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DEFENCE ENERGY AND ENVIRONMENT STRATEGY LACKS DEFINITIVE TARGETS FOR GHG REDUCTION IN MILITARY FLEETS

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JCSP 44

Exercise *Solo Flight*

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By Major Stephen Sultana

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Scientists have been warning the masses about Greenhouse Gas (GHG) emissions and global climate change for some time now. Incremental rises in the earth's temperature, melting of the polar ice caps, floods and droughts are all caused by GHG emissions. Scientists, environmental lobby groups, industry, and nations have argued over the merits of this wicked problem and how it can best be tackled. Internationally, nations have attempted to find resolution through treaties such as the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, and most recently the Paris Agreement. While Canada withdrew from the Kyoto Protocol in 2012, it reaffirmed its commitment to the Paris Agreement in 2017 even after the US decided to withdrawal[1]. To facilitate its commitment, the Canadian government created the Pan-Canadian Framework on Clean Growth and Climate Change (PCF). Subordinate to the Federal government's policy, DND adopted its own departmental policy to achieve the mandate set by the PCF, the Defence Energy and Environment Strategy (DEES). The DEES grouped defence activities into four goals: energy efficiency, sustainable operations, green procurement, and sustainable real property. Where the latter three goals focus on the environment, through managing contaminated sites and training areas, protecting flora and fauna, and integrating green procedures into business practices and real property development[2], the first goal of improving energy efficiency is focused on the reduction of GHG, and where this paper shall concentrate. Despite the promulgation of the DEES and its ability to achieve the goals set out in the PCF, the implementation of the DEES policy remains lacking as it fails to assign sufficient targets to the CAF which would decrease GHG emissions on deployed operations and

[1] Justin Trudeau, Statement by the Prime Minister of Canada in response to the United States' decision to withdraw from the Paris Agreement, Ottawa, Canada, 1 June 2017.
[2] Department of National Defence, *Defence Energy and Environment Strategy* (Ottawa: DND Canada, 2017), 16-26.

in military vehicle fleets. Determining the effectiveness of the DEES shall be accomplished through the analysis of each emitter of GHG, facilities, commercial vehicle fleets, deployed operations, and military vehicles fleets, compared to, or to the lack of policy targets.

PAN-CANADIAN FRAMEWORK ON CLEAN GROWTH AND CLIMATE CHANGE

The PCF was established to implement Canada's commitments made under the Paris Agreement, specifically to accelerate and intensify actions for a sustainable low-carbon future, and to limit the average temperature rise to well below 2 ^{O}C above pre-industrial levels. Development opened with a meeting of the First Ministers and the release of the Vancouver Declaration on March 3, 2016, where the First Ministers agreed to meet or exceed Canada's 2030 target of a 30% reduction below 2005 levels of GHG; reducing from 742 Mt to 523 Mt (Figure 1). Through a collaborative approach, the Provincial, Territorial, and Federal governments would work together with the citizens of Canada, including Indigenous Peoples, and other countries, to create a plan which would grow the economy while reducing emissions and building resilience to a changing climate. When the cost of inaction, estimated between $21-43B per year by 2050, is projected to be greater than the cost of action, the need for a Federal climate change policy was evident[3].

[3] Environment and Climate Change Canada, *Pan-Canadian Framework on Clean Growth and Climate Change* (Ottawa: Minister of Environment and Climate Change Canada, 2016), 1-2, 5.

