Columbia SIPA
School of International and Public Affairs
Energy Peace Partners

Source: Vecteezy

Mission: Emissionality

Capstone Project for

Energy Peace Partners

Authors
Poornima Pandian, Tarlee Dahn, Alexander Feil, Abubaker Suleonibo, Carrie Kim,
Yiwen Deng, Zihuan Tang, Zhixuan Hu, Sam Thanassi, Christopher Arroyo

May 2026

Source: Vecteezy

Acknowledgements

We would like to express our sincere gratitude to our faculty advisor, **Julia Farber**, for her guidance, support, and valuable feedback throughout this capstone project. Her advice and encouragement helped shape our research and strengthen the final outcome.

We also extend our heartfelt thanks to our clients, **Doug Miller** and **Katie Retz** from Energy Peace Partners, for their time, insights, and collaboration during this project. Their expertise, thoughtful direction, and commitment to expanding access to clean energy in underserved communities greatly enriched our work.

Table of Contents

1. Executive Summary

Energy Peace Partners (EPP) is a non-profit organization which specializes in electrifying under-electrified regions in areas at risk of high conflict, or located in high conflict potential regions. Their core program centers on utilizing its innovative financial instrument, the Peace Renewable Energy Certificate, to fund solar mini-grids. This report examines how Energy Peace Partners (EPP) can strategize and scale the P-RECs. A P-REC is an energy attribute certificate issued for one megawatt hour of renewable energy generated in conflict-prone regions. EPP's proposition is that renewable energy investments can be used to channel capital to high-carbon-saving projects that provide social and economic benefits to underserved and under-electrified communities. P-RECs originate from regions where energy poverty and conflict make every unit of clean electricity substantial.

This report summarizes the findings of the MPA Environmental Policy Workshop project. The report will review the challenge, outline the methods, summarize research and make a recommendation. This report argues that while global investments in renewable energy have grown, fragile regions continue to receive a meagre share of that capital. In Africa and some countries in Asia and the Middle East, communities are largely dependent on high-emitting energy sources, such as diesel generators, firewood, charcoal, kerosene, etc for daily energy needs. Emissionality, defined as the amount of carbon emissions avoided per unit of renewable energy generated, highlights the climate impact of displacing these fuels. The current global frameworks and corporate accounting systems do not reward emissionality-focused renewable energy projects, as their focus is on regionalizing the electricity sources connected to Scope II accounting. As a result, P-RECs remain difficult to scale within mainstream corporate purchasing behavior.

The following global carbon accounting and reporting frameworks were evaluated as part of the research phase of the project, including recent draft revisions issued for public comment in Q1 of 2026.: Greenhouse Gas Protocol (GHG Protocol) Scope 2 Guidance, the Science-Based Target Initiative (SBTi), and ISO 14064-1. The analysis finds that these frameworks establish robust, standardized principles and accounting rules to ensure consistency and credibility in emissions accounting and reporting. However, they also impose strict geographic requirements with respect to the purchase of Energy Attribute Certificates for offsetting Scope 2 emissions. ISO 14064-1 offers flexibility with no explicit provision for geographic requirements. Several large organizations use the ISO framework as their GHG accounting method. It is recommended that EPP explore opportunities with these organizations. Current draft revisions to the GHG Protocol and SBTi contain hourly matching criteria that would further restrict out-of-market purchases. Importantly, SBTi informs that the draft revisions have accommodated outside-the-grid purchases for companies, as a time-limited alternative, if the grid lacks sufficient low-carbon or zero-carbon electricity.

Due to the constraints faced by EPP to scale P-RECs within Scope 2 frameworks, the report also provides a detailed analysis of Scope 3 frameworks. The Scope 3 guidance for all the three frameworks consistently emphasizes direct emissions reductions within the value chain through supplier engagement and low-carbon procurement.. They do not permit the use of Energy Attribute Certificates (EACs) to offset energy-related scope 3 emissions. However, the third-party suppliers in the value chain of various global corporations could be a potential target for P-REC purchases. The Scope 2 emissions offsetting by these suppliers in EPP focus countries would count towards the Scope 3 emissions offsetting of the reporting corporations.

The current emisssions accounting systems do not incentivize capital flow to regions having high impact on the climate and local community, in other words, places with higher emissionality. To support this argument, the report presents an emissionality calculator designed to estimate avoided emissions associated with mini-grid renewable electrification in some African regions. Drawing on energy consumption data from World Bank Multi-Tier Framework Energy Access survey, emissionality is calculated through two methodologies. The first one analyzes the unelectrified household usage in isolation, whereas the second one compares the usage with grid-connected households.

The report also focuses on the size and growth potential of the REC market. The global REC market in 2025 is between \$20.6 and \$30.7 billion, with an average estimate of USD 25.7 billion. Using a voluntary market share of 44.4%, the report estimates the voluntary portion to be \$11.4 billion in 2025, with a potential to rise to \$23.3 billion by 2030. The analysis also models a scenario in which frameworks allow a modest 1% exemption to purchase RECs out-of-market. The model estimates the REC demand at \$90 million and \$170 million for 2025 and 2030, respectively. This projection demonstrates that even a limited reform to procurement rules could create a conducive market environment for channelling investments to under electrified regions.

The report complements this market exercise with a list of potential corporate buyers who are well suited targets for P-REC purchases. Using the recent public disclosures of corporations, the report evaluates firms that have familiarity with renewable electricity procurement and a meaningful presence in EPP's African markets. The principal finding is that the most credible prospects are in countries such as Nigeria, DRC, Kenya, Ethiopia, Uganda, and Zimbabwe. Nigeria is the clearest anchor market across sectors, while the DRC appears in a narrower but strategically important subset of firms.

The report finally assesses the socio-economic co-benefits of the renewable projects through willingness to pay (WTP) method for electricity access. Drawing on studies from Senegal, Kenya, Nigeria, Niger, and Ethiopia, the report shows that households and firms place considerable value on reliable electricity. The report also highlights evidence that electrification improves welfare beyond private consumption by supporting longer business hours, higher productivity, reduced use of hazardous fuels, better educational outcomes, and improved health services.

Based on the insights and findings, the report recommends the following five suggestions for the Energy Peace Partners.

- Prioritize companies with in-market presence: Focus on firms with a physical footprint in target countries, as current GHG Protocol and SBTi requirements favor geographically aligned REC procurement.

- Adopt a phased market expansion strategy: Begin with compliance-aligned buyers (in-market presence) and gradually expand to global buyers as accounting frameworks evolve to accommodate out-of-market procurement.

- Engage ISO 14064-1 reporting companies: Target firms using ISO frameworks, which offer relatively more flexibility on geographic procurement, while monitoring potential convergence with GHG Protocol standards.

- Leverage Scope 3 and BVCM positioning: Target companies addressing Scope 3 emissions and pursuing Beyond Value Chain Mitigation (BVCM), positioning P RECs as high-impact, voluntary climate investments in supplier and high-risk regions.

- Use emissionality to underpin P-RECs: Deploy the emissionality calculator to quantify avoided emissions and build a compelling case for P-RECs despite their higher cost relative to I-RECs.

2. Introduction

2.1 Background: Client

Energy Peace Partners (EPP) is a non-profit organization that promotes peace and development across fragile, conflict-prone regions through the generation of renewable energy. EPP's presence spans 27 countries, including 24 in Africa , along with Yemen, Bangladesh, and Myanmar (Energy Peace Partners, 2026). In Africa alone, 600 million people lack access to affordable and reliable electricity. By facilitating clean and reliable mini-grid solutions for these communities, EPP aims to advance climate change mitigation while enabling stability and development (Energy Peace Partners, 2026).

EPP highlights that electricity access is hindered by remoteness, limited proximity to national grids, financial barriers, and regional conflicts. Further, it positions renewables as the key adaptation/mitigation solution to protect vulnerable communities from the impacts of climate change. As a result, EPP focuses on the intersection of renewable energy, finance, and impact (environmental and social). It deploys innovative financial instruments, such as the Peace Renewable Energy Credit (P-REC), to direct investments into renewable energy projects in high-risk regions (Energy Peace Partners, 2026). A P-REC represents one megawatt-hour (MWh) of renewable electricity generated in a conflict-prone region. The primary objective of this financial tool is to create an additional revenue source for the renewable project developers in Africa and Asia, making the projects financially viable (Energy Peace Partners, 2026).

Through P-RECs, EPP aims to address a critical gap in the global energy markets, wherein capital flows are not directed towards high-impact regions in Africa and Asia (Energy Peace Partners, 2026). The communities in these regions are largely dependent on high-carbon-emitting energy sources, such as diesel generators, firewood, and charcoal. Providing access to renewable electricity can displace these fuels, avoid household emissions, free up time otherwise spent on fuel collection, and facilitate more economic activity (Energy Peace Partners, 2026). As a result, P-RECs serve as a high-impact financial instrument, delivering not only emissionality (avoided emissions) but also significant social and environmental co-benefits (Energy Peace Partners, 2026).

Despite its immense potential to avoid emissions, bypass intermediate sources like coal and natural gas, and mitigate climate change, demand for P-RECs remains limited. Global frameworks with respect to corporate Scope 2 emissions accounting practices impose geographic constraints, by way of requiring companies to purchase renewable energy certificates within the same market or region of operations (Energy Peace Partner Project Control Plan, 2026).

As a result, companies that may otherwise be interested in purchasing P-RECs lack a physical presence in the fragile regions where these credits are generated, which restricts their ability to use P-RECs for Scope 2 emissions accounting. Consequently, current P-REC purchases are driven mainly by social impact motivations rather than by mainstream corporate demand (Energy Peace Partner Project Control Plan, 2026).

