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EXPLORING THE FOREIGN DIRECT INVESTMENT OPPORTUNITIES FOR RENEWABLE ENERGY IN SOUTHEAST ASIA: AN IN-DEPTH ANALYSIS OF WIND POWER IN VIETNAM

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ABSTRACT

To contextualise opportunities for CEO's and decisionmakers, this thesis aims to explore the Foreign Direct Investment opportunities for renewable energy in Southeast Asia through an in-depth analysis of ASEAN countries' potential. Three countries (Vietnam, Thailand, and Indonesia) with subsequent renewable energy technologies (wind, solar and hydropower) are assessed on investment potential through quantitative ranking and qualitative expert interview insights to provide nuance on challenges, opportunities, and potential. This thesis concludes that currently solar power in Thailand presents the most attractive investment opportunity, with wind power in Vietnam and hydropower in Indonesia requiring local policy transformations and stabilisation to de-risk investments.

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Keywords: *Renewable Energy, Wind power, Solar power, Hydropower, ASEAN, Southeast Asia, SEA, Vietnam, Thailand, Indonesia, Foreign Direct Investment, FDI*

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1. INTRODUCTION

In the era of escalating environmental concerns and the global push towards sustainable development, the Renewable Energy (RE) sector in Southeast Asia, particularly within the Association of Southeast Asian Nations (ASEAN), stands at the forefront of a significant economic transition. To contextualise opportunities for CEO's and policymakers, this thesis explores the foreign direct investment opportunities in the renewable energy sector of ASEAN countries, delving into the challenges, opportunities and potential that these nations hold in the global shift towards sustainable energy sources.

1.1 Problem Definition and Research Relevance

This thesis addresses the pivotal research question of what the most viable investment opportunities for foreign entities within Southeast Asia's renewable energy sector are. The study scope encompasses the ASEAN region specifically due to its dynamic economic growth, its abundant untapped renewable resources, and commitments to sustainable energy development: As described by Brückner et al. (2018), it is a "rising star amongst growth markets in terms of trade and investment". The technical scope of this study focusses on solar power, wind power, and hydropower, selected due to high growth potential in the region as highlighted in prior literature and corroborated by expert interviews.

From an industry perspective, the transformation of ASEAN's energy sector is critical to meeting global sustainability goals set forth in the Paris Agreement. Notably, from 2000 to 2018, ASEAN's primary energy was predominantly fossil fuel-based, signifying a substantial opportunity for renewable energy expansion (Øverland, et al. 2021). From a managerial and investor perspective within the RE field, this study synthesises valuable insights from experts and desk analyses with particular focus on ASEANs unique investment landscapes: It aids managerial decision-making by evaluating potential resources, understanding regional market dynamics, and identifying key barriers and incentives.

Additionally, this research aligns with the Sustainable Development Goals (SDGs), emphasizing the role of renewable energy in sustainable development.

Figure 1 Research Alignment with SDGs

1.2 Research Topic

Main Research Topic: "Exploring the Foreign Direct Investment opportunities for renewable energy in Southeast Asia: An in-depth analysis of ASEAN countries' potential."

This exploration includes an assessment of which ASEAN country demonstrates the greatest potential for leading the renewable energy market and in which sector this potential is most pronounced. It examines technologies that ASEAN countries are implementing to maximize their renewable energy capacities and investigates the significant obstacles that foreign investors face when financing renewable energy projects in these countries. Finally, it seeks to recommend strategies and policies to ASEAN governments to enhance the development of their renewable energy sectors and attract more foreign direct investments.

2. LITERATURE REVIEW, RESEARCH CONTEXT AND GAP

Figure 2 ASEAN: Location of ASEAN-10 Member Countries in Asia

2.1 Regional Scope: ASEAN

Founded in 1967, ASEAN encompasses 10 nations in Southeast Asia (referred to as ASEAN-10: Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam) and aims at promoting financial development, institutional development, and economic integration. It has evolved into a significant force in global economics and politics, with the ASEAN Economic Community (AEC) established to deepen economic integration by promoting the free flow of goods, services, investment, and capital. The countries span a land area of 4.5 million km^2 near the equator with high temperatures and heavy precipitation.

2.1.1 Economic Development of ASEAN

ASEAN is the world's 4th largest economic group, evident in a global GDP share of 7% and participation in trade agreements such as the Regional Comprehensive Economic Partnership (RCEP) (ASEAN Secretariat 2021, World Economics n.d.). With a population of 661.8 million in 2021, ASEAN counts a large labour force and customer base for RE solutions specifically considering its growing middle class; Ogilvy's report on *Velocity-12 markets* elaborates specifically on the significance and gravitational pull towards these growth markets (Brückner, et al. 2018, Jetin 2019, ASEAN Secretariat 2021, Ogilvy & Mather 2016). ASEAN's population generally shows stable growth and a young workforce with 60% of the population being aged 20-65 (Statista 2023d, ASEAN Secretariat 2021). Urbanisation rates show increasing inhabitants in cities with Vietnam, Laos and Cambodia leading the way (though it must be noted Singapore is 100% urbanised): consequent energy demand in the entire region is expected to increase 1.6 times by 2040 (Statista 2023h, ASEAN 2021a).

Pre-Covid19 projections of GDP per capita for the 10 region show expected increases of 56% by 2028 with Singapore dominating (accounting for 54% regional GDP) while Brunei Darussalam, Malaysia and Thailand follow behind (with 20%, 9% and 5% of GDP respectively) (Statista 2023h). GDP specifications per nation are presented in Figure 3 below. Middle class growth, increasing urbanisation and energy demand drive emissions of Green House Gas (GHG) emissions: According to 2014 data, Laos dominated in terms of CO_2 emission growth compared to the 1990's with Cambodia and Myanmar, Vietnam and Thailand following behind (Duc Nha Le 2019).

	Population aged 20-65	**Unemployment rate**	**Adult Literacy Rate**	**GDP per capita**	**GDP per capita: change**
Year	2021	2020	2019	2021	2023
Unit	*% total*	*% working age*	*% total*	*US$*	*Projected % 2018-2028*
Brunei Darussalam	66%	7%	97%	31,788.96	32%
Cambodia	56%	2%	82%	1,679.92	66%
Indonesia	61%	7%	96%	4,362.68	79%
Lao PDR	55%	9%	70%	2,495.96	-14%
Malaysia	61%	5%	95%	11,449.78	62%
Myanmar	57%	1%	89%	1,216.81	17%
Philippines	55%	10%	96%	3,576.10	64%
Singapore	64%	4%	97%	77,710.07	66%
Thailand	65%	2%	94%	7,226.84	49%
Vietnam	61%	2%	97%	3,753.43	116%

Figure 3 ASEAN: Factsheet of ASEAN-10 Member Countries

Source: (Statista 2023b, ASEAN Secretariat 2021, Statista 2023d)

2.1.2 Natural Resources in ASEAN

Approximately half of ASEAN's GDP originates from the services industry, 37% from industry activities and 11% from the agricultural sector (ASEAN Secretariat 2021). The wide variety of geographic contexts determine availability of natural resources which influences development of dominating industries and determine regional differences in power demand (ASEAN Secretariat 2021). Brunei Darussalam has fed its economy of oil and gas production with its natural resources (e.g. petroleum reservoirs) while land-locked Laos relies on labour-intensive industries of mining of precious metals such as tin and gold, found near mountainous regions. Cambodia's fertile plains promote rice cultivation. Presence of natural resources on the lower plains of Thailand, combined with the favourable climate, lay foundation for agricultural practices and a growing tourism sector. Vietnam shows plains with rice cultivation while its inland mountains are characterized by steeper elevations (2000-3000 meters) (TrueWind Solutions LLC 2001). The natural resource lacking island of Singapore excels in knowledge industries of electronics and serves as financial regional hub. Presence of natural resources has in turn influenced energy budget variations and trade relations between ASEAN-10: Malaysia, Indonesia, Brunei, and Laos generate a positive energy budget with production exceeding consumption, while Singapore, Thailand, the Philippines and Cambodia strongly rely on imports to meet demand (EIA n.d., TrueWind Solutions LLC 2001). Geographical factors additionally link directly with climate change hazards, a topic with increasing relevance. Coastal river deltas are threatened by sea level rise through direct danger of floodings and indirect threat of agricultural system collapse: The Mekong delta in Vietnam, the Irrawaddy delta in Myanmar and the Chao Phraya delta in Thailand all carry major agricultural importance for meeting national food demand as well as international export levels. By 2100, GDP could decrease by 11% due to climate change effects (Øverland, et al. 2021). Growing urbanisation rates heighten these threats and migration rise comes with associated costs: A fitting example is the $33 billion USD move of Indonesia's capital city as a combination of overpopulation, land subsidence and climate change induced sea level rise (Tarigan and Milko 2023).

2.1.3 Political Environment of ASEAN

Despite differing political structures within ASEAN-10 (see Figure 4), ASEAN has set overarching environmental initiatives: *ASEAN cooperation objectives of 2018-2022* focused on enhanced energy security and cooperation, with 5-year implementation plans guiding action to improve energy efficiency, renewable energies, and clean coal technologies (ASEAN 2021a, The Straits Times, Koh and Hwee 2020, Haini 2021). Currently, *ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025* is in place (ASEAN 2023). Deloitte's *2023 RE Industry Outlook* highlights the importance of government policies, such as subsidies, tax incentives and Feed-in-Tariffs (FiTs) in achieving RE targets and encouraging market participation (Deloitte 2023). For policymakers specifically, the Intergovernmental Panel on Climate Change (IPCC) released a general report on *Renewable Energy Sources and Climate Change Adaptation* (Edenhofer, et al. 2011).

Country	Government Form	Country	Government Form
Brunei Darussalam	Absolute monarchy (Sultante)	Myanmar	Assembly-independant republic under military junta
Cambodia	Perliamentary constitutional monarchy	Philippines	Presidential constitutional monarchy
Indonesia	Presidential republic	Singapore	Dominant-party parliamentary republic
Lao PDR	One-party socialist republic	Thailand	Parliamentary constitutional monarchy
Malaysia	Parliamentary constitutional elective monarchy	Vietnam	Socialist republic

Figure 4 ASEAN: Government forms

Source: Own figure

2.2 Renewable Energy

Traditional domination by fossil fuel sources (e.g. coal, oil and natural gas) of the global energy landscape has powered economic growth but recently raised environmental concerns due to GHG emissions (EIA 2023b); RE sources offer sustainable alternatives with lower emissions and are becoming increasingly significant in the energy mix due to technological advances decreasing costs (GWEC 2020, IEA 2020a). While distinctions can be made between electricity and non-electricity sourced energy (e.g. heat from clean cooking solutions), this research uses both electricity and energy to specify electricity.

2.2.1 Technical Scope: Technology Types

Due to dominance within the RE landscape (which drives down costs due to scale advantages and increases attractiveness for development for investors) this research focuses on potential of solar, wind and hydropower specifically. Other renewable electricity generation technologies include geothermal methods (offering reliable output in geothermally active regions), bioenergy from organic material (contributing to energy generation and waste management) and other low-carbon technologies such as nuclear energy. Jacobsson and Bergek (2004) investigate challenges in transforming energy technologies, although primarily focussed on European countries. The combined integration of multiple technologies is critical in ensuring a stable energy supply and lowering geopolitical energy dependence.

Photovoltaic (PV) systems work by converting sunlight directly into electricity using solar cells made from semiconductor materials, typically silicon. When sunlight strikes these cells, it excites electrons, creating an electric current that can be harnessed for power generation (National Renewable Energy Laboratory 2023). Generally, installing huge amounts of utility-scale solar is far easier than building a distributed PV rooftop market, which takes a long time and requires extensive consumer education. This is the reason why emerging economies often begin with utility-scale solar bids and struggle to establish the dispersed rooftop segment (SolarPower Europe 2020).

Wind energy uses turbines to capture the power of the wind and create electricity. Wind forces the turbine blades to revolve, converting kinetic energy from the wind into mechanical energy. A generator converts this mechanical energy into electricity. There are three types of wind power projects: onshore wind, which is land-based and expected to remain the least expensive; fixed-bottom offshore wind, anchored to the seabed and likely to see significant cost reductions; and floating offshore wind, the most expensive currently but with potential for substantial cost decreases. These cost reductions are anticipated due to technological advancements such as larger, more efficient turbines, and lower capital and operating costs, with experts predicting notable improvements by 2030 and 2050 across all three types, which rank it as one of the fastest growing energy sources globally (Berkeley Lab 2016, GWEC 2020).

Hydropower is generated through water flow pushing against turbine blades which power a generator (EIA 2023a, WAVTEQ 2017). Systems can be conventional, through using the river's running current as force (also called *diversion* or *run-of-river*) or through using water's falling force (with reservoirs and dams or *impoundment*), or can be constructed with a pumping system that recreates water's falling force *(pumped storage*) (Office of Energy Efficiency and Renewable Energy n.d., EIA 2023a). The latter is mainly used to store generated power into the electricity grid and can level variable outputs from renewable sources such as wind and solar facilities: it competes as cheaper alternative to batteries with longer timespan (Silalahi, Blakers and Cheng 2022, IEA 2021a). This research limits its scope to run-of-river and impoundment facilities for small, medium, and large (<10MW) hydropower developments: these higher outputs are more financially more attractive for foreign investors whereas micro hydro (>10MW) tailors towards social development projects for rural electrification. Alternative hydropower (e.g. tidal generation) can provide stable output but is currently underdeveloped which brings high risk and complex funding for investors so is unconsidered.

The geographical requirements of hydropower, wind power, and solar power technologies varies significantly. Hydropower, particularly when reservoirs are involved, may greatly limit land usage for other uses such as agriculture. Wind energy uses less area; for example, 8 turbines generating 26.4 MW occupy 128 hectares, while only 2.5 hectares are utilised for infrastructure due to safety-mandated turbine spacing. Solar PV systems, on the other hand, require greater space, generally one hectare for one MW, which is around 10 times that of wind energy. Despite the increased geographical footprint, advances in solar technology, such as vertically mounted panels, can optimise energy production and distribution throughout the day. As a result, each technology provides distinct trade-offs between space utilisation and energy generating efficiency (Sakti, et al. 2023).

2.2.2 Status and Trends in ASEAN

Overall, renewables account for 33.5% of ASEAN's total energy capacity. Within this, hydroelectric power traditionally dominated but the last decade observed an emergence of solar and wind power, specifically in Vietnam (IRENA 2022b). The countries experiencing the highest growth in per capita electricity consumption are Myanmar, Lao PDR, and Cambodia (IRENA 2022b). Some countries benefit from considerable RE production from geothermal and bioenergetic sources (Lau, et al. 2022). For a more comprehensive overview of the distribution over the specified timeframe, please refer to Figure 45. For a brief overview of literature on reoccurring energy transition topics in ASEAN, see Figure 44.

With regional neighbours China and India leading globally in renewable installation and investments, ASEAN is poised to draw significant investments (estimated at $290 billion by 2025) supported by initiatives to boost interconnectivity and energy security (IRENA 2018, ACE 2020, REN21 2021). Huang, Kittner and Kammen (2019) investigate the ability of ASEAN-10 countries to meet set RE targets through initiatives of grid changes, while (Wu, Kimura and Shi 2014) elaborate on Energy Market Integration (EMI) in ASEAN specifically.

In early 2022, every ASEAN-10 nation presented their Nationally Determined Contributions (NDCs) (long term goals to drawn down GHG emissions) as part of the Paris Agreement; Many of these commitments highlight greater ambition strongly contingent upon international support (IRENA 2022b).

2.3 Foreign Direct Investment

Foreign Direct Investment (FDI) is a major driver of international economic integration, allowing companies and governments to extend their operations beyond domestic borders: it involves fund transferral as well as acquisition of influence and management control in a foreign enterprise.

2.3.1 Foreign Direct Investment Types and Theoretical Frameworks

The Eclectic Paradigm (also known as the OLI framework) offers a comprehensive lens for examining the strategic underpinnings of FDI: it suggests that a firm's decision to engage in FDI is predicated by ownership (O) advantages (e.g. proprietary technology or brand reputation), locational (L) advantages (e.g. nation dependant market size, resource endowments, and efficiency), and internalization (I) advantages (e.g. the preference for controlling production processes over licensing or exporting) (Dunning 1979, Dunning 2001). This study encompasses all subtypes of FDI without delving into distinctions, but for context three FDI types are highlighted: horizontal FDI involves duplication of domestic operations in another country, bypassing trade barriers or accessing new markets, vertical FDI connects different production stages internationally, and conglomerate FDI encompasses investments in unrelated business abroad, spreading risks or capitalising on new opportunities (Markusen 2002, Helpman, Elhanan 1984).

2.3.2 Foreign Direct Investment Determinants

Levels of FDI are influenced by a wide spectrum of determinants relating to the country of interest, several of which are outlined below. In terms of economic determinants, market size and growth prospects are primary attractors; firms generally seek to enter countries with large consumer bases and rising demand to maximize profitability and ensure long-term market presence. Regarding economic growth, Le and Quah (2018) write on the pairing of economic growth with urbanisation rates and consequent energy demand increase. Burger, et al. (2018) highlights the positive effects of urbanisation on energy usage and elaborate on environmental challenges stemming from increased urbanisation. Duc Nha Le (2019) and Lau, et al. (2022) support this through indicating strong correlations between economic growth in ASEAN-10 and CO_2 emissions through increased population and urbanization.

Other economic FDI determinants for corporations, such as efficiency drivers like labour costs, productivity levels, and business infrastructure, additionally dictate investment flows: firms look for optimal production and operational conditions. Furthermore, robust policy frameworks are significant in setting a reliable environment for long term planning: sound fiscal and monetary policies combined with stable political environments attract and retain FDI (Leshchenko, Pasenko and Sakhno 2023).

2.3.3 Role of Foreign Direct Investment in Sustainable Development

Foreign investment serves as a crucial engine of economic growth in recipient nations through allowing integration into the global economy, closing investment gaps and through encouraging innovation and productivity by means of technology and information transferral. It is a double-edged sword however, since industry progress is contrasted by the quality and duration of contributions to host economies; Advantages can be unequal and pose environmental and social issues (Moran, et al. 2005, UNCTAD 2021). In the case of energy infrastructure investments specifically, this encompasses risks of people displacement to make way for facilities construction and risk of environmental damage to flora and fauna amongst others. If implemented sustainably however, FDI can ensure energy security by diversification of resources (SDG 7), foster job creation (SDG 8) and boost innovation (SDG 9) (ACE 2020, Sovacool 2019).

2.3.4 Foreign Direct Investment in Renewable Energy in ASEAN

The United Nations Conference on Trade and Development (UNCTAD) underscores the driving role of FDI in RE towards a path of sustainable development: transferring capital, advanced technology, and managerial know-how are listed as essential for RE sector growth, specifically relevant for developing countries where investment gaps impede this goal (UNCTAD 2021). To bridge the investment divide in ASEAN's renewable energy ambitions, an estimated annual expenditure of $27 billion USD is imperative to attain the 2025 goal of a 23% renewable inclusion in the primary energy matrix (Vakulchuk, et al. 2022). However, from 2016 to 2021, the region's annual investment has consistently fallen short, not surpassing the $8 billion USD mark (Satyanegara and Hartina Hiromi 2023). The dynamic of international financial institutions and private investors having shaped investments in ASEANs RE sector.

Challenges impeding FDI growth of RE within ASEAN-10 span financial and regulatory environments; These aspects are briefly noted but are explored more in depth for selected countries in later chapters. Fragile domestic capital markets and political risks heighten financial insecurity which is specifically prevalent in lower Mekong countries (e.g. Cambodia and Lao PDR) (IRENA 2018). ASEAN wide climate change risks and concludes the region as one of the most vulnerable to climate change consequences (Øverland, et al. 2021). On project level, underdeveloped local markets impede private equity so lean heavily on bank loans and bring transaction costs which make investments unattractive for financial institutions (IRENA 2018, ADB Institute 2020). Regulatory hindrances take form of inadequately defined Feed-in-Tariff (FiT) rates, unbankable public-private agreements and low government effectiveness, as noted by (IRENA 2018). Effects of good governance on FDI inflows is studied by (Teeramungcalanon, et al. 2020), who conclude rule of law and political stability as having significant impact on FDI inflows. To tackle challenges outlined above and incentivise further investments in RE in ASEAN, (Vakulchuk, et al. 2022) recommend expanding the "institutional resource pool" and adopting best-practices.

2.4 Research Gap

Despite the growing body of literature on RE in ASEAN, an assessment of FDI opportunities in this field have yet to be addressed. While existing studies focus on regional status of RE, on macroeconomic aspects, domestic technical potential and policy challenges present, there is a scarcity of focussed research that intertwines these aspects and compares between member nations. This study aims to fill this gap by aggregating a practical and in-depth analysis of FDI opportunities within the RE sector in selected ASEAN-10 countries through assessment of constraints and incentives within the technical, policy, stakeholder, and financial environment per nation. This study additionally intends to give practical insights for policymakers, investors, and other stakeholders participating in the region's energy transformation.

3. METHODOLOGY

This research aggregates a country ranking based suitability selection with interview-based country deep dives to provide a comprehensive overview of country suitability for FDI in RE. The quantitative country ranking method compares suitability for FDI as well as sector suitability within the FDI-favourable countries, based on secondary data from desk research. The qualitative country deep dives investigate challenges and opportunities within the FDI landscape and are based on primary data from expert and stakeholder interviews (see Appendix E), as well as secondary data from desk research.

3.1 Country Suitability Selection

FDI environments across ASEAN-10 countries were evaluated and ranked to determine highest FDI attractiveness. Subsequently, a sector-specific potential ranking was conducted on the specified RE sectors—solar power, hydropower, and wind power—within each country identified as having a favourable FDI climate. Aggregation of these assessments pinpointed the most strategically advantageous pairings of countries with RE sectors for investment.

3.1.1 Preliminary Country Selection

The scope of the research is limited to the 10 member states of ASEAN.

3.1.2 Indicator Justification

For the respective rankings, 20 FDI indicators were aggregated into five categories and four sector specific indicators per RE sector. For full listing of categories and indicators per ranking, see Appendix C1.

3.1.2.1 Foreign Direct Investment Potential Indicators

To ensure analysis comprehensiveness, indicators for the FDI Potential Ranking were selected based on relevance to attractiveness for foreign investment. Economic metrics such as GDP per capita or inward FDI flows provide insights into domestic economic stability and market dynamics, as well as financial health and the readiness of markets for new investments. Human capital indicators shed light on the availability and skill level of the workforce, economic activity levels, and the general educational landscape. These include for example labour force participation and tertiary education levels. Indicators related to infrastructure and energy (e.g. road network length and electrification rates) provide a snapshot of a country's infrastructural readiness which aids in evaluating logistical RE project feasibility and the existing energy landscape. Environmental and sustainability goals are assessed through government targets and commitments under international agreements such as the Paris Agreement: These reflect the policy direction and level of commitment of a country towards sustainable energy practices, offering an indication of the regulatory and incentive landscape that investors might navigate. Country risk is gauged through ease of doing business rankings and political stability assessments, which signal operational risks and risks from the regulatory environment. The latter specifically is relevant for investors seeking stable and predictable markets. Elaborated reasoning for each of these indicators can be found in Appendix C2.

3.1.2.2 Sector Potential Indicators

Sector Potential indicators were selected to provide a consistent and comparable analytical framework across different energy technologies, which was challenged by data unavailability across countries and sector types. For all sectors, comparable data was selected on technical exploitable capacity, output-related information, Levelized Cost of Electricity (LCOE) and installed capacity. The solar energy sector was assessed using indicators like the Technical

Exploitable Capacity of Solar Energy, Specific Photovoltaic Power Output (PVOUT), the Levelized Cost of Energy (LCOE) of Solar PV, and the Installed Capacity of Solar Power. For hydropower, the chosen indicators included the Technical Exploitable Capacity of Hydro Power, Precipitation levels, the LCOE of Hydro Power, and the Installed Capacity of Hydro Power (including pumped storage). In the wind energy sector, the indicators comprised the Technical Exploitable Capacity of Wind Power with a specific focus on wind speeds above 7 m/s - a threshold considered ‘excellent’ for wind farms, Exploitable Capacity Utilization Hours, the LCOE of Wind Power, and the Installed Capacity of Wind Power. Further details on indicator selection can be found in Appendix C3.

3.1.3 Standardisation, Weighting and Ranking

Firstly, unit and scale differentiation in raw indicator input data was tackled through standardisation using the formulas below. The general case was that higher indicator input values signified positive results. In case of the opposite, the inverted formula was used to tackle irregularities in ordering systems.

$$X'_{ij} = \frac{X_{ij} - min_i}{range_i} * 99 + 1 \qquad X'_{ij,inverted} = \left(1 - \left(\frac{X_{ij} - min_i}{range_i}\right)\right) * 99 + 1$$

Equation 1 and 2: Standardisation (L) and inverted standardisation (R) formula

Source: (Gomes 2023)

Secondly, indicators were weighted according to relevance as well as accuracy and reliability using a generated weighting matrix. This matrix considers two key dimensions: relevance, and accuracy and reliability. Relevance was based on indicator alignment with research objectives and accuracy and reliability were evaluated based on data quality and trustworthiness. This weighting matrix serves to objectively prioritize indicators, facilitating an impartial ranking of FDI attractiveness among ASEAN-10 countries within the research context. For weighting per indicator, see the excel sheet that complements this research.

