

Monitoring & Evaluation (M&E) Plan and Impact Statement Form

Objective of the M&E Plan and Impact Statement:

- The M&E Plan and Impact Statement must be designed based on the Technical Assistance Response Plan and must enable the Implementer to complete the Closure Report at the end of the assistance.

Process for filling in the form:

- The Implementer must identify relevant quantitative and qualitative indicators as specified in the Closure Report. A sub-set of indicators to monitor and assess must be chosen among these.
- The Implementer may also identify other specific, measurable, achievable, relevant, and time-bound indicators suitable to monitor Activities, Outputs and anticipated Outcomes from the technical assistance and add to the M&E Plan and Impact Statement.
- During implementation of the TA or FTA, the Implementer must collect all relevant data as described in the Monitoring & Evaluation Plan. Aggregated data on selected indicators as well as an updated version of the Impact Statement will be presented in the Closure Report at the end of the assistance.

Basic Information	
Title of response plan	Pre-feasibility Study on Ocean Energy focusing on Salinity Gradient Energy Technology and Electrochemical Ocean Thermal Energy Conversion
Technical assistance reference number	CTCN Request ID# 2024000020 (PCA Reference: CTCN 24-017)
Country/ countries	Papua New Guinea
NDE focal point and organisation	Mr. Danny Nekitel, Manager-Mitigation and Low Carbon Growth with technical lead Ms. Emily Pomoh Climate Change and Development Authority (CCDA)
Sector(s) addressed	Energy-renewable energy generation; Ocean / Marine renewable energy
Technologies supported	Salinity Gradient Energy (SGE)-including Reverse Electrodialysis (RED); Electrochemical Ocean Thermal Energy Conversion (e-OTEC); Blue Battery Technology (seawater-based energy storage)

Implementation period and total duration	22 August 2024 – 31 May 2026 (≈21 months, following two no-cost extensions of an originally 12-month assistance)
Total budget for implementation	USD 246,500
Designer of the response plan	Hanki Kim, Korea Institute of Energy Research, South Korea (KIER), hankikim@kier.re.kr
Implementer of response plan	• [Project Manager] Dr. Hanki Kim, Korea Institute of Energy Research, South Korea (KIER) • [Project Coordinator / Focal Point] Dr. Woonho Baek, Korea Institute of Energy Research, South Korea (KIER) • [Technical Advisor] Dr. Joonhyun Kim, Korea Institute of Energy Research, South Korea (KIER) • [Ocean Energy Specialist] Dr. Kyosik Hwang, Korea Institute of Energy Research, South Korea (KIER) • [Energy Economy Specialist] Woohyun Kim, Korea Institute of Energy Research, South Korea (KIER) • [Resource Analysis] Assoc. Prof. Changhyun Jun, Korea University • [Gender Focal point] Boseok Seo, Korea Institute of Energy Research, South Korea (KIER)

(A) Outputs and Activities as described in the Response Plan	(B) Indicator	(C) Expected results	(D) Method and frequency for data collection	(F) Comments
Output 1: Implementation planning and communication documents	• Work plan, M&E plan, CTCN Impact Description and Closure Report delivered (Yes/No)	• Detailed work plan and budget • M&E plan and Impact Statement (initial and final) • Closure and Data Collection Report • Mandatory deliverables completed and accepted by CTCN	• Submission emails to CTCN; CTCN acceptance	Gender Assessment and Action Plan prepared alongside (minimum 1% gender budget).
Output 2: Preliminary Technical Preparation	• Project Steering Committee (PSC) established (Yes/No);	• PSC established with member organizations; 5 PSC meetings	• PSC meeting minutes; attendance lists with gender disaggregation	• PNG offers significant ocean energy resources with limited prior data

