ENERGY TRANSITION PARTNERSHIP

INCEPTION REPORT

PSA-TAF: Assessing the Commercial Competitiveness of VRE+BESS for Flexibility Services

APRIL 2026

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PSA-TAF: Assessing the Commercial Competitiveness of VRE+BESS for Flexibility Services

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Abbreviations

AGC	Automatic Generation Control
ASPA	Firm Ancillary Services Procurement Agreement
BESS	Battery Energy Storage System
BNEF	BloombergNEF
CAPEX	Capital Expenditure
CCGT	Combined-Cycle Gas Turbine
CRF	Capital Recovery Factor
COD	Commercial Operation Date
DAR	Department of Agrarian Reform (Philippines)
DENR	Department of Environment and Natural Resources (Philippines)
DoD	Depth-of-discharge
DOF	Department of Finance
DOE	Department of Energy (Philippines)
DPPA	Direct Power Purchase Agreement
EAV	Electricity Authority of Vietnam
EPIRA	Electric Power Industry Reform Act of 2001
ERC	Energy Regulatory Commission
ETP	Energy Transition Partnership
EVN	Vietnam Electricity
FRP	Flexible Ramping Product
GEAP	Green Energy Auction Program
HVAC	Heating, Ventilation, and Air Conditioning
IEA	International Energy Agency
IEMOP	Independent Electricity Market Operator of the Philippines
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
IRR	Internal Rate of Return
kWh	Kilowatt-hour
LCOF	Levelized Cost of Flexibility
LFP	Lithium Iron Phosphate
MEMR	Ministry of Energy and Mineral Resources (Indonesia)
MOIT	Ministry of Industry and Trade (Vietnam)
MW	Megawatt
MWh	Megawatt-hour
NGCP	National Grid Corporation of the Philippines
NPC-SPUG	National Power Corporation-Small Power Utilities Group (Philippines)
NPT	National Power Transmission Corporation
NREL	National Renewable Energy Laboratory
NSMO	National Power System and Market Operator
O&M	Operations and Maintenance
OCGT	Open-Cycle Gas Turbine
PEMC	Philippine Electricity Market Corporation
PLN	Perusahaan Listrik Negara
PSA	Power Supply Agreement
PSALM	Power Sector Assets and Liabilities Management Corporation (Philippines)

RTE	Round-Trip Efficiency
RUPTL	Rencana Usaha Penyediaan Tenaga Listrik (Electricity Supply Business Plan in Indonesia)
SoC	State of Charge
SPUG	Small Power Utilities Group
TAF	Technical Assistance Facility
TransCo	National Transmission Corporation (Philippines)
UNOPS	United Nations Office for Project Services
USD	United States Dollar
VRE	Variable Renewable Energy
VWEM	Vietnam Wholesale Electricity Market
WACC	Weighted Average Cost of Capital
WESM	Wholesale Electricity Spot Market (Philippines)

Executive Summary

The Energy Transition Partnership (ETP), managed by UNOPS, has commissioned this assignment under its *Private Sector Accelerator Technical Assistance Facility (PSA-TAF)* to assess the commercial competitiveness of variable renewable energy paired with battery energy storage systems (VRE + BESS) as a provider of flexibility services in Vietnam, the Philippines, and Indonesia. Across all three markets, rising VRE penetration and the limitations of incumbent flexibility providers (hydropower, coal in flexible mode, gas turbines, diesel) are opening a flexibility gap, while declining storage costs make VRE + BESS an increasingly plausible response. Private investment, however, remains constrained by the absence of a consistent, comparable basis for evaluating cost-competitiveness and a clear view of market-entry conditions.

This eight-month assignment (April–November 2026) closes that evidence gap through two analytical outputs: a **Comparative Cost of Flexibility Analysis** that benchmarks VRE + BESS against seven incumbent technologies on a common Levelized Cost of Flexibility (LCOF) basis, and a **Market Entry Strategies and Risk Assessment** that translates those cost findings into actionable investment-screening guidance for private developers, financiers, and international market entrants. The deliverables directly support ETP's de-risking-investments strategic pillar.

Project Objectives

The study has two sequenced objectives, framed around the investment decisions private sector actors actually face:

- Establish **cost-competitiveness.** Using a Levelized Cost of Flexibility (LCOF) framework expressed in \$/MW of capacity (for ramping and reserves) and \$/MWh of energy delivered (for short-duration peaking), compare the cost of delivering each Tier A flexibility service from VRE + BESS against incumbent providers, and identify the threshold conditions — fuel prices, BESS cost trajectories, utilization levels, Weighted Average Cost of Capital or WACC — at which VRE + BESS becomes the lower-cost option in each country.

- Translate cost findings into **market-entry guidance**. Map feasible entry pathways (utility procurement, competitive auctions, bilateral contracting, Wholesale Electricity Spot Market (Philippines) or WESM/Vietnam Wholesale Electricity Market of VWEM merchant participation), assess revenue-stacking potential under current and near-term regulatory regimes, and produce a country-by-country investment-readiness assessment covering commercial, regulatory, operational, and credit risks relevant to both domestic and international developers.

Scope at a Glance

Several load-following/fast-response services are acknowledged but excluded. monetization. Fast frequency response and reactive power do not have consistent procurement or compensation mechanism across the three countries, as they are usually mandated in grid-codes. Similarly, black start and T&D deferral capability of BESS do not yet have a monetization pathway in these countries. Long-duration storage is also excluded in this study. Energy arbitrage and VRE smoothing are retained as supplementary Tier B services — commercially material for investor decisions, but without standalone LCOF metrics because their cost structure overlaps with peaking support (arbitrage) or is a sizing question (smoothing).

Table 1. Project scope — services, technologies, and analytical boundaries

Dimension	Coverage
Countries	Vietnam · Philippines · Indonesia
Flexibility services (Tier A — with LCOF)	Ramping capability; reserve provision (incl. Automatic Generation Control or AGC); short-duration peaking support (1–4 h)
Supplementary services (Tier B — qualitative)	Energy arbitrage / time-shifting; VRE smoothing / output firming
Technologies benchmarked	Incumbent: diesel, Open-Cycle Gas Turbine or OCGT, CCGT (flex), gas reciprocating engines, hydropower, coal (flex). Emerging: solar + BESS, wind + BESS, standalone BESS
Analytical metric	Levelized Cost of Flexibility (LCOF) — $/MW for capacity-type services, $/MWh for energy-type services
Out of scope	Fast frequency response and voltage / reactive support are not amenable to LCOF analysis, as they are typically mandated by grid codes. However, they are included in the market analysis. Black start; T&D deferral; long-duration storage; detailed system-dispatch modelling; project-level IRR / bankability; contract drafting

Analytical Approach and Milestone Logic

The project is structured around three sequential milestones. Each produces the inputs required by the next, so that final outputs rest on a validated foundation rather than parallel workstreams assembled at the end.

Table 2. Deliverables and Analytical Questions structure

Deliverable	Due	Core Analytical Question
D1 — Inception Report (this document) + Assumptions Book template	April 2026	Is the analytical framework aligned with ETP expectations?

Deliverable	Due	Core Analytical Question
D2 — Comparative Cost of Flexibility Analysis (with Assumptions Book)	August 2026	Is VRE + BESS cost-competitive with incumbent flexibility providers, and under what conditions?
D3 — Market Entry Strategies and Risk Assessment	November 2026	Where cost-competitive, can private developers access the market, stack revenues, and manage risks?

The cost analysis is sequenced *before* the market-entry analysis: the relevance of any given entry pathway depends on which services, and which countries show competitive economics. Two principles govern analytical quality. First, a **standardized LCOF framework** — identical cost components, financial assumptions, and treatment of degradation, round-trip efficiency, replacement, and WACC — is applied uniformly across all three countries, with country-specific variations isolated and clearly flagged rather than embedded. Second, an **Assumptions Book** accompanies this report as a living Excel workbook and serves as the single reference point for every parameter used in the analysis, with full source traceability. Assumptions are stress-tested in M2 through sensitivity analysis, reviewed with ETP at each milestone, and updated through the Issues Log as stakeholder engagement surfaces new information.

Team, Governance, and Stakeholder Engagement

The assignment is delivered by an eleven-person team. The **Team Leader** (based in Vietnam) carries overall responsibility for cross-country integration and analytical quality; the **Energy Storage Specialist** supports the Team Leader with BESS-specific parameters; three **Electricity Market & Regulatory Specialists** and three **Power Systems & Flexibility Specialists** — one of each per country — provide country-specific analytical depth; and three **in-country Coordinators** manage stakeholder access and local data collection. Engagement runs through formal consultations with policymakers, system operators, utilities, Independent Power Producers (IPPs), and financiers, supplemented by semi-structured interviews with industry associations and academia. Personal data handling follows Indonesia's PDP Law, the Philippines' Data Privacy Act, and Vietnam's PDPL, with bilingual consent forms, data minimization, and encrypted cross-border storage. Coordination with ETP runs on a biweekly cadence, with formal review at each milestone.

Principal Risks and Mitigations

The table below summarizes the six most material risks for the project; the full register adds a seventh on confidentiality and data handling. Likelihood and impact are rated independently on a three-point scale (H / M / L). The register is a living document, reviewed at each biweekly coordination meeting and formally updated at each milestone review with ETP.

Table 3. Summary risk register

Risk Category	Principal Exposure	L × I	Primary Mitigation
Data Availability	Country operational data (dispatch, curtailment, BESS performance) may be incomplete or confidential, particularly at EVN and PLN.	**H × M**	International benchmarks (National Renewable Energy Laboratory or NREL ATB, International Renewable Energy Agency or IRENA, International Energy Agency (IEA), BloombergNEF or BNEF) as primary references, adjusted to country conditions; gaps documented transparently in the Assumptions Book.
Stakeholder Access	Regulators and system operators may be unresponsive within the M1–M2 window, delaying flexibility mapping and market-entry analysis.	**M × H**	Country specialists selected for existing institutional relationships; in-country coordinators for follow-up; engagement front-loaded in M1.
Timeline	Data, consultation, or review delays may compress the M2 or M3 analytical window.	**M × M**	Parallel country workstreams; biweekly ETP coordination to surface slippage early; contingency buffer between D2 and D3.
Cross-Country Consistency	Differences in data granularity and market design could undermine comparability of LCOF results across countries.	**M × H**	Standardized LCOF framework applied uniformly; shared Assumptions Book; Team Leader integration review before each submission.
Analytical Quality	Multi-country, multi-technology modelling creates risk of errors or inconsistencies.	**M × H**	Three-tier peer review (cross-disciplinary, cross-country, integration); Issues Log; ETP milestone review as external validation.
Regulatory Change	Evolving BESS and VRE regulations may change the applicable framework mid-project.	**H × M**	Continuous policy monitoring by Regulatory Specialists; regulatory-change scenarios tested in sensitivity analysis (A5). Note that only existing or expected regulations as of end of Q3 2026 will be included in the analysis.

Expected Outcomes

On completion, the assignment will provide ETP and the private sector with: (i) a transparent, replicable LCOF framework applied consistently across three Southeast Asian markets; (ii) country-level competitiveness thresholds that tell a developer when — not just whether — VRE + BESS becomes the lower-cost flexibility option; (iii) a clear reading of which revenue streams are currently bankable, which are regulated-but-undelivered, and which are emerging in each market; and (iv) a structured view of the commercial, regulatory, and operational conditions that make each country investable for domestic and international developers. These outputs are designed as practical investment-screening tools and are intended to contribute directly to a stronger pipeline of bankable VRE + BESS projects in Indonesia, the Philippines, and Vietnam.

1 Introduction and Project Background

1.1 Overview of ETP PSA-TAF

The Energy Transition Partnership (ETP), managed by United Nations Office for Project Services, supports Southeast Asian countries in advancing secure, sustainable, and inclusive energy transitions. Through its engagement in Indonesia, the Philippines, and Vietnam, ETP supports partner countries in addressing barriers to energy transition while contributing to economic development, energy security, and climate objectives.

Under this framework, this project is implemented through ETP's Private Sector Accelerator Technical Assistance Facility (PSA-TAF), established in collaboration with Southeast Asia Clean Energy Fund to catalyze private sector investment through technical assistance and capacity building. This assignment supports PSA-TAF's objective of strengthening the pipeline of investable clean energy opportunities through an assessment of the commercial competitiveness of VRE+BESS for flexibility services.

This assignment is aligned with ETP's four strategic pillars, namely policy alignment with climate commitments, de-risking investments, sustainable and resilient infrastructure, and just transition. In particular, the assignment contributes to ETP's de-risking investments pillar by supporting evidence-based analysis to inform market entry pathways, investment readiness, and private sector participation in emerging flexibility markets.

The need for this assignment arises from increasing flexibility requirements in Southeast Asia's power systems as variable renewable energy penetration grows. While VRE+BESS presents a potentially viable solution for providing load-following and fast-response services, uncertainties related to cost competitiveness, revenue opportunities, and market readiness continue to constrain deployment. This project responds to these challenges by providing a structured assessment of comparative flexibility costs, market entry strategies, and investment risks across the three target countries.

As such, this assignment is intended to serve as a strategic technical assistance intervention that provides a foundation for identifying commercially viable pathways for VRE+BESS deployment, while supporting broader objectives related to enhanced grid flexibility, investment readiness, and regional energy transition priorities.

1.2 Energy Transition Challenges in Southeast Asia

Southeast Asia's energy transition is increasingly characterized by rising VRE penetration, growing electricity demand, and an emerging flexibility gap as power systems require greater load-following, ramping, reserve provision, and short-duration peaking support to maintain reliability.

Across Indonesia, the Philippines, and Vietnam, flexibility has traditionally been provided by incumbent technologies such as hydropower, coal operating in flexible mode, gas turbines and engines, and diesel-based peaking resources. However, changing system conditions and declining storage costs are increasing interest in VRE+BESS as an emerging flexibility option.

- In Indonesia, increasing renewable deployment and differing system characteristics between Java-Bali and outer island grids are heightening the need for flexible resources to support reliability and renewable integration.
- In Vietnam, rapid solar and wind growth, curtailment pressures, and hydropower seasonality are reinforcing the importance of flexibility as market and regulatory frameworks for storage continue to evolve.
- In the Philippines, rising solar energy and onshore wind development, growing battery deployment, and evolving market arrangements through the WESM and ancillary services procurement by the National Grid Corporation of the Philippines (NGCP) reflect increasing demand for fast-response and balancing services.

Taken together, these country contexts demonstrate a shared regional challenge in which higher VRE penetration is increasing demand for flexibility, while limitations of incumbent technologies are driving growing interest in alternative flexibility solutions. This provides the common context for the comparative flexibility cost assessment and market entry analysis under this assignment.

1.3 Project Objectives

This project addresses a specific gap in the evidence base for private sector investment in grid flexibility across the three countries. Private developers and investors currently lack a consistent, comparable basis for evaluating whether VRE + BESS systems are cost-competitive with incumbent flexibility providers — and under what conditions they become so — across Indonesia, the Philippines, and Vietnam. The study has two core objectives:

- *First, to assess whether VRE + BESS is commercially competitive with traditional load-following and fast-response technologies*. Using a Levelized Cost of Flexibility (LCOF) framework expressed in \$/MW or \$/MWh of flexibility service delivered, the analysis will compare the cost of delivering ramping capability, reserve provision, and short-duration peaking support from incumbent technologies against VRE + BESS. It will identify the specific conditions — fuel price levels, BESS cost trajectories, utilization levels for flexibility assets — at which VRE + BESS becomes the lower- cost flexibility option for each service category in each country.
- Second, to translate sound technical and regulatory analysis into actionable insights to support private sector investment decision-making. Building on the cost analysis, the study will map feasible entry pathways, assess revenue stacking potential, and identify key commercial, regulatory, and operational risks in each country — producing a country-by-country investment readiness assessment that helps the private sector determine where, how,

and under what conditions VRE + BESS deployment for flexibility services is commercially viable.

Together, these objectives are designed to support enhanced grid flexibility by informing and catalyzing private sector interest in VRE + BESS, contributing to ETP's strategic outcome in de-risking investments to renewable energy, energy efficiency, and fossil fuel phasedown.

Study Limitations and Boundaries

This study is a screening-level, benchmark-based assessment drawing on standardized cost and performance benchmarks, representative operating assumptions, and publicly available data to produce comparative insights at a market level. It will not conduct detailed power system optimization modelling or full system dispatch simulation; undertake site-specific project design; perform project-level financial feasibility or returns analysis or cash flow modelling; draft contracts; or extend to long-duration capacity adequacy or baseload replacement.

The study only includes three major flexibility services and does not include fast frequency response, reactive power, black start, and long duration storage. We do, however, evaluate energy arbitrage and generation smoothing in a qualitative manner.

1.4 Logic and Structure

This inception report is organized into ten sections that collectively serve one purpose: to demonstrate that the NIRAS team and ETP share a common understanding of what this project will deliver, how it will be delivered, and what foundations are in place to ensure quality and timeliness.

- Section 1 – this Section (Introduction and Project Background) establishes the context — the ETP and PSA-TAF program framework, the flexibility challenge facing Southeast Asian power systems, and the objectives this project is designed to address.
- Section 2 (Scope of Services) specifies which flexibility services, technologies, and countries are in scope, and equally importantly, what falls outside the scope of this study. This section is intended to ensure that ETP and the NIRAS team are aligned on the analytical perimeter before work begins.
- Section 3 (Methodology and Workplan) is the core of this report. It is structured to mirror the two main analytical deliverables:
    - Section 3.1 presents the overall analytical approach — the sequential milestone logic, the investment-screening orientation, and the cross-country consistency principles that govern the entire study.
    - Sections 3.2 details the methodology for Deliverable 2 (Comparative Cost of Flexibility Analysis), progressing through the analytical chain: flexibility resource mapping (A2),

cost assessment and benchmarking (A3), LCOF comparative analysis (A4), and sensitivity analysis and competitiveness thresholds (A5).

- Section 3.3 details the methodology for Deliverable 3 (Market Entry Strategies and Risk Assessment), covering market access pathway analysis (A7), revenue stream and tariff assessment (A8), international developer market entry analysis (A9), revenue stacking evaluation (A10), and risk assessment and investment readiness (A11). This section explains how findings from Deliverable 2 will be translated into actionable market entry guidance.

- Section 3.4 consolidates the standardized cost, financial, and performance assumptions that underpin both deliverables into a single reference point. Full transparency on assumptions is provided here so that ETP can review and validate them independently of the analytical narrative.

- Section 3.5 presents the data sourcing strategy — where data will come from, how country-specific and international sources will be combined, and how data gaps will be managed.

Sections 4 through 10 address the project management and cross-cutting requirements that support the analytical work:

- Section 4 (Gender Mainstreaming Plan) outlines how the project will ensure balanced stakeholder representation and integrate gender dimensions into the analysis and monitoring.

- Section 5 (Gantt Chart) provides a detailed activity-level implementation schedule across the eight-month project period.

- Section 6 (Stakeholder Coordination Plan) identifies the key counterparts in each country and sets out the engagement approach, including data collection protocols and confidentiality arrangements.

- Section 7 (Project Management Structure) presents the team organization, roles and responsibilities, coordination mechanisms, and contract management arrangements.

- Section 8 (Risks, Mitigations, and Assumptions) documents the project risk register and the foundational assumptions on which the workplan is built.

- Section 9 (Monitoring and Evaluation Plan) describes an approach to collect, analyze, and verify data and evidence as required in the ETP's Results-Based Monitoring Framework (RBMF). This plan shall detail the methodologies, tools, and timeline for systematic data collection and reporting to effectively measure progress against established indicators.

- Section 10 (Communications Plan) sets out the schedule and specifications for all required communications outputs and the ETP approval workflow.

The report is accompanied by a *template* of the Assumptions Book (Excel workbook) that will contain the detailed data tables underlying Sections 3.4 and 3.5. This workbook is designed to serve as the living reference document throughout the project and will be updated and submitted alongside Deliverable 2.

2 Scope of Services

2.1 Target Audience and Intended Use of Outputs

The primary audience for this project's deliverables is the private sector—developers, investors, financiers, and Engineering, Procurement, and Construction Management (EPCM) firms evaluating VRE + BESS opportunities in Vietnam, Indonesia, and the Philippines.

All analytical outputs, including the LCOF comparative analysis, competitiveness threshold charts, and market entry assessments, are designed as practical investment screening tools, not academic exercises. The cost analysis that we expect to produce should support a developer to benchmark VRE + BESS against incumbent flexibility providers for specific service categories in specific markets, and the market entry strategies will address the operational questions that shape actual investment decisions: whether a foreign developer can access the market, which procurement and off-take pathways are available, what revenue streams can realistically be stacked, and what risks must be priced in.

Secondary audiences — government agencies, energy regulators, and C&I off-takers—will benefit from the same evidence base, but the framing, language, and level of commercial specificity throughout the deliverables are oriented toward private capital deployment.

2.2 Analytical Boundaries for LCOF Services

The ToR defines flexibility services as “load-following and fast-response services”. This taxonomy maps the family of services within that operational domain, organized into three tiers. **Tier A (Primary LCOF Services)** comprises the three service categories for which separate LCOF metrics can be calculated — the core comparative cost output of Deliverable 2. **Tier B (Supplementary Analytical Services)** covers two additional services that are commercially material for private sector investment screening and are assessed in Deliverables 2 and 3, but do not receive standalone LCOF metrics. **Tier C (Acknowledged but Excluded)** lists services within the load-following/fast-response family that are outside the analytical scope, with rationale for exclusion.

Table 4. Scope of Services

Service	Timescale	Definition	LCOF / metric	Country relevance	Treatment in this project	Key data sources
TIER A — Primary LCOF services (separate LCOF metric calculated for each)						
Ramping capability	Minutes to hours	Sustained upward/downward output changes in response to net load variations. Covers ramp rate (MW/min), ramp range, and sustained ramp duration.	$/MW of ramp rate delivered	**VN:** Critical — rapid solar ramp-down drives evening ramp need under PDP-8. **PH:** WESM price spikes correlate with net load ramps; CAISO-style Flexible Ramping Product (FRP) under discussion. Plants under Ancillary Services Procurement Agreement (ASPA) are to comply with the agreed ramp rate, else they are penalized. **ID:** Java-Bali mid-merit ramping; outer islands diesel, gas engine and gas turbine ramp constraints if located far from the VRE	Simplified LCOF calculation across all 9 technologies (see next subsection below). Cost components: cycling costs, part-load penalties, fuel during ramp, BESS degradation from ramp-intensive cycling.	NREL cycling cost study; NREL ATB (ramp rates); IRENA ESVF Phase 2 parameters Standard ASPA contract in PH
Reserve provision	Seconds to minutes	Maintaining dispatchable capacity available within defined response timeframes. Encompasses spinning/synchronous reserves, frequency regulation (AGC), and contingency reserves as defined by each country's grid code.	$/MW of reserve capacity held	**VN:** National Power System and Market Operator or NSMO requests reserves from existing power plants; evolving ancillary services framework under VWEM in the future. **PH:** NGCP ancillary services market — most developed in the three countries. **ID:** Perusahaan Listrik Negara **(**PLN) centrally manages reserves; no market-based procurement.	Simplified LCOF calculation. Includes frequency regulation/AGC as a sub-service. Cost components vary by sub-product and operating mode: (i) opportunity cost of foregone energy sales and part-load efficiency penalties for online units providing spinning reserve and AGC; (ii) expected start-up costs for offline quick-start units providing standing/contingency	NREL cycling study (part-load data); IRENA ESVF (reserve valuation); country grid codes; NGCP ancillary service rules

Service	Timescale	Definition	LCOF / metric	Country relevance	Treatment in this project	Key data sources
					reserve; (iii) Capital Expenditure (CAPEX) allocation for standby capacity across all configurations; (iv) marginal degradation per activation for BESS.	
Short-duration peaking support	1–4 hours	Energy delivery during peak demand periods. Covers daily peak shaving, evening ramp support, and short-duration energy injection to manage demand peaks or VRE shortfalls.	\$/MWh of energy delivered during peak	**VN:** Evening peak (17:00–21:00) post-solar ramp; growing gap as solar capacity increases under PDP-8. **PH:** WESM evening price spikes; Luzon/Visayas peak demand growth. Energy delivery during peak demand is the most immediate and monetizable role for BESS in the country and covers daily peak shaving, evening ramp support, and short-duration injections to manage VRE shortfalls. It's where batteries directly address WESM volatility and grid. **ID:** Java-Bali evening peak is relatively flat; while other big islands (Sumatera, Kalimantan, Sulawesi) have a sharper increase that is mostly supported by gas turbine and hydro plants. Small islands have diesel and gas engines that are a peaking demand replacement opportunity.	Simplified LCOF calculation across all technologies. Cost components: BESS CAPEX + degradation + Round-Trip Efficiency (RTE) losses; thermal start-up fuel + cycling costs; hydro opportunity cost.	NREL ATB (BESS CAPEX/ duration); IRENA (installed costs); BNEF (system prices); IEA WEO (fuel projections)
TIER B — Supplementary analytical services (qualitative/descriptive assessment, no standalone LCOF)						
Energy arbitrage /	Hours (intra-day)	Storing energy when prices are low (or VRE is	No standalone	**VN:** VWEM spot market provides time-varying price signals; Circular 62 BESS	Deliverable 2: Discussed as a use case within the	WESM historical price data;

Service	Timescale	Definition	LCOF / metric	Country relevance	Treatment in this project	Key data sources
time-shifting		abundant) and discharging when prices are high (or demand peaks). Exploits temporal price differentials in wholesale markets or structured tariffs.	LCOF. Cost structure overlaps with peaking support; revenue dimension assessed in Deliverable 3.	pricing mechanism; Direct Power Purchase Agreement (DPPA) framework (Decree 57/2025) creates structured price exposure. Currently limited by flat average wholesale settlement for surplus. **PH:** WESM spot prices show strong diurnal variation; evening peaks vs. midday solar surplus create clear arbitrage window. Most developed monetization pathway of the three countries. **ID:** Limited — PLN single-buyer structure with regulated tariffs; no wholesale price signal for merchant arbitrage. There is no tariff difference between peak load and off load. Potential only under future market reforms.	peaking support LCOF — the cost side is identical (BESS CAPEX, degradation, RTE). Diurnal price differential data will be presented as context. Deliverable 3: Assessed as a primary revenue stream in the revenue stacking analysis. Identifies monetizability under current WESM/VWEM rules and near-term regulatory changes.	VWEM price indices; IRENA ESVF Case 3 (Hornsdale arbitrage); BNEF LCOS benchmarks
VRE smoothing / output firming	Seconds to minutes	Damping short-term VRE output variability to meet grid code ramp-rate limits or contractual delivery profiles. Reduces forecast error penalties and enables firm delivery under DPPAs and consumer PPAs. VRE smoothing is considered a high on technical importance but low on	No standalone LCOF. Cost is BESS sizing for co-located smoothing; assessed qualitatively as an enabler of bankable	**VN:** Directly relevant to DPPA viability (Decree 57/2025). Corporate buyers under physical/virtual DPPAs need predictable delivery profiles; BESS smoothing reduces imbalance penalties and improves contract bankability. **PH:** Relevant for bilateral contracts and Green Energy Auction Program (GEAP) auction compliance; smoothing enables VRE+BESS to bid as firm capacity in WESM.	Deliverable 2: Discussed in the flexibility resource mapping — BESS co-location benefits for VRE output quality. Noted as a factor affecting VRE+BESS utilization assumptions. Deliverable 3: Assessed as a commercial enabler for DPPA/PPA bankability. Identifies how smoothing capability from BESS supports revenue certainty	IRENA ESVF Case 4; country grid codes (ramp rate limits); DPPA framework documentation; XanhTerra DPPA analysis