Finally, country scores were obtained per ranking through score summation. Through conversion, potential ASEAN-10 countries were ordered according to attractiveness of FDI climate and to potential for solar power developments, hydropower developments and wind power developments.

3.1.4 Suitability Overlays and Country Decision

To visually display combined suitability of FDI climate per country with country specific sector potential, rankings were aggregated in graphic overlays per RE sector. Suitability boundaries were set as FDI score > 20 with sector score > 40.

3.2 Expert Interviews and Desk Research

Primary data was collected through expert and stakeholder interviews, employing a qualitative methodology to add depth and nuance. The core of our data collection involved a set of baseline questions (see Appendix E1), focused on the development of the RE landscape, the influence, and trends of FDI, the challenges and opportunities for investors, and prospects for the industry in this region. Sub questions were specialised to interviewees expertise to provide a more nuanced understanding of essential aspects within the RE environment and FDI climate. Interviewees originated from international industry agencies, project developers, non-governmental organizations, intergovernmental institutions, and financing institutions. For a full interviewee list, see Appendix E2. The interviews were conducted in a semi-structured format with a duration on average of 60 minutes. It must be noted that interviewees expressed personal opinions, draw on their own experiences and do not speak for their place of work (for disclaimer used, see Appendix E3).

Primary data from expert interviews was complemented with secondary data obtained through extensive desk research, incorporating existing literature, reports, and up to date statistical data relevant to the RE sector and FDI in Southeast Asia to ensure a robust and comprehensive analysis. For clarity and systematic referencing in this thesis, each conducted interview has been assigned an individual alphabetic identification (see Appendix E2), marked in brackets, that will be used for referencing throughout the research.

4. COUNTRY SUITABILITY SELECTION

4.1 Results

The ASEAN-10 countries are ordered from most to least suitable for FDI with accompanying rankings per RE sector to signify potential. Noteworthy is that Vietnams shows high potential for all renewable sectors, while Singapore, famously known as regional financial centre and attractive hub for FDI, shows lowest potential for renewable project development due to restrictions in land mass as well as geographical factors.

		Sector Potential		
Rank	**FDI Potential**	**Solar power**	**Hydro power**	**Wind power**
1	**Indonesia**	**Thailand**	**Indonesia**	Philippines
2	**Vietnam**	Myanmar	**Vietnam**	**Vietnam**
3	Singapore	Cambodia	Malaysia	**Thailand**
4	Malaysia	**Vietnam**	Myanmar	Lao PDR
5	**Thailand**	Philippines	Lao PDR	**Indonesia**
6	Cambodia	Malaysia	Philippines	Myanmar
7	Brunei Darussalam	Lao PDR	**Thailand**	Malaysia
8	Philippines	Brunei Darussalam	Brunei Darussalam	Cambodia
9	Myanmar	Singapore	Singapore	Singapore
10	Lao PDR	**Indonesia**	Cambodia	Brunei Darussalam

Figure 5 Country ranking results: FDI and Sector Potential

Source: Own figure

The graphic overlay displayed in Figure 6 shows the concluding FDI potential with the Sector potential. For individual overlays, see the accompanying excel sheet. For solar and wind energy, Thailand and Vietnam emerge as most suitable options. Hydropower shows development potential for Indonesia and Vietnam with Malaysia as runner up.

4.2 Country Decision

Concluding from the quantitative ranking generated suitability overlays with set suitability boundaries, Thailand has been chosen as investment worthy for solar opportunities, Vietnam for wind power projects and Indonesia is suggested for FDI in hydropower developments.

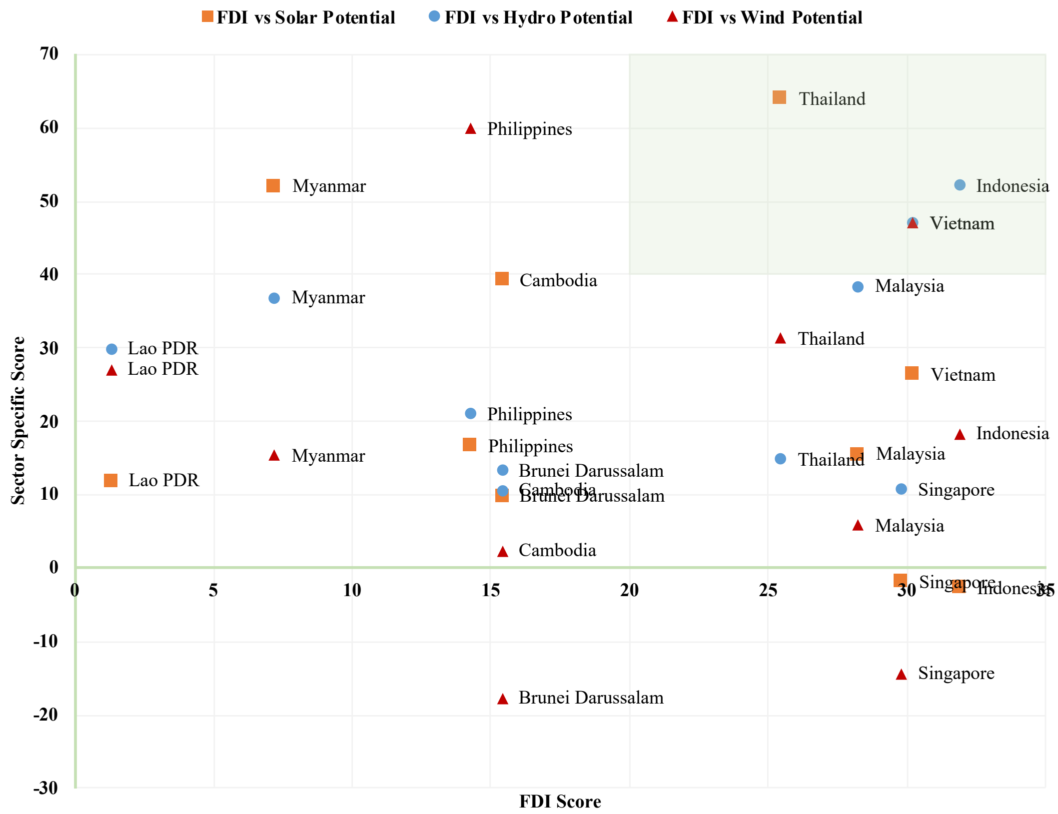


Figure 6 FDI ranking score versus Renewable Potential scores per sector

Source: Own figure

5. COUNTRY DEEP DIVE: WIND POWER IN VIETNAM

5.1 Country Profile Vietnam

Capital	Hanoi
Total Area *(km²)*	331.34
Population *(millions)*	98,186,856
Rural Population *(% of total population)*	61
GDP *(current $ USD)*	408.8 bn
GDP Per Capita *($ USD, 3-yr CAGR)*	4,163.5
FDI net *($ USD, 3-yr CAGR)*	15.7 bn (0.3%)
FDI % of GFCF	13.50%

Figure 7 Vietnam: Location in ASEAN and Country Profile Factsheet

Source: (The World Bank 2023c)

Vietnam has a coastline that stretches over three thousand kilometres and is marked by shallow water depths and relatively constant wind speeds (5.5 to 7.3 metres per second, depending on the season) around the South China Sea. Major ports along this coastline include Da Nang and Hai Phong. This not only facilitates trade but also serves as critical juncture for technology and equipment imports. A variety of natural resources complements the region's diversified landscape, which stretches from the Red River Delta in the north to the Mekong Delta in the south (Linklaters 2020).

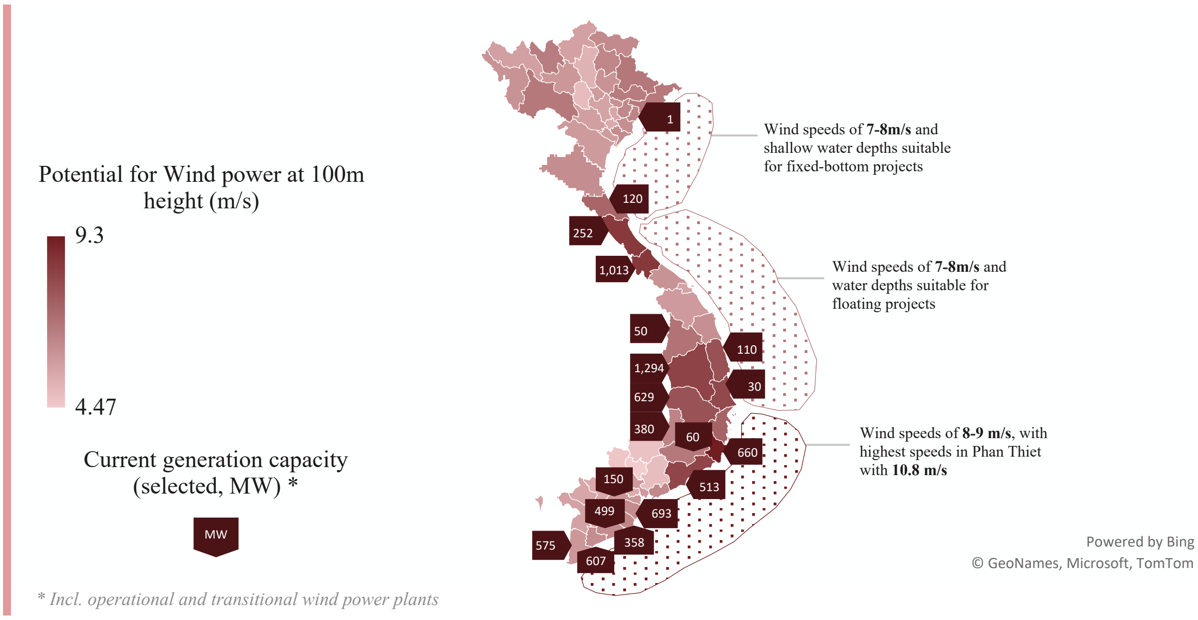


Figure 8 Vietnam: Wind Power Current Generation Capacity and Potential

Source: Own figure, based on (Global Wind Atlas 2023) and data from Syneria (Interview M)

With a population estimated at 98 million as of 2022 and 54 ethnic groups with own customs, Vietnam presents a dynamic socio-cultural environment (The World Bank 2022d). Major metropolitan centres like Vietnam's capital Ho Chi Minh City and Hanoi are undergoing significant expansion, influencing energy policy due to higher energy demands (ADB 2017). Vietnam's tourist industry, with well-known locations like Ha Long Bay and Hoi An, is vital to the nation's economy and cross-cultural interactions (ASEAN 2020, Linklaters 2020).

Socioeconomically, the country is transitioning from a predominantly agrarian society to one with a burgeoning middle class, driven by shifts towards industrial, service and technology sectors. Despite rapid industrialization, agriculture remains a cornerstone of Vietnam's economy, with rice, coffee, and seafood being major exports. The labour force is increasingly skilled, thanks to improvements in educational attainment, particularly in science and technology (Maclean, Jagannathan and Panth 2018, IMF 2020).

Vietnam is governed by the Communist Party of Vietnam (CPV). Vietnam's political structure, comprising the CPV-led National Assembly and decentralized local governments, reflects a blend of central control and regional autonomy. Vietnam's active participation in ASEAN-10 and strategic international relations demonstrate the country's growing importance in regional and global events, as it balances economic goals with diplomatic activities (Tran and Nguyen 2020)

5.2 Renewable Status and Future Plan

Total Power Capacity	79.31 GW
Renewables Capacity	45.32 GW / 58%
Renewables Capacity Target	72 GW by 2030

Figure 9 Vietnam: Renewable Status and Plan Overview

Source: (IEA 2023a)

The need for energy in Vietnam is continuously increasing to fuel the country's expanding economy (Interview M). Electricity is expected to expand at a near-double digit yearly pace in the next years. The current energy consumption in Vietnam reveals a significant reliance on fossil fuels, with a growing inclination towards renewable sources (see Figure 10) (Linklaters 2022, EIA 2017). Hydropower has been an important part of Vietnam's economic development; however, further expansion is limited (SolarPower Europe 2022).

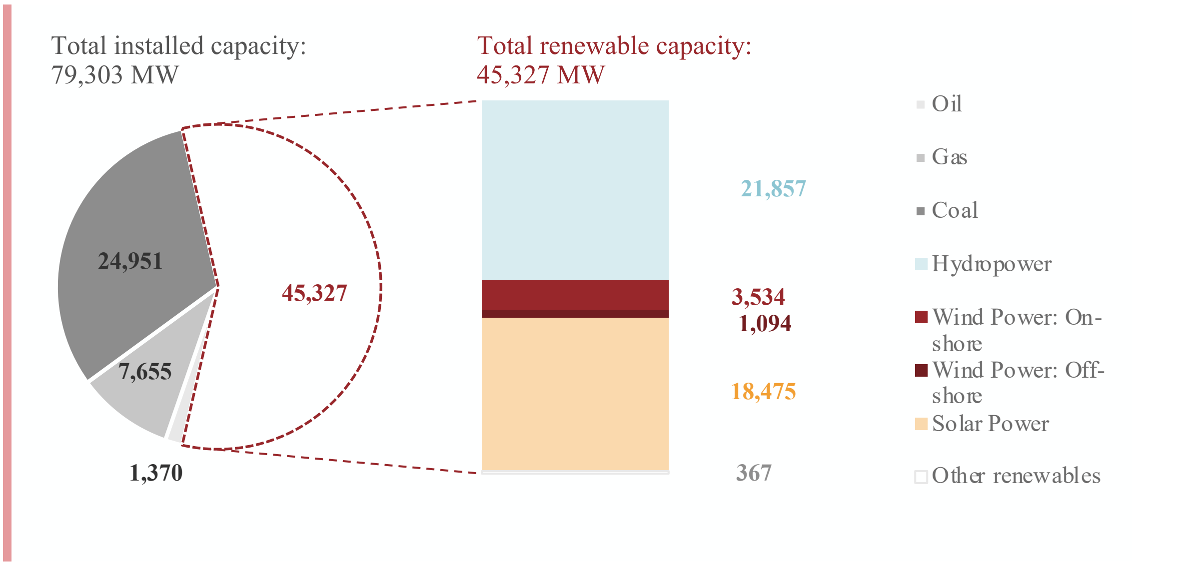


Figure 10 Vietnam: Current Power Generation Capacity

Source: Own figure, based on (IRENA 2022a)

Vietnam has potential to install, up to 599 GW, a massive amount of technical wind energy capacity (The World Bank 2021a) (Interview B, E). This includes 261GW from onshore wind and another 338 GW from offshore wind. This potential is much higher than that of other Southeast Asian countries, for example Indonesia having a potential of 277 GW. The World Bank's projection for Vietnam's offshore wind energy suggests the country has the capacity to develop up to 25 GW of offshore wind power by 2035, potentially meeting 12% of its total electricity demand. However, there are presently no fully operating offshore wind projects in Vietnam, with just a few nearshore ventures, such as the large-scale La Gan (3.5 GW) and Thang Long (3.4 GW) projects, under construction (The World Bank 2021a, ACE 2022, Linklaters 2020, Nam Do, et al. 2022).

To facilitate its RE goals, the Vietnamese government established clear regulations and incentives. The focus on wind energy began with the Prime Minister's *Decision 37/2011/QD-TTg* in 2011, followed by the update of *Power Development Plan 7 (PDP 7)* in 2016. These regulatory changes, along with appealing FiTs and reduced global manufacturing costs for RE, led to a significant increase in investment (Linklaters 2020).

The government is working to create a competitive and stable domestic RE market whilst also seeking to achieve Vietnam's ambitious "net-zero" target by 2050, in line with the Paris agreement (UNFCCC 2015, Linklaters 2022). The Just Energy Transition Partnership (JETP) for Vietnam, signed at the G20 Summit in 2022, underpins these signed principles. The deal includes a $15.5 billion USD commitment from the group of seven (G7) and other wealthy countries. This investment, which is critical for the country's transformation, was conditional on the release of Vietnam's *Eighth National Power Development Plan (PDP 8)* (CMS 2023, Linklaters 2022, UNFCCC 2015, World Economic Forum 2023).

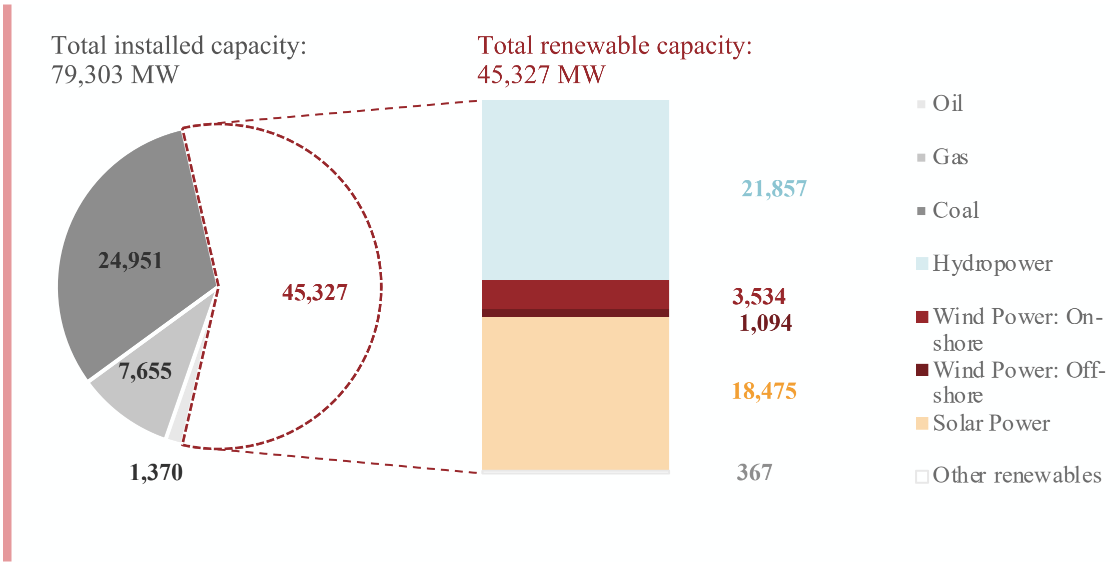


Figure 11 Vietnam: Planned Power Generation Capacity (2030)

Source: Own figure, based on (CMS 2023, British Chamber of Commerce Vietnam 2023, Vietnam Briefing 2023)

Vietnam has indicated that national energy security is critical to meeting its objectives of 7% GDP growth per year till 2050. Therefore, PDP8's main goal is to produce enough power to support these ambitions focusing on renewables and a smart-grid solution. It defines an ambitious course for Vietnam's energy industry, aiming to boost total installed power capacity to 150.000 GW by 2030, including a large share from renewables, and then to 480.000 to 570.000 MW by 2050 (see Appendix B, Figure 46 and Figure 47). Investments of up to $523 billion USD are expected to enable this transformation, with an emphasis on improving grid networks and transitioning away from coal in favour of renewable sources such as wind, solar, and hydropower. Wind ambitions of up to 130 GW by 2050 highlight the plan's commitment to this sector (Interview C). The strategy also prioritises domestic gas consumption, converting LNG-to-Power plants to hydrogen by 2050, and maintaining environmental protection in hydropower development (Linklaters 2022, CMS 2023, British Chamber of Commerce Vietnam 2023, PwC 2023).

Regional trade agreements are instrumental in facilitating technology transfer and regional cooperation in energy projects, thereby enhancing Vietnam's energy security and cooperation within the ASEAN-10 region. Vietnam's participation in international trade agreements extends beyond ASEAN-10. The EU-Vietnam Free Trade Agreement (EVFTA), for instance, is a pact that bolsters protection and incentives for FDI. The combined effect of these regional and international collaborations underscores Vietnam's strategic approach to leveraging partnerships for advancing its energy sector (ASEAN 2020, EU 2020, PwC 2023).

5.3 Power Structure System

Market Structure	Single-buyer utility with IPPs
Grid Ownership	State Owned
Pricing	Government Regulated
Generation Ownership	Mix of public and private

Figure 12 Vietnam: Power Structure System Overview

Source: (IEA 2023a)

The wind power generation system in Vietnam is concentrated in regions with high wind potential, such as the southern and central highlands (see Figure 12).

In Vietnam's power structure system, the distribution sector is heavily regulated by the government through Electricity Vietnam (EVN), focusing on ensuring fair access to the grid and promoting energy efficiency. The transmission model follows a single-buyer utility framework with Independent Power Producers (IPPs). EVN and its subsidiaries act as the wholesale purchasers of power from generators (see Figure 13). Despite the government's initial plans for a competitive electricity market at both wholesale and retail levels by 2021 and 2023, respectively, these timelines have been delayed. As of now, over 40% of total produced power is purchased through the competitive wholesale market, and plans for a competitive retail sector have been extended to 2025 (Linklaters 2022, Vietnam Business Law 2023, Mayer Brown 2021).

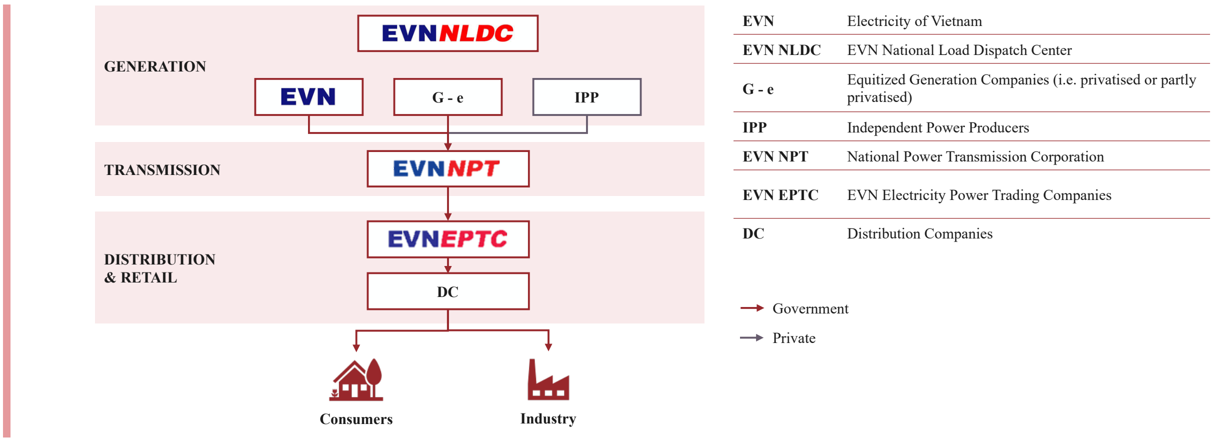


Figure 13 Vietnam: Energy Selling System Structure

Source: Own figure, based on (GES 2016, MOIT 2016, Ramachandra Rao 2016, AMPERES 2023)

RE generators and EVN are required by law to negotiate and sign Power Purchase agreements (PPAs) using the standard agreement formats. A PPA incorporates terms such as contract duration, fuel supply, performance guarantees, commissioning and commercial operation date, rights and obligations and the operation management system (Sepasthika, Sasongko and Muryanti 2023). To lay out their duties and entitlements, the parties may incorporate supplemental clauses in the standard form PPA. They must not, however, change the key aspects of the standard wind PPA, and any extra conditions must not conflict with or contradict the rules of the standard solar PPA. These agreements' typical formats distribute major costs and risks to investors, thereby affecting their bankability. The requirement that the seller, namely the generator, incur the expense and risk of connecting the plant to the transmission grid is arguably a concern. Furthermore, the lack of a 'deemed commissioning' clause in these contracts exposes the seller to danger when the plant is ready to produce power but the buyer, namely EVN, refuses to accept it. In addition, there is no stabilisation provision to safeguard the seller from legislative changes. Finally, by default, these contracts employ Vietnamese law as the prevailing legal framework and create the MOIT as the usual dispute resolution venue. However, domestic, and foreign lenders have agreed to fund projects with PPAs negotiated in the model form using various novel financing arrangements aimed at mitigating these bankability issues (Linklaters 2022). Another remuneration mechanism is the Direct PPA program (DPPA), which MOIT has been planning to launch a pilot project, allowing RE generators to bypass EVN and sell directly to consumers. This could improve the bankability and profitability of RE projects (SolarPower Europe 2022) (Interview C).

Vietnam's grid system is currently being upgraded to better support renewable energy, addressing regional variations in energy demand (McKinsey 2021, Linklaters 2022, Linklaters 2020) (see Appendix B, Figure 48). The Northern and Southern regions, driven by major cities like Ho Chi Minh City and Hanoi, account for 45% and 47% of the country's total energy consumption, respectively. In contrast, the Central region accounts for just 8%. The abundance of RE resources, particularly solar and wind in the Southern and Central regions, has led to grid congestion and power imbalances (SolarPower Europe 2022). The rapid RE expansion under the FiT scheme initially overburdened the national grid, causing extensive solar power curtailment (PwC 2023, ACE 2022, SolarPower Europe 2022). Recent blackouts, especially in the North, highlight these challenges (Interview M). The success of Vietnam's long-term energy strategy hinges on its grid infrastructure, which has seen improved efficiency with transmission-distribution losses decreasing from 10% in 2010 to 7% in 2020 (SolarPower Europe 2022).

