REPORT

Clean Energy Business Model and Net-Zero Roadmap for Thang Long II Industrial Park

SEPTEMBER - 2025

Prepared by:

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Acknowledgements

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Executive Summary

This initiative, ***Pilot Energy Investment and Planning for Industrial Parks and Economic Zones: Initial Study for Thang Long II Industrial Park***, is supported by the Southeast Asia Energy Transition Partnership (ETP) under UNOPS, in collaboration with Vietnam's Ministry of Finance (MoF). Its overarching goal is to advance sustainable energy practices in Vietnam's industrial parks through a pilot assessment of Thang Long II Industrial Park (TLIP II) in Hung Yen Province.

The report consolidates six months of analytical work combining policy research, technical assessment, and financial modelling. It presents a comprehensive analysis of the current power system, energy demand–supply patterns, and investment potential at TLIP II. Building on these findings, it proposes a clean energy business model and a roadmap for achieving Net Zero emissions by 2035, structured around technical feasibility, financial viability, and regulatory readiness.

The study applied both top-down and bottom-up approaches. At the macro level, it gathered data and policy insights from MoF, Hung Yen's Industrial Park Management Board, Hung Yen Power Company, and provincial departments. At the micro level, detailed surveys and energy audits were conducted across TLIP II's manufacturing tenants. A field survey in June 2025 verified on-site data and validated assumptions for energy consumption, load profiles, and rooftop solar potential. This multi-layered approach ensured analytical accuracy and relevance to real-world conditions.

The study highlights the need to shift from a conventional, one-way electricity supply model to a distributed energy ecosystem that can be coordinated and optimized in real time. Against the backdrop of growing pressure from markets, supply chains, and national policy frameworks to reduce emissions, the report argues that **industrial parks must no longer be viewed simply as energy consumers but as critical actors in Vietnam's energy transition strategy.**

Context and Potential of Thang Long II Industrial Park

Hung Yen Province has become a major industrial hub in northern Vietnam, hosting 17 industrial parks and 534 FDI projects with cumulative registered capital of USD 6.7 billion. Japan is the largest investor, accounting for 173 projects worth USD 4 billion. In 2024, the province achieved 7.7% GRDP growth, driven by an 11.07% increase in industrial output, and its 2021–2030 master plan envisions 30 industrial parks over 9,589 hectares, emphasizing green and sustainable infrastructure.

TLIP II, established in 2006 as a joint venture between Sumitomo Corporation and Licogi, is one of Vietnam's leading industrial parks. Spanning 527.5 hectares, it hosts 103 FDI projects valued at USD 2.9 billion, achieving 95.4% occupancy and employing around 25,000 workers. The park's infrastructure includes a 189 MVA 110 kV substation, a 24,000 m^3/day water plant, and a 15,000 m^3/day wastewater treatment system. Its ongoing expansion (Phases 3 and 4) will elevate TLIP II into an integrated industrial–urban complex, making it a prime candidate for piloting Vietnam's first Net-Zero Industrial Park model.

Power System Assessment

TLIP II's electricity load is stable and well-utilized, reflecting its concentration of automotive and electronics manufacturers. Load curves align closely with solar irradiance, offering strong potential for rooftop solar integration. Twenty-five rooftop solar projects currently provide 23.9 MWp, while the technical potential is estimated at 80–100 MWp, capable of meeting up to 70% of peak demand when combined with energy storage.

However, the grid infrastructure in Hung Yen Province is under strain. The 500 kV Pho Noi substation operates above design capacity, and several 220 kV substations are near overload. Provincial power-development plans (2021–2030) include upgrading Pho Noi to 1,800 MVA, building a new 500 kV Hung Yen substation, and adding 248 km of 110 kV transmission lines—investments critical to maintaining reliability.

Beyond grid capacity, TLIP II's current business model, based on EVN-supplied power and internal redistribution, ensures stability but limits renewable adoption and ESG traceability. Without advanced Energy Management Systems (EMS) or access to direct power-purchase agreements (DPPAs), both technical and financial bottlenecks emerge once renewable penetration exceeds 20–30%. Limited access to green finance further constrains SMEs. Overcoming these challenges requires a fundamental shift in both energy infrastructure and regulatory models.

Clean Energy Pathways and Hybrid Business Models

To unlock TLIP II's potential, the study recommends a **hybrid clean energy model** that layers short-term compliance tools with long-term energy autonomy. The model integrates:

- **External DPPAs**: Immediate, no-capex sourcing of renewable electricity from off-site generators, enabling 5–15% cost savings and rapid ESG compliance.
- **Internal DPPAs**: Mid-term mechanisms allowing rooftop and ground-mounted solar within the park to sell power directly to tenants, pending regulatory reform.
- **Smart EMS and BESS**: Centralized digital control and energy storage to reduce 2–5% technical losses (≈0.7 GWh/year), optimize dispatch, and improve resilience.
- **I-RECs**: Transitional certification mechanisms enabling up to 60% of tenants to demonstrate renewable sourcing until internal trading matures.
- **Regulatory Sandbox (2026–2028)**: A pilot enabling intra-park energy trading, shared infrastructure, and data-driven regulation of the new business model.

This integrated approach provides immediate ESG and financial benefits while laying the foundation for long-term energy independence and grid-friendly operations.

Investment Scenarios

These pathways translate into three investment scenarios, each with goals developed through stakeholder workshops (management, tenants, People's Committee of Hung Yen Province, MOF), baseline audits (load curves, renewable energy potential), and techno-economic modeling (LCOE/NPV/IRR, RE cost curves). The scenarios are:

1. **2030 Hybrid Scenario – 50–70% Renewable Energy**
   By 2030, TLIP II can reach 50–70% renewable penetration with USD 30–40 million in investments for 50 MWp rooftop solar, 20 MW/40 MWh BESS, and a park-wide EMS. This pathway delivers immediate ESG compliance, tangible cost savings (~USD 1.2–1.5M annually), and shortens rooftop solar payback from 5–7 years to 4–6 years when combined with I-RECs.
2. **Accelerated Scenario – Net Zero by 2035**
   With USD 80–100 million in investment, TLIP II can achieve 100% renewable supply by 2035. This requires 130 MWp of rooftop solar, 30 MW/60 MWh BESS, and full EMS-enabled intra-park trading. Returns are higher (12–16% ROI), with payback periods of 6–9 years, and annual savings of USD 5–7 million. This scenario positions TLIP II as Vietnam's pioneering Net Zero industrial park and a magnet for green FDI.
3. **Baseline Scenario – Net Zero by 2050**
   A gradual pathway requiring USD 50–70 million, reaching Net Zero by 2050. It emphasizes incremental rooftop solar, phased EMS deployment, and reliance on evolving regulations.

Returns are modest (10–12% ROI) with longer payback (8–12 years), but the risk profile is lower and more inclusive for SMEs.

Financing Strategies

The framework strategically combines traditional and innovative green finance instruments to unlock capital at scale, de-risk investments, and ensure SME inclusion. Each instrument is selected for its specific role, including compliance, cost reduction, revenue generation, or accessibility, and deployed in synergy across scenarios. Utilization prioritizes layering (e.g., guarantees and bonds), sequencing (e.g., short-term I-RECs to long-term internal DPPAs), and tenant-centric design (e.g., leasing for SMEs).

Table ES-1: Key Financing Instruments and Targeted Use for Thang Long II Industrial Park

Instrument	Purpose & Role	Target Use & Scale	Synergies
Green Bonds (ASEAN-aligned)	Fund large infrastructure (solar, BESS) with credible ESG labeling	USD 30–50M across scenarios	Paired with MDB guarantees to lower yields by 50–100 basis points (bps)
Sustainability-Linked Loans	Incentivize performance (RE% targets) via margin reductions	USD 20–25M (Hybrid/Accelerated)	KPIs tied to EMS deployment and I-REC issuance
PE/VC Funds	High-risk, high-return tech (EMS, BESS, smart metering)	USD 10–15M (Accelerated)	Co-invests with ECAs for tech imports
ECA Financing (Japan, Korea)	Low-cost, long-tenor loans for equipment imports	USD 10–12M	Bundled with local currency hedging to protect SMEs
I-RECs + Carbon Finance	Generate recurring revenue; bridge to full internal trading	USD 0.7–1.6M/yr	Funds O&M and accelerates payback (e.g., Hybrid: 4→6 years)
MDB/IFC Guarantees	De-risk private capital; reduce borrowing costs	Covers 20–30% of senior debt	Unlocks institutional investors; enables bond issuance
Leasing & Crowdfunding	Zero-upfront models for SMEs; democratize access	USD 5–10M (all scenarios)	Aggregated via park SPV; backed by I-REC revenue

•

Risk Assessment and Management

The report categorizes risks into **financial**, **legal and institutional**, and **market** risks. Key vulnerabilities include high upfront capital costs, unclear legal frameworks for intra-park energy trading, grid congestion, and market price volatility (for electricity and RECs).

The proposed mitigation framework centers on:

- **Diversified financing and risk sharing** through joint ventures and blended instruments;
- **Legal sandboxes** to pilot internal power trading;

- **Technical safeguards** via EMS-based grid codes; and
- **Phased deployment** to allow adaptive learning and capacity building.

POLICY ENABLERS

To realize the accelerated 2035 Net Zero roadmap, the report recommends eight breakthrough policy reforms, with a focus on deepening industrial-park governance, green finance mobilization, and grid integration. These support Vietnam's evolving regulatory landscape, unlock blended capital, and position TLIP II as a national prototype. MOF plays a key role in industrial-park licensing, master planning, and green finance architecture; MOIT handles energy mechanics; EVN oversees grid rules. The Hung Yen PPC acts as the local accelerator, including piloting reforms, issuing provincial green bonds, bundling with MOF guarantees, and offering fast-track licensing. Notably, the June 2025 merger of Hung Yen and Thai Binh into a unified Hung Yen Province requires an immediate priority action: revise the provincial master plan by Q1 2026. Led by the PPC with MOF, the update must embed renewable mandates, low-carbon zoning, and grid-support provisions to enable TLIP II's Net Zero roadmap. :

Table ES-2: Breakthrough Policy Reforms and Respective Roles of Stakeholders

Reform	Description/ Explanation	Importance	Lead Governmental Entity	Execution Role
Establish an Industrial Energy Transition Fund and credit guarantees	**MOF-seeded fund** offering partial credit guarantees, concessional loans below market, and viability gap grants.	De-risks debt , mobilizes private capital, closes SME equity gap.	**Ministry of Finance (MOF),** State Bank of Vietnam (SBV), PPC (People's Provincial Committee) for local implementation	Board: apply for funding; Tenants: access leasing; PPC: co-finance local share.
Launch Provincial Green Bonds with national backstop	Authorize PPCs to issue **municipal green bonds** for RE infrastructure, backed by MOF partial guarantee and project pipeline.	Crowds in institutional investors, reduces yields, funds 30–50% of Hybrid/Accelerated scenarios.	**MOF, PPC for issuance**	PPC: issue bonds; Board: submit bankable projects; MOF: guarantee facility.
Integrate clean-energy criteria into industrial-park licensing and planning	**Mandate RE + ESG audits in MOF master plans and licensing regulations**; prioritize low-carbon zoning in new/expanded parks.	Attracts rental premiums, prevents lock-in, aligns with national eco-industrial park strategy.	**MOF, PPC for provincial plans**	Board: prepare RE-compliant master plan; Tenants: meet ESG criteria; PPC: enforce zoning.
Enable shared infrastructure ownership and operation	**Revise regulations on industrial parks to allow multi-tenant SPVs owning**	Reduces SME capex, enables intra-park	**MOF, PPC for land allocation**	Board: form SPV; Tenants: co-own via leasing; SMEs:

	solar/BESS/EMS; permit revenue-sharing PPAs and leasing.	trading, scales shared RE.		zero-upfront access.
Develop a National Net-Zero Industrial Park Standard for certification and benchmarking	MOF tiered standard; links to **tax holidays, green bond eligibility, and carbon finance**.	Unlocks revenue, benchmarks vs. VSIP/Amata, signals ASEAN leadership.	**MOF; PPC for pilot certification**	Board: lead certification; Tenants: report data; PPC: offer local incentives.
Legalize internal DPPAs within industrial parks	Amend Electricity Law to permit direct tenant-generator contracts via private wires or virtual wheeling; allow park SPV as counterparty.	Enables tenant savings, scales RE.	**Ministry of Industry and Trade (MOIT), EVN for metering, PPC for local approval**	Board: sign DPPAs; Tenants: purchase direct; EVN: approve wheeling.
Recognize park operators as mini-grid managers	Grant licensed status for parks to operate internal grids, BESS dispatch, and EMS.	Cuts losses, ensures resilience, supports RE integration.	**MOIT, PPC for pilot licensing**	Board: operate mini-grid; Tenants: benefit from reliability.
Authorize grid-support services from industrial parks	Allow parks to provide **ancillary services** (frequency regulation, peak shaving) via BESS to EVN with clear remuneration	Provides clear revenue streams, reduces Hung Yen grid strain, accelerates payback.	**MOIT, EVN for dispatch integration; PPC for local pilots**	Board: dispatch BESS; EVN: integrate signals; Tenants: share revenues.

Implementation Roadmap and Next Steps

TLIP II is poised to redefine industrial parks from passive energy consumers to active renewable energy producers, including generating, storing, and trading clean power at scale. By 2030, the Hybrid Scenario transforms the park into a 70 MWp solar + 40 MWh storage microgrid, supplying 50–70% of its demand and exporting surplus via grid-support services. The Accelerated Scenario elevates TLIP II into a Net Zero energy-producing industrial park by 2035, with 130 MWp generation capacity exceeding internal load, enabling intra-park trading, ancillary services to EVN, and carbon-negative operations.

Table 0-1: Execution Plan for Thang Long II Industrial Park

Phase	TLIP II Key Actions	Owner	Indicative Timeline	Scenario
Phase 0: Pre-Launch	• Finalize **TLIP II RE Master Plan** (rooftop + EMS blueprint) • Secure **3+ anchor tenants** (RE100-committed FDI) • Form **TLIP II RECo SPV**	**TLIP II Management Board + PPC**	**Q4 2025**	All
	• Seed **Industrial Energy Transition Fund** (USD 50M, TLIP II as flagship)	**MOF**	**Q4 2025**	All
Phase 1: Pilot & Sandbox at TLIP II	• Launch **Sandbox** (internal DPPA + mini-grid pilot **exclusively at TLIP II**)	**PPC**	**Q1 2026**	All
	• Deploy **5–10 MW rooftop solar + 5 MW/10 MWh BESS** (Phase 3 roofs)	**TLIP II Board**	**Q3 2026**	Hybrid
	• Issue **Hung Yen's first provincial green bond (USD 15M) — 100% for TLIP II**	**PPC**	**Q3 2026**	Hybrid/Accelerated
	• Activate **TLIP II SME Green Leasing Facility (USD 5M)**	**PPC + TLIP II Board**	**Q4 2026**	Hybrid
Phase 2: Full Scale-Up at TLIP II	• Expand to **50 MWp solar + 20 MW/40 MWh BESS** (all phases + canopies)	**TLIP II SPV**	**Q2 2028**	Hybrid
	• Achieve **50–70% RE penetration** via **internal DPPAs + EMS dispatch**	**TLIP II Board**	**Q4 2030**	**Hybrid Complete**
Phase 3: Net Zero Certification at TLIP II	• Scale to **130 MWp + 30 MW/60 MWh BESS**	**TLIP II Board + PE/VC**	**Q3 2032**	Accelerated
	• Launch **ancillary services to EVN** from TLIP II BESS	**MOIT + EVN**	**Q1 2033**	Accelerated
	• Certify **TLIP II as Net Zero Industrial Park**	**MOF**	**Q4 2035**	**Accelerated Complete**
Phase 4: National	• Adapt **TLIP II model** to other **pilot parks**	**MOF + PPCs**	**2030–2032**	Baseline

Replication *(Triggered by TLIP II success)*	• Scale to **10+ parks** via **Net Zero Standard rollout**	**MOF**	**2033–2035**	Baseline

***Disclaimer**: All timelines are TLIP II-specific and assume Q1 2026 sandbox launch and post-merger master plan approval. Delays in regulatory reforms, funding, or EVN integration shift TLIP II milestones. Progress reviewed quarterly by TLIP II Board + PPC.*

As energy producers, industrial parks become critical nodes in Vietnam's power system: alleviating grid congestion, enhancing resilience, and accelerating PDP8/JETP goals. TLIP II's framework, blending policy reform, green finance, and digital infrastructure, offers a national blueprint and anchors Vietnam's Net Zero commitment.

1. Introduction and Project Overview

1.1. Industrial Parks as Engines of Vietnam's Economic Growth

Vietnam's industrial park (IP) strategy has underpinned three decades of industrialization and export-led growth. Since the first foreign-invested IP (Nomura, 1992) following the 1987 Law on Foreign Investment, IPs have evolved into a nationwide network enabling FDI attraction, technology transfer, and large-scale manufacturing. As of December 2023, **Vietnam hosts 414 IPs (including export processing zones), with approximately 69% of the country's industrial land allocated to IPs.** Of these, 293 are operational and 121 are in land clearance/compensation. Border-gate and coastal economic zones further expand industrial space and logistics connectivity.

Provincial master plans to 2030 envisage 221 new IPs and 76 expansions, deliberately spreading growth from legacy hubs (HCMC, Hanoi, Binh Duong) to emerging provinces (Thanh Hoa, Nghe An, Quang Ninh). **The economic salience is clear: IPs contribute over half of national export turnover and millions of jobs, making sustained investment in power, water, waste, logistics, and digital infrastructure a competitiveness imperative.**

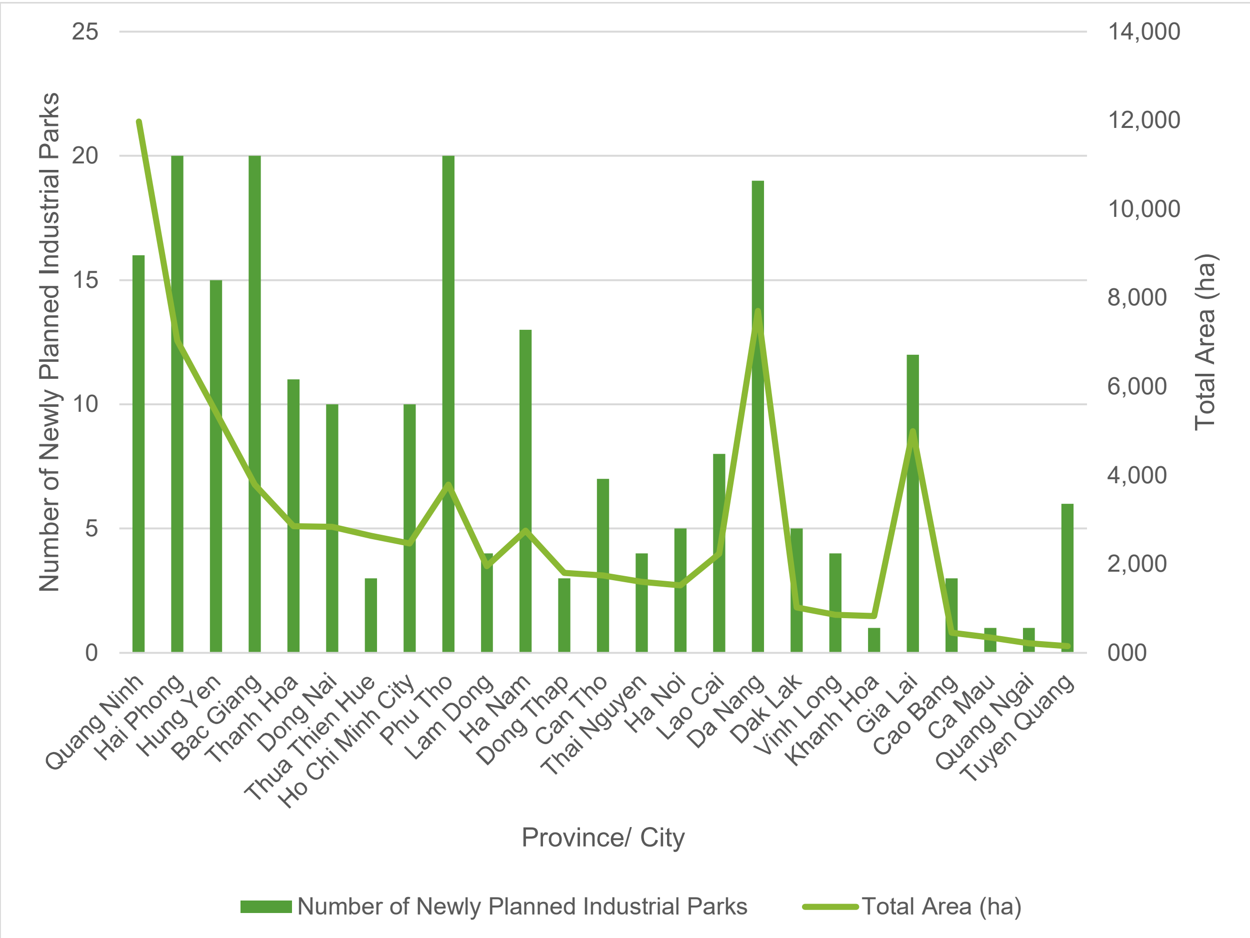


Figure 1-1: Number and Total Area of Newly Planned Industrial Parks by Province/City

This chart illustrates the number and total area (in hectares) of newly planned industrial parks in 25 provinces and cities across Vietnam. The primary y-axis (left) corresponds to the number of industrial parks (green bars), while the secondary y-axis (right) corresponds to the total area in hectares (green line). The chart is organized alphabetically by province/city.