	number of PSC meetings held • Number of stakeholders engaged (gender-disaggregated) • Site selection report completed • Monitoring equipment deployed • CTCN Core Indicator 3 (beneficiaries)	held (3 online: 1st PSC Feb 2025, 2nd PSC Mar 2025, 3rd PSC Dec 2025; 2 in-person: country mission May 2025 and 4th PSC Mar 2026) • ≥40 stakeholders engaged across PSC, technical seminars, and KIER-UPNG young professionals workshop • Candidate sites screened: Basu and Markham rivers near Lae (November 2024, not retained); Central Province coast, including a site visit and sampling at Kalo (May 2025); Kemabolo–Hula identified in the CCDA Technical Review (April 2026) • Lab-scale RED and oceanographic monitoring equipment installed at UPNG	• Site selection report including salinity and temperature data; bathymetry from GEBCO (CCDA Technical Review) • Equipment deployment log; raw data files; processing worksheets • Submission emails to CTCN; CTCN acceptance	• Strong PNG counterpart engagement (CCDA, NEA, UPNG, NISIT, PPL, ICC, CEPA) • Weather/access constraints managed through May (dry season) field deployment • The Response Plan foresaw deployment of pressure sensors, current meters and CTD instruments at the site for a specified duration; data collection was limited to one day of sampling (see Closure Report, Deviations).
Activity 2.1: Mapping stakeholders, background data analysis and site screening: review of oceanographic and geographic data; PSC formation; stakeholder mapping; inception visits to the Basu and Markham rivers (November 2024) and a site visit to Kalo (May 2025); collection of seawater and freshwater samples; salinity and temperature measurements				
Activity 2.2: Inception workshop and data collection: inception workshop with PSC and PNG stakeholders (Port Moresby, 11–13 November 2024); installation of lab-scale Reverse Electrodialysis (RED) equipment and oceanographic monitoring instruments at UPNG; capacity-building seminars at UPNG; KIER–UPNG young professionals workshop on marine energy with explicit gender equity focus				
Output 3: Pre-feasibility of the	• Pre-feasibility study completed (Yes/No)	• 1 final pre-feasibility report	• Review of draft and final pre-feasibility	• Data on PNG energy costs and

technologies: Salinity Gradient Energy and e-OTEC including Blue Battery Technology	• Number of stakeholder consultations / webinars • CTCN Core Indicator 1 (anticipated tCO₂e avoided) • CTCN Core Indicator 2 (anticipated resilience)	covering technical, socio-economic and financial analysis for SGE, e-OTEC and Blue Battery • ≥1 stakeholder consultation; technical findings validated • Quantified marine energy potential: SGE ≈1.2 GW gross / ≈360–368 MW technically feasible from four Central Province rivers; e-OTEC thermal gradient ≈23–26 K with a ~1,000 m intake (≈10–13 K at ~200 m) • Indicative tCO₂e/year quantified ex-ante for the follow-on pilot/full project	report by PSC and CTCN, and NDE comments (2026) • HYCOM ocean-model dataset 2024–2025; AI-based satellite interpretation; single-day in-situ sampling at Kalo; historical river-gauge records • Socio-economic and financial worksheets reviewed by external experts	demographics may be variable; use ranges and sensitivity analysis • Findings are being prepared for SCI-level publication.
Activity 3.1: Technical pre-feasibility (commissioning and operational aspects): processing of in-situ oceanographic data and ocean-model data; technology overview (SGE/RED, e-OTEC, Blue Battery); plant size, performance and indicative cost; climate-resilient operation across project lifetime; co-benefits assessment (freshwater via desalination, aquaculture integration)				
Activity 3.2: Socio-economic and financial analysis: cost-benefit analysis of each technology against PNG conditions; gender, employment, food and water security and capacity-building considerations; financial viability and identification of financing options				
Activity 3.3: Pre-feasibility report and stakeholder consultations (communities and government): Multi-Criteria Decision Analysis (MCDA); stakeholder consultation/webinar with online follow-up survey; integration of feedback into final report				
Output 4: GCF Concept Note and in-person workshop: final dissemination and follow-on financing pathway	• GCF Concept Note submitted (Yes/No) • Number of participants in in-person workshop (gender-disaggregated)	• 1 GCF Concept Note + supporting documents package prepared and delivered to CTCN (GCF submission once)	• Review of final GCF Concept Note and annexes • Workshop attendance sheets, photos, feedback forms	• Wrap-up workshop program to maximize impact • Korea-based program includes Jeju (KIER demonstration

