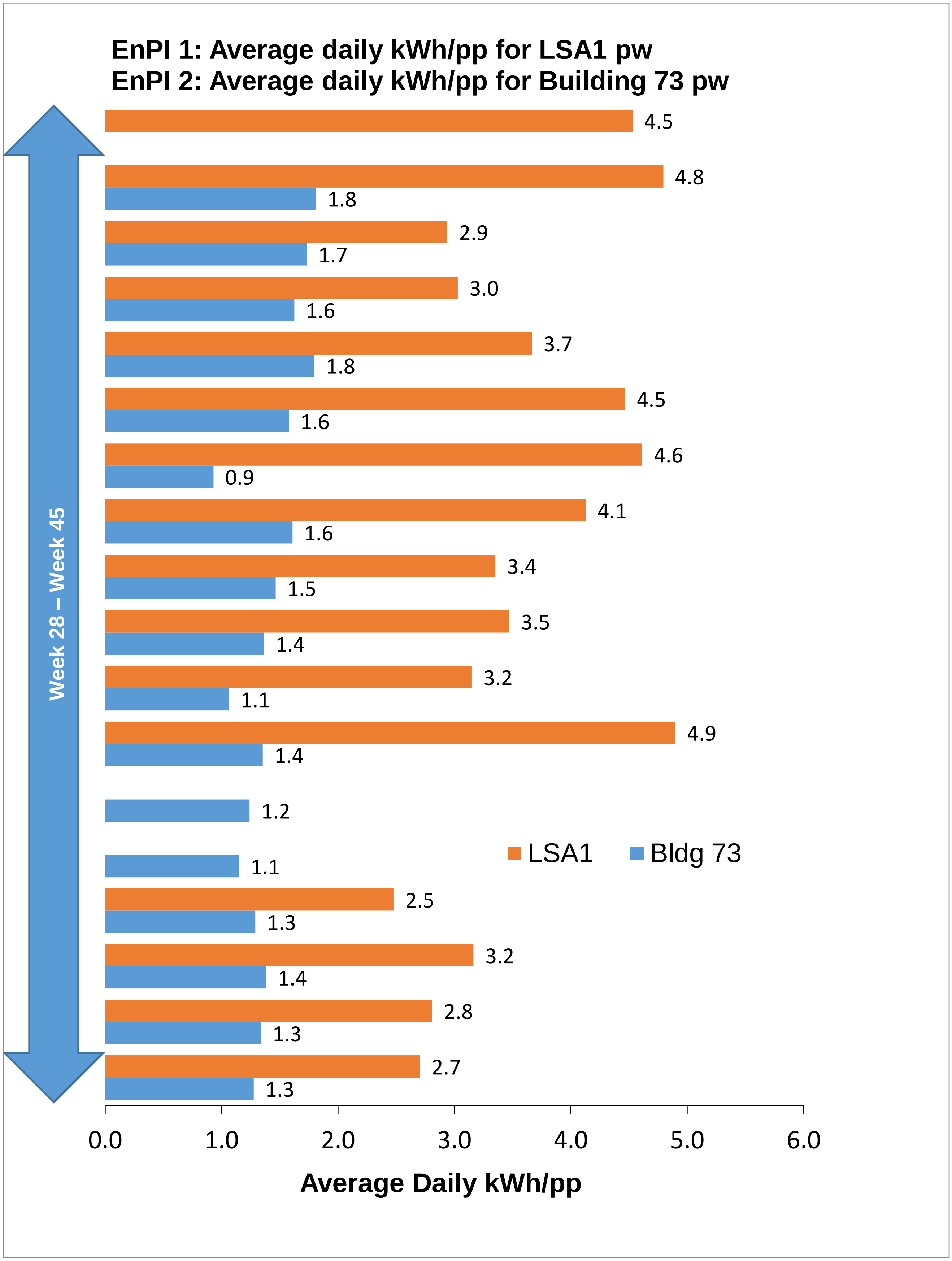
- Free-text responses for examples of things that would help to save energy included:
    - More information/training about energy saving.