Service	Timescale	Definition	LCOF / metric	Country relevance	Treatment in this project	Key data sources
		revenue certainty—Hence it is in the Tier B category.	offtake contracts.	**ID:** Relevant for PLN IPP contracts where dispatch predictability affects PPA compliance; outer island grids with low inertia particularly benefit. According to the 10-year plan, VRE developers are required to provide BESS for smoothing.	for RE developers and off-taker willingness to contract for DPPA.	
TIER C — Acknowledged but excluded (outside analytical scope)						
Fast frequency response (FFR) / synthetic inertia	Sub-second to seconds	Near-instantaneous (sub-second to second) power injection/absorption to arrest frequency deviations (rate of change of frequency) following contingency events. Includes virtual/synthetic inertia from inverter-based resources. Distinct from continuous AGC / secondary frequency control, which is treated within reserve provision (Tier A).	—	No formal FFR procurement mechanism exists in VN, PH, or ID. The Philippines' NGCP procures some contingency FCAS but not a distinct FFR product. No monetization pathway for private sector screening.	**Excluded.** No consistent procurement or compensation mechanism across the three countries. BESS capability for FFR is noted in the technology characterization but not costed as a separate service. *Revisit if any country introduces a formal FFR product during the project period.*	—
Voltage support / reactive power	Continuous	Maintaining voltage levels within acceptable bands through reactive power injection/absorption. Provided by synchronous generators, STATCOMS, and BESS inverters.	—	In VN, PH, and ID, reactive capability is mandated through grid codes (typically 0.95 lagging to 0.95 leading or similar PF envelopes) as an unpaid connection obligation. No competitive market product exists; the Philippines' NGCP procures Reactive Power Support under bilateral ASPA	**Excluded.** Mandated grid code capability rather than a discretionary revenue stream. BESS inverter Q-capability is noted and supports investor positioning vis-à-vis grid code compliance,	—

Service	Timescale	Definition	LCOF / metric	Country relevance	Treatment in this project	Key data sources
		Applicable across all voltage levels.		contracts with selected generators but at ERC-regulated rates without volumetric energy payment.	but it does not generate a separable revenue stream amenable to LCOF treatment No revenue stream for private developers.	
Black start capability	Minutes to hours	Ability to restart the grid after total system collapses without external power supply. Requires self-starting generation capability.	—	Contracted bilaterally by system operators on a per-plant basis. Very small number of units required per system; not a volume market. ID: normally use Hydro or Gas turbine in Java and other big islands for black start.	**Excluded.** High-value but extremely low-volume service. Not amenable to cross-technology cost benchmarking at screening level. Not a driver of private sector BESS investment at scale.	—
T&D congestion relief / investment deferral	Hours to seasonal	Using storage to reduce transmission/distribution congestion and defer capital investment in grid infrastructure upgrades.	—	Relevant in all three countries but value accrues to the network operator (EVN, PLN, NGCP/utilities), not to VRE+BESS project developers.	**Excluded.** Network planning service, not a load-following/fast-response service. Value is not monetizable by private VRE+BESS developers under current frameworks. Noted in Deliverable 3 as a potential future regulatory reform area.	—
Long-duration energy storage / capacity adequacy	Days to seasonal	Multi-day or seasonal energy shifting to address prolonged supply shortfalls. Includes technologies like pumped hydro, compressed air, and hydrogen.	—	Explicitly excluded by the ToR (para. 17). Relevant in all three countries but it is more relevant for pumped-hydro systems not BESS – particularly private sector BESS developers.	**Excluded per ToR.** "The assessment does not extend to long-duration capacity adequacy or baseload replacement." Beyond the 1–4 hour operational window.	—

Service	Timescale	Definition	LCOF / metric	Country relevance	Treatment in this project	Key data sources
				PH: Solar power developers are encouraged to include in their plants an energy storage system. ID: Introduction of using BESS and Fuel Cell with supply power from Solar PV. Small scale to mid-size island (Timor, Rote, Alor, etc.)		

Design rationale for LCOF treatment

The three-tier structure reflects the ToR's ultimate objective: *informing and catalysing private sector interest in VRE + BESS*. Tier A services are more relevant for LCOF treatment because they are the core cost-competitiveness question. Tier B services are included because they are commercially material for investor decision-making — energy arbitrage is a primary revenue stream in WESM and VWEM, and VRE smoothing is a bankability enabler for DPPAs — even though they do not require separate LCOF metrics (arbitrage shares cost structure with peaking; smoothing is a sizing/configuration question rather than a $/MW comparison). Tier C services are excluded because they either lack monetization pathways in the target countries, operate at timescales outside the study's operational window, or are explicitly excluded by the ToR.

Frequency regulation (AGC) is deliberately subsumed under "Reserve provision" rather than listed as a separate Tier A or Tier B service. At a screening level, the cost structure of maintaining regulation capacity is analytically identical to holding spinning reserves — both are $/MW capacity-holding costs — and the Philippines' NGCP procures them within the same ancillary services framework. Separating them would create a fourth LCOF metric without adding discriminating analytical power for the cross-technology comparison.

2.3 Technology Scope: Flexibility Technologies Assessed

This section confirms the technology scope, classifies each flexibility technology by its current role in the three target markets, and provides justification for any analytical refinements, additional inclusions, or exclusions.

We note that the *"gas turbines and gas engines"* category has been disaggregated into three distinct technologies—combined-cycle gas turbines (CCGT), open-cycle gas turbines (OCGT), and gas reciprocating engines—because their flexibility cost structures differ materially including cost of construction, operation and maintenance. This brings the total assessed technology count to **nine**.

2.3.1 Incumbent Flexibility Providers (Conventional)

These technologies currently provide the bulk of load-following and fast-response services in Vietnam, Indonesia, and the Philippines. They form the cost benchmark against which VRE + BESS competitiveness is assessed in this analysis.

2.3.1.1 High-Speed Diesel Generators

The dominant peaking and flexibility resource on Indonesia's outer island grids and a significant contributor in the Philippines' off-grid Visayas region particularly Palawan province, nearby islets and Mindanao particularly Dinagat island. These off-grid diesel generator power supply systems are called Small Power Utilities Group (SPUG), characterized by fast start-up times and high ramp rates, but high and volatile fuel costs. In Vietnam, fuel oil plays a smaller system-level role but remains relevant in isolated grids or in situations where the regional power system lacks power due to incidents or unusually high-power load.

LCOF cost components: Fuel costs at representative load levels, start-up costs, high variable operations and maintenance (O&M) characteristic of reciprocating engines under frequent cycling. Conventional power generators with a faster ramp up are usually picked first. Therefore, diesel generators have to be running idle to be able to reach their peak level at a shorter time, therefore consuming fuel in the long run. Revenue for these types are standby and dispatched.

2.3.1.2 Combined-Cycle Gas Turbines (CCGT) in Flexible Mode.

CCGTs are designed for efficient baseload or mid-merit operation but are increasingly dispatched flexibly to accommodate VRE variability. Their flexibility is constrained by slower start-up times (typically 2–4 hours for a hot start), minimum stable generation levels of 40–50% of rated capacity, and moderate ramp rates relative to OCGTs and engines.

The key country context is Vietnam, where the PDP-8 LNG-to-power pipeline will make CCGT the dominant new-build thermal technology—and these plants will face growing cycling requirements as solar penetration increases. The Philippines has existing CCGT capacity in Luzon and are preferred for base load and load following; Indonesia's Java-Bali system includes CCGT in the mid-merit order.

LCOF cost components: Cycling penalties (hot/warm/cold start costs, thermal stress on heat recovery steam generators), part-load efficiency losses, fuel costs under flexible dispatch, and the relatively high capital cost that makes low-utilization flexible dispatch economically punishing.

2.3.1.3 Open-Cycle Gas Turbines (OCGT)

OCGTs—including both heavy-frame industrial units and aeroderivative machines—are purpose-built peaking and fast-response assets. Aeroderivative OCGTs offer start-up times under 10 minutes and ramp rates exceeding 20 MW/min, making them the conventional technology most directly comparable to BESS for reserve provision and fast ramping. They carry higher fuel costs per MWh than CCGTs due to lower thermal efficiency (35–40% vs. 55–60%), but their value lies in fast response and low minimum run times. OCGTs are present across all three markets as designated peaking units.

LCOF cost components: Fuel costs at representative peaking utilization factors, start-up costs, and capital cost per MW of fast-response capability—the metric on which OCGTs compete most directly with standalone BESS.

2.3.1.4 Gas Reciprocating Engines

Medium-speed gas engines (e.g., Wärtsilä, MAN, Jenbacher) represent a distinct flexibility technology with operational characteristics between OCGT and CCGT: fast start-up (under 5 minutes to full load), high part-load efficiency due to modular multi-engine configurations (individual engines can be switched on/off to match load), ramp rates comparable to or exceeding aeroderivative OCGTs, and thermal efficiency approaching CCGT levels (45–49%).

Their modular architecture means a 200 MW plant comprising multiple engines can operate efficiently at 10–20% of total capacity by running only a few units—a significant advantage over single-shaft gas turbines with high minimum stable generation. These are gaining traction in Southeast Asia: Indonesia has Wärtsilä, and MAN dual fuel gas engine deployments for island grids; the Philippines has engine-based capacity in several provincial systems; and Vietnam is expecting to have such engines shortly.

LCOF cost components: Lower per-unit capital cost, modular O&M, competitive heat rates at part-load, start-up fuel costs. Treated separately because their cost structure differs materially from both OCGT and CCGT.

2.3.1.5 Hydropower

A major flexibility provider in Vietnam (large number of seasonal reservoir-based systems under EVN dispatch owned and operated by EVN) and the Philippines (particularly in Luzon and Mindanao). Indonesia has significant hydro capacity but its flexibility contribution is constrained by irrigation and flood-control priorities on Java—similar to Vietnam. Pump Storage power plants are expected to be built in Upper Cisokan, and West Java Indonesia to be used for peaking, as well for flexibility by designing some of the units with variable speed. Similarly, Vietnam has also planned and is building pumped storage hydropower plants, typically the Bac Ai pumped storage hydropower project - located in the south of Vietnam. With variable-speed motor-generator technology, the plant can continuously adjust pumping power, respond faster, and help provide balancing and ancillary services to the grid. However, variable-speed systems usually add cost and power-electronics complexity and is therefore only attractive when the plant is expected to earn value from frequency regulation, balancing variable renewables, and reserve and ramping services.

The assessment accounts for the opportunity cost of water use, seasonal availability constraints, and the distinction between reservoir hydro (dispatchable, flexible) and run-of-river (limited flexibility). Pumped hydro storage is *not* included as a separate technology—see Exclusions below.

LCOF cost components: Opportunity cost of water use, seasonal availability constraints, O&M, and the incremental cost of providing flexibility services versus steady-state generation.

2.3.1.6 Coal-Fired Power Plants in Flexible Mode

Coal remains the dominant baseload technology across all three countries. While not designed for flexibility, coal plants are increasingly called upon to cycle, ramp, and operate at part-load to accommodate VRE. This is particularly relevant in Vietnam (where PDP-8 implies significant coal cycling as solar penetration grows), Indonesia's Java-Bali system (where coal mid-merit dispatch is emerging), and the Philippines (where coal plants respond to WESM price signals).

This technology is assessed as an *incumbent comparator*—the cost of forcing flexibility from an inflexible fleet—rather than as a recommended flexibility solution. Where data permits, subcritical and supercritical coal plants will be distinguished, as their cycling cost profiles differ materially.
LCOF cost components: Cycling degradation, increased maintenance from thermal stress, efficiency losses at part-load, and hot/warm/cold start costs.

2.3.2 Emerging Flexibility Providers (VRE + BESS)

These are the technologies whose cost-competitiveness the study is designed to assess, reflecting the ToR's central question of whether VRE + BESS can displace incumbent flexibility providers for load-following and fast-response services.

2.3.2.1 Solar PV + BESS (Co-Located Hybrid)

The most commercially advanced VRE + BESS configuration in Southeast Asia, driven by the region's strong solar resource and the natural alignment between solar generation profiles and evening peak demand (the BESS charges during midday solar surplus and discharges during the evening ramp).

Country-specific relevance: Vietnam's DPPA framework (Decree 57/2025) creates a direct commercial pathway for solar + BESS; the Philippines' GEAP and bilateral contracting enable solar + BESS to bid as firm capacity; Indonesia's PLN IPP procurement increasingly accommodates hybrid configurations.

In Philippines, all RE plants are "must run" plants. There are times that these plants can generate more than what they are "allowed" to generate. The extra energy is lost revenue. This makes co-locating a BESS a viable option to store the extra energy and be dispatched later when there is a need, which usually are done on hours where WESM prices are higher.

LCOF cost components: BESS capital costs, degradation as a function of cycling regime, round-trip efficiency losses, O&M, replacement costs, and the solar capacity factor assumptions that determine charging economics.

2.3.2.2 Wind + BESS (Co-Located Hybrid)

Wind + BESS is at an earlier commercial stage than solar + BESS in all three markets but is included because wind's generation profile is complementary to solar (particularly offshore wind, which has stronger evening and nighttime output). Vietnam's offshore wind pipeline under PDP-8 is the most significant near-term opportunity; the Philippines has emerging onshore and offshore wind developments in Luzon and the Visayas; Indonesia's wind resource is more limited but relevant in specific locations (Sulawesi, NTT).

As a site-specific technology, the availability of infrastructures, like roads and more importantly the power line, is a challenge. In the Philippines, development on high potential sites have to rely from NGCP to consider building enough TL and SS capacities. Earlier built wind farms were curtailed due to limitations of grid capacity, that BESS was considered as an option to store un-dispatched energy.

LCOF cost components: Same BESS cost methodology as solar + BESS, with wind-specific capacity factor assumptions and a different representative cycling profile reflecting wind variability patterns.

2.3.2.3 Standalone BESS (Grid-Connected)

Standalone BESS is the purest flexibility asset—it charges from the grid (or under contract) and dispatches flexibility services independently of any specific generation source. This is the configuration most directly comparable to conventional flexibility providers since it can be sited at transmission nodes for maximum system benefit.

Country-specific context: the Philippines has the most developed regulatory pathway (BESS can participate in WESM and ancillary services); Vietnam's Circular 62 provides a nascent BESS pricing mechanism for private sector; Indonesia currently lacks a clear standalone BESS procurement framework, but PLN is exploring pilot projects.

LCOF cost components: Full BESS system costs without the benefit of co-located VRE charging economics, making this the most conservative BESS case. Includes capital costs, degradation, round-trip efficiency losses, O&M, and replacement costs over the project lifetime.

2.3.3 Technologies Considered but Excluded

The following technologies provide flexibility in certain contexts but are excluded from the LCOF comparative assessment for the reasons stated. Each exclusion is consistent with ETP/UNOPS guidance to load-following and fast-response services and the project's focus on informing private sector VRE + BESS investment decisions.

2.3.3.1 Demand Response (DR)

While demand response is an increasingly important flexibility resource globally, it is excluded because: (i) DR is not a generation technology and cannot be meaningfully compared using the same LCOF framework applied to dispatchable supply-side resources; (ii) formal DR programs remain nascent or non-existent in all three target countries—Vietnam has pilot programs under EVN, the Philippines has emerging interruptible load provisions, and Indonesia has no structured DR market; (iii) the private-sector investment focus for this work is on generation and storage assets.

DR is noted in Deliverable 3 as a potential complementary flexibility mechanism that could affect the utilization and economics of BESS.

2.3.3.2 Pumped Hydro Energy Storage (PHES)

PHES is technically capable of providing all three flexibility services assessed in this study (ramping, reserves, short-duration peaking), and in many power systems globally it is among the highest-performing flexibility assets. However, it is excluded from the LCOF comparative framework for three reasons specific to the project's scope and audience.

First, the study's focus on technologies that compete directly with or complement VRE + BESS at the investment decision level. Second, PHES projects in the three target countries—Vietnam's Bac Ai, the Philippines' various candidate sites, Indonesia's Upper Cisokan—are all state-led infrastructure investments with 5–10 year development timelines, site-specific geological requirements, and capital costs in the billions of dollars; they occupy a fundamentally different investment category from the private-sector BESS projects this study is designed to inform. Third, the existing conventional hydro fleet (included as Technology 3) already captures reservoir-based hydro flexibility within each country's current generation mix.

Where operational PHES exists or is under construction in a target country, its role will be noted in the flexibility resource mapping as context, but it will not receive a separate LCOF calculation.

2.3.3.3 Long-Duration Energy Storage (LDES)

Compressed air energy storage (CAES), liquid air energy storage, iron-air batteries, and green hydrogen for power are excluded as these technologies primarily address multi-day or seasonal storage needs beyond the 1–4 hour operational window that defines the study's flexibility services.

2.3.3.4 Geothermal

While geothermal is significant in the Philippines and Indonesia, it operates as baseload generation with very limited ramping capability and high costs of cycling. It does not provide load-following or fast-response services.

2.3.4 Sub-Technology and Configuration Specifications

Within the nine assessed technologies, the following sub-technology distinctions will be maintained where they materially affect flexibility cost and performance.

BESS chemistry and duration. Li-ion lithium iron phosphate (LFP) chemistry is the reference case, reflecting its dominance in the Southeast Asian market due to cost trajectory and thermal management advantages in tropical climates. Two duration configurations are assessed: 2-hour (aligned with reserve provision and ramping) and 4-hour (aligned with short-duration peaking). Sodium-ion and other emerging chemistries are noted as potential cost-reduction pathways in the sensitivity analysis but are not assessed as separate technologies given limited commercial deployment data in the region.

Coal plant type. Subcritical and supercritical coal plants will be distinguished where data permits, as their cycling cost profiles (start-up energy, thermal stress, efficiency degradation at part-load) differ materially.

Hydropower type. Reservoir hydro (dispatchable, flexible) and run-of-river (limited flexibility) are distinguished in the flexibility resource mapping. Only reservoir hydro receives a full LCOF assessment.

2.3.5 Summary of Technology Scope

The following table summarizes the nine technologies assessed and the four technologies excluded.

Table 5. Summary of Technology Scope

Technology	Category	Key Flexibility Characteristics	Primary Country Relevance
Assessed Technologies (9)			
High-speed diesel	Incumbent	Fast start, high ramp rate, high fuel cost	ID (outer islands), PH (off-grid, provincial like Mindanao, some as ancillary service)
CCGT (flex mode)	Incumbent	Slow start (2–4 hrs), high min stable gen, efficient at load	VN (PDP-8 LNG fleet), PH (Luzon), ID (Java-Bali, Sumatra)
OCGT	Incumbent	Fast start (<10 min), high ramp, lower efficiency	All three markets (peaking)
Gas engines	Incumbent	Fast start (<5 min), modular, high part-load efficiency	ID (island grids), PH (Luzon)
Hydropower	Incumbent	Fast ramp (reservoir), seasonal constraints, low marginal cost	VN (major), PH (Luzon/Mindanao, micro hydro in Visayas), ID (constrained). Currently, Saguling & Cirata hydro used for peaking and LFC

Technology	Category	Key Flexibility Characteristics	Primary Country Relevance
Coal (flex mode)	Incumbent	Slow, high cycling cost, efficiency penalties at part-load	All three markets (baseload forced to flex)
Solar + BESS	Emerging	Fast response, evening peak aligned, degradation-limited	VN (DPPA), PH (GEAP/WESM), ID (PLN IPP)
Wind + BESS	Emerging	Complementary to solar profile, earlier commercial stage	VN (offshore pipeline), PH (Luzon/Visayas)
Standalone BESS	Emerging	Purest flexibility asset, grid-sited, no VRE co-location benefit	PH (WESM/AS), VN (Circular 62), ID (pilot stage)
Excluded Technologies (4)			
Demand response	Excluded	Not a supply-side technology; no comparable LCOF metric. Nascent/non-existent formal DR programs in all three countries.	—
Pumped hydro (PHES)	Excluded	Technically capable, but state-led infrastructure (not private-sector BESS investment category). Not in ToR para. 16 technology list.	—Upper Cisokan & Jatiluhur are planned for peaking and frequency control
LDES (CAES, H_2, iron-air)	Excluded	Excluded per ToR para. 17: *"does not extend to long-duration capacity adequacy."* Beyond 1–4 hour window.	—
Geothermal	Excluded	Baseload technology with very limited ramping capability. No load-following/fast-response role.	PH, ID (baseload only)

2.4 Country Market Context

In this section, we share country-level summaries of the key power system characteristics and market conditions that shape flexibility needs and investment barriers in Vietnam, Indonesia, and Philippines. The context supports how we intend to develop the two main reports from this work.

2.4.1 Vietnam

Viet Nam's flexibility needs are being shaped by rapid electricity demand growth, a generation mix still dominated by coal and hydropower, and a renewable fleet that is becoming large enough to create increasing balancing and integration requirements. Based on 2024 power production and purchase data, total electricity supply reached 308,732 million kWh, up from 280,814 million kWh in 2023. Coal-fired generation remained the largest source at 152,775 million kWh (about 49.5% of total supply), followed by hydropower at 88,723 million kWh (28.7%), renewable energy at 39,641 million kWh (12.8%), gas-fired generation at 21,827 million kWh (7.1%), and imports at 5,144 million kWh (1.7%). This structure shows that the system still relies heavily on conventional generation, while the growing share of renewables is increasing the need for ramping capability, reserve provision, congestion management, and other flexibility resources.[1]

A key driver of flexibility demand in Viet Nam is the mismatch between where renewable capacity has been developed and where electricity demand is rising most quickly. Solar deployment has been concentrated mainly in the central and southern parts of the country, while demand growth has been stronger in the north, and transmission expansion has not kept pace. As a result, the 500 kV network is under strain, planned grid additions have lagged behind schedule, and renewable curtailment has already occurred. These conditions mean that Viet Nam's flexibility challenge is not limited to battery storage; it also depends on stronger interregional transmission, more flexible operation of thermal plants, better hydropower optimization, and eventually larger roles for storage, demand response, and other balancing resources.[2] [3]

Market conditions continue to constrain investment in flexibility solutions. Although the regulatory framework is evolving through the new Electricity Law and direct power purchase arrangements, investors still face concerns over PPA bankability, curtailment risk, tariff uncertainty, limited compensation mechanisms for ancillary services, and the continued dependence of transmission investment on public financing. Battery storage remains at an early stage of development, with only limited pilot deployment and no fully established revenue stack for services such as frequency regulation, voltage support, and reserve capacity. This means that, despite a clear and growing system need for flexibility, investment signals for storage and other flexible assets remain weak.[4] [5] [6]

2.4.2 Philippines

The Philippine power system is structured around three main island grids—Luzon, Visayas, and Mindanao—which are interconnected but still experience operational constraints and locational price differences. Electricity demand has grown significantly over the past decade, with total consumption increasing from 77.3 TWh in 2014 to 126.9 TWh in 2024, while peak demand rose from 11.8 GW to 19.3 GW, largely driven by Luzon.[7] This sustained growth, combined with geographic fragmentation, places increasing pressure on both system adequacy and the need for flexible, location-specific solutions.

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[1] EVN Annual report 2024-2025

[2] Ketelsen, T., Thi Ha Tien, L., Quang Bien, T., Ngoc Lap, H., & Quoc Khanh, N. (2023). MANAGING VIETNAM'S GRID ISSUES for Effective Energy Transition

[3] EREA & DEA. (2024). Viet Nam Energy Outlook Report2Pathways to Net-Zero.

[4] https://www.nortonrosefulbright.com/en/knowledge/publications/1d041eb0/vietnam-power-sector-snapshot

[5] GIZ. (2025). Sector Analysis Vietnam Battery Energy Storage Systems in the Commercial and Industrial Sector. https://commission.europa.eu/funding-

[6] World Bank. (2025). Growing Greener Pathways to a resilient and sustainable future.

[7] DOE. (2024). Annual Power Statistics. Link

The generation mix remains dominated by coal, which accounts for a substantial portion of installed capacity, while renewable energy has expanded but still plays a secondary role. Natural gas capacity has remained relatively stable, and oil-based generation has declined.[8] The growing share of VRE, particularly solar and wind, alongside a large baseload coal fleet, has intensified the need for flexibility to manage ramping requirements, frequency regulation, and system balancing.[9] Examples of existing BESS facilities in the Philippines include the Masinloc BESS (10 MW / 10 MWh), the approximately 1,000 MW / 1,000 MWh battery storage portfolio developed by San Miguel Corporation across 32 sites,[10] the 2 MW / 2 MWh Meralco–Hitachi distribution-connected BESS in Bulacan,[11] and the 24 MW Magat BESS providing ancillary services to the Luzon grid.[12]

The Philippine power market framework is relatively well-developed in Southeast Asia, centered on the Wholesale Electricity Spot Market (WESM) operated by the Independent Electricity Market Operator of the Philippines (IEMOP), with system operations and transmission managed by the National Grid Corporation of the Philippines (NGCP).[13] The Energy Regulatory Commission (ERC) oversees and approves key commercial arrangements, pricing methodologies, and cost recovery mechanisms, while governance functions are supported by the Philippine Electricity Market Corporation (PEMC).[14] WESM uses locational marginal pricing, which creates clear spatial signals for investment, and with the introduction of co-optimized energy and reserve market in 2024, it provides additional revenue streams for flexible assets. However, despite these structures, revenue stacking is not yet fully reliable in practice due to changing rules, market adjustments, and operational limitations.[15]

Flexibility needs are increasing rapidly due to rising peak demand, higher penetration of inverter-based resources, and transmission bottlenecks. These needs include fast frequency response, contingency reserves, intra-day balancing, and system strength services.[9] At the same time, congestion and curtailment risks highlight the growing importance of locational flexibility, particularly in areas where grid expansion is lagging behind generation development.

Despite strong fundamentals, investment barriers remain significant. Regulatory uncertainty, particularly in the reserve market, has been evident through a stop–start implementation pattern,

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[8] Ibid, 7.

[9] DOE. (2026). DOE sets load-based categorization of power resources to ensure adequacy, reliability, and system flexibility. Link.