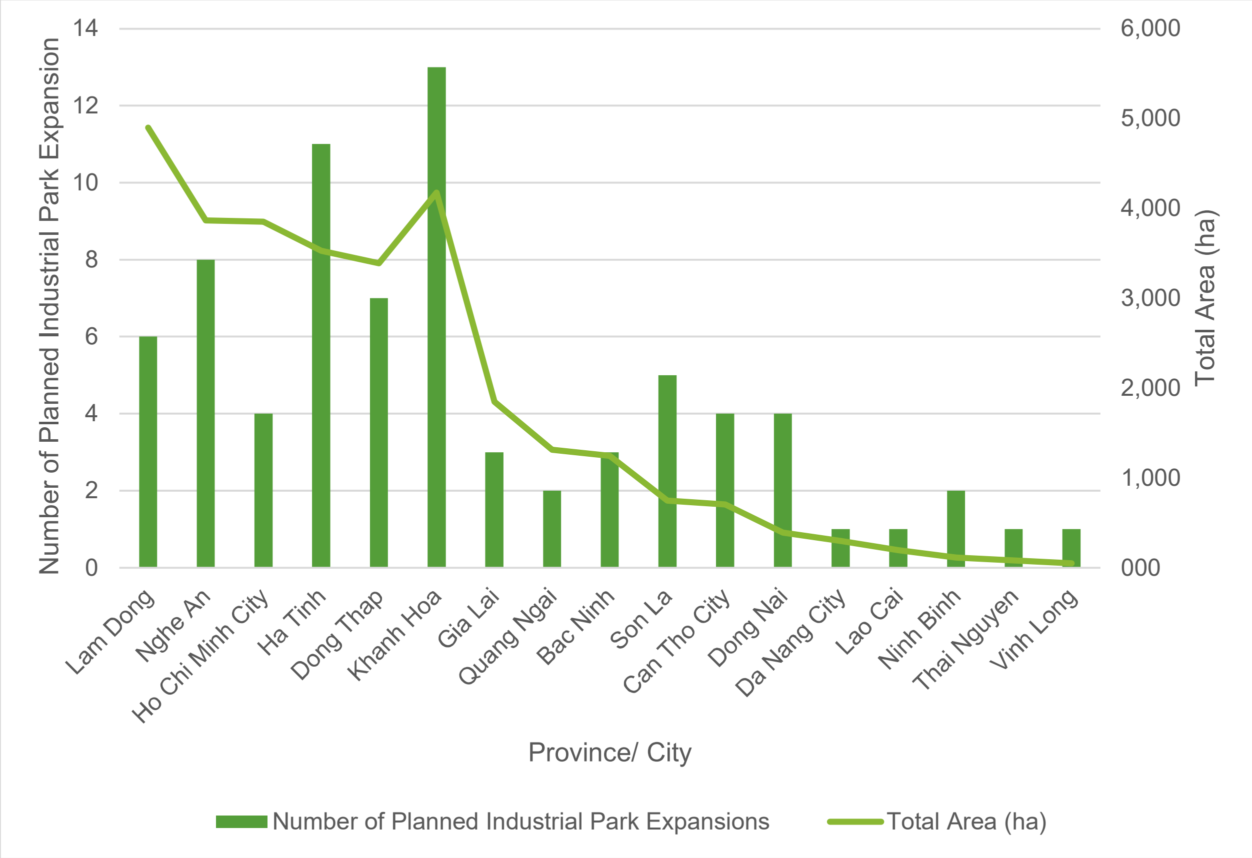


Figure 1-2: Number and Total Area of Planned Industrial Park Expansions by Province/City

This chart illustrates the number and total area (in hectares) of planned industrial park expansions across various provinces and cities. The green bars correspond to the number of planned expansions (left y-axis), while the green line represents the total area in hectares (right y-axis).

At the same time, global FDI preferences are shifting. Multinational corporations (MNCs) pursuing Net Zero/RE100 now prioritize locations with verifiable access to clean energy—via on-site renewables, off-site power purchase agreements (PPAs/DPPAs), credible certificates (e.g., I-RECs), and transparent metering/reporting. Corporate clean-energy procurement reached record levels in 2023–2024, led by technology, data centers, and advanced manufacturing. Jurisdictions that clarify PPAs, streamline grid access, and standardize certification are capturing higher-quality investment; delays or uncertainty, by contrast, are already influencing site selection in the region. **For Vietnam's IPs, clean-energy readiness is no longer optional; it is a core site-selection criterion that directly affects both occupancy and value-added.**

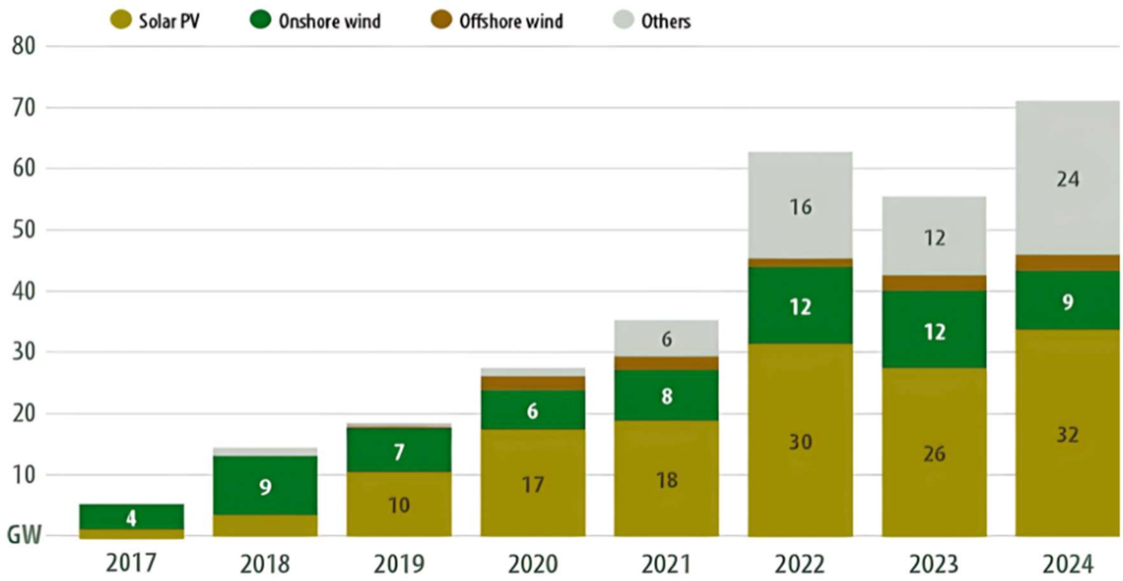


Figure 1-3: Corporate Clean Energy Procurement Technology Breakdown (GW)

Source: Authors' adaptation from S&P Global Commodity Insights

These market dynamics intersect with Vietnam's policy pivot toward Eco-Industrial Parks (EIPs), an agenda that links industrial growth with resource efficiency and decarbonization. Decree 82/2018 laid foundational incentives; Decree 35/2022 refined definitions, roles, and performance criteria for EIPs, emphasizing infrastructure for renewables, industrial symbiosis, and measurable outcomes. In practice, this means **IPs must evolve from passive consumers to active power-system participants, coordinating on-site generation, storage, and demand response with provincial grid plans and market rules.**

1.2. Case Focus: Thang Long II Industrial Park (TLIP II), Hung Yen Province

Hung Yen is a northern industrial hub with 17 IPs and strong Japanese FDI in electronics and automotive components. These parks have attracted 534 valid FDI projects, with a total registered capital of approximately $6.7 billion[1]. Japan is the leading investor, with 173 projects and over $4 billion in registered capital, driven by Hung Yen's strategic location and infrastructure. Approximately 170 Japanese projects are operational, employing 45,000 workers in sectors like electronics (e.g., Canon) and automotive (e.g., Toyota).

This study focuses on Thang Long II Industrial Park, located in Hung Yen Province, a key industrial hub in the northern region of Vietnam. TLIP II (estimatedly 2006 by Sumitomo and Licogi) spans approximately 527.5 ha, hosts 103 FDI projects (approximately USD 2.9bn), operates at approximately 95% occupancy, and employs about 25,000 workers. Infrastructure includes a 110 kV substation (189 MVA, upgrading to 216 MVA), 24,000 m³/day water supply, and 15,000 m³/day wastewater treatment. Ongoing expansion (Phase 4, about 391.7 ha) will evolve TLIP II toward an integrated industrial-urban model.

[1] Hà Thạch. 2023. Tập đoàn Nhật Bản rót thêm 500 triệu USD phát triển KCN Thăng Long II. Tin nhanh Nhà đất. https://tinnhanhnhadat.vn/tap-doan-nhat-ban-rot-them-500-trieu-usd-phat-trien-kcn-thang-long-ii.html

ADMINISTRATIVE BOUNDARY MAP OF HUNG YEN PROVINCE

TỈNH HƯNG YÊN

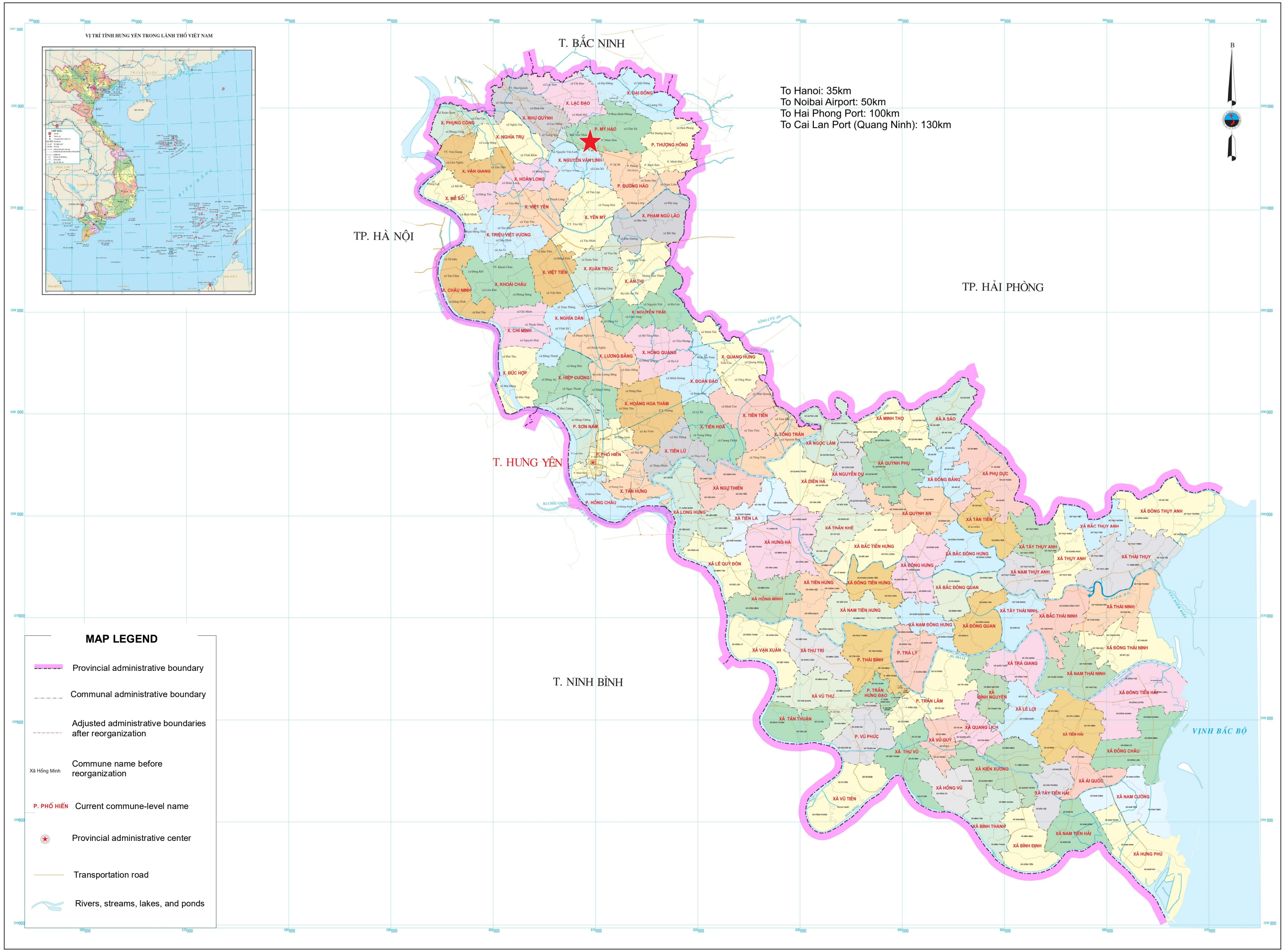


Figure 1-4: Location of Thang Long II Industrial Park on the Vietnam and Hung Yen Province Maps

Source: Authors' compilation

TLIP II is planned as a multi-sector industrial park, targeting high-tech and high-value-added industries. Key sectors include:

- Electronic component and precision engineering manufacturing
- Electromechanical and transportation equipment production
- Rubber products and automotive parts
- Light industry and industrial gases
- Pharmaceutical, vaccine, and biotechnological product manufacturing
- Optical glass and other high-tech industries

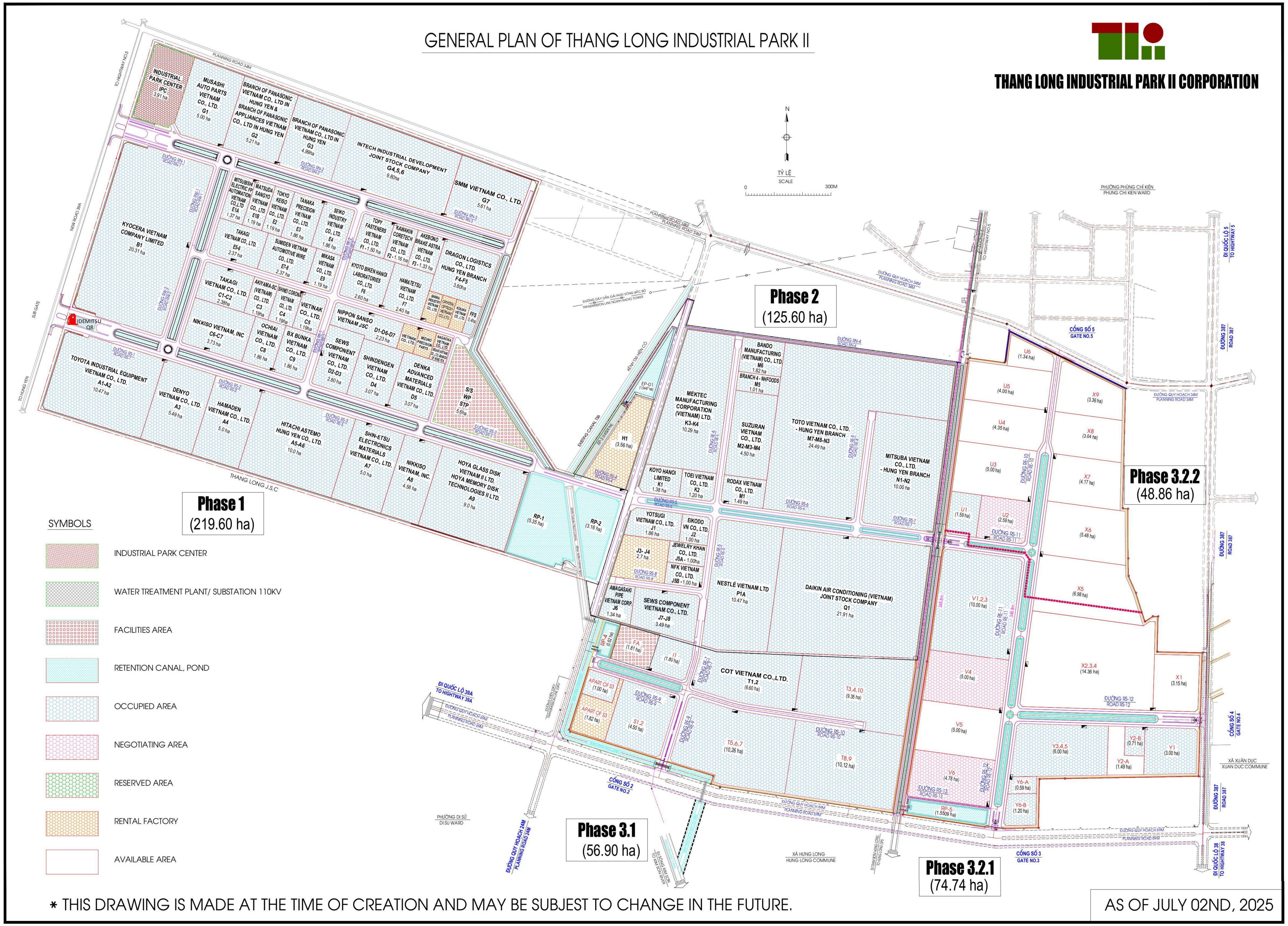


Figure 1-5: General Plan of Thang Long Industrial Park II

Source: Thang Long Industrial Park II Management Board

1.3. Scope of Study and Report Objectives

Against this backdrop, the present initiative, *Pilot Energy Investment and Planning for Industrial Parks and Economic Zones: Initial Study for Thang Long II Industrial Park (TLIP II)*, is supported by the Southeast Asia Energy Transition Partnership (ETP) under UNOPS, in collaboration with the Ministry of Finance (MoF). It was implemented over a six-month period (from March 2025 to September 2025), with an overarching purpose to **translate clean-energy ambitions into an investment-ready pathway** for a leading park, creating a replicable template for other IPs.