    - Posters/reminders about switching off the devices.
    - Qualitatively better equipment.
    - Using natural lighting more often.
    - Better insulation of buildings.

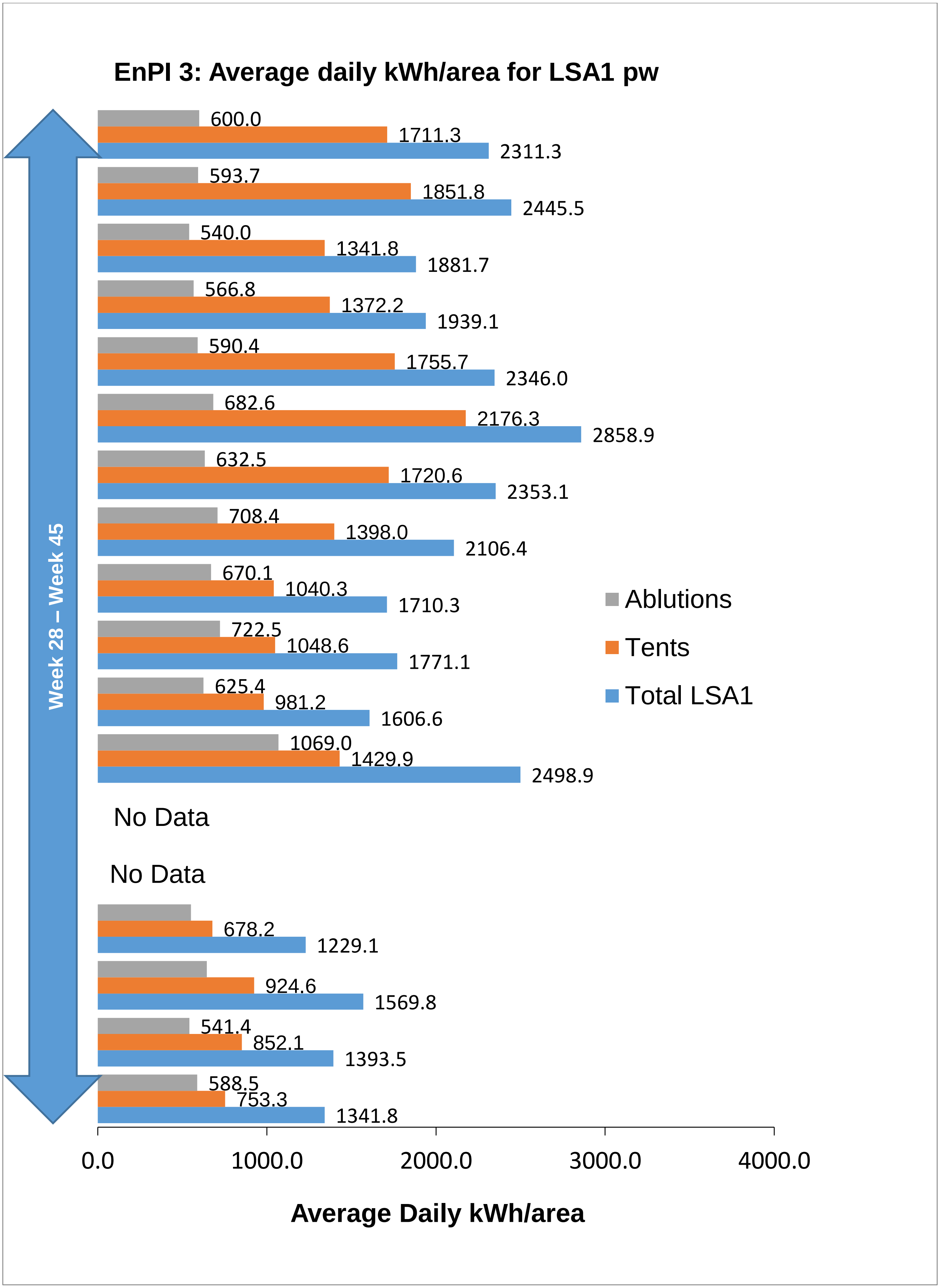
Graph 7: Reasons for Not Switching Off Devices

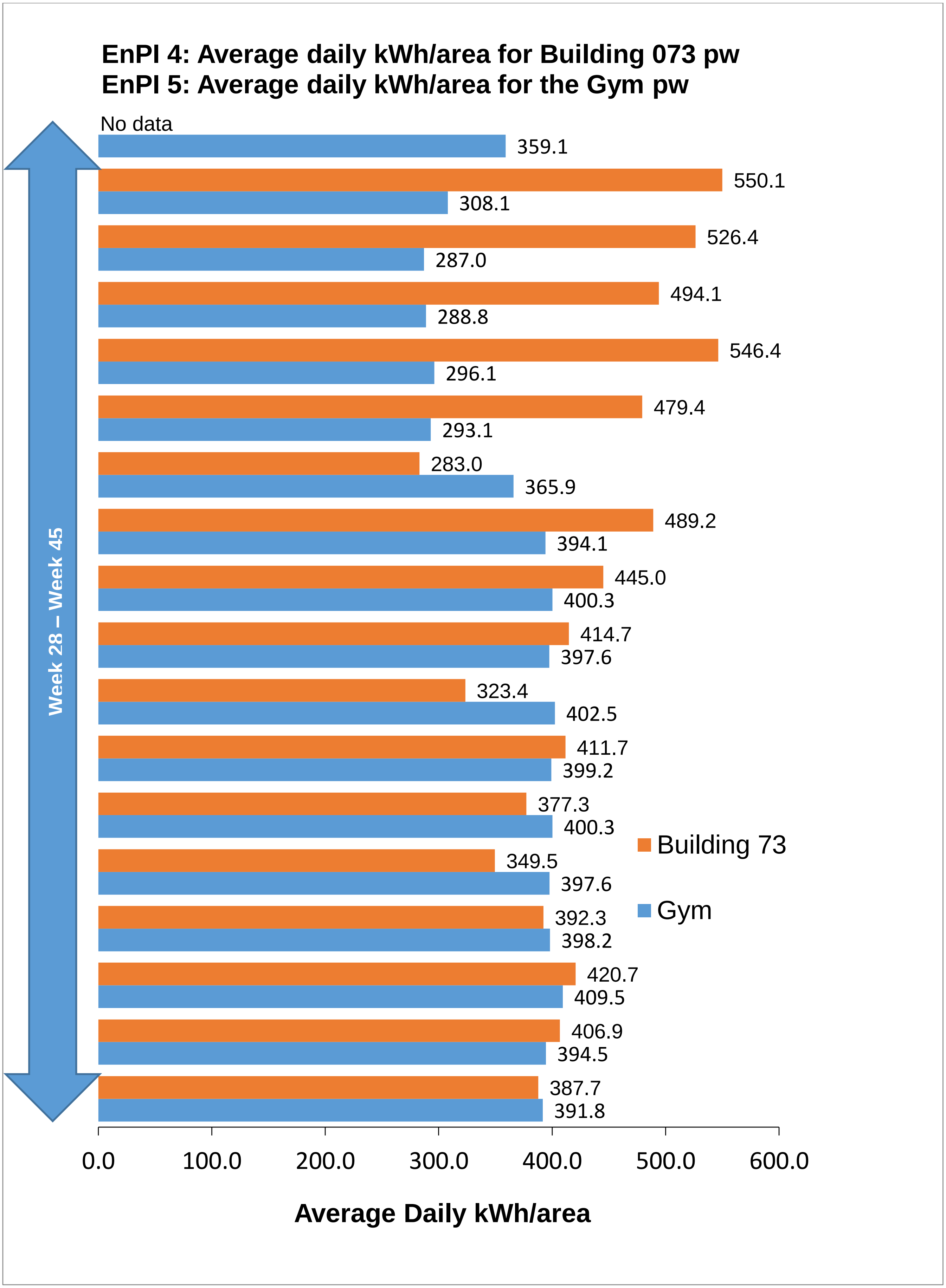


