



SIMPLIFYING THE REIMBURSEMENT RATES FOR RENEWABLE ENERGY SYSTEMS

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BACKGROUND

About 90 percent of the electricity used by UN Peace Operations is produced by diesel generators. While providing a flexible and low upfront investment cost energy solution, diesel generators contribute to almost half of the greenhouse gas emissions from the UN Secretariat and are expensive to operate and maintain, with yearly fuel expenditures of over \$100 million (US dollars) across all missions. The reliance on diesel generators limits UN Peace Operations' energy autonomy and the delivery of diesel fuel to remote bases may represent a significant logistics and security challenge for the UN and Troop / Police contributors (T/PCC).

In several resolutions, the UN General Assembly encourages UN Peace Operations to reduce their environmental footprint, including through use of renewable energy sources. In addition, at the Climate Summit in 2019, the UN Secretary-General set ambitious climate targets for the UN Secretariat including transitioning to 80 percent renewable energy by 2030¹.

Guided by the Environment Strategy for Peace Operations, UN missions are progressively introducing renewable energy solutions to reduce their reliance on diesel generators. In 2020-2021, about five percent of the electricity used in UN Peace Operations was provided by renewable energy sources, mostly UN-owned solar photovoltaic (PV) systems, and local power grids supplied by renewable energy sources². Transformative changes will be required to accelerate the transition to renewable energy and meet the Secretary-General's targets in UN Peace Operations.

One of such changes involves the progressive deployment of contingent-owned (COE) renewable energy systems by T/PCC to reduce the use of diesel generators in the field. In 2020-2021, COE diesel generators produced about 35% of the electricity used in missions, while accounting for about 23% of the Peace Operations' greenhouse gas emissions³.

¹ Additional targets include a 25 percent reduction in per capita electricity consumption by 2025 and 35 percent by 2030; 25 percent reduction in greenhouse gas emissions by 2025 and 45 percent by 2030

² MONUSCO's connection to local hydropower grids in the Democratic Republic of Congo contributes to about half of the 5% share of renewable energy

³ COE generators are the third largest source of greenhouse gas emissions in UN Peace Operations, following UNOE diesel generators and aviation, contributing for 32 percent and 27 percent, respectively.



Aside from reducing the carbon footprint of field operations, the transition to renewable energy solutions can bring several other practical benefits for T/PCC, including but not limited to:

- Improving the energy autonomy and self-sustainment capacity of T/PCC by reducing their reliance on diesel fuel.
- Reducing the need for security escorts for fuel supply convoys, relieving the burden for convoy protection, thereby increasing T/PCC's capacity to perform substantive and mandated tasks.
- Reducing safety, security and health risks related to air pollutants, noise emissions, and handling flammable diesel fuel.
- Extending the life expectancy of COE diesel generators.
- Reducing the risk of soil and water pollution from fuel and lubricant spills.

The transition to renewable energy solutions is expected to bring cost savings as they undercut the cost of diesel generated energy in most peace operation settings. It is expected that the transition to renewable energy will reduce the amount of diesel fuel, lubricants, oil filters, air filters and other consumables used to generate electricity, while reducing the cost of environmental remediation and carbon emission offsets.

At the 2017 COE Working Group, the COE Manual was amended to introduce reimbursement modalities to encourage T/PCC to deploy renewable energy systems as major equipment. With the current COE modalities, low-penetration integrated diesel generator-solar photovoltaic systems are reimbursed based on a wet lease rate, with incentives ranging from 120% to 180% of the equipment prime power rate, increasing with the size of the generators they are combined with in a hybrid configuration. The amendment also specified that other types of renewable energy systems, including medium-to-high penetration hybrid systems, autonomous photovoltaic and battery systems, and other solar powered equipment such as solar photovoltaic lighting units, are reimbursed as a special case.

Despite the introduction of these reimbursement modalities in 2017, the deployment of renewable energy systems by T/PCC remains limited so far to a single pilot project executed by Bangladesh in 2021. This project consists in the voluntary contribution of a 10 kilowatts peak (kWp) solar PV system installed in a Bangladeshi camp located in Juba, South Sudan.

Informal consultations were held with several T/PCC in the context of the 2021 Seoul Peacekeeping Ministerial to discuss the challenges and issues that may have prevented the deployment of renewable energy in the field since the introduction of reimbursement modalities in the Manual in 2017.

These consultations have highlighted that the way in which the reimbursement modalities have been structured and phrased in the COE Manual in 2017 may be misinterpreted by T/PCC, leading to an inaccurate financial assessment that discourages the uptake of renewable energy solutions.

