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nuru



Understanding the Peace effects of P-REC funded streetlights in Goma, DRC

May/June 2022

EXECUTIVE SUMMARY

In May – June 2022, Energy Peace Partners (EPP) travelled to Goma in the Democratic Republic of Congo to start gathering data on the peace benefits of Peace Renewable Energy Credit (P-REC) funded renewable energy projects.

EPP, the I-REC authorized issuer for the DRC, has worked with Nuru since 2020 to register and issue P-RECs from multiple Nuru solar projects in the country and has helped facilitate the sale of Nuru's P-RECs to corporate buyers like Microsoft and Google. Microsoft's 2020 purchase of P-RECs from Nuru's 1.3MW solar mini-grid financed an additional 'social impact' project, in the form of the deployment and connection of streetlights in the Ndosho neighbourhood of Goma. The streetlights were turned on in March 2020.

The data collection piloted EPP's monitoring and evaluation framework, focusing on a comparative assessment of two neighbourhoods: Ndosho, the beneficiary of the P-REC financed project, and the adjacent neighbourhood of Mugunga, which has no public lighting and generally very low levels of electrification. Nuru will be expanding its electricity provision to Mugunga in the very near future through its Goma II initiative (a larger solar mini-grid being built in Goma).

The data collection effort involved a combination of household surveys and focus group discussions, and was subsequently analysed using EPP's 'Positive Peace Calculator' methodology to generate estimates of SDG indicators (short- and medium-term outcomes in EPP's theory of change), as well as positive peace scores (longer-term impacts in EPP's theory of change).

Key findings:

- **The results show that the overall levels of positive peace in Ndosho are higher than that in Mugunga, by approximately nine percent.** Ndosho scores higher on six of the eight positive peace pillars, the exceptions being 'Equitable Distribution of Resources' and 'Sound Business Environment'. The results also show that although Ndosho scores better than Mugunga on 19 of 26 measured indicators, achievement of SDGs remains low across both communities.
- **The survey shows a heightened sense of security in Ndosho compared to Mugunga,** with 39 percent of respondents claiming they feel safe in the former compared to just 13 percent in the latter.
- **Both survey indicator data as well as FGD data also emphasize the particular effects of street-lighting for women and girls,** with respondents stating that women profited more by the

street lighting, enabling them to conduct trade at night as well as a reduction in the threat of sexual assault.

The nature of the intervention (P-REC funded streetlights), the lack of field collected comparable baseline data, and the particular research design (a product of budget considerations) used in the pilot do not allow causal conclusions to be drawn from electrification and public lighting to more peaceful outcomes. Nonetheless, the comparatively better situation in Ndosho is instructive, and allows EPP to be cautiously optimistic in its hypothesis that increased investment in renewable energy access can be used as a peacebuilding tool.

ACKNOWLEDGMENTS

EPP would like to thank the time, resources, and energy of our partner Nuru who helped facilitate not only site inspections of both Goma I and Goma II P-REC project sites, but all logistics pertaining to the field visit (from visas, to accommodation, and transport), as well as introductions to the highly capable CREDDA research institute.

Special thanks goes to the assistance of Kyle Hamilton and Laura Shabani who made the trip and this pilot possible.

EPP would also like to thank the highly competent and motivated enumeration team from ULPGL –CREDDA, led by Professor Kennedy Bindu, for their excellent and timely work collecting data in the field.

EXECUTIVE SUMMARY	1
ACKNOWLEDGMENTS	3
1. BACKGROUND	5
1.1 CONTEXT IN DRC AND NURU'S PROJECT	5
1.2 THE PEACE BENEFITS OF RENEWABLE ENERGY: THEORY OF CHANGE	6
2. METHODOLOGY	8
3. RESULTS	10
3.1 MEASURED LEVELS OF PEACE	10
BASELINE PEACE	13
3.2 MEASURED SDG INDICATORS	14
3.3 DIFFERING EFFECTS OF HOUSEHOLD LEVEL ELECTRIFICATION	15
ANNEX A: DETAILED M & E FRAMEWORK AND DATA COLLECTION	
METHODOLOGY FOR MEASURING PEACE	16
A. 1 M & E FRAMEWORK OPERATIONALIZATION	18
CALCULATING THE POSITIVE PEACE SCORES	19
CALCULATION METHODOLOGY	22
A2. IMPACT MANAGEMENT SYSTEM	24
A3. SPECIFICS OF DATA COLLECTION IN GOMA	25
HOUSEHOLD SURVEY	25
FGDs	26
ETHICAL CONSIDERATIONS FOR DATA COLLECTION: HUMAN SUBJECTS PROTECTION	26

I. BACKGROUND

Energy Peace Partners (EPP) is a U.S. based non-profit organization who works to increase access to renewable energy in fragile, climate vulnerable, and energy poor countries.

EPP's goal is to use renewable energy as a building block for peace in these regions. It does this by facilitating investments in renewable energy projects in these triple-threat contexts through the issuance of Peace Renewable Energy Credits (P-RECs).

P-RECs monetize renewable energy generated in fragile states in order to meet increasing corporate commitments to sustainability and social responsibility. This extends mature international REC markets into crisis contexts and increases financial incentives for renewable energy development. P-RECs support both public and private sector actors to introduce clean energy solutions that deliver tangible benefits to communities affected by conflict.

The importance of energy access and electrification globally is enshrined in Sustainable Development Goal (SDG) 7 which calls for a global commitment to action to “ensure access to affordable, reliable, sustainable, and modern energy for all” by 2030. The goal encompasses three dimensions: universal access to energy, a higher share of renewable energy, and an improvement in energy efficiency. Energy access ties into almost every other SDG by facilitating and enabling relevant development goals. Renewable energy in particular has been called out for its central importance to achieving many of the other SDGs¹.