	• CTCN Core Indicator 4 (anticipated funding leveraged)	an Accredited Entity is identified) • ≥20 participants in the CTCN TA cRD&D Marine Energy Specialist Workshop (11 March 2026, GLAD Yeouido, Seoul) – 24 attended • 1 final compiled report combining Outputs 1-4	• Final compiled report and presentation	sites), Seoul, and Incheon • The Response Plan foresaw the final workshop in PNG; its relocation to Korea is reported as a deviation in the Closure Report.
Activity 4.1: Development of one GCF Concept Note: project summary; detailed project description; indicative financing/cost; supporting documents (theory of change, indicative economic and financial assumptions, pre-feasibility study results, environmental and social risk screening). The Concept Note is delivered to CTCN as a TA deliverable; it will be submitted to the GCF once an Accredited Entity has been identified, in coordination with CCDA as NDA.				
Activity 4.2: In-person workshop and project wrap-up: wrap-up workshop program (8–13 March 2026 in South Korea: Jeju, Seoul, Incheon) including: site visits at the Jeju Agricultural Research Institute and Seogwipo Organic Waste Recycling Facility (Day 2); the final (4th) PSC meeting with GCF Concept Note review with Ecosian (Day 2 PM); Jeju Provincial Government visit and KIER / CFI / Lava Seawater technical tours (Day 3); the CTCN TA cRD&D Marine Energy Specialist Workshop at GLAD Yeouido, Seoul (Day 4); and cultural program (Day 5); the GCF visit planned for Day 6 was cancelled.				

Note: The Response Plan may contain information useful for the section below. The information in the table below will be used by the CTCN for public communication of the achieved and expected results of the Technical Assistance through the CTCN website www.ctc-n.org and other communication channels. See for example: https://www.ctc-n.org/sites/www.ctc-n.org/files/benin_a_ag_forestry.final_.pdf

Impact Statement	
Challenge	Papua New Guinea, with vast coastal and marine resources, faces significant challenges in transitioning its energy sector to sustainable, climate-resilient sources. Remote and island communities depend heavily on diesel and limited grid hydropower, resulting in high energy costs, unreliable supply and continued GHG emissions. Although emerging ocean energy technologies: Salinity Gradient Energy (SGE) and Electrochemical Ocean Thermal Energy Conversion (e-OTEC), including Blue Battery Technology, hold significant potential for PNG's geographic context, their adoption has been constrained by chronic data scarcity, absence of feasibility studies tailored to local conditions, and limited national institutional capacity to plan and oversee marine renewable energy projects.
CTCN assistance	• Establish PNG-PSC and conduct stakeholder mapping; analyse oceanographic conditions using the HYCOM ocean model (2024–