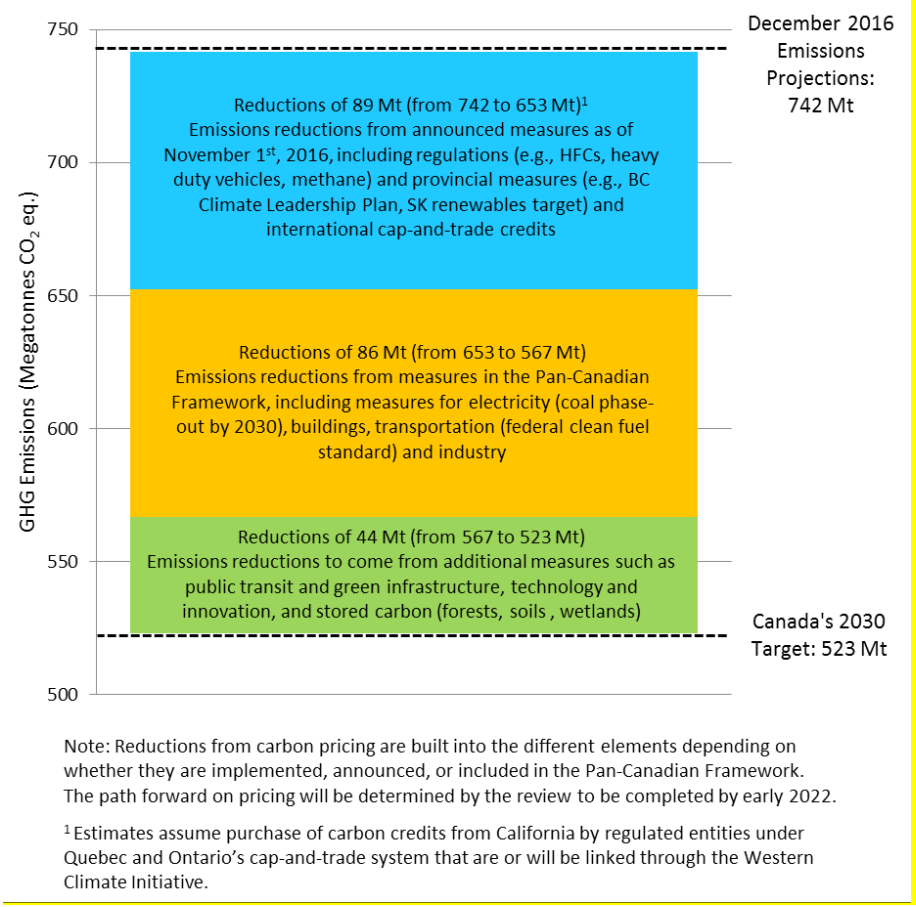

Figure 1. Pathway to meeting Canada's 2030 target[4]

The PCF has four main pillars, which together form the government's plan. First, pricing carbon pollution is aimed at reducing emissions, driving innovation, and encouraging people and business to pollute less. Secondly, the creation of complementary climate actions by sector including, electricity generation, building construction, transportation, industry, forestry and agriculture, and government to reduce emissions. For example, tightening energy efficiency standards and codes for vehicles and buildings will reduce emissions in their respective sectors. Thirdly, adapting and building resilience to climate change, by ensuring that Canada is

[4] *Ibid*., 45.

adequately prepared for floods, droughts, and wildfires. Lastly, investing in clean technology, innovation, and job creation to ensure Canada remains competitive in a low-carbon future[5].

The Second Annual Report on the Implementation of the PCF summarizes the progress achieved in 2018, including the adoption of the GHG Pollution Pricing Act, work on regulations governing coal-fired and natural gas-fired electricity generation, and how the government has streamlined access to programs to ensure companies can develop clean technology[6]. However, even with the progress published in the report, climate change watchdogs, Germanwatch, the NewClimate Institute, and the Climate Action Network, the publishers of the Climate Change Performance Index (CCPI), believe more can be done. The CCPI for 2019 monitored GHG emissions from 56 countries and the EU and compared the countries' status to categories of emissions, renewable energy, energy use, and climate policy (Figure 2). Overall Canada ranks an abysmal 54th, down from 51st the year before, and of the G20 countries was one of the lowest ranked for emissions, renewable energy, and energy use. Canada only fared well in the climate policy category, ranking 27th [7]. The watchdogs praise Canada's climate change diplomacy but suspect that there are gaps between the policy direction at the federal and provincial levels[8].

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[5] *Ibid.*, 2-3.
[6] Environment and Climate Change Canada, *Pan-Canadian Framework on Clean Growth and Climate Change Second Annual Synthesis Report on the Status of Implementation – December 2018* (Ottawa: Minister of Environment and Climate Change Canada, 2018), i-iii.
[7] Jan Burk *et al*, *Climate Change Performance Index Results 2019* (Bonn: Germanwatch, 2018), 3, 7-15.
[8] *Ibid*., 20.