To support T/PCC in their analysis of the suitability of these solutions in their deployment to UN missions, it is proposed to amend the reimbursement modalities for low-penetration solar PV systems, by proposing a methodology providing clarity, flexibility, and predictability to the financial assessment process, and providing a sound balance between the pay-back period for the T/PCC and the business case for the United Nations. It is



also proposed to add a reimbursement rate for energy storage systems, which may be used in conjunction with renewable energy production systems.

PROPOSAL

The COE Manual includes wet lease reimbursement rates for low-penetration hybrid systems, consisting in a combined power generation set-up including both diesel generators and a solar photovoltaic (PV) system. These are under the major equipment category “Generators, renewable energy integrated diesel-photovoltaic” (Chapter 8, Annex A). The rates are expressed as a premium based on the prime power diesel generator only rate. This premium ranges between 120 percent to 180 percent of the equivalent prime power rate, increasing with the size of the generators the solar PV system is combined with in a hybrid setup.

Challenges with the current reimbursement modalities

The way the reimbursement modality for low-penetration hybrid systems is currently structured presents a number of challenges to T/PCCs who wish to conduct an assessment of the financial feasibility related to the deployment of such system and incentivize the uptake of the lowest possible solar PV capacity.

First, as currently worded, the COE Manual may be interpreted as indicating that low-penetration hybrid systems may only be reimbursed if integrated with ISO 8528 prime power standard and role generators. This type of generators is not common in UN field missions as most of the diesel generators deployed by T/PCC are still under the category “generators, stationary and mobile”. The transition from generators “stationary and mobile” to ISO 8528 prime power standard and role generators is beneficial and encouraged as it is expected to lead to significant energy efficiency and fuel savings, however it will require time given that in some cases T/PCCs are still using existing stock of non-ISO-generators. Since low-penetration solar PV systems can be integrated with non-ISO generators such as those currently deployed under the stationary and mobile category, it would be beneficial to incentivize this integration explicitly stating in the COE manual the reimbursement rate that would apply to low-penetration solar PV systems integrated with stationary, non-ISO 8528, generators. This would allow T/PCCs to financially evaluate this solution also for grids which involve the use of generators under the stationary and mobile category are in use.

Second, similarly to diesel generator only reimbursements, the reimbursement for solar PV systems has been defined based on set system capacity ranges with the solar PV capacity established based on the load rating of the prime power diesel generator it is connected to. This is explained through a footnote that reads “Allowable power penetration range (photovoltaic peak power kW to generator 100 per cent load rating kW) of 25–35 per cent”. This could lead to confusion in the calculation of the reimbursement, as in most cases a low penetration hybrid system would have a solar PV system integrated into a grid with multiple diesel generators, often of different capacities. The clarification to this ambiguity is partially found in Chapter 3 Annex A, appendix 3, paras 5 and 10 which indicate that for grids with “prime power” role generators, there is one prime power generator (multiple in the case of synchronized generator banks) capable of continuously servicing 100 per cent of the load with the 100 per cent back-up being considered as either a limited time running or an emergency standby power generator. However, given the daily and seasonal variation in load profile and the adoption of different capacity generators to optimize the fuel use, it may not be straight forward to assess which generator qualifies for the “prime power” reimbursement and therefore conclude what the reimbursement for the low penetration hybrid system should be.



Alternative approaches considered

Several approaches have been explored to simplify the interpretation of the reimbursement modalities for low-penetration hybrid systems and to make them applicable to a wider range of T/PCC power generation set ups. These include:

- Proposing a wet lease reimbursement rate also for low penetration hybrid systems involving generators under the stationary and mobile category, using the current modalities from the COE Manual.
- Using a rate based on the renewable energy penetration achieved by the proposed low penetration hybrid system, measured as the amount of energy produced by the solar PV system versus the total energy produced by the hybrid system.
- Using a value per kWp capacity of the solar PV system to determine the generic fair market value (GFMV) and derive a dry and wet lease reimbursement rate per kWp of nominal capacity.

After analysis, the first approach was deemed as inefficient particularly if the existing reimbursement strategy were to be used, which as discussed introduces ambiguity for systems with multiple generators and does not incentivize maximization of solar PV system capacities. The second solution was also discarded because the “real” renewable energy penetration would only be assessed after the system has been deployed and enough data is collected from its operation and before deployment only an estimate would be known.