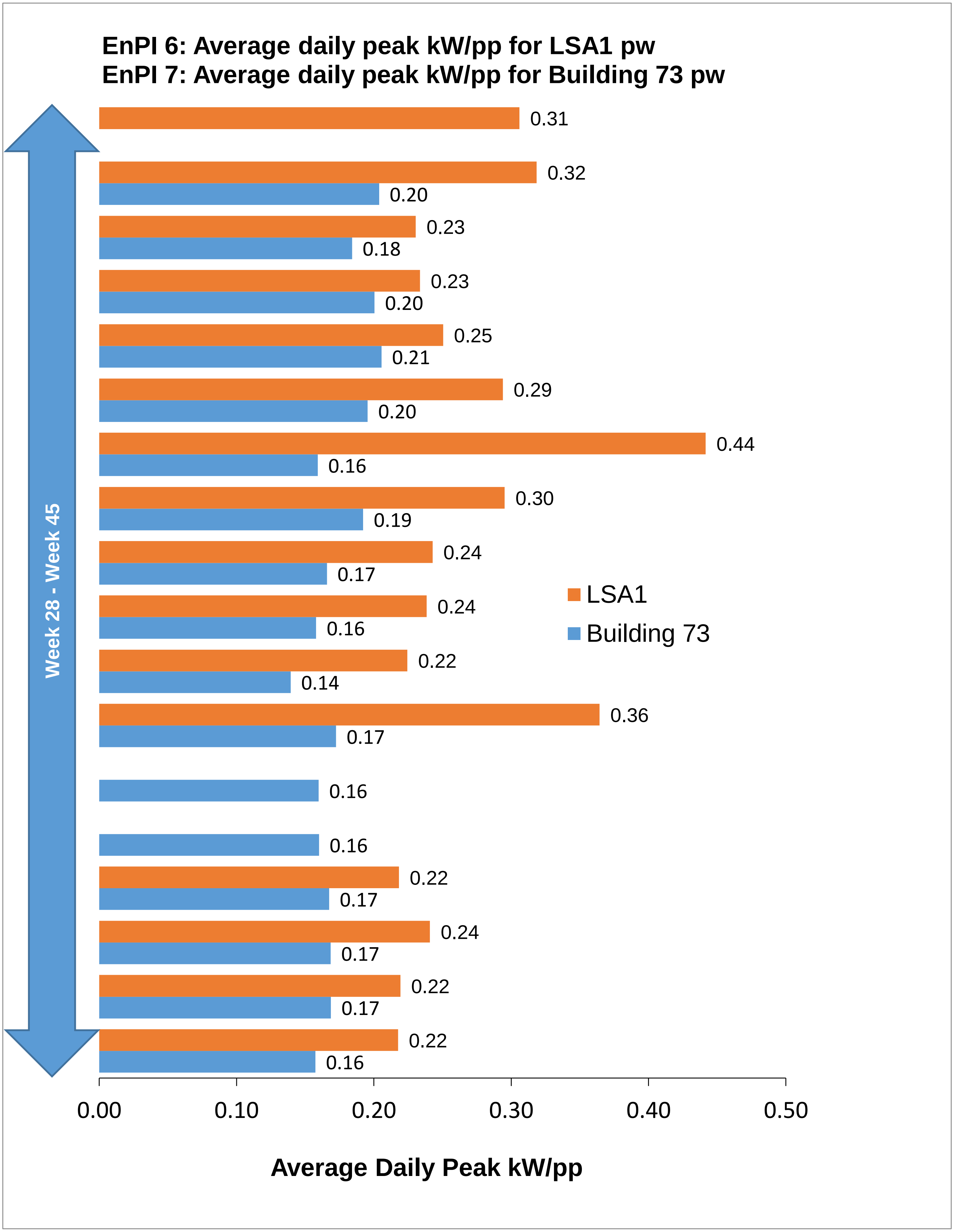
- The most popular reason chosen from the pre-set options provided for not switching off devices was “I forget” (69 people).