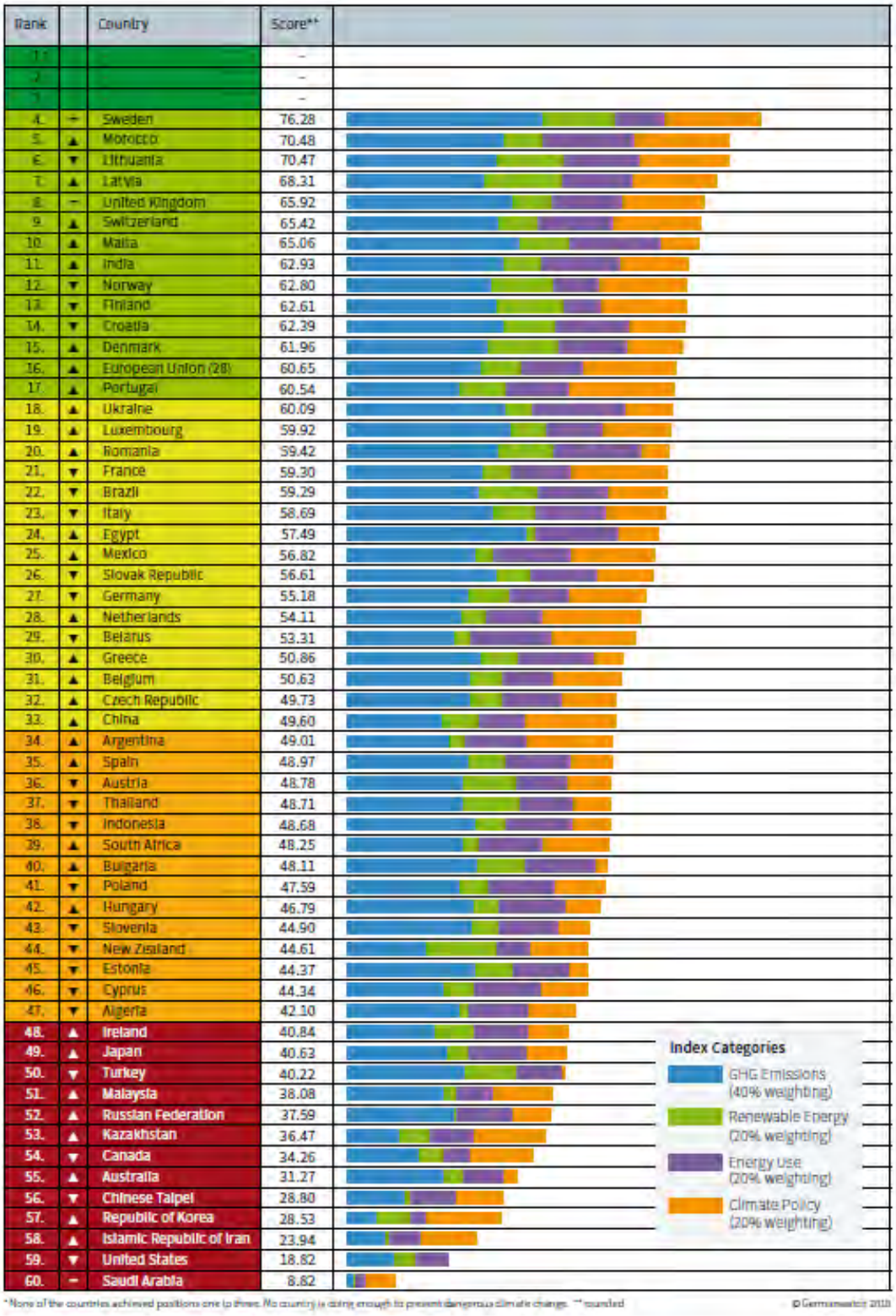

Figure 2. Overall results of the Climate Change Performance Index 2019[9]

DEFENCE ENERGY AND ENVIRONMENT STRATEGY

DND is the largest emitter of GHG in the Federal government, where real property and commercial vehicle fleet emissions alone make up 61% of the government's GHG emissions. As a result, under the Federal Sustainability Development Strategy (FSDS), DND prepared their own strategy, and in October 2017, for the first time, DND integrated both energy and environment strategy into one policy document, the DEES. DEES aims to delivery on four objectives: to waste less energy, use cleaner energy, reduce the defence environment footprint, and better manage energy and environmental performance[10]. As a subordinate departmental policy, DEES supports the PCF and is integrated with Strong, Secure, Engaged (SSE), Canada's defence policy[11]. DEES identifies 4 goals (Figure 3): energy efficiency, sustainable operations, green procurement, and sustainable real property, subdivided into initiatives and 18 measurable targets[12], six of which are shared with SSE. Nine of the 18 targets fall under the energy efficiency goal where the focus of reducing GHG emissions can be found. Four emitters of GHG, facilities, commercial vehicle fleets, deployed operations, and military vehicle fleets are addressed under this goal, and while there may be initiatives identified under this goal, not all of them have been designated with specific targets.

[10] Department of National Defence, *Defence Energy and Environment Strategy* (Ottawa: DND Canada, 2017), 3-4.
[11] *Ibid*., 8-9.
[12] *Ibid*., 4-5.