In this regard, the MPA-ESP capstone team at Columbia University is working with Energy Peace Partners to evaluate key barriers to adoption and identify policy, analytical, and market-based solutions to help scale P-RECs in the global energy markets.

2.2 Research Questions & Objectives

Against this backdrop, the project is structured around the following research questions and objectives.

The first objective is to evaluate how key global frameworks on Scope 2 emissions, particularly the Greenhouse Gas Protocol, the Science-Based Targets Initiative, and ISO 14064-1, govern the purchase of RECs to offset the energy emissions of the corporations. Given that geographic requirements strongly influence the demand for P-RECs, the team's task is to identify framework constraints and potential areas of flexibility that could enable greater adoption of P-RECs.

The second objective is to calculate emissionality per MWh of renewable energy generated in regions of Africa where diesel, firewood, and charcoal are the main energy sources. Instead of exclusively focusing on emissions reductions within a specific market boundary, emissionality helps identify the regions with the greatest marginal environmental benefit for investments. This is particularly important in fragile regions, where renewable energy projects lead to higher emissions reductions per unit of investment.

The third objective is to estimate the potential market demand for P-RECs under a model scenario, where global frameworks offer a 1% exemption for out-of-market renewable procurement. This helps to assess the current and future demand for P-RECs in the voluntary carbon markets.

The fourth objective is to identify potential corporate buyers for the purchase of P-RECs. The evaluation is based on corporations' presence in EPP target countries, their ESG strategies, climate commitments, and Scope 2 emissions disclosures to assess their eligibility and potential interests in P-RECs.

The final objective is to assess the additional social and economic benefits accruing to households from access to renewable electricity and the displacement of carbon-intensive energy sources. This enables EPP to position P-REC as not only a high environmental impact instrument but also a driver of social and economic development.

3. Framework Evaluation

Key Takeaways:

- Current frameworks mainly focus on accurate emissions reporting, but they do not fully reward broader climate impact.
- P-RECs can create higher real-world benefits by supporting clean energy in under-electrified and fragile regions.
- Existing rules often limit out-of-market purchases, which can reduce funding for high-impact projects.
- New framework revisions may create opportunities, but policy engagement is still important for EPP.
- EPP should target flexible pathways such as Scope 3 value chains, BVCM, and future consequential accounting systems.

Methodology

The team's approach relied on systematic analysis of the three major international guidelines on corporate GHG accounting and reporting: the GHG Protocol, the Science Based Targets initiative (SBTi), and ISO 14064-1. The choice of the above frameworks was determined by their importance for shaping the climate disclosure strategy and procurement of renewable energy by corporations worldwide.

For the analysis, the project team used the following four main sources:

(i) detailed examination of official framework guidance documents,

(ii) analysis of ongoing and proposed revisions to these frameworks,

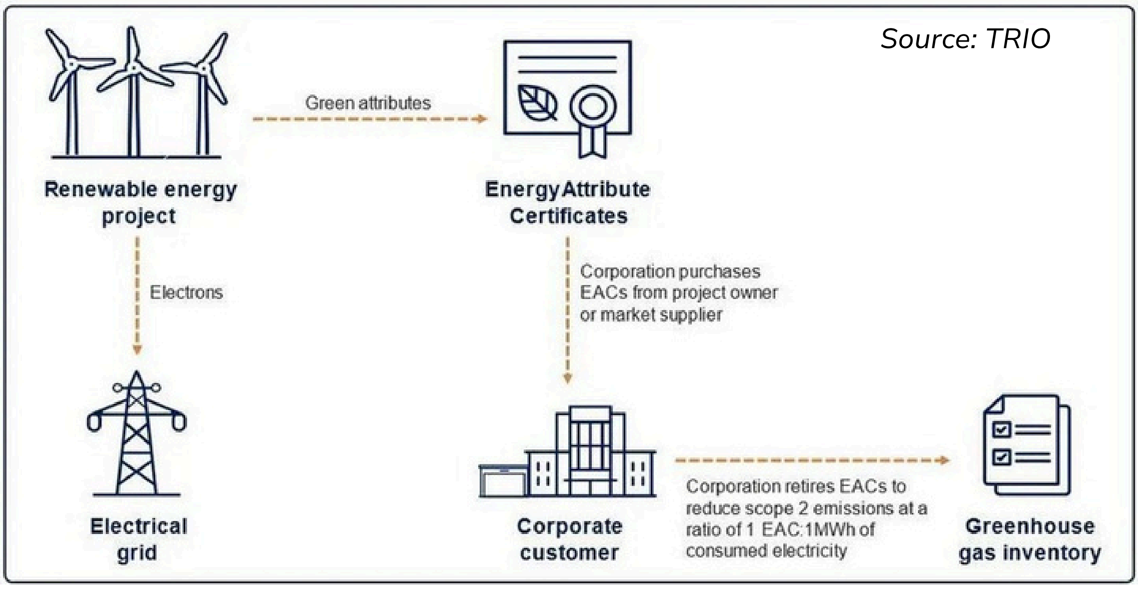
(iii) review of expert opinions and institutional publications, and

(iv) insights gathered through interviews with subject matter experts.

Findings

Relevance of the GHG Protocol Scope 2 for P-RECs/EPP

The Greenhouse Gas Protocol (GHG Protocol) remains the main reference framework for corporate GHG accounting, and its Scope 2 Guidance sets the standard for reporting emissions from purchased electricity (GHG Protocol, 2015). It informs the types of renewable electricity purchases that are credible and usable by corporations to offset Scope 2 emissions. The Scope 2 guidance follows two accounting methodologies: location-based and market-based accounting (GHG Protocol, 2015). The location-based method takes into account average grid emissions, while the market-based method incorporates renewables purchase contracts. The market-based approach provides companies with opportunities to procure RECs and, therefore, is of significant importance to EPP (GHG Protocol, 2015).



However, the framework is fundamentally designed around the electricity and REC purchases of the companies within their market boundary. This is a quality-criteria system meant to ensure that the RECs are real, not double counted, and relevant to the company's electricity usage (GHG Protocol, 2015). As a consequence, a buyer who wants to purchase RECs with emissionality or development benefits from outside the market may not meet conventional Scope 2 rules (Energy Peace Partners, 2025a). This restricts the currently targeted companies located in developed countries from extending their energy attribute certificate purchases into under-electrified countries. As a result, this market-based mechanism fails to incentivize support and mobilization of capital for clean energy projects in high environmental impact regions (Energy Peace Partners, 2025a).

Therefore, the Scope 2 accounting method invites recurring criticisms that accounting validity does not necessarily mean climate benefits. A key limitation is the lack of emissionality—the in-market REC purchases may not have avoided emissions from usage of other energy sources (GHG Protocol, 2015). In addition, the method lacks additionality, as renewable projects may have been commissioned regardless of REC purchases (GHG Protocol, 2015). Finally, the renewable generation may not be supplemented by broader social and economic benefits (Energy Peace Partners, 2023). To sum it up, the current methodology highlights the absence of consequential accounting.

At present, the GHG Protocol is undergoing Scope 2 revision processes and has a separate consultation on consequential methods for reporting emissions impacts (GHG Protocol, 2025a; GHG Protocol, 2025b). Though it acknowledges the concepts of emissionality and consequential accounting, it does not make it mandatory for validation under the protocol (GHG Protocol, 2025b). Rather, the revisions suggest stringent physical deliverability and geographic requirements for REC purchases and impose hourly matching (GHG Protocol, 2025b). These changes could continue to hinder capital flow to high-impact regions and also make it costlier for companies to conform to the reporting requirements. He et. al. (2024) report that hourly matching is between 9 and 28 times more expensive per MWh compared to annual matching. However, some opinion pieces and policy analyses argue that real grid decarbonisation cannot materialise with annual matching (NewClimate Institute, 2024).

It is evident that the intention of the revisions to the GHG Protocol are to ensure effective grid decarbonisation through hourly matching and strong physical and geographical deliverability (GHG Protocol, 2025b). It may be overly ambitious to expect GHG Protocol to incorporate blanket provisions for out-of-market purchases. The same perspective was reiterated by the subject experts our team interviewed. In this regard, EPP could push for a modest exemption (1%) for out-of-market purchases through revision committees and formal submission to decision-making bodies (Energy Peace Partners, 2025b).

Relevance of the SBTi Scope 2 for P-RECs/EPP

The Science Based Targets Initiative (SBTi) Scope 2 is another widely used global framework for corporate climate target setting. Built on the GHG Protocol, SBTi is designed as an accounting system that standardizes how companies set targets and report emissions, improving credibility and comparability of corporate disclosures in line with the Paris Agreement (Science Based Targets Initiative, 2025). Similar to the GHG Protocol, this framework accepts corporate Scope 2 emissions accounting using two methods: location-based and market-based. Both methods impose geographic restrictions for electricity usage and REC purchases (Science Based Targets Initiative, 2025).