	2025) and AI-based satellite interpretation, with initial in-situ sampling at Kalo • Install lab-scale Reverse Electrodialysis (RED) equipment and oceanographic monitoring instruments at UPNG, with capacity-building seminars and a KIER-UPNG young professionals workshop on marine energy • Conduct technical, socio-economic and financial pre-feasibility study for SGE, e-OTEC and Blue Battery technologies in PNG conditions • Prepare a GCF Concept Note and convene a final wrap-up workshop program in South Korea (8-13 March 2026), including the CTCN TA cRD&D Marine Energy Specialist Workshop at GLAD Yeouido, Seoul (11 March 2026)
Anticipated impact	• Technical and financial basis for follow-on pilot deployment of SGE and/or e-OTEC on the Central Province coast • Quantified marine energy potential: SGE ≈ 1.2 GW gross and ≈ 360–368 MW technically feasible (at $\sim 30\%$ membrane efficiency); e-OTEC thermal gradient of ≈ 23–26 K with a deep intake, with a shallower-intake option to be evaluated • Improved national institutional capacity to plan, regulate and oversee ocean energy projects • Credible pathway to mobilizing follow-on climate finance through the GCF Concept Note (Core Indicator 4) • Catalytic potential for replication across other Pacific Small Island Developing States (SIDS)
Anticipated co-benefits from the TA	Freshwater production through co-located desalination (water-energy nexus); aquaculture co-location with ocean energy installations; creation of skilled employment opportunities in coastal communities; reduced reliance on imported diesel fuel and associated foreign-exchange savings; improved energy reliability for remote and island communities, with associated benefits for healthcare access, education and economic activity; screening-level data foundation that reduces uncertainty and supports future investment.
Gender aspects of the TA	Gender mainstreaming has been integrated throughout the TA in line with CTCN gender mainstreaming requirements. A KIER-UPNG young professionals workshop on marine energy was organized during the May 2025 in-country mission with explicit attention to gender equity, providing opportunities for women students at UPNG. Gender content for this M&E framework and the Gender Action Plan was prepared by the KIER gender focal point, with a minimum of 1% of the budget allocated to gender-specific activities. Women made up $\sim 22\%$ of participants against a GAAP target of $\sim 30\%$.
Anticipated contribution to NDC	The technical assistance supports PNG's commitments under its Nationally Determined Contribution (NDC) and National Adaptation Plan (NAP) by establishing the technical and financial groundwork for ocean energy contribution to NDC implementation, supporting an increased share of renewable energy in PNG's national energy mix, and aligning with national priorities on climate-resilient infrastructure for the energy sector.
The narrative story	Papua New Guinea is a Pacific Small Island Developing State whose population of about 10 million is dispersed across a mainland and hundreds of islands, with many remote coastal and island communities dependent on diesel generation. At the same time, PNG's marine geography offers significant potential for emerging ocean energy technologies. Through this CTCN technical assistance, the National Energy Authority and the Climate Change and Development Authority partnered with the Korea Institute of

	Energy Research (KIER), a leading institution on Salinity Gradient Energy and electrochemical ocean energy systems, to assess the practical feasibility of SGE, e-OTEC and Blue Battery technologies at PNG sites, analyze oceanographic conditions across PNG waters using ocean-model and satellite data with initial in-situ sampling at Kalo (Central Province), conduct socio-economic and financial analysis, and prepare a GCF Concept Note for follow-on investment. The assistance establishes a screening-level data foundation and lays the groundwork for PNG to lead the demonstration of ocean energy technologies in the Pacific region.
Contribution to SDGs	• SDG 7 (Affordable and Clean Energy): Establishes the basis for renewable, affordable, reliable energy access in coastal and island communities • SDG 13 (Climate Action): Enables future displacement of fossil-fuel generation and contributes to PNG's NDC; supports climate-resilient energy infrastructure • SDG 14 (Life Below Water): Promotes sustainable use of marine resources through environmentally responsible ocean energy deployment, integrated with marine biodiversity considerations in the candidate area, including Coral Triangle Initiative areas • SDG 9 (Industry, Innovation and Infrastructure): Pioneering deployment of frontier marine energy technologies in a Pacific SIDS
Reference to knowledge products	<i>Please indicate if any UNFCCC Technology Executive Committee (TEC) knowledge products (publications, briefs, tools etc.) were used in the development of the TA request and/or are envisaged to be used during implementation of the technical assistance.</i> <i>Link to TEC knowledge database:</i> https://unfccc.int/ttclear/tec/documents.html <i>Which knowledge products do you envisage to use? Please list</i>