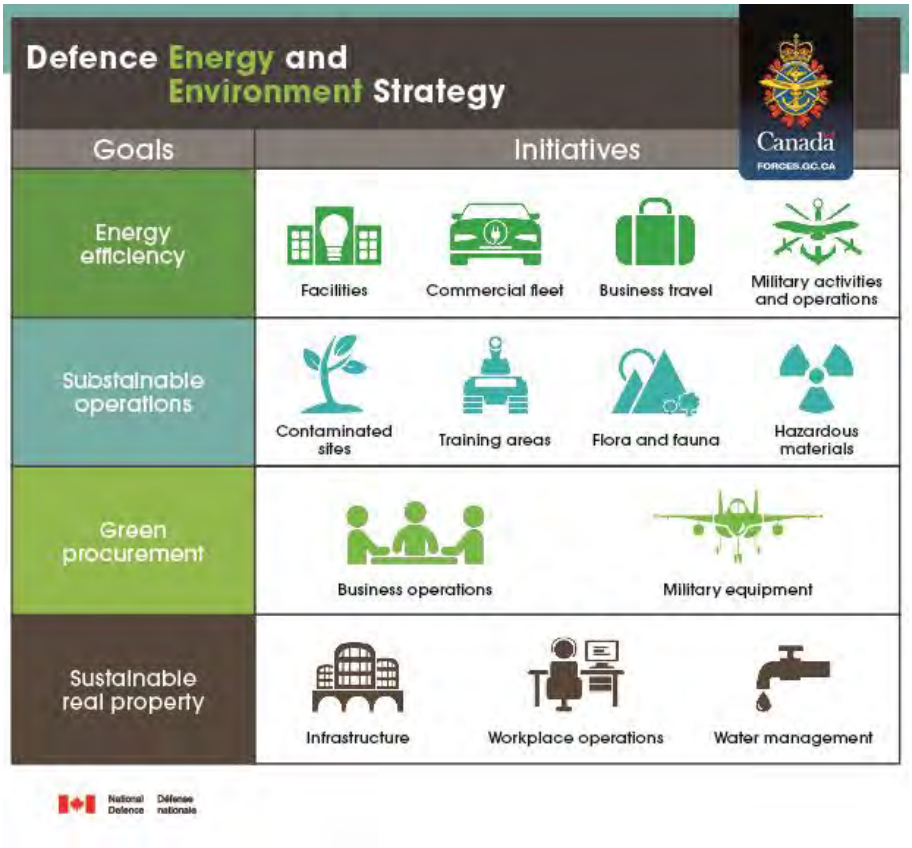

Figure 3. Defence Energy and Environment Strategy - Goals and Initiatives[13]

The first two targets are very broad and general in nature. Target 1 states that by 2030, DND will reduce GHG emissions in buildings and commercial vehicle fleets by 40%[14]. As a global overarching target, Target 1 can only be achieved if Targets 3 to 9 are successful. Failure to meet any of Targets 3 to 9 could result in an overall failure of Target 1. Target 2 states that DND will invest $225M by 2020 in a wide range of infrastructure projects across Canada to reduce DND's carbon footprint[15]. As this target is primarily based upon financial spending, the success of this target will also be based upon how successful that investment is. Spending $225M, without achieving the desired GHG reduction, would result in a failure of Target 2.

[13] *Ibid.*, 5.
[14] *Ibid.*, 9.
[15] *Ibid.*, 9.

FACILITIES

The first emitter to be analyzed is the DND facilities, and as the largest holder of real property and infrastructure in the Federal government, DND has determined it best to concentrate in this portfolio by assigning the greatest number of targets; Targets 3 to 7. A sound decision since much of the technology and innovation in this sector is already being developed by the non-defence construction and facilities management industry. DND is not required to develop its own niche technology, as it would when developing military operational equipment, as the rest of the world, from municipalities to large corporations are already using tested and reliable technology.

Target 3 states DND will designate energy managers at all bases and wings by 31 Mar 2019. The role of the energy managers is to find opportunities to reduce GHG, identify inefficiencies through the constant monitoring of building systems, negotiate with utility companies, and conduct training on energy conservation for building occupants[16]. At this time DND was able to hire 27/30 energy managers (90%), with the remaining staff to be hired in the fall of 2019.

The pursuit of opportunities to use clean power at all bases and wings by 2025 has been identified as Target 4. Generating renewable power through solar and wind farms on underused DND property provides great possibilities to achieve this target. Currently, DND has implemented projects to provide solar power at 5 Wing Goose Bay and CFB Petawawa[17].

Target 5 requires that new construction and major recapitalization projects meet or exceed the Leadership in Energy and Environmental Design (LEED) Silver standard for higher performance buildings, while Target 6 mandates the achievement of an EnerGuide energy

[16] *Ibid.,* 10.
[17] *Ibid.,* 10-11.

performance standard for all new or recapitalized residential housing units by 31 March 2020[18]. Both are achievable through the adherence of current design and construction practices. Several DND construction projects are striving for the LEED Silver standard including the refurbishment of the antiquated heating plant at CFB Halifax, which currently represents 17% of DND's GHG emissions. Once the refurbishment is completed, emissions are expected to be reduced by 7%[19].

Lastly, Target 7 states that DND will implement new energy performance contracts (EPC) at all bases and wings by 31 March 2025. Through these contracts DND partners with private industry to assess a facility's systems, identify energy savings, and then implement the recommendations. Approximately 30 EPCs are planned for all major defence installations[20]. Promulgation of the Green Building Directive by the Assistant Deputy Minister for Infrastructure and Environment (ADM (IE)), further reinforces the direction for having individually metered buildings to assist the energy managers, striving for LEED Silver and EnerGuide accreditation, and the implementation of EPCs[21].