- The second most popular response was “It is not something I think about” (64 people) and the third most popular response was “To help with software updates” (38 people).
- Thus, changes to energy management procedures should focus on reminding people to switch off devices, explaining the benefits, and confirming whether or not it is necessary to leave equipment on for software updates to take place.
- The most popular free-text reason provided for why people think that their colleagues do not switch off their electrical devices was “laziness” (9 responses).

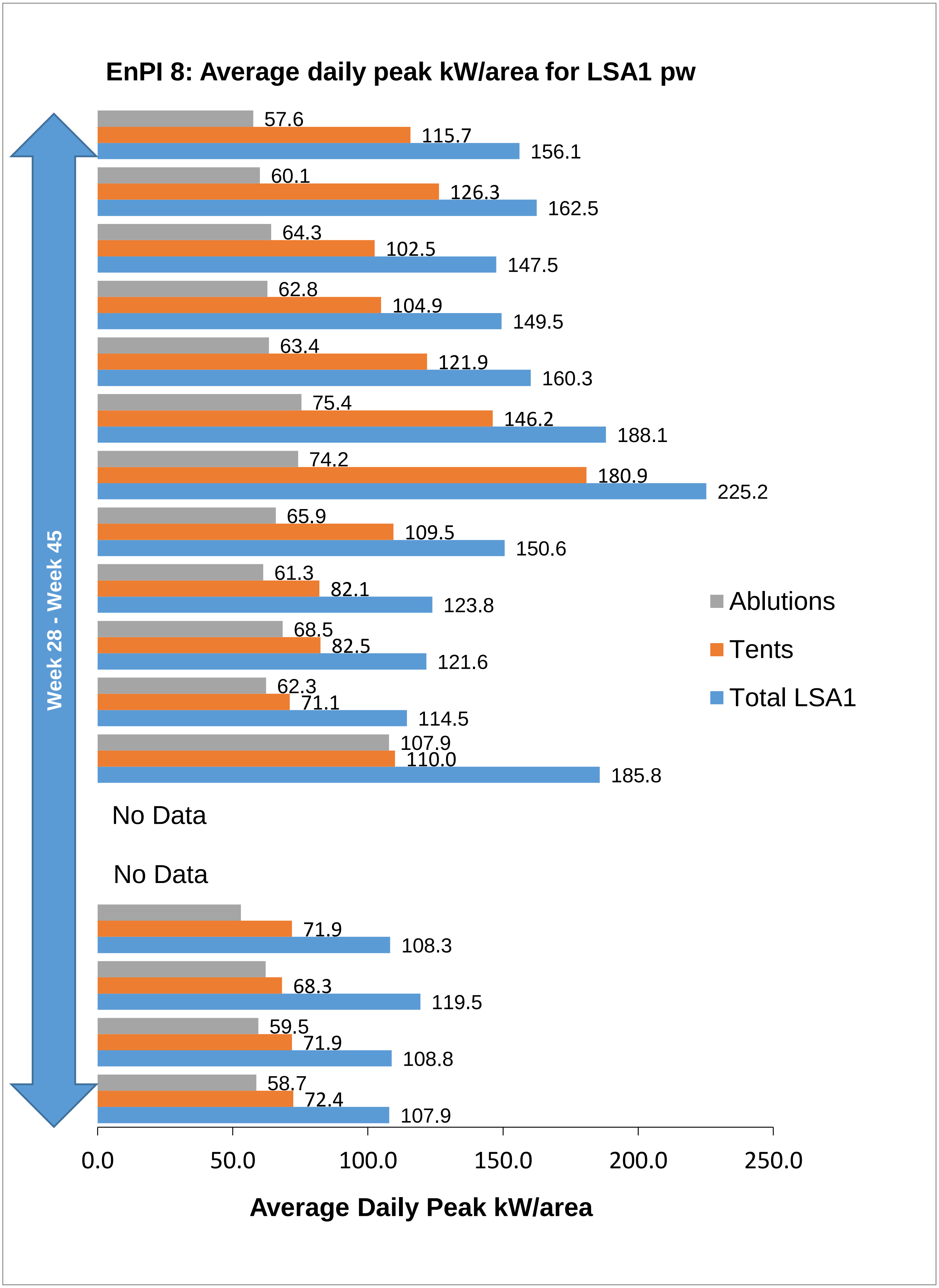
ANNEX L: Case Study 3 - eFP Latvia EnPIs

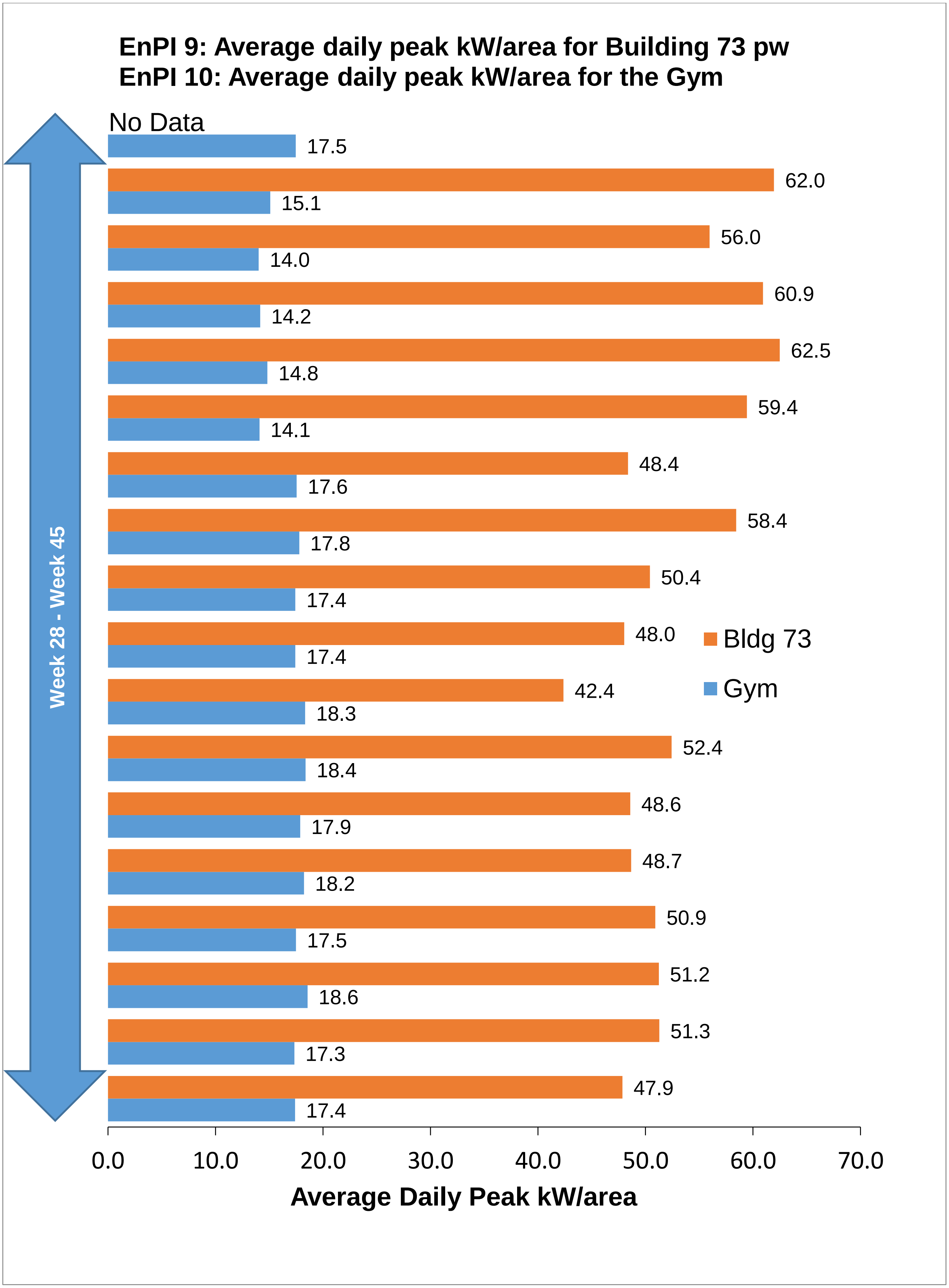



EnPI 3: Average daily kWh/area for LSA1 pw
Week 28 – Week 45
600.0
1711.3
2311.3
593.7
1851.8
2445.5
540.0
1341.8
1881.7
566.8
1372.2
1939.1
590.4
1755.7
2346.0
682.6
2176.3
2858.9
632.5
1720.6
2353.1
708.4
1398.0
2106.4