Yet roughly 800 million people in the world are still without access to electricity, 90% of whom live in fragile states. Fragile states themselves – led by the g7+ group of fragile states – are leading a global call to action to scale up energy investments within their borders. These states recognize that fragility and energy poverty are closely interlinked, and states can be caught in a fragility-energy poverty spiral which can lead to conflict, mass migration, and terrorism. In the wake of the Covid-19 pandemic and related economic and social shocks, an investment in energy access and renewable energy access in particular, can help “build back better.”²

EPP believes that bringing renewable energy into underserved fragile contexts has peace impacts through the provision of energy access, the expansion of energy access, and the replacement of fossil fuel energy sources. It further believes that new renewable energy projects in the ‘triple-nexus’ settings can create new entry points for peacebuilding and stabilization.³

I.1 Context in DRC and Nuru's project

¹ SDSN. (2019). *Mapping the Renewable Energy Sector to the Sustainable Development Goals: An Atlas* (Issue June).

² Council on State Fragility, “Powering up Energy Investments in Fragile States Call to Action,” G7+ group of fragile states. Launched 24/02/2021.

³ Results from EPP internal questionnaire

EPP has been working in the DRC since 2020, when it was authorized by the I-REC Standard as the I-REC country issuer. EPP has worked closely with Nuru, a DRC based solar developer, on the first-ever P-REC issuance and sale from the DRC.

In February 2020, Nuru commissioned a 1.3 MW solar system in Goma the provincial capital of North Kivu Province - becoming one of Africa's largest off-grid solar minigrid in operation. As of December 2021, 878 households, 460 SMEs and 47 social institutions had been connected to Nuru's minigrid – and of these, between 56 and 71 percent have secured energy access for the first time.

EPP has helped facilitate the sale of Nuru's P-RECs to corporate buyers like Microsoft and Google. Microsoft's 2020 purchase of P-RECs from Nuru's 1.3MW solar mini-grid in Goma financed an additional 'social impact' project, in the form of the deployment and connection of streetlights in the Ndosho neighbourhood of Goma. The streetlights were turned on in March 2020, and as of December 2021, 43 streetlights are operational in the neighbourhood. It is estimated that 35% of the population in Ndosho (or about 28,000 people) are benefiting from the first phase of this project.⁴

FIGURE 1: NDOSHO NEIGHBOURHOOD OF GOMA, ON STREET WITH P-REC FUNDED STREETLIGHTS



1.2 The Peace Benefits of Renewable Energy: Theory of Change

Energy access and renewable energy access in particular has been shown to have multiple socio-economic benefits that can accrue to individuals, households, and communities.⁵ But renewable energy also has potential implications for both negative peace – meaning the absence of violence and conflict, and positive of peace – which refers to a more lasting peace built on sustainable investments in economic development and institutions, as well as societal attitudes that foster peace.

⁴ This estimate is taken from Nuru's own internal research and estimation of the beneficiaries of their solar minigrid

⁵ See for example the literature review compiled by EPP.

An actionable measure of positive peace is the eight-pillar framework developed by the Institute for Economics and Peace, and shown in FIGURE 2. These eight component parts systemically interact to build a societies' attitudes, structures, and institutions that create sustainable peace.⁶

FIGURE 2: POSITIVE PEACE FRAMEWORK



This definition and measure of Positive Peace also provides a framework for assessing a country's, or community's, resilience; its ability to plan, absorb, and respond to shocks⁷. Climate change related disasters are one such type of shock for which a country, or community, needs resilience. This Positive Peace framework has strong overlap with the Sustainable Development Goals with research concluding that of the 169 targets outlined across all SDGs, 85% are relevant to more than two Positive Peace factors⁸.

EPP's Theory of Change (summarized in FIGURE 3) links the inputs provided by EPP, including catalytic capital, partnerships, and expertise, to the output of expanded renewable energy access, as well as the short, medium, and long term socio-economic outcomes which are operationalized by the Sustainable Development Goals and their indicators.

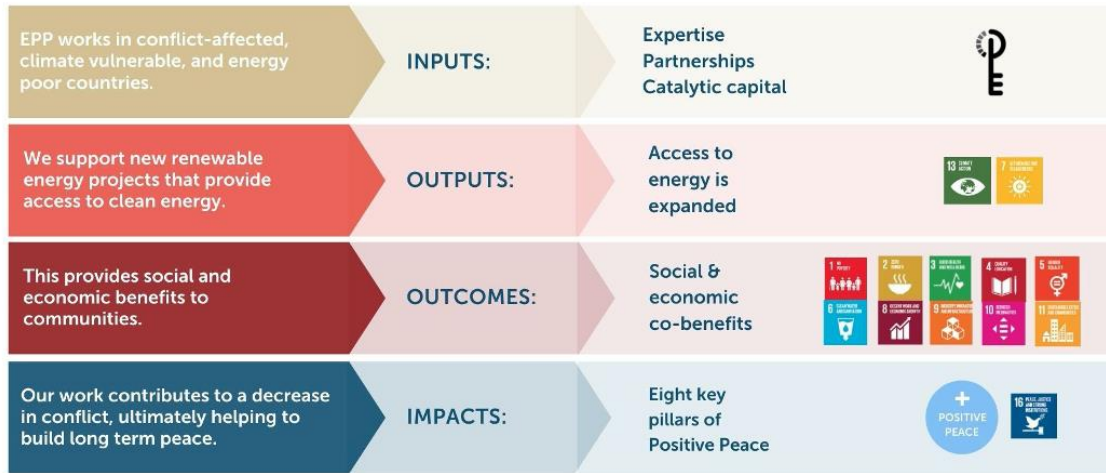
This culminates in the peace impacts of renewable energy access operationalized by the eight pillars of Positive Peace.

⁶ The eight pillars are derived through empirically analysing an estimated 25,000 data series to determine which factors are most highly correlated with negative peace. In this way, positive peace is known to be a statistically significant correlate of the absence of conflict and violence.

⁷ IEP. (2019a). Positive Peace Report 2019.

⁸ IEP. (2019b). SDG 16+ Progress Report 2019.

FIGURE 3: ENERGY PEACE PARTNER’S THEORY OF CHANGE



2. METHODOLOGY

In June 2022, EPP, in collaboration with a research team from CREDDA-UPLGL deployed a team of field enumerators to collect original survey and focus group discussion (FGD) data from two neighbourhoods in Goma: Ndosho and Mugunga.

This is the first data collection effort conducted by EPP to pilot its monitoring and evaluation framework for its Theory of Change. In the case of Nuru and Goma, the data collection specifically sought to understand and measure what the socio-economic and peace effects of Nuru’s P-REC funded streetlight project have been.