COMMERCIAL VEHICLE FLEET

Unlike the facilities emitter, the commercial vehicle fleet emitter only has one target associated with it. Target 8 states that DND will ensure that 30% of its light-duty vehicle fleet runs on hybrid, plug-in hybrid and/or electric technology, where suitable for operational needs and where vehicles with this technology are available in the Government Motor Vehicle Ordering Guide by 31 March 2020[22]. This target exceeds the 20% commercial hybrid and

[18] *Ibid*., 11-12.
[19] Department of National Defence, *Defence Investment Plan 2018* (Ottawa: DND Canada, 2018), 19.
[20] Department of National Defence, *Defence Energy and Environment Strategy* (Ottawa: DND Canada, 2017), 12.
[21] Department of National Defence, *ADM(IE) Green Building Directive* (Ottawa: DND Canada, 2018), 6-7.
[22] Department of National Defence, *Defence Energy and Environment Strategy* (Ottawa: DND Canada, 2017), 13.

electric vehicle fleet identified in SSE[23], and would include passenger cars from compacts to intermediate sedans, and light-duty trucks from minivans and SUVs to crew cab pick-up trucks and cargo vans. This target can also be easily achieved as the market has the capability to provide the required vehicles. With the amount of innovation currently ongoing in the hybrid and electric commercial vehicle fleet by industry leaders such as Tesla, DND may also be able to increase the size of class from light-duty trucks to heavy-duty trucks including tractor-trailers[24]. In order to support the use of hybrid and electric vehicles, DND has directed the installation of electric charging stations at new or recapitalized buildings for use with defence fleets and/or personal vehicles[25]. This means 2% of all parking spaces with the capacity to increase to 5% of all parking spaces shall be equipped with electric vehicle charging stations[26].

In addition to procuring hybrid and electrical vehicles, DND will incorporate best practices in design and land use planning to reduce the dependency of vehicles at bases and wings, and encourage carpooling and use of alternative forms of transportation including bicycles and transit.

DEPLOYED OPERATIONS

The first two emitters, facilities and commercial vehicle fleets, can be more easily managed due to the considerable amount of commercially available products such as energy efficient windows and doors, to zero emission electric vehicles. The next two emitters commencing with deployed operations requires DND to conduct its own research and development with industry or partner with allied nations to develop technologies for reducing

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[23] Department of National Defence, *Strong, Secure, Engaged Canada's Defence Policy* (Ottawa: DND Canada, 2017), 112.
[24] Tesla, last accessed 16 May 2019, https://www.tesla.com/en_CA/semi.
[25] Department of National Defence, *Strong, Secure, Engaged Canada's Defence Policy* (Ottawa: DND Canada, 2017), 112.
[26] Department of National Defence, *ADM(IE) Green Building Directive* (Ottawa: DND Canada, 2018), 6.

GHG. Here is where DEES begins to lose some of its effectiveness. With only one target remaining in the goal to increase energy efficiency, Target 9, the reduction of petroleum-generated electrical energy consumption by 50% at deployed camps by 2030 rests solely on DND's shoulders to achieve[27].

In order to achieve this requirement, Canadian Joint Operations Command (CJOC) has issued direction which identifies two main process steps, the first is to understand the energy needs of deployed camps, followed by improving the camp design. Since energy usage is not being measured and reported systematically the installation of energy monitoring capabilities is required. Monitoring stations are now being installed at several deployed camps, including the Ali Al Salem Air Base in Kuwait, Ādaži, Latvia, and Ouallam, Niger[28]. Upon collecting the data, CJOC will be able to use the data to update current field manuals whose current specified energy requirements of 3.0kW/hour/person[29] are suspected to be too high, resulting in over design of generators, and needless consumption of diesel fuel. In spite of this, CJOC's ability to adequately monitor energy usage is greatly constrained as CJOC does not decide when, where and for how long forces will be deployed[30].

Furthermore, DND is developing a camp sustainment project aimed at reducing fossil fuel consumption by 25-50%, water demand by 50-75%, and liquid and solid waste by 50-75%. Expected to be delivered by 2029, no single technology can be used to achieve the desired reductions, and thus the project is investigating numerous technologies such as power management systems, renewable energy systems, and energy storage[31]. The camp sustainment

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[27] Department of National Defence, *Defence Energy and Environment Strategy* (Ottawa: DND Canada, 2017), 14.
[28] 1261-1 J Engr Env Implementation Plan Integrated Camp Utility Technologies Update 001 dated 17 May 2018.
[29] Department of National Defence, B-GL-361-012/FP, *Engineer Field Manual Vol 12 Accommodations, Installations, and Engineering Services* (Ottawa: DND Canada).
[30] 1261-1 J Engr Env Implementation Plan Integrated Camp Utility Technologies dated 21 Dec 2017.
[31] Department of National Defence, *Defence Investment Plan 2018* (Ottawa: DND Canada, 2018), 19.

project along with the tactical power project, aimed at increasing the output of tactical generators, provides an ideal opportunity to meet Initiative 102 of SSE[32], by incorporating the use of alternative fuels. Regrettably, at this time the use of alternative fuels is not being considered, and the efforts to incorporate them in military vehicle fleets even less so.