[10] San Miguel Global Power. https://www.smcglobalpower.com.ph/our-business-bess

[11] https://bworldonline.com/spotlight/2019/09/13/253345/meralco-hitachi-unveil-phs-first-grid-scale-energy-storage-system-in-the-distribution-network/?utm_source

[12] SCATEC. (2025). SCATEC JV reaches financial close for 56 MW BESS in the Philippines and prepares for construction start. Link

[13] IEMOP Commences the Full Commercial Operations of Reserve Market. Link

[14] Resumption of the Full Commercial Operations of the Reserve Market. Link

[15] Ibid, 13.

which affects revenue predictability. Ancillary service prices have shown volatility, increasing exposure to regulatory scrutiny and risk for investors. Contract structures, such as short-term ancillary service agreements, are often misaligned with long-term financing requirements, limiting bankability. In addition, strict operational and compliance requirements introduce performance risks, while transmission constraints and delays in grid development create uncertainty around project dispatch and revenue realization. Although locational marginal pricing exists, the ability of storage and other flexible assets to fully capture congestion-related value is still evolving due to overlapping market mechanisms and regulatory frameworks.

Overall, the Philippines represents a high-potential but transitional market for flexibility investments. Strong demand growth and increasing renewable integration provide clear drivers for flexible capacity, supported by a relatively sophisticated market structure. However, regulatory uncertainty, short contract tenors, and infrastructure constraints continue to pose challenges, requiring carefully structured business models and a combination of revenue streams to ensure project viability.

2.4.3 Indonesia

The electricity system in Indonesia consists of on-grid systems on large islands (Java-Bali, Sumatera, Kalimantan, Sulawesi and Nusa Tenggara-Maluku-Papua) and off-grid systems on small islands. The largest system is Java-Bali, which accounts 70% of national demand and installed capacity. Furthermore, around 65% of the national on-grid supply comes from coal-fired power plants (CFPP), and the off-grid system typically relies on diesel generation. The on- and off-grid systems are managed by PT. PLN (Persero) who acts as the single buyer and system operator. Indonesia's power sector remains vertically integrated under PT. PLN (Persero), with procurement anchored in long-term Power Purchase Agreements (PPA). Based on the PT. PLN's planning in Rencana Usaha Penyediaan Tenaga Listrik or RUPTL 2025-2034, Indonesia's RE target for 2034 is 35%.[16] However, the current condition in 2025 is 13-14%, well below the 23% target.[17]

Presidential Regulation No. 112/2022 establishes the principal regulatory framework for accelerating renewable energy deployment in Indonesia by introducing technology-specific pricing that reflects project location and local system conditions. A key feature of the regulation is its explicit recognition of hybrid variable renewable energy (VRE) and battery energy storage system (BESS) projects as a single contractual entity. This provides important legal certainty for integrated renewable-plus-storage developments, enabling developers to recover capital, operating, replacement, and decommissioning costs over the full project lifecycle through a unified power purchase agreement (PPA). Complementing this framework, Minister of Energy and Mineral Resources Regulation No. 5/2025 provides detailed guidelines for renewable energy PPAs and standardizes key contractual provisions between PLN and project developers. While this regulation strengthens contractual certainty and improves bankability, it maintains Indonesia's

[16] Rencana Usaha Penyediaan Tenaga Listrik (RUPTL) PT.PLN 2025-2034

[17] Renewable Energy Indonesia Data Learning Hub. Link

traditional contract-based procurement model in which the operational value of flexibility, particularly the services provided by BESS, remains embedded within the overall energy tariff rather than being compensated through distinct and separately monetized revenue streams.

The regulation specific to hybrid power plants is mentioned in Permen ESDM 19/2025. It orders specific aspects in small-scale systems, such as remote islands or isolated areas, to support the de-dieselization program. The aim is to improve supply reliability and provide legal certainty for integrating RE and BESS into a single system. This regulation stipulates the technical configuration of a hybrid power plant to meet requirements for system flexibility and stability, as well as the procurement mechanism, with a price scheme based on upper and lower limits set by the government. In addition, electricity from the hybrid system is treated as a single unit in the PPA, without separating the value of each component (including BESS), and regulates aspects of cost compensation, carbon economic value, reporting, and supervision to ensure transparent and reliable implementation.

In line with RE targets under the latest RUPTL, system flexibility needs will be increasing rapidly, because of the planned substantial expansion of VRE, particularly solar PV. However, the current system relies heavily on coal-fired power plants, which are inherently inflexible and not designed for frequent ramping. Despite this increasing need, several investment barriers constrain the commercial deployment of VRE+BESS.

First, the absence of a formal ancillary services market means that flexibility services are not explicitly priced or procured independently, limiting storage projects' ability to monetize multiple value streams. Second, the monopsony structure of PT. PLN concentrates procurement decisions and reduces competitive price discovery, making project bankability highly dependent on PPA terms, tariff ceilings, and risk allocation. Third, financing conditions remain challenging, as the higher cost of capital for independent power producers (IPPs) compared to PLN-affiliated projects affects project competitiveness. Finally, regulatory provisions for BESS are still evolving, with storage often treated as a supporting component of hybrid systems rather than a standalone asset class with clear revenue mechanisms.

3 Methodology and Workplan

3.1 Overall Analytical Approach

The project is structured around three milestones that follow a deliberate analytical sequence: each milestone produces the inputs required by the next, so that the final outputs rest on a validated foundation rather than parallel workstreams assembled at the end.

3.1.1 Sequential Milestone Logic

Milestone 1 (this Inception Report) establishes the analytical framework before any substantive analysis begins. Rather than a procedural formality, the inception phase is to calibrate our framework and align with ETP's expectations. Any methodological ambiguity resolved here avoids costly rework downstream.

Milestone 2 (Comparative Cost of Flexibility Analysis) produces the core analytical evidence: technology-by-technology, country-by-country cost comparisons for delivering ramping, reserve, and short-duration peaking services, together with sensitivity analysis identifying the conditions under which VRE + BESS becomes cost-competitive. This deliverable answers the threshold question that the private sector needs resolved first: *"Is VRE + BESS cost-competitive for flexibility services"*?

Milestone 3 (Market Entry Strategies and Risk Assessment) then addresses the equally critical question: *"Even where cost-competitive, can private developers actually access the market, monetize flexibility services, and manage the associated risks?".* The market entry analysis is deliberately sequenced after the cost analysis because the relevance of any given entry pathway depends on which services and which countries show competitive or near-competitive economics. For example, if the LCOF analysis reveals that VRE + BESS is competitive for reserve provision in the Philippines but not yet for ramping in Indonesia, the market entry work focuses on whether reserve revenues are actually accessible in the Philippines and what regulatory or commercial barriers stand in the way — rather than mapping every theoretical pathway in every country with equal depth.

3.1.2 Private Sector Investment-Screening Lens

The entire analytical framework is organized around the sequence of decisions that private sector actors actually face when evaluating VRE + BESS opportunities in these markets. The cost analysis addresses the threshold question first: is VRE + BESS cost-competitive with incumbent flexibility providers for specific services in a given country, and under what conditions does it become so?

The sensitivity analysis and competitiveness threshold visualizations are designed to let a developer or investor quickly identify whether their assumptions on fuel prices, BESS system costs, and utilization fall within the range where VRE + BESS is the lower-cost option. Where the cost case holds, the market entry assessment then addresses the questions that follow: can a private developer—including an international one—actually access the market, through which procurement or contracting pathway, what revenue streams can realistically be monetized and stacked, and what commercial, regulatory, operational, and credit risks must be priced into the investment decision?

For each country, the analysis distinguishes between what is legally permitted and what is practically achievable, recognizing that for international developers and financiers, the gap between the two is often where investment decisions stall. This framing ensures that every analytical component serves a clear function in the investment screening process, from initial cost benchmarking through to a country-level assessment of investment readiness.

3.1.3 Principles for Ensuring Cross-country Consistency

The Lead Energy Economist/Team Leader maintains oversight of all analytical outputs, ensuring consistency across the three-country assessments and alignment with the methodological framework established in the inception report.

Internal review protocols operate at three levels. First, all cost assumptions and data inputs undergo peer review by the relevant cross-disciplinary specialist, the BESS Specialist reviews conventional technology cost assumptions, the Power Systems Specialists review BESS operational parameters, and the Regulatory Specialists verify that assumptions are compatible with prevailing market conditions. Second, draft deliverables undergo a structured cross-review before submission to ETP, with each team member reviewing sections outside their primary responsibility. Third, the Team Leader conducts a final integration review for internal consistency, cross-country comparability, and alignment with the Terms of Reference.

A living "Issues Log" will be maintained throughout the project, tracking open questions, data gaps, stakeholder feedback requiring follow-up, and analytical decisions. This log ensures that no issues are lost between milestones and that the team can demonstrate a clear audit trail for all methodological choices.

3.1.4 Study Scope Boundaries

The analysis in this study is comparative and screening-level only: it will not involve detailed power system optimization modelling, site-specific project design, project-level cash flow modelling, or financial returns analysis—although it will touch upon them lightly to support the analysis.

The LCOF framework benchmarks VRE + BESS against incumbent flexibility providers using standardized cost and performance assumptions—it does not simulate dispatch against actual system load curves or optimize plant configurations for particular grid nodes. Similarly, the market entry assessment identifies feasible commercial pathways, revenue stacking opportunities, and investment risks at the country level, but it does not extend to contract drafting, deal structuring, or bankability opinions on individual projects.

The revenue stacking analysis remains qualitative, identifying which streams are currently monetizable and which may become so in the near term, without modelling project-specific cash flows or Internal Rate of Return (IRRs). The assessment also does not extend to long-duration capacity adequacy or baseload replacement. These boundaries are deliberate: they keep the outputs at the level of generality where they are most useful to the broadest range of private sector decision-makers, while avoiding the site-specific and commercial assumptions that would narrow applicability and exceed the project's mandate.

3.1.5 Role and Responsibilities of In-Country Coordinators

The NIRAS team will deploy one dedicated coordinator in each of the three target countries. These coordinators serve as the local interface between the analytical team and in-country stakeholders, ensuring that consultations are scheduled efficiently, that locally available data and documentation are gathered systematically, and that stakeholder insights are captured and relayed to the specialist team in a timely manner.

Their role spans the full project lifecycle across four core functions:

- *Stakeholder access and relationship management.* The coordinators are the primary point of contact for in-country stakeholders — government agencies, regulators, utilities, system operators, developers, and industry associations. They manage the identification and scheduling of consultations, handle meeting logistics, maintain ongoing relationships between formal engagement points, and follow up on information requests. This is particularly important in markets where access to key counterparts depends on established local networks and institutional familiarity rather than cold outreach.

  The Vietnam Coordinator will manage engagement with Ministry of Industry and Trade (MOIT), the Electricity Authority of Vietnam (EAV), EVN, the National System and Market Operator (NSMO), and Vietnamese developers and financiers. The Indonesia Coordinator will facilitate access to PLN's planning and operations divisions, Ministry of Energy and Mineral Resources (MEMR), the IPP community, and Indonesian banking and investment stakeholders. The Philippines Coordinator will coordinate with the Department of Energy (DOE), Energy Regulatory Commission (ERC), National Grid Corporation of the Philippines (NGCP), Philippine Electricity Market Corporation (PEMC), distribution utilities, and Filipino developers and investors active in the Wholesale Electricity Sport Market (WESM) and ancillary services markets.

- *Data sourcing and collection.* The coordinators work alongside the country Power Systems and Market & Regulatory specialists to identify, locate, and obtain country-specific data — power development plans, regulatory filings, utility publications, tariff schedules, fuel price benchmarks, and procurement documents. They are responsible for tracking documents that may not be publicly available online, navigating local language sources, and managing requests to government or utility counterparts for unpublished data. When data gaps arise, the coordinators are the first line of inquiry for identifying alternative local sources or institutional contacts who can provide the needed information.

- Regulatory and institutional context. The coordinators provide the country specialists and the Team Leader with ongoing situational awareness on regulatory developments, policy shifts, or institutional changes that may affect the analysis — such as new draft regulations on hybrid systems, changes in procurement timelines, or shifts in government priorities around storage. This ensures that the analytical work reflects current conditions rather than relying solely on published documents that may already be outdated.

- Logistics and coordination support. The coordinators manage the practical aspects of in-country engagement — organizing stakeholder meetings (virtual or in-person), coordinating schedules across time zones between international and local team members, collecting and organizing country-specific regulatory documents and data files, and providing inputs to the Team Leader for integration into project deliverables.

The coordinators report to the Team Leader and work in close coordination with the respective country's Market & Regulatory Specialist and Power Systems Specialist. Their involvement is continuous from Month 1 through Month 8 — not limited to specific milestones — ensuring that the project maintains active in-country engagement throughout the entire implementation period.

Regular internal coordination meetings, at minimum biweekly, during active analytical phases will maintain alignment across the team and the three in-country coordinators.

3.1.6 Data Collection Protocols

All data collected under this project will follow a purpose-limited approach. Any personal data will be handled in accordance with UN data protection and privacy principles. Access to personal data will be restricted to relevant team members, stored securely, and retained only for the duration necessary to support project implementation.

In general, given that this project is not being implemented under a formal technical assistance agreement with each of the governments in Vietnam, Indonesia, and Philippines, the data collection will rely on three main methods:

- **Publicly** available data. Data is publicly available on reputable websites, including government entities, companies, donor agencies, etc.

- Officially provided data. Data gathered by requesting relevant agencies to provide the information for use in this project. Such requests could be through a formal request via letters or emails from ETP/UNOPS or NIRAS depending on agency. If access is granted, data will be handled as "Official Institutional Data."

- Proxy data. In some cases, data will need to be gathered through Expert Interviews to develop indicative data, relevant to the analysis. The data will be gathered via Structured Expert Interviews (SEIs) with independent specialists (former officials, legal advisors, and energy economists).

The following specific protocols and procedures will be established for the proxy data collections:

- **Interview and consultations with stakeholders.** Formal written requests for interview and consultation will be issued prior to any engagement, accompanied by a consent form and an indicative list of topics or preliminary questions to be discussed. Participation will be strictly voluntary; interviewees may decide to decline any specific questions or withdraw from the interview. Any direct quotations, attributed statements, or institutionally sensitive information extracted from the interviews will be shared back with the interviewee for review and validation prior to inclusion in reports or publication. Storage of data from the interviews will follow relevant data storage requirements of each country.

- **Registration and attendance in project activities**: Participants will be informed about how their personal data and/or photographs will be collected, used, and shared strictly for project implementation and reporting purposes.

- **Verification Standards:** To ensure the "Informed Professional Judgement" is accurate, the team will use a **Triangulation Method**—comparing inputs from at least three independent experts to validate a single data point (e.g., a specific gas price or dispatch constraint).

- **Anonymization by Default:** To protect experts (former officials), all inputs provided will be anonymized and categorized by professional background (e.g., "Expert Opinion - Former Grid Operator") rather than individual names.

- **Non-Disclosure Agreements (NDAs):** If necessary, NIRAS team will provide individual NDAs to experts to ensure that the "knowledge-exchange" does not expose them to professional or legal liability regarding the information they share.

- **Secure Synthesis:** Data points from multiple experts will be synthesized into "market benchmarks" before being included in the public-facing report, ensuring that raw, sensitive inputs cannot be traced back to a specific source.

- **Integrity of Findings:** All proxy data will be clearly flagged in the Inception Report and final deliverables as "Consultant Estimates based on Expert Consultation," ensuring ETP and stakeholders understand the limitations of the data granularity.

- **Data Attribution:** A strict protocol will be enforced to distinguish between "Official Data" and "Informed Professional Judgement" (Proxy Data) within the LCOF models to ensure transparency regarding the source's authority.

The table below provides a high-level summary of the data protection and privacy policies in each of the countries:

Table 6. Data protection and privacy policies

Laws and policies on data protection and data privacy	Brief description
Indonesia	

Laws and policies on data protection and data privacy	Brief description
Law No. 27 of 2022 on Personal Data Protection	Main legal framework for personal data protection, requiring personal data processing to be lawful, limited, specific, transparent, purpose-based, accurate, secure, confidential, and accountable. Data collection should be based on a clear legal basis or explicit consent, limited to what is necessary, supported by privacy notices, subject to access controls, and followed by proper retention, deletion, breach notification, and data subject rights procedures.
Minister of Communication and Informatics Regulation No. 20 of 2016 on Personal Data Protection in Electronic Systems	Provides operational requirements for electronic personal data handling, including acquisition, collection, processing, analysis, retention, display, publication, transmission, dissemination, and destruction.
Government Regulation No. 71 of 2019 on Electronic Systems and Transactions	Supports secure management of electronic data and records used in data collection activities.
Philippines	
Republic Act No. 10173 – Data Privacy Act of 2012 (DPA)	Primary law on collecting, recording, and use of any personal information from an interview; requires lawful basis (consent), transparency, proportionality, and security measures in data collection (i.e., interview) of names, opinions, and affiliations.
Executive Order No.2 s.2016 – Freedom of Information (FOI)	Defines the limits of disclosure when interviews involve government agencies to promote transparency.
Vietnam	
Vietnam Personal Data Protection Law 2025 (PDPL)	Establishes a comprehensive legal framework for personal data protection in Vietnam, defining principles such as lawful, transparent, and purpose-specific processing, data minimization, accuracy, security, and accountability. Requires a clear legal basis (including consent or other permitted grounds) for data processing, with stricter rules for sensitive personal data. Introduces obligations for data controllers and processors, including data protection impact assessments, breach notification, cross-border data transfer requirements, and appointment of responsible personnel. Ensures data subject rights such as access, correction, deletion, restriction of processing, and objection, alongside enhanced enforcement mechanisms and administrative sanctions for non-compliance.

Personal Data Handling

Despite the informal nature of the data gathering, the legal requirements for handling personal data remain unchanged:

- **Purpose-Bound Consent:** Every expert or specialist engaged will sign a **Bilingual Consent Form** acknowledging that their input is for a "screening-level commercial assessment" and that their PII (Personally Identifiable Information) will be protected.

- **Data Minimization:** We will only collect the minimum personal data required to establish the expert's credibility (e.g., years of experience, past institutional affiliation) without storing unnecessary biographical details.
- **Cross-Border Security:** Since data will be analyzed by a regional team (NIRAS Manila/NIRAS Indonesia/ RCEE Vietnam), all expert interview transcripts will be stored on encrypted servers, respecting each country's **Cross-Border Transfer Impact Assessment (TIA)** requirements for data residency.

3.2 Deliverable 2: Comparative Cost of Flexibility Analysis

This section sets out the methodology for Deliverable 2 — the Comparative Cost of Flexibility Analysis. The work proceeds through four sequential activities: mapping each country's flexibility resources (A2), establishing standardized cost and performance benchmarks for each technology (A3), running the LCOF comparison itself (A4), and stress-testing the results through sensitivity analysis and competitiveness thresholds (A5). The subsections below detail the action items, country perspectives, and analytical outputs for each step, feeding into the consolidated Cost Analysis Report (A6).

The table below shows the expected schedule for this deliverable:

Table 7. Deliverable 2 activity schedule

No.	Activity	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
A2	Flexibility Resource Mapping								
A3	Cost Assessment & Benchmarking								
A4	LCOF Comparative Analysis								
A5	Sensitivity Analysis & Thresholds								
A6	Deliverable 2: Cost Analysis Report								

The tables in the sections below lay out the plan and the activities to develop the Cost of Flexibility Report. The country perspectives column provide some additional information for the activities.

3.2.1 Flexibility Resource Mapping (A2)

No.	Action Items	Country Perspectives
A2.1	Collect and compile data on existing and planned flexibility resources per country (diesel, gas turbines/engines, hydropower, coal in flexible mode, solar + BESS, wind + BESS, standalone BESS) — including installed capacities, operational characteristics (ramp rates, minimum stable	**VN:** This information relates to national power grid dispatch and operation data – which is often not publicly available. *Approach:* combine PDP-8 published capacity figures with typical operational characteristics based on publicly available information.

No.	Action Items	Country Perspectives
	generation, start-up times, response times), and representative utilization patterns and dispatch profiles	**PH**: Data is the most accessible of the three countries but operational parameters require triangulation. *Approach:* DOE Power Statistics for installed capacity by technology; NGCP Grid Operations Annual Report for system-level dispatch; IEMOP RTD market data (12+ months) for revealed flexibility behaviour; ERC filings for plant-specific heat rates and ramp characteristics. Emerging BESS projects (e.g., SMC Limay/Masinloc, ACEN, AboitizRE Laguna) compiled from public commissioning announcements and developer disclosures. Identify responsible resource person from the list of agencies, developers and operators to obtain operational information. **ID**: PLN is a single buyer with limited public disclosure of operational data; outer-island flexibility regime differs fundamentally from Java-Bali. *Approach*: RUPTL 2025-2034 as the primary capacity source; PLN Statistik (annual statistical bulletin) for installed capacity by technology and region; MEMR regulations for IPP technical requirements. Local Coordinator (Indonesia) to engage PLN's system operation division for Java-Bali dispatch context and outer-island diesel utilization data.
A2.2	Design representative dispatch and operational scenarios per country, varying along key dimensions (VRE penetration level, fuel price assumptions, BESS cost trajectories, utilization levels); describe how these scenarios characterize typical flexibility provision rather than exhaustive system behaviour.	**VN:** Limited public dispatch data requires scenarios to be constructed from planning documents and representative load profiles in NSMO daily dispatch information, rather than historical operational records. *Approach*: build a base dispatch case from PDP-8 capacity trajectory combined with EVN and NSMO published typical daily load curves; sensitivity on VRE penetration and LNG price (regulated vs. import-parity) to bracket future flexibility need. **PH**: Historical WESM data is rich but reflects dispatch under evolving market design (GEAP rounds, evolving Reserve Market rules). *Approach*: construct a historical baseline scenario from 12+ months of IEMOP RTD data segmented by Luzon, Visayas, and Mindanao; build a forward scenario using DOE PEP 2023-2050 capacity outlook, NGCP Transmission Development Plan, and GEAP-3 results to capture procurement-driven flexibility additions. **ID**: Java-Bali and outer-island systems require separate scenario treatment given fundamentally

No.	Action Items	Country Perspectives
		different flexibility regimes. *Approach*: two-segment design — (i) Java-Bali interconnected scenario built from RUPTL subsystem data and PLN dispatch patterns; (ii) representative outer-island scenario (e.g., NTT or Maluku archetype) focused on diesel displacement economics. PLN system operation division engagement through Local Coordinator to validate scenario realism.
A2.3	Draft the scenario design rationale — explain selection logic, key variables, and how scenarios connect to the LCOF comparative analysis downstream	**PH:** The scenario design ensures that the comparative LCOF analysis is grounded in realistic system conditions, regulatory trajectories, and technology mixes. This approach highlights the true economic value of flexibility resources in stabilizing the Philippine grid, beyond what LCOE alone can capture. **ID**: Define the level of flexibility. Generation capacity, ramping capabi lity, storage capacity, share of VRE, Capex, Opex reserve requirement will affect the LCOF
A2.4	Identify and document to illustrative two-to-three VRE + BESS case studies from operational or advanced-stage projects in Asia-Pacific (not in Vietnam, Indonesia, and Philippines) or outside of Asia; define selection criteria and describe how they will demonstrate development, implementation, and monetization approaches	The following three case studies are currently under consideration to demonstrate distinct revenue models and to span the regulatory contexts relevant to VN, PH, and ID: 1. *Case 1 — Hornsdale Power Reserve, South Australia (150 MW/194 MWh, Neoen/Tesla, operational since 2017).* Co-located with the 316 MW Hornsdale Wind Farm. Hybrid contract structure: a contracted block providing SIPS grid stability services to the South Australian Government, and a merchant block participating in FCAS and energy arbitrage on the National Electricity Market. Directly relevant to PH, given the WESM Reserve Market's analogous structure and the BESS-dominated Regulating Reserve dynamics already evident in IEMOP data. Demonstrates: merchant + contracted hybrid revenue model, fast-response value capture, multi-year evolution of FCAS vs. arbitrage revenue mix. 2. *Case 2 — Kapolei Energy Storage, Oahu, Hawaii (185 MW/565 MWh, Plus Power, operational since December 2023).* Built to replace the retired 180 MW AES coal plant under a 20-year tolling contract with Hawaiian Electric. Service stack covers capacity, fast frequency response,

No.	Action Items	Country Perspectives
		synthetic inertia, and black start. Most directly relevant to ID's PLN single-buyer dynamic (Java-Bali and outer-island diesel displacement) and to VN's emerging single-off-taker BESS procurement under Circular 62. Demonstrates: long-term tolling contract economics, services-bundle valuation in a non-spot-market context, fossil displacement as the commercial proposition. 3. *Case 3 — Rajnandgaon Solar + BESS, Chhattisgarh, India (40 MW/120 MWh BESS + 100 MW solar PV, SECI/Tata Power, operational since early 2024).* India's first commercial utility-scale BESS, supported by an USD 8 million Clean Technology Fund grant with performance-linked supplier payments and technical know-how transfer provisions. Sits within India's broader VGF-supported BESS procurement pipeline that has set tariff benchmarks (e.g., INR 6.64/kWh for 250 MW/1,000 MWh standalone BESS) since 2024. Most directly relevant to VN's Circular 62/11 implementation challenge — how to structure the first competitive BESS procurement where the pricing framework exists but bankable project structures do not yet — and to ID's nascent BESS regulatory development. Demonstrates: VGF supported emerging market procurement, multilateral DFI risk-sharing, first-of-kind regulatory pathfinding.
A2.5	Design the structure of the assumptions book (Excel workbook to accompany Deliverable 2) — define tabs, data fields, and linking logic	

3.2.2 Cost Assessment and Benchmarking (A3)

No.	Action Items	Country Perspectives
A3.1	Explain the distinction between cost of flexibility and LCOE, and why a flexibility-specific cost metric is the appropriate basis for this study	While the main explanation for the use of LCOF will be same across all three countries, there are some country-level nuances that would also be evaluated.