670.1
1040.3
1710.3
722.5
1048.6
1771.1
625.4
981.2
1606.6
1069.0
1429.9
2498.9
No Data
No Data
678.2
1229.1
924.6
1569.8
541.4
852.1
1393.5
588.5
753.3
1341.8
0.0
1000.0
2000.0
3000.0
4000.0
Average Daily kWh/area
Ablutions
Tents
Total LSA1


EnPI 4: Average daily kWh/area for Building 073 pw
EnPI 5: Average daily kWh/area for the Gym pw
No data
359.1
550.1
308.1
526.4
287.0
494.1
288.8
546.4
296.1
479.4
293.1
283.0
365.9
489.2
394.1
445.0
400.3
414.7
397.6
323.4
402.5
411.7
399.2
377.3
400.3
349.5
397.6
392.3
398.2
420.7
409.5
406.9
394.5
387.7
391.8
Week 28 – Week 45
Building 73
Gym
0.0
100.0
200.0
300.0
400.0
500.0
600.0
Average Daily kWh/area


EnPI 6: Average daily peak kW/pp for LSA1 pw
EnPI 7: Average daily peak kW/pp for Building 73 pw
Week 28 - Week 45
0.31
0.32
0.20
0.23
0.18
0.23
0.20
0.25
0.21
0.29
0.20
0.44
0.16
0.30
0.19
0.24
0.17
0.24
0.16
0.22
0.14
0.36
0.17
0.16
0.16
0.22
0.17
0.24
0.17