Proposed amendment – Using a value per kWp of nominal capacity of the solar PV system to determine a dry and wet lease reimbursement rate per kWp

Amending the COE Manual to replace the existing complex reimbursement modalities for low-penetration solar PV systems with a simple lease rate calculated using a unit of nominal capacity (US\$ per kWp) offers the most flexible methodology to further encourage T/PCC to deploy such system in the field. The proposed methodology allows to simplify the financial assessment by T/PCC as it is independent of the type and the number of diesel generators the solar PV systems would be integrated with, thus allowing renewable energy systems to be integrated with prime power generators and stationary generators, the latter being the most common diesel generators currently deployed in the field. As solar PV systems are modular in nature and can be expanded over time, using a unit rate allows for simple adjustment of the reimbursement rate, proportionally to the size of the expansion and additional kWp.

Using a methodology based on a unit rate also allows to calculate the pay-back period for the T/PCC and the business case for the United Nations as represented by the ratio between the expected savings related to fuel economy (by producing electricity using solar energy rather than using diesel fuel-powered generators) and the COE reimbursement rates.

Low penetration solar PV systems

Using the UN global system contract for PV diesel hybrid power systems (PD/C0006/16), and baseline data collected in UN field missions through the Environment Strategy for UN Peace Operations as reference, a conservative average value of \$1650 per kW of peak nominal capacity for the solar PV system is proposed to estimate the GFMV and to derive dry and wet lease rates. This value would apply to the solar PV system



component of low-penetration hybrid systems (the generator being reimbursed using the existing COE Manual modalities), with a nominal capacity of up to 150 kWp. Using this value to estimate the GFMV, a dry lease rate and a wet lease rate of \$20 and \$23 per kWp of nominal capacity is proposed for the solar PV system. From this, dry and wet lease rates are proposed for various ranges of nominal capacity for solar photovoltaic system, as detailed at annex A. Low penetration systems with a nominal capacity greater than 151 kWp would be reimbursed as a special case.

Using these lease rates, the solar PV system **pay-back period for T/PCC is estimated to be between four and seven years**. It is worth noting that the expected life of solar systems is typically greater than ten years and that T/PCC could elect to repatriate or relocate the solar PV systems for continued use beyond this pay-back period. With these rates, the business case for the UN, as represented by the ratio between the savings related to fuel economy and the projected increase in COE reimbursement related to the deployment of renewable energy systems by T/PCC, is projected to be **cost neutral (or slightly positive)**.

Energy storage systems

It is also proposed to add a line to Chapter 8, Annex (pages 180 and 181/271) to indicate that energy storage systems used with solar PV systems would be reimbursed as a special case.

PROPOSED MANUAL TEXT

The proposed amendments are detailed in **Bold** at Annex A of this issue paper. The text proposed to be deleted is shown with ~~strikethrough text~~.

It is proposed to amend the text used at Chapter 8, Annex A (pages 180 and 181/271) to replace the current modalities with dry and wet lease rates for various ranges of nominal capacity for solar photovoltaic systems, calculated using a value of US dollar per kWp of nominal capacity.

It is proposed that solar PV systems and energy storage systems (when used in conjunction with the solar PV system) start to be reimbursed once commissioned and based upon confirmation and demonstration that the systems are operational and functioning.

FINANCIAL IMPLICATIONS

The proposed amendment is aimed at simplifying the financial assessment related to the deployment of low-penetration solar PV systems by T/PCC by providing a simple unit reimbursement rate per unit of peak capacity of the solar system. It is not expected to have significant financial implications as the unit rate proposed would provide reimbursement of similar value than with the current modalities, as shown in the example of calculation provided at Annex B of this issue paper. However, the amendment will simplify the financial assessment, likely leading to the deployment of more renewable energy systems by T/PCC, in line with the Environment Strategy for Peace Operations.

Overall, the proposed amendment is expected to allow T/PCC to deploy renewable energy system with a pay-back period of about four to seven years. In addition, the proposed methodology is expected to provide a cost



neutral (or slightly positive) business case to the UN, potentially leading to cost savings overall. For example, using a diesel cost of \$0.55 per litre, UN historical data related to generation efficiency and a solar energy capacity factor representative of African countries hosting UN Peace Operations, it is projected that using the approach proposed in this issue paper, deploying a 100 kWp solar PV system would result in a ratio for savings related to fuel economy divided by the COE reimbursement for the solar PV system of about 1.2 (e.g. fuel savings slightly greater than the amount reimbursed to the T/PCC).