5.4 Stakeholder Assessment

The wind power sector in Vietnam is undergoing rapid transformation, underscoring the need for an effective regulatory framework and enhanced stakeholder collaboration. A key aspect of this understanding is the country's Corruption Perception Index (CPI) rating. The CPI scores countries on a scale from 0 (highly corrupt) to 100 (very clean). Vietnam's score of 42 places it 77th among 180 countries, a ranking that may raise initial concerns. However, a closer examination of its recent trajectory reveals a gradual improvement, despite some setbacks. This upward trend in Vietnam's CPI score signifies a commitment to enhancing governance and transparency (Transpareny International 2022).

Mitchell, Agle, and Wood's Stakeholder Identification and Salience Framework provides a nuanced lens through which to evaluate the various actors and their respective roles (Mitchell, et al. 1997).

Figure 14 Vietnam: Energy Market Stakeholder Overview

Source: Own figure, based on (Norton Rose Fulbright 2019b, Linklaters 2020, The Wind Power 2022, Power Technology 2023, IEA 2023a)

The RE sector in Vietnam comprises a diverse array of stakeholders (see Figure 14) which can be divided in two groups: Mandatory and Optional Stakeholders. Mandatory stakeholders are those without whose involvement the wind energy projects cannot proceed. They include regulatory bodies such as the MOI and EVN, IPPs, developers, equipment suppliers and financial institutions. The complexity of bureaucracy presents a moderate risk to FDI in RE since the power sector is structured as an enhanced single-buyer model. Developers in the wind sector are mainly Japanese, Korean, European, American, and Chinese companies (Interview D). Equipment is obtained both locally and globally, with important vendors including China and Germany, reflecting geopolitical and economic issues (McKinsey 2021). Optional stakeholders are those whose involvement is beneficial but not critical to the project's existence. They can provide additional resources, expertise, and support, enhancing the project's efficiency and acceptance. For example, local communities are crucial for their support and acceptance of wind power projects (Interview K).

5.5 Government Incentives and Legal Considerations

Investment incentives in the RE industry, which is strongly supported, provide a variety of advantages to investors:

Incentives	**Description**
Revised Investment Law (from 2021)	The law simplifies market entry for entities with over 50% foreign-held capital, requiring an Investment Registration Certificate. It equalizes market access for international and domestic investors, applies industry-specific limits, and strengthens foreign investment protections. Additional incentives include tax breaks in key sectors like healthcare, education, and renewable energy, fostering a more attractive foreign investment climate.
Public-Private Partnership (PPP) Law (from 2021)	Effective since early 2021, consolidates and clarifies the country's PPP framework, emphasizing transparency and various models like BOT and build-own-operate. It enforces Vietnamese law in project agreements while permitting third-country arbitration. The law provides financial incentives, including minimum revenue guarantees.
Import Duty	Exemption applies to commodities imported to create fixed assets; and project materials, components, and semi-finished products that cannot be manufactured locally.
Corporate Income Tax	Exemption for the first four years: 50% reduction for the next nine years; preferred tax rate of 10% for the first 15 years; accelerated depreciation and higher costs as taxable income deductions.
Land Lease Fees	Depending on the project location, exemptions range from 14 years to the whole project duration.
PPP Law Benefits	Offers financial incentives like minimum revenue guarantee, transparency in PPP models (BOT, build-own-operate, and build-transfer-lease), and third-country arbitration in disputes.
Foreign Ownership	No limits on foreign ownership in the RE sector; foreign investors may own up to 100% of wind energy project companies.

Figure 15 Vietnam: Overview of Laws and Incentives

Source: (Linklaters 2022, Mayer Brown 2021, Investment Policy Hub 2020)

For RE projects that reached commercial operation before November 1, 2021, Electricity Vietnam (EVN) was obligated to purchase the power produced at high FiT rates. The FiT were set in Vietnamese dong but linked to the State Bank of Vietnam's announcement of the VND (Vietnamese Dong) - $ USD exchange rate. This connection protected investors from currency devaluation. The fixed-rate approach of 20 years gave investors long-term financial certainty, but also implied that they must bear any cost rises over the next two decades (Linklaters 2022, Dezan Shira & Associates 2023) (Interview N). 146 wind projects, only 84, with a combined capacity of 3.98 GW, had reached these FiT criteria and 62 wind projects failed due to the pandemic and cut-throat competition for equipment and contractors (ACE 2022).

Current FiTs as well as previous ones are illustrated in Figure 16:

				Current FiT		Previous FiT
Technology	**Duration**	**Inflation Adjustment**	**Grid Connection and Land**	**VND/kWh**	**USD cents/kWh** (for comparison)	**USD cents/kWh**
On-shore wind	20 years	No	Developer responsibility	1587.12	6.8	8.5
Off-shore wind				1815.95	7.8	9.8

Figure 16 Vietnam: Previous and current FiT

Source: (Dezan Shira & Associates 2023, Linklaters 2022, InCorp Vietnam 2023, IEA 2023a)

Since most FiT rates were higher than the average electricity retail prices, EVN accumulated losses over the years reaching $2.3 billion USD by September 2023 (Le 2024). Therefore, the MOIT of Vietnam announced numerous key revisions to the legislation controlling solar and wind energy projects in 2022 and 2023 sector as displayed in Figure 17 (CMS 2023, KPMG 2023).

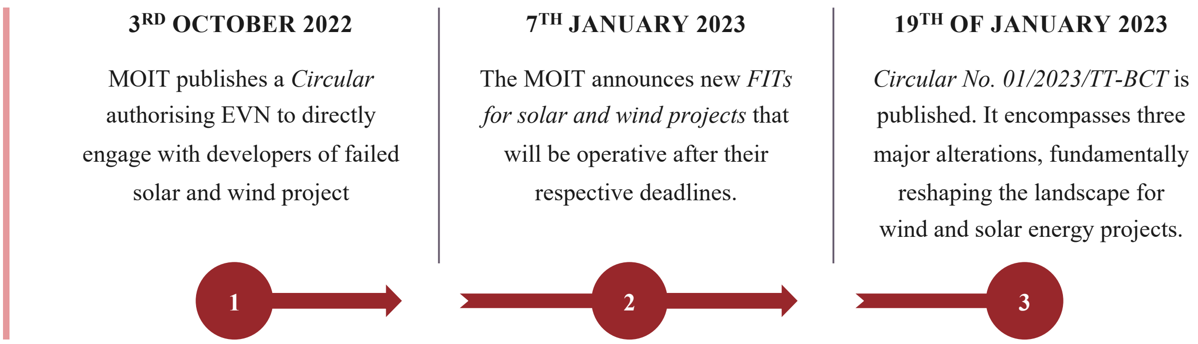


Figure 17 Vietnam: Timeline of Government Regulations

Source: Own figure, based on (CMS 2023, KPMG 2023)

These recent regulatory changes in Vietnam's energy sector encompass three major alterations, fundamentally reshaping the landscape for wind and solar energy projects. Firstly, EVN is using reduced FiT rates in its negotiations for tariffs with solar and wind projects that are currently without established tariffs. Secondly, the fixed 20-year PPA term has been discontinued, paving the way for more dynamic and potentially shorter-term contracts. Lastly, the shift from the $ USD/VND exchange rate to pricing exclusively in VND for electricity rates marks a significant move towards local currency use, impacting the financial dynamics, especially for foreign investors. The conversion of power costs from $ USD to VND may have an impact on the financial sustainability of future RE projects (CMS 2023, KPMG 2023). Recently the Danish energy company Ørsted paused market activities due to the limitations set by regulations, underlining the present regulatory issues Vietnam is facing (Duc 2023).

5.6 Macro and Micro Financial Considerations

Trailing 12M Currency Movement *(VND/$ USD)*	-2.92%
Sovereign Debt Rating *(S&P)*	BB+
10Y Gov. Bond Yield	4.92%
Energy Subsidies *(Yes/No, Type, $ USD)*	Yes, Coal (18.1 bn), Oil & Gas (13.4 bn)
CO2 Emissions *(per capita, 3-yr CAGR)*	3.55t (6.51%)
Carbon Pricing	No, environmental tax on gas (0,0428 $ USD/L) and diesel (0.0214 $ USD/L)

Figure 18 Vietnam: Macro Financial Metric Overview

Source: (IEA 2023a)

In Vietnam the dynamics of blended finance, compensation mechanisms, cost of capital, and risk management strategies in RE are critical for fostering industry growth and ensuring its long-term sustainability. Since Vietnam's financial system cannot meet the country's development needs on its own, foreign investment is necessary to help Vietnam realise their ambitious energy transformation strategy. However, investment in RE has slowed due to a lack of positive policy signals to assist the establishment of viable project pipelines (IEA 2023a, Tuan 2018).

Over the trailing 12 months, the Vietnamese Dong (VND) has depreciated by 2.92% against the $ USD. This trend reflects various economic factors, both domestic and international, impacting the Vietnamese economy. In response to these currency fluctuations, currency hedging has become a critical and important tool for businesses and investors in Vietnam

(Interview F, L). Currency hedging involves using financial instruments to reduce or eliminate the risk of losing money due to changes in exchange rates. By hedging against currency risks, companies can stabilize their financial planning and protect their profit margins from the adverse effects of currency movements (IEA 2023b, Trading Economics 2023).

Market analysts have raised concerns about the financial stability of EVN, noting its significant investment in power infrastructure while struggling to profit from low, regulated retail energy prices. Although this poses no immediate threat, it could lead to long-term systemic issues. To address this, the World Bank has aided EVN in bolstering its financial health and securing an independent credit rating. Consequently, Fitch Ratings has given EVN and its subsidiary, the National Power Transmission Corporation, a stable "BB" rating over the past three years, in line with Vietnam's "BB+" national credit rating.(Linklaters 2022).

Grants, equity investment, senior debt, mezzanine finance, leasing, and vendor financing are the six primary financing options used (MOIT 2016). In Vietnam, utility-scale RE projects is often funded with a combination of debt and equity, notably using shareholder loans, which are classified as debt under Vietnamese law, and syndicated secured financing facilities. Debt finance on a full non-recourse basis remains more difficult, and depending on the project, lenders may want some amount of sponsor involvement (Mayer Brown 2021).

In the ASEAN-10, Vietnam stands out for its active participation in blended finance, combining public and private capital (IEA 2023a) (Interview B, N). The RE sector in Vietnam is experiencing a significant investment surge. Leading this is Bamboo Capital Group, a major Vietnamese conglomerate, with a $1,031 million USD investment, highlighting its critical role in the industry. Xuan Thien Group follows with $867 million USD, showcasing its strong market influence and commitment to sustainable energy. PetroVietnam's $740 million USD investment reflects government support, while EVN contributes $734 million USD, underlining its importance in national energy integration. Trungnam Group's $673 million USD investment further indicates growing corporate interest in RE (IEA 2023).

Power projects commonly require substantial capital expenditure and are thus frequently funded with a major share of loan money. The Vietnamese government funds RE projects using subsidised loans and grants from the national budget through the Vietnam Development Bank (VDB). The VDB offers a variety of funding alternatives, including medium to long-term loans and dispersing ODA monies from Japan and the United States. It permits financing up to 85% of project costs with favourable conditions for wind generation. A major partnership with US EXIMBANK provided $1 billion USD in finance for wind projects in the Mekong River Delta, including loans at a 5.4% interest rate for projects employing US technology (MOIT 2016).

The Asian Development Bank (ADB) has backed RE in remote places and expects to provide $2 million in technical assistance for wind projects in many Asian nations, including Vietnam (MOIT 2016). The International Financial Corporation (IFC) works a lot with government through the World Bank but often on the IFC private sector side IFC guides RE projects with structuring, bringing in relevant parties, and handling contracts, including insurance solutions. Part of their work is to open governments' eyes to new opportunities assuming future projects need financing (Interview A).

Commercial banks in Vietnam, such as the Bank for Investment and Development of Vietnam (BIDV), the Joint Stock Commercial Bank for Foreign Trade of Vietnam (Vietcombank), Saigon Thuong Tin Commercial Joint Stock Bank (Sacombank), Asia Commercial Bank (ACB), and Vietnam Technological and Commercial Joint Stock Bank (Techcombank), frequently face resource constraints. As a result, they often provide partial finance for wind projects, usually in collaboration with international organisations such as the World Bank. With borrowing rates ranging from 8% to 10%, these banks often pay up to 70% of project expenditures. Development banks from Germany, France, and Finland also contribute to

Vietnam's wind energy finance, albeit Official Development Assistance (ODA) money has time constraints and minimum investment requirements. MOIT is critical in ensuring that RE projects receive ODA financing (MOIT 2016).

To assess the perceived risks and expected returns for wind energy in Vietnam, Figure 19 details cost of capital metrics. The numbers include projects from under the previous FiT rules as well as current projects:

Currency	VND
Technology	Wind
LCOE *($ USD/MW)*	70.6 - 106.7
WACC *(LCY)*	9.6% - 13.1%
Expected Return *(LCY)*	12.0% - 15.0%
Cost of Debt *(LCY)*	8.5% - 12.0%
WACC *($ USD)*	7.0% - 10.0%
Expected Return *($ USD)*	11.5% - 14.5%
Cost of Debt *($ USD)*	5.0% - 7.0%
Tariff currency indexation	$ USD
Leverage ratio	65.0% - 70.0%

Figure 19 Vietnam: Onshore wind Micro Financial Metric Overview

Source: (IEA 2023a)

Wind energy projects in Vietnam face significant technical challenges. The financial barriers are higher for wind energy, particularly for offshore projects, which can cost around $3,200 USD/KW, compared to $1,400 USD for onshore wind and in comparison, $900 USD for solar (McKinsey 2021). Using established industry criteria drawn from globally and Vietnamese averages, a capacity of 4,000 MW in wind farms equates to a $6.7 billion USD investment. Over the normal 25-year lifespan of these projects, this amount includes $6.51 billion USD in capital expenditures (CAPEX) and an additional $151 million USD in operations expenditures (OPEX). Such wind efforts have the potential to provide around 21,000 employments, enhancing coastal communities and contributing to Vietnam's development of a blue economy. A significant portion of this investment and employment creation takes place at the provincial level, notably in transportation, installation, and operations and maintenance (GWEC 2021).

In Vietnam, the expected return for onshore wind projects ranges from 12% to 15% influenced by the FiT scheme. The average cost of debt for onshore wind projects in Vietnam ranges between 8.5% and 12%. Recent interest rate increases as well as perceived bankability difficulties related to wind projects are factors affecting this. The undeveloped commercial banking sector in Vietnam also contributes to higher cost. Leverage ratios for wind projects in Vietnam are between 65% and 70%, lower than in most other markets. Non-recourse project financing structures are less common in Vietnam and therefore underscores the challenges in accessing commercial debt. Using financial strategies from developed economies or implementing credit upgrades may assist to cut debt expenditures and improve leverage ratios. In terms of local currency, the Weighted Average Cost of Capital (WACC) for onshore wind projects in Vietnam is predicted to range from 9.6% to 13.1%. This rate is higher than the Southeast Asia unlisted infrastructure index's average of little over 8%. When evaluated in local currency, Vietnam's relatively high WACC reflects the inherent financial risks and uncertainties associated with wind energy projects in the nation, which include factors such as legislative alterations and market volatility (see Figure 19).

The Levelized Cost of Electricity (LCOE) combines technical and financial factors and therefore gives a holistic overview of the cost-effectiveness. It covers investment, operating, and maintenance expenses, as well as fuel costs, and is impacted by factors like as interest rates, carbon pricing, and carbon capture technology (IESR 2023). LCOE for new onshore wind projects investment is between $0.076 to $0.1067 USD/kWh and lies above the LCOE for solar. This supports the financial metrics and their interpretations mentioned above (IEA 2019).

Offshore wind farms provide the greatest potential for large-scale wind power generation. However, offshore wind development in Southeast Asia, including Vietnam, is still in early stages (Interview B). Financial metrics as discussed above for offshore wind in Vietnam are scarce. As a proxy, looking at data from the US Department of Energy, the LCOE for floating offshore wind projects in 2022, under the assumptions of mature industry supply chains, is $82 to $255 USD/MWh with an expected decline to $66 to $128 USD/MWh by 2030 (US Department of Energy 2023). Offshore wind projects require higher initial investment costs in relation to onshore wind projects. However, returns of offshore wind projects can also be expected to be significantly higher than for onshore wind projects (Interview M, N). Nevertheless, considering Vietnam's transmission and grid problems, the LCOE can potentially expected to be higher than the proxy from the United States.

5.7 Sector specific potential assessment

Vietnam shows high potential for onshore and even higher for offshore wind due to regular windspeeds, increasing energy demand driven by the rising population and considerable government push towards RE developments (as outlined by *PDP8*). This setting opens possibilities for developing wind generation in impoverished areas, experimenting with direct sales methods such as DPPAs, and advocating for more flexible PPAs.

However, challenges in actualisation of potential arise from grid system limits (specifically related to grid capacity and reliability challenges) and unfavourable regulated PPAs with EVN (Interview B). The legal environment and governmental RE incentives in Vietnam have been difficult to assess for investors, due to its ever-changing nature. While laws safeguard against nationalization and profit repatriation, there is no guarantee for EVN's performance under PPAs or for foreign currency conversion. Investment momentum has slowed, partly due to the absence of government support for PPAs and the high FiT scheme, and concerns over currency devaluation, discarding the 20-year contract, and setting a lower price for electricity. Challenges in the financial environment include managing the devaluing VND, concerns about EVN's trustworthiness, and the lack of government guarantees for EVN's contractual commitments.

To tackle the abovementioned challenges, the following steps are recommended for investors:

RECOMMENDATIONS FOR INVESTORS

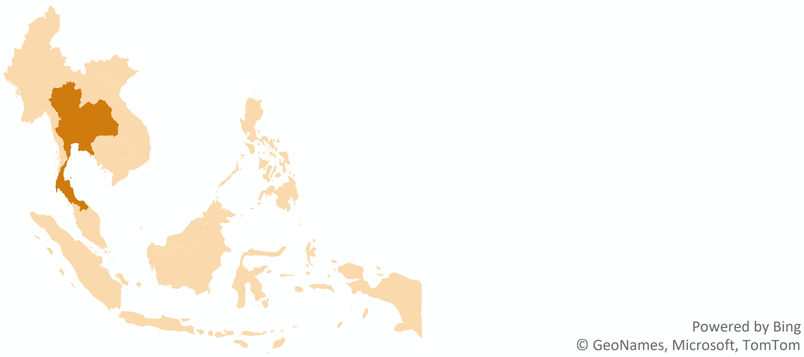
I. **Capitalising on High Potential:** Evolving technology, expected decreases in equipment costs (specifically turbines and associated technologies) as well as operational costs increase attractiveness of investing in wind energy in Vietnam (Berkeley Lab 2016, Elia, et al. 2020). Investors should monitor these trends closely as cost reductions can significantly impact overall project feasibility and profitability. Strategic investments in this sector should be informed by these evolving cost dynamics, making it a potentially lucrative area for investment as technology improves and costs become more competitive.

II. **Monitoring Policy and Infrastructure Developments:** Investors should monitor subsidy changes and regulatory shifts to minimize risks and expenses. Key areas include PPA alterations, such as termination and curtailment compensation, DPPA progress, and inter-ASEAN negotiations on renewable energy trade. Infrastructure development is crucial for success, especially considering the grid system's limitations, which could attract foreign investors (Interview C, D) (McKinsey 2023).

III. **Leveraging Vietnam's Commitment:** Vietnam's history of high subsidies and significant investments in RE demonstrates the governmental commitment to wind energy, which is a signal for the continued prioritization of RE, particularly wind power, in the country's energy mix. In addition, the commitments made in PDP8 indicate a willingness to continue driving growth in wind energy, and therefore, ensuring its attractiveness for investors. Effective balancing of wind energy with other RE sources, in alignment with Vietnam's diverse landscape and socio-economic needs, is crucial for the sector's sustainable development (McKinsey 2023). Investors should leverage the government's willingness to support and expand the wind sector.

6. COUNTRY DEEP DIVE: SOLAR POWER IN THAILAND

6.1 Country Profile



Capital	Bangkok
Total Area *(km²)*	513,100
Population *(millions)*	71.6
Rural Population *(% of total population)*	47
GDP *(current $ USD)*	505.57 bn
GDP Per Capita *($ USD, 3-yr CAGR)*	21,114 (3.19%)
FDI net *($ USD, 3-yr CAGR)*	12.2 bn (-2.7%)
FDI % of GFCF	10.2%

Figure 20 Thailand: Location in ASEAN and Country Profile Factsheet

Source: (The World Bank 2023b, IEA 2023a)

Thailand has long been a pivotal hub for regional trade, bolstered by significant ports (e.g. Laem Chabang and Bangkok) and abundant natural resources (e.g. tin, rubber, and natural gas) that drive its industrial sector (CIA 2023). The country's geography not only facilitates international commerce but also supports a diverse range of industries, from agriculture to manufacturing and services (The World Bank 2023b). Thailand nation's population is approximately 71.6m, with a notable urban-rural divide that influences income distribution and class structure (UN 2022, IEA 2023a). While urban areas like Bangkok exhibit higher income levels and a burgeoning middle class, rural regions often grapple with lower incomes and limited access to advanced education and job opportunities (UN 2022). This disparity is reflected in the country's labour skill levels, where there is a growing emphasis on education and training for green jobs to foster sustainable development (Esposto 2016).

Historically, the country has transitioned from an agriculture-based economy to one that is increasingly industrialized and service-oriented. Key sectors include tourism, electronics, automotive, and agriculture, contributing to its steady growth trends (The World Bank 2023b). However, economic performance has been uneven with periods of rapid growth followed by slowdowns, often influenced by global economic conditions (The World Bank 2023b).

Thailand's political landscape is marked by its constitutional monarchy and parliamentary democracy, which has seen various shifts in governance and policy direction (Wesley 2019) (Interview I).

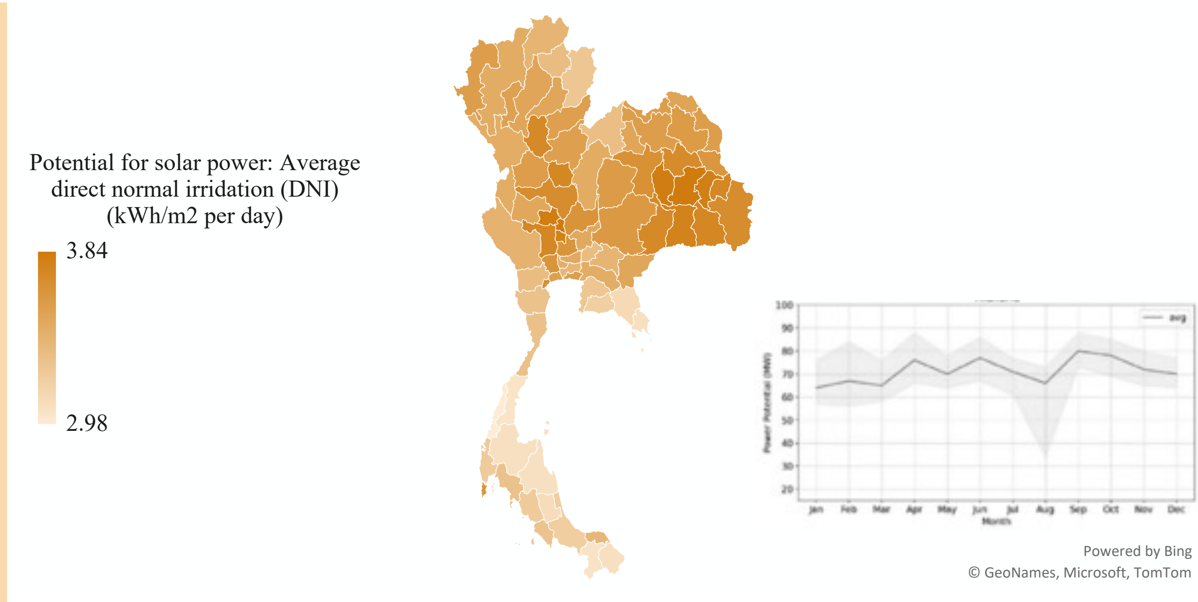


Figure 21 Thailand: Solar Power Potential and Seasonality

Source: Own figure based on (Sakti, et al. 2023, Global Solar Atlas 2023)

Thailand's solar energy landscape, particularly in the PV sector, presents a dynamic mix of potential and challenges. A comprehensive land suitability analysis identified substantial areas within Thailand as highly suitable for PV construction. The variability in solar energy potential throughout the year is a key factor in assessing the feasibility of solar power projects. In Southeast Asia, including Thailand, the highest energy potential from solar panels was observed in September, while the lowest was in March, indicating a moderated seasonal pattern influenced by factors such as solar irradiance, temperature, aerosol optical depth, and precipitation (Sakti, et al. 2023). Moreover, the time-series analysis in Figure 21 reveals that Thailand, along with other SEA countries, experiences tempered fluctuations in solar power potential throughout the year. For instance, Thailand's solar power potential peaked at approximately 80,263 MW, demonstrating the country's substantial capacity for solar energy generation (Sakti, et al. 2023). Since solar facilities require large surfaces for generation, land usage can pose challenges, however developing technologies present opportunities for dual land use (such as agrivoltaics which combines agriculture and solar generation) (Interview F, M).