Since no baseline data had been collected prior to the installation of streetlights by Nuru in Ndosho, a comparative study was designed to understand the current situation in these two neighbourhoods. Prior to deployment in the field, a pre-analysis plan was developed and submitted to the research ethics committee at UPLGL for approval.

Mugunga was chosen as the relevant comparison neighbourhood based on matching on certain relevant socio-economic and demographic indicators, as presented in TABLE I. Many of these indicators come from survey data collected by the Harvard Humanitarian Initiative in 2017.⁹

TABLE I: BASELINE CHARACTERISTICS OF NDOSHO AND MUGUNGA QUARTIERS, GOMA, DRC: 2017

⁹ The Harvard Humanitarian Initiative in 2017, has collected survey data at a neighbourhood level in Goma, looking at various demographic and socio-economic indicators disaggregated at a neighbourhood level as our source for baseline information as well as matching neighbourhoods. Please see http://www.peacebuildingdata.org/sites/m/pdf/DRC_P12_English_final.pdf for a summary.

	Neighbourhood	Ndosho: PRE-NURU STREETLIGHTS	Mugunga: NO STREETLIGHTS
	Population	80,254	20,669
	Access to Electricity (%)	3	1
	Asset based poverty (%)	40	54
	Access to drinking water (%)	28	49
	Access to education (%)	39	39
	Access to healthcare (%)	35	45
Indicator	Perception of the extent to which local authorities represent the interest of the population (% that agree strongly)	25	46
	Perception of relations with people from other ethnic groups (% good or very good)	79	82
	Trust in police (% high or very high)	49	74
	Safety in Daily activities (% agree)	73	80
	Safety in walking alone at night (% agree)	9	23
	Prevalence of physical violence over the past year	26	18

Mugunga will also be the site of further Nuru expansion in terms of electrification, therefore this survey data can be used to provide a baseline assessment for socio-economic impacts of Mugunga's electrification.

In total, 194 household surveys were collected across the two neighbourhoods, and two focus group discussions were conducted, one in each neighbourhood. TABLE 2 and TABLE 3 show the breakdowns of data collected.

TABLE 2: COLLECTED SURVEY DATA BY NEIGHBOURHOOD AND CONNECTION TYPE

Neighbourhood	Household type		
	Nuru mini grid-connected electrified	No grid-connected electricity ¹⁰	Other grid-connected electricity ¹¹
Ndosho	65	43	1
Mugunga	0	61	24

TABLE 3: BREAKDOWN OF DATA COLLECTED BY GENDER

Tool	Neighbourhood	Total Participants/Respondents	Female Participants/Respondents
Survey	Ndosho	54	55
	Mugunga	43	42
FGD	Ndosho	6	4
	Mugunga	5	5

The household survey data was collected using Kobo Toolbox, a free open source platform for collecting data in humanitarian and challenging environments in real time.

Please see Annex A for a detailed description of the data collection methodology, the overall M & E framework, as well as the impact management system that aggregates and calculates the indicators and peace metrics from the survey data.

3. RESULTS

The following analysis does not presume to ascribe any causal relationship between the P-REC project and impacts and outcomes; the nature of the project and timing meant that the research design was limited to measuring and observing differences across communities and household types.

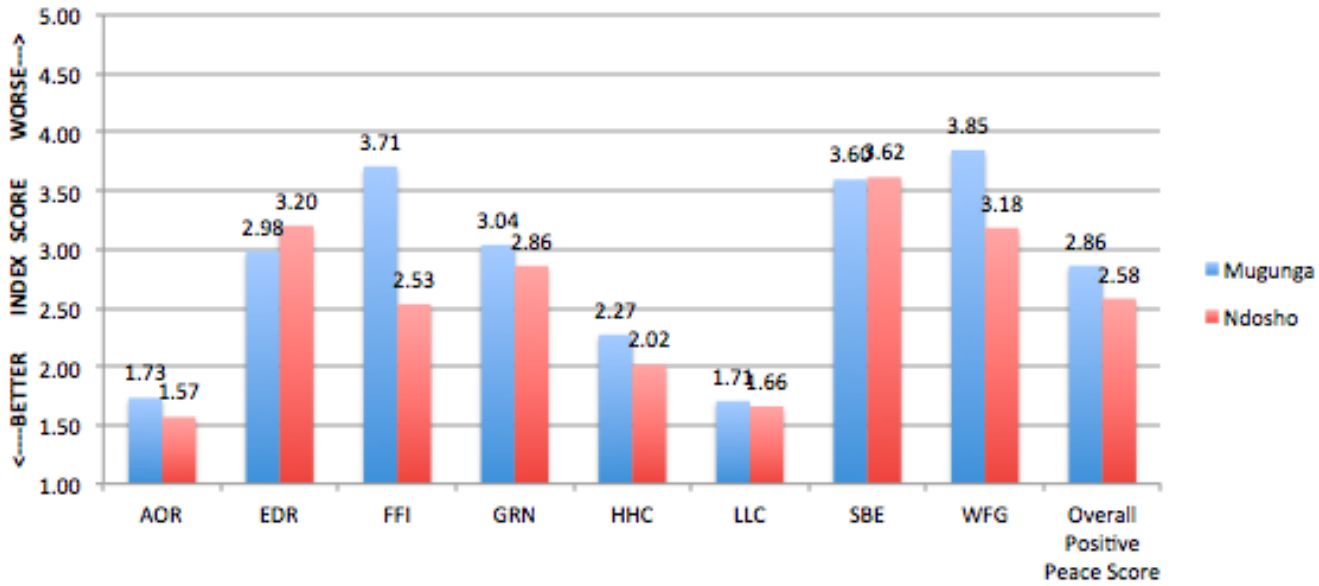
3.1 Measured levels of peace

¹⁰ This category includes for example houses with generators or shared generators, or stand alone solar home systems.

¹¹ This category includes households connected to SNEL (the Congolese National Utility Company).