No.	Action Items	Country Perspectives
		VN: MOIT and EVN/NSMO use system-level production-cost modelling and per-MWh LCOE benchmarks for tariff negotiations under Circulars 62/2025/TT-BCT and 11/2025/TT-BCT; a flexibility-specific cost metric is not yet part of the regulatory vocabulary. *Approach*: position LCOF explicitly as the cost-side counterpart to Circular 62's emerging BESS pricing principles, expressed in $/MW of reserve capacity held and $/MW of ramp rate delivered. **PH**: ERC and NGCP already use service-specific cost-and-payment constructs in ASPA (capacity payment, dispatch payment, performance penalty), providing a natural anchor for LCOF presentation. *Approach*: present LCOF as the technology-level cost-side analogue to the ERC ASPA payment structure, enabling direct comparison against the implicit revenue ceilings in current ASPA contract design and WESM Reserve Market clearing prices. **ID**: MEMR and PLN evaluate generation primarily through BPP and LCOE benchmarks under regulated tariff structures, with no flexibility-specific cost metric in current use. *Approach*: position LCOF as a screening complement to BPP — answering *"what does flexibility cost to deliver?"* rather than *"what does electricity cost to produce?"*
A3.2	Define the cost **component** framework for conventional thermal technologies — specify how fuel costs at representative load levels and during ramping, cycling costs (hot/warm/cold start penalties), part-load efficiency penalties, and incremental maintenance from flexible operation will be calculated	Supply agreement of each plants vary significantly in costs and the agreed delivery scheme (must take, take-or-pay, nominated, etc.). However, given the high-level nature of this analysis, we use an estimated value for each type of plant, and potentially consider some sensitivities around them. **VN:** In Vietnam, there are thermal power plants invested under the BOT or IPP (PPA and participation in the electricity market) mechanisms. *Approach*: a general estimation method will be used, considering important cost characteristics such as take-or-pay, PPA contract price, LNG pricing, and market biding. **ID**: PLN as single buyer holds the most granular plant-level cost data but discloses limited public information; domestic coal pricing is set by the Domestic Market Obligation, creating a fuel-cost structure unique to Indonesia and making cross-country fuel-cost comparison non-trivial. *Approach*: DMO-capped coal pricing for steam plant inputs; PLN

No.	Action Items	Country Perspectives
		Statistik and RUPTL for installed-capacity-weighted average heat rates; Local Coordinator engagement with PLN's planning division to validate cycling-cost parameters and flexible-operation maintenance multipliers. **PH***:* Plant-level operating parameters are partially disclosed through ERC filings and DOE Power Statistics; WESM dispatch data enables empirical estimation of cycling frequency and part-load operation at the plant level. *Approach*: ERC filings for plant-level heat rates and fuel cost pass-through; 12+ months of WESM settlement and dispatch data for revealed cycling behavior; LNG pricing on import-parity (DES Philippines) basis per recent regulatory submissions.
A3.3	Define the cost component framework for hydropower — specify how opportunity cost of water use and seasonal availability constraints will be modelled	In all three countries, use of water for irrigation and domestic needs are priorities over energy generation in hydro plants. During the rainy season, water cannot be stored in some cases. *Approach:* modelling will likely consider how much water will actually be available for flexibility, in each of the three countries.
A3.4	Define the cost component framework for VRE + BESS — specify how capital costs, degradation, round-trip efficiency losses, O&M, and replacement costs will be treated	See Section 3.4.2 for the initial BESS assumptions
A3.5	Specify indicative BESS configuration assumptions (system sizes, durations, C-rates, operational characteristics) with justification for parameter choices	See Section 3.4.2 for the initial BESS assumptions
A3.6	Document the BESS degradation modelling approach — describe treatment of calendar/cycle aging, depth-of-discharge profiles, and temperature sensitivity	See Section 3.4.2 for the initial BESS assumptions
A3.7	Document BESS operational constraint assumptions — SoC or State of Charge management strategy, auxiliary consumption, availability factors, thermal management considerations	See Section 3.4.2 for the initial BESS assumptions.

3.2.3 LCOF Comparative Analysis (A4)

No.	Action Items	Comments
A4.1	Design the LCOF calculation methodology — define the metric ($/MW or $/MWh of flexibility service delivered), formula structure, and key input–output relationships; explain why LCOF (or equivalent indicator) is the appropriate comparative tool	
A4.2	Develop service-specific LCOF calculation procedures for the three service categories: ramping capability, reserve provision, and short-duration peaking support	
A4.3	Define BESS-specific flexibility service metrics and how they integrate into the overall LCOF framework	Initial definitions are in 3.2.1.
A4.4	Document financial parameter conventions to be applied (WACC, plant lifetime, capacity factors, currency treatment) and explain how these ensure cross-country and cross-technology comparability	Initial assumptions are in 3.4.2.
A4.5	Describe how the framework will benchmark VRE + BESS costs against incumbent technologies under standardized assumptions	

3.2.4 Sensitivity Analysis and Competitiveness Thresholds (A5)

No.	Action Items
A5.1	Identify and justify the key sensitivity variables to be tested (fuel prices, BESS costs, utilization levels, battery degradation, WACC, VRE capacity factors) and define the range for each
A5.2	Design the competitiveness threshold visualization approach — describe how specific combinations of fuel prices, BESS costs, and utilization at which VRE + BESS becomes the lower-cost option will be identified and presented for each service category per country
A5.3	Explain how sensitivity outputs will be formatted as practical screening tools useable by private sector investors for go/no-go decisions

3.3 Deliverable 3: Market Entry Strategies and Risk Assessment

This section sets out the methodology for Deliverable 3 — Market Entry Strategies and Risk Assessment. Building directly on the cost findings from Deliverable 2, the analysis proceeds through five activities: identifying feasible market entry pathways (A7), assessing revenue streams and tariff arrangements (A8), evaluating market access conditions for international developers

(A9), examining revenue stacking opportunities (A10), and assessing investment risks and country-level readiness (A11). Together, these translate competitive economics into actionable investment-screening guidance, consolidated in the Market Entry Report (A12).

The table below shows the expected schedule for the development of this deliverable. While most of the work is expected to be completed after Deliverable 2, there might be some initial work that will be done earlier.

Table 8. Deliverable 3 activity schedule

No.	Activity	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
A7	Market Access Pathway Analysis								
A8	Revenue Stream & Tariff Assessment								
A9	International Developer Market Entry Analysis								
A10	Revenue Stacking Evaluation								
A11	Risk Assessment & Investment Readiness								
A12	Deliverable 3: Market Entry Report								

The tables in the sections below lay out the plan and the activities for the Market Entry and Risk Assessment Report. The country perspectives column provides some additional information for the activities.

3.3.1 Market Entry Pathway Analysis (A7)

No.	Action Items	Country Perspectives
A7.1	Assess feasible market entry strategies per country across the full spectrum of access mechanisms – utility procurement through PPAs or capacity contracts, competitive auction programs, bilateral contracting, and merchant participation in wholesale and ancillary markets.	**PH:** Generally, BESS entry strategy will be based on: 1. Power Purchase Agreements (Bilateral contract & capacity contract) 2. Competitive Auctions (e.g., GEAP) 3. Wholesale Electricity Market (e.g., WESM, VWEM) and Ancillary Services Market (e.g., WESM) The key entry-screening question is how these pathways stack commercially for revenue stacking under current WESM rules, and which combinations are regulatorily permitted. *<u>Approach</u>*: engagement with DOE on GEAP-3 design and the timeline for storage-eligible auction rounds; engagement with ERC and NGCP on ASPA structure adaptation for BESS. **VN:** There are two pathways for flexibility-oriented BESS: a) **Circular 62/2025/TT-BCT** (effective 26

No.	Action Items	Country Perspectives
		January 2026), which establishes a two-part tariff for standalone BESS providing grid services — a capacity payment for availability and an energy payment for discharge; and b) **Circular 17/2025/TT-BCT**, which permits EVN Power Corporations to invest directly in BESS as a grid asset and recover the investment through the tariff rate base. The key entry-screening question for private investors is therefore Circular 62 implementation maturity set against the scale of Circular 17 EVN PC deployment, which may absorb the most attractive grid locations during the 2026–2028 build-out. *Approach*: structured readiness assessment of Circular 62 implementation and direct engagement with MOIT and EVN to benchmark Circular 17 deployment progress and rate-base recovery methodology to gauge crowding-out risk for private developers. **ID:** Market entry pathways are dominated by PLN-led utility procurement with limited merchant or competitive mechanisms. The principal pathways are: (i) PLN competitive IPP tenders for solar PV with mandated BESS for smoothing; (ii) bilateral negotiated PPAs within the regulated BPP tariff envelope; (iii) emerging IPP tenders for standalone BESS under MEMR pricing frameworks still in development; *Approach*: Local Coordinator engagement with PLN procurement division on the RUPTL-aligned tender pipeline; MEMR engagement on the timeline for a standalone BESS pricing mechanism; outer-island opportunity assessment via PLN regional units (Wilayah) where diesel displacement economics are most compelling.
A7.2	Identify enabling conditions (grid connection procedures, licensing, permitting, BESS import/customs procedures) and regulatory constraints that currently limit private sector participation for each pathway, informed by direct engagement with developers,	For all three countries, the study will assess enabling conditions and regulatory constraints that may affect private sector participation across each market entry pathway, including grid connection procedures (e.g., approvals for System Impact Studies and Interconnection), licensing and

No.	Action Items	Country Perspectives
	regulators, and investors to capture actual (not just de jure) barriers.	permitting requirements, BESS importation and customs procedures, and market access rules. Particular attention will be given to practical barriers such as permitting timelines, transmission congestion, reserve market uncertainty, and financing constraints that may limit participation in practice.

3.3.2 Revenue Stream & Tariff Assessment (A8)

No.	Action Items	Country Perspectives
A8.1	Map compensation mechanisms beyond traditional PPAs per country.	**VN:** The mapping will document tariff structure, pricing methodology, annual price-approval cycle, and dispatch-rights provisions under both Circular 62 and 17, with reference points from EVNNPC and EVNHANOI procurement notices already in market. **PH:** The study will map compensation mechanisms beyond traditional PPAs, including revenues from the WESM, ancillary and reserve services, contracted capacity or grid support arrangements, and emerging revenue stacking opportunities. Examples include ancillary services participation by BESS assets within the San Miguel Corporation portfolio and the SN Aboitiz Power Group Magat BESS. **ID**: The activities will review the last regulatory framework and, beyond the current situation, including policies issued by MEMR and PLN, identify the existing and emerging mechanisms, such as capacity payments, ancillary service compensation, and flexibility schemes. The current compensation mechanism will take into account the single-market buyer that occurred in Indonesia.
A8.2	Assess the adequacy of existing compensation mechanisms for supporting flexibility investment and identify commercial risks arising from their current limitations.	The adequacy assessment will apply a common parameter framework to all three countries to ensure cross-country comparability under A8.3. Compensation mechanism assessed under A8.1 will be evaluated against standardized parameters (e.g., dispatch certainty, counterparty credit, stackability,

No.	Action Items	Country Perspectives
		maturity of implementation, and evidence of bankability). **VN**: Adequacy hinges on Circular 62 implementation maturity. Specific risks will be evaluated: annual price-approval cycle creating multi-year revenue uncertainty, absence of dispatch guarantee for BESS capacity, absence of operational precedent for tariff disputes, and crowding-out risk from EVN PC deployment under Circular 17. We will review Circular 62 implementing details, if any, and engage with MOIT, EVN, and developers in active discussion with EVN on Circular 62 contract terms (if any). **PH:** The study will assess whether existing compensation mechanisms in the Philippines provide sufficient revenue certainty to support flexibility investment, considering risks related to reserve market uncertainty, short contract tenors, revenue volatility, and financing constraints. Particular attention will be given to whether current mechanisms support bankability beyond projects backed by strong sponsor balance sheets, and whether existing monetization pathways, including ancillary services arrangements and merchant revenues, provide sufficient support for broader private sector participation. **ID**: There are several PV+BESS projects in Indonesia. The assessment will benchmark PLN's current arrangements, with a focus on whether these projects rely on flexibility as a source of cash flow and their ability to provide predictable, bankable cash flows. This analysis will be complemented by identifying resulting commercial risks, such as revenue uncertainty, lack of remuneration for ancillary services, and misalignment of tariff structures, through regulatory review and stakeholder consultations with the MEMR and market participants
A8.3	Produce a structured cross-country comparison of revenue mechanisms, identifying for each country: (i) which mechanisms are operational and provide bankable revenue certainty, (ii) which are established in regulation but lack implementation detail, and (iii) which are	Each compensation mechanism identified under A8.1 will be assessed against the standardized parameter framework defined in A8.2**.** Based on our assessment, a single comparative matrix will be developed classifying each mechanism in each country into one of three tiers — (i) operational and bankable, (ii) regulated but lacking implementation

No.	Action Items	Country Perspectives
	under development and may be available in the near term.	detail, (iii) under development with near-term availability. This classification directly informs the investment-readiness assessment in Deliverable 3 by distinguishing markets where revenue frameworks support immediate entry from those requiring early-mover risk acceptance or regulatory-reform monitoring.

3.3.3 International Developer Market Entry Analysis (A9)

No.	Action Items	Country Perspectives
A9.1	Assess the legal basis for foreign participation in RE and BESS per country — Public Service Act amendments (Philippines), Law on Investment and Electricity Law (Vietnam), Priority Investment List (Indonesia).	**VN:** Conduct legal review of the current regulatory framework governing international investors participation in the RE sector in Vietnam including Electricity Law 2024, Land Law 2024, Investment Law 2020 and other relevant legal regulations. Study the cooperation structures between foreign investors and domestic enterprises in previous RE projects to determine the potential opportunities and challenges for the VRE+BESS model in the upcoming time. **PH:** The study will review the policy and regulatory framework governing foreign participation in renewable energy and BESS in the Philippines, including relevant investment, ownership, and market access provisions applicable to international developers. This will include consideration of how the current framework has supported participation by international developers such as Nexif Ratch Energy, Scatec ASA, and Copenhagen Offshore Partners, and how these provide practical reference points for assessing market entry conditions for foreign investment. **ID:** For Indonesia, the assessment will review the legal basis for foreign participation in RE and BESS by analyzing the Indonesia Investment Law and the Presidential Regulation No. 10/2021 on Investment Priority List (including its amendments), to determine sector openness, ownership limits, and applicable conditions. This will be complemented by examining implementation through the Indonesia Investment Coordinating Board (BKPM) licensing processes and by practical application in PLN

No.	Action Items	Country Perspectives
		procurement to assess how regulatory provisions translate into actual market-entry opportunities.
A9.2	Identify practical barriers that may limit effective market access for international developers — licensing timelines, local partnership requirements, land access constraints, and provincial approval processes.	**VN:** Assess policy constraints affecting international investors participation in the RE sector in Vietnam including the level of priority granted to foreign-invested projects under PDP8 and grid connection, barriers related to land access as well as the structure of PPA and tariff mechanisms applicable to VRE+BESS projects in Vietnam. **PH:** The study will review practical factors that may influence effective market access for international developers, including project development timelines, interconnection processes, land access considerations, permitting coordination, and local implementation requirements. This will include consideration of practical challenges associated with multi-agency approvals, transmission interconnection processes, and other implementation-related factors that may affect project development in practice. **ID:** Based on the current situation, there are practical barriers that may limit market access for international developers. Identification will be done using secondary data and stakeholder interviews to identify barriers, such as permits, timelines, uncertain planning, land access, and local government approvals.
A9.3	Assess reform trajectories that may improve or restrict foreign developer access in the near term.	**VN:** Study the investment feasibility of VRE+BESS projects under the DPPA mechanism while analyzing the regulatory framework under Circular 62/2025, Circular 17/2025 and the roadmap for the development and liberalization of Vietnam energy market to assess investment opportunities as well as the short- and medium-term challenges for foreign investors participating in the RE sector in Vietnam. **PH:** The study will review relevant policy and regulatory developments that may influence foreign developer participation in the Philippine market, including evolving market design, investment-related reforms, and emerging policy directions relevant to storage and flexible resources. This may include consideration of reforms affecting market access, procurement structures, and ownership

No.	Action Items	Country Perspectives
		arrangements, as well as how future regulatory developments could strengthen or constrain investment conditions for international developers. **ID**: By assessing the existing policy and the latest long-, mid-, and short-term plans, and discussing with stakeholders, the reform trajectories can be defined. The existing and near-term procurement program can also be assessed to inform mid- and long-term planning. Not only in the Priority Investment List, but also in the procurement, local content requirements, and PLN procurement practices.
A9.4	Assess the Philippines' Green Energy Auction Program (GEAP) as a competitive procurement pathway for BESS — capacity offered, pricing outcomes, qualification requirements, timeline from award to commercial operation date or COD, and implications for VRE + BESS developers.	**PH:** The study will assess the Green Energy Auction Program (GEAP) as a potential competitive procurement pathway for VRE+BESS developers, including its role as an emerging route to market for flexible resources. This will include consideration of how GEAP's auction design, qualification requirements, procurement timelines, and pricing structures may influence bankability and project development. The assessment will also consider examples from existing GEAP rounds involving solar and wind and examine whether future auction structures could create opportunities for hybrid VRE+BESS or storage participation as part of evolving flexibility procurement mechanisms.
A9.5	Conduct a comparative assessment of foreign investment frameworks, identifying for each country: (i) the legal basis for foreign participation in RE and BESS, (ii) practical barriers that may limit effective market access (licensing timelines, local partnership requirements, land access constraints), and (iii) reform trajectories that may improve or restrict foreign developer access in the near term.	The comparative assessment is the analytical output of this activity and consolidates the country-level work from A9.1 (legal basis), A9.2 (practical barriers), and A9.3 (reform trajectories) into a structured cross-country comparison. Each country's foreign investment framework will be evaluated against a standardized parameter sets—for example: (i) legal openness — foreign ownership ceiling, sector-specific restrictions, conditional business-line treatment; (ii) licensing pathway — number of agencies involved, sequential vs. parallel approval structure, typical timeline from application to construction permit; (iii) partnership requirements — local content rules, joint-venture mandates, domestic equity thresholds where applicable; (iv) land and grid access — land use rights conversion process, grid connection queue dynamics, transmission capacity allocation

No.	Action Items	Country Perspectives
		transparency; (v) offtake counterparty — utility creditworthiness, sovereign-guarantee availability, contract enforceability track record; (vi) reform trajectory — direction and timing of near-term changes that may improve or restrict access in the 2026–2028 window. *<u>Output</u>*: a single comparative matrix classifying each country's foreign-developer entry conditions as (a) operational and accessible today, (b) legally open but constrained by implementation gaps, or (c) materially restricted with reform pending. This classification directly informs the international developer screening lens in Deliverable 3 by distinguishing markets where foreign capital can flow at scale today from those requiring early-mover risk acceptance or regulatory monitoring.

3.3.4 Revenue Stacking Assessment (A10)

No.	Action Items	Country Perspectives
A10.1	Identify which revenue streams can be monetized and combined under current and near-term conditions: energy arbitrage, ancillary/reserve services, contracted capacity or grid support services, and peak shaving/load management.	**VN:** Assess the existing revenue stream of VRE+BESS through mechanisms such as Decree 58/2025/ND-CP, Decision 988/QD-BCT while also analyze the structure of PPA and DPPA, payment mechanism and business model related to the provision of ancillary services aimed at enhancing power quality and improving the stability and reliability of the power system **PH:** The study will review potential monetization pathways relevant to VRE+BESS under current and near-term market conditions, including combinations of merchant, contracted, and grid support-related value streams. Examples to be considered may include emerging opportunities linked to the WESM, ancillary services arrangements, and practical reference points from existing BESS assets such as those within the San Miguel Corporation portfolio. **ID**: In the current condition, among energy arbitrage, ancillary/reserve services, contracted capacity or grid support services, and peak shaving/load management, the only monetization is the contracted capacity. The monetization of RE and BESS projects remains heavily reliant on

No.	Action Items	Country Perspectives
		bilateral contracts with PLN, primarily through capacity or energy-based payments under PPAs, which constitute the only bankable revenue stream. Others option will be assessed for the possibility of implementation in the near-term condition.
A10.2	Evaluate whether current regulations permit or prohibit stacking per country and identify where near-term regulatory changes may expand opportunities.	**VN:** Assess the existing monetization opportunities for conventional generation through the provision of one or multiple ancillary services and based on the development roadmap of Vietnam electricity market, propose the necessary conditions for the VRE+BESS model to participate in providing various types of ancillary services in Vietnam power system. **PH:** The study will review how existing market and regulatory arrangements influence the ability to combine value streams in practice, including areas where evolving market rules or reforms may affect future monetization opportunities. Particular attention will be given to developments relevant to reserve market implementation and potential expansion of flexibility-related compensation mechanisms. **ID**: To evaluate the current regulation, the first step is to review the current policies, frameworks, permits, and the barrier on the investment. Based on the existing condition, the opportunity to expand can be assessed.

3.3.5 Risk Assessment and Investment Readiness (A11)

No.	Action Items	Country Perspectives
A11.1	Identify preliminary country-specific commercial, regulatory, and operational risks based on initial research and team knowledge, to be validated through stakeholder consultation	**PH:** The study will undertake a preliminary review of investment conditions affecting VRE+BESS in the Philippines, including commercial, regulatory, and operational considerations relevant to market entry and project development. Examples to be considered may include risks associated with reserve market uncertainty, interconnection and transmission constraints, permitting complexity, and financing challenges affecting broader bankability beyond projects supported by strong sponsor balance sheets. Findings will be refined and validated through stakeholder consultation with developers, regulators, investors, and market

No.	Action Items	Country Perspectives
		operators to support a practical assessment of investment readiness. **ID**: Implementation of PV-BESS in Indonesia is growing, not only in large systems but also in small systems, such as the Dieselization Program, which replaces Diesel Power Plants in rural areas with PV+BESS. The secondary data will be used for the preliminary assessment, including commercial arrangements, regulations, and operational risks. The validation will be done through a stakeholders meeting
A11.2	Define the synthesis framework for producing country specific invest-ment readiness summaries. Specify relevant dimensions consolidated from A2 to A11.1 and an integration mechanism that ensures cross-country comparability.	The country-specific investment readiness summary is the synthesis output of Deliverable 3. A common synthesis framework will be applied identically to all three countries to ensure comparability, organized around five dimensions: (i) **cost competitiveness** — drawing on the Deliverable 2 LCOF outputs, classifying VRE+BESS as cost-competitive, conditionally competitive, or non-competitive against incumbent flexibility providers under the country's prevailing fuel, cost, and utilization assumptions; (ii) **market entry pathway availability** — drawing on A7, classifying each pathway as operational, regulated-but-untested, or under development; (iii) **revenue mechanism adequacy** — drawing on A8.3, applying the standardized parameter framework to each compensation mechanism identified; (iv) **foreign developer access** — drawing on A9.5, applying the standardized foreign-investment parameter framework; (v) **risk profile** — drawing on A11.1, applying a common commercial / regulatory / operational / credit risk taxonomy with consistent likelihood–impact rating conventions. *Output*: a one-page country table for each of VN, PH, and ID, showing the five-dimension rating, a top three risks summary, the principal market entry recommendation, and the regulatory developments to monitor in the 12 months following report submission. Cross-country comparability is enforced by the Team Leader's integration review (per Section 3.1 cross-country consistency principles), ensuring the same dimensions, rating conventions, and output structure are applied uniformly.

3.4 Standardized Cost, Financial, and Performance Assumptions

3.4.1 BESS-Specific Assumptions

This section consolidates the BESS-specific assumptions that will be in Deliverable 2: reference system configurations, capital and replacement cost trajectories, degradation parameters, round-trip efficiency, replacement schedules, economic lifetimes, and O&M.

The LCOF modelling will use a single chemistry and two duration configurations, consistent with NREL ATB conventions and the dominance of LFP in Southeast Asian stationary-storage procurement, as discussed above.

Table 9. Summary of BESS assumptions

Parameter	Assumption	Source
Reference chemistry	Lithium-ion LFP (lithium iron phosphate)	NREL ATB 2024[18]; BNEF 2025 Battery Price Survey[19]
Rationale for LFP reference	Primary stationary-storage chemistry globally from 2022 onward; cost trajectory and thermal tolerance advantages in tropical climates	NREL ATB 2024
Duration configurations	2-hour (aligned with reserves and ramping); 4-hour (aligned with short-duration peaking)	NREL ATB 2024
Operating assumption	Approximately 1 cycle per day (equivalent full cycle basis)	NREL ATB 2024
End-of-life threshold	70–80% of initial rated capacity (industry convention)	CATL datasheets[20]; BYD Energy Storage[21]; EVE Energy datasheets[22]
Sensitivity-only chemistries	Sodium-ion noted as cost-reduction pathway; not modelled as a separate technology	Project decision
Configurations assessed	Solar + BESS; Wind + BESS; Standalone BESS	See above

[18]NREL (2024). Utility-Scale Battery Storage, 2024 Annual Technology Baseline. National Renewable Energy Laboratory. https://atb.nrel.gov/electricity/2024/utility-scale_battery_storage

[19]BloombergNEF (December 2025). Lithium-Ion Battery Pack Prices Fall to $108 per Kilowatt-Hour: 2025 Battery Price Survey. https://about.bnef.com/insights/clean-transport/lithium-ion-battery-pack-prices-fall-to-108-per-kilowatt-hour-despite-rising-metal-prices-bloombergnef/

[20]CATL (Contemporary Amperex Technology Co., Ltd.). LFP energy storage product datasheets. https://www.catl.com/en/

[21]BYD Energy Storage. Utility-scale and industrial BESS product line. https://en.byd.com/energy/

[22]EVE Energy. Stationary energy storage LFP cell and system datasheets. https://www.evebattery.com/en/

Capital Cost — Reference Benchmark

Two distinct cost concepts are tracked separately to avoid confusion: (i) pack price, which is what BNEF reports annually and which covers cells + pack assembly only; and (ii) installed system cost, which includes inverter, balance-of-system, EPC, interconnection, and developer cost, and which is the basis for LCOF CAPEX inputs.

The trajectory applies the normalized decline multipliers from Cole et al. (2025) — the NREL projection — to the IRENA 2024 starting point. NREL's Moderate is assumed to be the Base Case. NREL's multipliers are expressed as 2024 = 1.000; Moderate 2035 = 0.701; Moderate 2050 = 0.533 (with equivalent values for Advanced and Conservative). SEA-specific installed cost is obtained by applying the country adjustment from the table above on top of these global-basis values.

Table 10. BESS Cost Reference

Parameter	Value	Year	Source
Reference installed system cost, utility-scale BESS (SEA basis)	$192/kWh	2024	IRENA RPGC 2024[23]
Prior-year reference (for trend context)	$273/kWh	2023	IRENA RPGC 2023[24]
US comparator — bottom-up 4-hour utility-scale BESS (includes Section 301 tariffs, US labor, US soft costs)	$334/kWh	2024	Cole et al. (2025), NREL[25]
Pack price — stationary storage segment	$70/kWh	2025	BNEF 2025 Battery Price Survey
Pack price — LFP chemistry, all segments (volume-weighted)	$81/kWh	2025	BNEF 2025 Battery Price Survey
Pack price — global average, all segments	$108/kWh (2025); $115/kWh (2024)	2024–2025	BNEF 2024 Battery Price Survey[26]; BNEF 2025 Battery Price Survey

[23]IRENA (2025). Renewable Power Generation Costs in 2024. International Renewable Energy Agency, Abu Dhabi. https://www.irena.org/Publications/2025/Jun/Renewable-Power-Generation-Costs-in-2024

[24]IRENA (2024). Renewable Power Generation Costs in 2023. International Renewable Energy Agency, Abu Dhabi. https://www.irena.org/Publications/2024/Sep/Renewable-Power-Generation-Costs-in-2023

[25]Cole, W., A. Karmakar, and W. Frazier (2025). Cost Projections for Utility-Scale Battery Storage: 2025 Update. NREL/TP-6A40-93281. https://docs.nrel.gov/docs/fy25osti/93281.pdf

[26]BloombergNEF (December 2024). Lithium-Ion Battery Pack Prices See Largest Drop Since 2017, Falling to $115 per Kilowatt-Hour. https://about.bnef.com/insights/commodities/lithium-ion-battery-pack-prices-see-largest-drop-since-2017-falling-to-115-per-kilowatt-hour-bloombergnef/

Table 11. BESS Price Scenarios

4-hour utility-scale installed cost (global basis)	Advanced	Base Case	Conservative
2024 (IRENA starting point)	$192/kWh	$192/kWh	$192/kWh
2030 (interpolated)	~$140/kWh	~$170/kWh	~$195/kWh
2035	$85/kWh	$135/kWh	$195/kWh
2040 (interpolated)	~$77/kWh	~$124/kWh	~$189/kWh
2050	$62/kWh	$102/kWh	$177/kWh

Global benchmarks (IRENA, NREL, BNEF) are predominantly derived from Chinese, US, and European market data. A multiplicative adjustment will need to be applied to account for Southeast Asian pricing. This adjustment could include factors such as indigenous BESS manufacturing; supply chain and logistics (shipping, import tariffs, inland transport); labor (installation wage differentials[27], specialized BESS workforce availability); financing and risk (country-specific WACC, currency hedging[28]); and environmental / site conditions (tropical thermal management, seismic design, grid interconnection). While we may not be able to fully separate out each driver, we will attempt to evaluate the adjustment factor for the LCOF calculations. The WACC differential is applied separately within the LCOF calculation to preserve cross-technology comparability (see below).