The study's objectives are to:

- **Assess supply reliability and load dynamics** at TLIP II within the context of provincial transmission constraints;
- **Evaluate renewable integration options** (on-site PV, off-site procurement) and system flexibility needs (EMS, BESS);
- **Propose viable business models** (e.g., external/internal DPPAs, energy-as-a-service, intra-park trading) and the enabling policy/market instruments;
- **Develop a sequenced investment roadmap** aligned with Vietnam's green growth and energy strategies (e.g., Resolution 55-NQ/TW; national energy strategy to 2030 with vision to 2045).

To realize the objectives, this study **integrates top-down and bottom-up approaches:**

- **Top-down:** engagement with MoF, Hung Yen IP Management Board, provincial departments, and the power utility to assess system adequacy, planning pipelines, and policy levers.
- **Bottom-up:** structured consultations and on-site data collection from TLIP II management and tenants (June–July 2025), plus a **field survey in June 2025** to validate infrastructure, metering, and operational practices.

The findings integrate operational data (load curves, utilization patterns), infrastructure assessments, renewable resource and technical potential, and bankability factors (financing structures, risk allocation). Drawing on robust data collection and extensive stakeholder engagement, the study puts forward action-oriented business models and investment pathways.

It should be noted that the analysis was conducted prior to the provincial merger finalized in June 2025, when Thái Bình and Hưng Yên were administratively consolidated. All data and consultations therefore reflect the former Hưng Yên boundaries. Where these administrative changes may affect comparability, the study explicitly states assumptions and provides sensitivity checks in the technical annexes.

1.4. Report Outline

This report is organized into the following main sections:

- **Section 1 – Introduction**
  This section introduces the role of industrial parks in Vietnam's economic development, their contribution to FDI and exports, and the national shift toward eco-industrial parks (EIPs) as part of the green growth agenda. It then presents Thang Long II Industrial Park (TLIP II) as the case study, outlining its background, infrastructure, and expansion trajectory. The section also explains the study's purpose, objectives, methodology, and data boundaries to provide a clear foundation for subsequent analysis.
- **Section 2 – Power System and Renewable Potential**
  This section analyzes the current status of the provincial grid and provides an overview of

TLIP II's internal energy system, highlighting load dynamics, reliability, and upcoming infrastructure upgrades. It evaluates the technical potential of rooftop solar PV, battery energy storage systems (BESS), energy management systems (EMS), and energy efficiency improvements. The findings establish how renewable energy can be integrated into the park while safeguarding stability and cost-effectiveness.

- **Section 3 – Enabling Policies and Instruments**
  This section reviews national and provincial policies supporting renewable energy and EIP development, such as Decree 35/2022/NĐ-CP, and identifies regulatory gaps that limit clean energy adoption in IPs. It discusses barriers to direct power purchase agreements, intra-park power trading, and advanced energy services. Potential enabling instruments, including energy-as-a-service models, shared EMS/BESS platforms, and International Renewable Energy Certificates (I-RECs), are highlighted as pathways for tenants to meet ESG requirements and strengthen competitiveness.
- **Section 4 – Investment Strategies and Business Models**
  This section develops practical investment strategies for clean energy deployment at TLIP II, including external PPAs, internal PPAs, and hybrid procurement approaches. It also considers EMS+BESS solutions for system flexibility and reliability. Different delivery and financing models are compared, with attention to risk allocation and their suitability for diverse tenant profiles, from large multinational investors to small and medium-sized enterprises.
- **Section 5 – Investment Roadmap for TLIP II**
  This section proposes a sequenced roadmap of actions to transition TLIP II toward Net Zero, structured across short-term (0–3 years), medium-term (3–7 years), and long-term (to 2035) horizons. The roadmap includes technical measures, regulatory reforms, and financing instruments, as well as governance arrangements for effective implementation. Milestones are set to ensure that clean energy adoption, infrastructure upgrades, and investment planning remain on track and scalable over time.
- **Section 6 – Conclusions and Recommendations**
  This section consolidates the study's findings and outlines priority actions for TLIP II and other industrial parks in Vietnam. Recommendations emphasize infrastructure improvements, regulatory and policy reforms, innovative financing and risk-sharing mechanisms, and institutional coordination among stakeholders. By following these actions, TLIP II can serve as a flagship model for green industrial park development and contribute to Vietnam's broader energy transition and green growth objectives.

In sum, Vietnam's IP system is expanding in scale and sophistication just as investors demand clean, reliable power and policymakers advance EIP standards. This report positions TLIP II to meet that convergence by pairing **infrastructure and operational upgrades** with **market-compatible business models and financing pathways**, so that clean energy becomes a source of competitive advantage for the park and a replicable model for Vietnam's next generation of industrial growth.

2. Power System and Renewable Potential

This chapter integrates evidence on the state of the provincial grid with observed electricity use in Thang Long II Industrial Park, and then assesses renewable options that are technically and operationally compatible with those conditions. The intent is to indicate not only what could be deployed, but how sequencing and system operation can safeguard reliability and cost-effectiveness.

2.1. Power-Supply System: Status, Reliability, and Near-Term Plans

Hung Yen is supplied from the Northern Power System through a tiered 500/220/110 kV network. Major 500/220 kV nodes (notably Pho Noi) feed a set of 220/110 kV substations (including Pho Noi and Kim Dong), which in turn supply the province's 110 kV backbone and industrial parks. Thang Long II Industrial Park is served by an on-site 110/22 kV substation with dual feeds and spare transformer headroom, providing local redundancy. While the 110 kV layer generally operates within normal limits, **several higher-voltage assets and a few 110 kV corridors run close to their thermal and bay-space limits at peak times, signalling tightening headroom in fast-growing zones**.

Reliability has improved year on year as reinforcements and operational changes take effect. Industrial parks are typically prioritised, benefitting from dual source configurations, planned maintenance in off-peak windows, and, at TLIP II, looped 22 kV distribution with ring-main units. Even so, province-wide outage duration remains higher than the national average, reflecting structural constraints: some bulk-supply transformers periodically approach rated loading; certain 220 kV/110 kV corridors experience congestion under coincident peaks; and a small number of substations have limited spare feeder bays. Dependence on a handful of high-capacity corridors also creates single-contingency pinch points during planned works or extreme weather.

Planned upgrades under PDP VIII and the Hung Yen Provincial Plan address these pressures: uprating of existing 500/220 kV capacity, a new 500 kV node in-province, additional 220/110 kV substations in growth corridors, and new or reconductored 220 kV and 110 kV lines. These works are designed to relieve current bottlenecks, create hosting capacity for new loads, and enable higher penetrations of distributed renewables. **The main risks are timing and sequencing**: delays to backbone projects or slow bay expansion can perpetuate local congestion, lengthen connection queues, and constrain large-load energisation.

For TLIP II specifically, **the near-term constraints are upstream**: high utilisation on the primary 220 kV supply corridor at peaks, limited spare bays at some receiving substations, and the absence of large on-site generation. Rooftop solar is growing but remains modest and largely uncoordinated behind the meter. **Without park-level coordination, hosting capacity can be quickly exhausted on sunny, low-load days due to voltage rise and reverse-power-flow limits, increasing the risk of curtailment.** In the interim, a practical pathway is: (i) stage new load connections alongside scheduled grid reinforcements; (ii) prioritise self-consumption PV with export limits and grid-friendly controls (power-factor and ramp-rate settings); (iii) develop shared battery energy storage to flatten peaks and absorb midday surplus; and (iv) implement a park-level interconnection plan (feeder-by-feeder hosting-capacity assessments, protection coordination, and harmonics management).

Taken together, the system provides a solid baseline for industrial growth, but with clear constraints that need active management until the next tranche of backbone upgrades is commissioned. Subsequently, Section 2.2 examines Hung Yen Province and TLIP II's actual demand patterns to identify where targeted interventions would yield the greatest operational and cost benefit.

2.2. Load Profile and Electricity Demand Analysis

Hung Yen's electricity demand is industrial-led: in 2024 the industry and construction sector accounted for about three-quarters of commercial consumption, with households, services and agriculture sharing the remainder **(Figure 2-1)**. This structure has been stable since 2019, providing a predictable base for planning and dispatch.

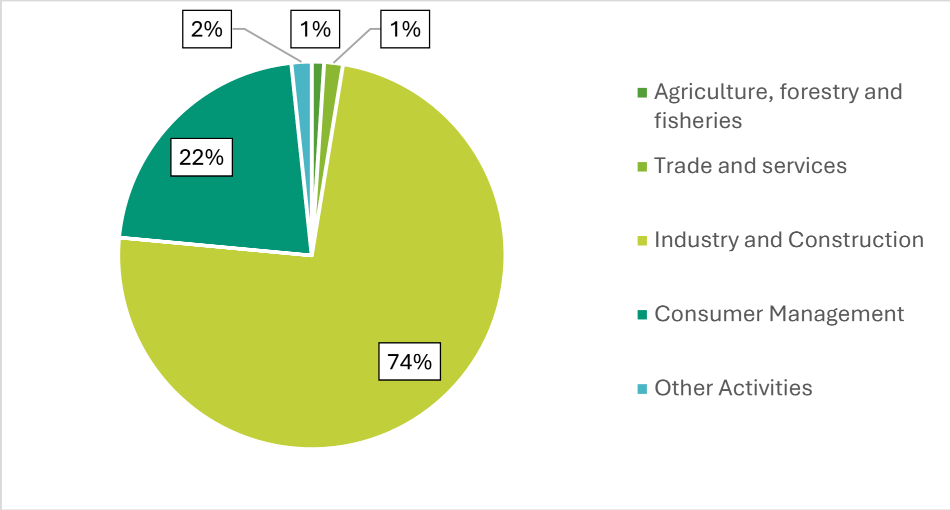


Figure 2-1: Load Composition of Hung Yen Province by Sectoral Structure

Source: Hung Yen Provincial People's Committee

At TLIP II, **annual consumption is steady** with modest year-to-year variation. Following a brief softening in 2023, demand in 2024 recovered to above 2022 levels, consistent with continuous, export-oriented manufacturing. Loads are dominated by production machinery and process HVAC; auxiliary services form a smaller share. Diesel standby sets are generally retained for contingency use only.

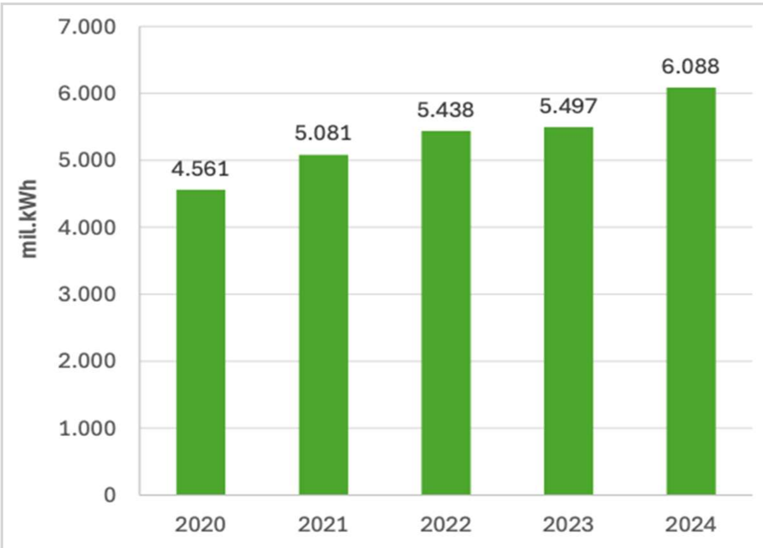


Figure 2-2: Growth of Commercial Electricity

Source: Hung Yen Provincial People's Committee

2.2.1. Daily load profile

A typical weekday shows a rapid morning ramp as shifts start, followed by a broad daytime plateau and an evening taper, yet night-time demand remains substantial due to multi-shift operations.

- Minimum load occurs pre-dawn, at roughly two-thirds to three-quarters of the daytime peak—evidence of a high baseload from continuous processes.

- Peak load sits in the late afternoon. Between 2022 and 2024 the daily peak moved slightly later, consistent with increased on-site solar and process schedules.

TLIP II currently hosts around 25 rooftop PV systems. Their generation window (roughly 09:00–16:00) overlaps the daytime plateau, shaving purchases from the grid, flattening the morning rise, and nudging the peak later. The gap between average and peak load has narrowed, easing stress on upstream feeders during business hours.

2.2.2. Monthly and seasonal pattern

Monthly curves are flat with limited intra-month swing (typically ~10–15%). Demand softens around Lunar New Year, then climbs through the hotter months, when cooling loads coincide with export-cycle production. Short-lived weather events can create temporary dips, but they do not alter the underlying, process-driven profile.

Seasonally, summer afternoons are the most energy-intensive, precisely when solar resource is strongest, while winter shows lower, flatter demand with less intra-day variability.

2.2.3. Implications for planning and reliability

The combination of high baseload and a daytime plateau is well-matched to PV self-consumption. Allocating a modest share of available roof area would enable tens of megawatts of PV, covering a substantial fraction of the midday peak and reducing purchases during higher-tariff periods. Because the evening shoulder remains elevated, BESS can shift midday surplus into the late-afternoon peak, further shaving maximum demand and improving power-quality margins. Given that some upstream assets already operate close to prudent utilization, PV/BESS deployment should be coordinated with the utility on export caps, staged energization and inverter settings so that on-site generation supports rather than stresses the wider grid.

Concurrently, tenant demand for verified low-carbon electricity is intensifying. Net-zero commitments by major FDI firms, supplier ESG requirements (including ISO-based green procurement), and external measures such as the EU CBAM are moving clean power from a reputational preference to a condition of market access. Early PV adoption at TLIP II and plans to scale across the Thang Long portfolio indicate a credible pathway; however, meeting forthcoming supplier audits will require larger, better-coordinated deployment and traceable accounting of renewable consumption.

2.3. Renewable Energy Potential and Feasibility in Hung Yen – Implications for Thang Long II IP

The resulting profile, with a high baseload with a broad daytime plateau, points to strong self-consumption potential for rooftop PV and a complementary role for storage to shift surplus into the evening shoulder. Building on this evidence, this section assesses renewable options are feasible and how they should be phased within current hosting-capacity limits.

Overall, according to the Power Development Plan 2016–2025 (Decision 4016/QĐ-BCT, 23 Oct 2017) and the Hưng Yên Provincial Master Plan 2021–2030 with vision to 2050 (Decision 489/QĐ-TTg, 10 Jun 2024), the province's most viable renewable options are waste-to-energy (WtE), rooftop solar, and biomass. Rooftop solar is further guided by provincial Decision 1506/QĐ-UBND (20 Jul 2023)[2].

2.3.1. Resource assessments

Provincial planning estimates ~30.9 MW of WtE potential, anchored in five planned solid-waste treatment zones (total ~89.5 ha; >3,750 t/day combined capacity). Indicative siting includes Vu Xa (Kim Dong), Lieu Xa/Tan Lap/Trung Hoa/Di Su (Yen My/My Hao), Dai Dong (Van Lam), and Hoa Phong (My Hao). While the feedstock is real and centralized, projects face high capital costs, complex technology choices, cautious tariff arrangements, stringent environmental approvals and

[2] The information and assessment data for Hung Yen province are used at the time before the province's merger on July 1, 2025.

lengthy land procedures. In practice this means **longer development timelines and a need for early tariff/bankability work if WtE is to reach financial close.**.

Rooftop solar is Hưng Yên's strongest near-term opportunity. The province receives ~1,650 sun-hours/year and ~4.01 kWh/m²/day of solar radiation (NASA), adequate for both industrial and residential systems. On 20 July 2023, the People's Committee of Hung Yen Province issued Decision No. 1506/QĐ-UBND approving the "Development Scheme for Rooftop Solar Power (RSP) in Hung Yen Province until 2030, with a Vision to 2045." The scheme **targets an installed rooftop solar capacity of approximately 1,407.6 MWp, representing less than 30% of the province's total power capacity. This comprises 542.4 MWp by 2030 and 865.2 MWp between 2031 and 2045, with >75% expected on industrial roofs.** Industrial parks such as TLIP II therefore sit at the heart of delivery. The main constraint is grid hosting capacity: high penetration can create local congestion and curtailment (to be discussed further in Section 2.2). This can be managed with a self-consumption-first design, staged interconnections, smart inverters, and, where justified, battery energy storage and demand-side measures aligned with the grid operator's limits.

Biomass resources (rice straw and husks; firewood) exist but are highly dispersed across smallholders, with limited aggregation, which raises collection costs and undermines supply reliability. Provincial estimates show a wide gap between theoretical and technical/economic potential; current consumption patterns also suggest limited scalable surplus. As such, **small, decentralised thermal uses near the source (e.g., process heat) are more realistic than grid-connected biomass power in the near term.**

2.3.2. Summary to 2030 and planning constraints

In line with Decision 489/QĐ-TTg and the rooftop-solar scheme, rooftop solar (self-consumed) and a limited WtE tranche are the priority technologies to 2030, subject to PDP VIII caps, siting, environmental compliance and grid-connection standards[3].

Table 2-1: Summary of Renewable Energy Potential in Hung Yen (to 2030)

No.	Power Plant	Estimated Capacity
1	Development potential of self-consumed rooftop solar power	542 MWp
2	Development potential of waste-to-energy projects	31 MW

Source: Decision No. 489/QĐ-TTG dated June 10, 2024, of the Prime Minister

Rooftop solar should be phased to maximize on-site use and respect feeder/substation limits; business cases may be strengthened by optional storage for peak-shaving and curtailment mitigation. WtE requires early tariff, EIA and land alignment and should be treated as a medium-term addition rather than immediate capacity. Biomass is best reserved for thermal applications near source; wind requires no near-term allocation.

For TLIP II, the least-regret pathway is a rooftop-solar-centered portfolio sized to park loads, with optional participation in WtE offtake if a bankable facility is developed within economic radius.

2.4. Renewable Energy Options for Thang Long II Industrial Park

2.4.1. Rooftop Solar as the Core Renewable Energy Pathway

Building on the system constraints outlined in Section 2.1 and the high-baseload, daytime-plateau demand profile in Section 2.2, rooftop solar photovoltaic emerges as the only near-term renewable option that is both technically and operationally well-matched to TLIP II. PV output coincides with

[3] In this report, "Hung Yen" refers to the former Hung Yen Province prior to its merger with Thai Binh Province.

the park's working-day plateau, enabling high self-consumption and immediate reduction in grid purchases during higher-tariff hours. By contrast:

- **Biomass/biogas**: feedstock is fragmented and spatially dispersed, with limited aggregation infrastructure. This undermines security of supply and bankability for continuous, plant-scale operation in an industrial park context; small, localized thermal uses near sources remain more realistic than grid-connected power.
- **Waste-to-energy (WtE)**: although included in provincial planning, facility siting requires large land take, lengthy approvals and stringent environmental controls. In a dense industrial area, these constraints, combined with haulage/logistics and public acceptability, make WtE unsuitable as an on-park solution (better treated at provincial scale with offtake considered only if a bankable facility is commissioned nearby).
- **Wind**: resource levels are below commercial thresholds for standard turbines; any future potential would be limited to pilots with next-generation low-wind machines rather than utility-scale deployment.