6.2 Renewable Status and Plan

Total Power Capacity	57.8 GW
Renewables Capacity	12.9 GW / 21%
Renewables Capacity Target	+32.5 GW by 2037
Anticipated retirement geneneration capacity	-25.3 GW by 2037

Figure 22 Thailand: Renewable Status and Plan Overview

Source: (IEA 2023b)

As of July 2023, Thailand's total power generation capacity stood at 57.8 GW with 12.9 GW originating from RE projects (21.1%) (IEA 2023b). The breakdown of Thailand's RE capacity as of that date is as follows:

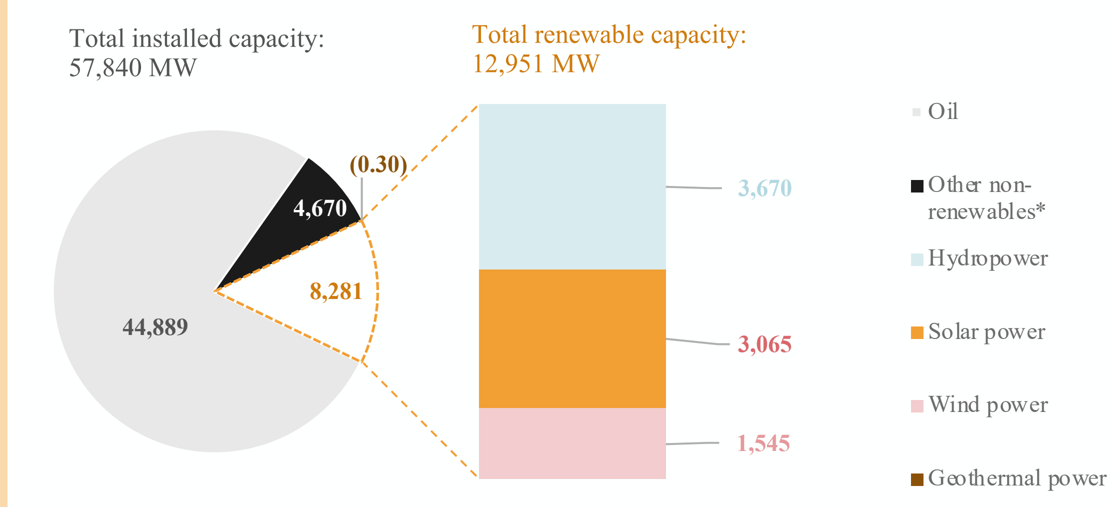


Figure 23 Thailand: Current Power Generation Capacity

Source: Own figure, based on (IEA 2023b)

In April 2019, Thailand's Ministry of Energy sanctioned a progressive blueprint for the nation's energy future, known as the *Power Development Plan 2018 (PDP 2018)*, encompassing a timeline from 2018 to 2037 (Ministry of Energy Thailand 2019). This ambitious plan projects a substantial enhancement in Thailand's total power generation capacity, targeting a rise to 77,211MW by the end of 2037 (ITA 2022a).

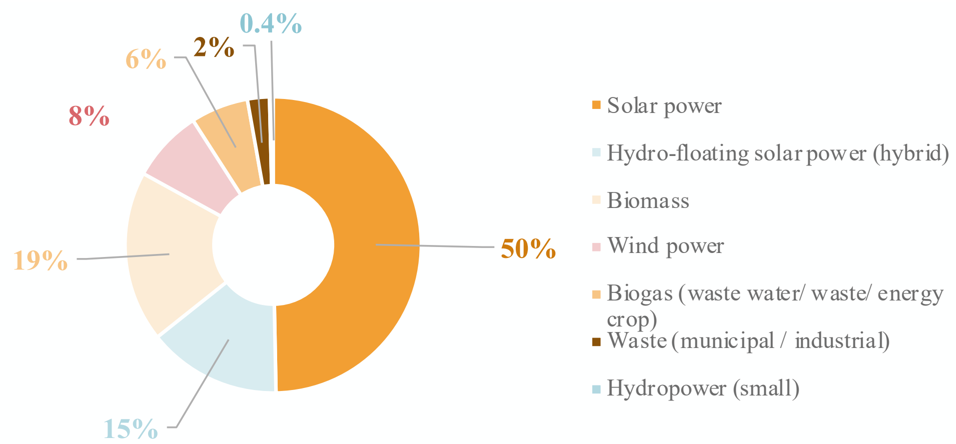


Figure 24 Thailand: Planned Power Generation Capacity (for 2037) (%)

Source: Own figure, based on (IEA 2023b, Linklaters 2022)

In a strategic move to bolster energy efficiency and fortify energy security, the *PDP 2018* underwent a revision in October 2020, labelled as *PDP 2018 Rev.1* (Ministry of Energy Thailand 2019). This revision reaffirmed the commitment to augmenting the generating capacity to 56,431MW by 2037, with RE projects earmarked to contribute a significant portion, approximately 20,766MW or 37% of the total capacity (Linklaters 2022).

Integral to this RE thrust is the *Alternative Energy Development Plan 2018-2037 (AEDP 2018)*, designed in synergy with the *PDP 2018 Rev.1's* policy framework (Ministry of Energy Thailand 2020). *AEDP 2018* partially focuses on amplifying power generation from renewable sources like biogas and biomass. A key component of this plan is the innovative community-based power plants for Local Economy Project (Linklaters 2022). This project champions the involvement of local communities in the development and operation of power plants, fostering a participatory approach to energy production. This not only aids in meeting the country's energy requirements but also stimulates local economies (Linklaters 2022). By 2037, the *AEDP*

2018 aspires to reach a total contracted capacity of 18,696MW from these RE projects. In line with their objectives of reaching carbon neutrality and net-zero greenhouse gas emissions by 2050 and 2065, Thailand has made a larger commitment to increase RE's contribution to at least 50% by 2050. This tactical step is part of that promise (ITA 2022a).

In October 2021, Thailand's Committee on Energy Policy Administration approved a proposal to revise the *PDP 2018 Revision 1* (CEPA 2021). This revision augmenting the RE production targets by the end of 2030. As per the proposed amendments, the generation capacity from wind power is set to see a significant increase as well as hydroelectric power purchased from neighbouring countries, specifically Laos (Linklaters 2022). The revision of *PDP 2018 Rev.1* is scheduled for a public hearing. The draft of this updated version was expected to be completed by mid-2023 (Bangkok Post 2023). However, as of now, there are no additional details available regarding the progression of this process.

6.3 Power Structure System

Market Structure	Single-buyer utility with IPPs
Grid Ownership	State Owned
Pricing	Government Regulated; tariffs set for residential and commercial use
Generation Ownership	Mix of public and private

Figure 25 Thailand: Power Structure System Overview

Source: (IEA 2023a)

In Thailand, the system of selling power is primarily structured around PPAs, facilitating the sale of electricity generated by various types of power producers to key customers. The Electricity Generating Authority of Thailand (EGAT), a state enterprise, plays a central role in this system. It oversees the generation, procurement, and delivery of power to regional electrical organisations like the Metropolitan Electricity Authority (MEA) and Provincial Electricity Authority (PEA), who subsequently provide it to customers. EGAT is seeking bids from private companies to provide power in line with *the PDP 2018*, which has been approved by the Cabinet and the National Energy Policy Council.

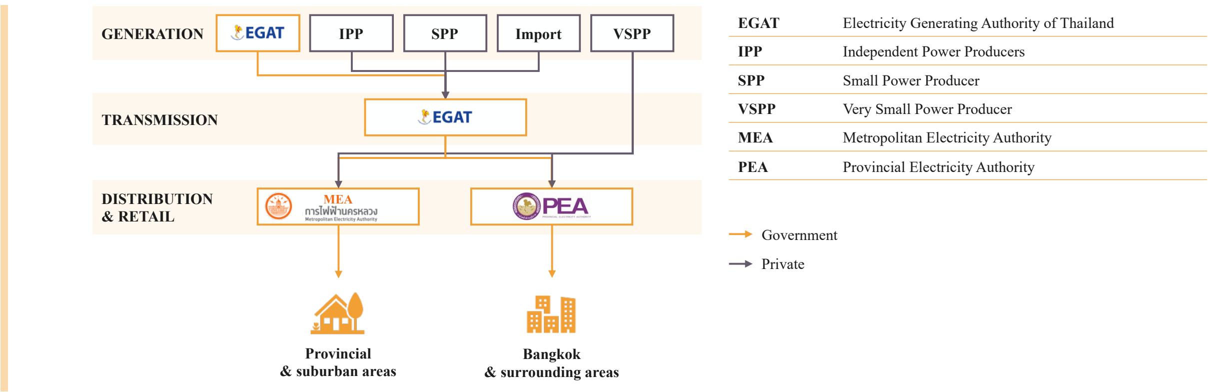


Figure 26 Thailand: Energy Selling System Structure

Source: Own figure, based on (IEA 2023c)

Small Power Producers (SPPs) and Very Small Power Producers (VSPPs) are critical components of this system. SPPs, with a maximum capacity of 90MW, sell electricity to EGAT under long-term PPAs typically lasting 20 to 25 years. VSPPs, on the other hand, are smaller-scale producers with a maximum capacity of 10MW. They sell electricity to either PEA or MEA, depending on the project's location. While most electricity distributed by PEA and MEA is purchased from EGAT, a portion comes directly from IPPs under the VSPP Program (Norton Rose Fulbright 2019b, Linklaters 2022). This category of VSPP is given Thailand and the potential Power Producers more flexibility and are faced even with less bureaucratic red tape inform of simple PPAs and grid connect priority (Interview G).

Furthermore, under long-term PPAs, IPPs with generating capacities greater than 90 MW also sell power to EGAT. Three IPP bidding rounds have been held in Thailand thus far: in 1994, in 2007, and in 2012. These auctions are a crucial part of Thailand's larger plan to bring the private sector into the country's electrical market, with the goal of developing a competitive and diverse energy sector (Linklaters 2022).

Most RE projects typically operate under non-firm PPAs: Such agreements do not require a specified capacity of electricity to be delivered by the project, and entities like EGAT, PEA, or MEA do not commit to a minimum purchase of electricity. However, recent initiatives by the Energy Regulatory Commission (ERC) are shifting the focus towards encouraging the development of RE projects with firm delivery commitments. In these arrangements, projects face penalties if they fail to deliver a pre-agreed percentage of their contracted capacity. Promoting hybrid projects that combine solar photovoltaic technology with other RE sources, such biomass and biogas, is one aspect of this change. (Norton Rose Fulbright 2019a).

6.4 Stakeholder Assessment

In the context of Thailand's burgeoning solar energy sector, Mitchell, Agle, and Wood's Stakeholder Identification and Salience Framework provides a nuanced lens through which to evaluate the various actors and their respective roles (Mitchell, et al. 1997).

The complexity of bureaucracy presents a moderate risk to foreign direct investment in RE. The power sector, structured as an enhanced single-buyer model, involves multiple stakeholders including the Ministry of Energy, the ERC, and the EGAT. While the Ministry formulates energy policies, the ERC focuses on regulating and promoting RE. EGAT's role as a central planner and single electricity buyer, controlling 34.5% of generation capacity, adds to the bureaucratic layers (IEA 2023c). Additionally, corruption, as indicated by the CPI of 36, further complicates the investment landscape.

Figure 27 Thailand: Energy Stakeholder Overview

Source: Own figure, based on (Bloomberg NEF 2023, Thailand Board of Investment 2022)

In Thailand's competitive RE sector, B.Grimm Power and Energy Absolute PCL stand out as formidable rivals, each advancing solar and wind projects to capitalize on the nation's sustainable energy shift, thereby illustrating the vigorous market landscape for IPPs and developers.

Development banks like the World Bank and ADB command a central position within this framework, their substantial financial clout and commitment to sustainable development lending them a high degree of power, legitimacy, and urgency, categorizing them as definitive stakeholders whose decisions have immediate and far-reaching implications for the sector's trajectory.

Commercial banks like Bangkok Bank and Kasikornbank are pivotal in financing solar projects, with their power and legitimacy hinging on their financial health and market perception. The urgency of their stake can vary, often becoming acute during periods of financial mobilization for new projects or when refinancing is crucial, which can swiftly elevate their stakeholder salience.

Incorporating equipment suppliers enriches the analysis of Thailand's solar energy sector. Companies like SPCG, Risen, Longi, Suntech, and Jinko emerge as potent forces, all mainly from China, their power and urgency defined by the immediate need for their advanced technologies in ongoing solar projects (Bloomberg NEF 2023). Their legitimacy is secured through their reputation for quality and innovation, creating a supply chain dependence for solar projects. These suppliers' influence on the competitive dynamics and their critical role in the supply chain magnifies their stakeholder salience, affecting the bargaining power of buyers and the overall competitive rivalry within the sector.

International law firms and accountancy firms are crucial for legal compliance and financial transparency.

6.5 Government Incentives and Legal Considerations

In Thailand, solar energy projects are categorized under the *Investment Promotion Act Section 7.1.2*, which significantly bolsters investment in RE. Projects exceeding 200 KW at each distribution point are eligible for the *A2 Incentive Level*, offering a blend of tax and other incentives. Incentives include large corporate income tax discounts and reductions as well as waived or reduced import taxes on equipment, raw materials, and imports for R&D. There are further deductions available for expenditures associated with the setup and operation of the facility, such as transportation, energy, and water supply. Permissions for foreign experts, land ownership rights, and ease of transmission of funds are among the non-tax advantages (Thailand Board of Investment 2023). Especially the land ownership allowances for foreigners solves a big hurdle that many RE development projects are facing (Interview H).

The ERC has launched a forward-looking initiative to augment the country's RE sector, detailed in the *New RE Quota Regulations* and the *Invitation Notifications for Purchasing Electricity* from RE Sources under FiT Scheme (Baker McKenzie 2022).

Technology	**Mechanism**	**Ceiling Price Level** (lifetime avg.)	**Duration**	**Currency of Payment**	**Inflation Adjustment**	**Grid Connection and Land**
Solar PV*	FiT	$65 USD/MWh	25 years	THB	No	Developer Responsibility
Solar PV Storage **	FiT	$86 USD/MWh	25 years	THB	No	Developer Responsibility

Figure 28 Thailand: Renumeration Mechanism – Solar PV

Source: (IEA 2023a)

**Other features +15/MWh if located in southern border province, min. 51% Thai Ownership*
***Other features +10-90 MW capacities, 100% output from 9am-4pm & 60% output from 6pm-6am, +15/MWh if located in southern border province, min. 51% Thai ownership*

The table outlines the remuneration mechanisms for utility-scale PV energy in Thailand, detailing two types of FiTs. The standard FiT offers $65 USD/MWh over a 25-year duration with payment in Thai Baht (THB), without inflation adjustment, and places grid connection and land responsibilities on the developer. There is an additional incentive for projects located in southern border provinces, requiring a minimum of 51% Thai ownership, which provides an enhanced tariff of $86 USD/MWh. For both mechanisms, energy production is optimized to match peak demand hours, with 100% output expected from 9 am to 4 pm, and a 60% output from 6 pm to 6 am for PV combined with storage. The latter is designed to incentivize energy storage integration by offering a higher tariff, reflecting the additional value of stored energy which can be dispatched to meet demand outside of solar generation hours. These remuneration mechanisms reflect Thailand's strategic approach to integrating solar PV into the national grid while promoting local ownership and addressing the energy needs of specific regions (IEA 2023a).

The process of choosing a project is based on a score system that considers factors such project location, technology, fuel kinds, and financial robustness, while also evaluating criteria like project readiness, development progress, and financial stability. Certain types of renewable power plants are given advantage in the process when numerous participants propose selling power at the same connection point (Baker McKenzie 2022).

These comprehensive regulations and structured bidding processes represent a substantial advancement in Thailand's RE policy framework, providing a robust platform for both domestic and international investors in the RE sector for the coming years (Interview G).

6.6 Macro and Micro Financial Considerations

Trailing 12M Currency Movement (THB/$ USD)	0.88%
Sovereign Debt Rating (S&P)	BBB+
10Y Gov. Bond Yield	2.66%
Energy Subsidies (Yes/No, Type, $ USD)	Yes, Coal (13.7 bn), Oil & Gas (18.6 bn)
CO2 Emissions (per capita, 3-yr CAGR)	4.02t (3.64%)
Carbon Pricing	Voluntary ETS

Figure 29 Thailand: Macro financial metric overview

Source: (IEA 2023a)

In assessing the financial risk at the macro level for Thailand, several key indicators provide insights into the country's economic stability and investment attractiveness. The trailing 12-month currency movement between the THB and the $ USD shows a modest 0.88% increase (IEA 2023a). This gain, especially against the $ USD, suggests reduced currency risk for investors, particularly those dealing with cross-border transactions or foreign investments. A stable currency environment is crucial for foreign direct investments, as it mitigates the risks associated with foreign exchange rate fluctuations.

Furthermore, Thailand's sovereign debt rating, as evaluated by Standard & Poor's, stands at BBB+ (IEA 2023a). This rating falls within the investment-grade category, reflecting a positive assessment of the country's creditworthiness and a relatively low risk of default. Such a rating typically instils confidence in investors, as it implies a stable economic and political environment and a government capable of meeting its financial commitments.

Additionally, the 10-year government bond yield in Thailand is recorded at 2.66%. This low government bond rate is indicative of a low-risk free rate in the country's financial markets (IEA 2023a). In a broader economic context, this low yield signals investor confidence in the government's financial stability and an effective monetary policy. It also suggests an attractive base for borrowing money, as lower interest rates on government bonds often correlate with lower interest costs for both corporate and personal borrowing. This environment can foster business investment and economic growth, making Thailand an appealing destination for both domestic and foreign investors. Overall, these macroeconomic indicators, i.e. currency stability, a favourable sovereign debt rating, and low government bond yields, collectively suggest a relatively low financial risk environment in Thailand. This scenario is conducive to attracting and sustaining FDIs, particularly in sectors like RE, where long-term financial stability is crucial for investment decisions (Interview L).

The landscape of power generation investment in Thailand, particularly for RE, is characterized by a synergistic approach through blended finance, which amalgamates capital from both public and private sectors. Notably, the Electricity Generating Public Company emerges as a predominant investor, contributing a substantial $411m USD, indicating a strong governmental endorsement and public sector engagement. Gunkul Engineering's investment of $165m USD reflects strategic private sector involvement, emphasizing corporate commitment to RE. The Solar Power Company and Aeolus Associated, with investments of $131m USD and $119m USD respectively, represent the targeted confidence from entities with specialized expertise in renewable technologies. Furthermore, the Tang Kim Heng Group's contribution of $113m USD illustrates the expanding spectrum of investors diversifying into sustainable energy financing. Collectively, these entities exemplify a concerted investment drive in Thailand's RE sector, underpinning the critical role of blended finance in facilitating risk-sharing and promoting the adoption of RE infrastructure (IEA 2023a).

The average cost of producing one kilowatt-hour (kWh) of energy over the course of a project's lifespan is measured by the level of cost per kWh for solar PV systems in Thailand. It includes CAPEX, land costs, and OPEX like maintenance and replacements. The calculation accounts for inflation, discount rates, solar irradiation, system performance, and module degradation. Thailand's LCOE trajectory shows a significant decrease over time. In 2020, Thailand was projected to have the highest LCOE for solar among the studied countries, but by 2040, its LCOE is expected to be the lowest at $0.074 USD/kWh. This downward trend in Thailand's solar PV LCOE is notable compared to Malaysia and Indonesia, with Malaysia predicted to have the highest LCOE in 2040. The primary factors contributing to this shift are Thailand's abundant solar irradiation resources and relatively low labour costs. In contrast, Malaysia's higher LCOE is attributed to its elevated CAPEX and OPEX. Interestingly, Indonesia's LCOE is expected to be the second lowest after Thailand by 2040, primarily due to its lower projected CAPEX compared to Malaysia (Al Matin, et al. 2019).

In Thailand, the investment landscape for PV solar energy exhibits a nuanced relationship between expected returns and associated risks. When expressed in local currency, the expected equity returns for utility-scale solar PV projects in Thailand are typically on the lower side, averaging between over 10% and over 13% on a deployment-weighted basis, as in other established ASEAN-10 countries. This tendency is frequently associated with a better developed market and regulatory environment, which typically results in lower projected returns and less risk (IEA 2023a).

Furthermore, for commercial and industrial (C&I) solar PV projects in Southeast Asia, the expected local-currency-based equity returns are estimated to range from 12% to 15%. In Thailand, these returns are on the lower end of this spectrum. This is partly due to the availability of FiTs for remuneration, which provides a more predictable revenue stream and thus reduces the investment risk compared to countries without such incentives (IEA 2023a).

Currency	THB
Technology	Solar PV
WACC *(LCY)*	7.0% - 9.2%
Expected Return *(LCY)*	10.0% - 13.0%
Cost of Debt *(LCY)*	6.0% - 7.5%
WACC *($ USD)*	5.5% - 8.0%
Expected Return *($ USD)*	8.5% - 11.5%
Cost of Debt *($ USD)*	4.5% - 6.5%
Tariff currency indexation	THB
Leverage ratio	70.0% - 75.0%

Figure 30 Thailand: Utility-scale Solar PV micro financial metric overview

Source: (IEA 2023a)

The WACC in local currency (LCY) for solar PV in Thailand ranges from 7.0% to 9.2%, with the expected return ranging between 10.0% and 13.0%. The correlation between expected returns and risks in the Thai PV market reflects a balance between regulatory stability and market maturity, which influences investor confidence and the cost of capital. The availability of FiTs, mature market conditions, and relatively stable regulatory frameworks contribute to a lower risk profile for solar PV investments in Thailand, thus influencing the expected returns (IEA 2023a).

6.7 Sector specific potential assessment

Thailand's solar PV energy landscape shows high potential, underscored by its peak potential of approximately 80,263 MW, which indicates its robust capacity for solar energy generation. (Sakti, et al., 2023). The Thai government's commitment to RE is evident in strategic initiatives like the New RE Quota Regulations and the FiT Scheme, aiming to increase the RE share to at least 50% by 2050. The FiTs for utility-scale solar PV in Thailand, offering $65 USD/MWh for a 25-year duration, especially during peak demand hours, encourage solar energy production (Interview G). The category of VSPP make an initial development very attractive, due less bureaucratic hurdles and is giving Thailand an edge among the ASEAN-10 (Interview G). The country's economic and financial stability, highlighted by a stable Thai Baht and a BBB+ sovereign debt rating, creates a low-risk environment for investors (IEA 2023a). The government's commitment to RE is evident through policies like the New RE Quota Regulations and the FiT Scheme, which aim to significantly increase the share of RE by 2050 (Linklaters 2022). Furthermore, the LCOE for solar PV in Thailand is projected to be the lower compared to other ASEAN-10 states by 2040, signifying cost-effectiveness in solar energy production. The investment landscape is further bolstered by the ease of deployment and therefore, resulting competitive expected returns on utility-scale solar PV projects (Interview G) (Al Matin, et al. 2019, IEA 2023a).

However, the sector faces some technical and regulatory challenges. Seasonal fluctuations in solar irradiance, temperature, and precipitation, peaking in September and dipping in March, create modest variability in solar energy potential throughout the year, affecting the feasibility of solar power projects. The large surface requirement of solar generation, a challenge, can be tackled with emerging technologies such as agrivoltaics or floating solar (Interview E, F, M).

To tackle the abovementioned challenges, the following steps are recommended for investors:

RECOMMENDATIONS FOR INVESTORS

I. **Start with a smaller investment:** Initially, it is advisable for investors to establish as a VSPP. This strategy provides easier access to the Metropolitan/Provincial Electricity Authority and simplifies the negotiation of Power Purchase Agreements (PPAs). This approach offers a streamlined entry into the local energy market.

II. **Contact Thailand Board of Investment:** The first touchpoint can be an overseas of office of the BOI. Here detailed information is provided on Investment Promotion Criteria, Incentives, and further steps. Also, which special economic zone to use should be discussed here.

III. **Leverage Acquired Knowledge:** Utilize the experience and insights gained from initial VSPP operations to expand investment scope and strategies. This includes exploring larger-scale projects, diversifying into other renewable energy areas, and forming strategic partnerships with local entities.