Replacement Schedule and Replacement Cost

Mid-life augmentation is modelled rather than full system replacement: additional battery modules are added to maintain rated capacity as cells fade, with the existing inverter, BOS, and civil works retained. Replacement cost is therefore materially lower than initial installed cost and must be priced at the year of augmentation rather than at the year of commissioning — otherwise the LCOF systematically overstates BESS whole-life cost.

Table 12. Parameters for determining BESS Replacement Costs and Timeline

Parameter	Approach
Augmentation scope	Battery modules, integration labor, BMS update, commissioning. Inverter/PCS, balance-of-system, civil works, interconnection, and developer costs are already in place and retained.
Cost decomposition	Augmentation = Pack × 0.80 + Integration × 0.20, priced at year of augmentation. Pack and integration components decline at different rates, reflecting NREL ATB's explicit finding that pack cost falls faster than other system components.
Pack trajectory (Moderate)	Today (2026): $70/kWh (BNEF 2025 stationary-storage pack); 2035: ~$40/kWh; 2050: ~$30/kWh. Consistent with BNEF's continued decline outlook (cell

[27] ILOSTAT. ILO Statistics on wages. International Labor Organization. https://ilostat.ilo.org/topics/wages/

[28] IEA (2024). World Energy Outlook 2024. International Energy Agency, Paris. https://www.iea.org/reports/world-energy-outlook-2024

Parameter	Approach
	overcapacity, LFP adoption, technology learning) and NREL's "pack falls faster" framing.
Integration trajectory (Moderate)	Today: ~$15/kWh; 2035: ~$12/kWh (~20% decline over the decade). Labor, BMS updates, and commissioning are cost-sticky relative to commodity pack pricing.
Price basis	Projected installed cost at year of augmentation (not at commissioning).
Replacement year — Solar + BESS	Year 12 (mid-life augmentation); ~1 cycle/day driving degradation
Replacement year — Wind + BESS	Year 12 (mid-life augmentation); comparable cycling profile to solar + BESS
Replacement year — Standalone BESS	Year 10; higher cycling intensity (arbitrage + reserves) → earlier augmentation
LCOF treatment	PV of augmentation cost at WACC, annualized via capital recovery factor or CRF over remaining economic lifetime

Augmentation cost is computed by decomposing into pack and integration components and projecting each forward separately — pack cost declines materially faster than integration cost over the project period, and a single blended decline factor would systematically overstate augmentation cost. The augmentation costs under the global basis are shown below.

BNEF's 2025 stationary-storage pack price is already $70/kWh today, and pack and integration at around $85/kWh. Since augmentation cost is dominated by pack cost plus a modest integration premium, a $50-54/kWh augmentation price in the mid-2030s is consistent with pack prices continuing their decline from today's level.

Why mid-life "augmentation" instead of full system replacement

Mid-life augmentation — periodic addition of battery modules to maintain rated capacity as cells fade — is the standard modelling convention for utility-scale Li-ion BESS economics, adopted in NREL ATB, IRENA ESVF, and BNEF LCOS benchmarks. The technical rationale is structural: the inverter/PCS, balance-of-system, civil works, interconnection, and developer/EPC costs incurred at commissioning retain substantial useful life when the cells reach end-of-warranty — typically 25–30 years for BoS and PCS versus 10–15 years for first-generation cells. Full system replacement would discard equipment with material residual life and is not industry practice.

A practical caveat, however, applies. The global utility-scale Li-ion BESS fleet remains young — the earliest large deployments (Hornsdale 2017, AES Notrees 2012) are only now approaching their first augmentation cycles, and verified post-augmentation cost data at scale is not yet publicly available. The methodology is therefore validated against forward pricing in EPC long-term service agreements and pack-price trajectories rather than against realized augmentation outcomes.

A second consideration concerns the technology that will actually be available for augmentation in the mid-2030s. The methodology implicitly assumes like-for-like LFP-to-LFP replacement, but this is unlikely to hold over a decade. Sodium-ion is already commercializing and higher-performing LFP variants — LMFP / manganese-doped chemistries, silicon-anode cells — are entering commercial production. The replacement product in 2036–2038 is therefore likely to be either a next-generation LFP variant or a different chemistry altogether, with two implications: (i) the pack $/kWh nameplate price may not track the trajectory derived from current LFP pricing, and could land higher if the higher-performance option commands a premium; and (ii) the integration cost share may rise above the assumed 20% because BMS, thermal management, and possibly inverter tuning will need adjustment for the new chemistry. Still, the core methodological principle — that BoS, PCS, civil works, and interconnection are retained and only the cells are replaced — remains valid; the variability sits in the unit cost of the replaced cells and the proportion of integration work required. A partial offset is that a higher-performing replacement may deliver longer cycle life or higher RTE, lowering $/cycle or $/MWh-throughput even where $/kWh nameplate is higher. The A5 sensitivity envelope (e.g., 30–50% above Moderate base case) will be structured to absorb this technology-evolution uncertainty alongside the empirical-validation gap discussed above; if EPC contractor proposals collected during Deliverable 2 indicate a wider plausible range, the envelope will be widened accordingly.

Economic Life of BESS

The economic life of BESS is shown in the financial assumptions below.

Table 13. Financial Assumptions on Cost of BESS Replacement

Configuration (augmentation yr)	Advanced	Base Case	Conservative
Today reference (2026)	~$85/kWh	~$85/kWh	~$85/kWh
Standalone BESS — Year 10 (2036)	~$35/kWh	~$54/kWh	~$78/kWh
Solar + BESS — Year 12 (2038)	~$32/kWh	~$50/kWh	~$73/kWh
Wind + BESS — Year 12 (2038)	~$32/kWh	~$50/kWh	~$73/kWh

Operations and Maintenance Costs

The O&M costs are estimated from IRENA and NREL sources. However, the team will check their validity in SEA context during Deliverable 2.

Table 14. BESS O&M Cost Assumptions

Parameter	Value range	Source
Fixed O&M — VRE + BESS (inclusive of both assets)	$20–28/kW-yr	IRENA RPGC 2024; NREL ATB 2024
Fixed O&M — standalone BESS	c. $10/kW-yr	NREL ATB 2024
Variable O&M (non-fuel)	$2.0–3.0/MWh	IRENA RPGC 2024; NREL ATB 2024

Note that BESS O&M is small relative to CAPEX and to thermal-plant O&M — typically 3–6% of annualized LCOF versus 40–70% for gas or diesel peakers — but the cost structure differs in ways that matter for the cross-technology comparison and need to be captured explicitly.

Fixed O&M covers scheduled preventive maintenance, Heating, Ventilation, and Air Conditioning (HVAC) and thermal-management servicing, BMS software updates, insurance, land lease, and site security. For standalone BESS, the reference value is around $10/kW-year. For co-located VRE + BESS, the value is higher ($20–28/kW-year) because it bundles O&M for both the renewable asset and the storage system, and the shared costs — grid interconnection, SCADA, site management — are allocated to the combined project rather than to the BESS alone. In Southeast Asian tropical climates, fixed O&M is likely at the upper end of the published range because thermal management runs harder year-round; this will be a sensitivity input.

Preventive Maintenance activities are generally checking on the following main components:

- Battery Management System, BMS: manages the batteries particularly the voltage, current, temperature to ensure safety and longevity.

- Safety Monitoring Unit, SMU: is a dedicated subsystem (One SMU per battery) that continuously supervises the safety, protection, and fault detection functions of the battery and its associated equipment. It works alongside the Battery Management System (BMS) but focuses specifically on hazard prevention and emergency response.

- Fire Suppression System, FSS: it is a critical safety layer designed to detect, contain, and extinguish fires or thermal runaway events in lithium-ion battery installations. It works in tandem with the Safety Monitoring Unit (SMU) and Battery Management System (BMS) to protect both equipment and personnel. It generally uses inert gas like N_2 to displace oxygen.

- Heating, Ventilation and Air Conditioning, HVAC: it is generally used as a cooling system in a Battery Energy Storage System (BESS) to ensure batteries, auxiliary equipment remain within safe temperature operating limits. It's more sophisticated than simple air cooling because it integrates temperature, humidity, and airflow control across the entire container or building housing the BESS.

- Control System: it is the heart of the BESS to control and monitor parameters of each major and minor components of BESS to ensure safe operation and provides all connectivity to central control room via Modbus RTU and Modbus TCP/IP

Variable O&M ($2–3/MWh) covers the throughput-linked costs that track with dispatch intensity: inverter wear, round-trip efficiency losses beyond the beginning-of-life assumption, ancillary consumption not captured in parasitic-load derating, and incremental BMS load from higher cycling. Variable O&M is kept deliberately separate from degradation and augmentation to avoid double-counting.

Round-Trip Efficiency

Round-trip efficiency (RTE) is the ratio of useful energy output to useful energy input over a full charge-discharge cycle. RTE drives the energy-cost penalty in the peaking LCOF and enters arbitrage economics in the revenue-stacking analysis. The reference value depends on where the measurement boundary is drawn — at the battery terminals (DC-side) or at the grid interconnection (AC-to-AC) and on the inverter topology of the specific configuration. The LCOF uses AC-to-AC RTE because that is what a grid operator, market settlement, or PPA offtaker sees.

Table 15. Round Trip Efficiency (RTE) Assumptions

Configuration / parameter	AC-to-AC RTE	Source / note
Standalone BESS (grid-charged)	87% (range 85–88%)	NREL ATB 2024 — *AC→DC→storage→DC→AC. NREL 85% retained as Conservative scenario.*
Wind + BESS	87% (range 85–88%)	NREL ATB 2024 — *same conversion topology as standalone for the BESS portion.*
Solar + BESS, DC-coupled (reference)	91% (range 89–92%)	NREL ATB 2024 — *shared bidirectional inverter; charging path skips one AC/DC conversion.*
Solar + BESS, AC-coupled (alternative)	87% (range 85–88%)	NREL ATB 2024 — *separate inverters; reverts to standalone-equivalent RTE.*
Battery / DC-side RTE (reference only)	93% (range 92–95%)	CATL datasheets; BYD Energy Storage; EVE Energy datasheets — *cell + BMS losses only; used for methodology cross-checking, not directly in LCOF.*
Auxiliary / parasitic load (cooling, BMS)	2–4% of rated MW	CATL datasheets; BYD Energy Storage; EVE Energy datasheets — *tropical climates at upper end; separate from RTE figures above.*
RTE end-of-life	2–3 percentage points below BoL	CATL datasheets; BYD Energy Storage; EVE Energy datasheets — *declines alongside capacity degradation; LCOF uses time-weighted average.*
Tropical climate parasitic penalty	1–2 percentage points offset against modern-equipment gains	Flagged for primary research — higher cooling load partially offsets Advanced-scenario RTE improvements.

The key configuration distinction is between DC-coupled solar + BESS (shared bidirectional inverter — charging path skips one AC/DC conversion, ~3 pp efficiency gain) and all other configurations (standalone BESS, wind + BESS, AC-coupled solar + BESS), which follow the standard AC→DC→storage→DC→AC path.

<u>Degradation</u>

Degradation is modelled with two additive components — cycle fade (function of equivalent full cycles) and calendar fade (function of time) — plus modifiers for depth-of-discharge, C-rate, and operating temperature. End-of-life is defined by two operational triggers rather than a single threshold: 80% retention triggers mid-life augmentation, 70% retention triggers end-of-life decision.

Given that BESS in this region is a new technology, with limited time of deployment, we will rely on interviews with end-users and battery manufacturers to cross-check the information in the assumptions below.

Table 16. Battery Degradation Assumptions

Parameter	Reference value	Source / note
Cycle degradation (current-generation LFP)	~0.002% per equivalent full cycle → ~10,000 cycles to 80% retention	CATL datasheets; BYD Energy Storage; EVE Energy datasheets
Calendar degradation (reference average)	~1.5%/year average over project life	NREL ATB 2024; CATL datasheets
Dominant fade driver by configuration	Solar + BESS / Wind + BESS: calendar-dominated. Standalone BESS: cycle + calendar roughly equal.	At ~1 cycle/day, 12-year cycle count is ~4,400 — well below cycle-life limit. Augmentation timing is driven by calendar fade for low-cycling configurations.
Depth-of-discharge (DoD) — reference	95% usable DoD (2.5% reserve at each end)	CATL datasheets; IRENA ESVF (2020)[29] — *Sensitivity case: 80% usable DoD reduces degradation by ~1.2× but requires ~18% more installed capacity for same usable output.*
C-rate impact	2-hour (0.5C) and 4-hour (0.25C) reference configurations are below the range where C-rate penalties are material.	CATL datasheets — *Sensitivity: sustained 1C operation reduces cycle life by ~15–25%.*
Temperature impact (Arrhenius)	Calendar fade approximately doubles per 10°C above 25°C reference	CATL datasheets; BYD Energy Storage; EVE Energy datasheets — *Well-known relationship. SEA base: 35°C average cell temperature → ~2× multiplier. Conservative: 40°C (poorly cooled outer-island) → ~2.8×.*
Tropical derating — SEA calibration	Country-by-country operating temperature calibration required	Needs cell-level operating temperature assumptions given each country's ambient and cooling design.
End-of-life — augmentation trigger	80% capacity retention	NREL ATB 2024.
End-of-life — repowering trigger	70% capacity retention	NREL ATB 2024.

[29] IRENA (2020). Electricity Storage Valuation Framework: Assessing system value and ensuring project viability. International Renewable Energy Agency, Abu Dhabi. https://www.irena.org/Publications/2020/Mar/Electricity-Storage-Valuation-Framework-2020

3.4.2 Conventional Technology Assumptions

Below, we have captured some initial information about the Philippines and Vietnamese conventional technologies. These are high level, initial assumptions that will be reviewed and cross-checked during the main part of the study.

Philippines:

Table 17. Initial information on Philippine conventional technologies

Technology	Heat Rate in kJ/kWh	Ramp Rate in %/min	Start up time	Min. stable generation in % of capacity	Fuel Cost Range in USD/MMBTU	Notes
Coal (Subcritical)	9,000-10,500	1-2	4-8 hours (cold) 1-2 hours (warm)	40-50%	3-5 (imported coal)	High inflexibility base load
Diesel generators, SPUG	N/A	10-20	5-15 min	10-20%	20-25 USD/MMBtu	Natural flexibility, seasonal Limits. Subsidized by government
CCGT (Combined cycle, OECD)	6,500-7,500	4-6	1-3 hours	40-50%	6-10	Efficient, flexible mid-merit. Operated as Base load

Sources: Enerdata World Power Plant Database (global operational parameters), World Resources Institute Global Power Plant Database, Thunder Said Energy dataset on ramp rates and start-up times, Wärtsilä technical notes on dispatchability and minimum stable load. Central Electricity Authority (India) operational performance report

Vietnam:

Vietnam's conventional flexibility assets include four technology families relevant to this study:

- Coal-fired thermal power: dominant baseload technology; mainly supercritical post since 2015.
- Combined cycle gas turbines (CCGT): southern grid; domestic gas supply declining, LNG transition underway.
- Large reservoir hydropower: highest-value flexibility asset due to zero fuel cost and fast response but constrained by hydrology.

- Gas ICE engines: emerging fast-response peaking asset; most direct incumbent comparator to BESS for short-duration flexibility services; the first project in Vietnam is implementing investment procedures.

3.4.3 Financial Parameters

The LCOF framework requires a consistent set of financial parameters to ensure cross-technology and cross-country comparability. This section defines initial set of the base case values for each parameter, the rationale for country differentiation, and the sensitivity ranges to be tested. All parameters will be applied uniformly across the nine assessed technologies within each country, so that cost differences in the LCOF output reflect technology fundamentals and local market conditions rather than arbitrary financing assumptions.

Weighted Average Cost of Capital (WACC)

The WACC is the single most consequential financial parameter in the LCOF calculation because flexibility technologies are capital-intensive and the LCOF is highly sensitive to discount rate assumptions. Base case values are drawn from the IEA Cost of Capital Observatory (2025 update),[30] which surveyed investors, lenders, and developers active in each market. The median WACC (nominal, post-tax, local currency) for solar PV reported by survey respondents was 9.4% in Indonesia, 9.0% in Vietnam, and 8.0% in the Philippines in 2024. BESS-specific financing costs are marginally higher due to technology novelty, but the Observatory found that WACCs for utility-scale batteries were higher than or equal to those for solar PV.

The base case WACC values adopted for the LCOF analysis are expressed in real, pre-tax terms to enable cross-country comparison on a consistent basis.

While we will conduct a more detailed assessment during the development of the second report, below are our current estimates for WACC, converting from the IEA's nominal post-tax figures using country-specific inflation and tax rates yield the following:

Vietnam: 7.0% real pre-tax (base case). The IEA median of 9.0% nominal corresponds to approximately 5.5–6.0% real after adjusting for Vietnam's 3.0–3.5% inflation target, then grossed up for corporate tax. The 7.0% base case reflects improving regulatory clarity following the Revised PDP-8 and DPPA framework, and reduced lending costs following rate cuts by the State Bank of Vietnam in 2024.

Philippines: 6.5% real pre-tax (base case). The lowest of the three countries, consistent with the Philippines' more mature RE investment environment, competitive WESM market, and GEAP auction track record. The IEA survey reported 8.0% nominal WACC for solar PV in the Philippines, below the other two markets.

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[30] IEA Cost of Capital Observatory (2025 update), available at iea.org/reports/cost-of-capital-observatory. This is the primary WACC source — it is the only publicly available, survey-based dataset that covers all three target countries for RE and storage technologies.

Indonesia: 8.0% real pre-tax (base case). The highest of the three, reflecting PLN counterparty risk, regulatory uncertainty around standalone BESS procurement, and the sovereign risk premium. Indonesia's 9.4% nominal median was the highest of the three SE Asian markets surveyed. For outer island projects, a further +1.0pp uplift (9.0% real) is applied to reflect additional infrastructure risk and limited grid connectivity.

Sensitivity range: ±2.0 percentage points for all countries. This captures the range between concessional DFI financing (lower bound) and merchant/uncontracted project risk (upper bound).

Project Economic Lifetime

Project lifetime determines the annualization period for capital costs and directly affects the capital recovery factor. Values are technology-specific, not country-specific, as asset physical life does not vary by geography. The convention follows NREL ATB and IRENA standards:

Table 18. Technology Lifetime Assumptions

Technology	Project Lifetime (Years)	BESS Augmentation Timing
Diesel	25	-
CCGT	30	-
OCGT	25	-
Gas engines	25	-
Hydropower	50	-
Coal	30	-
Solar + BESS	25	Year 12
Wind + BESS	25	Year 12
Standalone BESS	20	Year 10

The shorter standalone BESS lifetime reflects higher cycling intensity and the absence of a co-located generation asset that extends overall project economics. BESS augmentation cost and timing are modelled separately in the degradation parameters.

Inflation Assumptions

All LCOF calculations are conducted in real (constant 2025 USD) terms to strip out inflationary distortion and enable cross-country comparison. Country-specific inflation rates are used only for converting nominal financial data (interest rates, tariffs, fuel price escalation) into real terms.[31]

Vietnam: 3.5% per annum. Based on the State Bank of Vietnam's medium-term inflation target of 3.0–4.0% and the IMF World Economic Outlook April 2026 forecast for Vietnam CPI.

Philippines: 3.5% per annum. Aligned with the Bangko Sentral ng Pilipinas (BSP) inflation target of 2.0–4.0% and the IMF WEO forecast.

[31] Source: IMF World Economic Outlook (latest available edition); central bank published inflation targets (SBV, BSP, BI). These values are used to deflate nominal interest rates and tariff escalation clauses, not as direct LCOF inputs.

Indonesia: 3.0% per annum. Aligned with Bank Indonesia's inflation target of 1.5–3.5% and the IMF WEO forecast. Indonesia has achieved relatively stable inflation in recent years.

Exchange Rate Convention

The LCOF will be expressed in constant 2025 USD throughout the analysis for three reasons: (i) the target audience is international private sector investors who think in USD terms; (ii) BESS and VRE capital costs are USD-denominated (imported equipment); and (iii) cross-country comparability requires a common currency.

The exchange rate convention will be as follows. Capital costs (CAPEX, BESS system costs) are entered directly in USD as they are already denominated in USD from global benchmarks. Fuel costs are converted to USD using the average exchange rate for the 12 months preceding the analysis base date, sourced from central bank published rates. Local-currency operating costs (domestic labor, O&M components) are converted at the same reference exchange rate. No exchange rate escalation or depreciation forecast will be built into the LCOF calculation — currency risk is addressed qualitatively in Deliverable 3 as a market entry risk factor.

Reference exchange rates (to be updated at time of Deliverable 2 analysis):

- VND/USD — sourced from SBV daily reference rate (12-month average).
- PHP/USD — sourced from BSP reference rate (12-month average).
- IDR/USD — sourced from Bank Indonesia JISDOR rate (12-month average).

Tax and Depreciation

The base case LCOF will use pre-tax WACC and does not model country-specific tax or depreciation schedules, consistent with the screening-level nature of the analysis. This is a deliberate simplification: country-specific tax treatment (corporate income tax rates, investment tax credits, accelerated depreciation for RE/storage assets, import duty exemptions) materially affects project-level IRR but would introduce complexity disproportionate to a comparative screening tool.

The effect of tax incentives will be noted qualitatively for each country in Deliverable 3, where it informs the investment readiness assessment. Where specific incentive programs are known to materially alter BESS economics (e.g., the Philippines' CREATE law, Vietnam's investment

Table 19. Summary Table of Financing Assumptions:

Parameter	Vietnam	Philippines	Indonesia	Source
WACC (real, pre-tax) — base case	7.0%	6.5%	8.0% (Java-Bali) 9.0% (outer islands)	IEA Cost of Capital Observatory 2025; adjusted by NIRAS team
WACC sensitivity range	5.0–9.0%	4.5–8.5%	6.0–10.0%	±2pp
Inflation assumption	3.5% p.a.	3.5% p.a.	3.0% p.a.	IMF WEO; central bank targets

Parameter	Vietnam	Philippines	Indonesia	Source
Currency	Constant 2025 USD	Constant 2025 USD	Constant 2025 USD	—
FX reference rate	SBV 12-mo avg	BSP 12-mo avg	BI JISDOR 12-mo avg	Central bank published rates
Tax treatment	Pre-tax (screening level)	Pre-tax (screening level)	Pre-tax (screening level)	Qualitative in Deliverable 3
Project lifetime	Technology-specific (20–50 years)	Technology-specific (20–50 years)	Technology-specific (20–50 years)	NREL ATB; IRENA

3.4.3.1 Assumption Validation Process

Assumption validation is a continuous, structured process over the project timeframe rather than a one-time exercise. In this Inception Report, we have presented an initial nearly full set of proposed analytical assumptions to ETP. All assumptions will be put in a central assumptions book (excel file) and shared with ETP, serving as the initial reference point across the three countries.

During Milestone 2, assumptions will be stress-tested through structured sensitivity analysis across cost, performance, and regulatory scenarios to identify the parameters that most strongly influence competitiveness thresholds, with results documented and flagged for ETP discussion.

Throughout the engagement, an Issues Log captures emerging data, stakeholder feedback, and regulatory developments that may warrant revising working assumptions; material updates are surfaced in biweekly coordination and at each milestone review, where ETP provides external validation before assumptions are locked for the subsequent phase.

This closed-loop process ensures that the final analysis rests on assumptions that are transparent, defensible, and reflective of conditions at the time of delivery.

3.5 Data Sourcing Strategy

The classification of data availability, quality, and access constraints in this study is based on a qualitative assessment of the accessibility, reliability, and transparency of data sources in each country’s power sector.

Data availability is considered high when information is publicly accessible, regularly updated, and provided through official publications; medium when data is partially available, aggregated, or requires compilation from multiple sources; and low when data is not publicly disclosed and can only be obtained through direct stakeholder engagement or indirect estimation.

Data quality is categorized as high when sourced from official, consistent datasets suitable for quantitative analysis with minimal assumptions; medium when data is generally reliable but may contain gaps or inconsistencies or require adjustments; and low when data is fragmented, outdated, or heavily dependent on proxies and assumptions.

Access constraints refer to the level of effort required to obtain the data, ranging from low when data is readily accessible in the public domain, medium when access requires additional effort, such as registration, cross-referencing sources, or informal requests, and high when data is restricted, confidential, or only available through formal engagement with institutions such as utilities or project developers.

3.5.1 International Benchmark Sources

BESS Data Sourcing Strategy
The project draws on a structured inventory of BESS-specific data sources spanning system cost and pricing, performance and degradation, operational parameters, and financing. Primary cost benchmarks are sourced from NREL's Annual Technology Baseline, IRENA's Renewable Power Generation Costs database, the IEA World Energy Outlook technology assumptions annex, and BNEF's semi-annual LCOS Benchmark — cross-referenced to control for differences in cost boundary definitions across sources. Degradation and performance data combines manufacturer specifications (CATL, BYD, EVE datasheets), NREL and EPRI published test data, and academic parametric models. Each data source has been assessed for public availability, quality, and access constraints. While many of the core benchmarks are publicly accessible; the principal subscription dependency is BNEF for pack-level pricing and cost trajectories. Since BNEF information is not readily available, we will seek information from other stakeholders or rely on our own interviews with EPC contractors and BESS manufacturers. The other significant data gap identified is tropical climate performance — temperature derating factors for capacity, round-trip efficiency, and calendar life under Southeast Asian operating conditions (30–40°C ambient, high humidity) are poorly characterized in published literature and will require direct manufacturer engagement by the Energy Storage Expert and the Team Leader.

Regional Cost Adjustment Methodology
Global BESS cost benchmarks are predominantly derived from US, European, and Chinese market data and cannot be applied directly to Southeast Asia without adjustment. The project applies a multiplicative adjustment framework covering eleven factors organized into four categories: supply chain and logistics (international shipping, import tariffs, inland transport), labor and installation (local construction wage differentials, specialized BESS workforce availability), financing and risk premium (country-specific WACC, currency hedging), and environmental and site conditions (tropical thermal management, seismic design, grid connection). Each factor has been assessed for data availability and quality. Four factors rely on publicly accessible, relatively high-quality data (customs tariff schedules, ILO wage indices, national building codes, IEA/IRENA financing assumptions); three require subscription or developer interview data; and three — specialized labor, tropical cooling, and grid connection costs — are flagged as requiring primary research during Deliverable 2.