The extent of these savings is highly dependent on the cost of diesel fuel, which is country specific and strongly influenced by the global geopolitical context. Any significant rise in the cost of diesel fuel in the market would improve the business case for the UN proportionally, still maintaining the pay-back period between four and seven years for the T/PCC.

PREVIOUS HISTORY

The issue paper has not been previously submitted to the Contingent-Owned Equipment Working Group for its consideration.



Annex A

Reimbursement rates for major equipment under a wet lease or dry lease arrangement

(United States dollars)

<i>Category of equipment</i>	<i>Type of equipment</i>	<i>Generic fair market value</i>	<i>Estimated useful life in years</i>	<i>Maintenance rate</i>	<i>Monthly dry lease rate</i>	<i>Monthly wet lease rate</i>	<i>No-fault incident factor (percentage)</i>	<i>Monthly non-United Nations POL</i>	<i>Painting rate</i>	<i>Repainting rate</i>
Electrical equipment										
Generators, stationary and mobile	20-30 kVA	42 338	12	142	312	454	0.5	309	221	324
	31-40 kVA	44 840	12	184	330	514	0.5	432	221	324
	41-50 kVA	59 156	12	186	435	621	0.5	555	221	324
	51-75 kVA	71 837	12	199	529	728	0.5	771	221	324
	76-100 kVA	76 447	12	220	563	783	0.5	1080	334	352
	101-150 kVA	87 486	12	292	622	914	0.2	1543	334	352
	151-200 kVA	114 705	15	441	656	1098	0.2	2160	334	352
	201-500 kVA	164 773	14	551	1008	1560	0.2	3086	362	407
	Greater than 500 kVA	Special case								
Generators, ISO 8528 prime power standard and role generator	20-30 kVA	18 200	6	475	256	731	0.2	309	221	324
	31-40 kVA	20 600	6	483	290	773	0.2	432	221	324
	41-50 kVA	26 300	6	553	370	923	0.2	555	221	324
	51-75 kVA	27 600	6	575	388	963	0.2	771	221	324
	76-100 kVA	32 300	6	725	454	1179	0.2	1080	334	352
	101-150 kVA	39 400	6	1033	554	1587	0.2	1543	334	352
	151-200 kVA	47 600	6	1308	669	1977	0.2	2160	334	352
	201-330 kVA	53 600	6	1633	753	2386	0.2	2800	362	407
	331-500 kVA	64 550	6	1808	907	2715	0.2	3086	362	407
	Greater than 500 kVA	Special case								



Category of equipment	Type of equipment	Generic fair market value	Estimated useful life in years	Maintenance rate	Monthly dry lease rate	Monthly wet lease rate	No-fault incident factor (percentage)	Monthly non-United Nations POL	Painting rate	Repainting rate
Generators, ISO 8528	Limited-time-running power generator		12							Wet lease reimbursement at 50 percent of equivalent prime power rate
	Emergency-standby power generator		12							Wet lease reimbursement at 30 percent of equivalent prime power rate
Generators, excess	Excess requirement (only for the period 2017-2020)									Wet lease reimbursement at 10 percent of equivalent prime power rate
Generators, renewable energy integrated diesel-photovoltaic	20-30 kVA low penetration hybrid system									Wet lease at 120 per cent of equivalent prime power rate
	31-40 kVA low penetration hybrid system									Wet lease at 125 per cent of equivalent prime power rate
	41-50 kVA low penetration hybrid system									Wet lease at 130 per cent of equivalent prime power rate
	51-75 kVA low penetration hybrid system									Wet lease at 135 per cent of equivalent prime power rate
	76-100 kVA low penetration hybrid system									Wet lease at 140 per cent of equivalent prime power rate
	101-150 kVA low penetration hybrid system									Wet lease at 145 per cent of equivalent prime power rate
	151-200 kVA low penetration hybrid system									Wet lease at 150 per cent of equivalent prime power rate
	201-300 kVA low penetration hybrid system									Wet lease at 160 per cent of equivalent prime power rate
331-500 kVA low penetration hybrid system									Wet lease at 180 per cent of equivalent prime power rate	
Renewable energy – solar photovoltaic system integrated with diesel generator(s) in a hybrid low-penetration configuration ⁴	24-36 kWp nominal capacity (integrated in a hybrid system with a 101-150 kVA total capacity)	49740	7	90	600	690	0.2			
	37-48 kWp nominal capacity (integrated in a hybrid system with a 151-200 kVA total capacity)	70434	7	128	850	978	0.2			
	49-80 kWp nominal capacity (integrated in a hybrid system with a 201-300 kVA total capacity)	106860	7	193	1290	1483	0.2			
	81-120 kWp nominal capacity (integrated in a hybrid system with a 331-500 kVA total capacity)	166500	7	301	2010	2311	0.2			
	121-150 kWp nominal capacity (integrated in a hybrid system with a 500-625 kVA total capacity)	224505	7	406	2710	3116	0.2			