7. COUNTRY DEEP DIVE: HYDROPOWER IN INDONESIA

7.1 Country Profile

Capital	Jakarta (Java)
Total Area *(km²)*	1,916,906.77
Population *(millions)*	275.5 (4th most populous country globally)
Rural Population *(% of total population)*	43
GDP *(current $ USD)*	1.32 tr.
GDP Per Capita *($ USD, 3-yr CAGR)*	4788
FDI net *($ USD, 3-yr CAGR)*	2.21 bn. (3.8%)
FDI % of GFCF	5.80%

Figure 31 Indonesia: Location in ASEAN and Country Profile Factsheet

Source: (The World Bank 2023c)

As the world's largest archipelagic nation, Indonesia encompasses more than 17,000 tropical islands with a wealth of natural resources such as coal, natural gas, palm oil and rubber. It sees high humidity, high temperatures and abundant geologic activity that leaves fertile grounds (Liu, et al. 2019). The nation's plethora of rivers (counting over 800) present the most suitable geographical setting for hydropower in ASEAN (Sakti, et al. 2023). Disregarding micro hydropower facilities, Indonesia is equipped with both large (4196 MW) and small scale (64 MW) hydropower capacity, predominantly run-of-river facilities (Tang, et al. 2019, IEA 2022). Hydropower potential ranges from 75,000 to 79,090MW with 500 to 12,800MW categorised as small-scale development (Tang, et al. 2019, Linklaters 2022, Liu, et al. 2019). Determining factors count geography, seasonality, and population density (due to the large discharge area required) (Tang, et al. 2019, Sakti, et al. 2023). Reduced rainfall due to future climate change will impact future water input despite large catchment areas: The International Energy Agency

(IEA) estimates climate change impacts will reduce domestic hydropower capacity by 5 to 7% between 2060 and 2100 (IEA 2022). Due to strong location dependence, suitable locations for new hydro projects are challenged with finding unlicenced locations (Interview H, N). Similar barriers are present in Vietnam and present social complications of population displacement (Interview M). Displayed below is an overview of current hydropower facilities and potential.

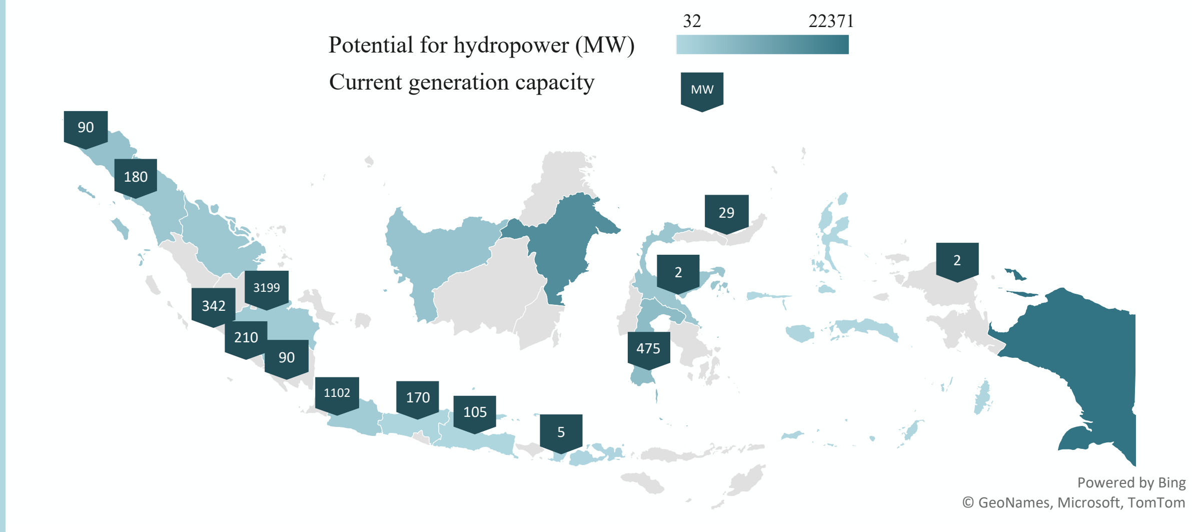


Figure 32 Indonesia: Hydropower Current Power Capacity and Potential

Source: Own figure, based on (IIPC 2022)

Due to its strategic position for trading between the Pacific and Indian Ocean, the nation has seen centuries of foreign investment forms: In the 14th century trade activity flourished near the Malacca straits, in 1870 the Dutch East India Company (VOC) opened the nation to foreign capital under Dutch colonial rule and in 1966, the Suharto regime sought out FDI in a post-guerrilla war closed market (Pigeaud and Leyden 1962, Lindblad 2018, White 2017). More recently, in the era of globalisation, international investments reached its peak at $43 billion USD (Dezan Shira & Associates 2020). As a democratic nation under a presidential republican form of government, Indonesia presents a fairly stable political environment. Corruption however still poses a barrier for foreign investors: Transparency International ranks Indonesia as 110/180 on the 2022 CPI, indicating high risk of corruption (Transpareny International 2022). Largest GDP growth in 2023 was observed in sectors of transportation and accommodation services (PwC Indonesia 2023). Within the energy sector, the nation is active in production of natural gas, coal, and mining of minerals such as nickel (Interview E).

Most of the 273m inhabitants (totalling more than 1/3 of ASEANs population) reside in metropolitan cities of Jakarta, Surabaya, or Bandung; however rural villages are still very much a part of the social fabric of the nation (ASEAN Secretariat 2021, Statista 2023c). Population density, climate change induced sea level rise and natural land subsidence have recently driven the country to prepare to move its national capital of Jakarta on Java to a freshly constructed capital of Nusantara in East Kalimantan (Tarigan and Milko 2023). Despite continuing economic disparities, the nation’s middle class has grown more than 9 times since 1993 (Dartanto, Rahmanto and Otsubo 2020, Ogilvy & Mather 2016). Education enrolment growth rates show improving education levels; Green economy education initiatives specifically are becoming more popular in a nation with ambitious sustainability targets (The World Bank 2020b).

7.2 Renewable Energy Status and Plan

Total Power Capacity	84 GW
Renewables Capacity	13 GW (15%)
Renewables Capacity Target	25% by 2030

Figure 33 Indonesia: Energy Capacity Factsheet

Source: (IEA n.d., Linklaters 2022)

As the 3rd largest coal producer globally; fossil fuels play a dominant role in Indonesia’s domestic power generation capacity (see Figure 34) (EIA 2021). Renewable generated energy consists primarily of hydropower (53%) and geothermal sources (19%) (IEA n.d.). Almost half the generated electricity flows to households, approximately 30% is used for industry and 18% flows to commercial users (EIA 2021).

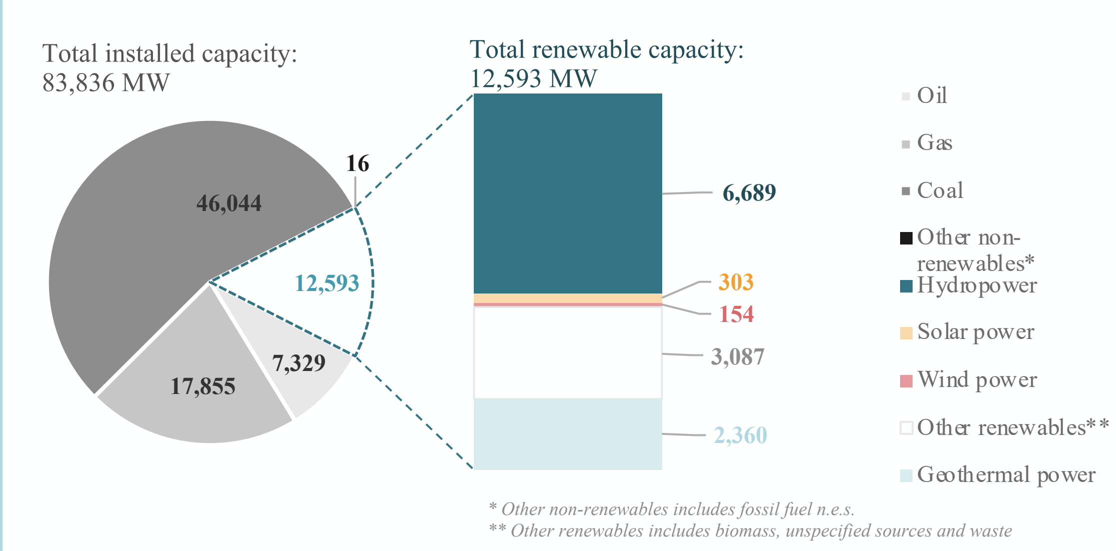


Figure 34 Indonesia: Current Power Generation Capacity

Source: Own figure, based on (IEA n.d.)

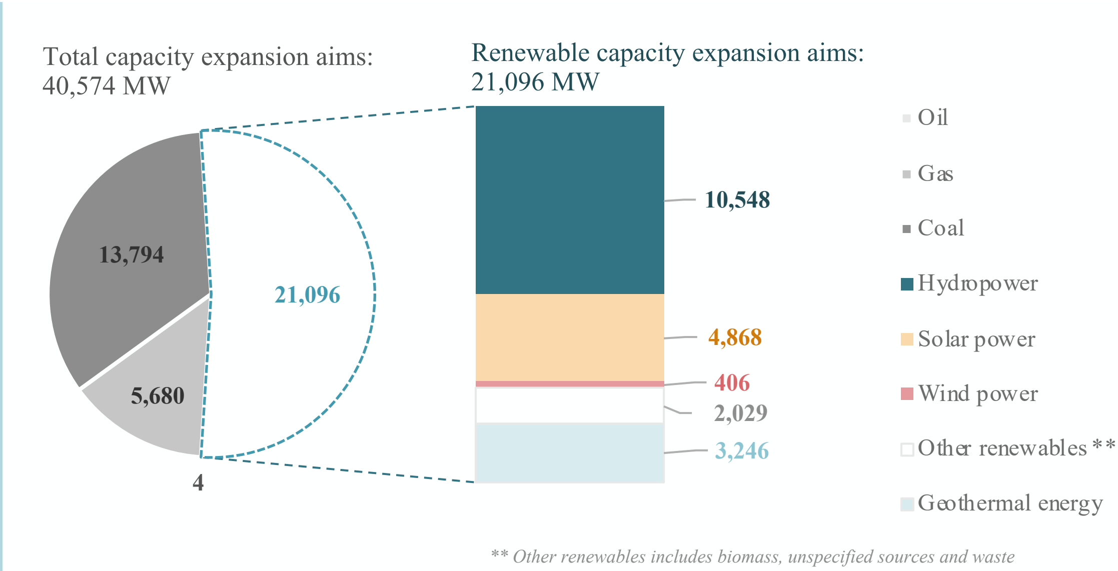


Figure 35 Indonesia: Planned Power Generation Capacity Expansion under RUPTL (2030)

Source: Own figure, based on (CEFIM 2021)

Future goals state ambitions of emission reduction of 42 to 43% by 2030 compared to business-as-usual and to reach carbon neutrality with net-zero emissions by 2060 (EIA 2021, Silalahi, Blakers und Cheng 2022, IEA 2023a).

Enacted in 2014, the *National Energy Policy* provides national long-term policy on energy management: it outlined a requirement for renewable share of 25% in the energy mix by 2030. This was complemented by the *Rencana Usaha Penyediaan Tenaga Listrik 2021-2030* (RUPTL)

(*Plan for Provision of Electricity)*: Key points include total capacity expansion to 40.6 GW by 2030 with over 50% renewables (see Figure 35) (WAVTEQ 2017, IEA 2023a). For a summarised timeline of planned capacity expansion, see Figure 36. For hydropower specifically, the government aims for 26 additional hydro power plants of which 11 are in progress, in Kalimantan, Jamali, Sumatra and Sulawesi (MordorIntelligence 2023, CEFIM 2021, WAVTEQ 2017). Methods to reach these goals are power plant conversion (from diesel to renewable), coal-fired plant closures and renewable plant expansion: the recently announced JETP encompasses plans for funding mechanisms between donor countries and Indonesia to retire coal plants early and incentivize replacement by Renewable Energy Power Plants (REPPs) (Draps, et al. 2023, IEA 2023a) (Interview N).

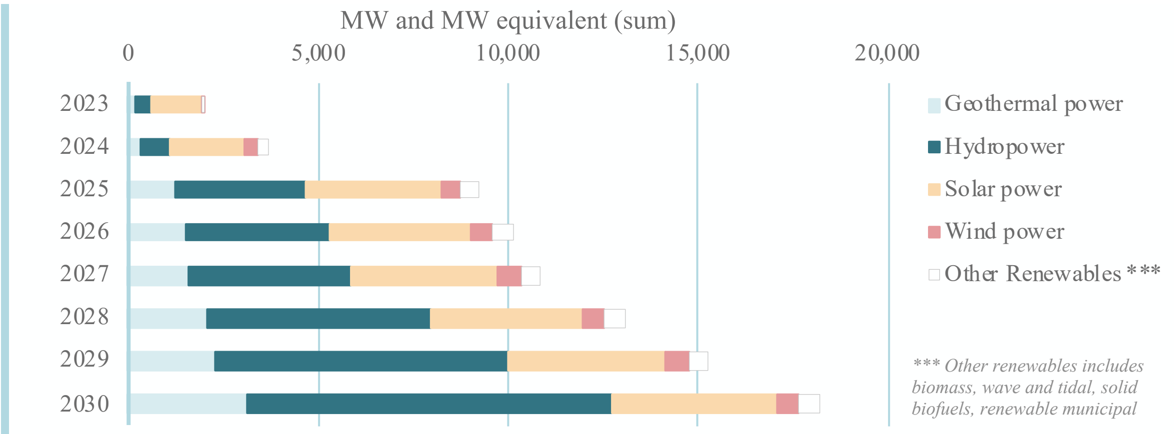


Figure 36 Indonesia: Timeline of Capacity Expansion for Renewables under RUPTL

Source: Own figure, based on (Linklaters 2022)

About half of planned capacity expansion will be constructed by IPPs which indicates opportunity for foreign investment: at least $78.2 billion USD is required in investments from IPPs (WAVTEQ 2017).

7.3 Power Structure System

Market Structure	Single-buyer utility, with IPPS
Grid Ownership	Public
Pricing	Long-term contracts mostly
Generation Ownership	Public and private mixed

Figure 37 Indonesia: Energy Structure Factsheet

Source: (IEA 2023a)

Indonesia exhibits a single buyer power system (SIPET 2022). Most of the hydro generation capacity is state-owned by electricity distributor Perusahaan Listrik Negara (PLN) and shows monopolistic characteristics, however a small share of IPPs is licensed to generate specific amounts to be sold under PPAs to off-takers (Interview C, E). PPAs for energy projects in Indonesia differ from project to project and are provided by regional PLN subsidiaries; areas of negotiation are e.g. commissioning, dispatch payments and triggering events for cost increases (Norton Rose Fulbright 2014) (Interview F). Captive Power (CP), in which industries generate power supply for direct usage, is present but in minimal amounts. An example of an IPP and CP is PT Vale; a mining subsidiary which runs three hydropower facilities to supply electricity to PLN as well as its own nickel production facilities (WAVTEQ 2017, Sunusi and Indriawati 2019).

IPP licenses are awarded through a selection process by PLN: upon meeting requirements and having a draft PPA in line with RUPTL, selected IPPs enter a bidder list for the competitive tender (Linklaters 2022, Yuliandhini, Sidabutar and Draps n.d.). If won, the winning party must execute its PPA within three to four months (Norton Rose Fulbright 2014). This tender process can be avoided in exceptional circumstances, e.g. times of local electricity shortages or excess IPP power (Linklaters 2022).

Power transmission and grid systems are public but hindered by geographic features of island barriers due to demand variation and by underdeveloped grid infrastructure: lengthy transmission corridors are required to connect to nearest substations and transmission grid links, discharge gauging stations, and road access can be lacking (Tang, et al. 2019, Norton Rose

Fulbright 2014) (Interview E, J). PLN owns most of the transmission grid: microgrids owned by IPPs in remote areas are the exception, which can have lower construction costs and resistance to natural disasters (SIPET 2022, Tang, et al. 2019).

In terms of electricity distribution, PLN remains the primary off taker for IPPs generating power: it buys the electricity through PPAs against a price approved by the Minister of Energy and Natural Resources (MENR) with government subsidies in place to cover the generation cost gap (Linklaters 2022). Regulation on price setting differs per technology: For micro hydro power, purchase prices set by government leave no room for negotiation while geothermal plants involve a ceiling purchase price only (Norton Rose Fulbright 2014). In practice, set prices are determined by seats of power which makes the electricity system strongly tied with politics (Interview E). Unspecified regulation on small, medium, and large-scale hydropower regulation in Indonesia leaves price setting methods untransparent. PPAs between IPPs and PLN have a maximum timeframe of 30 years under the RUPTL. As of currently, renewable PPAs have always been short-term for small scale hydro facilities and solar developments (Linklaters 2022).

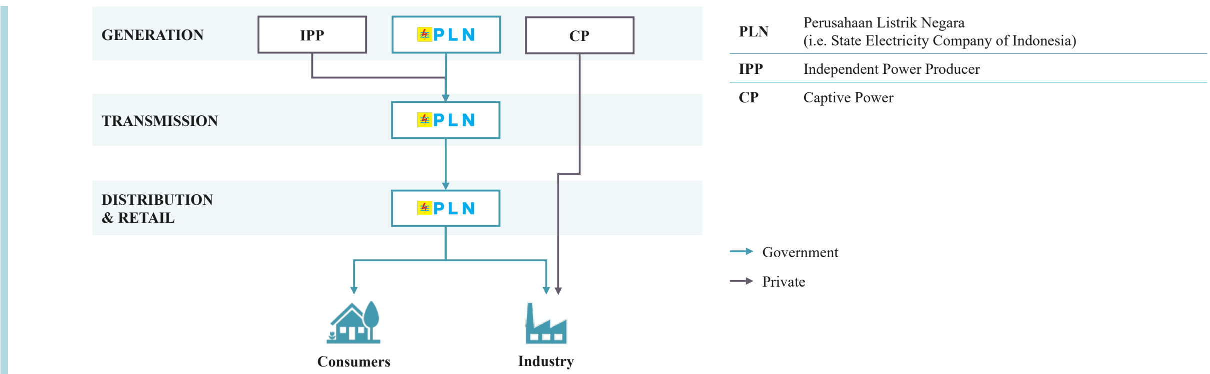


Figure 38 Indonesia: Hydropower Structure Energy Selling System

Source: Own figure, based on (SIPET 2022, Linklaters 2022, Sepasthika, Sasongko and Muryanti 2023)

7.4 Stakeholder Assessment

Stakeholders in Indonesia are listed according to dominance in terms of power, legitimacy and urgency, according to Mitchell, Agle, and Wood's Stakeholder Identification and Salience Framework (Mitchell, et al. 1997): the government has most power, legitimacy and urgency and enacts this through ministries as well as the state-owned energy distributor PLN. Funding institutions also have a dominant role. Other IPPs, suppliers and industry organisations rank lower. For a stakeholder overview, see Figure 39 presented below.

Figure 39 Indonesia: Hydropower Stakeholder Overview

Source: Own figure, based on (MordorIntelligence 2023, PT Kayan Hydropower Nusantara 2023) (Interview H)

The Government of Indonesia (GOI) shapes the RE landscape through aligning national and regional spatial planning by methods of laws and long-term regulation, enacted through ministries outlined Figure 50 in Appendix B. The Minister of Energy and Mineral Resources (MEMR) issues long term national electricity plans such as RUPTL, regulates IPP licencing, PPAs and risk regulation concepts that PLN and IPPs must follow and approves the price against which IPPs supply electricity to PLN. In terms of financing, the GOI provides aid through fiscal guarantees and incentives (Linklaters 2022).

PLN acts as main energy supplier (generating near 70% of supply, see Figure 40 below). Aside from its central role in power generation, transmission, and distribution, it selects IPPs to partake in the tender bidding process (Linklaters 2022).

Figure 40 Indonesia: Power Generation by Party (2020)

Source: Own figure, based on (Linklaters 2022)

Small projects are taken care of by local developers with local equipment, funded through development banks (such as the Dutch Entrepreneurial Development Bank FMO) and domestic funds (such as PT Indonesia Infrastructure Finance) (Interview H, J). Large scale developments see developers originating from Japan, Korea, and China, bringing in regionally sourced material from companies such as Ib Vogt and Andritz which primarily manufacture in China (Interview H, J). Domestic and international banks cater primarily towards large projects.

Stakeholders with less legitimacy and power span institutions which can aid investors on topics such as legal considerations of energy investments, such as consultancies with local branches (such as South Pole and PT Norconsult) which specifically focus on sustainability, RE and hydropower projects. National industry institutions such as the Indonesia Clean Energy Forum (ICEF) and the Indonesian Centre for Renewable Energy Studies (ICRES) share best practices regulation for the energy transition (IESR 2020), while the International Hydropower Association (IHA) specifically aids investors through information dissemination for social and environmental requirements and grid planning (IHA 2018). It hosted 2023's World Hydropower Congress in Bali to advocate sustainable hydropower development.

7.5 Legal Considerations and Government Incentives

For foreign investors, frequent regulatory changes lower clarity and impede long term planning (Yuliandhini, Sidabutar and Draps n.d.) (Interview D, J). High levels of corruption and bureaucracy within the nation create project lags and incentivises investors to look elsewhere (Transpareny International 2022) (Interview G). To avoid bureaucracy during dispute between companies, settlement between private foreign and national parties happens through international arbitration outside Indonesia: in the field of hydropower, this arbitration between IPPs under PPAs with PLN occurs in Singapore (Yuliandhini, Sidabutar and Draps n.d.).

In terms of regulation pertaining to FDI, several recent changes are noteworthy and are mentioned from general to project specific level. General employment law dictates regulation on expatriate employees and mandatory Indonesian understudies (such as *Rencana Penggunaan Tenaga Keya Asing* or *Expatriate utilisation plan*) (Yuliandhini, Sidabutar and Draps n.d.). The *Omnibus Law* (*Law No. 11 of 2020 on Job Creation*) and the *New Positive List* (*PR No. 49 of 2021)* have liberalised the power sector through lifting foreign ownership restrictions.

All RE projects should comply with the *Electricity L*aw (*Law No. 30 of 2009*), the National Electricity General Plan (2014) and the RUPTL (2021). Regulation is permit-heavy: for property procurement *Hak Guna Bangunan* (*Right of Building)* or *Hak Pakai (Right of Use)* should be acquired (Interview H). Protected forest can be utilised for hydropower projects if the right permit has been issued (Norton Rose Fulbright 2014). Additional licences are required for construction, electricity supply (such as the *Electricity Supply Business Licence*) and compliance with required environmental permits (such as the *Sertifikat Laik Operasi* or

Operation Worthiness Certificate and *Water Resource Utilisation Permit)* (Yuliandhini, Sidabutar and Draps n.d.) (Interview H).

Local Content Requirements (LCRs) for RE projects under regulation of *No. 54/M-IND/PER/03/2012* may apply; these raise investment prices significantly for solar and hydropower due to lacking economies of scale in the domestic manufacturing market and impede recent JETP plans due to conflicting requirements form donor countries (Yuliandhini, Sidabutar and Draps n.d., IESR 2023, Draps, et al. 2023).

The GOI provides incentives and financial aid to accelerate power infrastructure development (Linklaters 2022). The former involve loan guarantees for loans to PLN and business viability guarantees for IPPs to secure obligations of payment of PLN under PPAs. The latter encompass methods to attract investment by lowering financial barriers through government subsidies for the generation cost and consumer tariff gap as well as income incentives through for example taxable income reductions, extended tax loss carry-forward periods, accelerated rates for depreciation and amortization and tax concessions on dividend withholding. These government subsidy and tariff schemes change frequently, and arrangements display inconsistency over time, impeding reliable planning for investors: on paper plans show ambition however actions show a complex environment to navigate as foreign investors (Linklaters 2022) (Interview E). Recently, FiTs for RE were replaced by ceiling prices (see Figure 51 in Appendix B): PLN purchase prices are not capped at generation cost anymore but rather determined per location and present opportunity for IPPs to bid against as part of the tender selection process (SIPET 2022, Sepasthika, Sasongko and Muryanti 2023, Global Green Growth Institute 2023, Linklaters 2022). Additional government incentives like the recent JETP are being developed so cohesive roadmaps are not yet in place (Draps, et al. 2023, United States Embassy Jakarta 2023) (Interview N).

7.6 Macro and Micro Financial Considerations

Trailing 12M Currency Movement *(IDR/$ USD)*	- 4.98%
Sovereign Debt Rating *(S&P)*	BBB
10Y Gov. Bond Yield	4.62%
Energy Subsidies *(Yes/No, Type, $ USD)*	Yes, oil ($22 USD bn.), electricity ($2 USD bn.)
CO2 Emissions *(per capita, 3-yr CAGR)*	2.32t (2.73%)
Carbon Pricing	Yes, for coal power, $2 USD/t

Figure 41 Indonesia: Investment Climate Factsheet

Source: (IEA 2023a)

On wider domestic level, consideration should be given to the unpredictable investment climate in terms of frequent regulatory changes, untransparent power dynamics and risk of corruption which conclude a high-risk investment environment. Domestic regulation additionally requires settlement of financial obligations in the volatile Indonesian Rupiah (IDR); risks associated however can be tackled using derivative products from export credit agencies (e.g. the Extended Political Risk Guarantee from JBIC) or currency hedging (Halstead, Mikunda and Cameron 2014, Norton Rose Fulbright 2014, IEA 2023a) (Interview L). Although PLN has historically entered conversion agreements for large-scale projects with banks and sponsors, small projects should not rely on this aid (Linklaters 2022). On project level, the current subsidy system of heavy fossil subsidies present financial challenges to additional project development as renewable sources can hardly compete, despite enjoying subsidies (Rospriandana, et al. 2023) (Interview K). Additional renewable acquisitions present integration challenges for PLN (IEA 2023a).