The illustrative composite CAPEX adjustment could range from +5–10% for Vietnam to +8–15% for the Philippines and +12–20% for outer island Indonesia relative to global benchmarks, with labor cost savings partially offsetting logistics and tariff increases. However, these could vary, especially if BESS systems are being manufactured in Vietnam, Indonesia, and Philippines. This is an area to evaluate further during the Deliverable 2 time frame.

The WACC differential is applied separately within the LCOF calculation to maintain cross-technology comparability, and currency hedging will need to be addressed in the Deliverable 3 revenue analysis.

Table 20. BESS-Specific Data Sources — ETP BESS Flexibility Assessment

No.	Data Category	Key Sources	How Data is Obtained	Availability	Data Quality	Access Constraints
	BESS SYSTEM COST & PRICING					
1	**BESS pack price (cell + module)**	BNEF Energy Storage Prices Survey (annual); BNEF Battery Price Index (quarterly); CATL / BYD / EVE published price lists	BNEF: subscription database, annual survey of 200+ manufacturers and developers. Manufacturer lists: direct engagement or published investor presentations. Cross-reference multiple sources.	**Subscription**	High	BNEF requires institutional subscription (~$25k+/yr). Manufacturer lists may be commercially sensitive. If BNEF information is not readily available, we will seek information from other stakeholders or rely on our own interviews with EPC contractors and BESS manufacturers.
2	**Balance of system (BOS) cost**	NREL Annual Technology Baseline (ATB) — Storage section; IRENA Electricity Storage Valuation Framework (ESVF); Wood Mackenzie / IHS Markit storage reports	NREL ATB: publicly downloadable annual dataset with BOS cost breakdowns (inverter, thermal management, containers, wiring, site prep). IRENA ESVF: public reports with installed system cost ranges.	**Public / Open**	High	NREL ATB is US-centric; BOS costs require regional adjustment (see Sheet 2). IRENA ESVF provides global ranges but limited SE Asia granularity.
3	**EPC & installation cost**	BNEF 2H LCOS Benchmark; IRENA Renewable Power Generation Costs (annual); developer/EPC interviews; ADB/World Bank project cost data	BNEF LCOS: subscription benchmark with EPC cost component. IRENA: public annual report with regional installed cost ranges. ADB/WB: project appraisal documents for approved BESS projects in SE Asia (public post-approval).	**Mixed**	Medium	EPC costs are the most regionally variable component. Limited publicly available SE Asia BESS EPC benchmarks. Developer interviews needed to validate.

No.	Data Category	Key Sources	How Data is Obtained	Availability	Data Quality	Access Constraints
4	**Total installed system cost (all-in $/kWh)**	BNEF LCOS Benchmark; NREL ATB (Storage); IRENA Renewable Power Generation Costs; IEA World Energy Outlook — technology assumptions annex	Cross-reference all four sources. BNEF and NREL provide component-level breakdowns; IRENA and IEA provide all-in system cost ranges. Use latest available edition (2025/2026 vintages).	**Mixed**	High	Range across sources can be 15–25% due to different cost boundary definitions. Document what each source includes/excludes (e.g., grid connection, land, contingency). ETP/UNOPS may have BNEF access via institutional affiliation. TO BE CONFIRMED
5	**BESS cost projection trajectories**	BNEF New Energy Outlook (long-term); IRENA World Energy Transitions Outlook; IEA WEO Stated Policies / Net Zero scenarios; NREL ATB (Low/Mid/High trajectories)	Each source publishes annual or biennial cost trajectories to 2030/2050. NREL ATB provides three scenarios (Conservative/Moderate/Advanced). Use for sensitivity analysis and competitiveness threshold timing.	**Public / Open**	Medium-High	Trajectories have diverged significantly across sources in recent years. Document which scenario from which source is used. Learning rate assumptions vary by 5–10pp.
	PERFORMANCE & DEGRADATION					
6	**Round-trip efficiency (RTE)**	NREL ATB (Storage); manufacturer datasheets (CATL, BYD, Samsung SDI, EVE); Sandia National Labs ESS database; academic meta-studies	NREL ATB: published RTE by chemistry and year. Manufacturer datasheets: published specs (typically DC-DC; convert to AC-AC by applying inverter efficiency). Sandia: public database of operational BESS with measured RTE.	**Public / Open**	Medium-High	DC-DC vs. AC-AC distinction is critical — datasheet RTE (94–96% DC-DC) overstates system RTE (85–90% AC-AC). Tropical temperature effects further reduce RTE; limited SE Asia operating data.
7	**Cycle life & calendar life**	Manufacturer warranty terms (CATL, BYD, EVE — published or via supplier	Manufacturer warranties: guaranteed cycles to capacity threshold (typically 70–80%). NREL: published degradation	**Mixed**	Medium-High	Warranty terms are commercial documents — may require NDA for detailed data. Published

No.	Data Category	Key Sources	How Data is Obtained	Availability	Data Quality	Access Constraints
		engagement); NREL cycle life studies; DNV battery performance scorecard; academic degradation models (Xu et al., Schmalstieg et al.)	studies under various cycling regimes. DNV: independent testing data. Academic: parametric degradation models for LFP.			warranty summaries available from investor presentations. Lab-tested cycle life often exceeds real-world.
8	**Degradation rate (calendar + cycling)**	NREL Long-Duration Energy Storage and Battery Degradation studies; EPRI Battery Energy Storage Test Lab data; academic literature (Nature Energy, Journal of Power Sources); BNEF degradation benchmarks	NREL and EPRI: public technical reports with degradation curves by chemistry, DoD, C-rate, and temperature. Academic papers: parametric models validated against field data. BNEF: subscription benchmarks.	**Mixed**	Medium	Degradation data is chemistry-specific and evolving rapidly. LFP characteristics differ from NMC. Temperature-dependent degradation for tropical climates (30–40°C ambient) is sparse — key data gap.
9	**Temperature derating (tropical climate)**	Manufacturer thermal management specs; IEC 62619 / UL 9540A test data; CSIRO Australia tropical BESS data; limited SE Asia project operating data (Philippines BESS projects)	Manufacturer specs: published thermal operating range and derating curves. IEC/UL: testing standards with temperature profiles. CSIRO: published Australian tropical data (nearest climate analog). SE Asia project data: via developer engagement.	**Restricted**	Low-Medium	Major data gap. Most BESS performance data is from temperate climates. Tropical derating factors (capacity, RTE, calendar life) are poorly characterized. Direct engagement with manufacturers is necessary.
10	**Depth of discharge (DoD) impact**	Manufacturer DoD-cycle life curves (CATL, BYD datasheets); NREL ATB parametric assumptions;	Manufacturer curves: published or supplied via engagement showing cycle life vs. DoD. NREL: standardized DoD assumptions. Academic models: semi-	**Mixed**	Medium-High	DoD operating strategy significantly affects lifetime economics. LCOF estimates will use representative DoD profiles for each flexibility service (deeper

No.	Data Category	Key Sources	How Data is Obtained	Availability	Data Quality	Access Constraints
		academic degradation models; EPRI test data	empirical DoD-degradation relationships.			for peaking, shallower for frequency response).
	OPERATIONAL PARAMETERS					
11	**Response time & ramp rate**	Manufacturer specifications; NERC/IEEE grid code compliance test data; NGCP (Philippines) BESS commissioning test results; operational BESS project data (Hornsdale, etc.)	Manufacturer specs: published response time and ramp rate. Grid code compliance: published test results from commissioned projects. NGCP: via Philippines Power Systems Specialist.	**Mixed**	High	BESS response/ramp capability is well-characterized. Key question is not capability (millisecond response is proven) but grid code requirements determining which services BESS qualifies for in each country.
12	**Auxiliary / parasitic load (BMS, HVAC, cooling)**	NREL ATB (auxiliary consumption assumptions); manufacturer thermal management specs; EPRI BESS test data; project-level metering data	NREL: published parasitic load as % of rated capacity. Manufacturer: HVAC and BMS power consumption specs. EPRI: measured auxiliary loads from test installations.	**Mixed**	Medium	Tropical auxiliary load (3–8% of capacity) materially higher than temperate benchmarks (1–3%). Limited project-level data from SE Asia installations.
13	**SOC management (operating window)**	Manufacturer operating guidelines; NREL battery dispatch studies; IRENA ESVF case studies (Hornsdale, UK Enhanced Frequency Response); academic optimal dispatch literature	Manufacturer guidelines: recommended SOC window (typically 10–90% for LFP). NREL/IRENA: published dispatch strategies from operational projects. Academic: optimal SOC management models.	**Public / Open**	Medium-High	SOC strategy is operational choice, not fixed parameter. Different flexibility services need different SOC management — reserve needs high SOC headroom; peaking needs full charge at peak onset.
	FINANCING & INVESTMENT					
14	**BESS financing cost**	IEA WEO country-specific financing assumptions;	IEA WEO: published country financing assumptions by technology. IRENA:	**Mixed**	Medium	BESS-specific financing costs are higher than mature RE

No.	Data Category	Key Sources	How Data is Obtained	Availability	Data Quality	Access Constraints
	WACC by country	IRENA Renewable Energy Finance report; ADB private sector operations data; Climatescope (BNEF); SE Asia developer/lender interviews	global RE financing cost database. ADB: project financing terms from approved BESS projects. Climatescope: country risk indicators.			(solar/wind) due to technology risk perception and limited SE Asia track record. Lender interviews essential to validate.
15	**Insurance & warranty costs**	BNEF LCOS (insurance component); Marsh / Aon renewable energy insurance reports; developer commercial data; manufacturer warranty term sheets	BNEF: insurance as % of CAPEX in LCOS benchmark. Insurance brokers: published RE/storage insurance market reports. Developer data: via ESE specialist network. Warranty: manufacturer engagement.	**Restricted**	Low-Medium	Insurance costs evolving rapidly (fire risk driving premium increases). Limited SE Asia-specific data. Warranty cost embedded in system price — Separating warranty from system price requires manufacturer engagement.
16	**Project IRR / return benchmarks**	BNEF Clean Energy Investment Trends; IRENA/CPI Global Landscape of Climate Finance; Mercom Capital BESS deal tracker; ADB / IFC project hurdle rates	BNEF: subscription tracker of BESS investment returns. IRENA/CPI: published landscape reports. Mercom: deal-level data. ADB/IFC: published hurdle rates for SE Asia clean energy.	**Subscription**	Medium	IRR benchmarks are market-sensitive. SE Asia BESS return data is thin due to limited deployed capacity. We will use a reasonableness check on LCOF results.

Table 21. Regional Cost Adjustment Methodology — BESS for Southeast Asia

No.	Adjustment Factor	Applies To	Methodology	Indicative Range	Availability	Data Quality	Key Data Sources	Country-Specific Notes
	SUPPLY CHAIN & LOGISTICS							
1	**International shipping & freight**	BESS pack, BOS components	Estimate CIF vs. FOB differential using container freight indices (Drewry, Freightos) for China–SE Asia routes. BESS ships as containerized cargo (pre-assembled or palletized modules).	**+3% to +8% of FOB price**	**Public (headline); Subscription (routes)**	Medium	Drewry World Container Index; Freightos Baltic Index; freight forwarder quotes; ADB trade cost database	VN: short sea from China, lower cost. PH: moderate. ID: Java proximate; outer islands +2–5% additional.
2	**Import duties & tariffs**	BESS pack, BOS, inverters	Country-specific duty rates by HS code (8507.60 Li-ion; 8504.40 inverters). Check RE/storage duty exemptions. Apply VAT/GST. Verify HS classification (cell vs. module vs. system).	**0% to +15% (country-dependent)**	**Public / Open**	High	National customs tariff schedules (VN MoF; PH Tariff Commission; ID DGCE); Big 4 tax guides	VN: 0–5% under RE provisions. PH: 0% under CREATE law (need to verify BESS eligibility). ID: 0–10% MFN; potential exemptions.

No.	Adjustment Factor	Applies To	Methodology	Indicative Range	Availability	Data Quality	Key Data Sources	Country-Specific Notes
3	**Inland transport & last-mile logistics**	Complete BESS system	Port-to-site transport cost by distance, road quality, site access. Use country logistics indices. Indonesia outer islands: include inter-island shipping.	**+1% to +5% (site-dependent)**	**Public / Open**	Medium	World Bank LPI; country transport surveys; developer project data	VN: good roads, lower cost. PH: variable — Luzon OK, Visayas/Mindanao higher. ID: Java low; outer islands significantly higher.
	LABOR & INSTALLATION							
4	**Local construction labor differential**	EPC, civil works, electrical install	Adjust global EPC labor component using construction wage indices vs. US/Europe. SE Asia labor generally lower, partially offsetting other increases. Use ILO data and Turner & Townsend survey.	**−5% to −15% of EPC labor component**	**Public / Open**	High	ILO Global Wage Database; Turner & Townsend Intl. Construction Market Survey; national statistics offices	VN: lowest labor cost. PH: moderate; skilled electrical labor available. ID: variable; Java competitive, outer islands constrained.
5	**Specialized labor (BESS installation)**	PCS, BMS commissioning, safety systems	BESS needs specialized skills (power electronics, BMS config, safety). Estimate imported	**+2% to +8% of installation cost**	**Restricted**	Low-Medium	Developer/EPC interviews; PH DOE BESS project reports; ADB project completion reports	PH: most advanced local workforce. VN: growing, early projects used Chinese/Korean

No.	Adjustment Factor	Applies To	Methodology	Indicative Range	Availability	Data Quality	Key Data Sources	Country-Specific Notes
			specialist labor cost or training. Productivity adjustment for local workforce unfamiliarity.					teams. ID: limited outside Java.
	FINANCING & RISK PREMIUM							
6	**Country risk premium (WACC differential)**	Cost of capital	Country-specific sovereign risk, currency risk, project finance conditions. Use CDS spreads or IEA/IRENA published WACC. Applied in LCOF calc, not to CAPEX.	**+2pp to +5pp vs. US/EU base**	**Public / Open**	Medium-High	IEA WEO country WACC; IRENA RE Finance; sovereign CDS spreads; ADB risk assessments	VN: ~2–3pp premium. PH: ~2–4pp. ID: ~3–5pp (PLN counterparty risk dominates).
7	**Currency hedging cost**	Revenue in local currency vs. USD costs	Estimate using NDF rates for 5–10yr tenors. Some PPAs may be USD-indexed, reducing this factor. Applied in Deliverable 3 revenue analysis, not LCOF.	**+1% to +3% p.a. of revenue**	**Public (indicative); Subscription (NDF)**	Medium	Bloomberg/Reuters NDF rates; central bank data (SBV, BSP, BI); ADB macro forecasts	VN: VND managed float, moderate. PH: PHP more volatile. ID: IDR most volatile, highest premium.
	ENVIRONMENTAL & SITE CONDITIONS							

No.	Adjustment Factor	Applies To	Methodology	Indicative Range	Availability	Data Quality	Key Data Sources	Country-Specific Notes
8	**Tropical climate thermal management**	HVAC / cooling system; container specs	SE Asia ambient 30–40°C and high humidity exceed standard 25°C design. Estimate cost uplift for enhanced cooling (higher-capacity HVAC, liquid cooling, humidity control). Also factor increased auxiliary OPEX.	**+3% to +10% of BOS cost**	**Restricted**	Low-Medium	Manufacturer thermal specs; CSIRO tropical BESS study; developer interviews; SE Asia metrological data	All three countries. Coastal sites: additional corrosion protection. High-altitude ID sites: lower ambient. ESE specialist to advise on cooling spec.
9	**Seismic & natural hazard design**	Civil works, container anchoring, structural design	PH and parts of ID are high seismic zones. Estimate cost for seismic-rated foundations, anchoring, structural reinforcement. Also typhoon loading (PH) and flood-resistant design.	**+1% to +5% of civil works (PH, ID only)**	**Public / Open**	Medium-High	National building codes (NSCP Philippines, SNI Indonesia); ASCE 7; developer structural cost data	VN: low seismic. PH: high seismic + typhoon — most significant uplift. ID: variable, eastern ID higher.
10	**Grid connection & interconnection**	Transformer, switchgear,	Grid connection in SE Asia often higher due to	**Country-specific**	**Mixed**	Low-Medium	EVN / NGCP / PLN connection charges; developer data; ADB	VN: EVN process lengthy and costly. PH: NGCP more

No.	Adjustment Factor	Applies To	Methodology	Indicative Range	Availability	Data Quality	Key Data Sources	Country-Specific Notes
		metering, protection	limited infrastructure, longer distances, utility-imposed requirements. Not adjusted from global benchmark — estimated directly from local data.	**(direct estimate)**			grid integration studies	standardized but expensive. ID: Java OK; outer islands may need dedicated infra.
	AGGREGATE ADJUSTMENT							
11	**Total SE Asia cost adjustment (illustrative composite)**	All-in installed BESS system cost	Composite CAPEX adjustment: Adjusted = Benchmark × (1+shipping) × (1+tariffs) × (1+transport) × (1–labor saving) × (1+specialist labor) × (1+tropical cooling) WACC adjustment applied separately in LCOF. Currency hedging in Deliverable 3.	**VN: +5% to +10% PH: +8% to +15% ID-Java: +7% to +12% ID-outer: +12% to +20%**	**Derived**	Medium (composite of above factors)	Cross-referenced: ADB project data; IRENA SE Asia indices; developer interview validation	Higher end = greenfield in remote locations. Lower end = well-connected Java/Luzon/S. Vietnam with supply chains. Need to validate against actual PH BESS project costs.

3.5.2 Country-Specific Data Sources

The tables below provide the primary data that will be used for each country, and summaries of the data is provided below.

Vietnam

Vietnam provides data on power system planning, regulatory frameworks, and tariff benchmarks primarily through official government decisions (e.g., PDP8), MOIT/EAV publications, and EVN and related utility reports. These sources offer generally high-quality and reliable planning and legal data. However, key datasets required for detailed power system and market analysis—such as real-time dispatch, curtailment, ancillary services, and detailed electricity market operations—are limited or not publicly disclosed. In addition, commercial data, including PPA terms, generation cost structures, and project-level financial parameters, is often confidential or only partially available. Certain datasets (e.g., system operation data) require formal approvals or data-sharing agreements with authorities such as MOIT/EAV and NSMO. As a result, analysis of VRE+BESS in Vietnam relies on a combination of publicly available planning and regulatory data, supplemented by international benchmarks, assumptions, and stakeholder engagement to address data gaps and access constraints.

Philippines

The data for this study will rely on a combination of Philippine official government publications, system and market operator data, regulatory filings, and stakeholder consultations to ensure both accuracy and practical relevance. Core system planning data will be sourced from the Department of Energy (e.g., Philippine Energy Plans (PEP) and Philippine Development Plan (PDP)), while grid and transmission insights will be obtained from the National Grid Corporation of the Philippines. Wholesale market data, including WESM prices and reserve market developments, will be sourced from the Independent Electricity Market Operator of the Philippines, and regulatory frameworks will be compiled from issuances of the Energy Regulatory Commission and DOE circulars. Procurement and contracting information will be drawn from ERC filings, CSP notices, and publicly available PSAs and ASPAs, while fuel price benchmarks will be sourced from DOE and international indices. Investment and financing data will be supplemented by inputs from institutions such as the Asian Development Bank and the World Bank.

Indonesia

Indonesia provides data on power system planning, regulatory frameworks, and tariff benchmarks, primarily through publicly available government and PLN publications. However, critical data required to assess the value of flexibility, such as real-time dispatch, curtailment, ramping needs, and ancillary service requirements, remain limited or inaccessible due to the centralized, vertically integrated market structure. In addition, key commercial data, including detailed PPA terms and project-level financial parameters, is often confidential, constraining the ability to conduct fully market-based competitiveness assessments. Therefore, analysis of VRE+BESS in Indonesia relies on a combination of publicly available planning data, regulatory frameworks, and assumptions derived from international benchmarks and stakeholder engagement. The table below shows the early assessment of data sourcing strategy, quality, and access constraints.

Table 22.Data Sources for Vietnam

No.	Data Category	Key Sources	How Data is Obtained	Availability	Data Quality	Access Constraints
1	**Power Development Plans**	Revised PDP8 (Decision 768/QĐ-TTg 2025); EVN annual reports;	Publicly available reports (MOIT/EAV, website, EVN portal, Government portal)	High	High (official planning data)	Limited granularity; no hourly or system-level dispatch detail
2	**Utility Publications**	EVN annual reports; EVNNPT annual reports; NSMO operational statistics; EVN sustainability reports	Public reports; EVN website (evn.com.vn),; NSMO website (nsmo.vn)	Medium	High	Limited operational transparency; dispatch, curtailment and unit-level data not publicly disclosed
3	**Regulatory & Legal Framework**	Electricity Law 61/2024/QH15; grid codes; market rules; dispatching regulations	Government portal; MOIT/EAV official website	High	High (formal legal basis)	Interpretation required; implementation may be interpreted differently from stated provisions
4	**Electricity Market & PPA Data**	EPTC reports; PPA templates; NSMO market operation reports	EAV website; MOIT publications; NSMO website	Low	Medium	Most EPTC reports and PPA commercial terms are confidential; real-time electricity market operating data is not published in detail
5	**Tariff & Pricing Benchmarks**	Retail electricity tariff; cost of supply studies; FIT; avoided cost for small	MOIT/EAV publications; ministerial decisions; EVN's publish	Medium	Medium	Retail tariff structure publicly available; detailed generation cost by technology

No.	Data Category	Key Sources	How Data is Obtained	Availability	Data Quality	Access Constraints
		hydro power plants				not fully disclosed; cross-subsidy mechanism not fully transparent
6	**Fuel Price Benchmarks**	Coal price (domestic and imported benchmark); gas price; LNG import price; fuel oil price	MOIT; PVN/PVGas reports; TKV reports; EVN annual reports	Medium	Medium	Regulated prices differ from market prices; subsidy adjustments distort actual cost signals for dispatch modelling
7	**Power System Operation Data**	SCADA/EMS data (installed capacity, reserve capacity, demand, peak load...); RE curtailment	EAV, NSMO public data; limited in public domain	Medium	High (if accessed)	Restricted access; requires formal data-sharing agreement with NSMO and MOIT/EAV authorization
8	**Flexibility & Ancillary Services**	Reserve requirements; frequency control parameters; ramping capability by plant type; demand response baseline	Grid code; EVN, NSMO reports; international studies (IEA, NREL, GIZ, etc)	Medium	Medium	No formal ancillary services market → no standardized transaction data; DR mechanism not yet established
9	**BESS & Smart Grid Deployment Data**	BESS project pipeline; power system automation status (power loses, SAIDI, unmanned substation, remote control, etc.); AMI/AMR deployment data;	EAV, EVN, NSMO, EVNNPT, PCs reports; other publish reports	Medium	Medium	No centralized BESS/smart grid project database; AMI pilot data limited to EVNHCMC; automation data varies by utility
10	**Investment & Financing Data**	EVN capital expenditure	World Bank; ADB; IRENA; EVN;	Medium	Medium	Project-specific; not

No.	Data Category	Key Sources	How Data is Obtained	Availability	Data Quality	Access Constraints
		plans; World Bank / ADB project data; JETP investment framework	project case studies			standardized; private investment terms (IPP) are confidential
11	**Carbon & Environmental**	Carbon credit framework; REC regulation	MONRE; Ministry of Finance; World Bank; ESDM publications	Medium	Medium	ETS market still under pilot (2025–2027); limited transaction data; REC framework not fully operationalized
12	**Off-grid and Diesel System Data**	Island/off grid data; off grid RE pilots; Diesel system size, fuel consumption, cost	MOIT/EAV; EVN	Medium	Medium	Location-specific; partial disclosure; island grid operational data (Phu Quy, Con Dao, etc.) held by local utilities

Table 23.Data Sources for Philippines

	Data Category	Key Sources	How Data is Obtained	Availability	Data Quality	Access Constraints
1	Power Development Plans	PDP 2023-2050 (latest)	Official DOE Website	High and available anytime	Comprehensive	Transparent.
2	Utility Publications	Annual, performance reports and tariff filing including PSA disclosures of Meralco, VECO, Davao light, electric cooperatives and other utility companies.	Corporate websites on investor relation and publication	Publicly available	Reports are generally reliable	Major companies' reports are transparent. ERC report can be delayed and filings are sometime fragmented
			IEMOP WESM reports, ERC portal and NEA website on cooperative performance report			

	Data Category	Key Sources	How Data is Obtained	Availability	Data Quality	Access Constraints
3	Regulatory Framework	Department of Energy (DOE)	DOE website	Publicly available	Comprehensive, policy driven and aligned with national energy strategy	Update is sometime irregular
		Energy Regulatory Commission (ERC)	ERC website	Publicly available	Reliable and legally binding	Delay in posting and access is sometime fragmented
		The National Transmission Corporation (TransCo)	Transco Website	Publicly available	Technically comprehensive	TDP released every 2-3 years.
		National Grid Corporation of the Philippines (NGCP)	NGCP website	Publicly available	Technically comprehensive	TDP released every 2-3 years.
		Independent Electricity Market Operator of the Philippines (IEMOP)	IEMOP website	Publicly available	Consistent, standardized and reliable for market operation	General market summary. Detailed trading data, participant-level settlement files, and real-time dispatch data are not publicly released.
		National Electrification Administration (NEA)	NEA website	Publicly available	Standardized and reliable	Delay in posting.
		Other Agencies (Department of Environment and Natural Resources (DENR), Department of Agrarian Reform (DAR), Department of Finance (DOF), etc.)	Respective agency website	Publicly available	Reliable	ECC report of DENR is project specific and not posted on line. DAR reports are limited online and approvals often accessible only through project proponents.
4	Procurement & PPA Data	Energy Regulatory Commission (ERC)	ERC website	Publicly available	Comprehensive and legally binding,	Delay in posting
		Distribution Utilities (Meralco, VECO, Davao Light, Cooperatives	Utility websites	Publicly available	Reliable and transparent big utilities	Electric Cooperatives' reports are less transparent; some data can be checked from NEA or ERC reports
		Department of Energy (DOE)	DOE website	Publicly available	Comprehensive report, Auction report is credible	Updates are irregular.