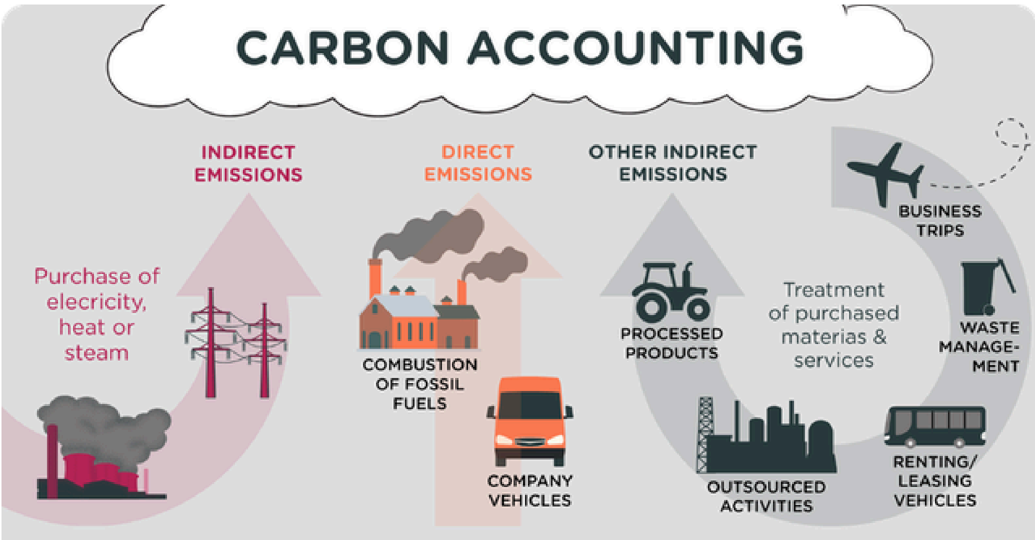
In addition, SBTi was not designed to measure real-world decarbonization outcomes. It has inherent limitations because it does not assess whether a company's procurement decisions lead to additional renewable energy generation or emissions reductions. It explicitly excludes avoided emissions and development impacts from Scope 2 accounting (Science Based Targets Initiative, 2025). This provision limits the ability of companies to support renewable energy projects in under-electrified or fragile regions where the marginal impact of investment could be higher. The draft SBTi Corporate Net-Zero Standard Version 2.0 introduces several revisions aimed at streamlining corporate action and grid decarbonization. Additionality and avoided emissions, though acknowledged, remain outside the scope of accounting methodology. The revisions continue to impose stricter requirements on geographic sourcing, increased transparency, and limited flexibility for REC purchases outside the market boundary (Science Based Targets Initiative, 2025).

However, expanding the ability of companies to engage in out-of-market procurement could unlock capital for high-impact renewable energy projects in under-electrified regions. Though not promoted as an out-of-market purchase, the SBTi revisions do propose outside the grid purchases if the grid that the company currently draws from lacks enough zero-carbon electricity (Science Based Targets Initiative, 2025).

“We recognize that some companies don't have access to grids with zero-carbon electricity, often due to regulatory constraints. That's why the draft standard also enables these companies to contribute to zero-carbon electricity from other grids as a time-limited alternative.” - SBTi

This provision could be useful to EPP to advance P-RECs to users of low-carbon grid electricity.

Relevance of ISO 14064-1 Energy Indirect Emissions for P-RECs /EPP



Source: Ecommerce Accountants

ISO, the International Organization for Standardization developed ISO 14064-1 as a global standard for greenhouse gas (GHG) accounting at the organizational level. It is an inventory-based standard that guides organizations to build their GHG inventory. The standard emphasizes principles such as relevance, completeness, consistency, accuracy, and transparency (ISO, 2018). ISO 14064-1 requires companies to include both direct and indirect emissions. Emissions from purchased electricity count as indirect emissions, which are conceptually similar to Scope 2 emissions, but the ISO 14064-1 does not use Scope 1, 2, and 3 terminology (ISO, 2018).

It also does not attempt to regulate how companies should procure electricity or which renewable energy claims are more impactful (ISO, 2018). ISO 14064-1 does not provide detailed rules for electricity accounting, including emission factor selection, market boundaries for electricity procurement, or geographic matching. It mainly ensures that whatever method is used is reported transparently (ISO, 2018). This highlights the core difference between ISO 14064-1 and other frameworks, such as the GHG Protocol Scope 2 Guidance, which defines market-based and location-based accounting and sets stricter provisions for RECs usage (GHG Protocol, 2015).

Since ISO 14064-1 does not impose strict geographic or market boundaries, EPP could target companies reporting under ISO to use P-RECs to offset their indirect emissions. However, this flexibility is not without its limitations. ISO does not have any provisions that would distinguish between conventional RECs and high-impact P-RECs. Consequently, the expensive P-RECs may not receive additional recognition/preference over the cheaper conventional RECs.

Another disincentive is that ISO focuses only on direct emissions associated with organizations and does not allow subtraction of avoided emissions from the organization's total emissions (ISO, 2018). The ISO technical committee emphasizes that inventory accounting should remain separate from mitigation/impact reporting that includes avoided emissions (ISO, 2018).

Another significant ongoing development to note is a new partnership between the GHG Protocol and the ISO standards committee focused on ISO TC 207 (GHG Protocol, 2025b). EPP could keep a close watch on the extent of incorporation of ISO provisions into the revised standard and vice versa. While EPP is undertaking all efforts to secure a 1% exemption for out-of-market purchases under the GHG Protocol, engaging with ISO technical committees and experts as a complementary pathway to influence the evolution of the GHG Protocol is also worth considering.

The pathway to influencing an ISO standard is explained in the ISO Directives and requires all new proposals, including amendments, to be considered by the committee. If a volunteer offers to lead the project and enough committee members support the initiative, it could move forward (ISO, 2018).

Relevance of TCAT Provisions for P-RECs /EPP

The Task Force on Climate-Related Action Transparency (TCAT) is a new framework that has launched Mitigation Action Accounting and Reporting Guidance (MAARG) in September 2025 to fill the critical gaps in and complement existing frameworks, such as the GHG Protocol and the SBTi (TCAT, 2025). It aims to supplement the traditional attributional GHG inventory (Scope 1, 2, and 3) with the incorporation of a new accounting methodology for mitigation claims (consequential accounting). It seeks to introduce new ways to recognize broader climate benefits of clean energy (TCAT, 2025).

As with any other methodology, the MAARG framework also has certain limitations. Consequential accounting seeks to quantify the impact of companies' operations on actual emission levels. Such an assessment involves defining the counterfactual baseline scenario on what would have happened otherwise. Furthermore, establishing additionality for the company's investments would be complicated for projects with multiple sources of funding. Another difficulty is choosing the appropriate emission factors (ex: average vs marginal). To address these limitations, the TCAT framework facilitates transparency in assumptions, definition of the baselines, separation of mitigation claims from emissions inventories, among others (TCAT, 2025).

In the phase 1 pilot, 13 companies participated to test the standards, without a commitment to adhere to the guidance in the future. The second pilot is scheduled in 2026. If implemented, this new framework could turn into an opportunity to reshape the incentives built into corporate clean energy accounting. It would help compare the emissionality for projects in developed and under-electrified regions and help create visibility for the projects in EPP focus countries (TCAT, 2025).

Relevance of the GHG Protocol Scope 3 for P-RECs/EPP

The GHG Protocol Scope 3 Standard and its revisions do not recognize either same-market or out-of-market RECs within Scope 3 accounting. However, the draft still contains elements that may be relevant to Energy Peace Partners (EPP). Most notably, it highlights a company's "influence" over value chain emissions through supplier engagement and low-GHG procurement. For EPP, this creates space to frame high-impact renewable energy procurement as a value-chain intervention, rather than only a Scope 2 instrument (GHG Protocol, 2026).

The draft also distinguishes between required and optional Scope 3 emissions, encouraging companies to disclose additional emissions where relevant. This opens a pathway for companies to discuss P-REC-related actions as voluntary value-chain measures, even if they do not fit neatly within the formal Scope 3 boundary. In that sense, the opportunity is more about disclosure than accounting recognition (GHG Protocol, 2026).

The proposed Category 16 ("Other value chain activities") could, in theory, accommodate such actions, but its usefulness remains limited due to the lack of calculation guidance. At present, it appears more like a placeholder than a practical route for recognizing P-RECs (GHG Protocol, 2026).

At the same time, the draft clearly avoids endorsing consequential or avoided-emissions accounting within Scope 3. It explicitly notes that companies should not report avoided emissions from underlying assets in their Scope 3 inventories. Overall, the update does not resolve the core accounting challenge for P-RECs. Its value lies instead in signaling a shift toward value-chain influence and optional disclosures—areas that EPP can leverage to position P-RECs as a credible, high-impact intervention (GHG Protocol, 2026).

Relevance of the SBTi Scope 3 for P-RECs/EPP

Scope 3 targets under the SBTi aim at slashing emissions from the value chain, and corporations must account for approximately 67% of Scope 3 emissions that are material to them. This standard emphasizes direct emissions reduction and energy procurement linked to the value chain and does not permit offsets and other external instruments to be utilized for achieving Scope 3 goals. Any emissions that are associated with energy (such as electricity generation upstream, fuel extraction, and energy transmission loss) can only be abated via value chain emission cuts, and not through certificate purchases outside the value chain. Therefore, the suppliers to global corporations based in target geographies in Africa with a clear value chain connection could be approached by EPP for P-REC purchases. This would help offset the corporations' energy-related emissions under Scope 3 (Science Based Targets Initiative, 2025; GHG Protocol, 2026).