⁴ Solar photovoltaic system integrated with diesel generator(s) where the solar photovoltaic system can provide between 25 and 35 per cent of the generator 100 per cent load rating as expressed in kW (kW=KVA*0,8). The dry and wet lease rates listed pertain to the reimbursement of the solar PV system only. The generator(s) is(are) to be reimbursed based on the applicable rates for the *generators, stationary and mobile*, and *generators, ISO 8528 prime power standards and role generator* categories as listed at Chapter 8, annex A.



<i>Category of equipment</i>	<i>Type of equipment</i>	<i>Generic fair market value</i>	<i>Estimated useful life in years</i>	<i>Maintenance rate</i>	<i>Monthly dry lease rate</i>	<i>Monthly wet lease rate</i>	<i>No-fault incident factor (percentage)</i>	<i>Monthly non-United Nations POL</i>	<i>Painting rate</i>	<i>Repainting rate</i>
	Greater than 151 kWp nominal capacity (integrated in a hybrid system with a greater than 626 kVA total capacity)	Special case								
Other types of renewable energy systems	Renewable energy storage systems⁵	Special case								
	Medium and high penetration ^h hybrid systems power penetration (photovoltaic peak power kW to generator 100 per cent load rating kW) of greater than 35 per cent ^c	Special case								
	Autonomous photovoltaic and battery systems, with or without backup or peak demand generators ^c	Special case								
	Solar photovoltaic area and street lighting units, equipped with LEDs, batteries and sensors-timers ^c	Special case								
	Other renewable energy systems	Special case								

⁵ Renewable energy storage systems are to be used in conjunction with a solar PV system in low, mid or penetration hybrid configuration.



Annex B EXAMPLE OF CALCULATION OF THE REIMBURSEMENT RATE FOR SOLAR PV SYSTEM USING THE CURRENT AND THE PROPOSED REIMBURSEMENT MODALITIES

Diesel generator capacity (kVA)		Solar PV system integrated with the diesel generator(s)			Total reimbursement
Setup	Monthly wet lease rate	Nominal capacity for low penetration	Reimbursement modality	Monthly reimbursement	
Current reimbursement modalities in COE Manual 2020					
Generators, stationary and mobile					
175 kVA	1098 US\$	No modalities in the COE Manual 2020 for renewable energy integrated diesel-photovoltaic for the category "Generators, stationary and mobile"			No modalities in the COE Manual 2020
Generators, ISO 8528 prime power standard and role generator					
175 kVA	1977 US\$	42 kWp (30% of generator capacity)	Wet lease reimbursement at 150 per cent of equivalent prime power rate	2966 US\$	2966 US\$ / month



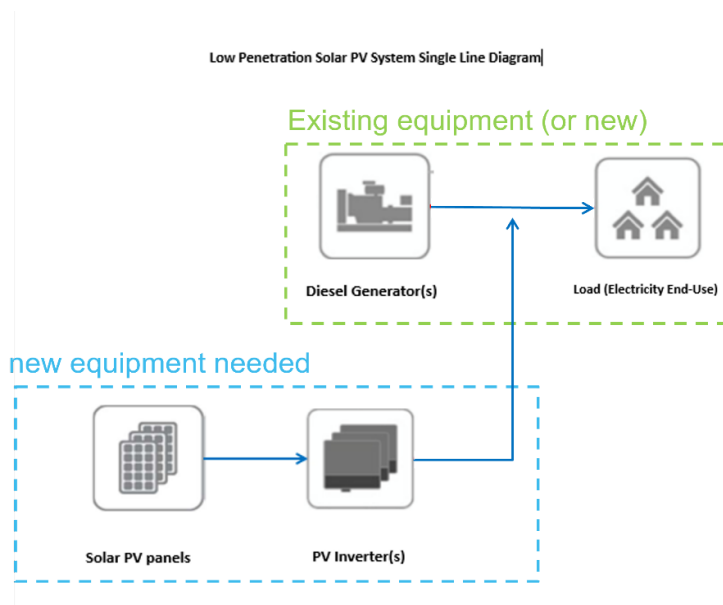
Diesel generator capacity (kVA)		Solar PV system integrated with the diesel generator(s)			Total reimbursement
Setup	Monthly wet lease rate	Nominal capacity for low penetration	Reimbursement modality	Monthly reimbursement	
New proposed reimbursement modalities					
Generators, stationary and mobile					
175 kVA	1098 US\$	42 kWp (30% of generator capacity)	Wet lease - 37-48 kWp nominal capacity (integrated in a hybrid system with a 151-200 kVA total capacity)	977,50 US\$	2075 US\$ / month (1098 US\$ for diesel generator + 977 US\$ for solar PV system)
Generators, ISO 8528 prime power standard and role generator					
175 kVA	1977 US\$	42 kWp (30% of generator capacity)	Wet lease - 37-48 kWp nominal capacity (integrated in a hybrid system with a 151-200 kVA total capacity)	978 US\$	2955 US\$ / month (1977 US\$ for diesel generators + 978 US\$ for solar PV system)