Using the 'Positive Peace Calculator'¹² and positive peace score calculation methodology described in Annex A,¹³ the survey results indicate that the overall levels of positive peace in Ndosho are higher than that in Mugunga, by approximately nine percent. Ndosho scores higher on six of the eight positive peace pillars, the exceptions being 'Equitable Distribution of Resources' and 'Sound Business Environment' - (although the SBE scores are virtually identical across the two neighbourhoods). FIGURE 4 shows how the neighbourhoods score on each pillar of positive peace as well as overall.

FIGURE 4: MEASURED LEVELS OF POSITIVE PEACE¹⁴ BY NEIGHBOURHOOD IN GOMA



When FGD respondents in both communities were asked whether there were differences between neighbourhoods with and without street lighting, the respondents overwhelmingly agreed that areas without lighting were less secure and that this relative insecurity affected the behaviour of those within the community.

Respondents from both communities expressed that one acute effect of public lighting on people's behaviour was expressed as difference in the ability to engage in commerce after dark, with this significantly limiting opportunities for those in Mugunga. The survey data in fact shows that the average reported monthly income is slightly higher in Ndosho than Mugunga - \$156 vs. \$137, which may be an artifact of expanded business hours due to lighting. Despite this, however, it is to be noted that levels of both male and female unemployment were reported as higher in Ndosho than Mugunga.

¹² The Positive Peace Calculator is an R project that takes as its input the raw survey data, runs through a number of data cleaning, munging and analysis scripts, and produces as its output both calculated SDG based indicators and Positive Peace scores.

¹³ The Impact Management System which does the backend calculations from the survey data uses R statistical computing as the program to do this. R is a free open source statistical analysis software.

¹⁴ The graph shows scores for each pillar of Positive Peace as well as over Positive Peace score. The acronyms are: AOR – Acceptance of the Rights of Others; EDR – Equitable Distribution of Resources; FFI – Free Flow of Information; GRN – Good Relations with Neighbours; HHC – High Levels of Human Capital; LLC – Low Levels of Corruption; SBE – Sound Business Environment; WFG – Well-functioning Government.

Respondents in Mugunga claimed that all activity stops after 6pm, and that everyone is in a rush to make sure they are home before then.

“Banditry and theft are becoming widespread throughout our entity. Passers-by are attacked on a daily basis. And we don't know how to prosecute the thugs because everywhere we are in the dark” – FGD respondent Mugunga¹⁵

There was agreement that the lack of public lighting affected women more than men in their daily lives, making them particularly economically vulnerable as they are the ones generally selling small goods street-side and must stop operations when it gets dark.

“So, economically, women remain vulnerable following these hassles that arise caused by the lack of lighting.” – FGD respondent Mugunga¹⁶

Respondents from Ndosho also claimed that women profited more by the streetlighting, enabling them to conduct trade at night and not spend money on lamps, torches and kerosene. They claimed the danger from sexual assault is also less now.¹⁷

Survey data shows a difference between communities in terms of the number of hours males and females spend on income generating activities, supporting the idea that women can be more economically empowered with the availability of public lighting. In fact in Ndosho, females were estimated to spend more time on income generating activities than males.

TABLE 4 : HOURS SPENT PER DAY ON INCOME GENERATING ACTIVITIES, BY NEIGHBOURHOOD AND GENDER

Neighbourhood	Average number of hours spent on income generating activities per day	
	Males	Females
Ndosho	3.4	3.61
Mugunga	7.21	6.04

Respondents in Mugunga suggested that the lack of lighting made it difficult for security forces to do their jobs in the neighbourhood, potentially exacerbating the insecurity if perpetrators feel they can roam and act unchecked.

When asked whether the difference in public lighting caused tensions between the communities, both sets of respondents claimed that it did. For respondents from Mugunga tensions were mostly around how residents of lit neighbourhoods felt ‘superior’, while they were treated as if they were ‘from the bush’ and not part of the town at all. For respondents from Ndosho the tensions were around how those residents of unlit communities tried to unfairly take advantage of them, for example by trying to use counterfeit money.

¹⁵ Original French: “Les plus grands défis liés au manque de l’éclairage sont que, le banditisme, le vol se généralisent partout dans notre entité. On agresse les passants au quotidien. Et on ne sait pas poursuivre les malfrats car, partout on est dans le noir »

¹⁶ Original French: “Donc, économiquement, les femmes restent vulnérables suite à ces tracasseries qui surviennent causées par le manque d’éclairage”

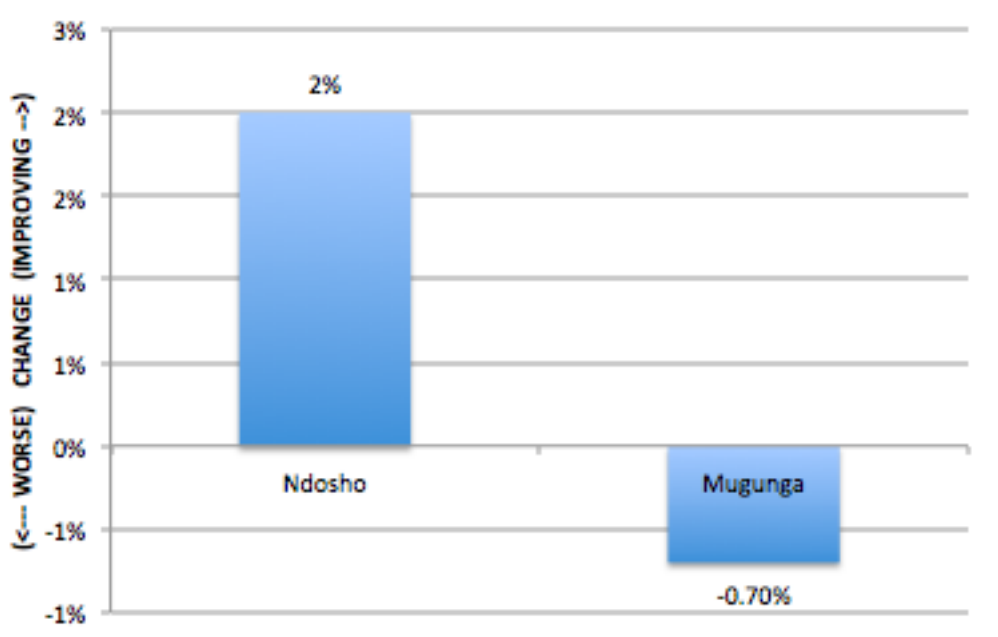
¹⁷ “Cela, également, nous évite le danger d’être agressées (violées) par des bandits de grands chemins.” FGD respondent Ndosho