Financing resources for hydropower projects are primarily structured as blended finance since commercial banks typically view hydropower risks are unattractive (Rospriandana, et al. 2023) (Interview L). Of all blended finance transactions for RE projects in ASEAN, 15% is attributed to hydro developments. Some commercial investors active in the Indonesian market are PLN Batam, Orka Energy, PT International Nickel Indonesia, Brantas Abipraya and groups such as Tamaris Hydro and Medco Energi (Rospriandana, et al. 2023, IEA 2023a). For less commercially attractive projects, development funds such as the Green Climate Fund or the Asian Development Bank take on larger roles in funding, but fund mobilisation takes longer (Interview G, H, L). For other involved financial institutions, see Figure 39. Regional bank support (for example Bank Mandiri) is often required to secure commercial debt financing since local variation in PPAs are not viewed as financially robust enough; due to the elevated regional risk, higher returns will be expected involved (Interview G). Local banks however often have higher cost of capital (Interview B).

In terms of cost considerations, financing costs for hydropower plants remain high despite decreasing renewable technology costs and technology prices of turbines are additionally unlikely to decrease further (Tang, et al. 2019, IEA 2023a) (Interview K). CAPEX, approximating 70% of investment costs, is intensive primarily due to installation costs of the turbine and generator (Rospriandana, et al. 2023, IEA 2022). For OPEX, fuel costs are zero and maintenance and operation costs remain relatively low (IESR 2023, IEA 2022). Micro financial metric overviews, such as the ones presented for the wind power sector in Vietnam and the solar sector in Thailand are unavailable for hydropower in Indonesia so typical CAPEX, OPEX and LCOEs for hydropower projects are listed below.

	Installed costs (CAPEX)	Operations and maintenance costs (OPEX)	Capacity factor	Levelised Cost of Electricity (LCOE)
Unit	*$ USD/kW*	*% per year of installed costs*	*%*	*$ USD*
Large hydropower	1050-7650	2-2.5	25 to 90	0.02-0.19
Small hydropower	1300-8000	1-4	20 to 95	0.02-0.27
Refurbishment/upgrade	500-1000	1-6	-	0.01-0.05

*Figure 42 Indonesia: Typical hydropower CAPEX, OPEX and LCOE (*assuming a 10% cost of capital)*

Source: (IRENA 2012)

The LCOE for Indonesia can be calculated using the tool on the Institute for Essential Services Reform (IESR) website; see https://energycost.id/. From all power generation technologies, coal shows lowest LCOE in Indonesia (see Figure 52 in Appendix B). For large hydropower projects, IESRs calculated LCOE is $7.91 USD/kWh (based on general assumptions of CAPEX of $6.65 USD/kWh, OPEX of $1.26 USD/kWh) (IESR 2022). The relatively long technical lifetime (±80 years) of hydropower facilities drives the LCOE down (IESR 2023, Blume-Werry and Everts 2022). Due to strong regional variances land use costs for plants are not included in calculations.

7.7 Sector specific potential assessment

In theory Indonesia's water resources offer opportunities for hydropower investment, however in reality most suitable hydropower locations for large-scale developments have already been licensed so projects for smaller scale stations are more viable (Tang, et al. 2019) (Interview M). With strong government aims for RE capacity, ambitions paint a favourable picture for incoming investors as illustrated by the recent JETP plans which include opportunities to replace coal-fired plants early by renewable alternatives. Low LCOE of hydropower as reported by IESR suggests attractive investment potential.

These opportunities are challenged however by high country specific risk: natural hazards increase construction risk, climate change reduces future yields, underdeveloped (grid) infrastructure challenges distribution and the complex legislative environment in a bureaucratic nation with high corruption risk poses significant barriers for foreign investments (Interview L). While presenting attractive opportunities in theory, JETP plans exhibit conflicting requirements for project funding and for local equipment use which underscore the complexity of Indonesia's regulatory environment (Draps, et al. 2023): Lengthy permit processes in a bureaucratic nation, limits in local experienced project developers and challenged competitiveness position of renewables against subsidised fossil sources raise significant barriers for investors (ADB 2018, Rospriandana, et al. 2023) (Interview D). The latter is specifically relevant in bottom-of-the-pyramid markets, as affordability is a key driver in energy market domination (see Figure 53 in Appendix B) (Interview J, K).

To tackle the abovementioned challenges, the following steps are recommended for investors:

RECOMMENDATIONS FOR INVESTORS

I. **Push Policy Developments to Leverage JETP Opportunities:** International pressure on RE policy reform should be increased (through initiatives such as COP) to align government ambitions with actionable policies favourable for foreign investors (specifically the JETP), increase regulatory transparency and derisk PPAs for investors (Rospriandana, et al. 2023, Liu, et al. 2019) (Interview F, J). If the regulatory environment has been simplified, foreign investors should make use of JETP plans to replace early retiring coal-fired plants with hydropower plants: in reality however, this will be a lengthy process. In the meantime, partnering with local players can help to navigate Indonesia's bureaucratic complexities to certain extent (ADB 2018, Rospriandana, et al. 2023, WAVTEQ 2017) (Interview J).

II. **Contribute to Grid Infrastructure Development:** If the policy climate improves, investors are recommended to develop grid infrastructure to connect areas with high generation potential with high demand regions (Rospriandana, et al. 2023) (Interview B, D, E, G, H). Once these challenges are tackled, small hydropower facilities can be built in eastern Kalimantan or Papua to supply to higher demand metropolitan regions (Rospriandana, et al. 2023, Liu, et al. 2019, IIPC 2022) (Interview J). Hydropower is crowned as the "Rolls-Royce of renewables": initial investment costs are high but low operating costs present considerable investment potential (Interview M).

III. **Explore Synergies and Alternative Technologies**: To leverage an optimal balance between RE generation and RE storage technologies, investors should invest in research and development into synergies between solar and hydro pumped storage in Indonesia as well as alternative technologies less challenged by location constraints such as floating solar.

8. DISCUSSION

Research results are discussed through comparison of quantitative and qualitative findings as well as comparison of country deep dives. The latter is specified per consideration aspect, geographical and economic potential, RE status and plan, power system, stakeholder assessment, government incentives and legal considerations, and financial climate.

8.1 Data and Research Limitations

Due to data availability constraints (a lack of up-to-date datasets, language barriers and intransparent regulation), conclusions and recommendations must be approached with caution. When technology, location or temporal specific data was unavailable, it was replaced by general data to provide approximation: This was specifically relevant in the case of Indonesia. Since the field of RE is dynamic and sees frequent regulation change, conclusions drawn upon this study should be compared with latest domestic regulations to ensure legal compliance.

Quantitative results from the country suitability ranking were often in line with insights gathered from expert interviews. Aside from the selected countries that were studied in greater depth, both quantitative research, expert findings and desk research indicated great technological potential for wind projects in the Philippines, solar projects in Malaysia and Myanmar. Although qualitative findings often supported up quantitative conclusions, deviations were present: To illustrate, although Singapore was not considered as showing great potential for FDI in RE (due to low ranking on technical RE potential despite showing a great FDI environment), expert findings indicated opportunities for multilateral collaboration for RE projects, such as projects in Indonesian RE generation being exported to Singapore. Qualitative research shed nuance on quantitative findings and considered aspects exempted from the country suitability ranking. The ranking of Regulatory Indicators for Sustainable Energy (RISE) from the World Bank exemplifies this: Indonesia was concluded as suitable for investments from a quantitative perspective however fared lower in the RISE evaluation and was further underscored by desk research. Challenges of crucial aspects impacting FDI potential, such as regulatory transparency, the effect of informal power dynamics and comprehensiveness of government incentives echoed the RISE framework requirements. Considerations of aspects such as these complement quantitative conclusions. In Vietnam's case, high RISE rankings highlight a robust RE system in line with qualitative findings. Thailand's renewable energy sector demonstrates promise with evolving legislative structures and incentives, paving the path for investment.

8.2 Comparison of Countries and Technologies

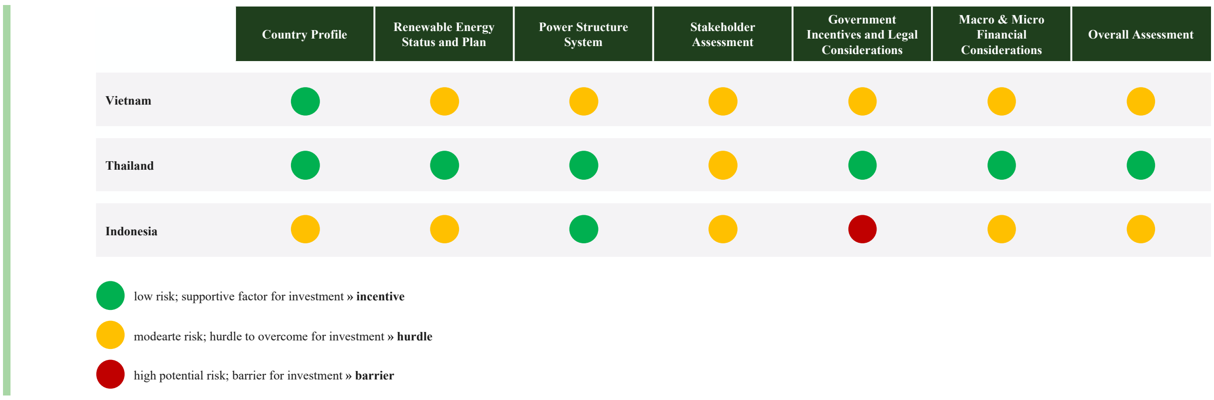


Figure 43 Comparison matrix per consideration aspect

Source: Own figure

Geographically, Vietnam and Thailand have favourable conditions for wind and solar power, respectively, due to their suitable windspeeds and high irradiation levels, alongside low geographical risk. Vietnam, with opportunities in wind development, contrasts with Thailand's potential as a regional energy exchange hub due to its central location and potential for optimal multilateral grid development. Indonesia, facing moderate geological risk, presents domestic opportunities especially with hydropower for its new capital in Kalimantan.

Regarding the status of RE generation and future plans, Vietnam is leading (currently at 58% with ambitions of reaching 32% under expanded capacity plans) with Thailand close behind (currently at 21% with aims of 37%). Indonesia compares with lowest current RE status of 15% share and aims for 25% by 2030.

In all selected countries, power structure systems display a large state-owned party role: PPAs in Vietnam and Indonesia pose risks to investors and financing sources. In Indonesia specifically, PPAs are regionally constructed which adds complexity. Thailand shows a more investor-friendly system through streamlined processes and more favourable PPAs.

In terms of stakeholder environments, all three countries face moderate risks due to bureaucratic complexities and risks of corruption through informal power dynamics. Indonesia shows high levels of bureaucracy in energy project licensing. Vietnam is slightly more attractive for investors when comparing corruption indices; Thailand shows a higher degree of corruption. Supply chain reliance is a common challenge within the general RE landscape, with Vietnam and Thailand being dependent on manufacturing and sourcing from China. Indonesia sees this as well, although some domestic self-reliance in smaller hydro projects is present.

In terms of general FDI regulations, Vietnam shows the most attractive landscape with flexible regulation on local employees; Thailand exhibits stricter regulation on foreign ownership and investors in Indonesia are challenged with local content requirements which impedes funding for recently proposed JETP plans. Government incentives towards actualisation of energy ambitions are untransparent in Indonesia, unspecific to different RE technologies and show frequent changes in pricing schemes which impedes investors from planning long term. Vietnam compares with a history of a stable FiT scheme on wind power until 2021 and new lower FiTs with less favourable conditions for investors. Thailand emerges as only country amongst these three with supportive government incentive landscape and is therefore suggested as favourable location for investors: its government presents comprehensive, stable and technology specific RE policies.

Financially speaking, Vietnam's wind sector offers moderate investment appeal: Despite challenges like currency volatility, high debt costs, and policy uncertainties, the sector's current FiT and offshore wind potential indicate a promising yet cautious investment environment. Thailand's RE sector exhibits low to moderate financial risk, bolstered by stable macroeconomic factors and favourable sovereign debt ratings, marking it an attractive investment destination. Indonesia's hydropower sector faces complications in project funding due to high investment risks, high initial project costs and its challenging competitive position in the power generation climate due to a strong fossil subsidy system.

8.3 Recommendation

To conclude, based on comparison of RE investment opportunities between wind power in Vietnam, solar power in Thailand, and hydropower in Indonesia, Thailand is suggested as the most attractive investment option for FDI relative to the other selected countries. It must be noted that risk appetite for investments differs amongst investors; however, this thesis assumes a moderate appetite for risk. Thailand distinguishes itself with a relatively low-risk and investor-friendly power system, open to foreign parties; Vietnam contrasts with challenges in its fully government-owned grid and riskier PPAs that allocate significant costs to investors. Indonesia shares these PPA risks and additionally presents complications in funding and strict material regulations. Stable and solar specific RE policies in Thailand present investors with a clear path and open door to investment opportunities, while strict material regulations and the lack of attractive subsidy schemes in Indonesia and the recently changed and less attractive FiT scheme in Vietnam decreases country attractiveness. Thailand’s relatively stable macroeconomic climate and the relative ease of deployment of solar technology complement the abovementioned arguments (Interview K). This strategic advantage should be leveraged by investors looking to capitalize on the growing RE demand in ASEAN.

9. CONCLUSION

This study has assessed FDI constraints and incentives in selected ASEAN-10 countries to conclude opportunities for investments in RE: Through combining a quantitative country selection based on macroeconomic and technical indicators with qualitative expert interviews and desk research, it has contextualised key aspects detailing investment attractiveness of ASEAN's unique domestic markets for investors and decision-makers. From selected countries, study findings indicate most attractive investment opportunities for solar power developments in Thailand, followed by wind projects in Vietnam and concluded with hydropower development in Indonesia. Developing government regulations prevail as general barrier for FDI in the selected nations. Findings additionally underscore the importance of collaborating with local partners and understanding the regional regulatory framework thoroughly to navigate these markets. In having done so, it has concluded 3 recommendations for future research:

- *Feasibility of Super Grid:* To optimise regional generation and take an overarching perspective on RE strategy, investing the feasibility and opportunities of a multilateral ASEAN grid is suggested. For a current overview on cross-border transmissions and initiatives, see Figure 54 and Figure 55 (Appendix B) (Interview D, H).
- *Social Considerations*: To critically assess social implications of the energy transition and view project success through an alternative lens of social impact, strategies to "reach the last mile" (off-grid opportunities), alternative energy approaches (e.g. clean cooking solutions), initiatives on RE technology education in developing markets and roles of social impact investing can be studied further (Interview K, L).
- *Alternative Risk Transfer Methods:* To secure a functional risk transfer in the future, alternative risk transfer methods such as RE project specific insurance options can be explored further to enhance accessibility and affordability of renewable energy projects (Interview A).

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APPENDICES

Appendix A1: List of Abbreviations

$ USD	United States Dollars	**kWh**	Kilowatt Hours
ACB	Asia Commercial Bank	**Lao PDR**	Laos People's Democratic Republic
ACE	ASEAN Centre for Energy	**LCOE**	Levelized Cost Of Energy
ADB	Asian Development Bank	**LCR**	Local Content Requirements
AEC	ASEAN-10 Economic Community	**LCY**	local currency
AEDP 2018	Alternative Energy Development Plan 2018-2037	**MEA**	Metropolitan Electricity Authority
APAEC	ASEAN Plan of Action for Energy Cooperation	**MENR**	Minister Of Energy And Mineral Resources
APG	ASEAN Power Grid	**MOIT**	Ministry of Industry and Trade
ASEAN	Association of Southeast Asian Nations	**MW**	Megawatt
ASEAN-10	ASEAN Member States	**MWh**	Megawatt Hours
BIDV	Bank for Investment and Development of Vietnam	**NDC**	Nationally Determined Contribution
C&I	commercial and industrial	**ODA**	Official Development Assistance
CPI	Corruption Perception Index	**PDP 2018**	Power Development Plan 2018
CPV	Communist Party of Vietnam	**PDP 7**	Power Development Plan 7
DPPA	Distributed Power Purchase Agreements	**PDP 8**	Eighth National Power Development Plan
EGAT	Electricity Generation Authority of Thailand	**PEA**	Provincial Electricity Authority
EMI	Energy Market Integration	**PLN**	Perusahaan Listrik Negara (State-Owned Electricity Distributor)
ERC	Energy Regulatory Commission	**PPA**	Power Purchase agreement
ETS	Emissions Trading Scheme	**PV**	Photovoltaic
EU	European Union	**PVOUT**	Photovoltaic Power Output
EVFTA	EU-Vietnam Free Trade Agreement	**RCEP**	Regional Comprehensive Economic Partnership
EVN	Electricity Vietnam	**RE**	Renewable Energy
FDI	Foreign Direct Investment	**REPP**	Renewable Energy Power Plants
FiT	Feed-in-Tariffs	**RISE**	Regulatory Indicators For Sustainable Energy
GHG	Green House Gas	**ROI**	Return On Investment
GJ	Gigajoules	**RUPTL**	Plan For Provision Of Electricity (Indonesia)
GOI	Government Of Indonesia	**SDG**	Sustainable Development Goal
GW	Gigawatt	**SPP**	Small Power Producer

IDR	Indonesian Rupiah	**TFEC**	Total Final Energy Consumption
IEA	International Energy Agency	**THB**	Thai Baht
IESR	Institute for Essential Services Reform	**TWh**	Terrawatt Hours
IHA	International Hydropower Association	**UNCTAD**	United Nations Conference on Trade and Development
IPCC	Intergovernmental Panel on Climate Change	**US**	United States
IPP	Independent Power Producer	**VDB**	Vietnam Development Bank
IRENA	International Renewable Energy Agency	**VND**	Vietnamese Dong
JETP	Just Energy Transition Partnership	**VSPP**	Very Small Power Producer
kW	Kilowatt		

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Appendix B: Assorted Figures

Topic	Sources
Feed-in tariffs and subsidy schemes	Sovacool (2010), Chua et al. (2011), Keyuraphan et al. (2012), Tongsopit and Greacen (2013), Pacudan (2014, 2018), Hasudungan and Sabaruddin (2018)
The impact of renewable energy on energy security	Sovacool and Bulan (2011, 2012), Shamsuddin (2012), Brahim (2014), Kumar (2016), Chunark et al. (2017), Liu et al. (2017), Bekhet and Othman (2018)
Scenarios, planning, and the potential utilization of renewable energy	Nguyen (2007a), Gan and Li (2008), Adhikari et al. (2008), Ong et al. (2011), Hasan et al. (2012), Roxas and Santiago (2016)
Resource and economic potential of renewables	Sadettanh (2004), Nguyen (2007b), Nguyen and Ha-Duong (2009), Malik (2011), Chua and Oh (2012), Ali et al. (2012), Siala and Stich (2016), Pacudan (2016), Tun (2019), Tuna and Tuna (2019), Salam et al. (2019)
Modeling of ASEAN power grids/electricity markets	Chang and Li (2013), Huber et al. (2015), Ahmed et al. (2017a, b), Ralph and Hancock (2019)
Modeling of various renewable energy resources for electricity production	Ahmad and Tahar (2014)
Cost–benefit analyses and business models for renewable energy	Tongsopit et al. (2016), Nguyen et al. (2019), Islam et al. 92019)
Renewable energy investment by major oil companies	Chaiyapa et al. (2018)
Electrification of transport	Li and Chang (2019)
Green jobs and clean energy sector employment	Sharpe and Martinez-Fernandez (2021)
Installation and operational and maintenance costs of photovoltaic solar (PV) projects in Brunei, Indonesia, the Philippines, and Vietnam	NREL (2019)

Figure 44 ASEAN: Selected topics discussed in energy transition literature

Source: (Vakulchuk, et al. 2022)

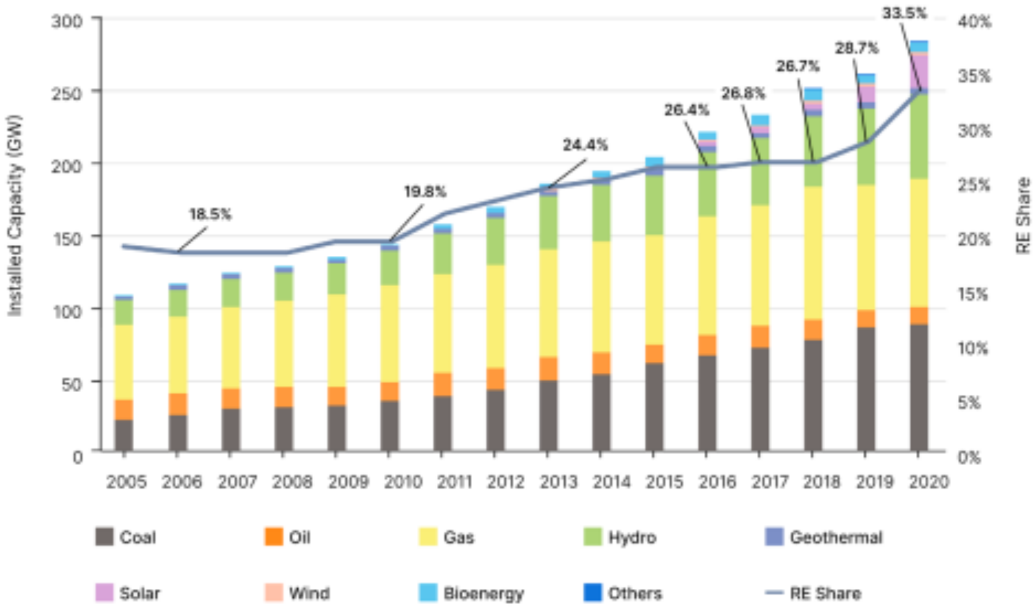

Figure 45 Southeast Asia: Power generation capacity and renewables share

Source: (IEA 2023a)

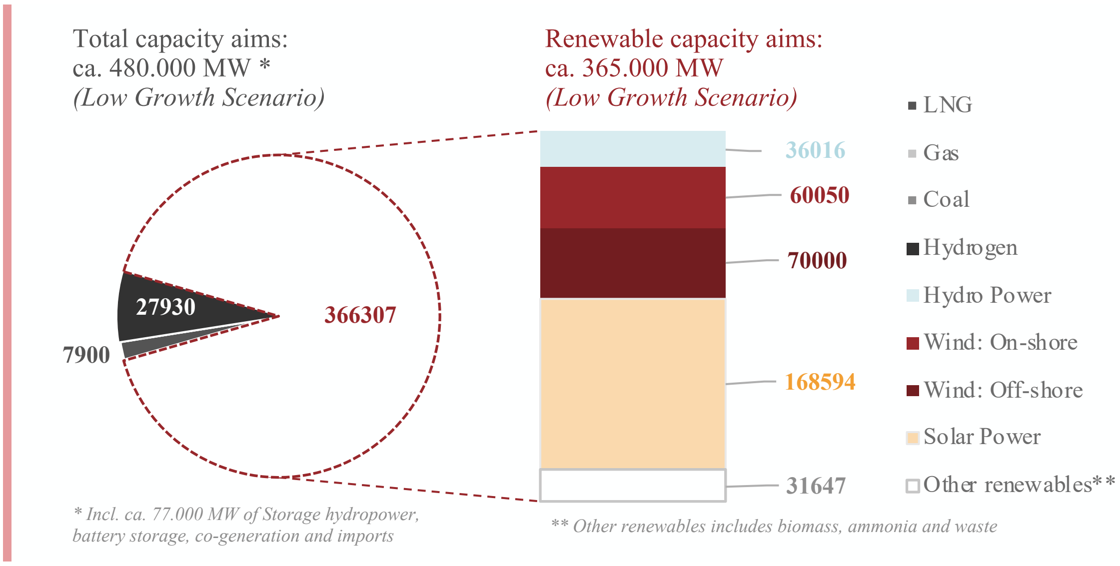

Figure 46 Vietnam: Planned Power Generation Capacity (2050) – Low Growth Scenario

Source: (CMS 2023, British Chamber of Commerce Vietnam 2023, Vietnam Briefing 2023)