Relevance of the SBTi Beyond Value Chain Mitigation (BVCM) for P-RECs/EPP

SBTi facilitates companies to set net-zero targets by covering 90% emission reduction under Scope 1, 2, 3, and the balance 5–10 % reduction from residual emissions. It is important to note that SBTi also enables companies to set additional voluntary targets to reduce emissions beyond the value chain, called Beyond Value Chain Mitigation. BVCM includes investments in projects that avoid or reduce GHG emissions or capture carbon from the atmosphere. This mechanism serves as a perfect fit for channeling investments towards P-REC projects. Therefore, EPP could target companies that have set Beyond Value Chain Mitigation (BVCM) targets (Science Based Targets Initiative, 2025).

Relevance of the ISO 14064 - 'Other Indirect Emissions' for P-RECs/EPP

Even under the ISO 14064-1 framework, similar to SBTi Scope 3, suppliers in EPP focus countries are a key entry point for integration of P-RECs into corporate value chains. ISO categorizes emissions as direct, energy indirect (from purchased electricity), and other indirect (value chain) emissions. Although P-RECs cannot adjust a company's own other indirect emissions inventory, they can impact emissions at the supplier level. When suppliers purchase P-RECs towards their energy indirect emissions, their total emissions may decrease. This reduction can indirectly lower the buying company's other indirect emissions, which rely on supplier data. Energy Peace Partners (EPP) should therefore focus on supplier-level energy transitions in addition to direct corporate inventory adjustments (ISO, 2018; GHG Protocol, 2026).

4. Calculator Design

Key Takeaways:

- The calculator measures avoided emissions from adding renewable electricity in off-grid communities.
- Replacing fuels like wood, kerosene, charcoal, and gasoline can create significant carbon reductions, especially in rural areas.
- The tool helps EPP compare projects, show climate impact, and support better investment decisions.

Methodology

The emissionality calculator evaluates the amount of carbon emissions that can be avoided when households gain access to electricity (primarily renewable). In addition to just providing households with energy supply, renewable electricity changes the way consumers use energy to power different activities (e.g., cooking, heating, cooling, etc.). In particular, some forms of traditional energy like charcoal, fuelwood, kerosene, diesel, and gasoline are consumed less once they have access to electricity. As renewable energy sources have significantly lower life cycle emissions (LCE), this shift in energy usage leads to a reduction in carbon emissions (Planete Energies, 2023; IPCC, 2006).

The emissionality calculator is designed to estimate the avoided emissions by 1kWh of added renewable energy. We apply the formula

$$E_a = \sum_{s \in S} X_s \cdot E_s$$

where E_a are the avoided emissions, X_s is the weight given to source s and E_s are the emissions per kWh generated by source S (IPCC, 2006; Our World in Data, 2025). We consider the sources S = {gasoline, diesel, kerosene, charcoal, wood} (Engineering ToolBox, n.d.). The weights X_s add up to 1 and can be thought of as the share of total energy consumption that is replaced by 1kWh of a renewable energy project. For example, if total energy consumption is reduced by 1kWh – of which 80% are kerosene for lighting and 20% are gasoline for electricity generation – then each would receive a weight of 0.8 and 0.2, respectively.

We calculate the shares X_s with two different approaches, which are outlined below. Both methodologies are based on the World Bank Multi-Tier Framework (MTF) household Energy Access Survey, that contains information on energy consumption, grid access, and in some cases, rural or urban distinction. The raw data included in the survey were considered for countries such as Kenya, DRC, Nigeria, Niger, Liberia, and Ethiopia.

The energy usage information in litres and kilograms were converted to kilowatt-hours of energy. The conversion factors for different fuel sources were determined using published data and other available databases of energy-related information (IPCC, 2006; Our World in Data, 2025; Climatiq, 2022). Life cycle emissions associated with using fossil fuels were also estimated based on published data from the IPCC or similar publications (IPCC, 2014; Planete Energies, 2023). This includes emissions from burning fossil fuels as well as upstream emissions from activities such as extraction, processing, and transportation. In addition, the life cycle emissions generated from renewable electricity sources like solar, wind, and geothermal were deducted in order to yield net avoided emissions.

Approach 1: The most used sources are reduced the most

This method assumes that electrification will reduce the consumption of all emitting energy sources to zero. The reduction weight X_s associated with each source is thus proportional to its current share of total energy consumption.

The World Bank dataset provides the household usage of each source in kg or L – for which we calculate the average across households. To allow for comparison between the sources, we use energy intensity figures of the IPCC to turn each source's usage from kg or L into kWh (IPCC, 2006). Defining U_S as this usage in kWh, we then derive Xs.

$$X_s = \frac{U_s}{\sum_{s \in S} U_s}$$

There is a caveat to this approach: Higher consumption of one source does not mean that it will be replaced by electricity. A household may find it easier to replace kerosene lighting with LEDs rather than replacing the firewood cookstove with an electric alternative.

Approach 2: Comparing connected households to unconnected households

Approach 2 aims to answer the caveat of Approach 1 by comparing energy usage in households without grid connection to those with grid connection. In the following, let $U_{s,g}$ be the usage of source S by households with grid connection and $U_{s,ng}$ be the usage of source S by households with no grid connection. Then the change in energy usage is defined as

$$\Delta_s = U_{s,g} - U_{s,ng}$$

By design, this means that a negative Δ_s correlates with a reduction in usage of a source from no grid access to grid access, as $\Delta_s < 0 \iff U_{s,g} < U_{s,ng}$.

We then plug Δ_s into a similar formula as in Approach 1 to calculate the weights of each source:

$$X_s = \frac{\Delta_s}{\sum_{s_i \in S} |\Delta_s|}$$

Variations

The calculator gives multiple options to adjust the methodology. Besides the comparison to households with grid connection, users can:

(1) tune the calculator to only consider rural households
(2) choose between approach 1 and approach 2 based on the requirement.

The first option is particularly relevant to the EPP: Most of its projects are located in rural areas and thus including urban households in the average may skew the results.

The second option is particularly relevant when identifying the effect of electrification in locations that use generators. Most households did not record gasoline or diesel usage, such that the consumption of a consumer with a generator might be considerably different from the average household. Therefore, we give the option of calculating the average consumption solely based on data points where the source is actually used.

Limitations and Considerations

The model has multiple limitations that we want to outline below alongside methodology considerations.

One limitation is that our calculator does not consider household income, size and type – each of which could influence energy consumption. This point is further outlined in the results section.

The team particularly highlights that this calculator is built on directly avoided emissions, not potentially avoided emissions of the future. Emissions of future generator usage or grid connection are therefore not regarded. The team decided to pursue an assumption that the shift to a solar minigrid would be the only available grid connected option, and decided not to assume that the current electrical grid mix would be available as an alternative. In other words, the question raised by the calculator is which energy sources are in use today, without being connected to the grid, and which are displaced when connected to a solar minigrid. It is not that the underelectrified region will be offered an option to be connected to the country's current grid, which is often a mix of coal, natural gas, or oil, (and in one case large scale hydro), versus solar minigrids.

Further, the datasets for the DRC and Niger only show binary data on usage instead of consumption in L or kg and therefore do not provide accurate representations of the situation. We thus only compare the change in the share of households using a specific source – not how much of a source is actually used.

Finally, this analysis is limited to a small combination of countries, meaning the results may not appropriately represent each respective area outside of those countries.

Findings

Our team synthesizes some of the main findings of our calculator and gives evidence to some of the limitations outlined in the section above.

The tables below indicate the weights, X_S, for Kenya, the DRC, Nigeria, Niger, Ethiopia and Liberia in Approaches 1 and 2 and then present the impact of variations 1 (rural filter) and 2 (usage filter) with Kebbi region of Nigeria as an example

Approach 1

Table 1: Emissionality Results for Each Country from Approach 1

Comparing to connected OFF, DON'T APPLY FILTER, RURAL YES						
Source	**Kenya**	**DRC**	**Nigeria**	**Niger**	**Ethiopia**	**Liberia**
gasoline	-0.35%	NA	-4.63%	NA	-18.02%	-90.94%
Diesel	0.00%	-0.082%	0.00%	0.000%	-0.04%	-8.08%
Wood	-88.15%	-81.701%	-89.57%	-85.699%	-46.78%	-0.39%
Charcoal	-9.34%	-18.217%	-0.35%	-14.301%	-24.13%	-0.59%
Kerosene	-2.16%	NA	-5.44%	NA	-11.03%	NA
Emissions Change	-409.52	-430.90	-365.63	-432.38	-448.87	-294.83

The table shows that wood is the dominant fuel in five out of six countries, resulting in an emission reduction between 449 and 294 kgCO2/MWh. Liberia is an exception, where gasoline is a major source of energy that is replaced by grid connection. Since the emission intensity of gasoline is lower than that of wood, the average reduced emissions are lower here.

Approach 2

Table 2: Emissionality Results for Each Country from Approach 2

Comparing to connected ON, DON'T APPLY FILTER, RURAL YES						
		No Rural		No rural		*Gasoline zeroec
Source	**Kenya**	**DRC**	**Nigeria**	**Niger**	**Ethiopia**	**Liberia**
gasoline	-0.18%	NA	79.22%	NA	-10.36%	0%*
Diesel	0.06%	0.085%	0.00%	0.000%	0.40%	-93.32%
Wood	-76.96%	-54.825%	13.54%	95.360%	-12.83%	-1.64%
Charcoal	20.97%	45.090%	3.95%	-4.640%	71.37%	-5.04%
Kerosene	-1.83%	NA	-3.29%	NA	-5.04%	NA
Emissions Change	-114.07	197.07	361.14	376.51	515.95	-326.59

The results vary for each country. For some, emissions actually increase. This is likely attributed to either the energy income ladder paradox, or income and household size inequality not included in our analyses, or both. When filtered to each region, the results are more precise. As a result, we suggest that EPP use Method 1 as support for quick recommendations to clients, and Method 2 for more detailed internal purposes.