“The unlit communities envy those that are lit” – FGD respondent Ndosho¹⁸

Baseline Peace

Baseline estimates for levels of positive peace in the two neighbourhoods were generated using comparable indicators based on data collected by the Harvard Humanitarian Initiative outlined above in TABLE 1.¹⁹ The baseline year was 2017, prior to Nuru installing streetlights in Ndosho. FIGURE 5 shows the percentage change in levels of positive peace in each neighbourhood between 2017 and 2022, with an improvement of 2 percent in Ndosho and a deterioration of 0.7 percent in Mugunga. The very nature of positive peace means that changes in levels of peace will be incremental; in general, in the absence of some external shock to the system, it takes time to change the institutions, structures and behaviours that create sustainable peace. As context, between 2009 and 2021, the global score for the PPI improved by 2.4 percent: in the DRC the score for the PPI decreased from 4.49 in 2009 to 4.3 in 2022, a marginal improvement of 4 percent.

FIGURE 5: CHANGE IN LEVELS OF POSITIVE PEACE BY NEIGHBOURHOOD IN GOMA, 2017 TO 2022



¹⁸ Original French: “les contrés non éclairées envient celle qui sont éclairées.”

¹⁹ To note, this is not an exact match in terms of indicators to the current survey round since EPP did not design the survey, but nonetheless the combination of indicators used to calculate the positive peace pillars and overall positive peace score conform to the definitions of the pillars defined by IEP, and to the extent possible match EPP’s framework.

Respondents from the Ndosho FGD claimed that there was a marked difference in their community since the installation of streetlights, in particular their ability to engage in more commercial activities, and also lower levels of crime such as petty theft and the use of counterfeit money.

3.2 Measured SDG Indicators

The survey data suggests variation in levels of progress across SDG indicators between neighbourhoods, as summarized in TABLE 5.

Although Ndosho scores better than Mugunga on 22 of 26 measured indicators, the survey data indicates that achievement of many SDGs remains low across both communities. The high rates of poverty, food insecurity and health spending in both neighbourhoods, as well as low rates of access to safe water, primary school completion and financial inclusion, are notable and of particular cause for concern.

One finding of note is the significant increase in perceptions of public safety at night in Ndosho as compared to Mugunga, relative to 2017 data (SDG 16.1.4). Positive perceptions increased from 23 to 39 percent in Ndosho, but only marginally increased from 9 to 13 percent in Mugunga.

TABLE 5: MEASURED SDG INDICATORS BY NEIGHBOURHOOD IN GOMA

SDG indicator	Mugunga	Ndosho
sdg 1.2.1: Total Population proportion below poverty line	92%	86%
sdg 1.2.1: Female Population proportion below poverty line	92%	85%
sdg 1.2.1: Male Population proportion below poverty line	93%	86%
sdg 6.1.1: Population proportion with access to safe water	12%	13%
sdg 6.1.1: Population proportion with access to safe sanitation	82%	83%
sdg 2.1.2: Population proportion that is food insecure	86%	72%
sdg 3.1.3: Malaria incidence per 1,000 population	229.17	188.00
sdg 3.8.2: Population proportion spending more than 25% income on health	11%	34%
sdg 4.1.2: Total Adult Population proportion that has completed primary school	91%	95%
sdg 4.1.2: Female Population proportion that has completed primary school	88%	90%
sdg 4.1.2: Male Population proportion that has completed primary school	93%	99%
sdg 5.4.1: Female Population proportion time spent on unpaid domestic work	27%	23%
sdg 5.4.1: Male Population proportion time spent on unpaid domestic work	6%	7%
sdg 5.b.1: Female Population proportion owning mobile phone	32%	46%
sdg 5.b.1: Male Population proportion owning mobile phone	40%	51%
sdg 8.5.2: Female Population proportion unemployed	57%	57%
sdg 8.5.2: Male Population proportion unemployed	38%	44%
sdg 8.10.2: Adult Population proportion with financial account	45%	54%

sdg 9.c.1: Population proportion covered by mobile phone network	50%	92%
sdg 10.3.1: Population proportion discriminated against in past 12 months	15%	13%
sdg 16.1.3: Population proportion subjected to violence in past 12 months	15%	17%
sdg 16.1.4: Population proportion that feels safe walking around neighbourhood alone at night	13%	39%
sdg 16.5.1: Population proportion asked or forced to pay bribe by public official	18%	17%
sdg 16.6.2: Population proportion satisfied with public services	22%	59%
sdg 16.7.2: Population proportion who believe decision-making is inclusive and transparent	35%	32%
sdg 17.3.2: Volume of remittances as share of income	0.3%	5%
sdg 17.8.1: Population proportion using the internet	15%	32%

3.2.1 SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all

Although this SDG does not contain indicators that directly feed into the Positive Peace framework and score, it is a key output of EPP’s work. Target 7.1 in particular is relevant at a project level in terms of tracking how P-REC funded renewable energy access can help to “ensure universal access to affordable, reliable and modern energy services” (by 2030).

In line with this target, a few results from the survey data are worth highlighting.

First on universal access, Mugunga is a neighborhood not yet comprehensively serviced by any energy provider. Although some households with electricity exist – with services provided by Virunga and BBox, the majority of households have no or very limited access to electricity.

On affordable access to energy, the survey data shows that the share of monthly income being spent on energy sources on average across all survey households is marginally higher in Mugunga (16 percent) than in Ndosho (13 percent). The share of income spent on electricity specifically is also higher in the households surveyed in Mugunga (12 percent), than Ndosho (9 percent).

On reliable energy access, households in Ndosho claimed to have almost 24 hour access to electricity (average of 23.4 hours), whilst those in Mugunga claimed to have on average only 10 hours access.

3.3 Differing effects of household level electrification

In both Mugunga and Ndosho, both Nuru grid-connected, other grid connected and not-connected households were surveyed, and collected data reveals some socio-economic differences between households with and without grid-connected electrification. Several key indicators are summarised in TABLE 6.