0.22
0.17
0.22
0.16
LSA1
Building 73
0.00
0.10
0.20
0.30
0.40
0.50
Average Daily Peak kW/pp


EnPI 8: Average daily peak kW/area for LSA1 pw
Week 28 - Week 45
57.6
115.7
156.1
60.1
126.3
162.5
64.3
102.5
147.5
62.8
104.9
149.5
63.4
121.9
160.3
75.4
146.2
188.1
74.2
180.9
225.2
65.9
109.5
150.6
61.3
82.1
123.8
68.5
82.5
121.6
62.3
71.1
114.5
107.9
110.0
185.8
No Data
No Data
71.9
108.3
68.3
119.5
59.5
71.9
108.8
58.7
72.4
107.9
Ablutions
Tents
Total LSA1
0.0
50.0
100.0
150.0
200.0
250.0
Average Daily Peak kW/area


EnPI 9: Average daily peak kW/area for Building 73 pw
EnPI 10: Average daily peak kW/area for the Gym
No Data
17.5
62.0
15.1
56.0
14.0
60.9
14.2
62.5
14.8
59.4
14.1
48.4
17.6
58.4
17.8
50.4
17.4
48.0
17.4
42.4
18.3
52.4
18.4
48.6
17.9
48.7
18.2
50.9
17.5
51.2
18.6
51.3
17.3
47.9
17.4
Week 28 - Week 45
Bldg 73
Gym
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
Average Daily Peak kW/area