The effect of filtering for rural households

To demonstrate the impacts of the filters in the calculator, the example below shows the emissions figures when certain filters are applied versus not applied. Below is a case study of the calculator filters in Kebbi, Nigeria.

Table 3: Emissionality Results for Kebbi, Nigeria with Supply Filter Off

Case Study Rural. Supply Filters off. Comparing to G connected ON		
	RURAL = TRUE	**RURAL = FALSE**
gasoline	0.00%	28.70%
Diesel	0.00%	0.00%
Wood	-41.43%	-43.26%
Charcoal	0.00%	1.63%
Kerosene	-58.57%	-26.42%
Emissions Change	-321.21	-121.84

This table provides a case study scenario of when the 'Rural' setting is applied versus when it is not applied. As a reminder, the 'Rural' filters the data set to only consider rural households. This is only available in Kenya, Nigeria, and Liberia.

In Kebbi, Nigeria, when only considering rural households, 321.21 kgCO2/MWh emissions are offset, and when considering rural and urban households, 121.84 kgCO2/MWh are offset. The fuel sources' consumption distribution shifts noticeably when urban households are considered. In particular, both kerosene and gasoline percentages increase, suggesting that urban households do not offset as much carbon when provided with new energy as rural households.

The effect of applying supply filters

When evaluating the effect of grid connection to households, there is uncertainty about whether households have been using a source before or after grid connection at all. This is especially true for gasoline: In most cases, less than 10% of households use gasoline, which means that the remaining households skew the average usage downwards. We therefore apply a filter that calculates the average usage based only on households that use a specific source. This filter can be applied to both connected and unconnected households, only connected households, or neither households.

Table 4: Emissionality Results for Kebbi, Nigeria with Supply Filter On.

Case Study SUPPLY FILTER. Rural ON. Comparing to connected ON			
	Filter both	**Filter Connected**	**Filter Off**
gasoline	0.00%	0.00%	0.00%
Diesel	0.00%	0.00%	0.00%
Wood	-26.52%	-10.89%	-41.43%
Charcoal	0.00%	0.00%	0.00%
Kerosene	-73.48%	-89.11%	-58.57%
Emissions Change	-308.09	-294.33	-321.21

The "Filter both" column restricts the data set to the connected and the non-connected households that already use the fuel in question. When filtering for households that use wood, the renewable energy project causes households to decrease their wood consumption by 26.52%. However, when not filtering for households that use the supply (wood in this case), fuel consumption decreased by 41.43%.

Strength of this approach: When applying the filter, the data set is narrowed to households that actually use the sources, so it gives more specific insight into how households' consumption patterns change while actively consuming the source. This can be particularly useful if the usage of households in the potential project area is known.

Limitation of this approach: When applying the filter, you do not factor in the households that shift off the energy source when they become connected to the grid, because it is only filtering for households that actively consume the source. Filtering for usage has an impact of ± 20 gCO2/kWh. The filter serves as an upper or lower bound for the actual reduction, as it is uncertain which/if households got rid of the source after connection to the grid.

5. Market and Growth Potential

Key Takeaways:

- The global REC market is already large, valued at about USD 20 to 30 billion in 2025, and is expected to keep growing by 2030.
- Growth in corporate net-zero goals, ESG demand, and clean energy policies will likely increase future demand for renewable energy credits.
- Even a small 1% market exemption could unlock millions of dollars for P-RECs and help fund high-impact renewable energy projects in EPP focus countries.

Methodology

The Renewable Energy Certificate (REC) market plays a critical role in reducing global greenhouse gas emissions by supporting investments in clean energy (Precedence Research, 2025). The global REC market is segmented into voluntary and compliance markets. The compliance market comprises regulated entities, such as utilities, that procure RECs to meet national or state regulations, such as renewable portfolio standards (RPS). The voluntary market comprises institutions or companies that procure RECs to offset emissions or meet renewable energy goals (Enel Global Trading, n.d.). While there are not many sources providing the distribution between voluntary and compliance markets, one source suggests that the compliance REC segment accounted for 55.6% of the revenue share in 2025, implying that about 44.4% of the global REC market is voluntary (Data Bridge Market Research, 2025). Therefore, the team has considered 44.4% to carve out the voluntary portion from the estimated market size.

To evaluate the current size of the global renewable energy credit market, our team analyzed estimates from various industry reports and peer-reviewed journals. Different estimates place the size of REC markets across a wide range of values. However, a common trend across these estimates is that the market is projected to have steady growth in the coming decades (GCC, 2024; Polaris Market Research, 2025; Research and Markets, 2025). Since diverse sources project diverse growth rates in future years, the methodology calculated the market size for 2030 using compound annual growth rates. As part of our analysis, the team performed a sensitivity analysis using a range of assumptions on total market size and growth rates, which is used to project how large the voluntary market could become under different scenarios.

Despite the sensitivity analysis, there are limitations to the methodology to consider which are due to the significant variations across data sources and estimation methods. Another constraint is the lack of adequate data on the share of the voluntary REC market and even more limited data on specific segments such as solar RECs. In addition, some assumptions, such as keeping the voluntary share constant over time, may not reflect real market changes.

Findings

Based on the reviewed information, the global REC market received investments in 2025 of roughly USD 20 to USD 30.1 billion, with an average of USD 25.70 billion (Precedence Research, 2025; Data Bridge Market Research, 2025; Polaris Market Research, 2025). Future estimates for 2030 suggest a lower bound of USD 38.74 billion, an average of USD 52.44 billion, and an upper bound of USD 70.56 billion Research and Markets, 2025; GCC, 2024). Based on the voluntary share of 44.4%, the estimated voluntary market size has lower and upper bounds of USD 9.16 billion and USD 13.63 billion, respectively, with an average of USD 11.42 billion in 2025. For 2030, the voluntary market yields lower and upper bounds of USD 17.20 billion and USD 31.33 billion, respectively, with an average of USD 23.28 billion.

In a scenario where market boundary rules allow a one percent exemption based on the current market size, the model estimates about USD 90 million in demand for P-RECs and similar market credits based on the current market size. Demand for P-RECs increases to approximately USD 170 million when extending the model to 2030 estimates. One important aspect to note is that this results is not specifically for solar RECs. Some sources suggest that solar is the largest segment and is expected to continue growing due to technological advancements and declining costs (Research and Markets, 2025; Polaris Market Research, 2025). The team further made some assumptions to estimate the solar component of the global REC market. The US REC market, estimated to be approximately USD 11.45 billion in 2021, has a solar share of about USD 3.3 billion, which represents approximately 28 percent (S&P Global, 2022). While the solar share may vary in other regions and countries, the solar component is largely believed to have grown in recent years. For this project, our team has assumed the solar share will equate to 25% conservatively, for the global REC market. Using this assumption, the results of a potential one percent exemption from the voluntary component show values ranging from USD 22.5 million to USD 35 million in 2025, and from USD 42.5 million to USD 77.5 million in 2030, respectively.

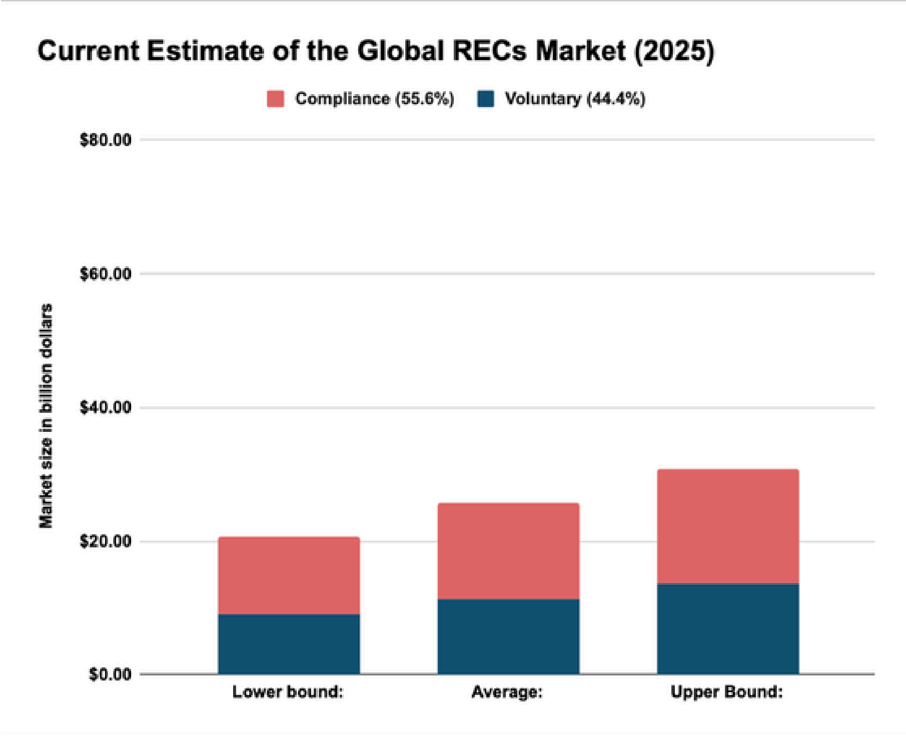


Figure 1: Estimates show the value of the global REC market to be between roughly USD 20 to USD 30.1 billion in 2025