Table 2-1: Renewable Energy Feasibility Comparison for TLIP II

Technology	Capacity Potential	Feasibility	Barriers	Investment Implications	Policy Needs
Rooftop Solar (RSP)	80–120 MWp (~140–210 GWh/year)	**High**	Substation reverse power cap (~30% penetration without upgrades)	Strong ROI (12–15%), \$1.2M/year savings, >100,000 tCO_2e reduction; aligns with RE100/ESG demand	Clarify intra-park DPPA rules (Decree 57/2025), enable shared RSP services, support EMS & BESS deployment
Waste-to-Energy (WtE)	30.88 MW (Vu Xa, 20 ha)	Low	Land scarcity, pollution risks, \$50M/MW CAPEX, long approval timelines	Not viable for TLIP II; only provincial-level consideration	Stricter emission standards, clearer siting rules, provincial financing support (not relevant for TLIP II)
Biomass	121.43 KTOE technical potential	Low	Fragmented supply, high logistics cost, no processing hubs	Only feasible for small-scale heat applications (1–2 MWth for textiles, food)	Develop biomass clusters, incentivise logistics hubs, but limited role in TLIP II
Wind	Negligible (<6 m/s avg at 150m)	Low	Poor resource conditions, low density	Infeasible in current tech environment	Long-term only if turbine tech improves (<7 m/s viability)

Taking these constraints into account, it is evident that the only **feasible renewable energy option for TLIP II is rooftop solar power, alongside small-scale distributed solar systems**. From a technical perspective, rooftop solar is well-matched to TLIP II's infrastructure and energy demand. With average solar radiation of 4.01 kWh/m²/day, the park can host between 80–120 MWp of rooftop solar capacity, translating into 140–210 GWh/year of clean electricity **(Table 2-6)**. This represents up to 30% of projected park demand by 2030. The park's 110/22 kV substation (100 MVA) can accommodate solar integration up to 30% of peak load without significant grid upgrades, making RSP both scalable and grid-compatible. In contrast, biomass and biogas are technically constrained by the lack of a stable feedstock supply and fragmented collection infrastructure, while wind speeds of 5–5.9 m/s at 150m hub height fall well below commercial thresholds. Waste-to-energy projects, though part of the provincial plan, require extensive land (20 ha+ per facility), costly technology (~$50M/MW), and raise environmental concerns unsuited to the dense industrial context of TLIP II.

Table 2-2: Rooftop Solar Potential in TLIP II

No.	Category	Phase 1+2	Phase 3	Phase 4	Total
1	Exploitable Land Area (ha)	247	427.5	819.2	1,493.7
2	Rooftop Area (ha)*	54	94	180	328
3	Estimated Installed Capacity (MWp)	50	80	150	80-120
4	Expected Operating Capacity (MW)	40	70	130	64-96

Assumptions: *Industrial park occupancy rate of 80%; building density of 55%; rooftop availability equivalent to 50% of constructed floor space.*

From an economic and investment standpoint**, rooftop solar delivers the most competitive returns.** With installation costs of $520–580/kWp, RSP projects achieve 12–15% ROI and payback in 5–7 years. For tenants, the model offers annual electricity bill savings of 15–25% (~$1.2M/year at 50 MWp) and enhances long-term cost predictability in the face of rising grid tariffs. By comparison, WtE projects struggle with uncompetitive tariffs and multi-year permitting processes, while biomass and wind lack economies of scale due to logistical inefficiencies and poor resource availability. These dynamics confirm that investors will find rooftop solar to be the least-risk, highest-return clean energy option in TLIP II.

However, **policy and regulatory factors** remain a critical determinant of feasibility. At present, self-consumption of solar is permitted, but the legal framework for Direct Power Purchase Agreements (DPPAs) within closed-loop industrial parks is still under development (Decree 57/2025). Without regulatory clarity, tenants cannot trade excess electricity internally, limiting optimisation opportunities. Similarly, the absence of Ministry of Industry and Trade (MOIT) guidelines for Battery Energy Storage Systems (BESS) delays adoption, despite their potential to enhance grid stability and peak load management. These gaps need urgent attention if TLIP II is to realise its full clean energy potential.

Overall, **rooftop solar is well-suited to the industrial park context because it directly aligns with the "self-generation and self-consumption" model**, under which enterprises can reduce electricity costs, improve energy security, and meet corporate sustainability targets without relying on the national grid. If regulatory conditions evolve to support intra-park electricity trading (via Direct Power Purchase Agreements or shared microgrid models), rooftop solar could also facilitate decentralized energy sharing between tenants. This would enhance efficiency, reduce dependence on external supply, and help build a resilient, low-carbon energy ecosystem within TLIP II. Rooftop solar also offers distinct strategic advantages:

- First, it provides a **high degree of scalability and flexibility**: systems can be deployed in phases to match the evolving demand and investment capacity of enterprises, reducing the risks associated with large upfront capital commitments.
- Second, rooftop solar **aligns strongly with the requirements of foreign direct investment firms**. Many multinational corporations in sectors such as electronics, automotive, and textiles already require renewable energy sourcing within their supply chains, and industrial parks with substantial solar capacity are more attractive to these investors.
- Third, rooftop solar integration creates **opportunities for coupling with smart energy management systems (EMS) and, in the medium term, with battery storage.**
- Finally, while the current regulatory framework supports self-consumption, its full potential depends on policy developments. In particular, **legal clarity on direct power purchase agreements within closed industrial park systems** would enable intra-park electricity trading, maximise efficiency, and further reduce reliance on the national grid.

2.4.2. Integration Pathways for Rooftop Solar in TLIP II

To move from a fragmented model of individual rooftop solar systems towards a fully integrated renewable energy ecosystem, TLIP II requires a staged strategy that evolves in line with investment capacity, regulatory reform, and technological readiness.

In the short term, the most practical and immediately deployable pathway is the **self-consumption model**. Under this arrangement, tenants directly invest in rooftop solar systems to meet their own internal consumption needs, reducing their dependency on grid power. This model has already been demonstrated in TLIP II through Sumitomo's 1 MW pilot, which shows clear cost-saving and environmental benefits. For enterprises with limited capital, rooftop leasing arrangements provide a viable alternative. In these cases, third-party investors finance the installations and sell electricity back to the tenant at rates typically 5–10% lower than EVN tariffs. Such contracts often span 15–20 years, after which ownership of the system may transfer to the rooftop owner. These leasing models are particularly beneficial for small and medium-sized enterprises that lack upfront capital, enabling them to access renewable energy without financial risk.

In the medium term, the park should progress towards **establishing third-party or ESCO-led models.** Here, either the park management or independent power producers (IPPs) would finance and operate shared rooftop solar and BESS infrastructure, with tenants purchasing electricity under long-term contracts. This model allows economies of scale to be realized, centralized maintenance, and unlocks access to green credit lines from domestic banks such as BIDV and Agribank, as well as international financiers including the Asian Development Bank (ADB) and the World Bank. However, the scalability of ESCO models in Vietnam is currently constrained by the lack of a clear legal framework for internal electricity distribution and revenue-sharing under Decree 31/2021/ND-CP. Closing these regulatory gaps would be pivotal to enable wider adoption.

A further stage in the integration pathway is the development of a microgrid with a smart Energy Management System (EMS). A park-wide EMS would allow for real-time monitoring of generation and consumption across multiple tenants, enabling the optimization of electricity flows, demand response, and loss reduction. Such systems can reduce distribution losses by 2–5% and allow the park to maximize internal use of renewable electricity. When combined with BESS, the EMS can facilitate peak shaving, frequency stabilization, and intra-park energy trading. Although initial investment for EMS is approximately $300,000–500,000, with additional grid reinforcement costs of $1–2 million, the long-term efficiency gains and resilience benefits justify the outlay.

The deployment of **Battery Energy Storage Systems** represents the next logical step. At TLIP II, a 5 MWh BESS would require an investment of $1.5–2 million but could generate annual savings of approximately $0.5 million through tariff arbitrage and peak load reduction, achieving a return on investment of 12–15%. BESS would also enable the park to absorb excess midday solar generation and release it during evening peaks, thereby increasing solar self-consumption rates. Beyond economics, BESS enhances reliability by providing backup power during outages, a critical requirement for FDI tenants with sensitive production processes. However, the absence of MOIT guidelines for BESS integration into industrial park grids creates uncertainty that must be addressed to ensure investor confidence.

In the longer term, TLIP II can transition towards **internal Direct Power Purchase Agreements (DPPAs)**. Once legally permitted, tenants will be able to trade solar generation with one another through intra-park microgrids, creating a competitive internal energy market. This would reduce dependency on EVN, increase the efficiency of solar use, and foster energy symbiosis among tenants. The model also directly supports ESG reporting by allowing companies to demonstrate traceable consumption of renewable energy. External DPPAs, where tenants purchase renewable electricity via the national grid from off-site projects, offer an interim solution but are less cost-competitive due to grid fees.

To support these integration strategies, TLIP II requires diversified financing mechanisms that reflect the heterogeneity of its tenants. Large FDI firms with strong balance sheets may prefer self-investment models, capitalising on short payback periods and high returns. SMEs, by contrast, are better served by rooftop leasing or ESCO models, which eliminate upfront capital requirements and spread costs over time. Park-level infrastructure such as EMS, microgrids, and BESS can be financed through blended finance arrangements, including green loans, development finance, and even green bonds issued at the park or provincial level. Public–private partnerships (PPP) also represent a viable model for shared infrastructure, pooling resources from park management, tenants, and financial institutions into joint investment vehicles.

3. Enabling Policies, Hybrid Delivery Framework and Barriers for Thang Long II Industrial Park

Vietnam's evolving policy landscape, including its net-zero commitment and power-sector reforms, provides a foundation for transforming industrial parks like Thang Long II Industrial Park (TLIP II) into active participants in clean energy. This section synthesizes key enabling policies with tailored investment strategies and business models, emphasizing TLIP II's unique context.

3.1. Policy Baseline, Incentives, and Market Drivers

Vietnam's net-zero commitment and recent power-sector reforms are shifting industrial parks from passive consumers to active participants in clean energy. Three strands matter for TLIP II:

1. **Eco-Industrial Park (EIP) policy** frames resource efficiency, on-site generation, and industrial symbiosis;
2. **Power-sector planning** recognizes distributed renewables and storage as part of supply–demand balancing;
3. **Market instruments** (rooftop self-consumption, direct procurement models, renewable certificates) create routes for tenants to source verifiable clean electricity. Together, these establish *permission* (what is allowed) and *priorities* (what is encouraged), but also reveal gaps around internal trading, storage integration, and SME finance.

For TLIP II, these policies align with the park's physical and operational realities outlined earlier: (i) a tiered 500/220/110 kV system with periodically constrained upstream corridors (Section 2.1); (ii) a high baseload with a daytime plateau and late-afternoon shoulder (Section 2.2); and (iii) growing tenant demand for low-carbon electricity. Particularly, TLIP II benefits from Vietnam's EIP framework under Decree 35/2022/ND-CP and Circular 05/2025/TT-BKHDT, which promotes resource efficiency, on-site generation, and industrial symbiosis, alongside power-sector planning that integrates distributed renewables and storage for supply-demand balancing. Market tools like rooftop self-consumption, direct power purchase agreements (DPPAs) via Decree 57/2025/ND-CP that formalizes DPPAs for large consumers (≥200,000 kWh/month), and I-RECs enable verifiable clean electricity sourcing.

The policy environment thus provides both the framework and motivation for deploying on-site photovoltaic systems, adding storage, and adopting contractual instruments to verify renewable consumption. Table 3-1 summarizes key investment incentives supporting the green transition in industrial parks.

Table 3-1: Key Investment Incentives Supporting Green Transition in Industrial Parks

Incentive Type	Description	Eligibility/Conditions	Legal Source
Corporate Income Tax (CIT) preferential rates	Reduced CIT of 10–17% for 10–15 years (vs. 20% standard).	Priority sectors (high-tech, renewables); ≥ VND 12B investment; SMEs with ≤ VND 3B revenue (15%).	Law No. 67/2025/QH15; Decree 218/2013 (amended).
CIT Tax Holidays	Full exemption 2–4 years, then 50% reduction for 4–9 years.	New projects in priority sectors, high-tech zones, EIPs.	Decree 218/2013; Investment Law 2020.
Import/Export Duty Exemptions	Duty-free imports for machinery/equipment (fixed assets) and raw materials for 5 years.	Incentivised sectors/areas.	Decree 134/2016; Investment Law 2020.

Land Rent Exemptions/Reductions	Up to 3 years exemption during construction, 3–15 years post-construction; 50% reduction for PPP projects.	High-tech zones, EIPs, difficult socio-economic areas.	2024 Land Law; Decree 103/2024.
Green Credit and Support	Access to green credit from BIDV, Agribank, ADB, World Bank; R&D deductions; labour training support.	SMEs, RE projects, high-tech industries.	Law No. 90/2025/QH15; Decree 31/2021/ND-CP.
Other Incentives	Accelerated depreciation, technology transfer, trade promotion; access to green bonds.	Innovation/environment projects.	Circular 05/2025; Law No. 90/2025/QH15.

Among the most significant incentives, the Government offers corporate income tax exemptions for renewable energy projects. Investors in industrial parks may benefit from a 10–17% preferential CIT rate for 10–15 years, with full exemptions for 2–4 years from the first profit-making year (or fourth revenue-generating year) and a 50% reduction for 4–9 subsequent years, depending on project scale (minimum VND 12 billion) and sector priority (e.g., high-tech, renewables). Post-October 2025, Law No. 67/2025/QH15 shifts IP incentives to sector-specific benefits, encouraging advanced, environmentally friendly technologies.

Vietnam's net-zero pledge has expanded access to international finance, including the Green Climate Fund (GCF), carbon credit programs, and blended finance initiatives like the Just Energy Transition Partnership (JETP) and Asia Zero Emission Community (AZEC). To maximize these opportunities, the Government must strengthen the legal framework, streamline investment procedures, and enhance private-sector roles. Industrial parks and foreign direct investment (FDI) enterprises are pivotal, facing strong demand for clean energy and increasing pressure from global supply chain environmental standards.

3.2. Hybrid Delivery Model and Barriers for TLIP II

3.2.1. Existing Structure of TLIP II and Rationale of the Hybrid Delivery Model

The current electricity model at TLIP II, in which EVN purchases power through the 110 kV substation and redistributes it internally, provides grid stability but limits both cost optimization and ESG traceability. By mid-2025, approximately 23.93 MWp of rooftop solar will be installed, helping reduce peak-hour costs and enabling certification schemes. However, reverse power flows have begun to strain the park's ring-structured grid, creating potential instability unless upgrades such as fast-response regulators, smart sensors, and battery energy storage systems are added.

Major implementation barriers include:

- **Financing constraints** among SMEs (≈ 70 percent of tenants) with limited collateral.
- **Regulatory restrictions** on intra-park energy trading.
- **Absence of an integrated Energy Management System (EMS)**, causing 2–5 percent technical losses (≈ 0.7 GWh/year for 50 MWp).

To address these, TLIP II should adopt a phased hybrid delivery model, combining self-investment, ESCO, leasing, market-based, and shared-energy approaches, each suited to specific tenant profiles and financing capacities. The proposed hybrid model for TLIP II integrates several delivery mechanisms into a single coordinated framework.

It aims to:

- Diversify investment sources and ownership structures;
- Ensure inclusion of SMEs alongside large FDI firms;
- Achieve measurable cost and emissions reductions; and
- Build long-term grid resilience through shared infrastructure.

Rather than operating as parallel systems, these mechanisms are sequenced over time and interconnected through digital management and regulatory alignment. In the short term, market-based instruments and compliance tools enable quick progress; in the medium term, third-party financing models expand access; and in the long term, cooperative and shared-energy systems consolidate park-wide autonomy.

3.2.2. Core Components of the Hybrid Model

3.2.2.1. Self-Investment by Large Enterprises

Major FDI manufacturers at TLIP II already have stable production loads and corporate sustainability commitments such as RE100 and SBTi. For them, self-investment in rooftop solar remains the most efficient solution. Projects of this type typically yield 15–25 percent electricity savings based on EVN's tariff of USD 0.08 per kWh, with returns on investment above 15 percent and payback within 5–7 years. When coupled with I-REC sales, payback can shorten to 4–6 years. However, individual installations often operate in isolation, resulting in fragmented generation and limited synergy. Coordination through the park management board could enable aggregated procurement, standardized interconnection, and collective performance monitoring.

3.2.2.2. ESCO and Green-Leasing Mechanisms

For the majority of SME tenants, direct investment is financially unfeasible. The hybrid framework therefore introduces Energy Service Company and green-leasing arrangements. Under the ESCO model, a specialized entity, or the park board itself, invests in solar, storage, and efficiency systems, recovering costs through energy-savings contracts. This approach removes the upfront burden for SMEs while ensuring professional operation and maintenance. Green leasing complements ESCOs by allowing third-party investors to rent rooftop space, install PV systems, and sell power to tenants at USD 0.06–0.07 per kWh, which is below EVN's retail rate. For a 10 MW consumer, such arrangements could yield annual savings of USD 200,000–300,000. Both mechanisms require clearer regulation of intra-park sales and standard contract templates to ensure transparency. International experience from Thailand and Malaysia shows that state-guaranteed credit lines and simplified licensing greatly accelerate uptake.

3.2.2.3. Market-Based Instruments: DPPAs and I-RECs

Direct Power Purchase Agreements and International Renewable Energy Certificates constitute the hybrid model's transitional compliance layer. Under Decree 57 (2025), generators with at least 10 MW capacity can sign private-wire or virtual contracts with large consumers, while Decree 135 (2024) opens possibilities for internal distribution within industrial parks.
At TLIP II, external DPPAs can supply renewable energy off-site without capital expenditure, typically saving 5–15 percent compared with grid tariffs. Over time, internal DPPAs could utilize up to 100 MWp of park-based generation once technical standards and sandbox exemptions are in place. For smaller tenants that cannot access DPPAs, I-RECs remain a cost-effective interim solution. TLIP II's existing 23.93 MWp of rooftop solar will generate about 42,000 I-RECs per year, providing verifiable ESG claims at USD 0.25–2.04 per MWh. While certificates alone do not reduce emissions physically, they build a track record of compliance that helps attract FDI and finance.

3.2.2.4. Shared Energy and Storage Infrastructure

In the long run, the hybrid framework envisions centralized renewable and storage assets managed through a digital EMS. A consortium or “Super ESCO” could develop park-level BESS facilities and operate them under subscription models. Shared infrastructure reduces per-unit storage costs, balances intermittent generation, and stabilizes the ring-structured grid. Internationally, Singapore’s Punggol Digital District demonstrates the benefits of such aggregation: a 2.5 MWh BESS cut 1,700 tCO_2 annually while improving grid reliability. For TLIP II, establishing a Special Purpose Entity to own and operate shared assets would require clarification of ownership rights and tariffs under Vietnam’s Electricity Law but would unlock large-scale efficiency gains.

3.2.2.5. Cooperative Investment Mechanisms

A cooperative structure would allow tenants to co-invest in solar and storage assets through equity shares in an SPE. A 30 MWp cooperative installation could generate collective savings of 10–15 percent, equivalent to USD 0.6–0.8 million annually. This model fosters long-term commitment and risk-sharing among tenants but demands robust governance and technical oversight through mandatory EMS integration. China’s eco-industrial-park framework illustrates how such cooperatives can evolve into energy-trading clusters once digital monitoring is in place.

3.2.2.6. Summary of Model Functions within the Hybrid Framework

Based on previous sections, there can be four types of clean energy business models: direct ownership (self-investment), third-party service models (ESCO, green leasing), market-based contracting (DPPA, I-RECs), and collective/shared models (shared energy/storage, cooperative). Each addresses unique financial, operational, and regulatory needs, but faces barriers like SME financing gaps and incomplete internal grid frameworks. **Table 3-2** below summarizes the seven models, detailing ownership, pros/cons, best fit, and policy needs.