SOLAR PV HYBRID SYSTEMS

About 90% of the electricity used in UN peacekeeping missions is still provided by diesel generators. Costly to operate, diesel generators used by the UN and troop and police contributing countries (T/PCC) in field missions emit more than 500,000 tonnes of greenhouse gas to the atmosphere on a yearly basis. As mandated by the General Assembly, the UN is striving to reduce the environmental footprint of peacekeeping operations and is accelerating its transition to renewable energy systems. Responsible for about 35% of the electricity produced in peacekeeping missions, T/PCC can contribute to this energy transition by deploying solar photovoltaic systems (PV) in the field, taking advantage of incentives offered in the COE Manual (chapter 8, Annex A).

Solar PV hybrid systems - a simple yet efficient way to introduce renewable energy in T/PCC camps

Combining solar PV systems (solar PV panels, inverters, controllers, and related equipment) with diesel generators is the simplest way for T/PCC to integrate renewable energy in their electricity production systems in UN missions. Solar PV systems can be integrated with the diesel generators already deployed in the field to create a solar PV – diesel hybrid power generation systems. When used in “low-penetration” configuration, the solar PV components are designed to provide between 25 and 35% of the peak energy production capacity during daytime, with the remainder being provided by diesel generators. Low-penetration systems do not require the use of batteries or energy storage systems and can therefore be readily integrated with the generators already used by T/PCC in the field.



Component of solar PV hybrid

% peak energy production capacity

Component of solar PV hybrid	% peak energy production capacity	
	Daytime	Nighttime
Solar PV	25-35%	Nil
Diesel generators	65-75%	100%

RENEWABLE ENERGY – MULTIPLE BENEFITS FOR T/PCC AND THE UN



The transition to renewable energy in the field brings multiple benefits, contributing to improving operational resilience, improving safety and security of peacekeepers, and reducing the environmental footprint of operations:

- ✓ Improving energy autonomy, reducing the dependency on diesel fuel deliveries for electricity production
- ✓ Reducing maintenance requirements of diesel generators and extending their useful life
- ✓ Reducing greenhouse gas emissions and contribution to climate change
- ✓ Reducing noise and air pollution in camps
- ✓ Reducing the fire risk related to handling flammable diesel fuel

Simple to operate and maintain, solar PV systems are modular in nature and can be expanded to suit the evolving energy needs of the unit. In addition, solar PV systems have an extended useful life (25-30 years), allowing them to be redeployed to other operating bases or to be donated to the host community when a T/PCC unit is repatriated. In the event that neither of these options are viable, the UN will ensure environmentally responsible disposal of the solar PV system.

SUPPORT AVAILABLE FROM THE UN DEPARTMENT OF OPERATIONAL SUPPORT

The Department of Operational Support (DOS) can provide support to T/PCC exploring opportunities to deploy renewable energy systems in the field. Some of the services DOS can provide to T/PCC include:

- ✓ Support in identifying project opportunities based on site specific context and mission needs
- ✓ Support the scoping and preliminary engineering design of renewable energy systems
- ✓ Explore capacity building opportunities
- ✓ Facilitate partnerships between T/PCC and other Member States aimed at implementing renewable energy projects in the field
- ✓ Support technical and economical assessments for the deployment of renewable energy systems
- ✓ Support for the delivery of renewable energy systems into mission.

For more information and a detailed briefing, please contact DOS at the Uniformed Capability Support Division (generic email address), the Environment Section (dos-ousg-envs@un.org), or DPO at the Strategic Force Generation and Capability Planning Cell (sfgcpc@un.org)