MILITARY FLEET VEHICLES

Reducing GHG emissions from the fleet of military vehicles is where DEES struggles the most. Lacking any specific targets, DEES only provides very broad and generic direction such as considering options to make use of synthetic fuels for the military fleet where possible, and subject to the availability and affordability of these fuels[33]. Compare this to the emphasis being placed upon developing alternative fuels by other nations such as the US and India for their military vehicle fleets, and Canada falls behind. This may be a result of loopholes found in the Kyoto Protocol where nations were not required to report or act upon the GHG emissions of their respective armed forces, or in the Paris Agreement where countries will no longer be automatically excluded from including their carbon emissions under national reductions targets yet still not be obliged to cut their military emissions[34].

Though the US has ratified neither the Kyoto Protocol nor the Paris Agreement, the US military being the largest institutional consumer of oil in the world, consuming more than 100M barrels of oil annually, can significantly benefit by finding ways to reduce its reliance on oil. For example, using that much oil makes the military vulnerable to price spikes where a $10 increase

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[32] Department of National Defence, *Strong, Secure, Engaged Canada's Defence Policy* (Ottawa: DND Canada, 2017), 112.
[33] Department of National Defence, *Defence Energy and Environment Strategy* (Ottawa: DND Canada, 2017), 14.
[34] Arthur Nelson, "Pentagon to lose emissions exemption under Paris climate deal," The Guardian, (14 December 2015), https://www.theguardian.com/environment/2015/dec/14/pentagon-to-lose-emissions-exemption-under-paris-climate-deal.

in the price of a barrel of oil will cost the military billions of dollars. That is money that could be used on procuring more advanced equipment, or training soldiers. The threat of transporting that much fuel across the battlefield also creates concern where during operations in Afghanistan one in 24 fuel convoys ended in an American casualty[35]. For these reasons the US military has become the US government's de facto environmental leader striving to reduce its dependence on fossil fuels and driving leading-edge technological innovation[36].

Much of that innovation is taking place in the fields of fuel economy and alternative fuels. A necessity borne from the fact that much of the US military's fleets suffer from atrocious fuel economy; from the HUMVEE which on average gets 8 MPG on the highway and 4 MPG in the city to the M1 Abrams Main Battle Tank (MBT) whose 1,500 hp gas turbine engine is only rated at 0.6 MPG[37]. To demonstrate its ambition to become more fuel economic, the US Army has been developing a diesel-hybrid HUMVEE which is estimated to use 70% less fuel than the in-service variant. Making use of a front electric drive motor, hybrid rear drive motor, and start-stop system technologies, the prototype's fuel economy nearly doubled at 14.2 MPG highway and 8.2 MPG city[38]. Another advancement in hybrid technology is the diesel-electric amphibious ship, the USS Makin Island, the first hybrid naval ship of its kind. Using more fuel-efficient diesel-electric engines to power the ship when operating at speeds less than 12 knots, the ship uses only 15K gallons per day versus the 35-40K gallons used by similarly sized conventional

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[35] Union of Concerned Scientists, "The US Military and Oil," last accessed 16 May 2019, https://www.ucsusa.org/clean_vehicles/smart-transportation-solutions/us-military-oil-use.html.

[36] Jai Galliott, "Trump's Military as the de facto Environmental Leader," *Ethics, Policy & Environment*, vol 21, no. 1 (2018): 14.

[37] Michael G. Richard, "7 Gas Guzzling Military Combat Vehicles," Treehugger, (23 September 2008), https://www.treehugger.com/cars/7-gas-guzzling-military-combat-vehicles.html.

[38] John Voelcker, "Army Diesel-Hybrid Concept: Twice the MPG, Just as Fierce as HUMVEE," Green Car Reports, (4 May 2012), https://www2.greencarreports.com/news/1075924_army-diesel-hybrid-concept-twice-the-mpg-just-as-fierce-as-humvee.

ships. Based upon these fuel reduction results, the US Navy plans to convert 35 of its 60 destroyers to hybrid engines[39].

In addition to just becoming more fuel efficient, US legislation has directed that the US military become petroleum free by 2040. The Renewable Fuel Standard, which Congress enacted in 2005 as part of the Energy Policy Act and the 2007 Energy Independence and Security Act mandates the increased consumption by volume of alternative fuels to 15B gallons of conventional biofuels, 1B gallons of biomass-based diesel fuel, 4B gallons of advanced renewable biofuels, and 16B gallons of cellulosic biofuels produced from wood, grasses, or non-edible plant parts by 2022[40]. To achieve these consumption rates, testing of alternative fuels was conducted by the US military. A US Navy Seahawk helicopter became the first military helicopter in history to fly on a 50-50 algae biofuel and jet fuel blend. Now the Navy is preparing to test the efficiency of a 50-50 algae biofuel and jet fuel blend in a US Navy F-18 Super Hornet[41]. Besides the US, the Indian Army, the world's 2nd largest standing army, is considering the use of biofuels for its MBT. The Defence Institute of Bio-energy Research (DIBER) in Haldwani, India along with eight other defence research laboratories are carrying out extensive research on different microalgae systems to extract biofuels[42]. Finally, one of the largest trials of biofuel use was the sailing of an entire carrier strike group, including an aircraft carrier with its