TABLE 6: SOCIO-ECONOMIC CONDITIONS BY TYPE OF HOUSEHOLD ELECTRIFICATION

	Household type		
	No grid connected electricity (n = 104)	Nuru mini-grid connected (n = 65)	Other grid connected (n= 25)
Monthly income	\$131.92	\$168.45	\$160.63
Study hours	0.8	1.3	1.1
Monthly health expenditure	\$28.33	\$39.35	\$19.43
Monthly energy expenditure	\$16.15	\$18.37	\$16.96
Monthly remittances	\$94.17	\$83.33	
Female Domestic Work (hr/day)	6.5	5.1	6.0
Male Domestic Work (hr/day)	1.4	1.7	2.4
Food insecurity	85%	66%	80%

When FGD respondents were asked what key differences in terms of daily life there were between households with and without electricity, two main themes were brought up in both neighbourhoods: 1. The ability of children to do their schoolwork, and 2. The ability to buy and use appliances. Television in particular was seen as a huge advantage, both in terms of keeping the kids out of mischief on the streets, and also keeping males in the households at home to watch football matches (rather than late night escapade to the local “videotheques”).

The differential effects of electrification on males and females was also couched in terms of the disadvantage to women who have to take care of domestic duties which is more time consuming without electricity.

FGD respondents also claimed that there were tensions between households with and without electricity. In Ndosho, respondents stated that children in particular were the source of conflict:

“It is often a lot of times that the neighbour’s children with no electricity enter the house where there is electricity, they can cause damage there, either by breaking something, or by stealing it, and this brings the two households into conflict” – FGD respondent Ndosho²⁰

4. Conclusions and Next Steps

Baring in mind the caveats of non-ideal baseline data and the limitations of the data collection efforts, including its small sample size, and the non-experimental nature of the evaluation, the findings nonetheless present cause for optimism regarding how P-REC funded social impact projects can contribute to increasing peacefulness where they are implemented.

The collaboration between EPP and Nuru in Goma is ongoing, with P-REC funding being secured for an expansion of Nuru’s Goma operations, which will now include electrifying Mugunga. As such, data collected from this round of analysis in Mugunga will provide EPP a more robust

²⁰ Original French: “il est souvent beaucoup de fois que les enfants de voisin chez qui il n’y a pas d’électricité entrent dans la maison où il y a de l’électricité, ils peuvent y causent un dommage, soit en cassant quelque chose, ou en le dérobant, et cela met en conflit les deux ménages.”

baseline for assessment, with plans to conduct a follow up evaluation in Mugunga approximately a year after Nuru begins operations there.

In addition to this, the Impact Management System (IMS) is being refined to ensure improvements in subsequent data collection efforts, and a pilot collaboration with Leonardo.impact is underway with a baseline data collection having been completed in Malakal South Sudan in December 2023. Leonardo.impact is a software solution for impact monitoring, data management, analysis and visualization. EPP is working with Leonardo.impact to automate the IMS to a great extent, making subsequent rounds of data collection and analysis straightforward.

Annex A: Detailed M & E framework and data collection methodology for measuring Peace

A. I M & E framework Operationalization

EPP's Theory of Change, through its M & E framework operationalizes input, output, outcome and impacts described in the ToC into measurable indicators. TABLE 7 presents the operationalization of outcomes based on the SDGs.

TABLE 7: OPERATIONALIZING SDG INDICATORS

SDG	Indicator
SDG 1: No poverty	G 1.4.1 Proportion of population living in households with access to basic services
	SDG 1.2.1 Proportion of population living below national poverty line, by sex, age
SDG 2: Zero hunger	2.1.2 Prevalence of moderate or severe food insecurity in the population based on the Food Insecurity Experience Scale (FIES): the percentage of individuals in the population who have experienced food insecurity at moderate or severe levels during the reference period
SDG 3: Good health and well-being	3.8.2 Household expenditures on health (share of population spending more than 25% of income on healthcare)
	3.3.3 Malaria incidence per 1,000 population
SDG 4: Quality education	SDG 4.1.2 Completion rate (primary, over secondary, upper secondary), by sex
SDG 5: Gender equality	SDG 5.4.1 Proportion of time spent on unpaid domestic work by sex
	SDG 5.b.1 Proportion of individuals who own a mobile phone, by sex
SDG 6: Clean water and sanitation	6.1.1 proportion of population using safely managed drinking water services.
	6.2.1a proportion of population using safely managed sanitation services.
SDG 7: Affordable and clean energy	Indicator 7.1.1: Proportion of population with access to electricity
	Indicator 7.1.2: Proportion of population with primary reliance on clean fuels and technology
SDG 8: Decent work and economic growth	SDG :8.5.2 Unemployment rate by sex
	SDG 8.10.2 Proportion of adults (15+) with a bank or mobile money account

SDG 9: Industry, innovation and infrastructure	SDG 9.c.1 Proportion of population covered by a mobile phone network
SDG 10: Reduced Inequalities	proportion of population reporting having personally felt discriminated against or harassed in the previous 12 months on the basis of a ground of discrimination prohibited under international human rights law
	10.2.1 proportion of people living below 50 per cent of median income, by sex,
SDG 16: Peace, justice and strong institutions	Proportion of population subjected to any form of violence in the past 12 months
	Proportion of population that feel safe walking around the area they live alone after dark
	proportion of persons who had at least one contact with a public official and who paid a bribe to a public official, or were asked for a bribe by those public officials, during the previous 12 months
	16.6.2 proportion of population satisfied with their last experience of public services
	proportion of population who believe decision-making is inclusive and responsive, by sex, age, disability and population group
SDG 17: Partnerships for the goals	17.3.2 Volume of remittances as percentage of GDP
	SDG 17.8.1 proportion of individuals using the Internet.

Calculating the Positive Peace Scores

The SDG indicators, which are considered as short-medium or long term outcomes, are combined with additional non-SDG indicators related to perceptions to track and measure the eight pillars of the Positive Peace framework, as outlined in TABLE 7. Please note the definitions of the Positive Peace pillars have been developed by the Institute for Economics and Peace, and as such EPP will be relying on this independent source for its own monitoring and evaluation purposes.