Table 3-2: Comparative Analysis of Renewable Energy Business Models for Industrial Parks

Model	Ownership & Financing	Pros	Cons	Best Fit	Policy/Enabler Needs
Direct Ownership					
Self-Investment by Enterprises	Tenant-owned; financed from corporate capital	• Long-term cost savings • Full control over energy use • Meets ESG demands directly	• High upfront cost • Fragmented deployment • SMEs excluded due to financing barriers	Large FDI firms with strong capital and ESG commitments	Tax incentives, net-metering for surplus, lower DPPA thresholds
Third-Party Service Models					
ESCO Model	Third-party (ESCO or IP operator) invests; tenants pay via savings or contracts	• No upfront tenant cost •Professional O&M • Aggregated systems improve efficiency	• Limited by lack of legal clarity for intra-park electricity sales • ESCO market in Vietnam underdeveloped	SMEs, IPs seeking centralised deployment	Clear ESCO regulation, credit guarantee schemes, intra-park distribution rights
Green Leasing Model	Third-party leases rooftops, sells electricity or I-RECs	• No upfront cost • Immediate savings ($0.06–0.07/kWh vs EVN $0.08) • Flexible for short-term tenants	• Limited rooftop availability • Regulatory barriers on intra-park sales	Short-term tenants (3–5 years), SMEs	Amend Decree 57/2025 to allow leasing; grid access for <1 MW projects
Market-Based Contracting Models					
DPPA Model	Direct contract between tenant and RE generator (private wire or virtual grid)	• Price stability • Access to large-scale RE • Strong ESG alignment	• Currently limited to ≥200,000 kWh/month users • Not applicable to closed-loop IP networks • Ceiling price caps restrict flexibility	Large energy consumers, MNCs with RE100 targets	Expand eligibility to SMEs; clarify intra-park DPPAs; remove price caps

I-REC Certificates	Market purchase of certificates separate from physical power	• Low-cost ESG compliance ($0.25–2.04/MWh) • Globally recognised (60+ countries) • Immediate RE100 alignment	• No physical RE or autonomy • Price volatility • Overlaps with carbon credits	Tenants needing quick ESG compliance (esp. RE100)	National registry oversight; stabilisation of I-REC market; clearer role vs carbon credits
Collective/ Shared Models					
Shared Cooperative Model	Tenants co-invest via SPE; joint ownership of RE + BESS	• Cost reduction (10–15%) • Shared risks and benefits • Long-term resilience	• Requires $1–2M grid upgrades • Complex governance • Legal gaps for cooperatives	Large groups of tenants with aligned ESG needs	Recognition of SPEs; Energy Transition Fund to de-risk investments
Shared Energy & Storage Services	ESCO/IP operator invests in centralised RE + BESS; tenants subscribe	• Economies of scale • Efficient EMS-based allocation • Improved reliability	• Tenants lack ownership • Requires governance of shared assets	SMEs and mixed tenant bases preferring subscription model	Legal framework for shared grid assets and tariffs; SPE guidelines

3.2.3. Barriers and Enabling Conditions

Despite clear technical and financial potential, several barriers must be resolved for the hybrid model to function effectively.

3.2.3.1. Financial barriers

Small and medium-sized enterprises face the most significant financial challenges in adopting renewable energy solutions. **The primary difficulty lies in the high upfront investment required for rooftop solar projects and other clean energy infrastructure.** The capital cost for rooftop solar is around USD 0.55 million per megawatt-peak (MWp), meaning that a large-scale deployment of 50 MWp would require between USD 26 and 29 million. For SMEs, which typically operate with limited cash reserves, short business planning horizons, and restricted access to credit, such capital commitments are unrealistic.

Although commercial banks such as BIDV and Vietcombank, along with international lenders, offer green loan products, SMEs are frequently excluded from accessing these due to a combination of limited collateral, short operating histories, and conservative lending practices. This exclusion persists even when enterprises demonstrate genuine demand for rooftop solar or energy efficiency upgrades. Short-term tenants, those leasing space for only three to five years, face an additional barrier. They do not own factory rooftops, their short operational timelines prevent capital recovery from rooftop solar investments, and their electricity consumption often falls below the 200,000 kWh/month threshold required for DPPA participation. Meanwhile, factory owners seeking to invest in rooftop solar to sell electricity to tenants are restricted by the "self-produce, self-consume" model, which prohibits third-party sales under current regulations, limiting the scalability of clean energy solutions[4].

Large-scale, capital-intensive models such as cooperative investment in shared renewable energy and storage services also face financial constraints. The absence of a dedicated national or provincial Energy Transition Fund prevents the pooling of concessional finance, guarantees, and private co-financing needed to support such projects. In comparison, Indonesia's USD 500 million Energy Transition Mechanism has demonstrated how targeted financial platforms can mobilize large volumes of private and international capital for energy transition initiatives. Vietnam has yet to establish a similar fund, and at the same time continues to underutilize international climate finance opportunities such as the Green Climate Fund and World Bank climate facilities. Fragmented governance and a limited project pipeline prevent SMEs and industrial park operators from fully tapping into these global resources, further slowing down the transition to renewable energy.

3.2.3.2. Regulatory Barriers

Vietnam's regulatory framework also presents significant obstacles for renewable energy adoption in industrial parks. Decree 57/2025/ND-CP currently restricts intra-park electricity trading under the "self-produce, self-consume" model. This means that factory owners who install rooftop solar systems cannot legally sell surplus electricity to neighboring tenants within the same industrial park. For example, Enterprise A cannot transfer excess rooftop solar generation to Enterprise B, even though they share internal grid connections. This constraint severely limits the scalability of the Energy Service Company (ESCO) model, the green leasing model, and cooperative investment models that rely on internal power sharing.

Direct Power Purchase Agreements, which are designed to allow large energy users to buy renewable power directly from generators, also exclude many industrial park tenants. Current eligibility criteria require consumption of at least 200,000 kWh per month or a connection at 22 kV or above, thresholds that effectively exclude SMEs and short-term tenants. Even for eligible

[4]Phương Thanh. 2025. Doanh nghiệp trong khu công nghiệp chưa tận dụng hết được chính sách mới của năng lượng tái tạo. Tạp chí Diễn đàn Doanh nghiệp.

companies, price caps imposed on dedicated-line DPPAs restrict negotiation flexibility and discourage both investors and consumers.

Furthermore, Decree 35/2022/ND-CP, which governs industrial parks and economic zones, does not yet provide clear recognition or support for innovative intra-park energy-sharing arrangements, including shared energy and storage services or cooperative investment models. This legal ambiguity limits investment confidence and hinders scaling up of collaborative renewable energy solutions.

The I-REC (International Renewable Energy Certificate) market also suffers from a lack of regulatory clarity. While the Ministry of Industry and Trade signalled its intent to develop a framework in Plan 4107/KH-BCT (June 2024), there is currently no official national registry or detailed guidance for issuance, trading, or retirement of I-RECs. This absence of oversight reduces transparency and limits tenant trust in using I-RECs for ESG compliance, despite their international recognition.

3.2.3.3. Technical Barriers

In addition to financial and regulatory constraints, there are substantial technical barriers to renewable energy integration within industrial parks. Most of Vietnam's 400-plus industrial parks **lack smart energy management systems, which are essential for coordinating distributed renewable energy sources and ensuring efficient use of generated electricity**. Without EMS, renewable energy deployment is fragmented and inefficient, resulting in energy losses of 2–5%, equivalent to roughly 0.7 gigawatt-hours per year at a 50 MWp capacity. The absence of coordinated control systems also prevents the development of internal microgrids, which are necessary for optimizing power sharing among tenants and minimizing curtailment in shared energy or cooperative models.

Battery energy storage systems represent a critical solution for balancing intermittent renewable generation, reducing peak demand, and stabilizing voltage and frequency. A typical 5 MWh system, with an investment cost of around USD 2 million, could reduce peak demand, lower reliance on the national grid, and cut carbon emissions by approximately 1,700 tonnes annually comparable to the achievements of Singapore's Punggol Digital District microgrid. Yet, in Vietnam, **no specific technical guidelines have been issued by MOIT for BESS integration, and no financial mechanisms exist to support enterprises in deploying storage.** This lack of regulatory clarity and investment support discourages BESS adoption, even though it is essential for scaling renewable penetration.

Finally, **the unpredictable variability of renewable energy sources, particularly solar power, forces tenants to continue relying heavily on EVN's grid, which charges an average tariff of USD 0.08 per kWh**. Sudden drops in solar output due to weather conditions or insufficient capacity during peak evening hours require the grid to maintain reserve capacity to ensure uninterrupted supply. This places additional pressure on the national transmission and distribution system and reduces the effective value of renewable investments for industrial parks like TLIP II.

3.3. International Lessons and Adaptation for TLIP II

International experience illustrate how targeted policy mechanisms and financing models can unlock investment, particularly for small and medium-sized enterprises that form the backbone of industrial park tenants.

Malaysia's **Green Technology Financing Scheme (GTFS)** demonstrates the importance of government-backed guarantees in mobilizing private sector lending. By covering up to 60% of loan risk and subsidizing interest rates, Malaysia has successfully de-risked SME investments in renewable energy and energy efficiency. The scheme has channeled over USD 3 billion into more than 350 projects, many SME-led, underscoring that credit risk guarantees can unlock otherwise inaccessible financing. For Vietnam, where SMEs at TLIP II face major collateral and credit access constraints, adopting a GTFS-style mechanism could significantly broaden access to green loans. This would be especially effective if coupled with Vietnam's domestic banking system, where institutions like BIDV and Vietcombank already operate green credit lines but currently exclude many SMEs due to high-risk perceptions.

Thailand's **Energy Efficiency Revolving Fund (EERF)** illustrates how dedicated revolving funds can create a sustainable and long-term financing cycle. By providing low-interest capital to banks, which in turn lend to enterprises at capped rates, Thailand mobilised more than USD 400 million, with 90% of projects implemented by SMEs. The revolving design ensures that repayments replenish the fund, allowing continuous cycles of financing without depleting state budgets. For Vietnam, establishing a revolving energy fund at either national or provincial level could help finance capital-intensive projects such as rooftop solar clusters, battery storage systems, and shared grid upgrades. For TLIP II, a revolving fund would directly address the lack of concessional finance for cooperative or ESCO-led models, while offering SMEs predictable and affordable access to capital.

India's **Perform, Achieve, Trade (PAT) Scheme** highlights how the ESCO model can overcome the hurdle of upfront investment for SMEs. Under this scheme, ESCOs finance and implement energy efficiency projects, with repayment linked to realized energy savings. This "performance contracting" model has enabled SMEs in energy-intensive clusters such as textiles, chemicals, and steel to adopt efficiency measures they could not otherwise afford. For Vietnam, where ESCOs face regulatory uncertainty around intra-park energy distribution, India's experience demonstrates that clear rules enabling third-party performance-based contracting can rapidly accelerate adoption. At TLIP II, scaling ESCOs could unlock rooftop solar, efficiency retrofits, and BESS investments for SMEs, while simultaneously creating professional management of shared infrastructure.

China's **Smart EMS deployment in Eco-Industrial Parks** provides lessons in addressing technical barriers to renewable integration. By making EMS mandatory in new eco-industrial parks and backing this requirement with subsidies and tax incentives, China has enabled real-time monitoring of energy, water, and emissions. This has improved grid stability and, crucially, facilitated internal energy trading among tenants, thereby supporting industrial symbiosis. Vietnam currently lacks policy recognition and incentives for EMS, leaving most IPs, including TLIP II, without the technical backbone to manage high renewable penetration. Adopting a Chinese-style regulatory mandate, supported by targeted subsidies, would allow Vietnam to modernize industrial park grids, optimize renewable use, and support intra-park energy markets.

Indonesia's **Energy Transition Mechanism (ETM)** and Climate Investment Fund showcase the power of blended finance in scaling renewable energy while phasing out fossil fuels. By combining concessional public capital with private investment, Indonesia has raised USD 500 million for its first ETM pilot, de-risking high-cost projects in the power sector. This model demonstrates how national-level transition funds can crowd in international climate finance while aligning with domestic policy priorities. For Vietnam, which has so far underutilized climate funds such as the Green Climate Fund, an ETM-style national or provincial-level Energy Transition Fund could serve as a game changer. At TLIP II, such a fund could cover the costs of grid upgrades, BESS integration, and cooperative solar projects, addressing precisely the financial and technical bottlenecks identified earlier.

Taken together, these international experiences suggest several clear lessons:

- **De-risking SME finance** through credit guarantees and interest subsidies is essential to broaden participation.
- **Revolving funds** can provide a sustainable financial base for continuous renewable energy deployment.

- **ESCO-led performance contracting** can overcome upfront cost barriers and professionalize project management.
- **Mandatory EMS standards**, supported by subsidies, can ensure technical stability and enable energy sharing.
- **Blended finance funds** at national or provincial level can mobilize large-scale investment and address systemic bottlenecks.

Table 3-3: Comparative Case Studies on SME Support, EMS Deployment, and Energy Transition Funds in Industrial Parks

Country / Initiative	Key Policy or Mechanism	Design Features	Outcomes / Lessons for Vietnam
Malaysia – Green Technology Financing Scheme (GTFS)	Government-backed financing scheme for SMEs investing in renewable energy, energy efficiency, and green manufacturing.	- Soft loans via commercial banks, with government guaranteeing up to 60% of the loan and subsidising 2% of the interest rate. - Eligible projects screened by the Green Technology Financing Unit (GTFS).	- Mobilised over USD 3 billion for >350 green projects, many led by SMEs. - Lesson: Government guarantees are crucial for de-risking banks' lending to SMEs in new green sectors.
Thailand – Energy Efficiency Revolving Fund (EERF)	Dedicated revolving fund to promote EE and RE projects across industries.	- Ministry of Energy provides low-interest loans to banks, which then lend to SMEs and industrial enterprises at capped interest rates. - Loans for EE retrofits, biomass, and rooftop solar.	- >USD 400 million mobilised, 90% of projects led by SMEs. - Lesson: Revolving funds create sustainable, long-term access to concessional finance.
India – Perform, Achieve, Trade (PAT) Scheme with ESCOs	Energy efficiency programme for large industries, extended to SMEs through Energy Service Companies (ESCOs).	- ESCOs invest in EE projects, with repayment linked to energy savings (performance contracting). - SMEs avoid upfront investment while sharing savings.	- Widespread uptake in clusters (textiles, chemicals, steel SMEs). - Lesson: Vendor/ESCO finance is effective for SMEs with limited capital and high energy intensity.
China – Smart EMS in Eco-Industrial Parks	EMS deployment as part of Eco-Industrial Park (EIP) standards.	- EMS mandatory in new eco-industrial parks. - Provides real-time monitoring of electricity, heat,	- Improved grid stability and allowed internal energy trading among tenants. - Lesson: Regulatory mandates, combined

		water, and emissions across tenants. - Supported by subsidies for installation and tax incentives.	with subsidies, accelerate EMS adoption and industrial symbiosis.
Indonesia – Energy Transition Mechanism (ETM) and Climate Investment Fund	Early stage just energy transition financing platform supported by ADB and GCF.	- Mobilises concessional capital for phasing out coal and scaling renewables. - Structured as a blended finance fund with both public and private capital.	- First pilot raised USD 500 million, targeted at power sector. - Lesson: A dedicated transition fund can crowd-in international capital and de-risk high-cost projects.

These international experiences provide a set of policy and financing tools that Vietnam can adapt to accelerate renewable energy adoption in TLIP II. They highlight how targeted instruments, ranging from SME credit guarantees and revolving funds to ESCO contracting, mandatory EMS standards, and blended finance platforms, can overcome the financial, regulatory, and technical barriers identified earlier. Together, they would create an enabling environment in which the hybrid model can mature from pilot to full deployment.

For Thang Long II, these lessons inform the design of an integrated investment strategy that converts the hybrid delivery framework into a bankable, scalable set of business models. The next section sets out this operational roadmap, detailing how different mechanisms will be structured, financed, and sequenced to achieve 50–70 percent renewable-energy penetration by 2030.

4. Investment Strategies and Business Models for Thang Long II Industrial Park

Building on the enabling policies and hybrid delivery framework outlined in Section 3, this section translates TLIP II's clean-energy vision into actionable investment and business models. It outlines how contractual mechanisms, financing instruments, and technological systems will be combined to deliver 50–70 percent renewable-energy penetration by 2030, while ensuring affordability, resilience, and inclusion of small- and medium-sized enterprises.

4.1. Strategic Orientation

The investment strategy for TLIP II is designed to operationalize the hybrid framework through four reinforcing pillars:

1. **Diversified procurement mechanisms** – combining external and internal direct power-purchase agreements with transitional International Renewable Energy Certificates.
2. **Smart infrastructure and digital management** – deploying park-wide Energy Management Systems and battery energy storage systems for stability and transparency.
3. **Blended financing and risk-sharing** – leveraging concessional funds, commercial loans, and guarantees to expand access for SMEs.
4. **Regulatory innovation and sandbox governance** – piloting intra-park electricity trading, shared storage, and cooperative investment under provincial and national supervision.

Together, these pillars turn the hybrid framework into a coherent implementation pathway linking short-term ESG compliance with long-term energy autonomy.

Figure 4-1: Rooftop Solar Project in Thang Long II Industrial Park Management Board

Source: Thang Long II Industrial Park Management Board

4.2. Operational Business Models

4.2.1. External DPPA Model – Immediate Compliance and Market Entry

As noted in Section 3, Decree 57 (2025) allows large consumers (≥ 200,000 kWh per month) to sign power-purchase contracts with renewable generators via EVN's grid. For TLIP II, external DPPAs represent the quickest route to verifiable renewable sourcing without capital expenditure. Participating tenants can secure fixed-price power 5–15 percent below EVN tariffs, hedge against future price volatility, and meet RE100/SBTi commitments.

These contracts should be prioritized in 2025–2027 for TLIP II's large FDI manufacturers, including electronics, automotive, and materials firms—while smaller tenants prepare to join through internal or aggregated arrangements later in the decade..

4.2.2. Internal DPPA Model – Building Energy Autonomy

Internal DPPAs will form the backbone of TLIP II's renewable portfolio once regulatory exemptions are tested through the sandbox. Under this model, electricity produced from rooftop or ground-mounted solar within the park is sold directly to tenants through the internal grid.

A typical 500 kWp system (USD 260,000–290,000 capex) can deliver 15–25 percent annual savings versus EVN tariffs and achieve 15–20 percent ROI, with payback in 5–7 years (4–6 when combined with I-REC revenue).

By 2030, internal DPPAs could supply half of TLIP II's total demand, reducing dependence on the national grid and positioning the park as a self-balancing microgrid.

4.2.3. Smart Energy Management System With BESS Integration – Digital Backbone and Stability Layer

The EMS will serve as the operational core of TLIP II's hybrid system, enabling real-time monitoring, demand forecasting, and energy-sharing optimization. Investment requirements are estimated at USD 300,000–500,000 for full-park deployment, with efficiency gains yielding returns above 25 percent through reduced technical losses (2–5 percent of total supply). Complementary BESS investments (2–5 MWh; USD 1.5–2 million) will provide frequency control, peak-load management, and backup supply—critical for export-oriented manufacturers. The combined EMS-BESS package creates a digital, resilient energy ecosystem capable of integrating higher shares of variable renewables while maintaining grid quality.

4.2.4. I-REC – Transitional ESG Instrument

RECs complement physical decarbonization by certifying renewable consumption while DPPAs and storage infrastructure scale up. TLIP II's 23.93 MWp of rooftop solar can generate around 42,000 I-RECs per year, representing USD 10,000–85,000 in potential annual revenue for producers and reducing project payback by one year.