	Data Category	Key Sources	How Data is Obtained	Availability	Data Quality	Access Constraints
		NGCP (System Operator)	NGCP website	Publicly available	Technically comprehensive and standardized	TDP released every 2-3 years.
		IEMOP (Market Operator)	IEMOP website	Publicly available	Standardized and reliable	Some data like real time dispatch and contractual data are only available on registered WESM participants
		National Power Corporation-Small Power Utilities Group (NPC-SPUG) / Power Sector Assets and Liabilities Management Corporation (PSALM) (Gov't Corporations)	NPC and PSALM websites, and ERC filings	Publicly available	Credible for subsidy-linked procurement	Limited detail. Project-specific data requires direct request.
5	Tariff & Pricing Benchmarks	Energy Regulatory Commission (ERC)	ERC website	Publicly available	Comprehensive and legally binding	Delay in posting and it is fragmented across portals.
		Independent Electricity Market Operator of the Philippines (IEMOP)	IEMOP website	Publicly available	Standardized, reliable for market benchmark	Aggregated data only. Granular settlement restricted to WESM participants
		National Grid Corporation of the Philippines (NGCP)	NGCP website	Publicly available	Technically comprehensive	ASPA pricing details limited; TDP is posted in every 2–3 years
		Distribution Utilities (Meralco, VECO, Davao Light, Cooperatives)	Distribution Utilities respective website	Publicly available	Reliable and audited for major utilities	No issue on major DU. Electric cooperatives reports are less transparent and some data are available in NEA or ERC
		Department of Energy	DOE website	Publicly available	Credible for fuel indices and auction rules	Limited LNG and RE+BESS cost data. Updates is irregular
		International & Multilateral Development Banks (MDB) Sources (Platts, JKM LNG, Newcastle coal, ADB, World Bank)	Subscription services; MDB publications	Subscription services or MDB publication	High quality and used for benchmarking	Subscription cost is barrier. MDB reports are periodic and not continuous

	Data Category	Key Sources	How Data is Obtained	Availability	Data Quality	Access Constraints
6	Fuel Price Benchmarks	Department of Energy (DOE)	DOE website	Publicly available on weekly basis	Official and consistent, It is widely used in tariff pass-through	Limited LNG detail. Advisories may lack historical depth unless archived manually
		International Fuel Indices (Platts, Argus, GlobalCOAL, S&P Global)	Subscription services; DOE/ADB/World Bank reports	Subscription	High quality and it a global benchmark	Subscription cost barrier. Limited public summaries
		Philippine Statistics Authority (PSA)	PSA website	Publicly available every month	Reliable, standardized statistical data	Commodity breakdowns sometimes aggregated and it requires manual extraction
		Distribution Utilities & Cooperatives	DU websites and ERC filing of PSAs fuel clauses	Publicly available	Legally binding and reflects actual fuel cost recovery	Access is fragmented. Filings not always searchable
		Multilateral Development Banks (ADB, World Bank, IFC)	MDB publications on energy sector reports	Publicly available	Credible, It is useful for regional comparison	Not continuous. Lag behind real-time market movements
7	Subsidy & Compensation Data	NPC-SPUG (Missionary Electrification)	NPC annual reports, ERC UCME rulings, DOE circulars	Publicly available, annual	Reliable, audited and linked to ERC approvals	Access is fragmented. ERC rulings sometimes delayed
		PSALM (Privatization & Stranded Debts)	PSALM annual reports and ERC rulings	Publicly available, annua	High quality and audited financial disclosures	Posting delays; fragmented across portals
		Energy Regulatory Commission (ERC)	ERC website	Publicly available	Authoritative and legally binding	Updates irregular;
		DOE (Policy Maker)	DOE website	Publicly available	Reliable for major utilities	Electric Cooperatives reports are less transparent and the data are often limited
		Distribution Utilities (DUs)	Respective DU's website and ERC filings	Publicly available	Credible and comparative framework	
		Multilateral Development Banks (ADB, World Bank, IFC)	MDB publication and project reports	Publicly available		
8	System Operation Data	NGCP-Transmission/System Operator)	NGCP website; ERC filing and DOE consultation ;	Publicly available (TDP every 2–3 years	Technically comprehensive.	Some operational bulletins are restricted to stakeholders.

	Data Category	Key Sources	How Data is Obtained	Availability	Data Quality	Access Constraints
						TDP is not always aligned with DOE timelines
		IEMOP (Independent Electricity Market Operator of the Philippines – Market Operator)	IEMOP website	Publicly available	Standardized, consistent and reliable for aggregated market indicators	Detailed settlement and dispatch data restricted to WESM participants. The public reports are aggregated
		Energy Regulatory Commission (ERC)	ERC website	Publicly available	Authoritative and legally binding	Posting delay and often times reports are fragmented
		Independent Electricity Market Operator of the Philippines (IEMOP) – Market Operator				
		Energy Regulatory Commission (ERC) – Oversight of System & Market Operators, These are Ancillary Services Rules (AS Rules) – reserve categories and compliance obligations. ASPA Approvals – pricing and cost recovery mechanisms.	ERC filings for PSA and ASPA participation.			
		Department of Energy (DOE) policy Philippine Energy Plan (PEP) and Power Development Plan (PDP) – policy frameworks for system expansion. DOE Circulars – rules on ancillary services, CSP, GEAP, and flexibility integration.	DOE website → Issuances / Plans.			
		Utilities & Generators regarding ASPA participation disclosure and Operational flexibility data (ramp rates, start-up times, BESS integration).	Corporate websites (annual reports, investor relations).			

	Data Category	Key Sources	How Data is Obtained	Availability	Data Quality	Access Constraints
9	Flexibility & Ancillary Services	National Grid Corporation of the Philippines (NGCP – System Operator) on Transmission Development Plan (TDP) – long-term grid expansion and reserve requirements. Ancillary Services Procurement Notices (ASPAs) – contracting schedules and technical requirements and on Grid advisories and operational bulletins.	NGCP website → Publications / Notices. ERC filings for ASPA approvals. DOE consultations for TDP validation.	High	High	
		Energy Regulatory Commission (ERC – Regulator) on Ancillary Service Rule, ASPA approvals and tariff decision related to Ancillary Services	ERC website on Issuances and Decisions.			
		Independent Electricity Market Operator of the Philippines (IEMOP – Market Operator) on WESM report, settlement data on actual traded prices and quantities	IEMOP website on Market Reports and DOE publication for any rule changes			
		Department of Energy (DOE – Policy Maker) on rules of ancillary services, GEAP, Philippine Energy Plan (PEP) and Power Development Plan (PDP)	DOE website on plans			
		Utilities & Generators on ASPA participation and Operational flexibility data (ramp rates, start-up times, BESS integration).	Corporate websites (annual reports, investor relations). ERC filings for PSA and ASPA participation.			
10	Hybrid & BESS Deployment Data	Department of Energy (DOE) on Renewable Energy Service Contracts (RESCs) with hybrid RE + BESS	DOE website on Issuances of Renewable Energy Service Contracts and GEAP Results.	High	High	No issue

	Data Category	Key Sources	How Data is Obtained	Availability	Data Quality	Access Constraints
		components. DOE Circulars on GEAP (Green Energy Auction Program) results, including hybrid projects. Philippine Energy Plan (PEP) and Power Development Plan (PDP) with BESS integration targets.				
		Energy Regulatory Commission (ERC) on Power Supply Agreements (PSAs) filed by utilities with hybrid RE + BESS components. Ancillary Services Procurement Agreements (ASPAs) involving standalone BESS.	ERC website on Issuances, Decisions and PSA filings.			
		NGCP (System Operator) on Ancillary Services Procurement Notices (ASPAs) where BESS participates. Transmission Development Plan (TDP) highlighting hybrid RE + BESS integration for grid stability.	NGCP website on Publications and Notices. ERC filings for ASPA approvals.			
		IEMOP (Market Operator) on WESM Market Reports showing merchant participation of hybrid RE + BESS projects. Reserve Market Clearing Prices where BESS provides frequency regulation.	IEMOP website on Market Reports which are monthly and quarterly reports with settlement data.			
		Utilities & Project Developers Data about corporate disclosures (Meralco, AboitizPower, ACEN, First Gen/EDC) on hybrid RE + BESS deployments.	Utility websites on Investor relations / Sustainability Reports. ERC filings for PSA approvals.			
		Annual reports and press releases on pilot projects and	NPC website on Reports about			

	Data Category	Key Sources	How Data is Obtained	Availability	Data Quality	Access Constraints
		commercial operations.	Missionary Electrification.			
		NPC-SPUG (Missionary Electrification) on Hybrid RE + BESS projects in off-grid islands including subsidy mechanisms (UCME) supporting deployment.	DOE circulars on subsidy allocation.			
11	Investment & Financing Data	Multilateral Development Bank (MDB) like Asian Development Bank (ADB) – Energy project financing, sector studies, tariff competitiveness, RE/BESS investment reports.	MDB websites → Publications and Project Databases.			No issue
		World Bank / IFC – Financing frameworks, PPP models, subsidy mechanisms, risk assessments.				
12	Carbon & Environmental Markets					
13	Project Development Timeline					
14	Off-grid & Diesel System Data					

Table 24. Data sources for Indonesia

	Data Category	Key Sources	How Data is Obtained	Availability	Data Quality	Access Constraints
1	Power Development Plans	PLN RUPTL, RUKN, KEN (ESDM)	Publicly available reports (PLN website, ESDM portal)	High	High (official planning data)	Limited granularity (no hourly/system-level detail)
2	Utility Publications	PLN annual reports, sustainability reports, and system statistics	Public reports; PLN website; stakeholder engagement	High	Medium–High	Limited operational transparency (dispatch, curtailment not disclosed)

	Data Category	Key Sources	How Data is Obtained	Availability	Data Quality	Access Constraints
3	Regulatory Framework	Perpres 112/2022, Permen ESDM (e.g., PJBL, hybrid systems)	JDIH ESDM (legal database), government portals	High	High (formal legal basis)	Interpretation required; implementation may differ in practice
4	Procurement & PPA Data	PLN procurement documents, PJBL templates, tender results	Public tender announcements; direct engagement/interviews	Medium	Medium	Most PPA terms are confidential; limited public disclosure
5	Tariff & Pricing Benchmarks	BPP (cost of generation), HPT/HPS, tariff regulations	ESDM publications; ministerial decrees	High	Medium–High	Regional detail available, but the methodology is not fully transparent
6	Fuel Price Benchmarks	Diesel price, coal price (HBA), gas price	ESDM, Ministry of Energy, PLN reports	High	Medium–High	Subsidy distortions: real cost vs regulated price differ
7	Subsidy & Compensation Data	Electricity subsidy, PLN compensation scheme	Ministry of Finance, ESDM, state budget reports	Medium	Medium	Aggregated data; limited project-level transparency
8	System Operation Data	Dispatch, reserve margin, curtailment, ramping	PLN internal data; limited in public domain	Low	High (if accessed)	Restricted access; requires direct PLN collaboration
9	Flexibility & Ancillary Services	Reserve requirements, frequency control, ramping needs	PLN, grid code, international studies (IEA, NREL)	Low–Medium	Medium	No formal market → no standardized data
10	Hybrid & BESS Deployment Data	Project pipeline, pilot projects (e.g., de-dieselization)	PLN, ESDM, project reports	Medium	Medium	Fragmented across projects; no centralized database
11	Investment & Financing Data	WACC, financing terms, and guarantees	World Bank, ADB, IRENA, project case studies	Medium	Medium	Project-specific; not standardized
12	Carbon & Environmental Markets	Carbon price, REC ownership, carbon trading	IDX Carbon, ESDM, World Bank	Medium	Medium	Market still emerging; limited transaction data
13	Project Development Timeline	Procurement duration, permitting process	Case studies, stakeholder interviews	Low–Medium	Medium	Not systematically documented

	Data Category	Key Sources	How Data is Obtained	Availability	Data Quality	Access Constraints
14	Off-grid & Diesel System Data	System size, fuel consumption, cost	PLN de-dieselization program, ESDM	Medium	Medium	Location-specific; partial disclosure

4 Gantt Chart

The overall schedule of activities for this project, and more specifically for the development of the two reports is provided below.

Table 25. Project Gantt Chart

	Tasks / Deliverables	M1 Apr	M2 May	M3 Jun	M4 Jul	M5 Aug	M6 Sep	M7 Oct	M8 Nov
A1	Kick-off Deliverable 1: Inception Report	★							
A2	Flexibility Resource Mapping								
A3	Cost Assessment & Benchmarking								
A4	LCOF Comparative Analysis								
A5	Sensitivity Analysis & Thresholds								
A6	Deliverable 2: Cost Analysis Report					★			
A7	Market Access Pathway Analysis								
A8	Revenue Stream & Tariff Assessment								
A9	International Developer Market Entry Analysis								
A10	Revenue Stacking Evaluation								
A11	Risk Assessment & Investment Readiness								
A12	Deliverable 3: Market Entry Report								★
A13	Stakeholder Engagement								
A14	QA/QC, Coordination, QA/QC, Coordination, Biweekly Progress Meetings, Communications Outputs								

5 Gender Mainstreaming Plan

5.1 Strategy for Balanced Women Representation

The Project Team is committed to gender mainstreaming throughout the project, integrating gender considerations into our operations, stakeholder engagement, analytical outputs, and monitoring framework.

Balanced stakeholder representation
We will actively seek to include women energy professionals, researchers, regulators, and policymakers in our consultation activities across all three countries. Stakeholder mapping will identify women leaders in relevant institutions—including MOIT/EAV in Vietnam, MEMR/PLN in Indonesia, and DOE/ERC in the Philippines—and our in-country coordinators will ensure that consultation invitations and scheduling are designed to facilitate participation by women.

We will design stakeholder consultations to encourage inclusive participation (i.e., facilitating space for diverse perspectives). We will track and report gender-disaggregated participation data in all stakeholder consultations.

5.2 Gender Dimensions for Deliverable 3

The market entry analysis (Milestone 3) will consider the gendered dimensions of clean energy employment and BESS sector development. Where data is available, we will note the representation of women in the emerging battery storage and renewable energy workforce and identify whether market entry pathways present opportunities or barriers that disproportionately affect women's participation in the sector. The investment readiness summaries will include, where relevant, observations on the gender responsiveness of procurement and employment practices in VRE + BESS development.

5.3 Gender-Disaggregated Data Collection Methodology

Gender-disaggregated data among participants and qualitative observations related to gender dynamics will be documented and integrated into project progress reporting and RBMF submissions.

5.4 Gender Balance Measures

The Project Team combines senior expertise with strong female representation
across technical, analytical, and coordination roles. Gender balance is considered in team formation, ensuring that women are meaningfully involved in both decision-making and substantive technical work.

Table 26. Team Composition, with gender disaggregation

NIRAS Team	Female	Male	Total
Indonesia	2	1	3
Philippines	2	1	3
Vietnam	2	1	3
Team Leader and BESS Expert		2	2
Total	6	5	11

6 Stakeholder Coordination Plan

6.1 Key Counterparts per Country

Vietnam

The primary institutional counterparts relevant to this study in Vietnam span five categories.

At the policy and regulatory level, the Ministry of Industry and Trade (MOIT) and its subordinate Electricity Authority of Vietnam (EAV) are responsible for power sector planning, tariff determination, market regulation, and the issuance of implementing legislation under the revised PDP8 and the 2024 Electricity Law. The National Power System and Market Operator (NSMO) separated from EVN since August 2024 manages real-time dispatch, wholesale electricity market (VWEM) operations, and holds the most granular system operational data critical to this study's flexibility resource mapping.

On the utility side, Vietnam Electricity (EVN) remains the dominant off taker, transmission and distribution asset owner, and the counterpart for all power purchase agreement negotiations; its subsidiaries, the National Power Transmission Corporation (NPT) and the five Power Corporations (EVNNPC, EVNCPC, EVNSPC, EVNHANOI, EVNHCMC), are relevant for grid access and distribution-level data.

Vietnam National Industry - Energy Group (PetroVietnam) and its gas subsidiary PV Gas are key counterparts for domestic gas supply data, while Vinacomin (TKV) holds domestic coal pricing and supply information.

In the private sector, independent power producers (IPPs), project developers, and financial institutions active in Vietnam's renewable energy market including international developers pursuing VRE and BESS opportunities under the revised PDP8 represent a critical source of commercial intelligence on investment conditions, contract structures, and bankability constraints.

Key stakeholders for Vietnam are summarized in the following table:

Table 27. Key Stakeholders for Vietnam

Category	Primary Stakeholders	Key Roles & Relevance to Study
Policy & Regulatory	MOIT (Ministry of Industry & Trade), EAV (Electricity Authority of Vietnam)	Power sector planning (PDP8), tariff determination, issuance of secondary legislation for the 2024 Electricity Law.
System & Market Operator	NSMO (National Power System and Market Operator)	Critical Partner: Manages real-time dispatch and VWEM operations. Source of granular data for flexibility resource mapping.
Utility & Grid	EVN (Vietnam Electricity), EVNNPT, Power Corporations (NPC, CPC, SPC, HN, HCM)	Principal Off-taker for PPAs. Asset owners of transmission and distribution grids; relevant for grid access and local data.
State Fuel Groups	PetroVietnam (PVN/PV Gas), Vinacomin (TKV)	Providers of data on domestic gas supply and coal pricing (essential for benchmarking BESS against incumbent thermal flexibility).
Private Sector	IPPs, Project Developers, Financial Institutions, BESS Task Force - Vietnam Energy Partnership Group (VEPG) and GEAPP, FESSIA, Vietnam Energy Association, Vietnam Clean Energy Association.	Source of commercial intelligence on investment conditions, contract bankability, and "Revenue Stacking" feasibility under PDP8.

Indonesia

Indonesia's power sector comprises a range of stakeholders, including government institutions, the state-owned utility, private developers, financial institutions, and industry associations. Policy direction and regulatory frameworks are primarily established by the Ministry of Energy and Mineral Resources (MEMR), while PT PLN (Persero) plays a central role in system planning, procurement, and operation. Private-sector participation is primarily facilitated through PLN-led procurement processes, supported by financing institutions and industry groups that contribute to project development and investment. This institutional landscape shapes how renewable energy and storage projects are developed, contracted, and implemented, and will inform the assessment of commercial competitiveness and flexibility services in the Indonesian context. Stakeholder's mapping is shown on the table below.

Table 28. Key stakeholders for Indonesia

Category	Institution / Organization	Role in the Sector & Relevance to Study
Government – Policy Maker	Ministry of Energy and Mineral Resources / Kementerian Energi dan Sumber Daya Mineral (ESDM)	National energy policy, tariff regulation, renewable targets
	Directorate General of Electricity (DJK – ESDM)	Power sector regulation, licensing, RUPTL approval

Category	Institution / Organization	Role in the Sector & Relevance to Study
	Directorate General of New, Renewable Energy and Energy Conservation (EBTKE – ESDM)	Renewable energy policy and program implementation
	Ministry of Finance / Kementerian Keuangan	Subsidies, compensation to PLN, fiscal policy
	Badan Perencanaan Pembangunan Nasional (Bappenas)	National development planning (KEN, RUEN alignment)
	Badan Pengatur Hilir Minyak dan Gas Bumi (BPH Migas)	Fuel regulation (diesel supply)
State Utility / System Operator	PT PLN (Persero)	Single buyer, system operator, planner (RUPTL), dispatcher
	PLN Indonesia Power	Generation subsidiary (large-scale plants)
	PLN Nusantara Power	Generation subsidiary
	PLN UID / Regional Units	Regional grid operation and project execution
	PLN Energi Primer Indonesia / PLN EPI	Fuel regulation (diesel supply)
Private Developers (IPP)	Independent Power Producers (e.g., ACWA Power, Masdar, local IPPs)	Develop and operate RE projects under PJBL
	Local renewable developers (e.g., Medco Power, Adaro Power, etc.)	Domestic project developers
Investors & Financing Institutions	Asian Development Bank (ADB)	Project financing, policy support
	World Bank	Energy transition programs, guarantees
	International Finance Corporation (IFC)	Private sector financing
	Commercial banks (local & international)	Project financing
Industry Associations	Asosiasi Energi Surya Indonesia (AESI)	Solar Industry Association
	Indonesia Battery Ecosystem Association (IBEA)	Battery Association
	Indonesia Independent Power Producers Association (APLSI)	IPP association
Research & Technical Institutions	Institute for Essential Services Reform (IESR)	Energy policy research
	BPPT / BRIN	Technology assessment and innovation
	Universities (ITB, UI, UGM)	Research and modelling

Philippines

The power sector has different group stakeholders and these are generally composed of Policymakers and Regulators & Asset Owners, Utilities & Distribution, Generation Companies &

Developers, Investors & Finance, and Industry Associations. These stakeholders have their own unique responsibilities and scope of works to ensure no overlapping of duties and responsibilities in the development, operation, distribution and other relevant works in the power industries.

Table 29. Key stakeholders for the Philippines

Category	Stakeholder	Roles In the Power Industry
Policymakers, Regulators and Asset Owners	Department of Energy (DOE)	Sets policy direction, issues the Philippine Energy Plan (PEP), oversees the Power Development Plan (PDP), and designs procurement programs (e.g., GEAP auctions).
	Energy Regulatory Commission (ERC)	Independent regulator for electricity rates, licensing, and compliance with Electric Power Industry Reform Act of 2001 (EPIRA). Approves Power Supply Agreements (PSAs) and Ancillary Services Procurement Agreements (ASPAs).
	National Electrification Administration (NEA)	Supervises electric cooperatives and rural electrification.
	Department of Environment and Natural Resources (DENR)	Permitting for land use, environmental compliance, and ancestral domain issues.
	Department of Agrarian Reform (DAR)	Land tenure and agricultural land conversion approvals.
	National Grid Corporation of the Philippines (NGCP)	Private concessionaire operating the transmission grid; manages ancillary services procurement under DOE/ERC oversight.
	National Transmission Corporation (TransCo)	Supervises the concessionaire's performance, supports grid expansion, and represents the state's interests in critical national infrastructure—particularly in transmission investments and cybersecurity matters.
	Independent Electricity Market Operator of the Philippines (IEMOP)	Operates the Wholesale Electricity Spot Market (WESM).
	National Power Corporation (NPC)	Managed Small Power Utilities Group (SPUG), supplies off-grid islands and missionary areas. Works under DOE oversight, aligning with national electrification and renewable integration goals.
Utilities & Distribution	Meralco (Manila Electric Company)	Largest distribution utility in the Philippines, serving Metro Manila and surrounding provinces. Supplies electricity to ~7.5 million customers, accounting for ~70% of Luzon's demand.

Category	Stakeholder	Roles In the Power Industry
	Aboitiz Power distribution subsidiaries, Visayan Electric, Davao Light, etc.	Second-largest private distribution utility in the Philippines and supplies power to Cebu City, Mandaue, Lapu-Lapu, Talisay, and parts of Metro Cebu.
	Electric Cooperatives	Distribution Utilities (DUs) serving rural and provincial areas. It is a Non-profit, community-based entities supervised by the National Electrification Administration (NEA). Provides electricity access to areas outside the franchise zones of private DUs like Meralco, VECO, and Davao Light.
Major Generation Companies & Developers	Aboitiz Power Corporation	Diversified portfolio (coal, hydro, geothermal, solar, BESS); strong nationwide presence.
	San Miguel Global Power	Operates one of the largest coal and natural gas fleets; expanding into LNG and renewables. Aggressive in the development of Solar Power Farm in the tandem with BESS in Luzon
	ACEN Corporation (Ayala Group)	Aggressive RE expansion in solar, wind, and BESS across the Philippines and ASEAN.
	First Gen Corporation (Lopez Group)	~3,639 MW portfolio; leader in natural gas (Sta. Rita, San Lorenzo, San Gabriel, Avion) and renewables via Energy Development Corporation (EDC), the world's largest vertically integrated geothermal company
Industry Association	Renewable Energy Association of the Philippines	Acts as a broad umbrella platform for RE stakeholders to promote renewable energy development, policy advocacy, industry collaboration, and knowledge sharing across technologies such as solar, wind, hydro, biomass, and geothermal
	Philippine Solar and Storage Energy Alliance	Leading industry alliance focused on solar energy and battery energy storage systems (BESS). Engages with DOE and regulators on policy reforms, grid integration, market development, investment promotion, and industry standards for solar and storage projects.
	Developers of Renewable Energy for Advancement, Inc.	Commonly known as DREAM. Serves as a national umbrella organization connecting different renewable energy associations to strengthen unified policy advocacy, regulatory engagement, and sector coordination.
	Global Wind Energy Council	International industry body actively supporting offshore wind development in the Philippines

Category	Stakeholder	Roles In the Power Industry
		through policy advocacy, market studies, supply chain discussions, and stakeholder engagement. Frequently collaborates with DOE and local industry stakeholders.
	Wind Energy Developers Association of the Philippines	Represents wind energy developers and stakeholders. Supports wind policy advocacy, permitting discussions, auction recommendations, and offshore/onshore wind market development.
	Philippine Energy Storage Alliance	Focuses on battery energy storage system (BESS) deployment, regulatory frameworks, grid flexibility, and integration of storage technologies into the Philippine power system.

6.2 Stakeholder Engagement Approach

Vietnam

The availability and level of detail of information provided by institutional counterparts may vary, and therefore, certain aspects of the country-specific analysis — particularly those related to NSMO dispatch data, MOIT/EAV draft regulatory documents, PetroVietnam gas contract pricing, and TKV domestic coal pricing — may rely on a combination of publicly available information, stakeholder consultations, industry references, and expert judgment where direct official data is not accessible. Nevertheless, the analysis approach is designed to ensure robust and credible findings through triangulation of multiple data sources and consultation inputs.

In the event that formal institutional engagement is unavailable or limited, the consulting team proposes the following alternative approach: **structured expert interviews** and **knowledge-exchange sessions with independent specialists** who have direct professional experience in Vietnam's power sector (as described above in the data collection section). This pool includes former officials from MOIT, EAV, EVN, and NSMO who have transitioned to advisory or academic roles; energy economists and legal practitioners at major law firms and consultancies active in Vietnam's power market (including those who have advised on PDP8 implementation, LNG-to-power transactions, and BESS regulatory development); academic researchers at the Vietnam Institute of Energy and relevant faculties of Vietnamese universities; etc. These experts can provide informed perspectives on technical parameters, regulatory intent, commercial practices, while operating outside the constraints of formal inter-institutional data-sharing protocols. All expert inputs obtained through this channel will be clearly attributed as informed professional judgement rather than official institutional data.

Stakeholder Engagement Schedule

The engagement proposal outlined herein represents the consulting team's desired approach rather than a guaranteed schedule. Information gathering may, of necessity, shift toward qualitative discussions and expert assessments provided by independent specialists and academia. This engagement plan remains flexible and will be adjusted based on the evolving realities of project implementation and the actual level of institutional access secured.

Table 30. Stakeholder engagement schedule for Vietnam

No.	Stakeholder – Organization / Individual	Engagement Method	Key Outputs / Data Expected	Timing
A. EAV				
1	**EAV**	Formal consultation meeting	• Assessment of power system and power market operation • Status of Smart Grid Program • BESS, VPP and DR regulatory development priorities • Ancillary services market design status • DR and TOU tariff regulatory	Week 2–4
B. EVN and member utilities				
2	**EVN**	Formal consultation meeting + structured survey	• Assessment of power system and power market operation • Electricity retail price assessment • EVN smart grid investment status • Gas, coal, oil price	Week 3–5
C. National Power System and Market Operator (NSMO)				
3	**NSMO**	Formal consultation meeting (with data-sharing protocol if possible)	• SCADA/EMS functions • Load and RE generation forecast accuracy (current MAPE) • Assessment of power system and power market operation	Week 3–5
D. Independent Experts and Academia				
4	**Vietnam Institute of Energy, MOIT**	Semi-structured interview	• Power system flexibility modelling results • Technical assessment of BESS and RE integration needs	Week 4–5
5	**Former Senior Official – MOIT / EAV (now advisory/academic role)**	Informal consultation / expert interview	•	Week 4–6
6	**Academic Researchers – HUST / EPU**	Semi-structured interview / online meeting	• Academic research on BESS, RE integration in Vietnam • Human resource capacity for energy sector	Week 5–7

No.	Stakeholder – Organization / Individual	Engagement Method	Key Outputs / Data Expected	Timing
	/ Other universities			

Note: The Vietnam team will closely coordinate and communicate with the ETP Vietnam team regarding stakeholder engagement activities, key developments, and any emerging issues related to the Vietnam scope throughout the implementation of the assignment.