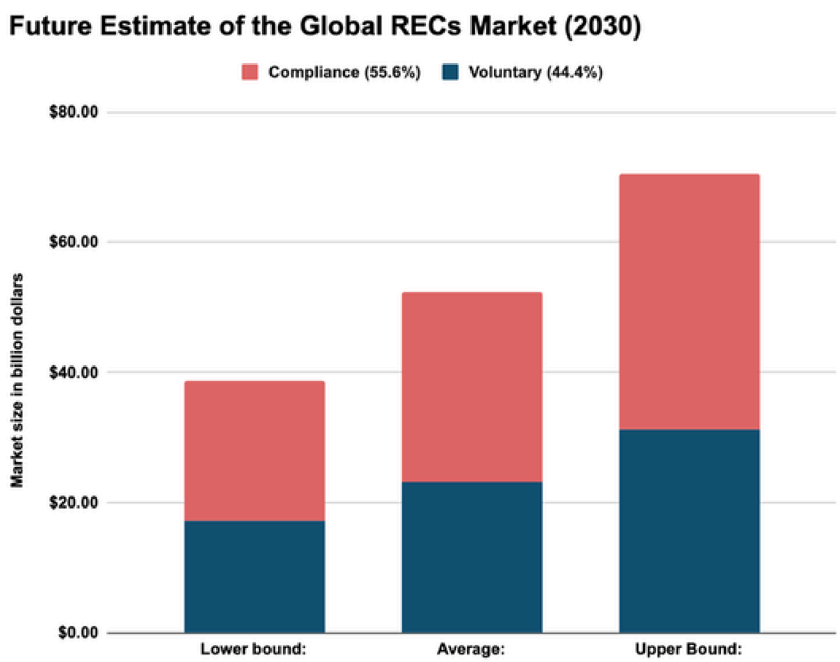


Figure 2: Future projections estimates that the value of the global REC market could increase to roughly between USD 38.74to be between USD 70.56 billion by 2030.

Table 5: One percent potential exemption value based on 25 percent estimate of the voluntary global REC market

	Current estimates (2025)	Future Estimate (2030)
Lower bound	$22.5M	$42.5M
Average	$27.5M	$57.5M
Upper bound	$35M	$77.5M

Sensitivity Analysis

The sensitivity analysis shows that the estimated market size varies significantly depending on both the assumed share of voluntary demand and the overall growth trajectory. Higher voluntary shares and stronger growth rates lead to substantially larger market estimates, while more conservative assumptions result in a smaller but still meaningful market size.

Table 6: Projected Market Size Under Different Compound Annual Growth Rate Scenarios (Value in USD billions)

CAGR Scenario	CAGR (%)	Initial Market Size (Low: $20.63)	Initial Market Size (Average: $25.73)	Initial Market Size (High: $30.70)
Low Growth	8.90%	$31.60	$39.41	$47.02
Average Growth	14.48%	$40.57	$50.60	$60.38
High Growth	25.64%	$64.59	$80.55	$96.11

Overall, the global REC market is expected to grow in the coming years. The expected growth is attributed to factors such as state RPS and clean energy standards, increasing investment in renewable energy projects, supportive government policies aimed at promoting sustainable energy generation globally, and importantly, companies' commitments to achieving net-zero and enhancing ESG credibility. The current size of the market and the expected growth represent a potential for increased demand in credits, including the P-RECs certified by EPP. If key frameworks allowed market boundary exemptions for even one percentage of this market, it could unlock millions of dollars for the impactful renewable energy projects in EPP's focus countries.

6. Potential Clients Mapping

Key Takeaways:

- The most suitable potential buyers combine experience with. electricity procurement & operational presence in target countries
- The potential for purchasing P-RECs vary across sectors.
- Nigeria stands out as the clearest anchor market.

Methodology

To identify corporate entities well-suited as targets for P-REC purchases, our team conducted a high-level assessment of entities whose sustainability commitments and operational presence in EPP's target countries may suggest potential demand. The team focused specifically on African countries for the development of the potential client list. The objective is to identify firms whose public disclosures reflect a credible alignment between renewable electricity generation and a footprint in EPP's P-RECs market.

The analysis applies a structured desk-review methodology based on publicly available corporate information, including sustainability reports, annual reports, energy transition plans, and corporate responsibility disclosures. The evidentiary base is concentrated in the 2023-2025 period, with the majority of sources drawn from 2024 and 2025. The review examined evidence of familiarity with renewable electricity procurement mechanisms, including RECs, energy attribute certificates (EACs), power purchase agreements (PPAs), and other similar instruments. The analysis also evaluated evidence of meaningful presence in EPP's African markets, including operating presence, infrastructure, manufacturing activities, banking networks, sourcing relationships, or philanthropic programs. The potential client mapping provides a practical assessment to determine where credible commercial opportunities may exist. Its principal value lies in narrowing a broad group of companies into a more focused set of firms whose sustainability strategies and African market presence indicate plausible commercial relevance.

Findings

At first, the strongest potential buyers tend to be those who combine experience with renewable electricity procurement and a documented operational presence in target countries. Another observation is that the opportunity set is not distributed evenly across sectors. The candidate list encompasses 28 companies across the technology (5), financial services (7), manufacturing and industrial (11), and retail and consumer sectors (5). Higher education and large investors were also evaluated, however they did not fit the criteria so they were excluded from the recommendations.

The review indicates that the manufacturing and industrial sector and the financial services sector offer the broadest near-term commercial potential, given their high concentrations of firms with broader African footprints. While the technology sector may represent a small portion of the list, these companies offer high-quality investment opportunities through their cloud and digital infrastructure. A few global sports equipment and clothing manufacturers have a strong presence in Nigeria through retail expansion and distribution. Their large direct electricity loads could be useful for making the case for higher-impact procurement. In addition, the retail and consumer sector creates relevance through brand positioning or philanthropic activity. Furthermore, some global apparel and coffee brands have footprints in Ethiopia through sourcing raw materials or semi-finished goods. Another global furniture company has provided support for an energy access initiative in Nigeria, demonstrating its commitment to making an impact on the continent.

Geographically, it is relevant to note that Nigeria is the country with the greatest operational footprint across companies and stands out as the clearest anchor market. The DRC appears to have limited representation, with just two companies. Some companies also have a presence in countries such as Ethiopia, Kenya, Nigeria, Uganda, and Zimbabwe.

It should be noted that the analysis has its limitations and should be interpreted with caution. Public sustainability reporting does not necessarily correspond to actual procurement appetite in African markets. In some instances, relevance is grounded in direct operations, but in others it derives from philanthropy or exposure to legacy markets. Therefore, these are not equivalent indicators of commercial commitment.

The assessment serves as an identification of commercial potential rather than a predictor of future REC transactions. It is also worth mentioning that the analysis does not capture internal market participation timelines, budget cycles, regulatory constraints, or the existence of an active or future project. Considering that our study relies on current public disclosures, it may understate or overstate opportunity depending on the scope and quality of company reporting. Therefore, Energy Peace Partners requires further direct exploratory engagement with these potential buyers to validate demand, understand internal decision-making processes, and convert interest into actionable transactions.

7. Co-benefits Assessment

Key Takeaways:

- Households place a high value on reliable electricity, demonstrating strong willingness to pay for improved energy access.
- Electrification leads to measurable gains in productivity, including longer business hours, diversification, and increased employment.
- Access to electricity improves gender outcomes by increasing female labor participation and significantly reducing time spent on household tasks.
- Electrification enhances education outcomes through improved study conditions, higher attendance, and better academic performance.
- Access to clean electricity improves health and safety by reducing indoor air pollution and strengthening healthcare service delivery.

Methodology

To measure the social and economic benefits of electricity generation in off-grid, fragile, conflict-prone regions, this study uses Willingness-To-Pay (WTP) as the primary evaluative measure. WTP refers to the maximum amount an individual is prepared to pay for a good or service. In the electricity context, WTP is used as an indicator of the value that households and firms assign to electricity access. WTP reflects the utility derived from energy services, since it measures the demand value of electricity connections. In various literature on electrification assessments, WTP has been used to estimate the private benefits of energy access and to inform cost-benefit analyses of infrastructure investments.

At the same time, WTP has a fair share of its limitations, especially in low-income settings. Since it is constrained by income and access to credit, it may understate the true welfare gains associated with electrification. In addition, WTP generally captures private benefits better, compared to the broader social effects such as improvements in public health or educational success. In addition, estimates derived from surveys may also be influenced by imperfect information or hypothetical bias, making WTP a lower-bound estimate of the total social value of electrification.

A comprehensive assessment requires complementary approaches like impact evaluation in order to capture the wider and longer-term benefits of electricity access. For example, empirical evidence indicates that electrification is associated with incremental gains in female employment by reducing the time burden associated with household tasks, mainly water and fuel collection. With respect to education, access to electricity is associated with better educational outcomes by way of reduced dependence on children for household tasks and, consequently, availability of additional time for learning, particularly in the evenings. Nearly half of the households and over 90 percent of schools report improvements in academic performance following electrification. With respect to health benefits, electrification helps prevent health hazards from fuels such as fuelwood, charcoal, kerosene, and diesel. In addition, health facilities report better vaccine refrigeration and storage of supplies post electrification.

Findings

Findings show that households place a high value on electricity access, often allocating more than 10% of their expenditure to energy services. Various studies report that WTP consistently increases with income, but varies by the technology involved in electrification. Households demonstrate a preference for electricity access of higher quality as income rises. For example, empirical evidence from Senegal indicates that households exhibit significant WTP for reliable electricity services, where the estimated maximum WTP per kWh is USD 0.31 for men and USD 0.22 for women among nonconnected households, and USD 0.24 for men and USD 0.22 for women among connected households. The median WTP is ~USD 0.20 per kWh for both men and women. It is worth mentioning that in some survey contexts, men are generally identified and agreed as the household head. Therefore, the WTP figures from men may not be representative of women or the entire household, since women spend more time collecting fuel sources. At the same time, women often derive substantial benefits from reliable electricity but may report lower WTP due to more limited access to disposable income.