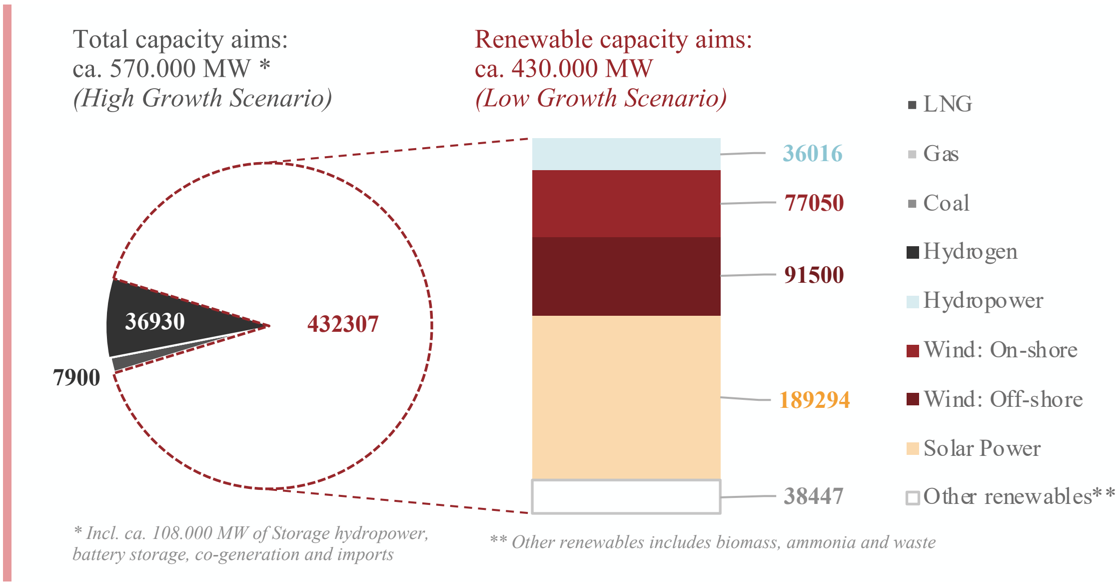

Figure 47 Vietnam: Planned Power Generation Capacity (2050) – High Growth Scenario

Source: (CMS 2023, British Chamber of Commerce Vietnam 2023, Vietnam Briefing 2023)

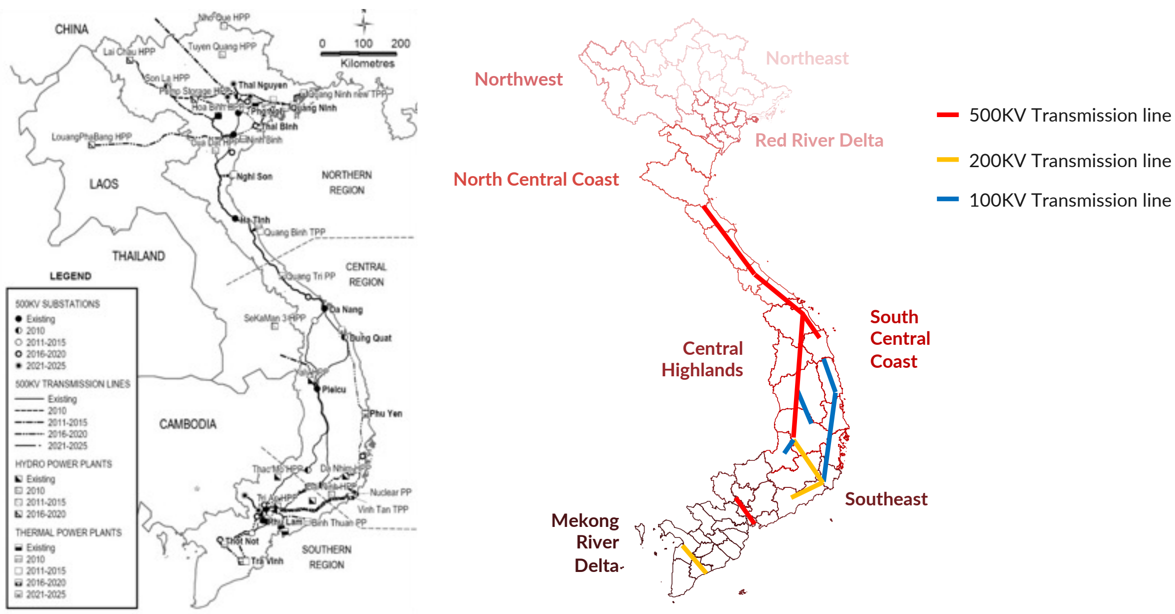

Figure 48 Vietnam: Current Energy Grid

Source: (Pham Khan Toan, Nguyen Minh Bao and Nguyen Ha Dieu 2011)

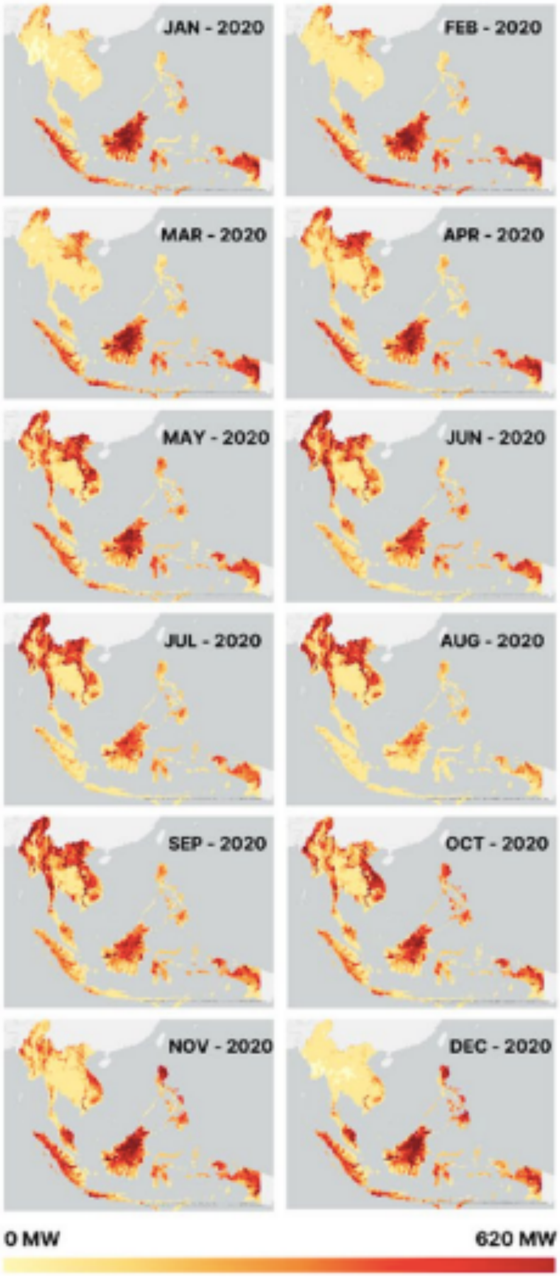

Figure 49 Indonesia: Seasonal hydropower potential, January to December (2020)

Source: (Sakti, et al. 2023)

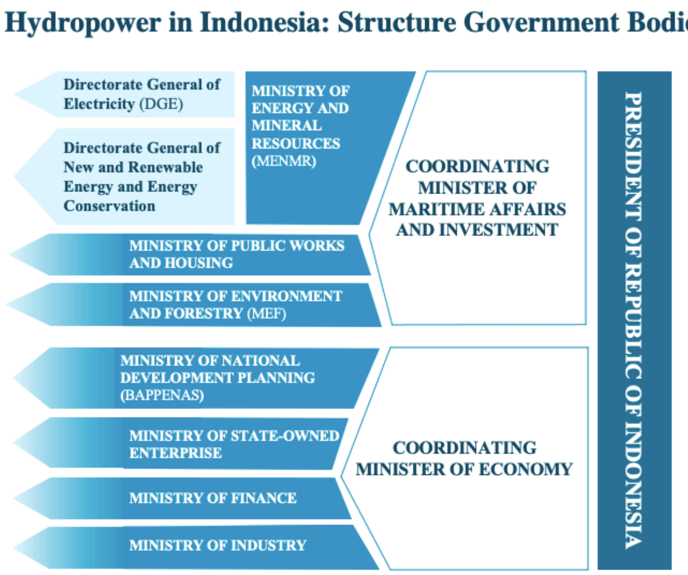

Figure 50 Indonesia: Structure government bodies influencing hydropower projects

Source: Own figure, based on (SIPET 2022, Linklaters 2022, Sepasthika, Sasongko and Muryanti 2023)

No.	Capacity	Highest benchmark price (US cents/kWh)	
		Years 1–10	Years 11–30
1	up to 1 MW	11.23×F	7.02
2	>1 MW up to 3 MW	10.92×F	6.82
3	>3 MW up to 5 MW	9.65×F	6.03
4	>5 MW up to 20 MW	9.09×F	5.68
5	>20 MW up to 50 MW	8.86×F	5.54
6	>50 MW up to 100 MW	7.81×F	4.88
7	>100 MW	6.74×F	4.21

F is the location factor and ranges from 1.0 (Java) to 1.5 (Papua)

Figure 51 Indonesia: Location-dependent ceiling purchase prices for hydropower*

Source: (Rospriandana, et al. 2023)

**Under Presidential Regulation No. 112/2022*

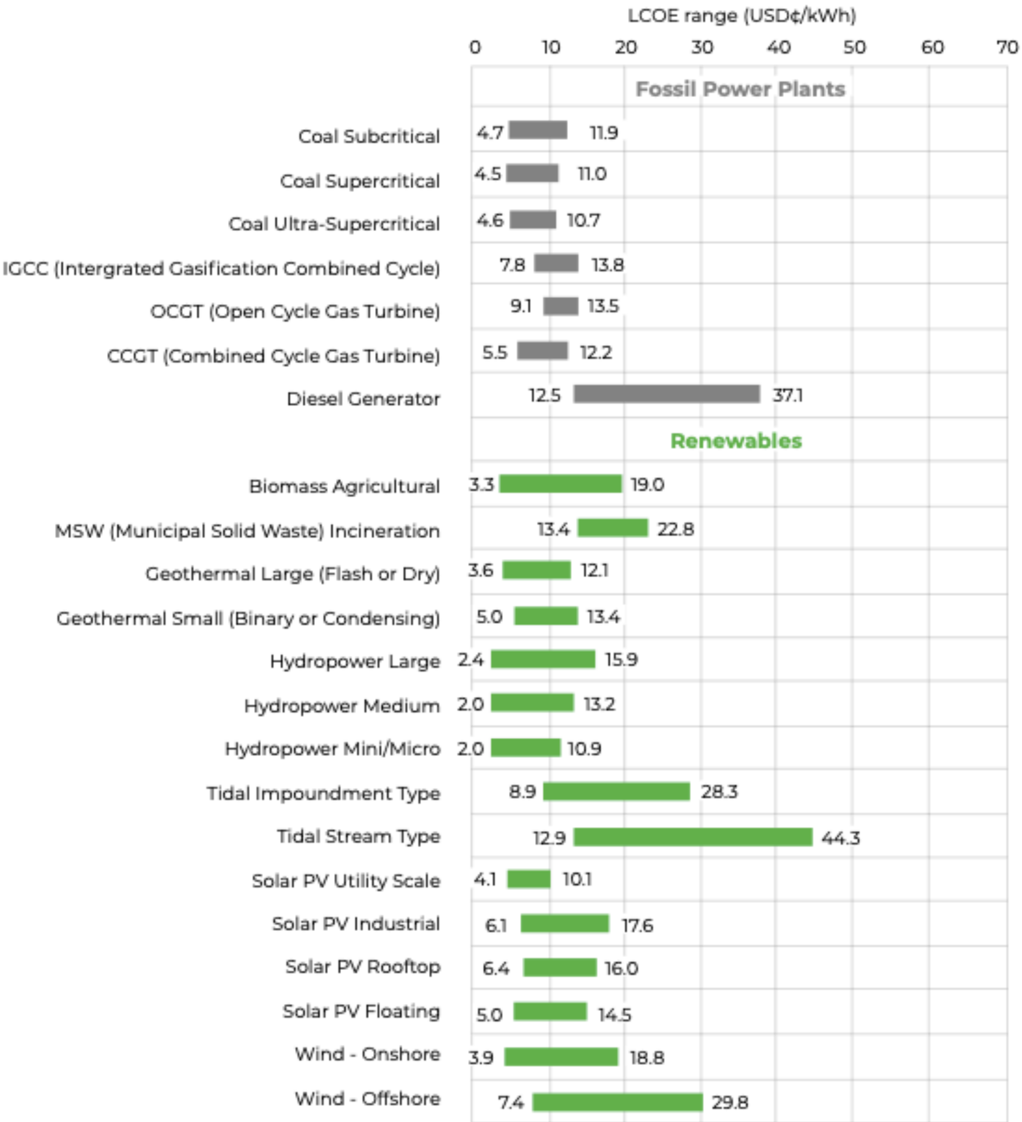

Figure 52 Indonesia: LCOE from selected technologies

Source: (IESR 2023)

Figure 53 Selected ASEAN-10 countries: Electric power affordability

Source: (SIPET 2022)

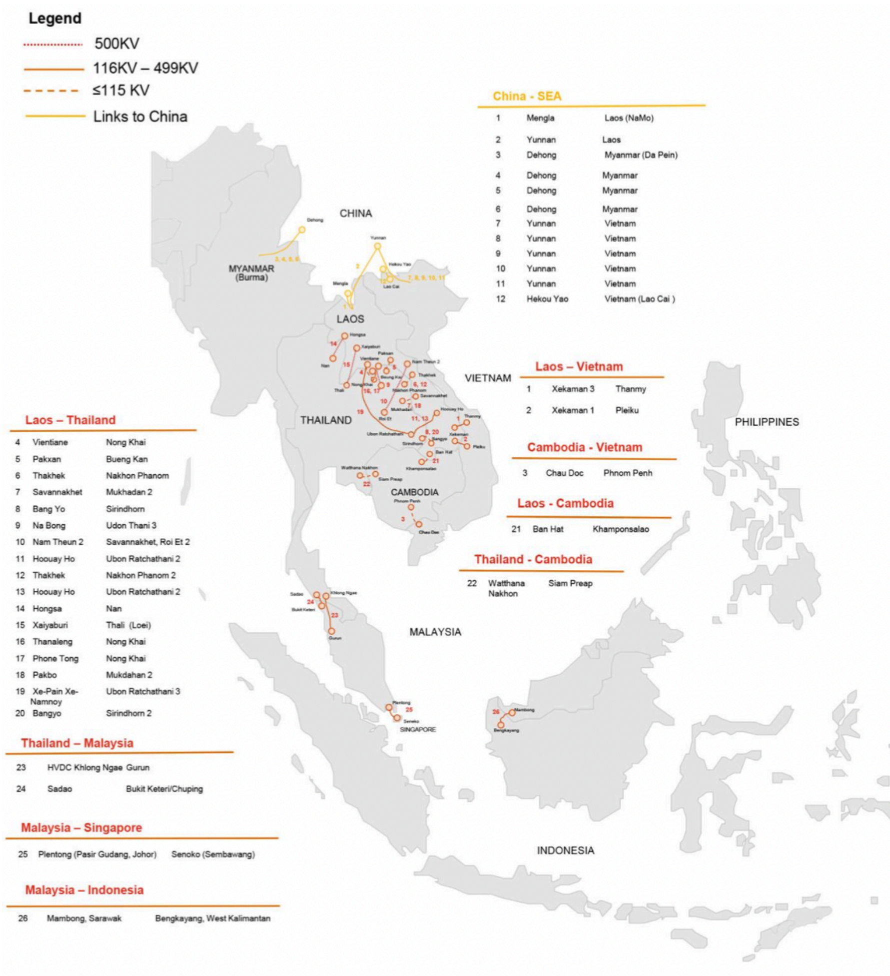

Figure 54 Cross-border transmission between ASEAN countries

Source: (PwC 2022)

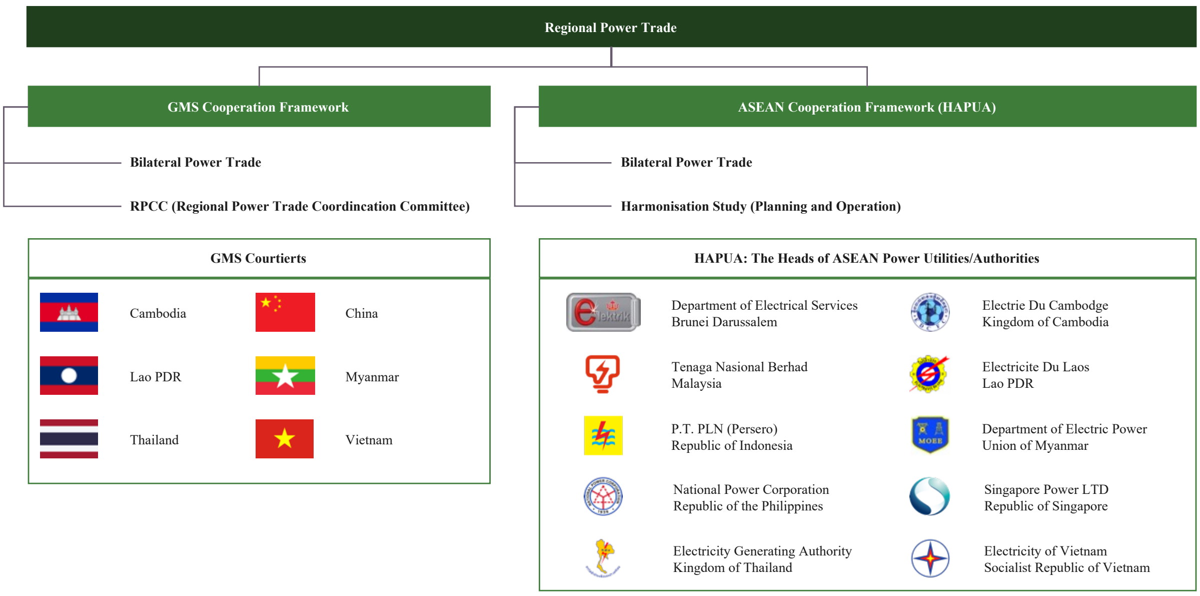

Figure 55 Leading Regional Initiatives for ASEAN Grid Integration

Source: (PwC 2022)

Appendix C1: Indicator Overview

Ranking	Factor	Indicator	*Unit*	Year	Source
FDI POTENTIAL	Economic Indicators	GDP per capita	*US$*	2021	(Statista 2021a)
		GDP per capita: Growth (projected)	*% growth compared to base year*	2018-2028	(Statista 2021a)
		Inflation Rates (Year-on-Year Average)	*%*	2022	(ASEAN 2022)
		Flows of Inward FDI	*Million $ USD*	2022	(ASEANStatsDataPortal 2022)
	Human Capital	Labour Force Participation Rate	*%*	2020	(ASEAN Secretariat 2021)
		Unemployment rate	*% working population*	2020	(ASEAN Secretariat 2021)
		Population aged 25-60	*% total population*	2021	(Statista 2021b)
		Average Annual Rate of population change	*%*	2020-2025	(UN Department of Economic and Social Affairs 2022)
		Literacy rate, adult total	*% of people ages 15 and above*	2021	(The World Bank 2022e)
		Gross enrolment ratio for tertiary education	*%*	2018-2023	(The World Bank 2022e)
	Infrastructure and Energy Indicators	Infrastructure: road network total length	*Kilometres (km)*	2009-2017	(The World Factbook 2021b)
		Energy Consumption total	*Tera Joules (TJ)*	2020	(IEA 2020b)
		Renewable electricity generation	*% of total electricity generation*	2020	(ASEAN-German Energy Programme (AGEP) 2022)
		Renewable electricity generation *(total)*	*Megawatt (MW)*	2022	(ASEAN-German Energy Programme (AGEP) 2022)
		Electrification Rate	*%*	2020	(ASEAN Centre for Energy 2023b)
		Energy Consumer Price Inflation	*%*	2022	(The World Bank 2023a)
	Government Ambitions	Government goals: share renewable of total energy by 2035	*%*	2025-2035	Multiple sources (see attachment)

SECTOR POTENTIAL

	Government Paris Agreement ambitions: NDC contributions (unconditional of international finance and technical support)	*% reduction in GHG emissions by 2030 from Business-as-Usual Case*	2020-2022	(UN Climate Change 2022)
Country Risk	Ease of doing business	*Ranked 1 to 191*	2020	(The World Bank 2019)
	Political instability (perceptions of the likelihood of political instability)	*% ranked to other countries*	2021	(The World Bank 2022a)
Solar Energy	Technical Exploitable Capacity of Solar Energy	*Gigawatt (GW)*	2019	(ASEAN Centre for Energy 2023a)
	Specific photovoltaic power output (PVOUT)	*kWh/kWp*	2018	(Global Solar Atlas 2023)
	LCOE of Solar PV	*US$/MWh*	2020	(Global Solar Atlas 2023)
	Installed Capacity of Solar Power	*Megawatt (MW)*	2020	(Sreenath, et al. 2022)
Hydro Energy	Technical Exploitable Capacity of Hydro Power	*Gigawatt (GW)*	2022	(IRENA 2022b)
	Precipitation levels	*mm per year*	2020	(The Global Economy 2020)
	LCOE of Hydro Power	*Average US$/KWh*	2019	(ASEAN Centre for Energy 2019)
	Installed Capacity of Hydro Power (*including pumped storage)	*Megawatt (MW)*	2022	(IHA 2022)
Wind Energy	Technical Exploitable Capacity of Wind Power	*Gigawatt (GW)*	2021	(ASEAN Centre for Energy 2023c)
	Exploitable Capacity Utilisation Hours	*Annual average hours*	2021	(ASEAN Centre for Energy 2023c)
	LCOE of Wind power	*Average of US$/KWh*	2021	(ASEAN Centre for Energy 2023c)
	Installed Capacity of Wind Power	*Kilowatt (KW)*	2019	(ASEAN Centre for Energy 2023c)