[39] Jeanette Steel, "Navy's First Hybrid Warship Goes to Sea," The San Diego Union Tribute, (14 November 2011), https://www.sandiegouniontribune.com/military/sdut-navys-first-hybrid-drive-warship-goes-action-2011nov14-story.html.
[40] John C.K. Daly, "US Military Gets Serious about Biofuels," Oil Price, (26 March 2012), https://oilprice.com/Alternative-Energy/Biofuels/U.S.-Military-gets-Serious-about-Biofuels.html.
[41] EcoFriend, "5 Military Vehicles that are Powered by Biofuel," last accessed 16 May 2019, https://ecofriend.com/5-military-vehicles-powered-biofuel.html.
[42] Krishna Chaitanya, "Army Goes Green, to Produce Biofuel for Battle Tanks," The New Indian Express, (16 March 2016), http://www.newindianexpress.com/states/tamil-nadu/2016/mar/16/Army-Goes-Green-to-Produce-Bio-fuel-for-Battle-Tanks-912184.html.

supporting destroyers, cruisers and submarines in 2016[43]. Now while this trial did not go off without any problems, including concerns over the cost of biofuels, it definitely demonstrated what is feasible through the use of renewable energy. Though the motives of the US military may be solely on reducing its reliance on fossil fuels, studies have confirmed that the use of biofuels such as ethanol can provide GHG emission reductions of 40% while biodiesel has the potential to reduce emissions by 83%[44]. Witnessing these advances in innovation made by Canada's superpower neighbour to the south should not preclude Canada from also pursuing these opportunities, regardless of the lack of a specific target in DEES.

CONCLUSION

Brought into force by federal policies, both the PCF and FSDS and supported by the defence policy, SSE, DEES sets out to achieve the goals mandated by its superior policies. Sadly, the implementation of the DEES policy lacks potency as it fails to assign sufficient targets which would decrease GHG emissions on deployed operations and in military fleet vehicles. While Targets 1 to 8 could effectively be met through investments in infrastructure and hybrid, plug-in hybrid and electric commercial vehicles, DEES struggles with meeting Target 9 for deployed operations as the data on energy usage is not readily available and subject to operational fluctuations, and projects in development to further reduce emissions on deployments are not seriously considering the use of alternative fuels. Nonetheless, where the policy lacks the most is in its inability to provide targets for the reduction of GHG in the military vehicle fleets. While the US has opted out from ratifying any agreements to limit its GHG emissions, the US

[43] Jeanette Steel, "Navy's First Hybrid Warship Goes to Sea," The San Diego Union Tribute, (14 November 2011), https://www.sandiegouniontribune.com/military/sdut-navys-first-hybrid-drive-warship-goes-action-2011nov14-story.html.

[44] Melike Bildirici, "Impact of Military on Biofuels Consumption and GHG Emissions: The Evidence from G7 Countries," *Environmental Science and Pollution Research*, 25 (2018): 13562.

military still sees value in reducing its reliance on fossil fuels. It is in this area that the CAF through its collaboration with Canadian industry should be continuing to investigate options such as the use of biofuels and fuel-efficient vehicles, becoming an environmental leader in Canada by further reducing GHG, and facilitating green technology innovation which can later be used commercially by the civilian populace.

Bibliography

Bildirici, Melike. “Impact of Military on Biofuels consumption and GHG emissions: the evidence from G7 countries.” *Environmental Science and Pollution Research*, 25 (2018): 13560-13568.

Burk, J., U. Hagen, F. Marten, N. Hoehne, and S. Singer. *Climate Change Performance Index Results 2019*. Bonn: Germanwatch, 2018.

Buxton, Nick. “The elephant in Paris – the military and greenhouse gas emissions.” (19 November 2015). https://newint.org/blog/2015/11/19/the-military-and-greenhouse-gas-emissions.

Canada. Department of National Defence. *ADM(IE) Green Building Directive*. Ottawa: DND Canada, 2018.

Canada. Department of National Defence, B-GL-361-012/FP, *Engineer Field Manual Vol 12 Accommodations, Installations, and Engineering Services*. Ottawa: DND Canada.

Canada. Department of National Defence. *Defence Energy and Environment Strategy*. Ottawa: DND Canada, 2017.

Canada. Department of National Defence. *Defence Investment Plan 2018*. Ottawa: DND Canada, 2018.

Canada. Department of National Defence. *Implementation Plan Integrated Camp Utility Technologies*. Ottawa: DND Canada, 21 December 2017.