Zuch (2025) examines household demand for electricity access in rural Kenya by estimating WTP for (1) grid connections and (2) off-grid solar home systems. The major contribution of this research is that it provides a demand perspective on electrification by quantifying how much households value different forms of electricity access. Results show a preference for grid electricity over off-grid alternatives. On average, households are willing to pay ~USD 78 for a grid connection, compared to ~USD 43 for solar home systems. The findings also indicate that WTP is positively associated with income, asset ownership, self-employment, and familiarity with solar technologies (Zuch, 2025).

Olanrele (2024) analyzes households' WTP in Nigeria and examines how socioeconomic characteristics or electricity consumption patterns affect WTP. Results show that income, education, household size, and expenditure on backup generators influence households' WTP. Experience with unreliable grids and additional dependence on self-generation (e.g., diesel generators) increase WTP, as households seek to avoid the high costs associated. The estimated mean WTP is ~ ₦164.81 per kWh (~USD 0.37/kWh) for a 70 percent improvement in electricity supply, representing an increase of nearly 195% above current tariffs (Olanrele, 2024). About 85% of the households surveyed are willing to accept this higher cost, suggesting strong demand for reliable electricity services.

Similarly, Oseni (2020) analyzes how households' reliance on self-generation (diesel generators) in Nigeria affects their WTP for reliable electricity from the grid. Approximately one out of every three Nigerian households owns a generator, and households spend between USD 0.27 and USD 0.41 per kWh to produce their own electricity (higher than grid tariffs, which range from USD 0.09 to USD 0.15 per kWh). The results show that households without generators are willing to pay USD 0.14 per kWh and households with generators USD 0.16 per kWh. Additionally, the average household is willing to pay ~USD 6.82 per month for improved service, rising to USD 7.44 per month among generator-owning households (Oseni, 2020). While households report WTP of around USD 0.14–0.16 per kWh, they actually spend an average of USD 0.34 per kWh on self-generation, which is more than double their stated willingness to pay. This gap suggests that traditional survey-based WTP measures underestimate the true economic value of electricity.

Bhandari et al. (2020) examine WTP for solar photovoltaic (PV) rural electrification in Niger, a country where electricity access is limited. Its research focuses on trying to understand if community ownership models can increase households' WTP for solar electricity. The study proposes a framework where electricity systems are shared among users and managed collectively, allowing for cost-sharing and demand management. Under conventional ownership models, only ~17 percent of households are willing to pay for solar electrification (Bhandari et al., 2020). However, when collaborative consumption and community ownership are introduced, monthly energy costs can be reduced by up to 80 percent, increasing WTP to ~81 percent of households.

Entele (2020) analyzes households' WTP for access to electricity services in rural Ethiopia, with a focus on comparing grid electricity and solar PV systems. The results show that the median WTP for grid electricity is estimated at 3,240 Ethiopian birr (~USD 150.7) as a one-time connection fee, or 65.86 birr per month (~USD 3.06) if paid in installments. For solar PV electricity, the median WTP is at 2,923 birr (~USD 135.9) as a lump-sum payment, or 59.92 birr per month (~USD 2.80) (Entele, 2020). The results indicate that households are willing to pay for electricity access, but they consistently prefer grid electricity over solar PV, likely due to perceptions of higher reliability. A key finding of the paper is that WTP is not sufficient to cover the full cost of connection, which is estimated at ~5,000 birr (~USD 233) for both grid and solar systems.

Other empirical research has examined the impacts of solar mini-grids across rural regions of Sub-Saharan Africa, with special attention in Kenya, Senegal, and Nigeria. These studies evaluate changes across development dimensions including economic activity, gender equality, health, safety, productivity, among others (Carabajal, 2023). The findings indicate that decentralized renewable energy systems (i.e., solar mini grids), represent a viable and effective alternative to centralized grid expansion in underserved rural areas.

Economic and Productivity Impacts


Source: World Bank

Access to electricity in areas that were not connected to the grid leads to improvements in household welfare and business productivity. Electrification extends lighting hours, reduces time spent on energy tasks like fuel collection, and enables the adoption of electrical appliances, which benefits those who spend unnecessary time on activities that are replaceable by machines. Business activity also expands markets following electrification. In the reviewed papers, approximately 87 percent of firms report longer operating hours, 51 percent diversified their products and services, and 16 percent hired additional workers. Income effects vary across countries. For example, in Kenya, median household income increases by 17 percent following electrification. Importantly, electrification in Kenya leads to measurable reductions in energy services. Evidence shows that access to solar home systems reduces spending on kerosene and phone charging, lowering total monthly energy costs by ~USD 1.7 per household.

Gender and Labor Outcomes

While the proportion of women-owned businesses declines following electrification, female labor force participation increases, driven by higher demand for labor among newly electrified firms. Empirical evidence indicates that each additional set of connections is associated with incremental gains in female employment. A 2021 article in the Princeton University Journal reports a 9–9.5% increase in female employment post electrification. The article also reports a reduction in time burden by 20–25 hours/week through electrified water access. These time savings contribute indirectly to gender equality by permitting greater participation in education and income-generating activities (Clark, 2021).

©Natasha Elkington/CIFOR

Education and Human Capital

Improved access to electricity has a positive effect on educational outcomes. The reduced need for child labor in household tasks is associated with higher school attendance, while better lighting conditions improve the quality of study environments and the quantity of time that can be dedicated to education. Nearly half of households and over 90 percent of schools report improvements in academic performance following electrification. Specifically, a 2022 paper based on a study in Nigeria reports that grade progression increases by 2.76%, non-attendance falls by 1.5–2.5%, and transitions to higher grades rise slightly by 0.43% (Nano, 2022).


Source: Shutterstock

Health, Safety, and Welfare

Electrification generates improvements in health outcomes by reducing reliance on fuels causing indoor air pollution, such as wood, charcoal, kerosene, and diesel. A 2017 study indicates that replacing firewood and charcoal reduces PM2.5 concentration by 66% and acute respiratory infections by 8–14% (Barron & Torero, 2017). Safety outcomes are generally positive: for example, better public and household lighting reduces risks of nighttime travel and poor visibility, thereby improving overall community safety. Electrified health facilities gain the capacity to refrigerate vaccines and store essential medical supplies, thereby improving the quality and reliability of healthcare services. In a pilot electrification project conducted by Shell Foundation (2024) for health facilities in Nigeria, the DRC, and two other countries, health facilities reported an increase in equipment purchase in 50% of the facilities, an increase in revenue in 100% of the facilities, and an increase in staff in 90% of the facilities. In addition, patient satisfaction increased by 15%, and the facilities were able to introduce e-bikes for vaccine distribution (Shell Foundation, 2024).

Source: Sun-Connect

8. Recommendations

Based on the insights and findings, the capstone team suggests the following key recommendations as EPP continues to pursue pathways to scale the P-RECs.

Firstly, the team recommends that EPP approach companies with a physical footprint in target countries. Given the more stringent proposed physical deliverability requirements of the Greenhouse Gas Protocol and the Science-Based Targets Initiative, key frameworks providing guidance on energy procurement, corporate buyers could continue to prefer RECS generated from within their market boundary. Considering a scenario where the stringent requirements get diluted in the current and future revisions, allowing for out-of-market boundary purchase, EPP may gradually transition towards companies without a physical footprint.

Secondly, the team recommends that EPP approach companies reporting under the ISO-14064-1 framework. While the most widely followed frameworks globally are the Greenhouse Gas Protocol and the Science-Based Targets Initiative, some companies undertake emissions accounting under ISO 14064-1, which does not explicitly outline the within-the-market purchase requirements. However, given the chances of GHG Protocol and ISO converging in the future, EPP could closely follow the provisions adopted by the merged framework. In addition, EPP could influence the provisions of the GHG Protocol by engaging with ISO technical committees.

Thirdly, the team recommends that EPP pursue companies seeking to reduce their Scope 3 energy-related emissions and engage in Beyond Value Chain Mitigation (BVCM) under SBTi. A company's geographic reach expands when scope and value chain are taken into consideration. The GHG Protocol and the SBTi recognize how a company's value chain can impact the environment through increased emissions. Corporations with suppliers in EPP focus countries have Scope 3 emission reduction targets. Therefore, targeting the Scope 2 emissions of suppliers would help offset the Scope 3 emissions of corporations. In addition, EPP could focus on the optional Scope 3 emission reductions if the draft revisions come to fruition.

Fourthly, the team recommends that EPP use the REC market size and potential client list developed through this project to guide its outreach and prioritization strategy.

Finally, the team recommends that EPP use the outputs of the emissionality calculator to underpin the environmental benefits that the P-RECs provide. While EPP has been positioning P-RECs as higher impact RECs, the calculator helps quantify that impact to potential buyers. The avoided emissions from P-REC projects could influence companies' decision making. One of the main insights the team observed over the project is that companies purchasing P-RECs usually require a strong reasoning to select a P-REC over an I-REC due to its considerably higher cost, which is often 20 times greater. The calculator tool could help build a robust, quantitative case by demonstrating the additional climate impact delivered per unit purchased.