TABLE 8: INDICATORS FOR TRACKING THE EIGHT PILLARS OF POSITIVE PEACE

Positive Peace Pillar	Indicators
Equitable Distribution of Resources (EDR):	EDR is measured based on :

<p>Equitable distribution of resources includes equity in access to education, and equality in income distribution</p>	<p>SDG 10.2.1 proportion of people living below 50 per cent of median income, by sex,</p> <p>SDG 3.8.2 Household expenditures on health (share of population spending more than 25% of income on healthcare)</p> <p>SDG 1.4.1 Proportion of population living in households with access to basic services</p> <p>Safe water: "A safely managed drinking water service is defined as one located on premises, available when needed and free from contamination."</p> <p>Sanitation: "improved facilities which are not shared with other households and where excreta are safely disposed in situ or transported and treated off-site"</p>
<p>Low levels of corruption (LLC):</p>	<p>LLC is measured based on:</p>
<p>Corruption can lead to inefficiency in resource allocation, public distrust and a lack of funding for public goods and services, as well as civil unrest.</p>	<p>SDG 16.5.1 proportion of persons who had at least one contact with a public official and who paid a bribe to a public official, or were asked for a bribe by those public officials, during the previous 12 months</p> <p>SDG 16.7.2 proportion of population who believe decision-making is inclusive and responsive, by sex, age, disability and population group</p>
<p>Well-functioning government (WFG):</p>	<p>WFG is measured based on:</p>
<p>Well-functioning government refers to the strength of economic conditions as well as the formal institutions that support the operation of the private sector to enable business competitiveness and economic productivity</p>	<p>SDG 8.10.2 Proportion of adults (15+) with a bank or mobile money account;</p> <p>SDG 17.3.2 Volume of remittances as percentage of GDP</p> <p>SDG 8.5.2 Unemployment rate by sex</p>
<p>Well-functioning government (WFG)</p>	<p>WFG is measured based on:</p>

<p>G is defined as one that engenders and participation, upholds the rule and delivers quality public services</p>	<p>16.6.2 proportion of population satisfied with their last experience of public services</p> <p>SDG 16.7.2 proportion of population who believe decision-making is inclusive and responsive, by sex, age, disability and population group</p>
<p>Good Relations with Neighbours (GRN)</p>	<p>GRN is measured based on:</p>
<p>It is defined as peaceful internal and external relations within and around a country. Internally, it refers to socially cohesive relationships between groups within a country.</p>	<p>SDG 16.1.4 is the proportion of population that feel safe walking alone around the area they live.</p> <p>Conflict and Trust questions (from Afrobarometer)</p>
<p>High levels of Human Capital (HHC):</p>	<p>HHC is measured based on:</p>
<p>HHC is the stock of intangible knowledge, social and other personal attributes such as health, that enable economic productivity</p>	<p>SDG 4.1.2 Completion rate (primary, lower secondary, upper secondary), by sex: The number of persons in the relevant age group who have completed the last grade of the level of education is expressed as a percentage of the total population (in the survey sample) of the same age group</p> <p>SDG 2.1.2 Prevalence of moderate or severe food insecurity in the population based on the Food insecurity Experience Scale (FIES)</p> <p>SDG 3.3.3 Malaria incidence per 1,000 population</p>
<p>Free flow of information (FFI)</p>	<p>FFI is measured based on:</p>
<p>It relates not only to a free and independent press, but also to transparency within governance institutions and an environment in which the flow of information is made possible in a timely manner.</p>	<p>SDG 17.8.1 Proportion of individuals using the Internet;</p> <p>SDG 9.c.1 Proportion of population covered by a mobile phone network</p>
<p>Respectance of the Rights of Others (AoR)</p>	<p>AOR is measured based on:</p>

<p>includes formal laws guaranteeing human rights and freedoms as well as formal social and cultural norms that relate to the behaviours of people. It includes rights and empowerment for minority groups and non-discrimination.</p>	<p>10.3.1 proportion of population reporting having personally felt discriminated against or harassed in the previous 12 months on the basis of a ground of discrimination prohibited under international human rights law (ethnicity, gender, religion)</p>
	<p>5.4.1 Proportion of time spent on unpaid domestic work by sex; (difference between men and women)</p>

Calculation methodology

In calculating local level positive peace scores, EPP follows the methodology developed by the institute for Economics and Peace in calculating their Positive Peace Index. This is done in a five-step process taking indicators as inputs and resulting in both individualized scores for each of eight positive peace pillars, as well as an overall positive peace score. This is summarized in TABLE 8.

TABLE 9: METHODOLOGY FOR CALCULATING POSITIVE PEACE SCORES

Methodology				
Steps	Calculation	Explanation	Additional notes	Justification or Assumption
<p>Every indicator is standardised to run between 1 and 5, where 1 will be most peaceful outcome and 5 least peaceful outcome to match PPI</p>	<p>When lower indicator values are better: $(x - \min) / (\max - \min) * (\max - \min) + \min$</p>	<p>Value of the calculated indicator as per sheet "positive peace indicator calculation", where \max = possible minimum and \min = possible maximum values of the indicator, and $\max/\min = 1/5$ (the lower and upper limits of the standardised indicator).</p>	<p>Just look at higher values indicator desirable. Where</p>	<p>Matches the methodology of the PPI</p>
	<p>When higher indicator values are better: $\max - (x - \min) / (\max - \min) * (\max - \min)$</p>			