Appendix C2: Indicator Justification – FDI Potential

Category	Indicator	Justification
Economic Indicators	GDP per capita	GDP per capita is a pivotal metric for gauging a country's FDI potential in renewable energy, indicating economic stability and market readiness. It correlates with the quality of infrastructure and policy environment supporting renewables, as evidenced by its association with economic growth and FDI influx. A higher GDP per capita also suggests a market with sufficient purchasing power for RE adoption, serving as a reliable benchmark for investment decisions (Encinas-Ferrer and Villegas-Zermeño b 2015).
	GDP per capita: Growth (projected)	Projected GDP per capita growth is a crucial indicator, as it signals future economic health and market growth. This foresight aligns with the World Bank's analysis, which underscores the importance of growth alongside human capital and financial systems to maximize FDI's impact on development. Furthermore, as economies grow, as per Khan and Rehan (2020), so does energy demand, which can spur RE investments. Hence, this indicator helps investors pinpoint countries with both immediate and long-term growth prospects for RE expansion (Benetrix, Pallan and Panizza 2023).
	Inflation Rates (Year-on-Year Average)	Inflation can significantly impact investment decisions, as it affects purchasing power, costs, and expected returns. According to research inflation is a major concern for businesses and investors due to its potential to erode investment value and increase uncertainty in long-term planning. High inflation may deter FDI by creating an unstable economic environment, whereas moderate inflation can indicate a growing economy with increasing consumer spending, which may drive demand for energy, including renewable sources. Therefore, monitoring inflation rates is essential for investors to evaluate the economic stability and risk associated with FDI in RE projects (Tafekman 2022).
	Flows of Inward FDI	Inward FDI flows reveal investment trends and investor confidence, reflecting the economic allure and potential of a host country. Steady growth in FDI suggests a dynamic economy with promising prospects, essential for RE sector confidence. For Southeast Asia, this analysis pinpoints successful investment-attracting countries and effective policies, informing strategic FDI planning in renewables (Saini, Madan and Batra 2016)
Human Capital	Labour Force Participation Rate	A high labour force participation rate signals a country's capacity to supply a skilled workforce for industries like renewable energy, which is labour-intensive for installation and maintenance. This robust workforce attracts FDI by ensuring local human resource availability, which can decrease reliance on expatriate staff and cut costs. In Southeast Asia, varying labour participation rates serve as a barometer for human capital readiness in RE investments (Finkelstein Shapiro 2018).
	Unemployment rate	The unemployment rate is a double-edged sword; it may indicate a pool of available labour but can also reflect on the economic stability of a country. High unemployment can deter FDI due to concerns over purchasing power and domestic demand, whereas low unemployment in a growing economy suggests a competitive environment with a skilled labour market. For the RE sector, which benefits from both skilled and unskilled labour, the unemployment rate can influence the cost-effectiveness and feasibility of investments (Nashohah and Yuliana 2019).
	Population aged 25-60	The demographic composition of a country, particularly the proportion of the population within the working age of 25-60, is a significant determinant of economic dynamism and labour market resilience. This age group typically encompasses the most productive and economically active citizens whose employment directly correlates with consumption patterns and economic growth. In the context of renewable energy, a larger working-age population may promise a sustainable consumer base and a skilled workforce, which are key factors in attracting FDI (Piven and Kubatko 2023).
	Average Annual Rate of population change	Population growth rates are reflective of market expansion potential and the long-term sustainability of economic development. A growth rate may signal a burgeoning market with increasing labour and consumer bases, which is attractive for FDI in sectors like RE that require substantial initial investments with long-term returns. Conversely, negative growth can suggest market contraction, potentially affecting the viability of long-term investments (Crenshaw, Ameen and Christenson 1997).
	Literacy rate, adult total	Literacy rates are often correlated with the level of human capital development. High literacy rates suggest a well-educated workforce capable of adapting to advanced

		production techniques and innovation, which is particularly pertinent in the technology driven RE sector. For Southeast Asian countries, literacy rates can highlight the potential for sophisticated, knowledge-based economic activities and the effective implementation of complex RE projects (Ayhan 2019).
	Gross enrolment ratio for tertiary education	The gross enrolment ratio for tertiary education is an indicative measure of a country's educational attainment. Higher education levels typically correlate with greater awareness and understanding of RE benefits, which can foster a more receptive environment for such initiatives. The referenced study on the impact of RE in West Africa illustrates that education not only promotes the adoption of renewable technologies but is also crucial for the innovation and implementation of these projects. By assessing the gross enrolment ratio, one can gauge the potential workforce's skill level and the public's readiness to support RE development, making it a valuable indicator for FDI potential in this sector (Mihaela 2016).
Infrastructure and Energy Indicators	Infrastructure: road network total length	The extent and quality of a country's infrastructure, including its road network, are fundamental to the efficiency of business operations and the movement of goods and services. For the RE sector, adequate infrastructure is essential for the construction and maintenance of energy projects as well as the distribution of generated power. A well-developed road network can significantly reduce logistical costs and operational risks, thereby enhancing the region's attractiveness RE FDI (Jeevaratnam 2019).
	Energy Consumption total	Total energy consumption is a proxy for industrial activity and economic development. In the context of RE FDI, high energy consumption may indicate a market with substantial demand, which is an opportunity for investment in alternative and sustainable energy sources. Energy consumption patterns can provide insights into the current energy mix and the potential for RE market penetration (Muhammad, et al. 2021).
	Renewable electricity generation	The percentage of electricity generated from renewable sources is a direct indicator of a country's commitment to sustainable energy practices and the maturity of its RE sector. A higher percentage suggests a favourable regulatory environment and market readiness for RE investments. For investors, this indicator helps assess the risk and potential return on investment in Southeast Asia's RE landscape (Barasa Kabeyi and Akanni Olanrewaju 2022).
	Renewable electricity generation (total)	Renewable electricity generation capacity in MW signals a country's market size and growth potential for renewable energy, influencing FDI. High capacity indicates a developed market with existing investments and a commitment to sustainable energy, which can attract more FDI. This figure is critical for evaluating the impact of renewable policies and the future potential for energy security and sustainability (Barasa Kabeyi and Akanni Olanrewaju 2022).
	Electrification Rate	The electrification rate, indicating the percentage of a population with access to electricity, serves as a gauge for a country's technological progress and potential to adopt new energy technologies. High electrification suggests a market ready for RE integration, while lower rates highlight areas ripe for investment in modern, off-grid solutions. For FDI, this rate helps identify where RE projects can be most effectively implemented, aligning investment with both infrastructure needs and technological advancement opportunities (Barasa Kabeyi and Akanni Olanrewaju 2022).
	Energy Consumer Price Inflation	Energy Consumer Price Inflation is a critical indicator for REFDI, reflecting how energy cost volatility impacts the economic viability of projects. In Southeast Asia, where energy dynamics are pivotal, this measure helps investors gauge the stability of energy prices and the potential impact on returns. The noted causality between increased electricity consumption and inflation, which can erode consumer purchasing power, emphasizes the need for FDI strategies that consider long-term energy cost trends and their macroeconomic effects (Gatzert and Vogl 2016).
Government Ambitions	Government goals: share renewable of total energy by 2035 Government Paris Agreement ambitions: NDC	The government's target for the share of renewables in total energy by 2035 is a potent indicator of a country's commitment to sustainable energy policy, which is crucial for attracting FDI in renewable energy. Such targets, especially when aligned with international frameworks like the Paris Agreement, signal a country's long-term dedication to transitioning towards renewable energy, often backed by supportive policies, incentives, and regulatory measures. The study by Emodi and Ebele (2016) reinforces this view, showing that government policies are decisive in either fostering or impeding RE growth,

	contributions (unconditional of international finance and technical support)	highlighting the importance of policy clarity for investment decisions in this sector (Emodi 2016).
Country Risk	Ease of doing business	The ease of doing business ranking is a composite indicator reflecting the regulatory environment of a country and is a critical consideration for FDI. A higher ranking indicates simpler regulations and stronger protections for businesses, which can significantly reduce entry barriers and operational risks for foreign investors. In the RE sector, where investments are often large-scale and long-term, a favourable business environment in Southeast Asian countries can be a decisive factor for attracting FDI (Bayraktar 2014).
	Political stability (perceptions of the likelihood of political instability)	Political stability is a fundamental indicator, as it reflects the risk associated with the potential for political upheaval, which can affect investment returns and operational continuity. A country perceived as stable is more likely to attract FDI, as stability is synonymous with predictability in investment climates. The ranking provides a comparative measure of the country's investment risk profile. The meta-analytic review supports the theory that institutional factors, including political stability, are significant determinants of FDI attractiveness, as they assure investors of a secure environment for their investments. In Southeast Asia, a region marked by diverse political landscapes, this indicator is particularly salient for investors who are seeking to minimize risks associated with political disruption (Bailey 2017).

Appendix C3: Indicator Justification – Sector Potential

Category	Indicator	Justification
Solar Energy	Technical Exploitable Capacity of Solar Energy	The Technical Exploitable Capacity (TEC) of Solar Energy is a vital indicator for gauging the potential solar power generation of an area, factoring in technical feasibilities. Advanced methodologies like LiDAR and GIS are instrumental in this assessment, as detailed by Vancho Adjiski, et al., providing precise data on suitable surfaces for photovoltaic installations. This approach is essential for urban planning, policymaking, and promoting solar investments. The National RE Laboratory (NREL) supports this with guidelines that consider environmental and topographic data to estimate solar capacity accurately. Such technical evaluations are crucial for ensuring that solar energy investments are both practical and beneficial, offering a solid basis for strategic energy planning and development (NREL Technical Report) (Adjiski, Kaplan und Mijalkovski 2023).
	Specific photovoltaic power output (PVOUT)	The Specific Photovoltaic Power Output (PVOUT) is an efficiency metric for solar photovoltaic (PV) power plants. It indicates the energy output per unit of installed capacity, reflecting how well a plant converts solar energy into electrical energy. The study by S. C and M. Kumar M V on a 50-kW grid-connected PV power plant underscores the utility of PVOUT as a benchmark for plant performance, including daily yield and capacity utilization factor. By evaluating PVOUT, stakeholders can determine a solar plant's operational effectiveness, guiding investment and operational decisions to optimize energy production and financial returns. This indicator is crucial for investors and operators to assess and compare the productivity of solar installations across different regions and technologies (Sarannya und Manoj Kumar 2021).
	LCOE of Solar PV	The Levelized Cost of Energy (LCOE) of Solar PV encapsulates the average cost to generate a unit of electricity, incorporating all the expenses over the system's lifetime. This includes the costs of construction, operations, maintenance, and the total energy produced. The LCOE is a comprehensive measure of the competitiveness of different electricity generation sources, including solar PV. According to the ASEAN Centre for Energy and the China RE engineering Institute (2021), the LCOE is an essential financial metric for assessing the viability and performance of solar energy projects within the ASEAN region. It allows for an apples-to-apples comparison of solar energy costs with other energy sources by accounting for the economic, production, and maintenance parameters over the entire lifespan of a solar project. This metric is particularly useful for policymakers and investors when making informed decisions about developing new solar energy capacities (National Renewable Energy Laboratory (NREL) 2020).
	Installed Capacity of Solar Power	The Installed Capacity of Solar Power is a direct indicator of the scale at which a country or region has adopted solar energy. It reflects the cumulative capacity of all solar PV installations, including both large-scale power plants and smaller, distributed generation projects. The paper by Aditya Pandey, et al. offers an overview of solar energy's role in India, highlighting installed capacity as a measure of the country's commitment to embracing solar power and its readiness for future growth in this sector. The installed capacity is a crucial metric for understanding current capabilities and for planning expansion to meet increasing energy demands sustainably. It serves as a benchmark for the progress made in the solar industry and is indicative of the potential for technological advancement and economic opportunity within the RE market (Pandey, Pandey und Tumuluru 2022).
Hydro Energy	Technical Exploitable Capacity of Hydro Energy	The Technical Exploitable Capacity (TEC) of Hydro Energy in gigawatts (GW) assesses the potential for hydropower generation, factoring in technical possibilities and environmental limits. Research on high-head storage hydropower underscores the importance of balancing energy production with ecological impacts, using models that consider water availability, technical capacity, and economic factors like LCOE. This approach is crucial for sustainable hydropower development, guiding investment towards environmentally responsible and economically feasible projects (Bieri 2012).
	Precipitation levels	Annual precipitation levels are vital for hydropower potential, as they determine water availability for electricity generation. More rainfall means higher water flow and reservoir capacity, crucial for hydropower output. This data guides investment and infrastructure development, ensuring sustainable water and energy management in the hydropower sector (Rajakaruna, Ghosh und Holmatov 2017).

	LCOE of Hydro Power	The Levelized Cost of Energy (LCOE) for Hydropower is a comprehensive metric that encapsulates the total cost of building, operating, and maintaining a hydropower plant over its expected life. It divides this sum by the total electricity the plant is expected to produce, providing a clear picture of the economic competitiveness of hydropower. The ASEAN Centre for Energy and the China RE engineering Institute (2021) highlight the LCOE as a critical factor in evaluating the lifecycle costs of hydropower projects, which includes assessing economic feasibility, production efficiency, and ongoing operational expenses. This figure is instrumental for investors and policymakers in determining the viability of hydropower in comparison to other energy sources, ensuring that financial planning for energy projects is grounded in a thorough understanding of long-term economic implications (National Renewable Energy Laboratory (NREL) 2020).
	Installed Capacity of Hydro Power (*including pumped storage)	The Installed Capacity of Hydropower, including pumped storage quantifies the total potential output of hydropower systems. The study by Mitri and Anderson illustrates the importance of pumped storage in enhancing power system reliability and meeting peak demands, which is critical for assessing a country's hydropower capacity. This capacity reflects not just current energy production but also the ability to manage demand fluctuations, making it a key metric for evaluating the robustness of hydropower infrastructure (Frederick und Kevin 2023).
Wind Energy	Technical Exploitable Capacity of Wind Energy	The viability of wind energy projects hinges on understanding key indicators such as the Technical Exploitable Capacity (TEC), which assesses the technical and economic feasibility of generating electricity from wind. Complementing TEC, the Levelized Cost of Energy (LCOE) for Wind Power calculates the total cost over a project's life against the electricity produced, offering a metric for economic comparison. Meanwhile, Exploitable Capacity Utilization Hours measure a wind plant's operational efficiency, reflecting the real-world performance of turbines given the variability of wind and technological efficiency. A techno-economic study on South Korea's wind energy potential illustrates the interplay of these indicators, emphasizing their collective importance in evaluating the realistic potential, operational performance, and financial prudence required for the strategic development of wind power systems (Sajid, Lee und Jang 2017).
	Exploitable Capacity Utilisation Hours	
	LCOE of Wind power	
	Installed Capacity of Wind Power	The Installed Capacity of Wind Power is a fundamental indicator of the current extent and potential scalability of wind energy within a power grid. It represents the total capacity of all wind turbines installed and ready to generate electricity. The referenced research on the techno-economic benefits of a global energy interconnection underscores the significance of installed capacity. It highlights how a robust installed capacity can capitalize on the vast resource potential of wind energy, providing insights into the scalability challenges and opportunities. By assessing installed capacity, policymakers and investors can gauge the maturity of the wind energy sector and its readiness to meet energy demands, contribute to energy security, and support the transition to a low-carbon economy (Wang, et al. 2021).

Appendix D: Graphic overlays of FDI versus Sector Specific Potential

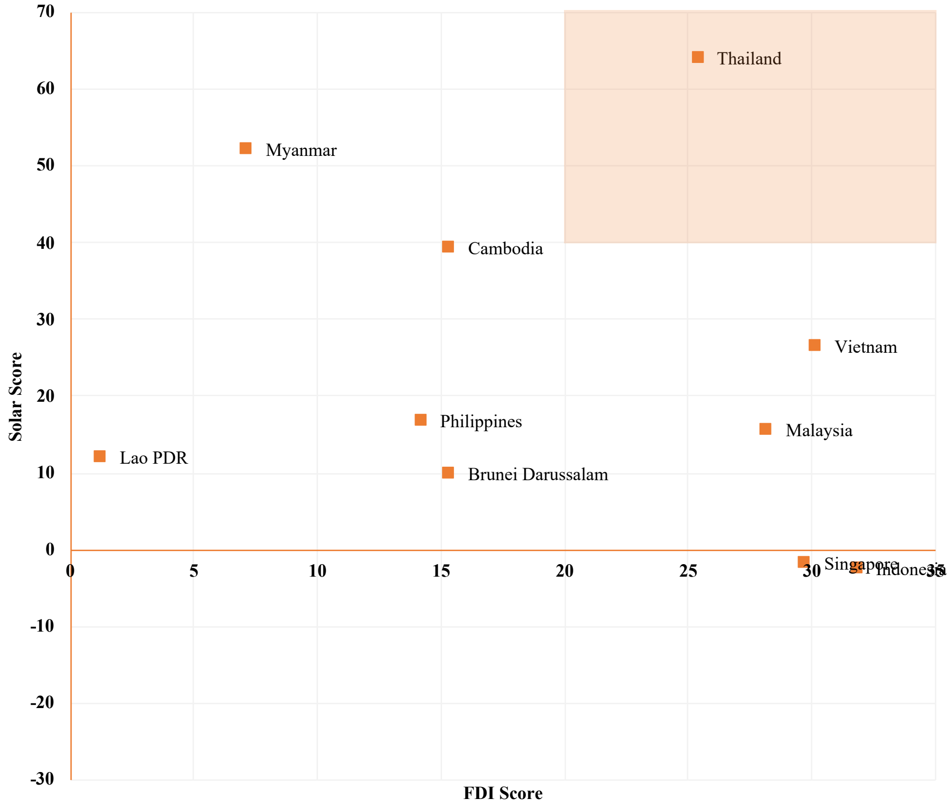

Figure 56 Graphic Overlay: FDI versus Solar potential

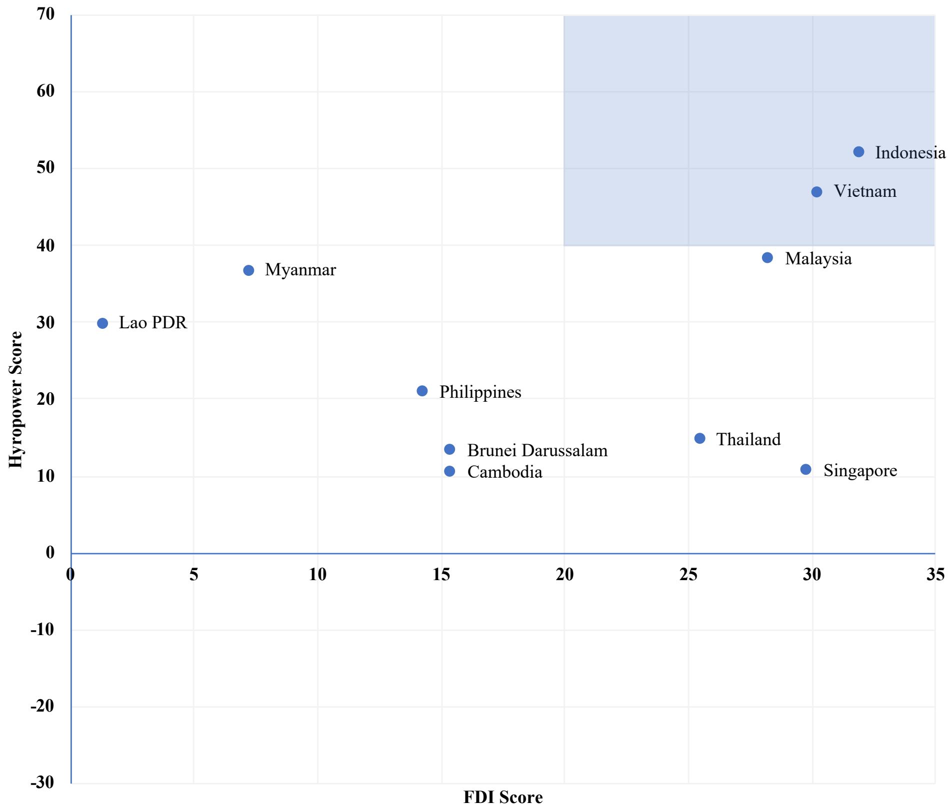

Figure 57 Graphic Overlay: FDI versus Hydro potential

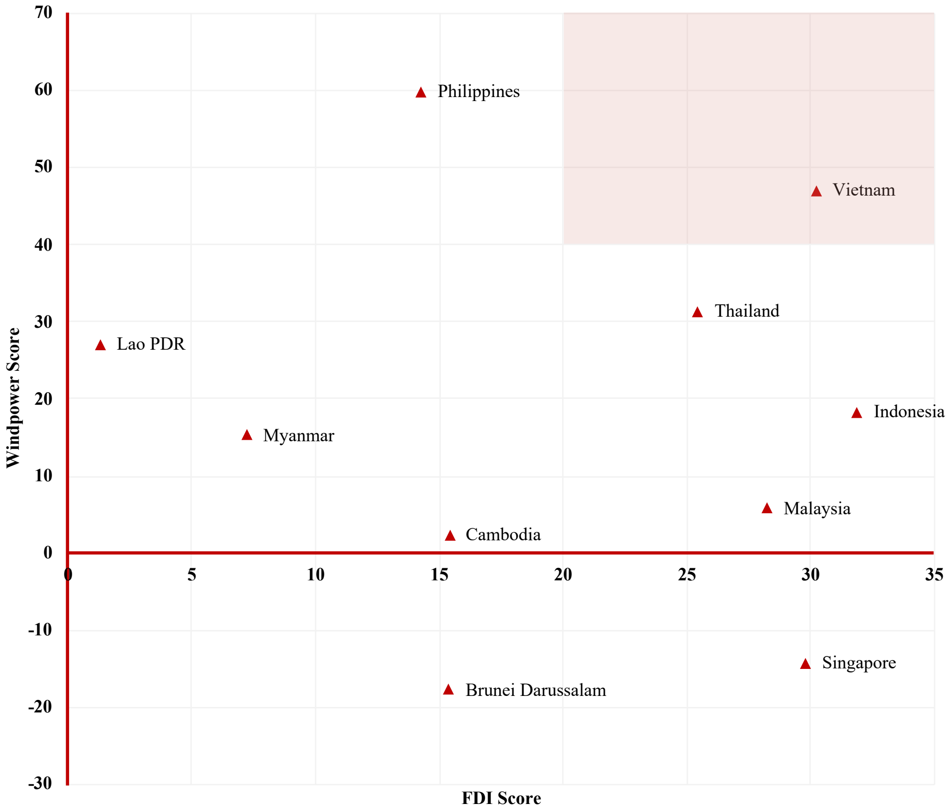

Figure 58 Graphic Overlay: FDI versus Wind potential

Appendix E1: Interview Structure Guideline

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INTERVIEW GUIDE

Research type: Master thesis for Master of Science in Management

Institution: Nova School of Business and Economics (Lisbon, Portugal)

Research Topic: Exploring the Foreign Direct Investment Opportunities for Renewable Energy in Southeast Asia: An in-depth analysis of ASEAN countries' potential.

Dear Participant,

Thank you for agreeing to participate in our research interview. Your expertise will greatly contribute to our understanding of:

- The Renewable Energy Sector in ASEAN
- The Foreign Direct Investment (FDI) landscape in ASEAN

We have asked you to participate specifically due to your topic relevant knowledge and appreciate any insights you can share. Shared information will solely be used for the thesis research. To structure our topics of interest, a question portfolio is outlined on the next page: Feel free to preview the questions before the interview.

The interview (30min-1h) will take place virtually using Microsoft Teams. Do not hesitate to reach out to any of us with questions or concerns.

We appreciate your participation and are looking forward to learning from your insights!

Best regards,

Sarah Strack,
Eric Möller,
Amélie van Lynden

Prepared for:

Date:

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INTERVIEW QUESTION PORTFOLIO

Introduction (ca. 2 min)

- Welcome, team introduction, interviewee introduction.
- Explanation of the purpose of the interview and research goals.

Background Information (ca. 2 min)

1. Can you briefly describe your professional role and your experience in the renewable energy sector (*if applicable:* in Southeast Asia)?

Renewable Energy Landscape in ASEAN (ca. 8 min)

2. How is the renewable energy landscape evolving in Southeast Asia?
3. Which ASEAN countries stand out in terms of technological advancement, financial climate, and legal environment?

Foreign Direct Investment (FDI) in Renewable Energy (ca. 12 min)

4. How have you observed the role of foreign investments in (ASEAN's) renewable energy sector over the years? Are there any notable trends or shifts?
5. In your opinion, what factors are driving foreign investments in (ASEAN's) renewable energy?
6. How dependent do you think the renewable energy sector (in ASEAN) is on FDI, and what are the potential implications or consequences of such a reliance?

Opportunities & Potential (ca. 8 min)

7. Which renewable energy sources, hydro power, solar energy, or wind power, do you believe hold significant investment opportunities in ASEAN?
8. Which ASEAN countries do you believe have the highest potential for renewable energy FDI in the coming years and why?

Challenges & Barriers (ca. 12 min)

9. What are the main challenges or barriers foreign investors might face in the renewable energy sector (in ASEAN)?
10. How do regulatory frameworks and policies impact FDI in the renewable energy sector across different ASEAN countries?

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11. In driving the energy transition in ASEAN, do you see a dominant role for governments, the private sector, or a collaboration of both?

Market Dynamics in ASEAN (ca. 4 min)

12. Considering the renewable energy market in ASEAN, would you describe it as homogeneous or heterogeneous? And from your perspective, who are the major competitors or key players in this landscape?

Future opportunities and Recommendations (ca. 12 min)

13. How do you see foreign investments shaping the renewable energy sector (in ASEAN) in the upcoming years?

14. From your perspective, what considerations are important for those looking to invest in the renewable energy sector in Southeast Asia?

15. Our current research predominantly focuses on hydro power, solar energy, and wind power as sectors with potential. Do we have any blind spots for other upcoming renewable technologies with potential?

Conclusion (ca. 2 min)

16. Is there anything else you would like to add or emphasize regarding FDI opportunities in renewable energy in Southeast Asia?

- Thank you for their time and insights.

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Appendix E2: Interviewee List

Name	Role	Company Name	Interview	Transcription weblink
Jan Mumenthaler	*Regional Insurance Lead*	*International Finance Corporation (IFC)*	A	[Interview A] Transcript.pdf
Anonymous interviewee	*Renewable Energy Business Development Lead for Southeast Asia*	*A leading multinational in the oil and energy sector*	B	[Interview B] Transcript.pdf
Nadhila Shani	*Senior Officer on PFS Department*	*ASEAN Centre for Energy*	C	[Interview C] Transcript.pdf
Ross Grainger	*Commercial Manager, ASEAN, and East Asia*	*Mott MacDonald*	D	[Interview D] Transcript.pdf
Aloysius Damar Pranad	*Policy Strand Coordinator/Lead*	*Castlerock Consulting*	E	[Interview E] Transcript.pdf
Jens Martin	*Former Vice-Chair of Emerging Markets Task Force; Manager for Customer Solutions*	*Solar Power Europe; EON*	F	[Interview F] Transcript.pdf
William I.Y. Byun	*Chief Executive Officer*	*New ASEAN Energy Inc.*	G	[Interview G] Transcript.pdf
Andre E. Susanto	*Chief Technology Officer*	*Quantum Power Asia Pte Ltd*	H	[Interview H] Transcript.pdf
Anonymous interviewee	*Asset manager*	*Public fund*	I	[Interview I] Transcript.pdf
Yansong Wang	*Hydropower Practice Leader, Asia, and Pacific*	*Mott MacDonald*	J	[Interview J] Transcript.pdf
Olivia Coldrey	*Guest Research Scholar*	*The University of Queensland*	K	[Interview K] Transcript.pdf
Anonymous interviewee	*Team Head Restructuring / Senior Restructuring Specialist - Funded Activities*	*Climate fund focussed on climate change adaptation and mitigation*	L	[Interview L] Transcript.pdf
Gary Martin Dit Latour	*Renewable Energy Senior Consultant & ASEAN Business Developer*	*Syneria*	M	[Interview M] Transcript.pdf
Anonymous interviewee	*Chairman Investment Committee*	*Fund specializing in clean energy investments in Southeast Asia*	*N*	[Interview N] Transcript.pdf

Appendix E3: Interview Disclaimer

Primary data was gathered from conducted interviews with professionals from fields of consultancy, energy generation, international organisations, funds, and corporates from various fields. Interviewees do not represent their companies, rather their individual insights. Citations from interviews will be paraphrased.