9. Conclusion

This report examined how EPP could strengthen the effectiveness and scalability of Peace Renewable Energy Certificates (P-RECs). According to the results, P-RECs are an answer to the global clean energy economy's missing link. Although climate finance is growing, the vulnerable and developing nations still do not get enough renewable energy investments. Consequently, P-RECs are a tool for directing funds to areas where clean energy would yield the most significant benefits. The emissionality calculator and co-benefits analysis illustrated the effect of electricity access in under-electrified regions across multiple dimensions, including climate change mitigation, gender welfare, family welfare, public health, education, and security.

At the same time, the report indicates that a main challenge for P-RECs lies in the accounting and policy frameworks through which corporate climate action is currently assessed. ISO 14064-1, the GHG Protocol Scope 2 Guidance, and the SBTi provide important tools for consistency and transparency in emissions reporting, but they are not designed to determine where renewable energy investment produces the greatest impact. The emissionality calculator helps determine where one additional unit of renewable electricity displaces the most carbon-intensive energy sources. It shows that the climate value of electrification is not uniform across regions and that renewable energy generation in underserved areas may produce larger marginal benefits.

The report also finds that P-RECs have a strong potential for scalable growth. Even modest changes in procurement rules, such as a limited exemption for out-of-market renewable procurement, could increase demand for P-RECs. This suggests that the future of P-RECs does not depend on a complete transformation of the voluntary REC market. The client mapping exercise reinforces this conclusion by identifying that the strongest prospects are firms that combine experience in renewable generation with presence in EPP’s African markets. Taken together, the findings suggest that EPP should continue strengthening its own evidence base through tools such as the emissionality calculator while pursuing a more targeted approach to market engagement.

10. References

Barron, M., & Torero, M. (2017). Household electrification and indoor air pollution. Journal of Environmental Economics and Management, 86, 81–92. https://doi.org/10.1016/j.jeem.2017.07.007

Bhandari, R. (2020). Rural electrification in Africa – A willingness to pay assessment in Niger. Renewable Energy, 161, 1–10. https://doi.org/10.1016/j.renene.2020.07.073

Carabajal, A. T. (2023). Social and economic impact analysis of solar mini-grids in rural Africa: A cohort study from Kenya and Nigeria. arXiv. https://arxiv.org/abs/2401.02445

Clark, L. (2021, May 5). Powering households and empowering women: The gendered effects of electrification in sub-Saharan Africa. Journal of Public and International Affairs, Princeton University. https://jpia.princeton.edu/news/powering-households-and-empowering-women-gendered-effects-electrification-sub-saharan-africa

Climatiq. (2022). Emission factor: Wood logs (net CV). https://www.climatiq.io/data/emission-factor/b72c39b8-5e5e-4653-9f57-fd6138ad8c2b

Data Bridge Market Research. (2025). Global renewable energy certificate market size, share and trends analysis report – Industry overview and forecast to 2033. https://www.databridgemarketresearch.com/reports/global-renewable-energy-certificate-marketsrsltid=AfmBOopreuNTFkQhWawjef72Kh4IQpAiGT4HODLn1eEt1i3EJmi-M7LM

Engineering ToolBox. (n.d.). Fuels - Densities and specific volumes. https://www.engineeringtoolbox.com/fuels-densities-specific-volumes-d_166.html

Energy Peace Partners. (2023). Guidance on reporting P-RECs in environmental disclosures. https://www.energypeacepartners.com/blog/guidance-on-reporting-p-recs-in-esg-disclosures

10. References

Energy Peace Partners. (2025a). EPP appeal for complete "Scope 2" guidance including higher ambition corporate action. (formal letter, June 16). https://www.energypeacepartners.com/blog/epps-appeal-for-complete-scope-2-guidance

Energy Peace Partners. (2025b). EPP's appeal for complete "Scope 2" guidance for higher ambition corporate action (blog, June 17). https://static1.squarespace.com/static/5cc327c55acb9b00019d816a/t/68506e46aa2d0a60741432c6/1750101575718/EPP+Appeal+Letter+to+GHG+Protocol+Secretariat+%26+ISB+-+June+2025.pdf

Enel Global Trading. (n.d.). Voluntary REC markets. https://globaltrading.enel.com/financial-products/voluntary-rec-markets

Entele, B. R. (2020). Analysis of households' willingness to pay for a renewable source of electricity service connection: Evidence from a double-bounded dichotomous choice survey in rural Ethiopia. Renewable Energy, 147, 1741–1750. https://doi.org/10.1016/j.renene.2019.09.094

The Green Certificate Company. (2024, May 13). Renewable energy certification markets: A global surge in growth and challenges. https://www.gcc.re/news/renewable-energy-certification-markets-a-global-surge-in-growth-and-challenges

Greenhouse Gas Protocol. (2015). GHG Protocol Scope 2 Guidance: An amendment to the GHG Protocol Corporate Standard. World Resources Institute. https://ghgprotocol.org/sites/default/files/2023-03/Scope%202%20Guidance.pdf

Greenhouse Gas Protocol. (2026). Scope 3 standard revisions: Phase 1 progress update. World Resources Institute. https://ghgprotocol.org/sites/default/files/2026-03/S3-Phase1ProgressUpdate-20260331.pdf?_bhlid=8cff8fa5e6623880f4ec35e3756367d257a092d9

10. References

Greenhouse Gas Protocol. (2025a). Scope 2 Technical Working Group progress update. World Resources Institute. https://ghgprotocol.org/blog/scope-2-technical-working-group-progress-update

Greenhouse Gas Protocol. (2025b). GHG Protocol Public Consultations. World Resources Institute. https://ghgprotocol.org/ghg-protocol-public-consultations

He, H., Derenchuk, A., Tabors, R., & Rudkevich, A. (2024). Cost and emissions impact of voluntary clean energy procurement strategies. The Electricity Journal, 37, 107383. https://www.sciencedirect.com/science/article/pii/S1040619024000186

Intergovernmental Panel on Climate Change (IPCC). (2006). 2006 IPCC guidelines for national greenhouse gas inventories. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf

Intergovernmental Panel on Climate Change (IPCC). (2014). Climate change 2014: Mitigation of climate change (Annex III). Cambridge University Press. https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_annex-iii.pdf

International Organization for Standardization. (2018). ISO 14064-1:2018 Greenhouse gases—Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals. ISO. https://www.ditan.com/static/upload/file/20240419/1713505579197549.pdf

Nano, E. (2022). Electrifying Nigeria: The impact of rural access to electricity on kids' schooling. The Graduate Institute, Geneva. https://www.econstor.eu/bitstream/10419/253255/1/1795097124.pdf

NewClimate Institute. (2024, October). 24/7 renewable electricity matching is a far more credible approach for the GHG Protocol and the SBTi than the Emissions First Partnership proposal. https://newclimate.org/sites/default/files/202410/NewClimate_EEP_QA_briefing_Oct24.pdf

10. References

Our World in Data. (2025). Carbon dioxide emission factors. https://ourworldindata.org/grapher/carbon-dioxide-emissions-factor?country=Lignite~Aviation+Gasoline~Bitumen~Shale+Oil~Anthracite~Charcoal~Coke~Crude+Oil~Diesel+Oil~Jet+Gasoline~Motor+Gasoline~Natural+Gas~Oil+Shale+%26+Tar+Sands~Peat~SubBituminous+Coal~Oil+Shale+and+Tar+Sands~Coke+Oven+Coke+and+Lignite+Coke~Gas+Oil

Olanrele, I. (2024). Willingness to pay for reliable electricity supply in Nigeria: Evidence from residential consumers. African Journal of Economic Review. https://ideas.repec.org/a/ags/afjecr/362937.html

Polaris Market Research. (2025). Renewable energy certificates (REC) market size, share, & industry analysis report: 2025–2034. https://www.polarismarketresearch.com/industry-analysis/renewable-energy-certificates-market

Precedence Research. (2025, March 19). Renewable energy certificate market revenue to attain USD 136.30 Bn by 2033. https://www.precedenceresearch.com/press-release/renewable-energy-certificate-market

Planete Energies. (2023). Electricity generation and CO_2 emissions. https://www.planete-energies.com/en/media/article/electricity-generation-and-related-co2-emissions

Research and Markets. (2025). Renewable energy certificate (REC) market by energy type, capacity, end use, and region – Global forecast & trends to 2030. https://www.researchandmarkets.com/report/global-renewable-energy-certificates-market srsltid=AfmBOophi4ooGmrUTpUbdFGXo3ZNtJGxCskGFR8omBiMlpnnnlj-I5es

10. References

Science Based Targets Initiative. (2025). Corporate net-zero standard version 2.0 (draft). https://sciencebasedtargets.org/blog/draft-corporate-net-zero-standard-v2-explained-scopes-1-2-and-3

Shell Foundation. (2024). Pilot programme for innovative financing and project solutions for health electrification. https://shellfoundation.org/wp-content uploads/2024/02/Health-Electrification-Final-Report.pdf

S&P Global Commodity Insights. (2022, December 16). US renewable energy credit market size to double to $26 billion by 2030. https://www.spglobal.com/market-intelligence/en/news-insights/research /us-renewable-energy-credit-market-size-to-double-to-26-billion-by-2030

Taskforce on Climate-Related Action Transparency. (2025). Mitigation action accounting and reporting guidance (MAARG) FAQs. https://www.tcataction.org/faqs

Zuch, M. (2025). Rural electrification in sub-Saharan Africa: A willingness to pay analysis of electricity access in Kenya. Energy Policy, 206, 114720. https://doi.org/10.1016/j.enpol.2025.114720