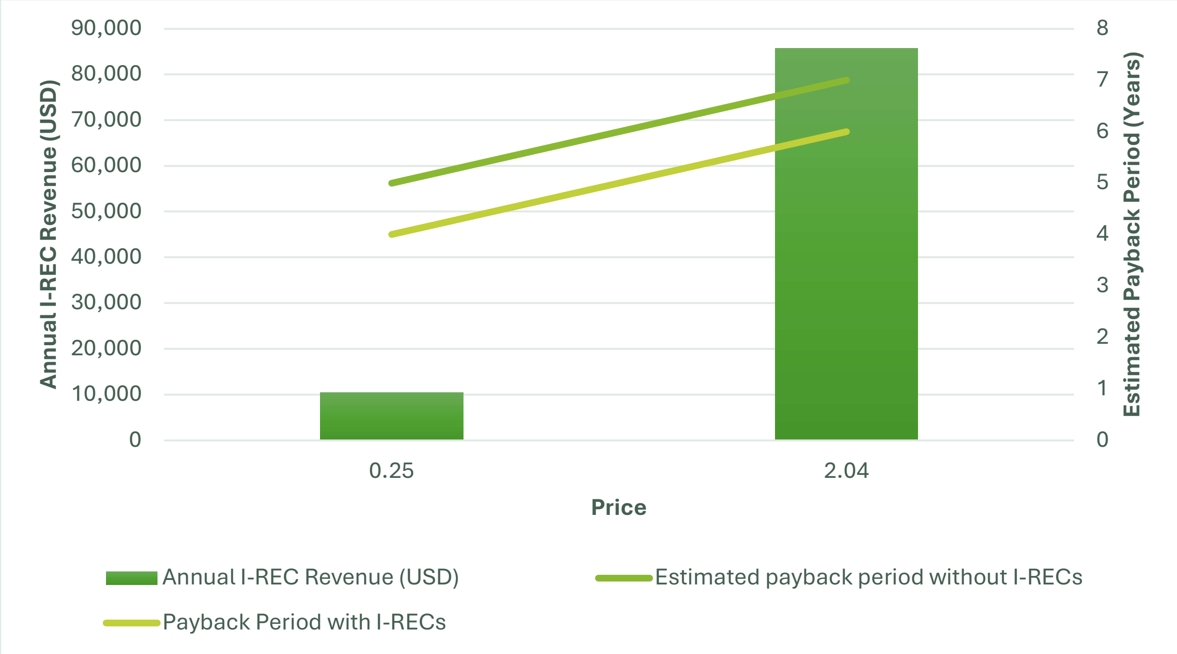


Figure 4-2: Annual I-REC Revenue and Impact on Payback for Thang Long II Industrial Park's 23.93 MWp Rooftop Solar

This graph shows both the annual I-REC revenue range for TLIP II's 23.93 MWp rooftop solar and the impact on payback periods. At current capacity (23.93 MWp, ~42,000 MWh/year), annual revenues range from USD 10,500 at USD 0.25/MWh to USD 85,680 at USD 2.04/MWh. This additional income improves rooftop solar project economics, reducing payback periods from 5–7 years to 4–6 years.

At USD 0.25–2.04 per MWh, certificates allow SMEs to demonstrate RE100-aligned compliance at minimal cost. Although purely virtual, I-RECs attract green-supply-chain clients and investors, strengthening TLIP II's competitive positioning until internal renewables reach scale.

Nevertheless, the role of I-RECs for TLIP II should be seen as **transitional rather than permanent**. While they ensure ESG compliance and market competitiveness, I-RECs do not reduce dependence on the EVN grid or enhance energy resilience in the way that on-site renewable generation, internal DPPAs, or ESCO-led microgrid models could. Their greatest value is therefore in bridging the short- to medium-term policy gap, allowing TLIP II to remain competitive while laying the groundwork for deeper integration of renewable energy through internal trading systems, shared energy storage, and smart EMS platforms. By combining I-RECs with its expanding rooftop solar capacity and preparing for DPPA-based trading once regulations mature, TLIP II can evolve from being a consumer of renewable certificates to becoming a model eco-industrial park with genuine energy autonomy and resilience.

Table 4-1: Cost–Benefit Assessment of I-RECs for TLIP II

Aspect	**I-RECs**	**Rooftop Solar (Self-Investment)**	**Internal DPPA (Third-Party Rooftop Leasing)**	**ESCO/Shared Microgrid with BESS**
Capital Investment	None (certificates purchased annually).	High upfront cost (~USD 0.55M/MWp).	No upfront cost (borne by investor).	Moderate to high (shared infra, BESS USD 350–450/kWh).

Operating Cost	Low: purchase price USD 0.25–2.04/MWh.	O&M ~1–2% of CAPEX annually.	Embedded in PPA tariff (5–10% lower than EVN).	O&M managed by ESCO, pooled costs.
Return/Revenue Potential	None for buyers (pure compliance). Revenue stream for solar generators (USD 10,500–85,680/yr for TLIP II's 23.9 MWp).	ROI ~12–18%, payback 5–7 years.	Tenant saves 5–20% on bills; investor ROI 10–15%.	Savings from bulk power mgmt., peak shaving, and reliability; ROI 10–15% (higher if policy support).
ESG / RE100 Compliance	Strong — internationally recognized; easy verification.	Strong — physical RE generation.	Strong — verifiable direct sourcing.	Strong — integrates RE + EMS; positions park as EIP.
Grid Independence / Resilience	None — still 100% reliant on EVN supply.	Moderate — self-consumption, ~20–30% load coverage.	Moderate — internal consumption covered, some autonomy.	High — microgrid + storage enable 50–70% independence.
Scalability for TLIP II	High — can cover entire park immediately, regardless of roof space.	Limited by rooftop availability (~100 MWp by 2030 target).	High within park, but dependent on regulatory clarity.	High potential, but requires strong policy, financing, and coordination.
Risk Factors	Price volatility; regulatory uncertainty; no physical decarbonisation.	Policy risk on FIT/tariffs; tech performance.	Legal uncertainty on intra-park sales; contract enforcement.	Policy gaps on ESCO rights, internal grid recognition, high upfront CAPEX.
Strategic Role for TLIP II	Short-term bridge for ESG compliance; tenant attraction.	Medium-term competitiveness, cost savings.	Transitional model until internal trading framework matures.	Long-term pathway to resilience and eco-industrial lea

4.2.5. Legal Sandbox for Net Zero

In the context of Vietnam's commitment to achieve net-zero greenhouse gas emissions by mid-century and the gradual development of a competitive electricity market, the introduction of a legal sandbox mechanism at Thang Long II Industrial Park offers a practical solution to test new business and operational models for electricity that align with the future direction of distributed energy and digitalized grid management. It would create a supervised regulatory environment to evaluate three key areas: (i) the technical feasibility of intra-park electricity trading, (ii) the operational efficiency of EMS-driven management, and (iii) the policy and market implications of these new models. The park, with its advanced infrastructure, professional management, and strong demand for renewable electricity from tenants, is well-positioned to serve as a demonstration site between 2026 and 2028. The sandbox would include the following components:

- **Intra-Park Direct Power Purchase Agreements (DPPAs):** Enterprises inside TLIP II would be allowed to sign long-term renewable energy contracts directly with in-park generators. Electricity would flow through the park's internal grid, without the need for a conventional operating license or state-regulated tariffs during the pilot. Measurement, settlement, and verification would be managed by the park-level EMS under regulatory oversight.
- **Smart Energy Management System (EMS) and Dispatch Center:** TLIP II's management or an authorized operator would act as a "mini grid operator," managing load monitoring, renewable dispatch, intra-park balancing, and BESS operations. The EMS would link to enterprise-level meters to coordinate distribution and support ESG reporting. This would be Vietnam's first attempt to establish a distributed dispatch center at the industrial park level.
- **Shared Electrical Infrastructure:** Tenants would jointly use medium-voltage lines, substations, and communal BESS. Costs for investment and operations would be transparently allocated, possibly via ESCO participation or joint-venture models, reducing individual capital burdens and optimizing land and infrastructure.
- **Governance and Oversight:** An inter-agency working group would be established, including representatives from the Hưng Yên Provincial People's Committee, Ministry of Finance, Ministry of Industry and Trade (MOIT), Hưng Yên Power Company, and TLIP II's management board. The group would conduct semi-annual reviews, publish results, and report on technical performance, cost outcomes, and market acceptance.

If implemented effectively, the sandbox could:

- Increase the share of clean energy consumed within TLIP II to more than 50% by 2030.
- Reduce enterprise energy costs by 5–15% compared to current regulated tariffs.
- Generate real-world data to support the design of Vietnam's formal regulatory framework for intra-park DPPAs, microgrids, and smart EMS by 2030.

The pilot would run for three years (2028–2030), with a mid-term evaluation in 2029 and a final review in 2030. Successful results would inform national regulations on microgrids and industrial-park energy markets.

Despite its urgency and pioneering significance, the sandbox faces multiple challenges:

- **Legal Constraints for Intra-Park DPPA**: Current Electricity Law and its sub-laws do not yet recognize direct renewable electricity trading between enterprises within an industrial park using internal grid systems unless participants hold an electricity operation license. This lack of a legal basis could mean that direct intra-park electricity trading is deemed a violation. Without a **dedicated legal pathway,** such as a conditional pilot approval or regulatory exemption, the rollout would face major institutional obstacles.
- **Technical Integration with the National Grid:** The internal grid of TLIP II will need to coordinate with the national power system to ensure stability, especially when large-scale rooftop solar and BESS are deployed. Issues include grid synchronization, reverse power flows, and maintaining frequency/voltage stability when renewable penetration is high. The lack of national standards for microgrid interconnection could delay or complicate technical approval.
- **Readiness and Capacity of Park Tenants:** Many SMEs in the park may lack the technical knowledge, financial resources, or confidence to participate in new contractual models such as intra-park DPPAs or shared EMS. Tenants may also be reluctant to commit to long-term renewable contracts due to uncertainty about production cycles or future relocation.

Capacity-building and clear communication on cost savings, ESG benefits, and contractual safeguards will be essential.

- **Financing Models and Investor Confidence:** While innovative financing mechanisms (ESCOs, green bonds, blended finance) are proposed, many domestic investors and banks are still cautious about renewable energy and BESS investments due to perceived risks and lack of proven track records in Vietnam. High upfront costs for BESS and EMS may deter early adoption without concessional financing or government guarantees. Clear revenue streams from RECs or carbon credits are not yet established, reducing the bankability of projects.
- **Market Acceptance and Fair Competition:** Traditional power providers may resist models that reduce reliance on EVN-supplied electricity. Ensuring non-discriminatory access to intra-park DPPA contracts, transparent pricing, and equitable cost-sharing for common infrastructure will be critical for tenant acceptance.
- **Operational and Cybersecurity Risks:** A centralized EMS managing multiple enterprises introduces new cybersecurity and data protection risks. Operational reliability of shared BESS and internal dispatch systems must be guaranteed, since any malfunction could disrupt multiple tenants simultaneously.

Nonetheless, governmental authorities should consider establishing a legal sandbox for industrial parks such as Thang Long II. This would provide a controlled, risk-managed environment to test innovative electricity market models, reduce policy uncertainty for investors, and position TLIP II as Vietnam's pioneering Net Zero industrial park.

4.3. Financing Architecture

Effective financing is pivotal to making TLIP II's hybrid model bankable. The park will apply a layered structure combining commercial, concessional, and innovative instruments:

- **Corporate self-investment and equity** from large tenants and park management;
- **Green credit lines** from domestic banks (BIDV, TPBank) and international financiers (IFC, ADB, GCF);
- **ESCO and leasing contracts** for SMEs, eliminating upfront cost barriers;
- **Blended-finance structures** that merge concessional and commercial capital; and
- **Performance-based revenue mechanisms** such as I-REC trading and cost-sharing for shared assets.

This blended approach maximizes leverage while reducing risk exposure, ensuring alignment with ESG-driven investor expectations.

4.4. Scenario-Based Pathways for TLIP II's Net-Zero Transition (2035 and 2050)

Building on the financing architecture above, TLIP II targets 50–70 percent renewable-energy penetration by 2030, mobilizing USD 30–40 million for 50 MWp of rooftop solar (RtS), a park-wide EMS, and a 5 MWh BESS. These investments align with FDI tenants' sustainability targets and national green-growth priorities.

The hybrid investment strategy will **require an estimated USD 30–40M by 2030**. Returns vary significantly depending on model type: external DPPA offers the quickest compliance at no cost, internal DPPA and rooftop solar deliver the highest long-term ROI, EMS ensures efficiency and grid stability, while I-RECs provide a low-cost bridge.

Table 4-2: Consolidated Investment Metrics for TLIP II Business Models

Model	Capital Cost ($M)	Annual Savings ($M)	ROI (%)	Payback (Years)	Tenants Targeted	Notes
External DPPA	0	0.4–0.6	8–10	N/A	Large FDI (30%)	Zero capex, compliance-focused
Internal DPPA	26–29	1.2–1.5	12–15	5–7 (4–6 w/ I-RECs)	Mixed (50%)	High ROI, but needs grid upgrades & regulatory reform
Smart EMS	0.3–0.5	0.1–0.2	25	2–3	All (100%)	Low-cost enabler, boosts RE efficiency
BESS (5 MWh)	1.5–2	0.5–0.7	12–15	3–5	Mixed (50%)	Becomes attractive post-2027
I-RECs	0.005–0.041	N/A	N/A	N/A	SMEs + FDI (20%)	Low-cost interim solution, enhances compliance

Source: TLIP II data, S&P Global 2024, I-TRACK Foundation.

- **External DPPA**: No upfront capital; tenants contract off-site RE (e.g., solar, waste-to-energy in Hung Yen) via EVN's grid, saving $0.4–0.6M/year (20 MW) via reconciliation. Targets 30% of tenants (large FDI, RE100).
- **Internal DPPA**: $26–29M for 50 MWp RSP (rooftop, canopies) at $0.52–0.58M/MWp, saving $1.2–1.5M/year (15–25% bill reduction). ESCO models reduce tenant costs to $0 with 10–15% markup, targeting 50% of tenants.
- **Smart EMS**: $300–500k (software, meters, data center), or $150–250k via third-party rental, yields 25% ROI via 2–5% loss reduction (0.7 GWh/year at 50 MWp) and 3–7% cost savings ($0.1–0.2M/year). Benefits all tenants.
- **I-REC**: $5,000–$40,800/year for 20,000 I-RECs ($0.25–2.04/MWh) supports 20% of tenants (SMEs, FDI) for ESG compliance. TLIP II's 23.93 MWp RSP generates ~42,000 I-RECs ($10,500–$85,680/year), shortening payback from 5–7 to 4–6 years.
- **BESS**: $1.5–2M for 5 MWh at $350–450/kWh (projected $260/kWh by 2027) yields 12–15% ROI via peak shaving (185% peak/off-peak price gap) and backup, saving $0.5–0.7M/year. Targets 50% of tenants.

These models offer complementary financial pathways: external DPPAs provide immediate compliance with no capital outlay; internal DPPAs and RtS yield the highest long-term ROI; EMS enhances efficiency and resilience; I-RECs bridge ESG reporting; and BESS ensures operational stability.

4.5. Investment Roadmap for Net-Zero Energy Transition by 2035 and 2050 in TLIP II

In response to the urgent demand for supply chain decarbonisation and Vietnam's broader green transition commitments, Thang Long II Industrial Park can pursue **two investment trajectories** to achieve Net Zero:

- **Scenario 1 – Baseline 2050:** Gradual, low-risk adoption aligned with national timelines, suitable for diverse SMEs and incremental policy reform.

- **Scenario 2 – Accelerated 2035:** Ambitious, FDI-driven transition leveraging advanced governance, concessional finance, and international partnerships.

4.5.1. Baseline Scenario – Net Zero by 2050

The baseline scenario is designed for gradual, lower-risk development. It aligns with the diverse structure of TLIP II enterprises (many SMEs with limited capital), incremental improvements in infrastructure, and gradual policy reforms. This scenario allows for a step-by-step integration of rooftop solar (RtS), gradual development of EMS, and adoption of external DPPAs, before moving into more complex internal DPPA models that require stronger policy reforms.

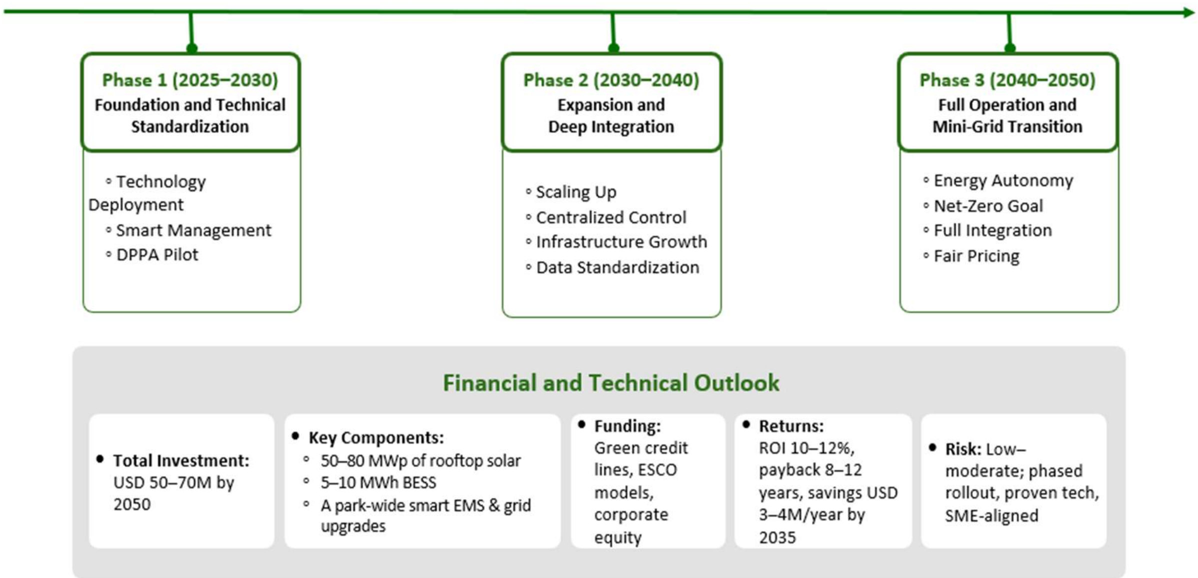


Figure 4-3: Overview of Baseline Scenario for TLIP II

- **Phase 1 (2025–2030) - Foundation and Technical Standardization**
    - Rooftop solar deployment on suitable factory roofs, with BESS pilots for high-load tenants. Assist new businesses in phases 3 and 4 with integrating rooftop solar and BESS solutions directly into their factory design.
    - Build a smart EMS for the industrial park level. This system will connect to data from key enterprises to monitor real-time output, load, and efficiency.
    - Deploy a pilot Direct Power Purchase Agreement model, allowing a few pioneering businesses to buy power from a renewable energy generator through a bilateral contract using both the national and internal grids..
- **Phase 2 (2030–2040) - Expansion and Deep Integration:** Once the legal framework for internal DPPA and EMS is more established, TLIP II will fully expand the model.
    - Apply the pilot internal DPPA model to more businesses, especially small and medium-sized enterprises, using a clean energy-sharing mechanism.
    - Implement a central EMS with the ability to monitor and coordinate power generation and consumption throughout the entire park.
    - Expand both rooftop and centralized solar power systems on the industrial park's common land.
    - Standardize metering equipment, data architecture, and information management platforms to support ESG (Environmental, Social, and Governance) reporting and carbon management.

- **Phase 3 (2040–2050) - Full Operation and Transition to a Mini-Grid:** The final phase involves perfecting the smart and green industrial park model, allowing it to operate as an independent and energy-optimized mini-grid.
    - Operate the internal power grid as a mini-grid, capable of balancing power and dispatching locally without being fully dependent on EVN.
    - Achieve 100% of electricity consumption from renewable energy sources.
    - Fully integrate the metering, dispatching, and data verification systems to support carbon audits and international Net Zero certification.
    - Apply a fair and transparent pricing framework to allocate the costs of shared electrical infrastructure to all businesses within the park.