Indonesia

Stakeholders will be formally approached by the local coordinator through email and, where necessary, through direct messaging channels such as WhatsApp. Interviews will be conducted through a combination of in-person meetings and online platforms, including Zoom and Microsoft Teams, depending on stakeholder preference and availability. While one-to-one interviews are preferred, the team will accommodate requests for Focus Group Discussions where appropriate. This flexibility will be exercised while remaining aligned with the specific objectives of each engagement. The engagement schedule will remain adaptive, recognizing that many of the stakeholders approached, particularly within government institutions, hold highly dynamic schedules. Any changes to interview timing will be communicated promptly, and engagement activities will be managed within the designated interview period.

The engagement approach is guided by several key principles. First, engagement will be targeted and staged, with early interactions shaping analytical assumptions, mid phase engagements validating emerging findings, and later engagements focusing on confirming recommendations and implementation pathways. Second, a triangulation approach will be applied by cross checking perspectives from government and system operators with inputs from market actors such as independent power producers, financial institutions, and industry associations, as well as technical and academic experts. Third, confidentiality will be respected throughout the process, with anonymized inputs from private developers and financiers used where appropriate to encourage candid and open discussion.

Table 31. Stakeholder engagement schedule for Indonesia

No.	Stakeholders	Purpose of Engagement	Engagement Method	Timeline
1	Government – Policy Maker	• Core policymaker shaping RE deployment, pricing, and hybrid regulation • Key for market structure, PPA framework, and system planning • Key for VRE and hybrid (VRE+BESS) policy direction • Critical for understanding tariff affordability and financial viability • Influences long-term energy transition strategy • Relevant for diesel displacement	Formal consultation meeting	Month 3–6
2	State Utility / System Operator	• Central actor for procurement, dispatch, and flexibility utilization • Represents utility-owned generation (competes with IPPs) • Important for internal dispatch and investment dynamics • Key for isolated grids and hybrid deployment (diesel replacement) • Relevant for diesel displacement economics	Formal consultation meeting	Month 3–6
3	Private Developers (IPP)	• Key for investment perspective, bankability, and risk allocation • Provide insight on local constraints and financing challenges	Semi-structured interview/online meeting	Month 3–6
4	Investors & Financing Institutions	• Key for financing conditions and risk mitigation • Provides insights on market reform and investment barriers • Important for IPP bankability perspective • Provide insight into credit risk and financing constraints	Semi-structured interview/online meeting	Month 4–6
5	Industry Associations	• Insight into PV + BESS deployment barriers • Broader RE investment perspective • Industry voice on regulatory and market barriers	Semi-structured interview/online meeting	Month 4–6
6	Research & Technical Institutions	• Provides analysis on RE and storage economics • Technical insights on BESS and hybrid systems • Academic validation and modelling support	Semi-structured interview/online meeting	Month 4–6

Note: The Indonesian team will closely coordinate and communicate with the ETP Indonesian team regarding stakeholder engagement activities, key developments, and any emerging issues related to the Indonesia scope throughout the implementation of the assignment.

Philippines

Interviews of key personnel of each stakeholder in the power industries has to be done through formal and/or personalized approach through actual or phone interviews or through other means of communication like emails. This approach depends on how you know these persons through personal acquaintances and through other personal connections.

Conduct thorough research and review of the present and future programs of each stakeholder before engaging the above strategies to ensure that the needed information and data are aligned with their corresponding policy, regulations and their ultimate objectives. Technical discussion may arise during the meeting, but it should be confined within the boundaries of each stakeholder duties, responsibilities and mandate.

Table 32. Stakeholder engagement schedule for the Philippines

	Stakeholders	Purpose of Engagement	Engagement Method	Timeline
1	Government agencies	• Renewable energy plan of the country. • Present progress particularly on renewable energy development and upgrade of transmission line backbone from 138 kV to 230 kV by NGCP • Future plans	Research and interviews	Month 2-5

2	Regulators	• Plans to reduce cost of electricity to consumers
		• Programs to attract private developers of renewable energy:
		  • Ancillary Services Procurement Agreements
		  • Reserve Market Participation (WESM)
		  • Energy Arbitrage (WESM)
		  • Hybrid Renewable Energy + BESS Optimization
		  • Green Energy Auction Program (GEAP)
		  • Microgrid and Missionary Electrification Programs
			Research and interviews	Month 3-5

3	Distribution Utilities	• Gather insights on power procurement needs, flexibility requirements, potential off-take arrangements, distribution-level integration of VRE+BESS • Role of DUs in supporting reliability, distributed storage, and future market opportunities for flexible energy solutions.	Research and interviews including experiences	Month 3-5
4	System Operators	• Issues on grid stability especially on those power coming from VRE which are intermittent due to uncontrolled natures like availability of wind and cloudy skies causing voltage fluctuation and power shortage	Research and interviews	Month 3-5

	Stakeholders	Purpose of Engagement	Engagement Method	Timeline
		• Needs on fast acting ancillary services power source to resolve voltage fluctuation, under and over frequency, capacity shortage and other electrical problems that will cause unstable grid system. • Thin reserves, especially during scheduled and unscheduled shutdown of big power plants like coal fired power plants. Capital issues on transmission lines upgrade.		
5	Private developers	• Concerns on government laws in developing new power plants. • Issues on land conversion on agricultural areas to industrial. Permitting and regulatory issues. Land acquisition and right of way issues. Financing and capital cost. Battery Energy Storage System needs. • Concerns on inadequate grid infrastructures and upgrade of the transmission lines from 138kV to 230kV. Policy and market uncertainties issues. Off grid market challenges.	Research and interviews	Month 4-5
6	Investors	• Issues on government permitting from local to national government. • Issues on shift of policy brought about by cabinet changes and national government leadership. • Delays on connection to grids particularly on System Impact Study by NGCP and Distribution Impact Study by local electric cooperatives. Issues on shortage of skilled manpower.	Research and interviews including experiences	Month 4-5
7	Industry Associations	• Issues on grid connection considering the distance of transmission line to nearest substation of NGCP • Slow permitting due to bureaucracy to get approval of the project • Changes in policy due to change in government leadership.	Research and interviews including experiences	Month 4-5

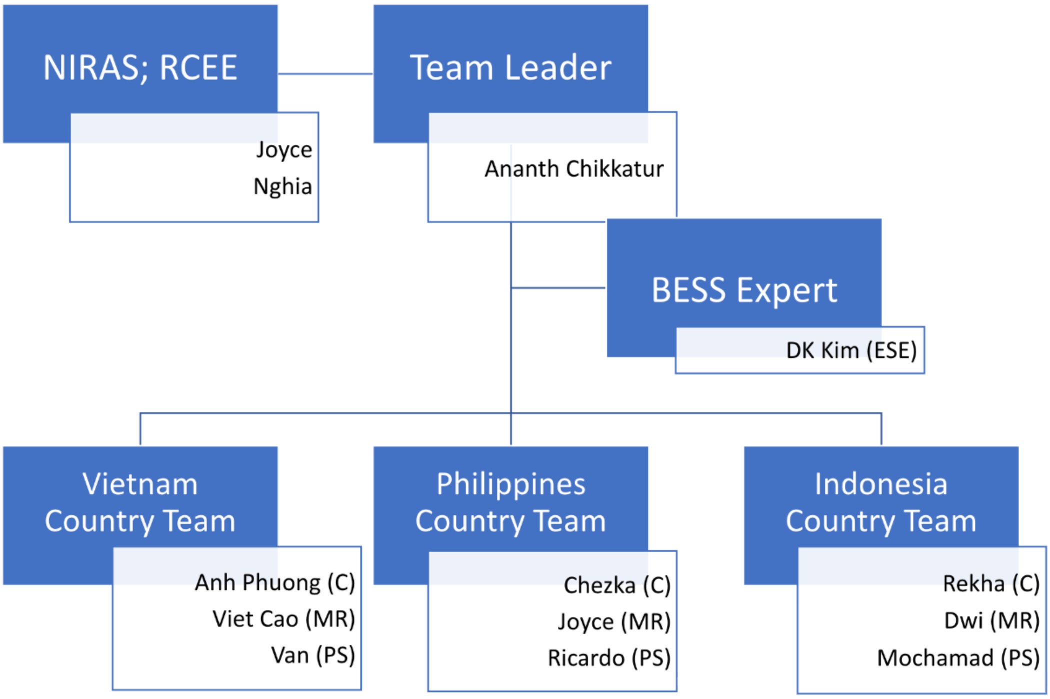
Note: The Philippine team will closely coordinate and communicate with the ETP Philippines team regarding stakeholder engagement activities, key developments, and any emerging issues related to the Philippine scope throughout the implementation of the assignment.

7 Project Management Structure

7.1 Organizational Chart

The project is organized with a clear and streamlined structure to ensure effective coordination and delivery across all countries. NIRAS Asia Manila oversees the overall implementation, supported by technical expertise and country-specific teams. Each country team contributes localized knowledge and supports the execution of activities within their respective markets. This structure ensures alignment across workstreams, efficient communication, and consistent delivery of outputs throughout the project.

Figure 1. Organizational Chart



7.2 Key Personnel

The project will be delivered by a team of international and in-country experts with strong experience in power systems, energy markets, and battery energy storage systems (BESS). The team is structured to ensure effective cross-country coordination, high analytical quality, and efficient stakeholder engagement across Indonesia, the Philippines, and Vietnam. The Team Leader provides overall strategic direction and ensures integration of outputs across all deliverables, supported by technical specialists in power systems, market and regulatory analysis, and energy storage. Country-specific experts contribute localized insights and technical depth, while local coordinators facilitate stakeholder engagement, data collection, and project administration. This structure ensures a balanced combination of regional expertise, technical rigor, and on-the-ground execution to support timely and high-quality delivery of the assignment.

Table 33. Key Personnel and Tasks

Item No.	Position	Name	Tasks
1	Team Leader	Ananth Chikkatur	The Team Leader bears overall responsibility for project delivery, analytical quality, and cross-country integration across all three milestones. Based in Vietnam with regional coordination responsibilities, this role involves continuous engagement from inception through final delivery.
2	Local Coordinators - Vietnam	Nguyen Anh Phuong	Three local coordinators—one per country—provide administrative and logistical support throughout the project: (Vietnam), (Philippines), and (Indonesia). Their role is primarily administrative, freeing the technical specialists to focus on analytical work. Each coordinator contributes 16 person-days (48 days total), with the majority of effort in cross-cutting stakeholder engagement and administrative activities. Philippines will be the Lead Project/Client Coordinator for this Project
3	Lead Project/Client Coordinator - Philippines	Maria Frahn Chezka Tabajonda	
4	Local Coordinators - Indonesia	Rekha Amanda	
5	Energy Storage Expert	Dae Kyeong Kim	The BESS Specialist provides technology-specific expertise on battery storage systems and hybrid VRE + BESS configurations across all three countries. Based in Korea with strong familiarity with Southeast Asian BESS markets and global benchmarks, this role is most intensive during Milestone 2 and includes responsibility for designing the LCOF analytical framework and establishing the standardized cost and performance assumptions that underpin the entire comparative analysis.
6	Electricity Market and Regulatory Specialists - Vietnam	Nguyen Thi Nhu Van	Three country-specific Regulatory Specialists provide dedicated market and institutional analysis for their respective countries: (Vietnam), (Philippines), and (Indonesia). Each specialist follows the same scope of work adapted to their country's context, with effort concentrated in Milestone 3 (market entry) where deep regulatory knowledge is most critical. Each specialist contributes 20 person-days (60 days total across the three specialists).
7	Electricity Market and Regulatory Specialists - Philippines	Joyce Anne Asilo	
8	Electricity Market and Regulatory Specialists - Indonesia	Dwi Novitasari	
9	Power Systems and Flexibility Specialists (PS) in Vietnam	Cao Hoang Viet	Three country-specific Power Systems Specialists provide the technical foundation for the flexibility assessment in their respective

Item No.	Position	Name	Tasks
10	Power Systems and Flexibility Specialists (PS) in Indonesia	Mochamad Prayudianto	markets: (Vietnam), (Indonesia), and (Philippines). Each specialist follows the same scope of work adapted to their country's power system
11	Power Systems and Flexibility Specialists (PS) in Philippines	Ricardo Abad	

7.3 Contract Management

Contract management responsibilities are overseen by NIRAS Asia Manila. The designated Contract Manager for non-technical coordination and invoice submission is Ms. Maria Frahn Chezka Tabajonda. From the Kick-Off Meeting, the following practices are noted:

- Compliance: adhere to all contractual obligations, including scope, timeline, and quality standards.
- Communication: maintain open communication with ETP/UNOPS to address any issues or concerns promptly.
- Documentation: keep detailed records, including progress reports, invoices, and correspondence.
- Change management: follow standard process, ensuring proper documentation and approval.

Table 34. Contract Management Do's and Don'ts

Do's	Don'ts
Inform ETP focal person of any potential delays of deliverable submission	Make additional commitments to the beneficiary without prior approval from ETP
Inform ETP focal person of any potential challenges, risks and requests for change	Implement changes to the project scope/activities/budget/timeline/key personnel without proper documentation and due process

7.4 Internal Coordination Mechanisms

A bi-weekly coordination meeting is scheduled with UNOPS ETP Team every other Wednesday. This meeting is structured to discuss clarifications, report progress, and issues encountered. Regular check-ins allow the team to provide updates on ongoing activities in the implementation and raise concerns, ensuring alignment with UNOPS to maintain progress against the project deliverables.

8 Risks, Mitigations, and Assumptions

8.1 Project Risks

The risk register below identifies the principal risks to successful delivery of the ETP BESS assignment across five core categories — data availability, stakeholder access, timeline, cross-country consistency, and analytical quality — together with two adjacent risks (regulatory change and confidentiality) that arise directly from the nature of the analytical work and the Southeast Asian operating context. Each risk is assigned a likelihood and impact rating on a three-point scale (H / M / L), together with the concrete mitigation measures the team will implement.

The register is a living document: it will be reviewed at each biweekly coordination meeting, formally updated at each milestone review with ETP, and linked to the Issues Log so that emerging risks surfaced during stakeholder engagement are captured and rated as they arise.

Rating convention. Likelihood and impact are rated independently on a three-point scale. The combined exposure of each risk is implicit in the Likelihood × Impact pair (e.g., H × H = critical, M × H or H × M = high, M × M = moderate).

Table 35. Likelihood and Impact Rating Scale

Scale	Likelihood	Impact	Score
High (H)	Expected to occur; early signals already present	Material effect on deliverable quality, scope, or timeline	**3**
Medium (M)	Plausible; has occurred on similar engagements	Manageable within the existing workplan with rework	**2**
Low (L)	Possible but unlikely within the project horizon	Minor effect, absorbed through normal QA processes	**1**

Ownership and review cadence. The Team Leader is the overall owner of the risk register. Individual risks are monitored by the functional lead closest to the exposure — Country Regulatory Specialists for R2 and R6, Country Coordinators and the BESS Specialist for R1, the Team Leader for R3, R4, and R5, and Country Coordinators for R7.

Status against each risk is reviewed at biweekly internal coordination meetings, summarized in milestone reports to ETP, and escalated to ETP at any point where a High-rated risk is materializing and cannot be absorbed within the existing mitigation plan.

Table 36. Project Risk Register and Mitigation

ID	Risk Category	Risk Description	Likelihood	Imp	Mitigation Measures
R1	**Data Availability**	Country-specific operational data (dispatch profiles, curtailment records, flexibility utilization, and actual BESS performance data) may be incomplete, confidential, or inaccessible — particularly from EVN (Vietnam) and PLN (Indonesia), where public disclosure is limited.	**H**	**M**	International benchmarks (NREL ATB, IRENA, IEA, BNEF) used as primary cost and performance references, adjusted to country conditions; in-country coordinators pursue alternative and regional sources; all gaps and proxy approaches documented transparently in the Assumptions Book; data sourcing strategy (Section 3.5) identifies redundant sources for every critical input.
R2	**Stakeholder Access**	Key counterparts (EVN, PLN, NGCP, ERAV, MEMR, DOE, ERC, system operators) may be unresponsive or unable to provide timely inputs within the M1–M2 engagement window, delaying flexibility resource mapping and market-entry analysis.	**M**	**H**	Country-specific Regulatory and Power Systems Specialists selected for existing institutional relationships; in-country coordinators for persistent follow-up; stakeholder engagement front-loaded in M1; written information requests logged in the Issues Log with escalation timelines; ETP focal point engaged to facilitate introductions where needed.
R3	**Timeline**	Delays in data receipt, ETP review cycles, stakeholder consultations, or unforeseen events may compress the analytical window for Milestone 2 (Comparative Cost Analysis) or Milestone 3 (Market Entry and Risk Assessment), affecting deliverable quality or submission dates.	**M**	**M**	Parallel country workstreams rather than sequential; front-loaded data collection in M1–M2; weekly internal progress check-ins plus biweekly ETP coordination to surface slippage early; contingency buffer built into M5 between D2 finalization and D3 analytical start.
R4	**Cross-Country Consistency**	Differences in data granularity, market design, and regulatory maturity across Vietnam, the Philippines, and Indonesia could undermine the comparability of LCOF results and weaken the cross-country investment screening narrative.	**M**	**H**	Standardized LCOF framework applied uniformly across all three countries with common cost components and financial assumptions; country-specific variations isolated and clearly flagged rather than embedded; shared Assumptions Book ensures common baseline parameters; Team Leader integration review explicitly targets comparability before each deliverable submission.

ID	Risk Category	Risk Description	Likelihood	Imp	Mitigation Measures
R5	**Analytical Quality**	Complex multi-country, multi-technology modelling (9 technologies × 3 countries × multiple flexibility services) creates risk of calculation errors, internal inconsistencies, or conclusions unsupported by the underlying data.	**M**	**H**	Three-tier peer review: (i) cross-disciplinary technical review by the BESS Specialist and Power Systems Specialists, (ii) cross-country review among country leads, (iii) Team Leader integration review for consistency; Assumptions Book with full traceability to sources; Issues Log for open analytical questions; ETP review cycle at each milestone provides external validation.
R6	**Regulatory Change**	BESS and VRE regulations are evolving rapidly across all three markets — new circulars (e.g., Vietnam Circular updates), GEAP rounds, PLN procurement guidelines, or tariff revisions during the project may change the applicable framework used for market entry analysis.	**H**	**M**	Country Regulatory Specialists monitor policy developments continuously through the engagement; analysis structured to reflect current and near-term regulatory trajectory rather than a single point-in-time snapshot; regulatory-change scenarios tested explicitly in the sensitivity analysis (A5); Issues Log captures developments for ETP discussion at biweekly coordination and milestone reviews.
R7	**Confidentiality & Data Handling**	Stakeholder-provided data (commercial cost information, operator dispatch data, developer project economics) may carry confidentiality restrictions that limit what can be disclosed in public-facing deliverables (Executive Summary, PowerPoint, ETP website articles).	**M**	**L**	Data-sharing protocols (NDAs, use limitations) agreed with each stakeholder in advance; aggregation and anonymization applied where required; confidential inputs held in a restricted internal repository; all public-facing deliverables reviewed for disclosure risk before submission to ETP; UN personal-data protection principles followed throughout (see Section 6 data protection protocols).

8.2 Key Assumptions

Data availability constraints: Country-specific operational data (dispatch profiles, curtailment records, actual flexibility utilization) may be incomplete or inaccessible. Mitigation: Use internationally recognized benchmarks as primary data sources, supplemented by stakeholder interviews and in-country coordinator intelligence. The assumptions book will transparently document all data gaps and the proxy approaches used.

Stakeholder access challenges: Key counterparts (regulators, system operators) may be unresponsive or unable to provide timely inputs. Mitigation: Country-specific specialists with established institutional relationships; in-country coordinators for persistent follow-up; multiple alternative sources for critical data points; front-loading stakeholder engagement in M1.

Regulatory changes during the project: BESS and VRE regulations are evolving rapidly in all three countries. Mitigation: Regulatory Specialists monitor policy developments continuously; analysis is structured to reflect current and near-term regulatory trajectories rather than a single point-in-time snapshot; sensitivity analysis tests the impact of regulatory scenarios on competitiveness.

Cross-country comparability: Different data availability and market structures across countries could undermine comparability. Mitigation: Standardized LCOF framework applied uniformly; country-specific variations clearly isolated and documented; Team Leader's integration review specifically targets comparability.

Analytical quality: Complex multi-country, multi-technology analysis creates risk of errors or inconsistencies. Mitigation: Structured peer review protocols; assumptions book with full traceability; Issues Log for tracking and resolving open questions; ETP review cycle at each milestone provides external validation.

9 Monitoring and Evaluation Plan

9.1 RBMF Framework

Table 37. Results-Based Monitoring Framework

Results-Based Monitoring Framework	
Anticipated Impact	Increased BESS capacities in Vietnam, Indonesia, and the Philippines to support grid flexibility
Outcome	2.2a Robust pipeline of bankable RE, EE, and grid projects to increase investments
Output	This project will cover three main outputs: • Comparative Cost Analysis • Market Entry Strategies • Risk Assessment
Indicator	Target
OC2.2 Value of Investments of RE, EE, and grid projects facilitated	**The value will be determined and captured in RBMF during project implementation*
OP2.2 Number of investment roadmaps, scoping studies, market assessment, and other pre-development analyses and tools completed for RE, EE, fossil fuel phasedown, and grid projects	1- Comparative Cost Analysis 1- Market Entry Strategies and Risk Assessment

To achieve OP2.2, the Project team will collect data from stakeholder engagements and report the activity and findings according to the RBMF to ETP.

All data will be turned over to UNOPS ETP for monitoring the achievement of OC2.2 after the project has been completed.

9.2 Reporting Schedule for RBMF Submissions

The RBM F template will be submitted on a biannual basis, as presented in the table below with corresponding coverage.

Table 38. Submission timeline of the RBMF

Period coverage	Submission
January 2026 to June 2026	15 June 2026
July 2026 to December 2026	15 December 2026

10 Communications Plan

To ensure effective knowledge dissemination and stakeholder engagement, a range of communication materials will be developed and shared throughout the project cycle. The table below outlines the planned communication materials, their content focus, expected timeline, and additional remarks.

The key objectives are:

- Promote awareness of project objectives, milestones, and expected outcomes
- Support knowledge sharing with stakeholders across Indonesia, the Philippines, and Vietnam
- Strengthen transparency and visibility of project activities
- Encourage private sector and stakeholder engagement through accessible and targeted communication

Target audiences for these communication materials are:

- Government
- Energy regulators
- Impact investors
- Private developers
- Engineering, Procurement, and Construction Management (EPCM)
- Commercial & Industrial (CI)
- Banks
- General public with interest in energy transition and market development

10.1 Communications Outputs and Schedule

Table 39. Communication Requirements

No	Communication Items	Quantity and description	Content specifics
1	**Social Media Post** The Project Team will provide texts for social media updates (approx. 100 words). The ETP team	**1 post** per milestone reached Total of 3 posts including caption	**Post 1:** Milestone 1: Inception Report Content: Overall objective of the project Draft submission: 8 May 2026 Target publication: 22 May 2026

No	Communication Items	Quantity and description	Content specifics
	will publish the content on ETP's social media sites (LinkedIn, Facebook, Twitter)	and visuals (photos, charts/figures, etc.)	**Post 2:** Milestone 2: Comparative Cost of Flexibility Analysis Content: key results and figures for different scenarios in Indonesia, Philippines, and Vietnam Draft submission: 11 September 2026 Target publication: 25 September 2026 **Post 3:** Milestone 3: Market Entry Strategies and Risk Assessment Content: investment readiness and market entry conditions in Indonesia, Philippines, and Vietnam, specifically, entry pathways, associated business models, and key risks affecting private sector participation. Draft submission: 7 December 2026 Target publication: 21 December 2026
2	**Articles for ETP Website** The Project Team will compile texts, following which the ETP team will publish the article on ETP website. The articles will be impactful and engaging, and capture key project activities. Each article will be submitted with a minimum of 3 high-quality photos/graphics	**Total of 2 articles** including 1 by mid-project and 1 upon project completion	**Article 1** To be published at Mid-project completion. Content: Initial project findings Draft submission: 31 July 2026 Target publication: 14 August 2026 **Article 2** To be published at Project completion Content: Relevant to the project wrap-up presentation, covering the project's validated findings and analyses Draft submission: 4 January 2027 Target publication: 18 January 2027
3	**Project wrap-up presentation** A 15-20 minute recorded presentation (with slide deck) summarizing key highlights of the project. The recording will be featured on the ETP website as a knowledge item.	**Total of 1** upon project completion	One project wrap-up will be prepared highlighting the key findings of the project. Draft submission: 4 January 2027 Target publication: 18 January 2027
4	Press releases The Project Team will compile texts, following which, the ETP team will publish the press release on ETP website	**1 post** per public workshop/ event	Press releases will be drafted from project activities, which includes stakeholder consultations.

No	Communication Items	Quantity and description	Content specifics
5	Database of project photographs from events/activities	**15-20** high-quality images per workshop/event/ activity, inclusive of ‘action shots’ capturing key speeches, activities, and participant engagement	Throughout the project cycle, we will collect photographs during the project activities, following policy of inclusivity and balanced representation of women.

Note: Dates are subject to change

10.2 ETP Communications and Visibility Compliance

The Project Team will thoroughly review and adhere to the ETP Communications and Visibility Guidelines to ensure full compliance, thereby facilitating timely and efficient approval of communication materials. These guidelines cover requirements related to approved color scheme, proper use of logos, design standards, disclaimers, and fair use principles.

10.3 Internal Review and ETP Approval Workflow

An internal review and approval workflow for all external communications and project-related updates will be developed. The table below outlines the teams involved, along with respective roles and responsibilities in developing and approving the communication requirements.

Table 40. Team Roles and Responsibilities for Project Communication Requirements

Team	Roles and Responsibilities
Project Team	• Draft communication content, key messages, and supporting visuals. • Ensure technical accuracy and alignment with project outputs. • Ensure compliance with ETP Communications and Visibility Guidelines.
ETP Communications Team	• Review and provide feedback on submitted materials for quality, clarity, and alignment with the project. • Publish approved materials across relevant platforms.

All communication materials will be submitted to the ETP Communications Team, undergoing a 10-working day review and approval process. Final publication will proceed only after formal clearance.

Prepared by:

NIRAS

ENERGY TRANSITION PARTNERSHIP

UNOPS

AFD AGENCE FRANÇAISE DE DÉVELOPPEMENT

Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Australian Government
Department of Climate Change, Energy, the Environment and Water

CIFF CHILDREN'S INVESTMENT FUND FOUNDATION

SEQUOIA CLIMATE FOUNDATION