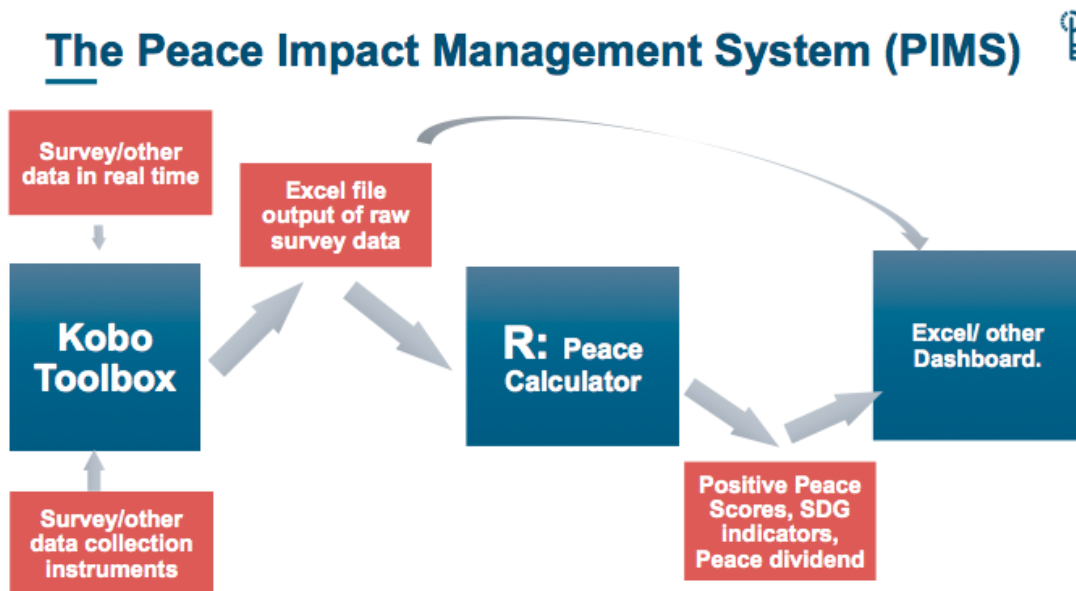
Indicators are all listed equally in a				we have no a-priori reason to list indicators differently
Each pillar is given an average score for each indicator in the pillar, making the scores lie between 1 and 5, where 1 is most peaceful and 5 is	score = sum(indicator scores)/number(indicators)	average score calculation		Matches the methodology of IEP
Each pillar is listed equally to combined score				we have no a-priori reason to list pillars differently, but we play with weightings to see. IEP methodology is each pillar marginally equally each year, based on strength of correlations between individual pillar scores and internal GPI score, which can change slightly year to year based on addition of new data. But weight changes are very minimal.
Overall PPI is the average score across all pillars standardized to run between 1 and 5, where 1 is most peaceful and 5 is				
Standardize the pillar scores according to the standardized weights (where 1 is most peaceful and 5 is most peaceful) so that all pillars can be weighted equally	score = sum(weight_pillar_i * score_pillar_i)		Standardize pillars equally	Standardized, this is the sum of all pillar scores
Calculate the minimum possible total values	score = sum(weight_pillar_i) * 5		Standardize pillars equally	Standardized, this is the sum of all pillar scores
	score = sum(weight_pillar_i)			

Standardise the score out of its original range to lie in the range 1 to 5.	$\frac{\text{total} - \text{min_total}}{\text{max_total} - \text{min_total}} * (\text{tmax} - \text{tmin}) + \text{tmin}$	total = raw total score		
		min_total = minimum score calculated according to the scale		
		max_total = maximum score calculated according to the scale		
		tmax = 5		

A2. Impact Management System

EPP’s impact management system is used to operationalize its M & E framework, collecting field data from project sites through a suite of data collection tools, converts this field data into the relevant output, outcome and impact metrics defined and operationalized in the M & E framework, and ultimately presents these in a UX friendly dashboard to visualize. It uses three main software tools to do this: Kobo Toolbox for field data collection, R statistical software for data processing and indicator calculation, and Microsoft excel for data storage and presentation. An overview of this system is shown in FIGURE 6.

FIGURE 6: OVERVIEW OF THE IMPACT MANAGEMENT SYSTEM



A3. Specifics of Data Collection in Goma

Between May 19th and May 21st 2022, EPP was in Goma to train up CREDDA's qualified research enumerators on the specifics of this data collection effort and survey tool. In total, a team of eight enumerators (four male and four female) were trained and used to collect both the household survey data and the FGD data in Goma.

FIGURE 7: ENUMERATORS FROM ULPGL-CREDDA AND EPP AFTER ENUMERATOR TRAINING, MAY 2022



Household Survey

For this exercise, total sample size was pre-set and constrained by budget considerations. The survey sampled enough households in each neighbourhood to be able to pick up differences across groups through simple tests such as difference in means (t-tests) and ANOVA testing.

Survey Sampling technique

Ndosho:

Nuru connected households:

Nuru assisted in providing a list of Nuru connected households in the neighbourhood, from which a random sample of 60 was drawn using Microsoft Excel's inbuilt randomization function. Only the limited list of 60 households was shared with CREDDA to be surveyed.

Other households:

The household sampling technique followed a non-probability sample, randomly selecting households following a standard protocol that involved the enumerators starting in a random

spot in the neighbourhood, picking a direction to walk and sampling every tenth household until the quota for that neighbourhood was met.

Mugunga:

Households that had signed a letter of intent with Nuru:

Nuru assisted in providing a list of households that had signed LOI's with Nuru for their expanded electrification project in Mugunga. There were 20 households on this list, which were targeted for surveying.

Other households:

The household sampling technique followed a non-probability sample, randomly selecting households following a standard protocol that involved the enumerators starting in a random spot in the neighbourhood, picking a direction to walk and sampling every tenth household until the quota for that neighbourhood was met.

In each household, the enumerators targeted either the head of the household or the most "important" decision maker, striving to balance female and male survey respondents.

FGDs

FGDs were conducted in both Ndosho and Mugunga in order to better understand the how and why of any relationships between energy and electricity access and socio-economic indicators and outcomes. Each FGD was mixed gender²¹.

Criteria for participation in the community FGDs were being 18 years of age or older, being a resident of the particular community/neighbourhood of interest. FGD participants were selected from the households that took part in the survey; in Ndosho participants were chosen from Nuru connected households, in Mugunga participants were chosen from households without connection.

Ethical considerations for data collection: Human Subjects Protection

Both the household survey and the FGD involve voluntary participation, and as such, the enumerators/interviewers had to ask for informed consent before commencing any data collection (as outlined in the data collection tools).

Participants had the option of remaining anonymous for the purposes of recording data, and could stop participation whenever they chose.

For the household survey, female enumerators conducted interviews with females respondents, and male enumerators with male respondents. No geo-tagged information was recorded on the surveys.

²¹ Ideally, with budget permitting EPP would hold separate FGDs for male and female participants in each location that is relevant for the round of data collection.