Financial Outlook

- **Total investment required**: USD 50–70 million by 2050.
- **Funding sources**: green credit lines, ESCO models, corporate self-financing.
- **Risk profile**: relatively low, due to stepwise implementation and reliance on proven technologies.

4.5.2. Accelerated Roadmap: Achieving Net Zero by 2035

The accelerated scenario is suitable for FDI-driven industrial parks with stronger capital mobilisation capacity, high ESG visibility, and advanced governance structures such as TLIP II. This pathway requires simultaneous technical, financial, and regulatory reforms, but in return it provides a major first-mover advantage, boosting green investment attractiveness and positioning TLIP II as a pioneer Net Zero industrial park in Vietnam.

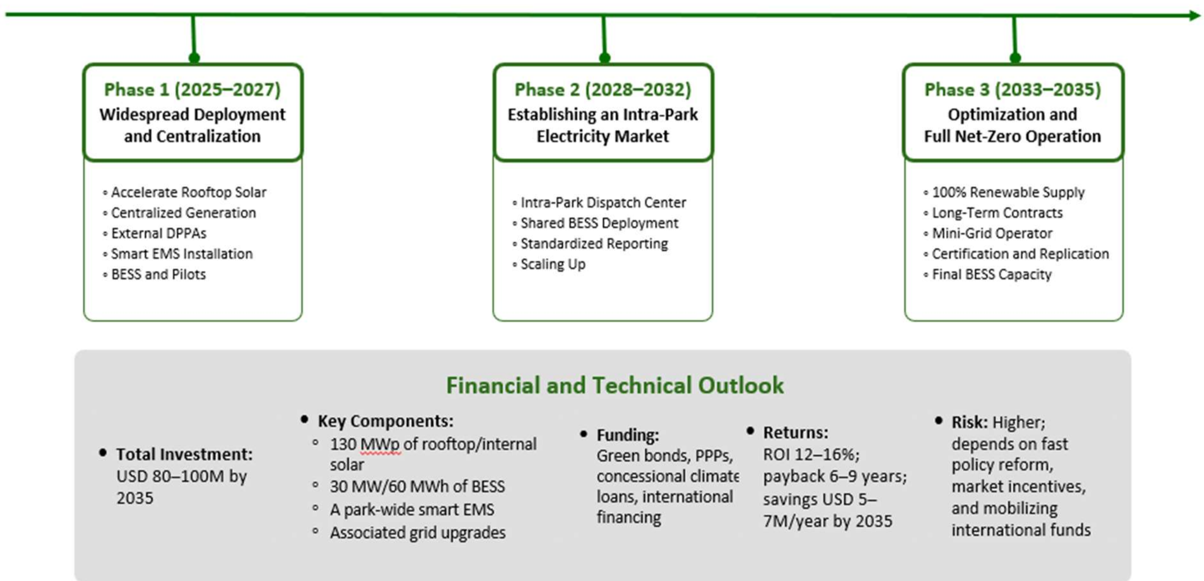


Figure 4-4: Overview of Accelerated Scenario for TLIP II

Phase 1 (2025–2027): Widespread Deployment – Activating Centralized Renewable Energy Models

- Accelerate incentives for tenant-led rooftop solar installations.
- Invest in ground-mounted and rooftop solar systems operated by Energy Service Companies on unused land or rooftops

- Facilitate large-scale external Direct Power Purchase Agreements for off-site renewable energy
- Install a centralized smart Energy Management System with real-time metering and connectivity to all tenants to enable load dispatch and clean energy traceability.

Phase 2 (2028–2032): Establishing an Intra-Park Electricity Market – Comprehensive DPPA Operations

- Operate the EMS as an “intra-park dispatch center,” managing power flows, clean energy contracts, and ESG data for 100% tenant integration.
- Deploy a shared Battery Energy Storage System, balancing loads and stabilizing the internal grid.
- Establish a transparent data management system for ESG reporting, standardizing energy metrics across IP to support RE100 and SBTi compliance.

Phase 3 (2033–2035): Optimization and Model Replication

- Fully develop intra-park renewable energy (rooftop solar) to meet daytime demand.
- Implement long-term intra-park DPPA contracts with shared grid infrastructure, covering tenant demand.
- Ensure all electricity comes from renewable sources via DPPAs and EMS-dispatched grids.
- Position TLIP II’s management board as a mini-grid operator, overseeing metering, dispatch, ESG reporting, and energy data management.
- Achieve international net-zero certification (e.g., ISO 50001, PAS 2060) and replicate the “smart-green IP” model across Vietnam’s IPs.

Financial Outlook:

- Total investment: **USD 80–100 million**
- Funding sources: Green bonds, PPP models, concessional loans, climate funds (ADB, GCF)
- ROI: **12–16%**, Payback: **6–9 years**
- Risk profile: Higher, dependent on rapid policy reform, but with high FDI attractiveness

4.6. Technical and Financial Capacity Plan for TLIP II’s Net-Zero Implementation

Building on the scenario framework above, this section translates TLIP II’s strategic pathways into concrete capacity targets, investment needs, and load projections. It defines the renewable-energy mix, battery storage requirements, and financing structures needed to achieve full net-zero operation under the Baseline (2050) and Accelerated (2035) scenarios.

4.6.1. Clean-Energy Capacity Outlook

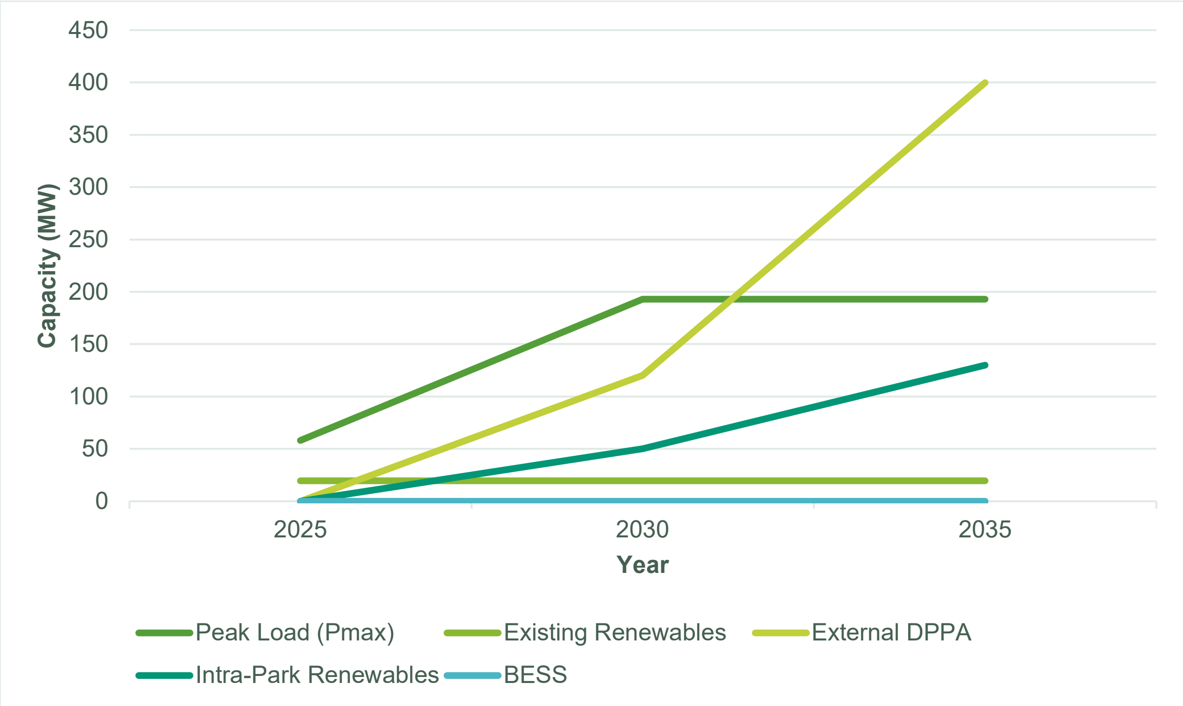
The development roadmap for TLIP II’s clean-energy transition is summarized in the table below. It demonstrates how internal and external renewable-energy sources, supported by storage systems, will scale to meet the park’s growing load demand.

Table 4-3: Clean Energy Capacity and Investment for Net Zero 2035

Metric	2025	2030	2035
Peak Load (Pmax)	58.2 MW	193 MW	193 MW

Existing Renewables	19.6 MW (rooftop solar)	19.6 MW	19.6 MW
External DPPA	0	120 MW	400 MW
Intra-Park Renewables	0	50 MW	130 MW
BESS	0	20MW/40 MWh	30MW/60 MWh

By 2030, TLIP II's peak load is expected to reach 193 MW, more than triple its current demand. The park will progressively integrate 120 MW of off-site renewable power through Direct Power Purchase Agreements and 50 MW of new internal solar capacity, raising total renewable supply to nearly 190 MW.



Looking ahead to 2035, the park will scale to a total clean-energy capacity of over 500 MW, including:

- 130 MW of internal rooftop and canopy solar, fully utilising available roof areas;
- 400 MW of external renewable supply via DPPAs (primarily wind and waste-to-energy to meet nighttime loads);
- 30 MW / 60 MWh of BESS, ensuring flexibility and grid stability.

Even with this transformation, the national grid will remain a critical backup for evening or low-generation periods, maintaining reliability while TLIP II progressively shifts toward self-balancing operation.

4.6.2. Load Profile and Energy Management Implications

TLIP II exhibits a high load-utilisation ratio, with nighttime demand reaching nearly 80% of daytime consumption. This profile implies that:

- Internal solar generation will primarily serve daytime industrial operations with minimal surplus for storage.
- BESS systems will need to be charged using external DPPA sources—especially wind and waste-to-energy—during off-peak hours.
- Efficient Energy Management Systems (EMS) are essential to optimise this mix, coordinate generation and consumption, and balance intermittent renewable supply.

Primary Functions of BESS (30 MW / 60 MWh):

1. Short-Term Power Regulation: Smooth hourly fluctuations and reduce peak stress on the internal grid.
2. Backup Power: Provide 1–2 hours of instantaneous backup to protect critical production lines.
3. Coordination Hub: Serve as a control node linking rooftop solar, DPPA imports, and EMS-based dispatch.

Estimated Investment: USD 12–15 million for high-reliability LFP (Lithium Iron Phosphate) systems, installed by 2030 and expanded by 2035.

Adjustment Scenarios:

- Earlier expansion may be required if backup reliability must increase or if nighttime DPPA charging becomes viable.
- Doubling of BESS capacity may be warranted if daytime solar DPPAs increase significantly.

4.6.3. Scenario Comparison and Investment Requirements

The two strategic scenarios, including the Baseline Net Zero by 2050 and Accelerated Net Zero by 2035, differ in pace, scale, and financing approach but share the same technical foundation.

Table 4-4: Comparison between Scenario 1 (Baseline) and Scenario 2 (Accelerated)

Aspect	Scenario 1 – Baseline (2050)	Scenario 2 – Accelerated (2035)
Total Investment	**USD 50–70M**	**USD 80–100M**
Key Components	50–80 MWp RtS, EMS, 5–10 MWh BESS, grid upgrades	130 MWp RtS, EMS, 30 MW/60 MWh BESS, grid upgrades
Annual Savings (2035)	USD 3–4M	USD 5–7M
ROI	10–12%	12–16%
Payback Period	8–12 years	6–9 years
Capital Mobilisation	Phased bank loans, ESCOs, corporate equity, SME financing pilot	Green bonds, PPPs, concessional loans, climate funds
Risk Profile	Low–moderate (incremental approach; stable but slower returns)	Higher (depends heavily on policy clarity, market incentives, and international financing)
FDI Attractiveness	Medium (gradual alignment with ESG norms; suitable for SMEs)	Very high (strong alignment with RE100, ESG, and multinational investor requirements)
Suitable for	SMEs and domestic enterprises with limited capital	Large-scale FDI enterprises with explicit net-zero targets

Required Policies	Adjusted Direct Power Purchase Agreement (DPPA) and EMS regulations from 2028–2030	Adjusted DPPA and EMS regulations after 2030; stronger carbon pricing/REC market
Co-benefits	Improves energy reliability, reduces O&M costs, gradual workforce adaptation	Positions TLIP II as a regional net-zero leader; enhances brand reputation; maximizes use of green financing instruments
Key Risks to Monitor	Slow policy reforms; limited SME financing capacity	Policy uncertainty; grid integration challenges; dependency on concessional finance

Note: *Investments are calculated on the basis of benchmark costs: solar PV at USD 0.52–0.58M/MWp (rooftops, ground/parking canopies), BESS at USD 350–450/kWh now (falling to ~USD 260/kWh by 2027), EMS at USD 0.3–0.5M for full park coverage, and grid upgrades at USD 1–3M. The total is adjusted for scale: 50–80 MWp vs. 130 MWp solar, and 5–10 MWh vs. 60 MWh storage.*

A calculation of midpoint averages was conducted and produced the following results:

	Baseline (2050)	**Accelerated (2035)**
Average Investment	USD 60M	USD 90 M
Average Annual Savings	USD 3.5M	USD 6M
Roi	11%	14%
Payback	10 years	7.5 years

The two scenarios represent different levels of commitment in terms of timeline and investment. The accelerated scenario delivers higher returns (14%) compared with the baseline scenario (11%), making it more attractive for international investors. Additionally, the accelerated strategy achieves payback in 7.5 years, compared with 10 years under the baseline. This shortens the capital recovery timeline and improves investor confidence.

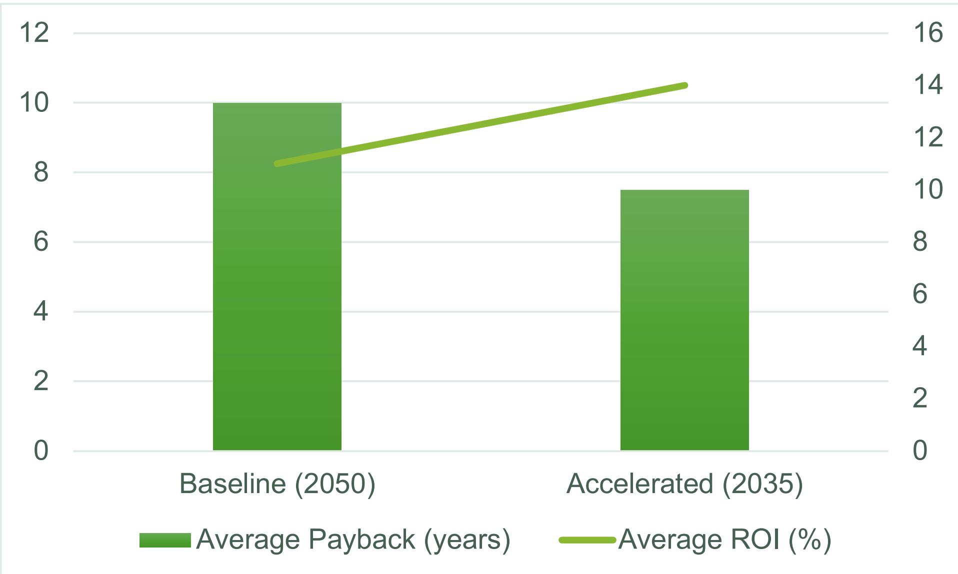


Figure 4-5: Average ROI and Payback Period Comparison

While the ROI and payback analysis underscores the financial attractiveness of the accelerated scenario, **Figure 4-6** complements this by showing how different financing instruments can be structured to support each investment component, thereby translating higher returns into a feasible capital mobilization strategy.

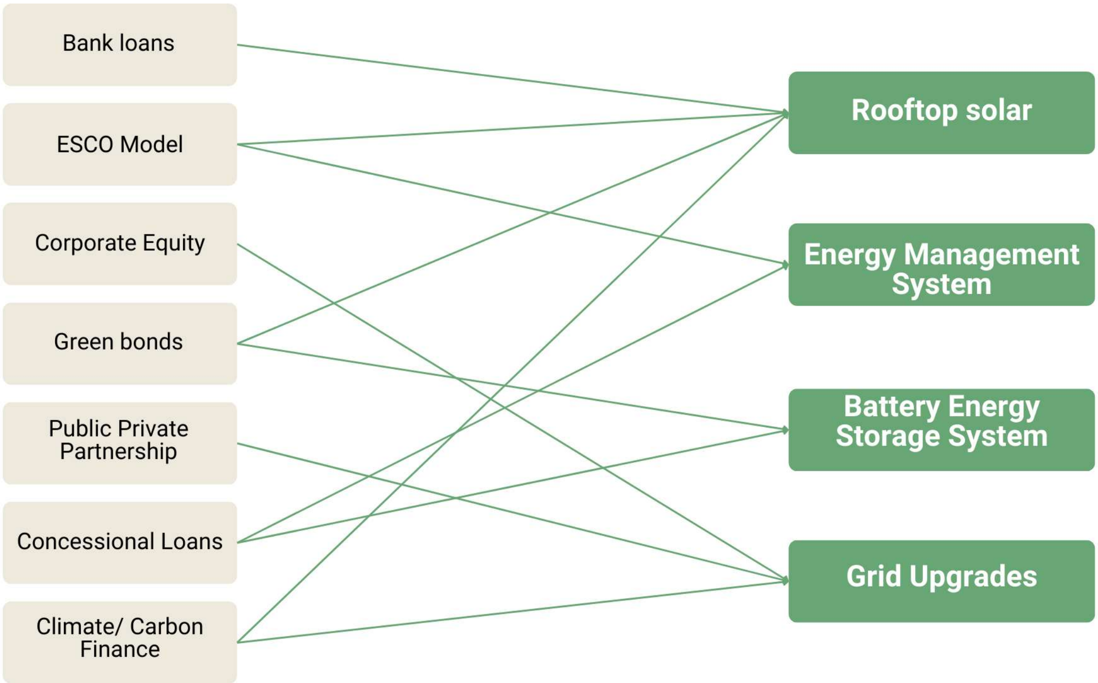


Figure 4-6: Potential Capital Mobilization Flow for Thang Long II Industrial Park Net Zero Transition

The figure demonstrates a relationship between different funding sources (e.g., bank loans, ESCOs, corporate equity, green bonds, etc.) with investment uses (e.g., rooftop solar, energy management system, BESS, and grid updates). The arrows show which financing instruments typically flow into which asset categories.

4.6.4. Financing Structure and Capital Mobilization

4.6.4.1. Scenario 1: Traditional and Phased Financing

Scenario 1 requires a lower upfront investment (USD 50–70M for 50-80 MWp RtS, 5-10 MWh BESS, EMS, and grid upgrades) and delivers steady but modest returns (ROI 10–12%), with a longer payback horizon (8–12 years). It can be comfortably financed through a mix of corporate equity, phased bank loans, and ESCO participation, making it more suitable for SMEs with limited capital.

- **Bank loans (phased):** Local and international commercial banks provide medium-term loans, disbursed in project phases to match rooftop solar and BESS expansion. This reduces upfront burden on SMEs and aligns repayment with achieved savings.
- **ESCO model:** Energy Service Companies invest in rooftop solar and EMS infrastructure, with repayment structured through shared-savings contracts. This removes the need for SMEs to commit upfront capital.
- **Corporate equity:** Park management or larger tenants contribute equity, particularly for grid upgrades and EMS installation, securing control and gradual returns.
- **Risk sharing:** Financing spread across multiple SMEs through collective agreements reduces default risk and makes it easier to negotiate terms with lenders.