Canada. Department of National Defence. *Implementation Plan Integrated Camp Utility Technologies Update 001*. Ottawa: DND Canada, 17 May 2018.

Canada. Department of National Defence. *Strong, Secure, Engaged Canada’s Defence Policy*. Ottawa: DND Canada, 2017.

Canada. Environment and Climate Change Canada. *Pan-Canadian Framework on Clean Growth and Climate Change*. Ottawa: Minister of Environment and Climate Change Canada, 2016.

Canada. Environment and Climate Change Canada. *Pan-Canadian Framework on Clean Growth and Climate Change Second Annual Synthesis Report on the Status of Implementation – December 2018*. Ottawa: Minister of Environment and Climate Change Canada, 2018.

Chaitanya, Krishna. “Army Goes Green, to Produce Biofuel for Battle Tanks.” *The New Indian Express*. (16 March 2016). http://www.newindianexpress.com/states/tamil-nadu/2016/mar/16/Army-Goes-Green-to-Produce-Bio-fuel-for-Battle-Tanks-912184.html.

Daly, John C.K. “US Military Gets Serious About Biofuels.” *Oil Price*. (26 March 2012). https://oilprice.com/Alternative-Energy/Biofuels/U.S.-Military-gets-Serious-about-Biofuels.html.

EcoFriend. “5 Military Vehicles that are powered by Biofuel.” Last accessed 16 May 2019. https://ecofriend.com/5-military-vehicles-powered-biofuel.html.

Fernandes, G, J Fuschetto, Z Filipi, D Assanis, and H McKee. “Impact of military JP-8 fuel on heavy-duty diesel engine performance and emissions.” *Institution of Mechanical Engineers Part D Journal of Automobile Engineering* 221(8) (August 2007): 957-970. https://www.researchgate.net/publication/245391489_Impact_of_military_JP-8_fuel_on_heavy-duty_diesel_engine_performance_and_emissions

Galliott, Jai. “Trump’s Military as the de facto Environmental Leader.” *Ethics, Policy & Environment*, vol 21, no. 1 (2018): 13-16.

Gilroy, William G. “Understanding the 'wicked problem' of climate change.” *University of Notre Dame*. (21 December 2015). https://news.nd.edu/news/understanding-the-wicked-problem-of-climate-change/.

Government of Canada. “Federal Government to significantly reduce its own greenhouse gas emissions.” Last accessed 30 Mar 2019. https://www.canada.ca/en/treasury-board-secretariat/news/2016/11/federal-government-significantly-reduce-greenhouse-emissions.html.

Government of Canada. “Greening Defence.” Last accessed 30 Mar 2019. https://www.canada.ca/en/department-national-defence/services/greening-defence.html

Government of Canada. “Greening Government.” Last accessed 30 Mar 2019. https://www.canada.ca/en/treasury-board-secretariat/services/innovation/greening-government.html.

Lazarus, Richard J. “Super Wicked Problems and Climate Change: Restraining the Present to Liberate the Future.” *Environmental Law Reporter* no 40 (2010). http://www.law.harvard.edu/faculty/rlazarus/docs/articles/Lazarus_WickedELRArticle.pdf

Nelson, Arthur. “Pentagon to lose emissions exemption under Paris climate deal.” *The Guardian*. (14 December 2015). https://www.theguardian.com/environment/2015/dec/14/pentagon-to-lose-emissions-exemption-under-paris-climate-deal.

Richard, Michael, G. “7 Gas Guzzling Military Combat Vehicles.” *Treehugger*. (23 September 2008). https://www.treehugger.com/cars/7-gas-guzzling-military-combat-vehicles.html

Steel, Jeanette. “Navy’s First Hybrid Warship Goes to Sea.” *The San Diego Union Tribute*. (14 November 2011). https://www.sandiegouniontribune.com/military/sdut-navys-first-hybrid-drive-warship-goes-action-2011nov14-story.html.

Sun, Jiazhe, and Kaizhong Yang. “The Wicked Problem of Climate Change: A New Approach Based on Social Mess and Fragmentation.” (December 2016) 1-14.

Tesla. Last accessed 16 May 2019. https://www.tesla.com/en_CA/semi.

Trudeau, Justin. Statement by the Prime Minister of Canada in response to the United States’ decision to withdraw from the Paris Agreement, Ottawa, Canada, 1 June 2017.

Union of Concerned Scientists. “The US Military and Oil.” Last accessed 16 May 2019. https://www.ucsusa.org/clean_vehicles/smart-transportation-solutions/us-military-oil-use.html.

Voelcker, John. “Army Diesel-Hybrid Concept: Twice the MPG, Just as Fierce as HUMVEE.” *Green Car Reports*. (4 May 2012). https://www2.greencarreports.com/news/1075924_army-diesel-hybrid-concept-twice-the-mpg-just-as-fierce-as-humvee.