4.6.4.2. Scenario 2: Innovative and Large-Scale Financing

By contrast, Scenario 2 demands a larger capital outlay (USD 80–100M for 130 MWp RtS, 30 MW/60 MWh BESS, EMS, and grid upgrades) but generates stronger returns (12–16%) and a shorter payback (6–9 years), largely because higher renewable penetration accelerates cost savings and improves the park's energy independence. Scenario 2, however, requires innovative financing structures such as green bonds, PPP models, and international climate funds (e.g., ADB's Energy Transition Mechanism, GCF) to mobilise large upfront capital at concessional terms.

- **Green Bonds:**
  - TLIP II can issue corporate or project-based green bonds aligned with ICMA's Green Bond Principles.
  - Institutional investors (pension funds, sovereign wealth funds) are attracted to the predictable cash flows from renewable energy assets.
- **Public–Private Partnerships (PPPs):**
  - Park management collaborates with the provincial government to co-invest in grid upgrades and large-scale storage.
  - PPP structures allow government to de-risk private investment by offering guarantees or viability gap funding.
- **Concessional Loans and Climate Funds:**
  - Access financing from ADB's Energy Transition Mechanism (ETM), the Green Climate Fund (GCF), and JICA's concessional credit lines.
  - These facilities lower cost of capital (2–3% compared with 6–8% for commercial loans), making large BESS investments viable.
- **Blended Finance:**
  - Combine concessional climate funds with commercial loans to de-risk large-ticket investments. For example, concessional finance can cover the BESS while private loans focus on rooftop solar expansion.
- **Carbon Finance and RECs:**
  - Monetise excess clean energy via Renewable Energy Certificates (RECs) or potential carbon credits under Article 6 of the Paris Agreement.
  - Revenue streams from carbon markets can improve project bankability and reduce reliance on debt.

Given TLIP II's advanced infrastructure, high FDI participation, and strong governance, the Accelerated Scenario (Net Zero 2035) is the preferred pathway. However, its success depends on:

- Timely regulatory reforms for internal DPPAs and EMS licensing;
- Establishment of green-finance facilities (funds, guarantees, and bonds); and
- Early coordination between the Hung Yen Provincial People's Committee, EVN, and international development partners.

With these enablers in place, TLIP II can achieve full renewable integration and net-zero certification by 2035, setting a precedent for replication across Vietnam's industrial park network.

4.7. Investment Roadmap Risk Analysis

The journey toward a net-zero industrial park is complex and capital-intensive, marked by several layers of uncertainty. For TLIP II, these challenges fall into three main categories, including financial, legal and institutional, and market-related risks, each of which requires tailored mitigation measures. A successful transition will depend on identifying, quantifying, and managing these risks through proactive coordination among investors, park operators, and government authorities.

This **risk framework** is built on:

- **Stakeholder workshops** with IP Owner, anchor tenants, and PPC;
- **Global benchmarks** (IRENA 2025, IFC ESG Standards, BloombergNEF BESS forecasts);

- **Scenario-specific sensitivity testing** across **Hybrid, Accelerated, and Baseline pathways**.

4.7.1. Financial Risks

The foremost challenge concerns **capital mobilization and cash-flow stability**. Renewable-energy assets, storage systems, and smart-grid infrastructure require large upfront investments and long payback periods—often extending 10–15 years or more. This exposes investors to interest-rate volatility, liquidity risk, and delayed cost recovery if projected savings are not realised.

At the industrial-park level, most **small and medium-sized enterprises** have limited access to preferential "green" credit lines and must often rely on high-interest commercial loans, which undermines project viability.

Additional vulnerabilities include:

- **Exchange-rate risk**, since imported equipment is priced in USD or EUR, meaning depreciation of the VND would inflate project costs;
- **Inflation risk**, which may increase future operation and maintenance expenses; and
- **Participation risk**, in which one or more partners in a joint-investment model withdraw, shifting the financial burden to remaining participants.

These risks underscore the need for a **diversified financing ecosystem**, blending equity, concessional loans, ESCO contracts, and green-credit facilities rather than relying on a single investor or financial instrument.

4.7.2. Legal and Institutional Risks

Vietnam's legal framework for clean-energy markets is evolving but remains incomplete. Although regulations on DPPAs and private-grid operations have been introduced, they are still in pilot stages and awaiting implementation feedback. This creates uncertainty for early projects such as TLIP II, where internal electricity transactions between tenants may be restricted without specific licensing.

Permitting procedures for energy-storage systems and shared infrastructure (e.g., substations or private lines) are also unclear, raising compliance risks.

Institutional resistance represents another challenge. EVN and its local subsidiaries, which must maintain backup capacity for reliability, may perceive intra-park renewable trading as a revenue loss. Without an agreed compensation mechanism (e.g., a backup service fee), administrative hurdles or delays could arise.

The absence of a comprehensive and stable legal foundation is arguably the most systemic risk. It heightens investor uncertainty, especially for 15- to 20-year contracts, and inhibits large-scale capital mobilization. Without regulatory clarity, financial and technical risks are more difficult to mitigate.

4.7.3. Market and Price Volatility Risks

The clean-energy market is dynamic and highly sensitive to policy and pricing shifts. TLIP II faces several market-related risks:

- **Electricity-price volatility:** While renewable power costs are fixed under long-term contracts, national grid tariffs—set by the state—can fluctuate. If grid prices fall due to fuel subsidies, the relative savings from renewables diminish. Conversely, if tariffs rise sharply, profitability increases but could attract policy intervention (e.g., temporary price caps).
- **REC price fluctuations:** International Renewable-Energy Certificate (REC) prices have been strong but may decline after 2030 if global oversupply occurs. This could erode secondary-market revenues for TLIP II's participants.

- **Demand variability:** Industrial-park electricity demand depends on tenant occupancy and economic cycles. If major tenants relocate or production slows, renewable systems may face surplus capacity and underutilization.
- **Technological competition:** As EVN expands its national renewable portfolio, it may offer lower-cost "green electricity" packages that compete with TLIP II's internal grid.

These uncertainties highlight that a net-zero transition is not purely a technical exercise; it is also a **market enterprise**. The TLIP II business model must remain flexible, continuously adapting to both supply-side and demand-side dynamics.

4.7.4. Proposed Risk-Management Framework

To address these challenges, TLIP II requires an **integrated risk-management framework** jointly implemented by the industrial-park management board, investors, and relevant government bodies.

- **Diversify and Share Financial Risks:** Form a joint-venture or project-company structure with multiple investors contributing equity and debt, reducing concentration risk. Blend funding sources, including internal capital, domestic bank loans, international green credit, and provincial loan guarantees, to lower average financing costs.
- **Establish a Legal Sandbox and Continuous Dialogue:** Create a regulatory sandbox allowing controlled pilots of internal electricity sales, supported by regular performance reporting. In parallel, initiate early dialogue with EVN and provincial power authorities to agree on operational arrangements such as a *capacity-backup fee* paid to EVN for maintaining reserve supply. This approach aligns incentives and minimises institutional friction.
- **Implement Technical and Operational Safeguards:** Deploy an **integrated Energy Management System** from the outset to monitor voltage, frequency, and load balance. Adopt a dedicated internal grid code requiring all renewable and storage units to include protection devices and follow central dispatch commands. This ensures safety, interoperability, and reliability.
- **Adopt a Phased Implementation Approach:** Prioritize smaller pilot projects (e.g., 5–10 MW) to validate operational performance and governance mechanisms before scaling to 50–100 MW. This phased rollout allows learning and capacity building while reducing exposure to technical or financial shocks.

4.8. Required Breakthrough Policies for an Accelerated Net-Zero Roadmap at TLIP II

To transform the accelerated 2035 roadmap into reality, TLIP II requires **systemic policy innovation**, not just incremental adjustments. This report proposes eight breakthrough policy reforms to remove regulatory bottlenecks, unlock blended capital, and create an enabling environment for a green, smart, and resilient industrial-park model. Leadership from the Ministry of Finance will be crucial to steer financial and governance reforms in industrial parks, driving them towards net-zero transition. Additionally, the June 2025 merger of Hung Yen and Thai Binh into a unified Hung Yen Province requires an immediate priority action: revise the provincial master plan by Q1 2026. Led by the PPC with MOF, the update must embed renewable mandates, low-carbon zoning, and grid-support provisions to enable TLIP II's Net Zero roadmap.

The success of the transition hinges on collaboration among diverse actors—public, private, and provincial. TLIP II's decarbonization roadmap depends on coordinated execution across ministries, park operators, tenants, utilities, and local authorities. The table below outlines the respective roles and responsibilities of key stakeholders in operationalizing the 2035 roadmap.

Table 4-5: Roles and Responsibilities of Local Stakeholders

Actor	Key Roles
Park Management Board (Operator)	Acts as SPV sponsor, mini-grid manager, and EMS operator. Aggregates tenant demand, secures financing, owns shared assets, and distributes I-REC and carbon revenues.
Tenants (especially SMEs)	Participate through leasing, internal DPPAs, or crowdfunding; gain cost savings, ESG compliance, and co-design input.
Large Anchor Tenants	Provide demand stability, co-invest in BESS, and anchor RE100 commitments.
Hung Yen PPC	Issues provincial green bonds, accelerates permitting, and coordinates with national guarantee mechanisms.
EVN	Enables grid interconnection, ancillary services, and standardized metering for internal and external power flows.

To turn strategic vision into bankable action, TLIP II requires a mix of financial, regulatory, and governance reforms. The following table details the eight priority reforms designed to mobilize green capital, de-risk private investment, and integrate renewable-energy systems within industrial parks. Each reform identifies its rationale, key implementing bodies, and execution roles at the park and provincial levels.

Table 4-6: Breakthrough Policy Reforms and Respective Roles of Stakeholders

Reform	Description/ Explanation	Importance	Lead Governmental Entity	Execution Role
Establish an Industrial Energy Transition Fund and credit guarantees	**MOF-seeded fund** offering partial credit guarantees, concessional loans below market, and viability gap grants.	De-risks debt , mobilizes private capital, closes SME equity gap.	**Ministry of Finance (MOF),** State Bank of Vietnam (SBV), PPC (People's Provincial Committee) for local implementation	Board: apply for funding; Tenants: access leasing; PPC: co-finance local share.
Launch Provincial Green Bonds with national backstop	Authorize PPCs to issue **municipal green bonds** for RE infrastructure, backed by MOF partial guarantee and project pipeline.	Crowds in institutional investors, reduces yields, funds 30–50% of Hybrid/Accelerated scenarios.	**MOF, PPC for issuance**	PPC: issue bonds; Board: submit bankable projects; MOF: guarantee facility.
Integrate clean-energy criteria into industrial-park licensing and planning	**Mandate RE + ESG audits in MOF master plans and licensing regulations**; prioritize low-carbon zoning in new/expanded parks.	Attracts rental premiums, prevents lock-in, aligns with national eco-industrial park strategy.	**MOF, PPC for provincial plans**	Board: prepare RE-compliant master plan; Tenants: meet ESG criteria; PPC:

				enforce zoning.
Enable shared infrastructure ownership and operation	**Revise regulations on industrial parks to allow multi-tenant SPVs owning solar/BESS/EMS**; permit revenue-sharing PPAs and leasing.	Reduces SME capex, enables intra-park trading, scales shared RE.	**MOF, PPC for land allocation**	Board: form SPV; Tenants: co-own via leasing; SMEs: zero-upfront access.
Develop a National Net-Zero Industrial Park Standard for certification and benchmarking	MOF tiered standard; links to **tax holidays, green bond eligibility, and carbon finance**.	Unlocks revenue, benchmarks vs. VSIP/Amata, signals ASEAN leadership.	**MOF; PPC for pilot certification**	Board: lead certification; Tenants: report data; PPC: offer local incentives.
Legalize internal DPPAs within industrial parks	Amend Electricity Law to permit direct tenant-generator contracts via private wires or virtual wheeling; allow park SPV as counterparty.	Enables tenant savings, scales RE.	**Ministry of Industry and Trade (MOIT), EVN for metering, PPC for local approval**	Board: sign DPPAs; Tenants: purchase direct; EVN: approve wheeling.
Recognize park operators as mini-grid managers	Grant licensed status for parks to operate internal grids, BESS dispatch, and EMS.	Cuts losses, ensures resilience, supports RE integration.	**MOIT, PPC for pilot licensing**	Board: operate mini-grid; Tenants: benefit from reliability.
Authorize grid-support services from industrial parks	Allow parks to provide **ancillary services** (frequency regulation, peak shaving) via BESS to EVN with clear remuneration	Provides clear revenue streams, reduces Hung Yen grid strain, accelerates payback.	**MOIT, EVN for dispatch integration; PPC for local pilots**	Board: dispatch BESS; EVN: integrate signals; Tenants: share revenues.

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The **Hung Yen Provincial People's Committee** plays a decisive role in piloting these reforms. As a province with strong Japanese FDI and an emerging green-industry base, it can become Vietnam's model for sustainable industrial development by:

- **Launching pilot programmes** for internal DPPAs and smart EMS systems at TLIP II;
- **Creating a Provincial Energy-Transition Fund** blending local budgets, JICA/ADB concessional loans, and GCF support;
- **Offering preferential policies** for FDI firms adopting RE100 or ESG standards;
- Establishing a local SME Green Leasing Facility backed by I-REC revenues; and

- **Facilitating local green-bond issuance** through guarantees or co-financing schemes, following guidance from MOF.

By integrating these actions into the provincial master plan for industrial-park and economic-zone development, Hung Yen can make TLIP II a certified Net-Zero Industrial Park and a replicable benchmark for other provinces.

4.9. Implementation Roadmap and Next Steps

This TLIP II-specific roadmap transforms the park from current pilot to Vietnam's Net Zero industrial park, with national replication as a secondary outcome. All actions are anchored at Thang Long II Industrial Park, using its infrastructure, FDI base, and Hung Yen PPC partnership as the core engine. National scaling (Phase 4) is conditional on TLIP II success.

Table 4-7: Execution Plan for Thang Long II Industrial Park

Phase	TLIP II Key Actions	Owner	Indicative Timeline	Scenario
Phase 0: Pre-Launch	• Finalize **TLIP II RE Master Plan** (rooftop + EMS blueprint) • Secure **3+ anchor tenants** (RE100-committed FDI) • Form **TLIP II RECo SPV**	**TLIP II Management Board + PPC**	**Q4 2025**	All
	• Seed **Industrial Energy Transition Fund** (USD 50M, TLIP II as flagship)	**MOF**	**Q4 2025**	All
Phase 1: Pilot & Sandbox at TLIP II	• Launch **Sandbox** (internal DPPA + mini-grid pilot **exclusively at TLIP II**)	**PPC**	**Q1 2026**	All
	• Deploy **5–10 MW rooftop solar + 5 MW/10 MWh BESS** (Phase 3 roofs)	**TLIP II Board**	**Q3 2026**	Hybrid
	• Issue **Hung Yen's first provincial green bond (USD 15M) — 100% for TLIP II**	**PPC**	**Q3 2026**	Hybrid/Accelerated
	• Activate **TLIP II SME Green Leasing Facility (USD 5M)**	**PPC + TLIP II Board**	**Q4 2026**	Hybrid
Phase 2: Full Scale-Up at TLIP II	• Expand to **50 MWp solar + 20 MW/40 MWh BESS** (all phases + canopies)	**TLIP II SPV**	**Q2 2028**	Hybrid
	• Achieve **50–70% RE penetration** via **internal DPPAs + EMS dispatch**	**TLIP II Board**	**Q4 2030**	**Hybrid Complete**

Phase 3: Net Zero Certification at TLIP II	• Scale to **130 MWp + 30 MW/60 MWh BESS**	**TLIP II Board + PE/VC**	**Q3 2032**	Accelerated
	• Launch **ancillary services to EVN** from TLIP II BESS	**MOIT + EVN**	**Q1 2033**	Accelerated
	• Certify **TLIP II as Net Zero Industrial Park**	**MOF**	**Q4 2035**	**Accelerated Complete**
Phase 4: National Replication *(Triggered by TLIP II success)*	• Adapt **TLIP II model** to other **pilot parks**	**MOF + PPCs**	**2030–2032**	Baseline
	• Scale to **10+ parks** via **Net Zero Standard rollout**	**MOF**	**2033–2035**	Baseline

***Disclaimer**: All timelines are TLIP II-specific and assume Q1 2026 sandbox launch and post-merger master plan approval. Delays in regulatory reforms, funding, or EVN integration shift TLIP II milestones. Progress reviewed quarterly by TLIP II Board + PPC.*

5. Conclusion

This report presents a comprehensive analysis and roadmap for the Thang Long II Industrial Park to achieve net-zero emissions by 2035 through a clean, smart, and financially viable energy transition. It outlines a phased hybrid business model that integrates renewable generation, digital energy management, and innovative financing to balance environmental objectives with economic competitiveness.

As an essential first step, a hybrid delivery strategy to be implemented by 2030 will combine external and internal DPPAs, an integrated Energy Management System (EMS) supported by Battery Energy Storage Systems (BESS), I-REC certification, and a regulatory sandbox for internal power trading. This phase will build upon TLIP II's existing 23.93 MWp of rooftop solar, expanding to 100 MWp with an estimated USD 30–40 million investment. The model will enable the park to achieve 50–70% renewable energy integration while ensuring near-term ESG compliance, improving energy resilience, and delivering 5–15% cost reductions through external DPPAs and USD 10,500–85,680 per year in additional revenue from I-RECs. The regulatory sandbox (2028–2030) will serve as a testing ground for legal and technical innovations, particularly for intra-park power trading and shared infrastructure governance.

Looking ahead, the report defines two strategic pathways for long-term implementation:

- **The Accelerated Scenario** targets 100% renewable energy by 2035, deploying 130 MWp of rooftop solar, 60 MWh of BESS, and a fully integrated park-level mini-grid. This pathway requires USD 80–95 million in investment, delivers a 12–16% ROI, and yields USD 5–7 million in annual savings while positioning TLIP II as a model for Vietnam's industrial decarbonization.
- **The Baseline Scenario** achieves full decarbonization by 2050 with USD 50–65 million in investment, delivering moderate returns but offering a lower-risk, incremental approach suitable for SMEs and domestic enterprises.

The financing architecture blends traditional mechanisms, including corporate equity, bank loans, and ESCO participation, with innovative green instruments such as green bonds, sustainability-linked loans (SLLs), carbon and I-REC revenues, and MDB-backed guarantees. These mechanisms are designed to de-risk investments and crowd in private capital, in partnership with the Hung Yen Provincial People's Committee and international development institutions.

The analysis also identifies four core risk dimensions—financial, legal, technical, and market—and proposes a structured mitigation framework built on diversified funding channels, legal sandboxes, smart EMS and grid codes, and phased pilot deployment. Together, these measures enhance system resilience and investor confidence, while ensuring regulatory alignment and operational safety.

Finally, the report calls for a set of breakthrough policy actions to institutionalize Vietnam's clean-industrial transformation. These include legalizing internal DPPAs, empowering mini-grid operators, enabling shared infrastructure models, creating dedicated green-finance instruments, integrating clean-energy criteria into industrial planning, and establishing a National Net-Zero Industrial Park Standard. These reforms—anchored by proactive provincial leadership from Hung Yen—will not only enable TLIP II to reach net zero by 2035 but also create a scalable framework for replication across Vietnam's industrial park network.

By aligning short-term hybrid implementation with long-term systemic reforms, TLIP II can demonstrate how public–private collaboration, green finance innovation, and energy-market modernization together drive industrial decarbonization. This will make the park a benchmark for sustainable FDI attraction, a driver of provincial green growth, and a flagship model supporting Vietnam's national net-zero agenda by 2050.

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